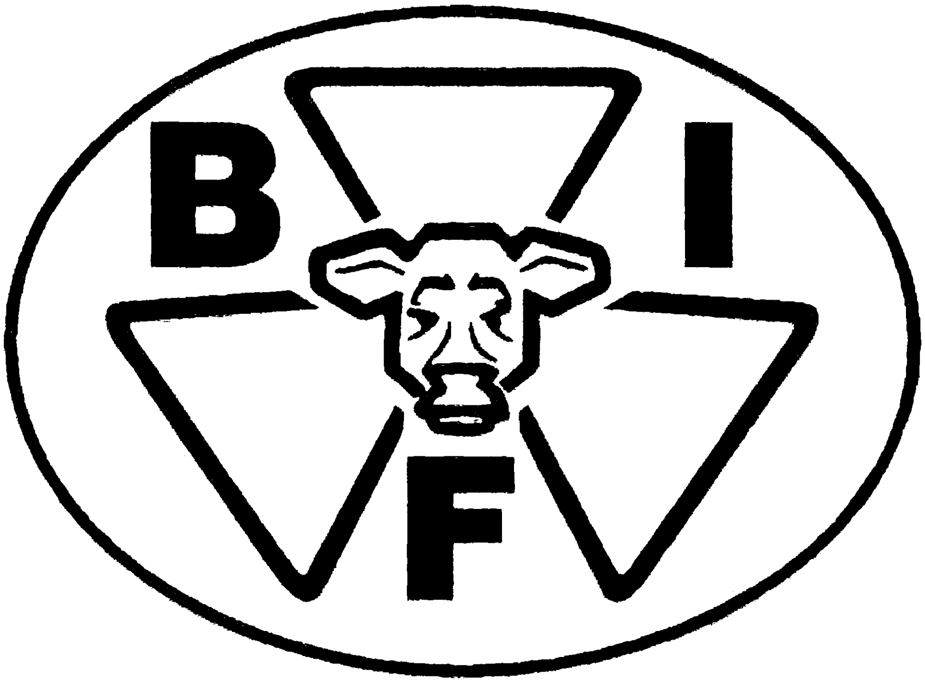
PROCEEDINGS

Beef Improvement Federation
33rd Annual Research Symposium and Annual Meeting



July 11-14, 2001
Omni Hotel
San Antonio, Texas

Hosted By:

Extension Animal Science Program Unit,
Texas A&M University

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2001 Beef Improvement Federation Conference
Omni Hotel
San Antonio, Texas
July 11-14, 2001

Wednesday, July 11, 2001
3:00-9:00 p.m. Registration
2:00 p.m. Board of Directors Meeting
5:30 p.m. Reception
7:00 p.m. National Association of Animal Breeders Symposium

Thursday, July 12, 2001
7:30-5:00 p.m. Registration
8:00a.m.-Noon General Session

Today's Beef Industry: What Do We Do With The Information?

Moderator: John McNeill, Texas A&M University
8:00 a.m. Welcome-Dr. Bryan Johnson Texas A&M University
8:15 a.m. 2000 National Fed Beef Quality Audit-Gary C. Smith, Colorado State University
9:00 a.m. Collecting and Utilizing Data What are the challenges?- Dr. Daryl Strobehn, Iowa State University and Jim Gosey, University of Nebraska
9:45 a.m. Break
10:15 a.m. Producer Panel: What have we learned?

- Tom Woodward, Boseco Ranch, Decatur, Texas
- Butch Schuler, Schuler Red Angus, Bridgeport, Nebraska
- Mark Williams, Triple W Farm, Marian, Kentucky
- Tommy Brown, Auburn University, Marion Junction, Alabama

11:30 a.m. Challenge to the Industry- Bill Miles, Texas A&M University
Noon Lunch Introduction of Nominees For Seedstock and Commercial Awards
2:00-5:00 p.m. Concurrent Committee Sessions
Genetic Prediction – Larry Cundiff, Chair
Producer Application – Sally Dolezal, Chair
Live Animal, Carcass & Endpoint – Robert Williams, Chair
5:00 p.m. Tour of Vista Genetics, Sabinal, TX

Friday, July 13, 2001
7:30-5:00 p.m. Registration
8:00 a.m.- Noon General Session

What is the Genetic Structure of Tomorrow's Industry?

Moderator: Kent Andersen, North American Limousin
8:00 a.m. Company Perspectives (30 min. each)

- Ronnie Green, Future Beef
- Paul Gehno, King Ranch, Inc.

9:15 a.m. Break
9:45 a.m. Breed Association Perspectives

- Richard Spader, American Angus Association
- Bob Hough, Red Angus Association of America
- Doug Husfield, Beefmaster Breeders Universal

11:15 a.m. Challenge to BIF-Harlan Ritchie, Michigan State University
11:45 a.m. Annual Meeting and Director Elections
Noon Awards Luncheon
2:00-5:00 p.m. Concurrent Committee Sessions
Whole Herd Analysis–Robert Hough, Chair
Emerging Technology–Ronnie Green, Chair
MultipleTrait Selection – Darrh Bullock, Chair

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General Session #1: What Do We Do with the Information?

General Session #2: What is the Genetic Structure of Tomorrow's Industry?

Genetic Prediction Committee - (Larry V. Cundiff, Chair)

Producer Application Committee – (Sally L. Dolezal, Chair)

Live Animal, Carcass and End Product Committee – (Robert Williams, Chair)

Whole Herd Analysis Committee – (Robert L. Hough)

Emerging Technology Committee – No Report

Multiple Trait Selection Committee – (Darrh Bullock, Chair)

Frank Baker Memorial Scholarship Award Recipient Essays

IMPROVING THE QUALITY, CONSISTENCY, COMPETITIVENESS AND MARKET-SHARE OF FED-BEEF

THE FINAL REPORT OF THE THIRD BLUEPRINT FOR TOTAL QUALITY MANAGEMENT IN THE FED-BEEF (SLAUGHTER STEER/HEIFER) INDUSTRY

NATIONAL BEEF QUALITY AUDIT—2000

Conducted By:
Colorado State University
Texas A&M University
Oklahoma State University
West Texas A&M University
For The:
National Cattlemen's Beef Association
Funded By The:
Cattlemen's Beef Promotion and Research Board

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Renee M. Lloyd, National Cattlemen's Beef Association
Chad A. Vorthmann, National Cattlemen's Beef Association

This project was funded by beef producers through their $1-per-head checkoff and was for the Cattlemen's Beef Board by Colorado State University.

TITLE: NATIONAL BEEF QUALITY AUDIT—2000

GOAL: To conduct, as a sequel to the National Beef Quality Audits of 1991 and 1995, a quality* audit of slaughter cattle, their carcasses and their dress-off/offal items for the U.S. beef industry, in 2000, establishing baselines for present quality shortfalls and identifying targets for desired quality levels by the year 2010. (*In the context in which it will be used in this document, "quality" includes all factors affecting value/desirability of slaughter cattle, their carcasses and their dress-off/offal items).

OBJECTIVES:

(a) To obtain information, via use of questionnaires, related to adjustments that seedstock generators, cow/calf producers, stockers/backgrounders and cattle feeders have made in management practices since 1991 resulting from benchmarking of quality challenges in the National Beef Quality Audits of 1991 and 1995.

(b) To identify, via use of questionnaires, the top-ten beef quality challenges of seedstock generators, cow/calf producers, stockers/backgrounders, feeders, packers, purveyors, restaurateurs, and supermarket operators.

(c) To characterize and quantify, numerically and monetarily, quality challenges in U.S. slaughter cattle, their carcasses and their dress-off/offal items via a substantive national audit in 30 U.S. beef packing plants.

(d) To compare results of the 1991 and 1995 Audits to those of the 2000 Audit to determine the extent to which changes have been made in, and by, the U.S. beef industry in response to the challenges and opportunities for change that were made evident by the original National Beef Quality Audit—1991 and the subsequent National Beef Quality Audit—1995.

(e) To determine, via a Strategy Workshop which old (1991, 1995), and which new (2000), strategies to pursue, goals to try to achieve, problems to solve, opportunities to capitalize-upon and nonconformities to correct—and, to ascertain probable successes in each of these endeavors.

RATIONALE: The rationale for the National Beef Quality Audit—2000 is as it was in the 1991 and 1995 National Beef Quality Audits....The U.S. cattle industry cannot expect improvements in prices for its products/byproducts when "quality" doesn't warrant such increases. W. Edwards Deming said "Industry cannot <u>manage</u> its quality problems until it can measure them." The beef industry must characterize its quality challenges because one or a combination of these could result in its downfall unless the root-causes can be identified so the quality problems can be corrected. The beef industry must correct its quality defects to assure that every customer who purchases cattle, beef byproducts or beef products as well as every consumer who eats beef or beef products will be satisfied with their purchase.

In 1991, the National Cattlemen's Association decided that the beef industry needed to conduct a "quality audit," to determine where it was in 1991 and to decide where it should be by the year 2001. That audit was completed, and since then, the industry has had 9 years in which to change. The National Beef Quality Audit—1995 assessed the extent of changes that occurred relative to correcting deficiencies and reducing quality concerns compared to the benchmark study (NBQA—1991) and allowed for mid-course corrections relative to improving the consistency and competitiveness of fed beef.

METHODOLOGY: The methodology used for this quality Audit consisted of effort conducted in three phases:

Phase I. A series of questionnaires answered by representatives of every sector of the beef industry quantified producer changes in management practices and identified the Top-Ten quality concerns as well as sought to quantify changes in the incidence and importance of quality defects in U.S. slaughter cattle, their carcasses and dress-off/offal items during the period of 1991 to 2000.

Phase II. A substantive national audit was conducted in May through November of calendar year 2000—in 30 U.S. beef packing plants, which characterized and quantified, numerically and monetarily, quality defects in slaughter cattle, their carcasses and dress-off/offal items. A "snapshot" depiction of quality defects in a set of packing plants chosen to represent over 70% of the Federally Inspected Slaughter (FIS), and demographically selected to represent the entire U.S. slaughter steer/heifer industry was accomplished. In addition, information was solicited from the major beef packers and from AMS-USDA regarding percentages of carcasses by carcass weight, Quality Grade and Yield Grade. These data were compared to data gathered from our "snapshot," in-plant, cooler audits.

Phase III. A Strategy Workshop was convened to identify strategies and tactics needed to reduce incidence of, or eliminate, specific defects, and to determine which strategies to pursue, tactics to use, targets to shoot-at, goals to try to achieve, problems to solve, opportunities to capitalize-upon and nonconformities to correct–and to ascertain probable successes in each of these endeavors.

PROTOCOL:

Phase I. With the assistance and at the direction of Dr. Gary Cowman, Renee Lloyd and Chad Vorthmann, we developed, distributed, accumulated and analyzed questionnaires designed to obtain information related to adjustments made in management practices by seedstock generators, cow/calf producers, stockers/ backgrounders and cattle feeders. These producers were asked to identify those management practices that they changed, since 1991, resulting from benchmarking of quality challenges in the National Beef Quality Audits of 1991 and 1995. Of additional interest was their opinion of the impact that results of past NBQAs had on the changes they had made.

Packers, purveyors, retailers and restaurateurs were asked to respond to questionnaires regarding the greatest improvements made since 1991 in reducing the incidence of quality defects or nonconformities and the impact that results of past NBQAs had on those improvements. In addition, packers described characteristics (weight, Quality Grade, Yield Grade and defects/ nonconformities) of their carcasses and decontamination technologies. Purveyors, retailers and restaurateurs answered questions about Quality Grades of beef they purchase and length of aging time for beef.

Phase II. A large national audit was necessary to achieve the mission of this phase of the study. Packing plants (N=30) were chosen to represent over 70% of the Federally Inspected Slaughter across the geographic and demographic regions of the U.S. Data were collected during May through November of calendar year 2000. In order to maximize efficiency, plants were divided into four groups and were evaluated by personnel from the four universities--Colorado State University, West Texas A&M University, Texas A&M University and Oklahoma State University. Data for carcass-weight, gender, Quality-Grade, and Yield-Grade groups obtained from packing plant records were compared to data that we collected during these in-plant audits.

Colorado State University	
ConAgra, Greeley	E
Excel, Fort Morgan	A
IBP, Lexington	G
IBP, Boise	B
IBP, Pasco	D
Washington Beef, Sunnyside	D
Harris, Selma	E
E.A. Miller, Hyrum	B

West Texas A&M University	
Excel, Plainview	E
Excel, Friona	A
IBP, Amarillo	F
ConAgra, Cactus	B
Excel, Dodge City	G
ConAgra, Garden City	D
IBP, Garden City	D
Shamrock, Vernon	C

Texas A&M University	
Sam Kane, Corpus Christi	G
Sun Land, Tolleson	A
IBP, Dakota City	B
IBP, Denison	D

Oklahoma State University	
Murco, Plainwell	C
ConAgra, Grand Island	A
IBP, Emporia	A
Taylor, Wyalusing	E

IBP, West Point	F	Moyer, Souderton	E
Nebraska Beef, Omaha	D	IBP, Joslin	G
PM Beef, Windom	B	Packerland, Green Bay (I)	G
		Packerland, Green Bay (II)	G

Letters (A through G) indicate the month in which the audit of that plant was conducted (to cover the May through November period, optimizing proportions of calf vs. yearling slaughter cattle). On single trips, if two plants were audited they had a common letter.

Information was obtained on the slaughter floor and in the cooler of each packing plant. Data were collected by live cattle lot number for 50% of all cattle on the slaughter floor and for 10% of all chilled carcasses in the cooler during the applicable time-period spent in that plant. Slaughter data were collected as animals progressed along the slaughter chain and specific data on disposition of head, offals, and carcass were not necessarily correlated–i.e., were not always from the same individual animals. Information was collected regarding brands, horns, manure, hide color, bruises and condemnations. Cooler data were collected on the grading chain and included fat thickness; ribeye area; kidney, pelvic and heart fat percentage; hot carcass weight; USDA marbling score; USDA maturity score; and lean color. From this information, USDA Yield Grade and Quality Grade were determined.

Arrayed by university and month, the schedule of Audits were as follows:

Code	Month	CSU	WTAMU	TAMU	OSU	Code
A	May	Excel, FM	Excel, Friona	Sun Land, Tolleson	IBP, Emporia ConAgra, Grand Islan	A
B	June	IBP, Boise Miller, Hyrum	ConAgra, Cactus	IBP, Dakota City PM, Windom	None	B
C	July	None	Shamrock, Vernon	None	IBP, Joslin Murco, Plainwell	C
D	August	IBP, Pasco Wash., Sunnyside	ConAgra, G. City IBP, G. City	IBP, Denison Nebraska, Omaha	None	D
E	Sept.	None	Excel, Plainview	None	Taylor, Wyalusing Moyer, Souderton	E
F	Oct.	ConAgra, Greeley Harris, Selma	IBP, Amarillo	IBP, West Point	None	F
G	Nov.	IBP, Lexington	Excel, Dodge City	Sam Kane, C. Christi	Packerland, G. Bay (I) Packerland, G. Bay (I	G

Data-collecting teams were comprised of six people. Three trained people, with the assistance of LSD, AMS, USDA personnel, were responsible for obtaining Yield Grade, Quality Grade and other carcass data, two people were assigned to the slaughter floor to evaluate slaughtering/dressing, carcass, and offal defects and one person was assigned to work in the stunning/exsanguination area (to observe horns, brands, mud and other physical characteristics of cattle). To assure that teams from the three cooperating universities were consistent in their evaluations, a training session was conducted at the IBP plant in Amarillo, TX during the period of May 15-19, 2000. At least one representative of each of the four cooperating universities was present during the training session.

Data were analyzed by personnel at Texas A&M University to determine factors affecting quality and/or value and the relative impact of each type of quality defect. In addition, the frequency of the quality defects was determined. Frequency also was determined for combinations of categories. These estimates are presented in a national format. Seasonal variation was taken into account by spacing collection trips.

Phase III. As the data in Phases I and II were being collected and assembled, and as specific quality-improvement opportunities were identified that would benefit from more thorough analysis/evaluation, we contacted individuals from the private and public sectors (this group included packers, purveyors, university scientists, veterinarians, stockers/ backgrounders, affiliated industry personnel, association employees, restaurateurs, government officials, cattle feeders, seedstock generators, etc.) and invited them to participate in a Strategy Workshop to discuss these issues.

Data obtained from Phase II of this study were used to help determine the causes of the quality defects. From these findings, recommendations for reducing the quality problems were made. From Phases I and II, combined, we were able to identify, characterize and quantify the "quality defects" and the "costs for nonconformance" for slaughter steers/heifers, their carcasses and their dress-off/offal items. When all of the data was collected, assembled, summarized and analyzed (preliminarily), a Strategy Workshop was convened (at the Dallas/Fort Worth Airport). At the Strategy Workshop, responses to the questionnaires (Phase I); results of assessments of cattle on harvest floors (hide on), assessments of carcasses and offal on the harvest floor and assessments of carcasses in coolers (Phase II); costs (losses per steer/heifer) for quality defects/ nonconformities identified by the National Beef Quality Audit—2000, directives to cattlemen, "Top Ten Quality Concerns" for the U.S. Fed Beef Supply, what the U.S. beef industry is doing well, and Strategies/ Tactics for "Improving Quality, Consistency, Competitiveness And Market Share Of The U.S. Fed Beef Supply" were determined.

RESULTS OF PHASE I OF THE NATIONAL BEEF QUALITY AUDIT—2000: In Phase I (Questionnaire Results), 518 Seedstock Generators reported that Changes They Had Made Since 1991 were: (1) Improved genetics (using performance), (2) Changed injection-site location, (3) Improved genetics (using physical traits), (4) Increased record-keeping, (5) Improved genetics (using carcass traits), (6) Improved genetics (using ultrasound), (7) Improved handling practices, (8) Collected carcass data, (9) Changed vaccination program, and (10) Maintained health/ management data, and that Results of Past NBQAs had "Strong Impact" (21.2%), "Moderate Impact" (54.0%) or "Weak Impact" (24.8%) on changes they had made. Cow/Calf Producers (N=1,424) reported that Changes They Had Made Since 1991 were: (1) Changed injection-site location, (2) Improved genetics (using performance), (3) Improved genetics (using physical traits), (4) Increased record-keeping, (5) Improved handling practices, (6) Increased individual animal identification, (7) Changed vaccination program, (8) Improved genetics (using carcass traits), (9) Changed preconditioning program, and (10) Maintained health/management data, and that Results Of Past NBQAs had "Strong Impact" (17.3%), "Moderate Impact" (59.7%) or "Weak Impact" (23.0%) on changes they had made. Stockers/Backgrounders (N=407) reported that Changes They Had Made Since 1991 were: (1) Changed injection-site location, (2) Changed genetic type(s) of cattle, (3) Improved handling practices, (4) Increased record-keeping, (5) Changed vaccination program, (6) Maintained health/management data, (7) Increased worker/employee awareness, (8) Provided incentive for preconditioning, (9) Provided incentive for genetic superiority, and (10) Collected and used carcass data, and that Results of Past NBQAs had "Strong Impact" (14.0%), "Moderate Impact" (59.5%) or "Weak Impact" (26.5%) on changes they have made. Feedlot Operators (N=262) reported that Changes They Had Made Since 1991 were: (1) Changed injection-site location, (2) Changed genetic type(s) of cattle, (3) Collected and used carcass data, (4) Improved handling practices, (5) Increased record-keeping, (6) Increased worker/ employee awareness, (7) Changed implant strategy, (8) Provided incentive for preconditioning, (9) Maintained health/management data, and (10) Increased individual animal identification, and that Results Of Past NBQAs had "Strong Impact" (47.7%), "Moderate Impact" (40.5%) or "Weak Impact" (11.8%) on changes they had made.

In Phase I (Questionnaire Results), 29 Packers reported that the Greatest Improvements Made Since 1991 were in reducing the incidence of these quality defects or nonconformities: (1) Presence of injection-site lesions, (2) Carcass weights too light, (3) Reduced Quality Grade/ tenderness due to implants, (4) Inadequate muscling, (5) Too small ribeyes, (6) Hide damage due to parasites, (7) Carcass condemnations, (8) Excess fat cover, (9) Presence of bruises on carcasses, and (10) Hide damage due to brands, and that Results Of Past NBQAs had "Strong Impact" (6.9%), "Moderate Impact" (55.2%) or "Weak Impact" (37.9%) on those improvements. Purveyors (N=37) reported that the Greatest Improvements Made Since 1991 were in reducing the incidence of these quality defects or nonconformities: (1) Presence of bruises on cuts, (2) Injection-site lesions, (3) Excess fat cover, (4) Inadequate overall palatability, (5) Low cutability, (6) Inadequate flavor, (7) Lack of uniformity in cuts, (8) Inadequate tenderness, (9) Insufficient marbling, and (10) Inadequate juiciness, and that Results Of Past NBQAs had "Strong Impact" (6.9%), "Moderate Impact" (55.2%) or "Weak Impact" (37.9%) on those improvements. Retailers (N=44) reported that the Greatest Improvements Made Since 1991 were in reducing the incidence of these quality defects or nonconformities: (1) Excess fat cover, (2) Presence of bruises on cuts, (3) Injection-site lesions, (4) Low cutability, (5) Lack of uniformity of cuts, (6) Inadequate muscling,

(7) Excess seam fat, (8) Inadequate overall palatability, (9 tie) Cut weights too light, and (9 tie) Inadequate tenderness, and that Results Of Past NBQAs had "Strong Impact" (10.3%), "Moderate Impact" (82.1%) or "Weak Impact" (7.7%) on those improvements. Restaurateurs (N=32) reported that the Greatest Improvements Made Since 1991 were in reducing the incidence of these quality defects or nonconformities: (1 tie) Presence of bruises on cuts, (1 tie) Injection-site lesions, (3) Excess fat cover, (4 tie) Inadequate overall palatability, (4 tie) Inadequate flavor, (4 tie) Inadequate tenderness, (7) Lack of uniformity in cuts, (8) Inadequate juiciness, (9) Inadequate muscling, (10 tie) Cut weights too light and (10 tie) Insufficient marbling, and that Results Of Past NBQAs had "Strong Impact" (11.5%), "Moderate Impact" (76.9%) or "Weak Impact" (11.5%) on those improvements. Aggregated responses for Results Of Past NBQAs on the Greatest Improvements Made Since 1991 indicated "Strong Impact" by 17% of producers, 7% of packers and 10% of end-users (wholesalers/retailers), "Moderate Impact" by 60% of producers, 55% of packers and 72% of end-users (wholesalers/ retailers), or "Weak Impact" by 23% of producers, 38% of packers and 18% of end-users (wholesalers/retailers).

In Phase I (Questionnaire Results), all Producers combined identified the Greatest Quality Challenges as: (1) Inadequate tenderness, (2) Lack of uniformity in live cattle, (3) Insufficient marbling/USDA Quality Grade too low, (4) Too frequent injection-site lesions, (5) Inadequate flavor, (6) Low cutability, (7) Excess fat cover, (8) Carcass weights too heavy, (9) Inadequate muscling, and (10) Presence of bruises on carcasses. Packers identified the Greatest Quality Challenges as: (1) Lack of uniformity in live cattle, (2) Carcass weights too heavy, (3) Excess fat cover, (4) Inadequate tenderness, (5) Insufficient marbling/USDA Quality Grade Too Low, (6) Reduced USDA Quality Grade/tenderness due to implants, (7) Assuring food safety, (8) Low cutability, (9) Presence of bruises on carcasses, and (10) Too high (numerically) USDA Yield Grades. End-Users (Wholesalers/Retailers) identified the Greatest Quality Challenges as: (1) Insufficient marbling, (2 tie) Lack of uniformity in cuts, (2 tie) Inadequate tenderness, (4) Excess fat cover, (5) Inadequate flavor, (6) Too heavy cut weights, (7) Too large ribeyes, (8) Low cutability, (9) Inadequate juiciness, and (10) Inadequate overall palatability.

From questionnaires returned by 29 packers as a part of Phase I of the National Beef Quality Audit—2000: (a) Percentages of carcasses in their plants weighing less than 400 pounds, 400 to 600 pounds, 600 to 800 pounds, 800 to 1,000 pounds and more than 1,000 pounds were 0.2, 3.7, 58.2, 36.9 and 0.9, respectively; (b) Percentages of their carcasses by Quality Grade were 3.6 for Prime, 17.2 for Upper Two-Thirds Choice, 39.5 for Low Choice, 33.5 for Select and 2.5 for Standard; (c) Percentages of their carcasses by Yield Grade were 12.5 for Yield Grade 1, 41.9 for Yield Grade 2, 40.8 for Yield Grade 3, 3.4 for Yield Grade 4 and 0.6 for Yield Grade 5; (d) Percentages of their carcasses that were B-maturity, hardboned, with callused ribeyes, dark cutters or with blood splash were 1.3, 1.5, 0.1, 1.0 or 0.4, respectively; (e)

Average number of "Branded Beef" programs per packer was 4.5; of those, 33.2%, 40.4%, 95.0% or 71.9% programs had specifications for breed, hide color, marbling or Yield Grade, respectively. From questionnaires answered as a part of Phase I of the National Beef Quality Audit—2000: (a) Purveyor (N=37) purchases of beef by Quality Grade were 3.6% Prime, 42.7% Upper Two-Thirds Choice, 17.9% Low Choice, 22.4% Select and 3.0% Standard; (b) Retailer (N=44) purchases of beef by Quality Grade were 1.8% Prime, 34.2% Upper Two-Thirds Choice, 19.7% Low Choice, 35.0% Select and 1.0% Standard, and; (c) Restaurateur (N=32) purchases of beef by Quality Grade were 20.6% Prime, 51.3% Upper Two-Thirds Choice, 25.5% Low Choice, 24.2% Select and 0.0% Standard.

RESULTS OF PHASE II OF THE NATIONAL BEEF QUALITY AUDIT—2000: In Phase II of the National Beef Quality Audit—2000, researchers audited 30 packing plants, geographically distributed throughout the U.S., collecting data on the harvest floor from 43,415 cattle/carcasses for brands, horns, manure, hide color, bruises and condemnations. Percentages of brands on cattle, by number, were 49.3% none, 46.2% one, 4.0% two and 0.4% three; cattle with horns was 22.7% and without horns was 77.3%. Manure was present on the body of 81.5% of cattle and absent on the body of 18.5% of cattle; the 81.5% of cattle that had manure present on their body was comprised of 20.1% with manure in only one location and 60.5% with manure in several (multiple) locations. Manure was present around the tail-base and rectum of 33.4% of cattle, on the topline of 24.5% of cattle, on the side of 36.0% of cattle, on the belly of 65.3% of cattle and on the legs of 64.4% of cattle.

Predominant hide color of cattle evaluated was 45.1% black, 31.0% red, 8.0% yellow, 5.7% black and white (Holstein-Friesian), 4.0% grey, 3.2% white, 1.7% brown and 1.3% brindle. Carcasses with no bruises were 53.3% of those evaluated while those with one, two, three, four or more than four bruises, respectively, represented 30.9%, 11.4%, 3.5%, 0.8% or 0.1% of those evaluated. Of all bruises detected on carcasses 14.9% were on the round, 25.9% were on the loin, 19.4% were on the rib, 28.2% were on the chuck and 11.6% were on the thin cuts (flank, plate, brisket). Severity was "critical/extreme" for 2.6%, 5.1%, 6.7%, 3.9% and 4.0%, respectively, of the bruises detected on rounds, loins, ribs, chucks and thin cuts while those that were "minor" accounted for 83.0%, 70.0%, 73.6% and 71.1%, respectively of the bruises detected on rounds, loins, ribs, chucks and thin cuts. Condemnation rates were 30.3% for liver, 13.8% for lungs, 11.6% for tripe, 6.2% for heads, 7.0% for tongues, and 0.1% for carcasses. A fetus was present in 1.2% of carcasses (approximately 3.8% of carcasses from female cattle). Of livers condemned, 44.8% were due to abscesses, 21.7% were due to flukes and 33.6% were due to other reasons (including contamination during evisceration).

In the 30 packing plants, researchers collected data from 9,396 carcasses; traits evaluated included carcass weight, gender, breed type, Quality Grade and Quality

Grade factors (marbling scores were assigned by USDA officials; all other factors were assigned by university personnel), Yield Grade and Yield Grade factors (adjusted fat thickness was assigned by USDA officials; all other factors were measured or assigned by university personnel), dark cutters, blood splash, yellow fat and callused ribeyes. Carcass weight distribution was 0.7% less than 550 pounds, 6.6% 550 to 650 pounds, 27.1% 650 to 750 pounds, 40.1% 750 to 850 pounds, 21.7% 850 to 950 pounds and 3.9% greater than 950 pounds. Gender of carcasses was 67.9% steer, 31.8% heifer and 0.3% bullock. Breed type of carcasses was 90.1% native, 6.9% dairy and 3.0% *Bos indicus* influenced (greater than 4-inch hump). Mean values for Quality Grade factors were Small^{23} for marbling, A^{66} for skeletal maturity, A^{65} for lean maturity, A^{66} for overall maturity and Select^{85} for Quality Grade. Marbling score distribution was 2.3% Slightly Abundant or higher, 4.8% Moderate, 13.1% Modest, 33.3% Small, 43.3% Slight and 3.4% Traces. Overall carcass maturity was 96.6% "A," 2.5% "B" and 0.9% "C" or older. Quality Grade distribution was 2.0% Prime, 17.3% Upper Two-Thirds Choice, 31.8% Low Choice, 42.3% Select and 6.5% Standard and hardboned. Ribeye Area (square inches) distribution was 1.4% less than 10, 6.5% 10 to 10.9, 17.9% 11 to 11.9, 24.2% 12 to 12.9, 22.2% 13 to 13.9, 14.6% 14 to 14.9, 7.6% 15 to 15.9 and 5.3% 16 or larger. Fat thickness (inches) distribution was 4.9% less than .20, 13.9% .20 to .29, 15.9% .30 to .39, 18.4% .40 to .49, 16.2% .50 to .59, 15.8% .60 to .69, 6.3% .70 to .79, 4.4% .80 to .89, 2.0% .90 to .99 and 2.3% 1.00 or thicker. Mean values for Yield Grade factors were 0.49 inches for adjusted fat thickness, 787 pounds for carcass weight, 13.1 square inches for ribeye area, 2.35% for kidney/pelvic/heart fat and 3.0 for Yield Grade. Yield Grade distribution was 4.2% Yield Grade 1A, 8.0% Yield Grade 1B, 15.3% Yield Grade 2A, 22.1% Yield Grade 2B, 22.1% Yield Grade 3A, 16.5% Yield Grade 3B, 7.4% Yield Grade 4A, 3.0% Yield Grade 4B and 1.3% Yield Grade 5. Carcasses with yellow fat, blood splash and callused ribeyes occurred at a frequency of 0.4%, 0.5% and 0.0%, respectively. Carcasses with dark cutter discounts of one-third grade, one-half grade, two-thirds grade and a full grade occurred at a frequency of 1.0%, 0.6%, 0.4% and 0.3%, respectively; 2.3% of all carcasses evaluated in this study were discounted for dark cutting beef.

Comparative data for Quality Grades and Yield Grades from the 1991, 1995 and 2000 National Beef Quality Audits and USDA Annual Summaries revealed that for 1974, 1987, 1991, 1995 and 2000, respectively, percentages of carcasses grading: (a) Prime were 6.6, 2.0, 1.4, 2.1 and 3.0; (b) Choice were 68.0, 60.7, 54.2, 53.9 and 52.4; (c) Select were 21.3, 1.5, 12.5, 29.5 and 36.1, while; (d) ungraded/no-roll were 4.1, 35.8, 31.9, 14.5 and 8.5. Comparison of USDA Annual Summary data for FY-2000 as compared to data from the National Beef Quality Audit—2000, respectively, for steer/heifer carcasses indicated that 3.0% vs. 2.0% graded Prime, 52.4% vs. 49.1% graded Choice, 36.1% vs. 42.3% graded Select while ungraded/no-roll were 8.5% vs. 6.6% and that 9.8% vs. 12.3% were Yield Grade 1, 40.7% vs. 37.4% were Yield Grade 2, 35.5% vs. 38.6% were Yield Grade 3, 1.8% vs. 10.4% were Yield Grade 4 and 0.2% vs. 1.3% were Yield Grade 5 (according to the USDA Annual Summary, 12.0% of steer/heifer carcasses were not Yield Graded). According to USDA Annual Summaries, fiscal year trends (1993 through 2000), total numbers of "Certified" carcasses (by USDA Marketing & Regulatory Programs) increased from approximately 850,000 to about 3,500,000 under all "Schedules" approved by USDA, and total numbers of "Certified" carcasses with Modest-minus or higher marbling scores increased from about 1,000,000 in 1994 to approximately 2,600,000 in 2000.

RESULTS OF PHASE III OF THE NATIONAL BEEF QUALITY AUDIT—2000: In Phase III of the National Beef Quality Audit—2000, one goal of the Strategy Workshop (to capitalize upon knowledge gained in this endeavor) was characterized as "Improving The Quality, Consistency, Competitiveness And Market-Share Of Fed-Beef." Economic assessment of quality losses per slaughter steer/heifer was made and consensus was achieved; it was agreed-upon that the beef industry was losing—through Quality Problems/Defects/ Shortcomings/Shortfalls/Nonconformities—<u>$100.10</u> for <u>every</u> steer/heifer harvested in 2000. Amounts lost were $50.96 due to <u>Waste</u>, $24.45 because of <u>Taste</u>, $18.23 due to <u>Management</u> and $6.46 because of <u>Weight</u>.

Included among items in the "Success Story" for the National Beef Quality Audit—2000 were: (a) 86.3% of steers/heifers were appropriately branded or not hot-iron branded. (b) 96.2% of steers/heifers were free of excess mud. (c) 77.3% of steers/ heifers were polled or dehorned. (d) 88.4% of steer/heifer carcasses were free of major and critical bruises. (e) 93.5% of steer/heifer carcasses graded U.S. Select or better. (f) 88.3% of steer/heifer carcasses had Yield Grades of 3 or better. (g) 97.5% of top sirloin butts were free of injection-site lesions (up from a low of 78.7%). (h) 100% of federally inspected packing facilities had implemented a HACCP approach to food safety. (i) 85% of fed cattle were harvested in plants that are using multiple-hurdle decontamination systems. (j) 47 states had a Beef Quality Assurance program. (k) 52 USDA certified/process-verified beef programs had been developed. (l) ¼-inch trim beef was the industry standard.

According to participants in the Strategy Workshop of the National Beef Quality Audit—2000, the "Top Ten Quality Challenges" for the fed-beef industry are: (1) Low overall uniformity and consistency of cattle, carcasses and cuts. (2) Inappropriate carcass size and weight. (3) Inadequate tenderness of beef. (4) Insufficient marbling. (5) Reduced Quality Grade/tenderness due to implants. (6) Excess external fat cover. (7) Inappropriate USDA Quality Grade mix. (8) Too much hide damage due to brands. (9) Too frequent and severe bruises. (10) Too frequent liver condemnations.

Participants in the Strategy Workshop of the National Beef Quality Audit—2000 agreed that those in the fed beef industry should make "A Commitment To Never-Ending Improvement" that stated the following: "I am a member of the U.S. beef industry and because I am committed to the role I play as a producer of safe, nutritious and wholesome food for myself, my family and humanity, I promise to: (a) Continually seek to learn more about my business and my industry so that my family can prosper, that opportunities can be created for others, and that better products can be made available to the world's consumers. (b) Collect, share and use meaningful information that affects the value and quality of beef. (c) Seek opportunities to improve relationships with others in the production, processing and marketing of cattle, beef and beef by-products. (d) Train and retrain myself and my employees in the principles and procedures of Beef Quality Assurance. (e) Be a good steward of the natural resources, the animals and the products under my care."

"Strategies" for improving the quality of beef from fed steers/heifers are: (1) Assist producers with use of selection and management techniques to produce cattle that fit customer expectations for marbling, red meat yield, weight and other value-determining attributes. (2) Assist producers with the process of collecting and analyzing data and sharing and utilizing information. (3) Enhance an already commendable record in regards to the production of safe, nutritious and wholesome beef. (4) Assure delivery of predictable and uniform lots of cattle by more correctly managing implants, nutrition, horns, castration, sorting and health programs while refining selection strategies to meet specific market windows. (5) Assure that the needs of case-ready product marketing efforts can be met by improving the yield, consistency and palatability characteristics of beef. (6) Implement new production technologies only after carefully considering the consumer demand-perception, economic, environment and animal welfare consequences. (7) Encourage continued use of cattle-marketing systems that identify, categorize and assign price to product attributes that affect consumer satisfaction by appropriately rewarding and discounting performance. (8) Identify breeding, management and sorting systems that optimize production, palatability, cutability and profitability. (9) Encourage post-harvest product enhancement technologies to assure the delivery of suitably tender and flavorful products to consumers while simultaneously managing the pre-harvest production process to achieve the same objectives.

"Tactics" for improving the quality of beef from fed steers/heifers are: (1) Develop and implement a voluntary, industry-driven, standardized electronic individual animal identification system that is tied to a seamless system of transmitting information up and down the production, processing and distribution chain. (2) Merchandize and purchase only those seedstock that are accompanied by objective performance information relative to economically important traits (production and end-product). (3) Eliminate side brands. (4) Eliminate horns via selection or early dehorning. (5) Castrate early. (6) Match implant strategies to cattle types to optimize product quality with economic returns. (7) Develop management/production practices to reduce variation in weight and cut sizes within a lot. (8) Utilize health management and nutrition protocols that contribute to improved quality attributes. (9) Match a vast majority of the fed cattle to carcass weight targets of 650–850 pounds. (10) Handle and transport cattle in a safe and humane manner. (11) Train 100% of beef and dairy producers, veterinarians, transport providers and others with an impact on cattle, in Beef Quality Assurance principles and procedures as well as humane handling practices. (12) Move all injections to the neck region and eliminate intramuscular injections. (13) Reduce immediately those genetic and management practices that contribute to production of USDA Standards, Yield Grade 4s and 5s, dark cutters and non-conforming carcass weights and cut sizes. (14) Change the Quality Grade and Yield Grade mix to 6% Prime, 27% Upper Two-Thirds Choice, 32% Low Choice and 35% Select, and to 15% Yield Grade 1, 26% Yield Grade 2A, 27% Yield Grade 2B, 24% Yield Grade 3A and 8% Yield Grade 3B. (15) Participate in partnerships and coordinated market chains to foster communications and the delivery of products that meet consumer demands. (16) Continue to support and encourage development of branded beef product concepts and value-added, further processed beef items.

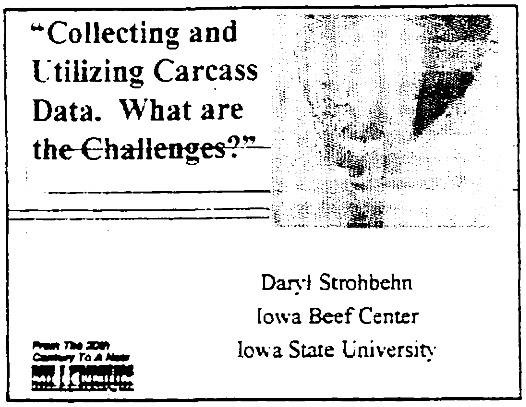
"Goals, By 2005" for improving the quality of beef from fed steers/heifers are: (1) Eliminate USDA Standards. (2) Eliminate Yield Grades 4 and 5. (3) Eliminate injection-site lesions from whole-muscle cuts including the chuck. (4) Eliminate side branded hides. (5) Reduce horns to less than 5% of the fed cattle supply. (6) Develop and implement a standardized electronic individual animal identification system. (7) Develop an information system that allows each producer to conduct a quality audit for his/her own herd. (8) Assure that 100% of seedstock animals are accompanied by meaningful genetic data (EPDs, etc.) for production and end-product traits. (9) Assure that 100% of cattlemen complete BQA training. (10) Eliminate major and critical bruises that result in a devaluation of subprimals. (11) Improve the transportation (handling and equipment) of cattle. (12) Improve continually the eating quality of beef.

Research Goals identified by participants in the Strategy Workshop of the National Beef Quality Audit—2000 are: (1) Better understanding the influence of calfhood and lifetime management on the quality of beef. Specifically, how does stress at various points of a calf's life affect its ability to deposit marbling? (2) What are the levels of stress caused by dehorning at various life-stages versus the improvement in bruise prevention that results from dehorning? (3) How can we sort/implant/ manage/re-sort cattle of unknown genetics to achieve uniformity targets in cut size for retail and hotel/restaurant/institutional end-users? (4) Better understand how to interpret feedlot and endproduct data at the cow/calf and seedstock levels. (5) Better understand how automation at the packing and processing sectors will affect desired characteristics of cattle and carcasses. (6) Better understand and communicate the role of each production sector on the wholesomeness, nutritional value and quality of beef. (7) Develop carcass and cattle specifications for weight, muscling, fat and marbling based on case-ready fabrication requirements, rather than trying to fit current cattle to a case-ready approach. (8) What are the tenderness implications of injection-site lesions in the lower round (as a follow-up to the top-butt research).

CONCLUSION: U.S. cattle producers have responded to needs in the marketplace delivering, in the year 2000, cattle with fewer quality nonconformities to the packer, and beef with fewer quality defects to the consumer, than they did in 1991 or 1995. Overall, the fed-beef industry has reduced costs for quality nonconformities and defects by 15.4% since 1995. Reductions in cost (for every steer/heifer harvested) of quality defects between 1995 and 2000 were greatest for Taste (39.6%; from $40.47 in 1995, to $24.45 in 2000) and intermediate for Waste (9.1%; $56.07 in 1995, to $50.96 in 2000) and Management (11.1%; from $20.51 in 1995, to $18.23 in 2000) while the industry lost ground on Weight (increase of 393%; from $1.31 in 1995, to $6.46 in 2000). Greatest improvements in cattle/carcass characteristics were evident as reduced incidences of: (a) cattle with horns, (b) condemned carcasses, (c) bullocks, (d) U.S. Standard carcasses, (e) B maturity carcasses, (f) carcasses with less than 11 square inch ribeyes, (g) carcasses weighing less than 600 lb., (h) carcasses of U.S. Yield Grades 4 or 5, and (i) carcasses with "dark-cutting" lean. Quality challenges for the fed-beef industry are: (a) to make cattle more uniform and consistent, (b) to arrest the continual increase in harvest weights, (c) to improve tenderness and marbling of beef, (d) to use growth-promotant regimens that do not decrease tenderness and/or USDA Quality Grade, (e) to decrease external fat cover thickness, (f) to produce more carcasses of U.S. Prime and Upper Two-Thirds U.S. Choice and fewer carcasses of U.S. Standard, (g) to reduce hide damage due to brands, (h) to reduce frequency and severity of bruising, and (i) to reduce incidence of liver condemnations.

Collecting and Utilizing Carcass Data: What are the Challenges?

Daryl R. Strohbehn
Iowa Beef Center at Iowa State University



"Collecting and Utilizing Carcass Data. What are the Challenges?"

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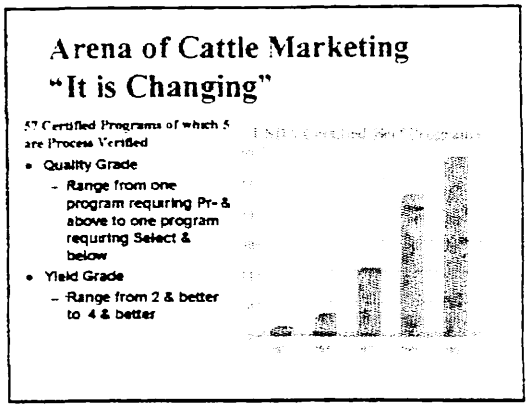
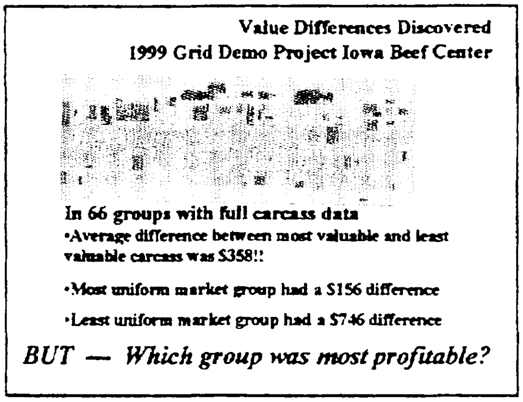


Arena of Cattle Marketing "It is Changing"

57 Certified Programs of which 5 are Process Verified

- Quality Grade
  - Range from one program requiring Pr- & above to one program requiring Select & below
- Yield Grade
  - Range from 2 & better to 4 & better



**Value Differences Discovered
1999 Grid Demo Project Iowa Beef Center**

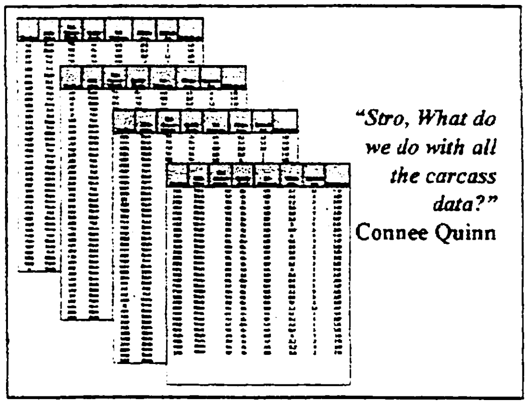
In 66 groups with full carcass data

•Average difference between most valuable and least valuable carcass was $358!!

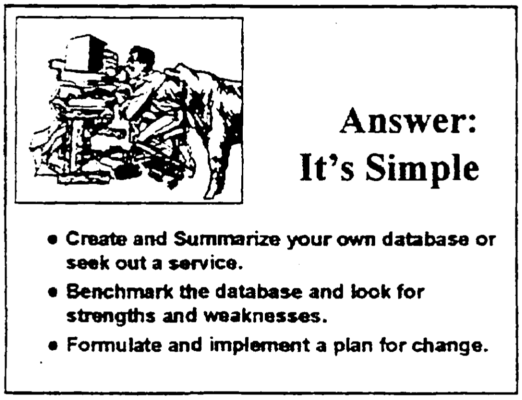
•Most uniform market group had a $156 difference

•Least uniform market group had a $746 difference

BUT — Which group was most profitable?



"Stro, What do we do with all the carcass data?"
Connee Quinn



Answer: It's Simple

- Create and Summarize your own database or seek out a service.
- Benchmark the database and look for strengths and weaknesses.
- Formulate and implement a plan for change.

Challenges to the Databases

- Standardization of the data.
- Free range on names and abbreviations has to end.
- Consistent measurement methodology.

Use the BIF guidelines!!!

Example of Poor Standardization
_SM_0
SM_0
SM__0
SM0
SMALL0
SMALL_0
SMALL__0
SM_0
S_0
SMAL_0

Collecting and Utilizing Carcass Data: What are the Challenges?

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How to Summarize?

- Method depends on its end use
  - –Genetic evaluation
  - –Level of Herd production
  - –Gain marketing power
- The last two may not differ.

I am not going to touch on the first one here.

Genetic Evaluation

- The reality: I'm no Pollak, Wilson, Bertrand or Golden!
- Personally, I believe the current breed data is being crunched and presented in a very good manner. We just have to use it better.
- Centralized processed ultrasound data has added immensely to our arsenal.
- For greater change - we need more progeny groups evaluated.
- Genetic trade-offs seem to be a reality. But the more breeding stock we evaluate, the better chance of finding outliers that defy the genetic trends.

Level of Herd Production & Gaining Market Power

First things First

- We have to get the notion of an "IDEAL" beef animal or carcass out of our head.
- The market place wants groups of cattle that fit a reasonable range of parameters.

Level of Herd Production & Gaining Market Power

- Averages for carcass traits help us with getting an initial idea..... but

	Group 1 229 Head	Group 2 152 Head
Carcass Wt	774 lbs	749 lbs
Ribeye Area	12.9"	11.9"
Fat Cover	0.46"	0.49"
% Ch & better	75.4%	57.9%
% YG 3 & better	93.4%	98.8%

Level of Herd Production & Gaining Market Power

- .... But data distributions can give us a more complete picture...... for instance

Yield Grade	Group 1 229 Head	Group 2 152 Head
1	10.5%	0.7%
2	51.8%	35.6%
3	31.1%	62.4%
4	5.7%	1.3%
5	0.9%	0.0%
Totals	100.0%	100.0%

Level of Herd Production & Gaining Market Power

- .... But data distributions can give us a more complete picture...... for instance

Yield Grade	Group 1 229 Head
1	10.5%
2	51.8%
3	31.1%
4	5.7%
5	0.9%
Totals	100.0%

Collecting and Utilizing Carcass Data: What are the Challenges?

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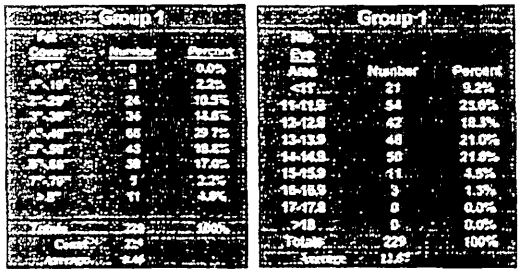
Iowa Beef Center at Iowa State University

Level of Herd Production & Gaining Market Power

	Group 1 229 Head
Prime	2.6%
Upper Ch	21.0%
Low Ch	51.8%
Select	22.8%
Off Grades	1.8%
Totals	100.0%

- .... But data distributions can give us a more complete picture.

Level of Herd Production & Gaining Market Power



Group 1		
Fat Cover	Number	Percent
<.1"	0	0.0%
.1"-.19"	5	2.2%
.2"-.29"	24	10.5%
.3"-.39"	34	14.8%
.4"-.49"	68	29.7%
.5"-.59"	43	18.8%
.6"-.69"	39	17.0%
.7"-.79"	5	2.2%
>.8"	11	4.8%
Totals	229	100%
Count	229	
Average	.44	

Group 1		
Rib Eye Area	Number	Percent
<11	21	9.2%
11-11.9	54	23.6%
12-12.9	42	18.3%
13-13.9	48	21.0%
14-14.9	50	21.8%
15-15.9	11	4.8%
16-16.9	3	1.3%
17-17.9	0	0.0%
>18	0	0.0%
Totals	229	100%
Average	[illegible]	

- .... But data distributions can give us a more complete picture.

Gain Marketing Power Ultimately: What are we trying to accomplish???

- *PREDICTION: Will or can the producer data set be used in prediction of future performance within one or several market places??*

ibp

ANGUS AMERICA

GeneNet

US PREMIUM BEEF

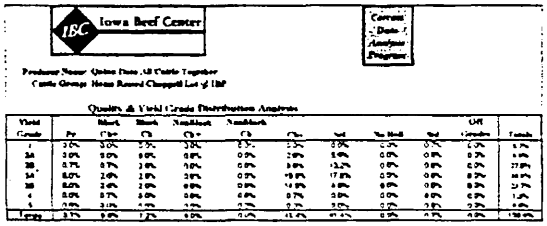
EXCEL
A CARGILL FOODS company

ConAgra Beef Company

Gain Marketing Power
Prediction

- Database summary has to be economically pertinent.
- Useful for applying to a set of specific formula markets.
- Means data analysis currently has to include:
  - Quality grade breaks: P, C^+, C^o, C^-, Se^+· Std, No Rolls, Off Grades
  - Yield Grade breaks: 1, 2A, 2B, 3A, 3B, 4 and 5.
  - Hide color
  - Carcass weight breaks
- FUTURE ?

Gain Marketing Power



Iowa Beef Center

Carcass Data Analysis Program

Quality & Yield Grade Distribution Analysis

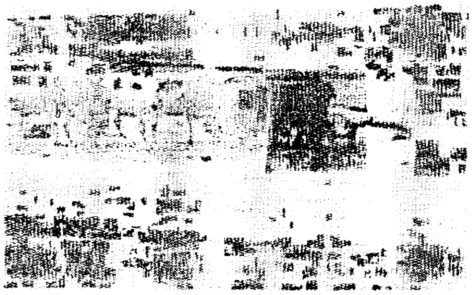
Benchmarking for Level of Herd Prodution

- Herd strengths and weaknesses
- Competitive position
- Prioritization of culling and selection
  - CAUTION !

Collecting and Utilizing Carcass Data: What are the Challenges?

Daryl R. Strohbehn
Iowa Beef Center at Iowa State University

Repeatability ?



Benchmarking

- What do we compare against?
  - A generic national data set
  - A regional data set
  - A specific market data set
- Appears obvious - we would want to know our COMPETITIVE POSITION in the specific market place where we are competing for a price.

Benchmarking Angus GeneNet

Quality Grade	Average	Top 25%
Prime	4.4%	9.6%
Upper 2/3 Choice	17.4%	30.3%
Low Choice	50.3%	50.1%
Select	26.2%	9.7%
Off Grades	1.7%	0.3%
Yield Grade		
1	5.5%	2.5%
2	36.5%	31.6%
3	57.2%	65.4%
4 & 5	0.8%	0.5%
Premium $/Hd.	**$19.91**	**$49.91**

Represents 30,148 cattle from April, 2000 - June, 2001

Data compliments of Dr. Ken Conway Angus GeneNet

Benchmarking Laura's Lean Beef

	Averages for Laura Lean Beef	Top 10 Finishers*	Top 10 Cow Calf Producers*
Hot Carcass Weight	677	657	660
Rib Eye Area	13.57	13.84	14.21
Fat Cover	0.27	0.19	0.2
Yield Grade	1.76	1.39	1.3
Finishing Bonus/Head	$13.23	$58.75	–
Cow-Calf Bonus/Head	$4.09	–	$23.78

*Determined by Bonus Dollars per head

Bradley, Laura's Lean Beef

Benchmark Data Adjustment?

- Factors that influence carcass traits and benchmark data sets
  - Market / Formula
  - Age: Calf vs. Yearling Marketings
  - Implants: Mild vs. Aggressive Programs
  - Month of the year
  - Days on feed
  - Level of nutrition: protein and energy
  - Breed influence
  - Others
  - Interactions between many of the above

The BIF Challenge

- Will or should there be a set of national summaries that cow-calf and feedlot operators can benchmark against???
- Will or should these data sets be adjusted for important factors that influence end performance?
- If BIF does not do it, who will?

Collection and Utilization of Data: What are the Challenges?

Jim Gosey
University of Nebraska

Collection & Utilization of Data:
What are the Challenges ?

Jim Gosey
University of Nebraska

Data has little value,
unless it produces Information,
that results in Knowledge,
that leads to an Action.

Optimum Data Utilization

- Universal ID / Data Tracking
- Predict Outcome Group & Value
- Tailor Selection Index to Environment & Market
- Apply Crossbreeding to Bridge Maternal - Terminal Carcass Gap

Carcass Data Utilization Should Focus on Primary Traits, for example..................

Carcass revenue depends on :

- Carcass Weight
- % "Out Cattle"
- USDA Quality Grade

Extreme Uniformity in carcass traits is not needed.

Collection and Utilization of Data: What are the Challenges?

Jim Gosey
University of Nebraska

Heritability of Reproduction Traits

about 20%

- Conception rate
- Calving rate
- Calving ease

Heritability of Production Traits

about 30 to 35%

- Birth , Wean, Year. Wts.
- Feed Intake
- Feed Conversion
- Mature Wt. ~ 50%

Heritability of Product Traits

about 40%

- Fat
- REA
- Cutability
- Marbling
- Shear ?

Carcass Traits can be changed Genetically

But at what price in terms of Reproduction & Production ?

Genetic Antagonisms

• Calving ease & Birth wt.	-.74
• Marbling & Cutability	-.25
• Marbling & Year. wt.	-.33
• Marbling & REA	-.21
• Marbling & Backfat	.35
• Marbling & Shear	-.31 ?

Genetic Correlations Between Reproduction & Product Traits

Female Trait	Fat Trim	Retail Product
Age Puberty	-.29	.30
Services / Conc.	.21	.28
Calv. Difficulty	-.31	-.02
Birth Wt.	-.07	.30
Mature Wt.	-.09	.25

Collection and Utilization of Data: What are the Challenges?

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University of Nebraska

Relative Economic Values

Trait Catagory

Reproduction-Production-Product

- Willham = 10-2-1
- Melton (Ind. Integrated) = 2-6-1
- Melton (Trad. Cow- Calf) = 7-1-1

An "Industry Integrated" operation will have a much different optimum mix of traits (reproduction, production, product) than will a "Traditional Cow Calf' operation.

Most post-wean & product traits will have a negative weighting in a selection index for a Traditional Cow- Calf Operation

Standardized Selection Emphasis

	Ind. Integ.	Cow-Calf
• Repro.	31	47
• Prod.	29	23
• Product	40	30

A "Resource Limited" Cow-Calf operation will need to place even greater emphasis on Reproductive traits.

Optimum Data Utilization

- Universal ID / Data Tracking
- Predict Outcome Group & Value
- Tailor Selection Index to Environment & Market
- Apply Crossbreeding to Bridge Maternal - Terminal Carcass Gap

Collection and Utilization of Data: What are the Challenges?

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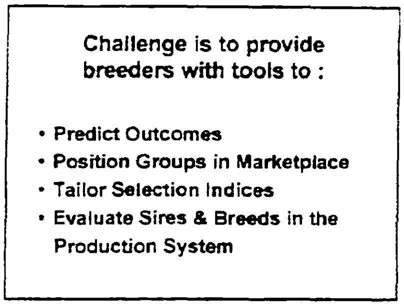

Challenge is to provide breeders with tools to :

- Predict Outcomes
- Position Groups in Marketplace
- Tailor Selection Indices
- Evaluate Sires & Breeds in the Production System

WHAT HAVE WE LEARNED?

Butch Schuler, Schuler Red Angus

Introduction

Schuler Red Angus has been collecting and analyzing feedlot and carcass data generated from its seedstock and commercial cowherds for over a decade. Carcass data from their sire-identified progeny have been used to calculate EPDs on Schuler Red Angus herd sires as well as other Red Angus sires used by the operation. Based on our observations, gains from improving carcass traits can be realized by the producer only if cowherd efficiency is not sacrificed to obtain it.

Operation

Schuler Red Angus is a diversified ranching and farming operation located in the panhandle of western Nebraska. The ranch calves 800-1000 head of Red Angus seedstock, Red Angus influenced composites, and commercial cattle annually. Progeny are backgrounded and performance tested in the ranch's feedyard utilizing forages and corn produced on the ranch. The top bull calves are sold as seedstock either in the ranch's annual spring bull sale or by private treaty. The commercial steers and cull progeny from the seedstock operation are either calf fed or summered as yearlings then fed to finish. The breeding program relies heavily on EPDs and natural selection to create cattle that are environmentally friendly and are well balanced for economically important traits.

Carcass Testing

Most carcasses used by Schuler Red Angus for data collection are offspring from the ranch's commercial cowherd. To prevent bias that can result from selective matings, the cows are randomly mated to test sires and at least one reference sire of known carcass merit. Similar structured carcass test are utilized using cooperating customers' herds.

Currently the Red Angus Association only accepts carcass data from harvested cattle to calculate EPDs. In the future, it is likely that ultrasound data will be used as well.

The following are carcass data collected on the ranch's progeny over the last 5 years.

1996-2000 Carcass Data

- 1492 head
- 3.6 lb Average daily gain (ADG)
- 778 lb Hot carcass weight (HCW)
- 50% Yield Grade 1 and 2 (YG1 & YG2)
- 75% Quality grade of choice or better
- 36% Quality grade of upper two thirds choice or better
- $21.96 head in premiums
- $32,758 total premiums

Schuler Red Composites

It is well documented that heterosis achieved through crossbreeding and composite systems can increase the productivity of the cowherd by up to 25%. An additional bonus is the increase in desirable carcass traits achieved through breed compliments. Schuler Red Angus has developed a composite line of cattle called Schuler Reds. They are primarily ¾ English and ¼ Continental cattle utilizing Red Angus, Hereford, Simmental, and Gelbvieh breeds. The cows have a similar mature weight of 1200-1250 lb as the ranch's seedstock Red Angus cows and are well suited to environments of most of our Red Angus customers.

The following carcass and performance data are from Red Angus and Red Angus composite cattle that were bred and raised at the ranch and were fed in the same pen. While this is not a structured carcass test it is an example of the impact breed differences may have on feedlot and carcass traits.

Feedlot and Carcass Traits
Composite Vs British

Red Angus	Red Angus Composite
• 44 head yearlings	• 83 head yearlings
• 65% YG1 & YG2	• 77% YG1 & YG2
• 70% choice	• 84% choice
• 3.7 lb ADG	• 3.6 lb ADG
• 726 lb HCW	• 737 lb HCW
• $12.10 premiums	• $36.13 premiums

Observations and discussion

Current marketing grids reward higher grading cattle and severely discount nonconformers such as heavyweights, lightweights, YG 4 & 5s, dark cutters, etc. The industry has accepted a target of **70% Choice + 70% YG1 & YG2 + 0% Outs = 140**. It may not be as important to have a mix of 70:70 as it is to strive for a total of 140 with no "out" cattle. Most of us would agree that the biological type of the cow needs to fit the environment first and the "box" second. However that is not to imply that we cannot make genetic and management changes that will move the yield and quality of the beef we produce closer to the target.

Selection for greater marbling is no free lunch. Nearly all literature estimates would indicate that selecting for an increase in marbling traits will reduce yield. In 1999, MARC scientists Gregory, Cundiff, and Koch published a -.60 genetic correlation between marbling and retail product yield. Carcass EPDs can and should be used to help producers identify and perpetuate cattle that are considered "outliers" for these antagonisms.

Besides differences in quality and yield grade, the most obvious difference impacting the value of carcasses is weight. Larger carcasses sell for more dollars than smaller ones as long as they don't become overweight or YG4. While heavier carcasses have been blamed for negatively impacting the beef market at times and we hear rhetorical demands for smaller ribeyes, most value-based grids do not discount carcasses until they reach 900-1000 lb. This is not to suggest producers should select breeding stock with larger mature weights which would likely increase the maintenance costs of the cowherd. However, producers should select for as much growth as their environment will allow. Management changes such as longer backgrounding periods on small to moderate framed cattle can increase carcass revenue through additional weight. This may give the producer an opportunity to take advantage of lower cost gains on grass, corn stalks, etc.

Another and maybe more direct way to get cattle to hit carcass targets is to make use of breed differences or compliments in crossbreeding and composite mating systems. In addition to producing more desirable carcasses, the production advantage from heterosis is well documented on lowly heritable traits such as fertility and milk production making this a win-win scenario.

While it would be fun to sell pens of cattle that predictably grade 100% Choice or better with a yield grade of 2, it is simply not practical. Many things can influence the profitability of a pen of cattle besides quality and yield grade and in most cases should not be sacrificed for small premiums in selling price. These include cowherd maintenance costs, feed conversion, seasonal price trends, feed costs, etc. Carcass EPDs and common sense however can push us in the right direction so that more value can be realized over the "average" selling price.

RESULTS OF COLLECTING AND USING PERFORMANCE DATA TO IMPROVE BEEF PRODUCTION

Tommy J Brown- Regional Extension Animal Scientist, Marion Junction, AL

Introduction

A combination of two of the purposes of BIF is to aid in the compilation, utilization and interpretation of performance records to improve efficiency, profitability and sustainability of beef production. During the past 30 years I have enjoyed the unique opportunity of encouraging beef producers to collect and utilize performance data to improve their odds at being profitable. It became real evident early in my career that if there were not some economic rewards tied to all this work then no one would be interested. Therefore different types of marketing efforts were incorporated with these performance programs.

Early Years – Setting the Foundation

A majority of the feeder calves produced in Alabama are marketed at weaning time therefore weaning weight or pounds produced per cow are economical traits to beef producers. The old saying "it use to be a lot simpler " sure applied in the 1970's when the only data collected was weaning weight and frame score. Also this was the time that the continental breeds came on the scene and made it easy to increase the growth rate in beef cattle. The data we have collected through the Alabama Beef Cattle Improvement Association (BCIA) indicates that an average producer who begins collecting and using weaning weight and frame score data in his cow herd, can increase the average weaning weight of his herd by 10 pounds per year for the first 8 to 10 years with out sacrificing efficiency or reproduction. Also special feeder calf and replacement heifer marketing programs have been developed which have added $60 to $100 per head premiums to normal market prices. These economical facts have encouraged producers to participate in the BCIA program so that in 2001 there will be over 8,000 head of feeder calves in Alabama that are source identified to their dam and majority to single sires. Most of the producers are BQA trained therefore these calves are on target to fit industry guidelines for the feedyards or alliances.

Carcass Data

Since a majority of Alabama feeder cattle face a 800-1200 mile haul at weaning time to be grazed or put on feed it has been almost impossible to collect individual carcass data. Through the Alabama Pasture to Rail Program, data on 400 to 800 calves per year has been collected since late 1980's. Also a few producers have retained ownership on their cattle and collected carcass data. This data shows that these cattle on the average fit the carcass weight, REA, fat thickness, and yield grade set forth by the industry, but they need additional marbling to reach the 70% choice level. These calves are sold on a grid and there is usually a $200-$300 spread in net value of a group of calves from a producer. This data puts a different viewpoint in selection criteria for a producer that has been focused on weaning weight values, since the top weaning calf is not always the most valuable at harvest time based on carcass value.

Cow Families

While sorting through performance data and carcass data it is evident that on most commercial operations there are certain cow families that are consistent top weaning weight producers. Many producers will select their replacement females based on production records and certain cow families. On the carcass data side there are cow families that are consistent in producing the top quality and higher yielding carcass. In one herd the same cow has produced the highest kill data marbling score ever recorded in the herd. Her next two heifer calves recorded the highest ultrasound per cent intramuscular score for their respective calf crops. All three calves were sired by different sires.

Carcass Data vs Ultrasound Data

In 1993 an on the farm demonstration was set-up with Tim Minor of Sunshine Farms to look at using ultrasound data vs actual carcass data to select and improve carcass merit in a breeding program of Angus, Simmental and Sim-Angus cattle. From 1995-2000 the lower end (152 hd) of the bull crop was steered at weaning and fed for carcass data. The top bull calves (178 hd) were developed and ultrasounded as yearlings to be sold in his annual bull sale. Also all heifers have been retained since 1993 and the 1997-2000 heifer crops (179 hd) have been ultrasounded as yearlings. The data in the chart below indicates that ultrasound information call be used to sort carcass merit between breed combinations as accurate as using actual kill data.

Kill Data

	REA		MB		F. T	
Breed	Actual	Ratio	Actual	Ratio	Actual	Ratio
PB An	12.8	96	Sm 30	106	.52	82
½ S ½ A	13.3	100	Sm 30	106	.44	95
¾ S ¼ A	13.4	101	Sl 80	94	.39	107
PB Sim	13.7	103	Sl 30	94	.34	119

Ultrasound Data

	REA		%IMF		F.T.	
Breed	Actual	Ratio	Actual	Ratio	Actual	Ratio
PB An	12.0	91	3.88	123	.165	100
½ S ½ A	13.5	102	3.10	98	.186	89
¾ S ¼ A	13.7	104	2.89	91	.165	100
PB Sim	13.6	103	2.77	88	.150	110

Also when the kill data and ultrasound data has been used to compare progeny from individual sire and dams the result are similar.
Another observation that has been made in this herd is that the heifers that have had the higher ultrasound measurements have not necessarily been the top weaning weight producers. So balancing production traits and carcass traits into a workable combination will be challenging and confusing for commercial producers.

This information along with over 40 different EPDs for the major breeds used in our area has the commercial producer confused on what selection data to use in herd sire selection. To help alleviate some of this confusion I am suggesting the following challenges to the leaders in the performance arena:

1. For the breed associations and university geneticists to work toward putting the data from all breeds on the same computer model and have the same EPDs for all breeds.
2. To use across breed EPDs based on whichever breed that is deemed appropriate by the Beef Industry to be used as the base breed.
3. All breeds use 0 as the average for each EPD in that breed, so it can be determined if an animal is above or below breed average without having to search for a chart that list breed averages.
4. Continue to develop economic selection indexes that combine several EPDs which effect the same production trait.

What will be the Genetic Structure of the Beef Industry in the Future?

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Future Beef Operations, LLC
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Introduction

The science of genetics is advancing at an unprecedented speed as the new millennium begins. In all fields of science where genetics plays a role, advances in instrumentation and methodology have made it possible to identify specific genes, define specific gene effects, and manipulate gene activation and function. No single endeavor in the history of biological research has been funded at the level at which genetics research is currently funded. Important scientific discoveries are imminent, making the possibilities created by these developments mind-boggling and virtually impossible to predict and fully comprehend.

Simultaneously, advances in reproductive technologies are equally exciting. Commercialization of semen sexing and cloning will likely redefine the way the beef industry implements genetic improvement. More rapid and precise genetic progress combined with mass production of superior genetics will greatly improve the speed of genetic advances.

It is doubtful that the segmented and uncoordinated business structure within the traditional beef industry will provide the necessary incentives or technical support to fruitfully implement such new technologies as they are made available. For instance, a producer who does not currently keep any production records -- such as individual cows production records or sire comparisons based on measured progeny differences -- is not in a position to use more precise genetic tools based on DNA technologies. If selection is currently performed without using all available objective information, having elaborate new tools that dissect the DNA will not matter.

It is inevitable that the beef industry will follow the evolutionary pathway of the poultry and pork industries relative to genetic structure. The creation of highly sophisticated tools and methods, based on specific DNA information, will simply accelerate the process because it will dramatically raise the knowledge barrier that must be cleared by seedstock producers if they are to remain in the seedstock business. The level of expertise required to compete in the seedstock business will increase by an order of magnitude. Such a transaction occurred in the pork seedstock industry in the span of a mere decade wherein it changed from being a farmer-breeder industry -- broadly dispersed, owned by small breeders, dominated by personal breed preferences -- to an industry that is currently controlled by a handful of highly-sophisticated genetic suppliers who create genotypes suited for specific production environments and product specifications.

History clearly defines the impetus for such a pronounced paradigm shift in genetic improvement programs and methodology. The impetus is always the same. It first occurred in the poultry industry, then the pork industry, and will be the driving force for the change in the beef industry. It is integration and it is inevitable. Once an industry integrates, so that the supplier of the first input (the animal), truly becomes part of a coordinated chain leading to production of the final food product, the power of genetic technology cannot be left in the hands of thousands of independent producers who lack the expertise required by the new paradigm. Realizing many producers possess valuable expertise in production methods regarding their specific environments and resources, the complexity of the field of genetics will dictate that genetic decisions are largely placed in the hands of experts who can efficiently implement needed changes.

The Full-Service Genetic Provider

For years genetic suppliers have existed and even prospered with an "if you build it, they will come" mentality. However, in the last decade through the use of such technologies as artificial insemination and embryo transfer and tools like expected progeny differences (EPD), high quality cattle are become more homogenous among breeders of all sizes. Commercial producers are and will continue to demand more than just acceptable cattle from their seedstock sources. Genetic suppliers will be forced to offer their customers a wide array of services and proof of the "genetics profit producing potential" of their genetics if they plan to survive the next ten years. They will truly have to become *Full-Service Genetic Providers (FSGP's).*

Seedstock producers, who have produced cattle that fit wide and varying windows of acceptability in terms of phenotype, performance and genetics, have managed to convince commercial cattlemen that the animals they saw best fit to produce were also best suited to their commercial needs. *Full-Service Genetic Providers*, on the other hand, will develop comprehensive customer analysis protocols, produce cattle that actually increase profits for their commercial customers and change and adjust genetics based on the data and feedback they receive.

Full-Service Genetic Providers will have the following five traits in common:

1). Be able to accurately and comprehensively assess the current performance status of their customer's operations.
2). Return data accompanied by a consulting report that interprets and provides implementable action points leading to increased profits.
3). Use or provide access to a Decision Support System (DSS) designed to simulate customer operations and assist in making profitable decisions.
4). Be data driven and able to set emotions aside when making genetic decisions.
5). Be able to accurately and comprehensively sort available genetics to specified target needs of their customers.

An accurate and comprehensive assessment of customer's operations is a more difficult task than one might think. Many areas need to be documented including management practices, characterization of the cowherd, genetic program design, program goals, economic resources, environmental resources and limitations, and general philosophies of the customer. With literally thousands of possible production scenarios, attempting to systematically record, store and recall detailed customer information is a complicated task. Surveys and questionnaires may suffice for initial overviews and classifications of customer operations. However, personal herdvisits to customer operations will prove to be invaluable in terms of building lasting relationships between *Full-Service Genetic Providers* and their customers.

With industry increases in retained ownership and value-based marketing, data overload is fast becoming a reality for all segments of the beef industry. Commercial customers who are not getting data feedback on their cattle are asking for help from their genetic suppliers in doing so. Commercial customers who are getting data feedback on their cattle are asking their genetic suppliers to help in interpreting the meaning of the data. *Full-Service Genetic Providers* will do more than simply align their customers in systems designed to provide data feedback. The FSGP will become the filter for data management and data interpretation. The FSGP will be required to assimilate and summarize data into implementable action points designed to lead to increased profits for their customers. Data will have to be condensed into understandable and meaningful consulting reports provided to the commercial supplier.

Status quo mandates that cattle production decisions are largely based on tradition, emotion, and outdated knowledge in a guess and check fashion. Tomorrow's beef industry will not be forgiving enough to allow room for this level of error. Faulty decisions, specifically pertaining to genetics, can have dramatically negative repercussions for many years to come and may ultimately be the deciding factor of survival. Decision Support Systems (DSS) similar to the Decision Evaluator for the Cattle Industry (DECI), will need to be developed and used by both FSPG's and their customers. Such a systems approach would allow the complex and interrelated actions of an individual beef production system to be fully realized. By accurately modeling specific production systems and forecasting results of suggested changes prior to implementing change, levels of risk can be significantly decreased and odds of survival can be raised.

Tomorrow's beef industry will require cattle that produce efficiently under a standardized management protocol and are targeted to a specific product goal. Realizing the myriad of cowherd production environments, there will undoubtedly be multiple combinations of genetics that will work for any single production system. However, contrary to today's standard operating protocol, the decision making process of the FSGP will be driven by data, science and fact rather than tradition and emotion. When color is removed from genetic decisions the answers become clearer. Genetic selection and breeding program design in the absence of prejudice allows the creation of highly efficient and profitable production systems.

Finally, FSGP's will require the ability to accurately and comprehensively sort available genetics of specified target needs of their customers programs. Three stages are involved in this process; 1) analyzing and categorizing customer needs (discussed earlier), 2) production of complete and accurate genetic evaluations (discussed later), and 3) tools developed to match customer needs with available genetics. In some regards Decision Support Systems will assist in this process. However, additional methods, specifically economically relevant selection indices, need to be developed and used. By providing access to customizable selection indices to their customers FSGP's can help ensure that the proper genetics are being appropriately matched with customer operations and that they are resulting in increased profits for the entire system.

There is little doubt that the stringent requirements of beef genetic suppliers in the future will be a harsh realization for many successful seedstock breeders of today. Tomorrow's beef industry will demand that genetic suppliers be completely commercially focused. Integrated beef production systems will have no room for the purebred party trading mentality that currently exists. As pricing signals are carried down through integrated production chains, true value differentiation will soon be realized between proven, profitable genetics and unproven hype. Genetic suppliers will become specification minded, knowing the plan and sticking to it. Successful breeders will be those with disciplined and principled breeding programs designed to produce large amounts of trouble-free, valuable and consistent genetic packages at reasonable prices. Larger genetic suppliers will have a decided advantage in making this a reality. However, genetic suppliers may represent a single entity, or a coordinated effort of many like-minded cooperators.

A sound understanding of genetics will also be crucial for genetic supplier success. Comprehending the role that genetics play in the overall plan and its contribution to production efficiency at all levels will be extremely important. Exploiting the benefits of breed complementarity and heterosis will be essential. Realizing and admitting that no one gene pool of cattle can be all things to all people will be a fundamental necessity. Survival is suspect for those not currently incorporating these simple facts we know to be true.

As the field of genetics becomes increasingly more complex, corporate relationships will prove to be more vital to the genetic supplier's sustainability. Corporate partners will allow genetic suppliers access to cutting-edge technologies, information and tools, giving them competitive advantages over their independent counterparts. As these technologies become the differentiating factors between beef production chains, partnerships with not just a corporate partner, but with the most progressive corporate partner, will prove to be invaluable. The shift from independence to interdependence will be a major adjustment for many and a barrier for many on the genetic supplier's road to success.

Genetic Evaluation

Not only are the genetic suppliers themselves going to be forced to change, but also the tools they use are going to have to evolve into more accurate and efficient predictors of genetic potential. Genetic evaluations and EPD's have served the beef industry well over the last couple of decades. Individual breeds and breeders have made tremendous strides and genetic advancements, defying perceived antagonisms and moving genetics trends in favorable directions with reasonable speed. However, there are still many obstacles, which must be overcome in order to make genetic prediction a more meaningful and relevant science.

The primary fault of current genetic evaluation is a lack of direct economic relevance. Too many traits currently evaluated are simply predictor traits of the larger and more important issue, accounting for only small portions of the variation expressed. Genetic evaluations of the future will need to include truly economic relevant traits (ERT's), as amply described by Bruce Golden at last year's BIF symposium. Current genetic evaluations possess large holes failing to evaluate traits of substantial economic importance. Traits such as feed efficiency, feedlot health, postweaning gain and growth curve parameters, feedlot disposition, days to finish, maintenance requirements, fleshing ability, and accurate predictors of red meat yield and palatability simply do not exist.

A second shortcoming of current genetic evaluations is the lack of usability of real-world data derived in commercial environments. The commercial segment of the beef industry is far larger and has the ability to produce many times the amount of data as does the seedstock industry, our current data source for genetic evaluations. In a well-designed production chain commercial suppliers should be properly "incentivized" to record and report the valuable data necessary to produce economically relevant genetic evaluations. In order for such data to be useful, genetic evaluation methodology must be altered to accommodate the commercial data source.

In dealing with commercial data new rules will have to be derived concerning contemporary grouping of cattle. Commercial beef production dictates that cattle are moved, commingled, and/or sorted for a variety of reasons ranging from production efficiency to managerial issues such as inadequate labor, water or feed resources. In future genetic evaluations, use will needs to be made of these data. Similarly, adjustments will be required to make use of data from calves of unknown specific sires, conceived in multi-sire pastures. Again many environments and managerial limitations dictate multi-sire pastures are used for breeding purposes. While individual data points may have less influence on genetic prediction, the mass of data that could be collected in this manner makes the use of multi-sires data extremely important.

Additionally the use of commercial data would help solve any legitimacy issues surrounding current data and reporting. A whole herd or total herd reporting system would have to be mandated, as it should be now in current breed association genetic evaluation. Opportunity for selective reporting and "numbers manipulation" will have to be minimized if not totally removed to ensure the accuracy and reliability of future genetic prediction.

The lack of a more rapid and more widespread use of genetic evaluation is the direct result of an inadequate meaningful interpretation on the part of commercial cattlemen. Explaining that the meaning of an EPD is simply a comparative value used to project differences between animals is grossly unimpressive. Compounding that with the fact that EPD's of animals of different breeds are not comparable, the sluggish progress of uptake of EPD's is understandable. Future genetic evaluations will have to be breed-blind and allow accurate genetic comparison across breeds. Furthermore, they will have to be presented in a form more meaningful to commercial producers, one that expresses phenotypic performance differences. This will require development of methodology accounting for heterotic affects. And ultimately, genetic evaluation will have to be boiled down into economic selection indices customized, or at a minimum classified, to match individual commercial cattlemens' needs.

Future genetic evaluations will be required to be robust. Not only will they need to incorporate traditional seedstock data, and commercial data, but also allow fusion of DNA genotype information and prediction of new threshold type traits. To compound the demands, genetic evaluations will be required to be timelier than current protocol - almost real-time. A production supply chain where year round delivery of product and inputs is essential translates to constant addition of usable data. In such a system today's status quo of running genetic evaluations bi-annually is antiquated and unacceptable.

Breed Associations

Similar to their largely seedstock producing members, breed associations must undergo transformation to survive the next decade. Much like their membership, successful breed associations will have many things in common. Surviving breed associations will be commercially focused and think with a systems approach. They will also be multi-breed tolerant and understand and openly admit to the advantages of breed complementarity and heterosis.

As the industry evolves and larger, more progressive breeders find their needs met by corporations rather than associations, associations will have to redefine the role they play in their members' operations. Successful breed associations will find ways to work with corporate entities rather than compete against them. Breed associations must realize that direct competition with corporate entities would be nearly impossible to win by such a diverse, non-profit group guided by membership largely tied to tradition and emotion. Successful breed associations will develop working relationships with multiple corporate entities and understand how they can most efficiently work together. Breed associations will likely evolve into the storehouse and source of maternal economically relevant traits leaving postweaning genetic evaluation to the corporate entities. Breed associations will also have to be technology proficient in new tools developed by companies and will know how to direct and facilitate their breeders in working with them.

On the course we are on today, there will be far fewer breed associations in 2011 than today because many will not be able to see beyond individual self interest to achieve the above list. It is not unforeseeable that there may be as few as five "biological type" breed organizations if the utilities and efficiencies are improved as the industry evolves.

Conclusion

A quick evaluation of current re-structuring and change occurring in the beef industry of 2001 makes it clear that the next decade will see unprecedented progress in the production of beef and beef by-products. The genetics sector of the industry will be forced to make warp speed change. Those breeders who see the writing on the wall today, when we are in the first steps of these changes, will be successful and sustainable in the long term. Even though these changes, and the inherent challenges encompassed within them, are apparent they will not be easy. An open mind and more attention to science rather than "marketing" will be necessities. *Full Service Genetic Provision* and all that it entails will be the standard rather than either "lip service" or the exception.

We all have a great future to anticipate in the beef industry. We are very fortunate to be in the "eye of the storm" at this time in its history. Won't it be fun to look back 10, or even 25, years from now and see how much forward progress we have made? Furthermore, we can say with a great deal of assurance that the Beef Improvement Federation can and will be a major facilitator of that process, just as it has been over the last 33 years. Frank Baker is looking down from above and we can hear him saying "we'll get there if we keep working at it". How true, how true!

WHAT IS THE GENETIC STRUCTURE OF TOMORROWS' INDUSTRY? A BREED ASSOCIATION PERSPECTIVE

Dick Spader, American Angus Association

Everyone would readily agree that cattle production is a ball game that has changed dramatically over the past few decades. Increasingly, farmers and ranchers are learning that it is now a game with new rules, new stakes and most of all, new opportunities.

The nation's most successful cattlemen are now looking at a deliberate and knowledgeable approach to these opportunities as a vital part of their game plan. And a big part of managing that plan in the beef business is managing the genetic inputs.

My charge today is a breed association perspective and my crystal ball says breed associations will play a significant role in the genetic structure of the beef industry of the future. I would temper that by saying that this will happen only if breeds continue to focus on characterizing respective breeds for the traits of economic importance to the beef and food industries, promote that philosophy to our members and the beef industry and continue to embrace the tools that help us achieve those goals.

If I may reflect for just a moment and span the last 30 years in the U.S. beef industry, it must be noted that great change has already occurred in the genetic structure of our business—especially as it relates to breeds of beef cattle.

If you look at this industry in 10 year increments from 1970 to the present time, the makeup of the registered beef industry and thus the commercial industry has changed dramatically. In 1970 the registered beef industry was basically dominated by British breeds and the seedstock business was composed of 80% British, 14% Continental and 5% Eared cattle. By 1980 the mix had changed to 70% British, 16% Continental and 13% Eared. By 1990, the figures were 49% British, 35% Continental and 14% Eared. And by the year 2000 the figures showed 58% British, 27% Continental and 13% Eared. This is not the complete story, however, because in 1970, the seedstock industry recorded nearly a million head of registered cattle and by the year 2000 that figure had dropped to slightly over 696,000 head as reported to the National Pedigree Livestock Council.

Before anyone becomes too concerned about this trend, it is also worth noting that from 1970 to 2000 the beef industry went from over 42 million beef cows to about 33 million beef cows throughout the U.S. Total beef cow numbers dropped by 25-30% as did beef breed registrations during this same time period. During this same period, the number of registered and commercial cattle that were A.I.ed has remained fairly constant.

So breed associations and registered cattle breeders remain a very big part of our industry. Add to that the A.I. companies and breed composites that are being produced, and you have the genetic structure of our industry from a breed standpoint.

In the business I am most acquainted with, the American Angus Association, the board and membership realized in the l970s and l980s that we had problems. We had an image problem coming out of a time when too many "comprest Angus" existed and we had to consider ways to add value to an Angus pedigree and the Angus breed in general.

From the discussions that happened over an extended period of time, we realized that adding objective data to a non-duplicated registration number was the start; and aggressive efforts got underway to promote the importance of Angus Herd Improvement Records, (AHIR) started in l958. Likewise in the early l970s; l972 to be exact, we embarked on a new program called National Angus Sire Evaluation. The first report was taken to the Association's annual meeting in Louisville, Kentucky in November l974. Few people at that meeting had any idea how this report would ultimately change the game of beef production. About the same time, in 1972, the A.I. rules of the Association were liberalized to allow widespread use of genetics.

We all know the rest of the story as the database, I assume, in most of our breeds has become the currency of our industry. It's where the value lies because it ties to the economics of the beef industry. And no matter what other factors influence our decisions, at some point in time economics has to kick in. The combination of predictable data and open A.I. launched the performance movement in the Angus breed. In 2000, 44% of all calves registered with the American Angus Association were the product of A.I. That accounted for 119,000 head in fiscal 2000.

Breed associations today and in the future will continue to become information centers and use the tools to identify superior genetics. "Consumer focus" and "consumer genetics" will be our buzzwords. These tools will change as they have in the past, but efforts will continue to incorporate new technology when it best serves our needs. The tools to give us the best indication of carcass value will be our near term focus while not giving up any of the established reliable traits of our breeds.

We consider the strength in the Angus industry as being generated by the size of the gene pool. The key is getting young sires tested and a large membership, some with discretionary income, contribute greatly to that end.

It takes a large sampling of young sires in order to find outliers and a large membership aids in that effort.

For example, Holstein evaluated about 1,500 new sires a year and Jersey about 120. From fall 2000 National Cattle Evaluation to Spring 2001 NCE EPDs were calculated on

3,264 new Angus sires. A total of 1,345 new sires were published in the fall 2001 Angus Sire Evaluation Report.
Beef industry progress will be the result of the size and scope of the genetic database.

In the Angus breed, consumer focus has been a major part of our 118-year history—from the early days of the International Livestock Show carcass contests in Chicago to present time. Consumer focus drove the decision in 1978 to start the Certified Angus Beef Program. Dr. Bob Van Stavern from the Ohio State University laid the groundwork for the program with his presentation on the Science Behind the Sizzle that was the basis for the specs of the Certified Angus Beef Program. Whether you agree with the specs on not, the point is simply that quality specifications and consistency sell beef—backed by the marketing of the product.

The program has shown what can be done and I believe the pull-through effect of the CAB program has shown that demand can be developed for genetics of our industry.

Our goal as an association of over 30,000 adult and junior members is to provide reliable and predictable Angus genetics for whatever quality-focused end product marketing program wishes to embrace Angus genetics. It would appear to me the goal of all seedstock production is to offer a specification product in terms of an estimate of what the genetics will transmit to the offspring in the buyers herd. Our performance database helping develop that specification is a reason for being.

What will breed associations look like in the future to be a force in genetics? I'll venture an uneducated guess. There will likely be some consolidation of associations—maybe not associations all under one roof and with one board of directors but at least in technology use. Technology, programming and personnel are expensive for associations or private enterprise, and this may be an opportunity for efficiency. Among the most important services a breed association contributes is in the area of communication, education, and support both through office staff and field staff. These areas of importance will no doubt remain essential factors for the success of breed associations in the future.

In the Angus business this past year, we took one small step in that direction. Last year was the first for a joint sire evaluation analysis with Canada. Two other countries are in discussion with us today. That gives us an opportunity to expand our database and conduct sire evaluation in a cooperative way with other countries—a move toward international sire evaluation. It allows us to expand our database and potentially identify new and superior genetics. But it also identifies the kind of partnerships that may form in the future.

I believe the genetic structure within our breed and across breeds will trend toward larger seedstock operators. Our records would show that this has occurred over the past 20 years with producers who registered over 100 head last fiscal year accounting for 35.85% of total registrations compared with that same group registering 25.66% of the total in 1980. Comparing 1980 to 2000 figures, we had 8 members who registered over 500 head in 1980, while 22 members registered that many in 2000. Similarly, 30 members registered 300 head in 1980 versus 73 members in 2000. These larger seedstock operations will market to larger commercial operations and will seek out cooperative alliances for everything they do. They will also assist in marketing of their customer's progeny and provide more services.

Smaller breeders and mid-size breeders will have an opportunity in the beef business as well. I see more cooperative marketing arrangements between seedstock producers in the years ahead. Smaller breeders with common goals will pool genetics, marketing dollars and manpower and many of these cooperative marketing efforts will be very successful. Servicing customers will be an important part of any size seedstock operation. And many independent producers will be very successful because of their ability to produce and aggressively market superior cattle.

Breed associations must continue to offer programs that help improve and add value to their members' genetics. One year ago our association began collecting and processing information on commercial cattle through the Beef Record Service. BRS is an attempt to characterize the commercial cowherd and to provide producers with individual data on fertility, production and end product value in a format of useful, decision-making tools. By identifying the genetics that profitably produce a high-quality product for the beef consumer, value is added to the genetics our members market to the industry.

Continuing to develop opportunities that benefit innovative breeders of all sizes will contribute to the success of breed associations. Just as we see larger operations to grow and expand, we must also always remember that about 80% of the beef cattle operations in the country have less than 50 cows. No one will beat a path to your door just because you have a good product. It has to be marketed at all size of operation levels.

At the Angus Association we have taken a look at two important areas for the future. The first is the role of molecular genetics in the future of our database. We realize we must position ourselves to incorporate DNA molecular information into the database and to make the transition as soon as the technology warrants. DNA technology will not replace current selection tools, but will be used to enhance those prediction tools. Our five-year goal in this area is to prioritize traits that can in the near term benefit from the incorporation of molecular information; such as lowly heritable traits, difficult to measure traits and in the area of immune response. It is also recognized that there is tremendous education required for this endeavor.

The second area is the general area of Hybrids, composites etc. We have a task force meeting in one month to "explore the potential of a service to generate ancestral data and genetic predictions for Angus derivative cattle." Both areas of discussion are very timely in our business today and we are addressing them in a systematic and proactive way. Our number one goal as an association is to "become the leading information and service center, utilizing the most current communication technology for the beef industry." We feel this task force is an important part of that process and long- range goal.

A great old baseball player, manager and philosopher, Yogi Berra once said, "Predicting is tricky, especially about the future." As a philosopher and baseball player, he understood there's a lot to the game he played. There's a lot to the game of beef production and I firmly believe if breed associations stay focused on the needs of the industry and utilize the tools available, their role in the genetic structure of the beef industry will be significant for a long time to come.

Genetic Prediction Committee
Minutes
July 12, 2001
San Antonio, Texas

Submitted: Larry V. Cundiff, Chairman

Larry Cundiff called the meeting to order at 2:00 p.m. The first order of business was a discussion of Guidelines Revision for National Cattle Evaluation, which is due for revision this year. Larry Cundiff indicated that William Hohenboken, Virginia Tech will serve as Editor. A final draft of the revised Guidelines is to be submitted to the BIF board of directors before their mid-year board meeting on October 19-20, Kansas City.

Dale Van Vleck (U.S. MARC, ARS, USDA) was called on to address the topic, "What should be deleted from the current Guidelines?"(pages 44-73 and appendices pages 117-134 of the current Guidelines, 7th edition, 1996). He indicated that most sections were reasonably current and should require only minor editing. Special attention should be given to the discussion of connectedness of sires, a critical component of genetic evaluation. Heterotic effects should be mentioned in the discussion of Genetic group effects in Animal Models and Reduced Animal Models. He suggested adding sections either to the text or appendix on threshold traits using inputs from Richard Quaas and survival traits using inputs from Steve Kachman. He indicated that the Interim EPD discussion should be shortened with inputs from Keith Bertrand and that the section on "hybrid EPDs" should be renamed multiple breed EPDs and revised with inputs from Richard Quaas. He noted that the section on across breed EPDs should be revised slightly to provide for use of data from diallel experiments (straightbred and reciprocal crosses) and backcross progeny as well as that from topcross progeny. He suggested moving details of analytical models to appendices and including additional references.

In addressing the topic, "What should be added to the current Guidelines", Bruce Golden (Colorado State University) indicated that no major additions would be required. He recommended adding discussion about economically relevant traits and suggested reorganizing the listing of traits currently provided on pages 45-46 to distinguish between indicator traits and economically relevant traits.

Follow up comments and inputs were provided in short presentations by a panel of respondents which included Kent Anderson, Limousin Foundation; Keith Bertrand, University of Georgia; John Crouch, Angus Association; Doyle Wilson, Iowa State University; and Richard Quaas, Cornell University; .

Kent Anderson emphasized:

- Mentioning that BLUP models account for nonrandom mating and selection bias.
- Adding procedures to estimate EPDs for embryo transfer cattle.

Adding heifer pregnancy as a trait.
Criteria for handling indicator traits.
Interim EPDs are useful.
Percentile ranking tables need mentioned.
Counts (number of daughters, sons) to encourage accuracy.
Add discussion about possible change.
Appendix table on genetic parameters needs to be updated and some new traits need to be added (e.g., ultra sound traits, mature size, heifer pregnancy).
Add a bibliography of classic papers.

Keith Bertrand emphasized:
Careful editing to improve readability.
Distinguishing between methodology currently used versus that recommended for future consideration and development.
Adding discussion on use of prior values in genetic evaluations.
International evaluations.
How to adjust for heterogeneous variances.
Genetic evaluation of ultrasound and carcass traits.
Revision of the interim EPD section.

John Crouch emphasized:
Aids for understanding on farm and ranch performance recording procedures.
Expanded discussion of contemporary groups (definitions and criteria for their structure).
Guidelines for estimating EPDs on cloned animals.
Edits for identifying outliers and filtering out accidental or fraudulent errors.

Doyle Wilson emphasized:
Reduced emphasis on RAM.
Moving sections on solutions and numerical procedures to appendix.
Condensing discussion of interim EPDs.
Ultrasound traits should be added to list of EPD traits.
Classify traits into economically relevant and indicator traits.
Use of EPDs in the industry.

Richard Quaas emphasized:
Increased discussion of estimation or adjustment for heterosis effects.
Expanded discussion of procedures for assigning contemporary groups (including carcass traits).
Section on solution methods should be expanded or deleted.
Hybrid EPDs should be changed to multi-breed EPDs and expanded.
Discussion should be added to cover procedures for multi-sire breeding

pastures.

Use of external EPDs (EPDs from a separate genetic evaluation).

Dale Van Vleck made a presentation on the updated across breed EPD adjustments for 2001. A table of adjustment factors breeds was presented which can be added to EPDs from the spring 2001 genetic evaluations to compare animals of 14 different breeds on the same EPD scale. His comments focused particularly on changes between 2000 and 2001.

Bruce Golden made a presentation about progress on development of a National Cattle Evaluation Center. Congress has appropriated planning money, and he recommended that everyone to encourage their members of congress to support appropriation of permanent funding.

Harvey Blackburn (ARS, USDA, Fort Collins, CO) made a presentation about progress in establishing a repository for beef cattle germplasm. He indicated that initial efforts are focused on procedures for sampling a broad sample of sires in the Hereford breed with other breeds to follow.

ACROSS-BREED EPD TABLES FOR 2001 ADJUSTED TO BREED DIFFERENCES FOR BIRTH YEAR OF 1999

L. D. Van Vleck and L. V. Cundiff
Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, Lincoln and Clay Center, NE 68933

Introduction

This report is the 2001 update of estimates of sire breed means from data of the Germplasm Evaluation (GPE) project at the U.S. Meat Animal Research Center (MARC) adjusted to a 1999 base using EPDs from the most recent national cattle evaluations. Factors to adjust EPD of 14 breeds to a common birth year of 1999 were then calculated and reported in Tables 1-4.

Changes from the 2000 update (Van Vleck and Cundiff, 2000) are as follows:

1) Estimates of heterosis from Hereford-Angus diallels included in the GPE program were used to preadjust direct and maternal heterosis to 100%. These corrections for heterosis influenced adjusted table values for Angus relative to other breeds with less influence on adjustments among other pairs of breeds.
2) New information was available on 428 Hereford, 356 Angus, 106 Simmental, 91 Limousin, 122 Charolais, 106 Gelbvieh and 101 Red Angus sired calves due to including purebred Hereford and Angus calves and calves from 4 to 5 bulls born in 1997 and 1998 for each of the Hereford, Angus, Simmental, Limousin, Charolais, Gelbvieh, and Red Angus breeds.
3) The change in base for national Maine-Anjou genetic evaluations to a system similar to the Simmental base resulted in major changes in the table adjustments for Maine-Anjou. The South Devon base for MILK changed from 0.1 to 6.1, although changes in base for South Devon for BWT, WWT, YWT were slight.

The across-breed table adjustments apply **only** to EPD for most recent (in most cases; spring, 2001) national cattle evaluations. Serious biases can occur if the table adjustments are used with earlier EPD which may have been calculated with a different within-breed base.

Methods

The philosophy underlying the calculations has been that bulls compared using the across-breed adjustment factors will be used in a crossbreeding situation. Thus calves and cows would generally exhibit 100% of direct and maternal heterozygosity for MILK analysis and 100% of direct heterozygosity for BWT, WWT, and YWT analyses. The use of the MARC III composite (1/4 each of Pinzgauer, Red Poll, Hereford, and Angus) as a dam breed for Angus, Brahman, Hereford and Red Angus sires requires different adjustments for level of heterozygosity for analyses of calves for BWT, WWT and YWT and for cows for maternal weaning weight. Some sires (all multiple sire pasture mated) mated to the F1 cows are also crossbred so that adjustment for direct heterozygosity for the maternal analysis is required. Two approaches for accounting for differences in breed heterozygosity were tried which resulted in similar final table adjustments. One approach is to include level of heterozygosity in the statistical models which essentially adjusts to a basis of no heterozygosity. The other approach is based on the original logic that bulls will be mated to another breed or line of dam so that progeny will exhibit 100% heterozygosity. Most of the lack of heterozygosity in the data results from homozygosity of Hereford or Angus genes from pure Hereford or Angus matings and also from Red Angus by Angus and from Hereford, Angus or Red Angus sires mated with MARC III composite dams (1/4 each, Pinzgauer, Red Poll, Hereford, and Angus). Consequently, the second approach was followed with estimates of heterosis obtained from analyses of BWT, WWT, YWT, and MWWT using only records from the imbedded diallel experiments with Hereford and Angus. Red Angus by Angus matings were assumed not to result in heterosis.

The steps were:

1) Analyze records from H-A diallel experiments to estimate direct heterosis effects for BWT, WWT, YWT (1,341, 1,273, and 1,242 records for BWT, WWT, and YWT, respectively, representing 153 sires). The H-A diallel experiments were conducted as part of Cycle I (1970-1972 calf crops), Cycle II (1973-1974), Cycle IV (1986-1990) and Cycle VII (1999-2000) of the GPE program at MARC.
2) Adjust maternal weaning weight (MWWT) records of calves of the H-A cows from the diallel for estimates of direct heterosis from 1) and then estimate maternal heterosis effects.
3) Adjust all records used for analyses of BWT, WWT and YWT for lack of direct heterozygosity using estimates from 1), and
4) Adjust all records used for analysis of MWWT for lack of both direct and maternal heterozygosity using estimates from 1) and 2).

Models for the analyses to estimate heterosis were the same as for the across-breed analyses with the obvious changes in breed of sire and breed of dam effects. Estimates of direct heterosis were 2.88, 14.82, and 29.97 lb for BWT, WWT and YWT, respectively. The estimate of maternal heterosis was 23.45 lb for MWWT. As an example of step 3), birth weight of a H by H calf would have 2.88 added. A Red Angus by MARC III calf would have (1/4) (2.88) added to its birth weight. A Red Poll sired calf of an Angus by MARC III cow would have (1/8) (14.82) plus (1/4) (23.45) added to its weaning weight record to adjust to 100% heterozygosity for both direct and maternal components of weaning weight.

After these adjustments, all calculations were as outlined in the 1996 BIF Guidelines. The basic steps were given by Notter and Cundiff (1991) with refinements by Núñez-Dominguez et al. (1993), Cundiff (1993, 1994), Barkhouse et al. (1994, 1995), and Van

Vleck and Cundiff (1997, 1998, 1999, 2000). All calculations were done with programs written in Fortran language with estimates of variance components, regression coefficients, and breed effects obtained with the MTDFREML package (Boldman et al., 1995). All breed solutions are reported as differences from Angus. The table values to add to within-breed EPDs are relative to Angus.

For completeness, the basic steps in the calculations will be repeated.

Models for Analysis of MARC Records

Fixed effects in the models for birth weight, weaning weight (205-d) and yearling weight (365-d) were: breed of sire (14), dam line (Hereford, Angus, MARC III composite) by sex (female, male) by age of dam (2, 3, 4, 5-9, ≥10 yr) combination (26), year (19) of birth (1970-76, 86-90, 92-94 and 97-99, 2000) and a separate covariate for day of year at birth of calf for each of the three breeds of dam. Dam of calf was included as a random effect to account for correlated maternal effects for cows with more than one calf (4246 dams for BWT, 4004 for WWT, 3891 for YWT). For estimation of variance components and to estimate breed of sire effects, sire of calf was also used as a random effect (577).

Variance components were estimated with a derivative-free REML algorithm. At convergence, the breed of sire solutions were obtained as were the sampling variances of the estimates to use in constructing prediction error variance for pairs of bulls of different breeds.

For estimation of coefficients of regression of progeny performance on EPD of sire, the random sire effect was dropped from the model. Pooled regression coefficients, and regression coefficients by sire breed, by dam line, and by sex of calf were obtained. These regression coefficients are monitored as accuracy checks and for possible genetic by environment interactions. The pooled regression coefficients were used as described later to adjust for genetic trend and bulls used at MARC.

The fixed effects for the analyses of maternal effects included breed of maternal grandsire (13), maternal grand dam line (Hereford, Angus, MARC III), breed of natural service mating sire (16), sex of calf (2), birth year-GPE cycle-age of dam subclass (68), and mating sire breed by GPE cycle by age of dam subclass (36) with a covariate for day of year of birth. The subclasses are used to account for confounding of years, mating sire breeds, and ages of dams. Ages of dams were (2, 3, 4, 5-9, ≥10 yr). For estimation of variance components and estimation of breed of maternal grandsire effects, random effects were maternal grandsire (412) and dam (2212 daughters of maternal grandsires). Sires were unknown within breed. For estimation of regression coefficients of grandprogeny weaning weight on maternal grandsire EPD for weaning weight and milk, random effects of both maternal grandsire and dam (daughter of MGS) were dropped from the model.

Adjustment of MARC Solutions

The calculations of across-breed adjustment factors rely on solutions for breed of sire or breed of maternal grandsire from records at MARC and on averages of within-breed EPDs. The records from MARC are not included in calculation of within-breed EPD. The basic calculations for BWT, WWT, and YWT are as follows:
MARC breed of sire solution adjusted for genetic trend (as if bulls born in the base year had been used rather than the bulls actually used).

$$M_i = MARC\ (i) + b[EPD(i)_{YY} - EPD(i)_{MARC}].$$

Breed table factor to add to the EPD for a bull of breed i:

$$A_i = (M_i - M_x) - (EPD(i)_{YY} - EPD(x)_{YY})$$

where,

MARC(i) is solution from mixed model equations with MARC data for sire breed i,

$EPD(i)_{YY}$ is the average within-breed EPD for breed i for animals born in the base year (YY, which is two years before the update; e.g., YY = 1999 for 2001 update),

$EPD(i)_{MARC}$ is the weighted (by number of progeny at MARC)

average of EPD of bulls of breed i having progeny with records at MARC,

b is the pooled coefficient of regression of progeny performance at MARC on EPD of sire (for 2001: 1.02, .86, and 1.16 for BWT, WWT, YWT),

i denotes breed i, and

x denotes the base breed x, which is Angus in this report.

The calculations to arrive at the Breed Table Factor for milk are more complicated because of the need to separate the direct effect of the maternal grandsire breed from the maternal (milk) effect of the breed.

MARC breed of maternal grandsire solution for WWT adjusted for genetic trend:

$$MWWT(i) = MARC(i)_{MGS} + b_{wwt}[EPD(i)_{YYWWT} - EPD(i)_{MARCWWT}]$$
$$+ b_{MLK}[EPD(i)_{YYMLK} - EPD(i)_{MARCMLK}]$$

MARC breed of maternal grandsire solution adjusted for genetic trend and direct genetic effect:

$$MILK(i) = [MWWT(i) - .5\ M(i)] - [\overline{MWWT} - .5\ \overline{M}]$$

Breed table factor to add to EPD for MILK for bull of breed i:

$$A_i = [MILK(i) - MILK(x)] - [EPD(i)_{YYMLK} - EPD(i)_{MARCMLK}]$$

where,

$MARC(i)_{MGS}$ is solution from mixed model equations with MARC data for MGS breed i for WWT,

$EPD(i)_{YYWWT}$ is the average within-breed EPD for WWT for breed i for animals born in base year (YY),

$EPD(i)_{MARCWWT}$ is the weighted (by number of grandprogeny at MARC) average of EPD for WWT of MGS of breed i having grandprogeny with records at MARC,

$EPD(i)_{YYMLK}$ is the average within-breed EPD for MILK for breed i for animals born in base year (YY),

$EPD(i)_{MARCMLK}$ is the weighted (by number of grandprogeny at MARC) average of EPD for MILK of MGS of breed i having grandprogeny with records at MARC,

b_{WWT}, b_{MLK} are the coefficients of regression of performance of MARC grandprogeny on MGS EPD for WWT and MILK (for 2001: .52 and 1.12),

$M(i) = M_i$ is the MARC breed of sire solution from the first analysis of direct breed of sire effects for WWT adjusted for genetic trend,

$\overline{MWWT}$ and $\overline{M}$ are unneeded constants corresponding to unweighted averages of MWWT(i) and M(i) for i = 1,..., n, the number of sire (maternal grandsire) breeds included in the analysis.

Results

Tables 1, 2, and 3 (for BWT, WWT and YWT) summarize the data from, and results of, MARC analyses to estimate breed of sire differences and the adjustments to the breed of sire effects to a 1999 base. The last column of each table corresponds to the "breed table" factor for that trait. The most new information in many years was available for the 2000 analyses mostly from progeny of Hereford (11), Angus (7), Simmental (7), Limousin (4), Charolais (8) and Gelbvieh (7), bulls first used in 1999 or from earlier Hereford by Hereford and Angus by Angus matings.

The general result shown in Tables 1-4 is that many of the breeds are becoming more similar to the arbitrary base breed, Angus. Many of the other breeds have not changed much relative to each other. Column 7 of Tables 1-3 and column 10 of Table 4 represent the best estimates of breed differences for calves born in 1999. These pairs of differences minus the corresponding differences in average EPD for animals born in 1999 result in the last column of the tables to be used as adjustments for pairs of within-breed EPD.

The addition of records of purebred Hereford and Angus calves and cows, the corresponding adjustments for heterosis to 100% heterozygosity, and the addition of new samples of bulls make interpretation of changes from the 2000 (1998 base) to the 2001 (1999 base) updates impossible. Because the model now used makes nearly optimal use of all records, discussion will center on the new adjusted breed of sire solutions.

The range in estimated breed of sire difference for BWT relative to Angus are large and range from 1.3 lb for Red Angus to 9.5 lb for Charolais and 12.2 lb for Brahman. The relatively heavy birth weights of Brahman sired progeny would be expected to be completely offset by favorable maternal effects reducing birth weight if progeny were from Brahman or Brahman cross dams which would be an important consideration in crossbreeding programs involving Brahman cross females. In general, the changes from the 2000 update were reductions in the difference from Angus from .4 lb (RA) to 1.7 lb (CH) with most reductions of more than a pound. Changes in differences between other breeds were smaller. The reduction in differences from Angus may be due to Angus calves becoming bigger or other calves becoming smaller at birth. In any case, the breeds seem to be becoming more similar, although still quite different for BWT.

Suppose the EPD for a Charolais bull is +2.0 (above the 1999 average for Charolais), and for a Hereford bull is also +2.0 (below the 1999 average for Herefords). Then the adjusted EPD for the Charolais bull is 10.5 + 2.0 = 12.5 and for the Hereford bull is 3.6 + 2.0 = 5.6. The expected birth weight difference when both are mated to another breed of cow, e.g., Angus would be 12.5 - 5.6 = 6.9 lb.

Weaning weights also seem to be becoming more similar for the breeds when used as sire breeds. Again the reasons for the differences between the 2000 and 2001 updates are not clear. Most sire breed means for WWT adjusted to 1999 born are within 10 lb of the Angus mean. The largest reductions in differences from Angus from 2000 to 2001 are for Simmental (32.1 to 24.7), for Charolais (28.0 to 20.2), for Gelbvieh (20.6 to 11.8) and largest for Red Angus (1.2 to –9.4). The Red Angus data nearly doubled since last year.

Yearling weights extend the pattern seen for weaning weights almost proportional to the difference in average yearling and weaning weights. For most breeds, the difference between Angus and other breeds was reduced by from 10 to 15 lb. The improved model and better characterization of Angus and Herefords undoubtedly are reasons. What the similarity means is that yearling weights for all breeds have become more similar. Most are now within ± 20 lb of Angus. The exceptions include Brahman which rank high for WWT, but at the bottom for YWT when managed for spring calving in Nebraska. The other two exceptions are Pinzgauer and Tarentaise which have not had new genetic evaluations for several years.

The MILK breed means adjusted to a 1999 base were not affected much by the addition of calves of purebred Hereford and Angus cows which were adjusted for lack of maternal heterozygosity. Grandprogeny of sire breeds used in Cycle 7 (about 20 sires each of Hereford, Angus, Simmental, Limousin, Charolais, Gelbvieh, and Red Angus) have not yet been included in the analysis of maternal weaning weight. The first of those grandprogeny will be in the 2002 update which will allow Red Angus to be included in the table for adjusting MILK EPD.

Table 5 summarizes the average BIF accuracy for bulls with progeny at MARC weighted appropriately by number of progeny or grandprogeny. South Devon bulls had relatively small accuracy for all traits as did Brahman and Maine-Anjou bulls. Table 6 reports the estimates of variance components from the records that were used in the mixed model equations to obtain breed of sire and breed of MGS solutions. Neither Table 5 nor Table 6 changed much from the 2000 report.

Table 7 updates the coefficients of regression of records of MARC progeny on sire EPD for BWT, WWT and YWT which have theoretical expected values of 1.00. The standard errors of the specific breed regression coefficients are large relative to the regression coefficients. Large differences from the theoretical regressions, however, may indicate problems with genetic evaluations, identification, or sampling. The pooled regression coefficients of 1.02 for BWT, 0.86 for WWT, and 1.16 for YWT were used to estimate breed solutions as of the 1999 birth year. These regression coefficients are reasonably close to expected values of 1.0. Deviations from 1.0 are believed to be due to scaling differences between performance of progeny in the MARC herd and of progeny in herds contributing to the national genetic evaluations of the 14 breeds.

The regressions by sex for YWT EPD changed in 1998 so that the female regression (1.13) was smaller than the male regression (1.23) whereas in 1997 the reverse was found (1.29 and 1.19). For YWT in 1999, the female regression decreased to 1.02 and the male regression increased to 1.32 which are similar to the .94 and 1.36 in the year 2001 analysis. This pattern of the regression coefficients by sex changing over years has not yet been explained. The change in 1998 was thought to be due to joint adjustment of records for sex, age of dam and dam breed.

The coefficients of regression of records of grandprogeny on MGS EPD for WWT and MILK are shown in Table 8. Several sire (MGS) breeds have regression coefficients considerably different from the theoretical expected values of .50 for WWT and 1.00 for MILK. The standard errors for the regression coefficients by breed are large except for Angus and Hereford. The standard errors for regression coefficients associated with heifers and steers overlap for milk EPD. Again, the pooled regression coefficients of

.52 for MWWT and 1.12 for MILK are reasonably close to the expected values of .50 and 1.00, respectively.

Prediction Error Variances of Across-Breed EPD

The standard errors of differences in the solutions for breed of sire and breed of MGS differences from the MARC records can be adjusted by theoretical approximations to obtain variances of adjusted breed differences (Van Vleck, 1994: Van Vleck and Cundiff, 1994). These variances of estimated breed differences can be added to prediction error variances of within-breed EPDs to obtain prediction error variances (PEV) or equivalently standard errors of prediction (SEP) for across-breed EPDs (Van Vleck and Cundiff 1994, 1995). The variances of adjusted breed differences are given in the upper triangular part of Table 9 for BWT, lower triangular part of Table 9 for YWT, upper triangular part of Table 10 for direct WWT, and lower triangular part of Table 10 for MILK. How to use these to calculate standard errors of prediction for expected progeny differences of pairs of bulls of the same or different breeds was discussed in the 1995 BIF proceedings (Van Vleck and Cundiff, 1995).

Even though the variances of estimates of adjusted breed differences look large, especially for YWT and MILK, they generally contribute a relatively small amount to standard errors of predicted differences. For example, suppose for WWT a Salers bull has an EPD of 15.0 with prediction error variance of 75 and a Hereford bull has an EPD of 30.0 with PEV of 50. The difference in predicted progeny performance is (Salers adjustment + Salers bull's EPD) - (Hereford adjustment + Hereford bull's EPD):

$$(26.9 + 15.0) - (0.4 + 30.0) = 41.9 - 30.4 = 11.5.$$

The prediction error variance for this difference is (use the 21.3 in the upper part of Table 10 at intersection of row for HE and column for SA):

V(Salers breed - Hereford breed) + PEV(Salers bull) + PEV(Hereford bull):

$$18.1 + 75 + 50 = 143.1$$

with

standard error of prediction $\sqrt{143.1} = 12.0$.

If the difference between the Salers and Hereford breeds in 1999 could be estimated perfectly, the variance of the estimate of the breed difference would be 0 and the standard error of prediction between the two bulls would be:

$\sqrt{0+75+50} = 11.2$ which is only slightly smaller than 12.1.

Implications

Bulls of different breeds can be compared on a common EPD scale by adding the appropriate table factor to expected progeny differences (EPDs) produced in the most recent genetic evaluations for each of the 14 breeds. The AB-EPDs are most useful to commercial producers purchasing bulls of two or more breeds to use in systematic crossbreeding programs. Uniformity in AB-EPDs should be emphasized for rotational crossing. Divergence in AB-EPDs for direct weaning weight and yearling weight should be emphasized in selection of bulls for terminal crossing. Divergence favoring lighter birth weight may be helpful in selection of bulls for use on first calf heifers. Accuracy of AB-EPDs depend primarily upon the accuracy of the within-breed EPDs of individual bulls being compared.

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Table 1. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1999 base and factors to adjust within breed EPDs to Angus equivalent - BIRTH WEIGHT (lb)

Breed	Number Sires	Number Progeny	Raw MARC Mean (1)	Ave. Base EPD Breed 1999 (2)	Ave. Base EPD MARC Bulls (3)	Breed Soln at MARC + Ang (4)	Breed Soln at MARC vs Ang (5)	Adjust to 1999 Base + Ang (6)	Adjust to 1999 Base vs Ang (7)	Factor to adjust EPD to Angus (8)
Hereford	102	1625	86	3.9	2.3	88	3.7	89	4.9	3.6
Angus	93	1213	84	2.6	2.1	84	.0	85	.0	.0
Shorthorn	25	181	87	1.8	.9	90	6.2	91	6.6	7.4
South Devon	15	153	80	.1	-.1	89	4.6	89	4.3	6.8
Brahman	40	589	98	1.7	.7	96	11.7	97	12.2	13.1
Simmental	48	623	87	3.2	2.7	91	7.4	92	7.4	6.8
Limousin	40	589	83	1.4	-.4	87	3.4	89	4.7	5.9
Charolais	75	675	89	1.6	.5	93	8.9	94	9.5	10.5
Maine-Anjou	18	218	94	3.4	6.1	95	10.6	92	7.3	6.5
Gelbvieh	48	595	89	1.8	.6	88	4.3	90	5.0	5.8
Pinzgauer	16	435	84	-.1	-.4	89	5.1	89	4.9	7.6
Tarentaise	7	199	80	2.4	1.8	87	3.4	88	3.5	3.7
Salers	27	189	85	1.2	1.4	88	4.4	88	3.7	5.1
Red Angus	21	206	85	.6	-.6	85	.7	86	1.3	3.3

Calculations:
(4) = (5) + (1, Angus)
(6) = (4) + b[(2) - (3)] with b = 1.02
(7) = (6) - (6, Angus)
(8) = (7) - (7, Angus) - [(2) - (2, Angus)]

Table 2. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1999 base and factors to adjust within breed EPDs to Angus equivalent - WEANING WEIGHT (lb)

	Number		Raw MARC Mean	Ave. Base EPD		Breed Soln at MARC		Adjust to 1999 Base		Factor to adjust EPD to Angus
Breed	Sires	Progeny	(1)	Breed 1999 (2)	MARC Bulls (3)	+ Ang (4)	vs Ang (5)	+ Ang (6)	vs Ang (7)	(8)
Hereford	99	1501	499	34.0	18.8	496	-.8	509	3.4	.4
Angus	94	1110	497	31.0	20.7	497	.0	506	.0	.0
Shorthorn	25	170	521	12.0	6.3	510	13.0	515	9.0	28.0
South Devon	15	134	443	14.1	.2	497	.1	509	3.2	20.1
Brahman	40	509	532	12.7	4.7	515	17.8	522	15.8	34.1
Simmental	47	564	505	35.0	23.2	520	23.4	531	24.7	20.7
Limousin	40	533	477	10.9	-.6	498	1.0	508	2.0	22.1
Charolais	74	600	514	13.5	6.6	520	23.2	526	20.2	37.7
Maine-Anjou	18	197	459	17.3	23.5	513	16.4	508	2.3	16.0
Gelbvieh	48	559	507	34.7	27.8	512	14.7	518	11.8	8.1
Pinzgauer	16	415	478	.6	-4.1	497	.5	501	-4.3	26.1
Tarentaise	7	191	476	11.3	-4.8	501	3.8	515	8.8	28.5
Salers	27	176	525	12.1	7.2	510	12.7	514	8.0	26.9
Red Angus	21	199	535	25.6	27.7	498	1.2	496	-9.4	-4.0

Calculations:
(4) = (5) + (1, Angus)
(6) = (4) + b[(2) - (3)] with b = .86
(7) = (6) - (6, Angus)
(8) = (7) - (7, Angus) - [(2) - (2, Angus)]

Table 3. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1999 base and factors to adjust within breed EPDs to Angus equivalent - YEARLING WEIGHT (lb)

	Number		Raw MARC Mean	Mean EPD		Breed Soln at MARC		Adjust to 1999 Base		Factor to adjust EPD to Angus
Breed	Sires	Progeny	(1)	Breed 1997 (2)	MARC Bulls (3)	+ Ang (4)	vs Ang (5)	+ Ang (6)	vs Ang (7)	(8)
Hereford	99	1419	843	57.3	31.8	845	-17.4	874	-8.5	-8.8
Angus	94	1055	862	57.0	39.1	862	.0	883	.0	.0
Shorthorn	25	168	918	18.3	13.0	877	15.1	883	.4	39.1
South Devon	15	134	744	19.6	.1	859	-3.2	881	-1.4	36.0
Brahman	40	438	838	21.3	8.5	823	-38.9	838	-44.8	-9.1
Simmental	47	528	852	58.1	39.3	880	18.2	902	19.2	18.1
Limousin	40	527	797	20.6	1.9	841	-21.2	863	-20.2	16.2
Charolais	74	566	882	23.2	12.7	888	25.6	900	17.0	50.8
Maine-Anjou	18	196	787	33.1	46.6	875	13.4	860	-23.2	.7
Gelbvieh	48	555	849	61.6	50.3	854	-7.5	868	-15.3	-19.9
Pinzgauer	16	347	838	.7	-8.0	838	-24.3	848	-35.0	21.3
Tarentaise	7	189	807	20.7	-4.1	828	-33.7	857	-25.8	10.5
Salers	27	173	899	19.8	11.6	871	9.2	881	-2.1	35.1
Red Angus	21	194	916	42.7	47.8	869	6.7	863	-20.0	-5.7

Calculations:
(4) = (5) + (1, Angus)
(6) = (4) + b[(2) - (3)] with b = 1.16
(7) = (6) - (6, Angus)
(8) = (7) - (7, Angus) - [(2) - (2, Angus)]

Table 4. Breed of maternal grandsire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1999 base and factors to adjust within-breed EPDs to Angus equivalent - MILK (lb)

		Number		Raw MARC	Mean EPD Breed		Mean EPD MARC		Breed Soln at MARC MWWT		Adjust to 1999 Base MWWT		Adjust to 1999 Base MILK	Factor to adjust MILK EPD
Breed	Sr	Gpr	Daughters	Mean (1)	WWT (2)	MILK (3)	WWT (4)	MILK (5)	+ Ang (6)	vs Ang (7)	+ Ang (8)	vs Ang (9)	(10)	to Angus (11)
Hereford	79	2132	530	470	34.0	11.3	13.7	1.2	469	-18.2	491	-16.4	-18.4	-14.4
Angus	74	1405	350	487	31.0	15.0	13.4	5.2	487	.0	507	.0	-.3	.0
Shorthorn	22	251	69	527	12.0	2.4	6.3	7.5	515	27.8	512	5.0	.2	13.1
South Devon	14	347	69	488	14.1	6.1	.0	5.7	494	7.2	502	-5.1	-7.0	2.2
Brahman	40	880	216	522	12.7	7.0	4.9	2.7	523	35.7	532	24.5	16.3	24.6
Simmental	27	796	152	513	35.0	8.8	15.2	10.4	518	30.9	526	19.4	6.7	13.2
Limousin	20	764	150	477	10.9	4.2	-10.9	-.5	480	-7.2	496	-10.7	-12.1	-1.0
Charolais	46	708	149	502	13.5	8.4	.0	2.4	503	15.9	517	9.5	-1.0	6.0
Maine-Anjou	17	485	86	533	17.3	4.2	23.0	4.2	511	24.1	508	1.2	-.3	10.8
Gelbvieh	25	653	143	537	34.7	18.6	24.8	15.3	521	33.8	530	22.6	16.4	13.1
Pinzgauer	15	545	133	504	.6	-1.0	-1.7	6.4	503	16.1	496	-11.0	-9.2	7.2
Tarentaise	6	341	78	513	11.3	2.0	-6.0	4.8	510	22.8	516	8.6	3.9	17.2
Salers	25	351	87	534	12.1	7.7	6.0	8.9	514	27.3	516	9.1	4.8	12.4

Calculations:
(6) = (7) + (1, Angus)
(8) = (6) + b_{WWT} [(2) - (4)] + b_{MLK} [(3) - (5)] with $b_{WWT} = .52$ and $b_{MLK} = 1.12$
(9) = (8) - (8, Angus)
(10) = [(9) - Average (9)] - .5[(7, Table 2) - Average (7, Table 2)]
(11) = [(10) - (10, Angus)] - [(3) - (3, Angus)]

Table 5. Mean weighted[a] accuracies for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), maternal weaning weight (MWWT) and milk (MILK) for bulls used at MARC

Breed	BWT	WWT	YWT	MWWT	MILK
Hereford	.66	.65	.54	.63	.52
Angus	.88	.86	.83	.82	.80
Shorthorn	.81	.79	.67	.81	.78
South Devon	.37	.39	.37	.41	.42
Braham	.50	.54	.37	.54	.40
Simmental	.93	.91	.90	.97	.96
Limousin	.94	.92	.86	.95	.92
Charolais	.80	.77	.66	.76	.67
Maine-Anjou	.71	.71	.71	.71	.71
Gelbvieh	.74	.68	.61	.68	.63
Pinzgauer	.85	.68	.62	.70	.64
Tarentaise	.95	.95	.94	.95	.95
Salers	.85	.84	.74	.83	.80
Red Angus	.83	.79	.77	--	--

[a] Weighted by number of progeny at MARC for BWT, WWT, and YWT and by number of grand progeny for MWWT and MILK.

Table 6. REML estimates of variance components (lb^2) for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), and maternal weaning weight (MWWT) from mixed model analyses

	Direct			Maternal
Analysis[a]	BWT	WWT	YWT	MWWT
Direct				
Sires (577) within breed (14)	11.7	163	699	
Dams (4004) within breed (3)	30.1	1012	1351	
Residual	67.5	1486	4050	
Maternal				
MGS (412) within MGS breed (13)				192
Daughters within MGS (2212)				904
Residual				1228

[a] Numbers for weaning weight.

Table 7. Pooled regression coefficients (lb/lb) for weights at birth (BWT), 205 days (WWT), and 365 days (YWT) of F_1 progeny on sire expected progeny difference and by sire breed, dam breed, and sex of calf

	BWT	WWT	YWT
Pooled	1.02 ± .05	.86 ± .06	1.16 ± .05
Sire breed			
Hereford	1.07 ± .08	.82 ± .07	1.15 ± .07
Angus	.97 ± .12	.76 ± .10	1.17 ± .08
Shorthorn	.75 ± .47	.80 ± .42	1.17 ± .34
South Devon	.92 ± .58	-.24 ± .37	-.12 ± .44
Brahman	1.83 ± .27	1.11 ± .27	.73 ± .24
Simmental	1.12 ± .23	1.24 ± .17	1.34 ± .15
Limousin	.67 ± .16	.58 ± .15	1.18 ± .14
Charolais	.98 ± .14	.93 ± .15	1.02 ± .14
Maine-Anjou	1.06 ± .40	.84 ± .47	.66 ± .48
Gelbvieh	.99 ± .16	1.19 ± .27	1.17 ± .22
Pinzgauer	1.28 ± .17	1.51 ± .21	1.68 ± .16
Tarentaise	.85 ± .89	.77 ± .52	1.36 ± .59
Salers	1.19 ± .38	1.07 ± .50	1.03 ± .51
Red Angus	.56 ± .20	.69 ± .34	.82 ± .31
Dam breed			
Hereford	.96 ±.08	.76 ± .08	1.02 ± .07
Angus	1.09 ±.06	.89 ± .07	1.20 ± .06
MARC III	.95 ±.08	.91 ± .11	1.27 ± .10
Sex of calf			
Heifers	1.00 ± .06	.95 ± .07	.94 ± .06
Steers	1.04 ±.06	.76 ± .07	1.36 ± .06

Table 8. Pooled regression coefficients (lb/lb) for progeny performance on maternal grandsire EPD for weaning weight (MWWT) and milk (MILK) and by breed of maternal grandsire, breed of maternal grandam, and sex of calf

Type of regression	MWWT	MILK
Pooled	.52 ± .05	1.12 ± .07
Breed of maternal grandsire		
Hereford	.56 ± .07	.98 ± .11
Angus	.59 ± .10	1.01 ± .16
Shorthorn	.230 ± .35	.65 ± .43
South Devon	.27 ± .25	-1.37 ± .80
Brahman	.43 ± .21	.73 ± .37
Simmental	.69 ± .25	1.30 ± .61
Limousin	.72 ± .30	2.56 ± .35
Charolais	.32 ± .17	1.50 ± .27
Maine-Anjou	.09 ± .31	.46 ± .34
Gelbvieh	.53 ± .30	1.45 ± .37
Pinzgauer	.71 ± .19	.26 ± .57
Tarentaise	.21 ± .58	.84 ± .75
Salers	.98 ± .35	2.61 ± .38
Breed of maternal grandma		
Hereford	.43 ± .07	1.40 ± .11
Angus	.60 ± .06	1.00 ± .10
MARC III	.46 ± .11	.86 ± .16
Sex of calf		
Heifers	.55 ± .06	1.07 ± .10
Steers	.49 ± .06	1.16 ± .09

Table 9. Variances (lb^2) of adjusted breed differences to add to sum of within breed prediction error variances to obtain variance of differences of across breed EPDs for bulls of two different breeds[a]. Birth weight above diagonal and yearling weight below diagonal

Breed	HE	AN	SH	SD	BR	SI	LI	CH	MA	GE	PI	TA	SA	RA
HE	.0	.3	.8	1.4	.5	.5	.5	.4	1.0	.5	.8	2.6	.8	.8
AN	18.	.0	.9	1.4	.5	.5	.6	.4	1.1	.5	.9	2.6	.8	.8
SH	55.	56.	.0	2.0	1.2	1.1	1.2	.9	1.6	1.0	1.3	3.1	1.1	1.4
SD	89.	89.	128.	.0	1.8	1.4	1.4	1.4	2.1	1.6	2.0	3.8	2.0	1.9
BR	39.	39.	81.	116.	.0	.9	.9	.8	1.3	.8	1.0	2.7	1.1	1.2
SI	32.	32.	72.	85.	60.	.0	.6	.5	1.3	.6	1.1	2.9	1.1	.9
LI	34.	34.	75.	88.	62.	33.	.0	.5	1.3	.7	1.1	2.9	1.1	.9
CH	26.	27.	62.	86.	54.	30.	33.	.0	1.2	.5	1.0	2.8	.9	.8
MA	65.	68.	100.	134.	89.	79.	82.	74.	.0	1.0	1.5	3.2	1.5	1.6
GE	30.	32.	65.	100.	56.	40.	42.	35.	65.	.0	1.0	2.8	.9	.9
PI	57.	59.	89.	130.	69.	74.	76.	67.	99.	67.	.0	2.7	1.3	1.5
TA	164.	167.	200.	236.	171.	181.	184.	175.	204.	177.	170.	.0	3.1	3.2
SA	51.	53.	72.	124.	77.	69.	72.	59.	97.	62.	86.	197.	.0	1.4
RA	51.	51.	93.	119.	80.	54.	55.	52.	101.	56.	96.	204.	90.	.0

[a] For example, a Hereford bull has within breed PEV of 300 for YWT and that for a Shorthorn bull is 200. Then the PEV for the difference in EPDs for the two bulls is 55 + 300 + 200 = 555 with SEP $= \sqrt{555} = 23.6$.

Table 10. Variances (lb^2) of adjusted breed differences to add to sum of within breed prediction error variances to obtain variance of difference of across breed EPDs for bulls of two different breeds. Weaning weight direct above diagonal and MILK below the diagonal

Breed	HE	AN	SH	SD	BR	SI	LI	CH	MA	GE	PI	TA	SA	RA
HE	.0	5.7	19.1	29.2	11.4	10.4	11.0	8.5	22.9	9.7	16.2	44.1	18.1	18.6
AN	19.6	.0	19.8	29.5	11.9	10.8	11.4	8.9	23.9	10.5	17.3	45.2	19.0	18.9
SH	52.2	55.9	.0	43.7	27.0	25.3	26.0	21.8	36.2	22.7	28.6	57.8	26.2	33.7
SD	63.3	65.6	100.2	.0	37.6	28.1	29.1	28.3	46.4	33.3	41.3	68.8	42.7	41.1
BR	27.0	29.1	66.3	77.9	.0	18.8	19.3	16.8	30.1	17.3	18.9	45.1	25.9	27.4
SI	43.0	45.3	80.0	68.5	57.6	.0	10.9	9.9	28.2	13.4	22.4	50.4	24.4	19.8
LI	47.4	49.8	84.5	73.1	62.1	53.0	.0	10.7	28.6	13.8	23.1	51.2	25.2	20.1
CH	31.9	34.7	65.4	65.6	46.3	45.4	50.0	.0	26.3	11.7	20.2	48.4	21.0	19.0
MA	57.7	61.6	92.7	104.6	71.2	84.4	88.9	73.1	.0	22.5	32.4	60.0	35.2	36.8
GE	37.3	41.0	68.4	84.6	51.1	64.0	68.4	51.2	59.5	.0	20.1	48.8	21.8	20.3
PI	52.9	56.9	86.0	101.2	59.1	80.8	85.4	68.4	90.0	66.7	.0	44.2	27.9	31.3
TA	127.9	131.9	164.2	176.3	130.9	156.1	160.6	144.7	160.3	141.2	133.8	.0	56.8	59.4
SA	43.7	47.6	70.0	91.8	57.9	71.6	76.1	57.1	90.4	66.9	82.0	141.7	.0	32.8
RA	--	--	--	--	--	--	--	--	--	--	--	--	--	.0

Producer Applications Committee
Minutes
Thursday July 12, 2001
San Antonio, Texas

The meeting was called to order by Sally Dolezal at 2:05 p.m., on July 12, 2001, at The Omni Hotel, San Antonio TX, with 120 in attendance. Dolezal welcomed participants and described the format of the BIF session. The Producer Applications Committee addresses issues of interest to local and national cattle producers on how information and technology are used to promote genetic improvement.

Dolezal encouraged all those present to be active in the discussion and to provide input for future meetings. A questionnaire for future programming ideas was distributed to those in attendance.

Speakers and their topics were:

Behind the Scenes of Nolan Ryan's Tender Aged Beef Program
Doug Husfeld, Dir. of Commercial Activities, Beefmaster Breeders United

Interpreting Performance Data To Make Better Breeding Decisions: Producer Perspectives

Ben Olivarez, Olivarez Ranches, Mission, Texas

Clark Milligan, Milligan Farms and Ranches, North Platte, Nebraska

Mark Williams, Triple W Farm, Marion, Kentucky

Each speaker presentation was followed by a discussion period. Dolezal adjourned the committee meeting at 4:40 p.m.

Respectfully submitted,

Sally L. Dolezal

Sally L. Dolezal, Chair

Live Animal, Carcass and End Product Committee
Minutes
San Antonio, TX
July 12, 2001

The meeting was called to order by Chairman Robert Williams at 2:00 p.m. on July 12, 2001.

Chairman Williams welcomed everyone to the committee meeting and updated attendees on the committee purpose and briefly went through the agenda.

Mark Thallman, Ph.D., Meat Animal Research Center, discussed data that breeders should be collecting to prepare for the age of DNA testing. He explored options for DNA collection and storage, which animals to run tests and collect DNA on, and what breeders should know in order to decide which DNA tests to run. Mark also discussed the need for continued phenotype collection as DNA testing becomes more prevalent.

Glen Dolezal, Ph. D., Excel Corporation, gave an overview of Excel programs and direction. Dolezal ended his presentation by discussing carcass data collection opportunities in packing plants.

Danny Fox, Ph. D., Cornell University, discussed opportunities to measure feed intake in feedlot environments. His presentation focused on models developed at Cornell for allocating feed to individual animals fed in groups being used in Individual Cattle Management Systems.

John Pollack, Ph. D., Cornell University, gave an excellent review and wrap-up for the afternoon's program. Dr. Pollack re-focused the group on the steps necessary to insure that the data being collected can be utilized in National Cattle Evaluation Programs.

The session was heavily attended with standing room only. There was good discussion after each presentation and general questions of the presenters at the end of the session.

After all discussion and with no other business from the floor to be discussed, Chairman Williams closed the meeting at 5:00 p.m.

Respectfully submitted,

Robert E. Williams
Chairman

WHAT DATA SHOULD BREEDERS BE COLLECTING TO PREPARE FOR THE AGE OF DNA TESTING?

R. Mark Thallman
U.S. Meat Animal Research Center
Agricultural Research Service
U.S. Department of Agriculture
Clay Center, NE 68933

Introduction

Beef cattle breeders have heard for years that DNA testing is coming and that it will change the way they breed cattle. Those that regularly attend BIF conventions have had the benefit of numerous educational programs on the latest developments in genomics and the associated jargon. At long last, the time is here when DNA testing for economic traits is available, albeit in a very immature form. Breeders must decide whether to use the technology, and if so, how to use it. Breed associations must decide what role, if any, they will play in the adoption of this technology.

This presentation will address the following questions:

- How should breeders decide which DNA tests they will use?
- Should breeders store DNA/tissue samples for future use?
- How can breeders store DNA/tissue samples?
- Which animals should have DNA/tissue samples stored for future use?
- Will trait phenotypes continue to be necessary when DNA testing technology develops more fully?
- How should breeders use information from DNA testing?
- Which animals should be tested with currently available tests?

The following responses to these questions are "just one person's opinion, on one given day," as our friends in the show ring would say. Other scientists would, undoubtedly, respond differently. DNA testing technology is evolving very rapidly and there is no real consensus on where it is going. It would really help if the next Genetic Prediction Workshop included a session in which people with divergent views debated how the technology is likely to develop and, more importantly, how it should be implemented by the beef industry. Hopefully, as a result, the industry would move closer to a consensus. Because of the lack of such consensus, I will start by presenting one vision of how DNA testing may evolve and be used by the beef industry, along with some assumptions that are required in order to address the above questions that are of immediate practical importance to breeders.

A vision of the future for DNA testing

DNA testing will probably be required for beef to maintain competitiveness with pork and poultry. Our competitors' seedstock industries are structured to use DNA testing very effectively to improve their genetics. However, there are more challenges in applying genetic testing to beef cattle than to many other food species. Consequently, the adoption of this technology is likely to be slower in beef cattle.

It is likely that there will be multiple companies in the DNA testing business and that many of the tests will be proprietary. Therefore, breeders that wish to evaluate their cattle as thoroughly as possible may need to send samples to multiple DNA service labs. New tests will continue to be developed for the foreseeable future. Consequently, some important animals will need to be tested at several points in time, perhaps many years apart. We should assume that the cost per test will decrease substantially over time due to improvements in technology and to greatly increased volume of DNA testing. Eventually, it should not cost much more to run a battery of many tests per animal than to run only one test per animal. There will probably be discounts for submitting samples on large numbers of animals simultaneously, provided the same battery of tests is requested on all of the animals.

If the technology is successful, there will be too many tests available for breeders to make breeding decisions based on raw test results. The relative emphasis on each gene will need to be weighted by its effect and the relative importance of the trait(s). Most DNA tests will be related to several traits.

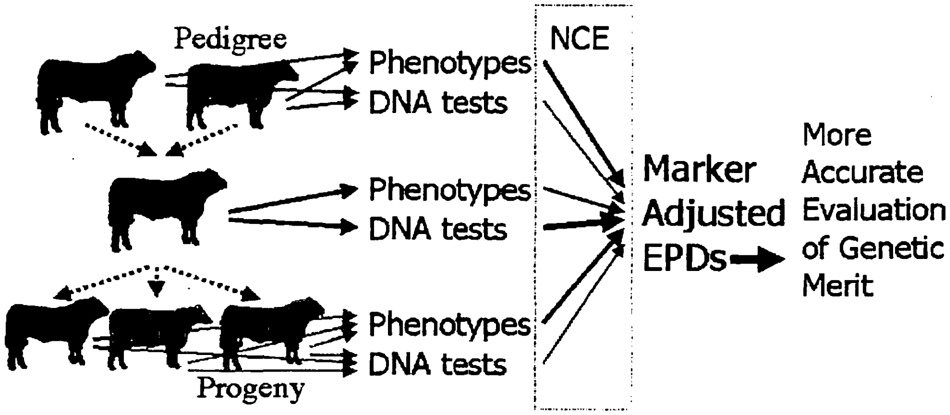


Figure 3. A More Realistic Vision

Currently, genetic merit is evaluated in the form of EPDs, which are computed from phenotypes on the individual and its relatives as illustrated in Figure 1.

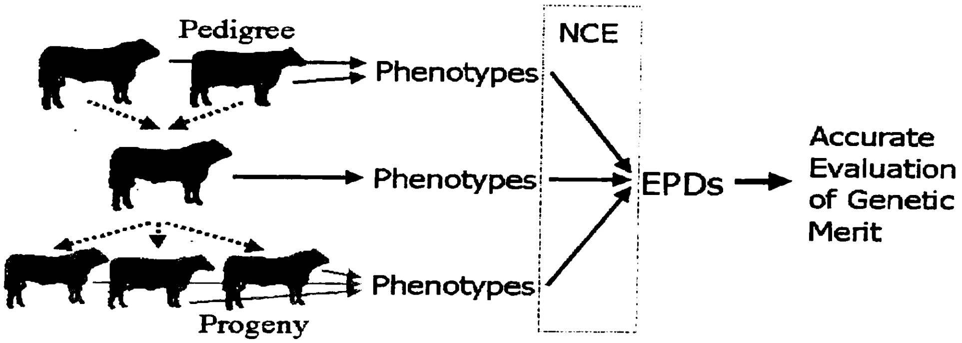


Figure 1. Current Genetic Evaluation

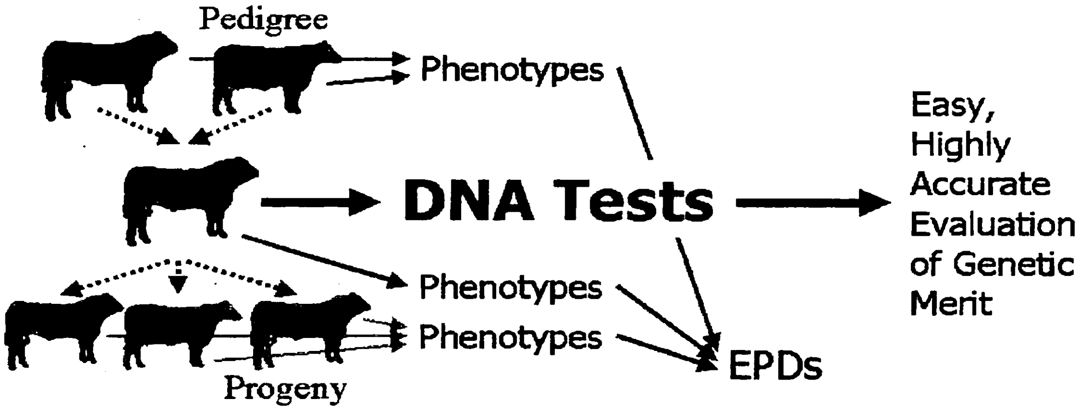


Figure 2. The Myth

For a long time, cattlemen have been told that it will become possible to determine an animal's genetic potential by simply testing a DNA sample. This myth is illustrated in Figure 2, where the pedigree, phenotypes, progeny and EPDs fade into the background. Perhaps this will happen some day, but it will be too far into the future to be of any practical value now. Most economically important traits in beef cattle are influenced by a large number of genes that interact with one another, the environment, and the management system in a multitude of ways. Accounting for all of these genes and their interactions individually will not be trivial.

For the foreseeable future, DNA tests will only account for some of the genetics of any trait; we will still need EPDs. A more realistic vision is illustrated in Figure 3, where phenotypes and DNA tests on the individual and its relatives are combined, through National Cattle Evaluation(NCE), to produce marker-adjusted EPDs, upon which selection decisions can be made.

Unfortunately, the myth in Figure 2 could lead to complacency. Under this scenario, there would be no incentive for breeders to store DNA for future use or submit DNA test results to centralized databases and it would discourage the collection of phenotypes. Consequently, there would be no organized data analysis and no way to validate that the DNA tests actually performed according to the claims of their developers. This could be dangerous for reasons to be explained later.

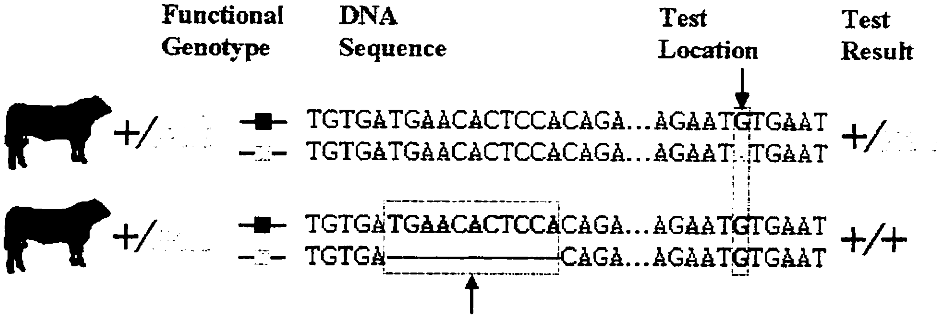
An accurate vision of the future requires realistic expectations. DNA testing will probably make cattle breeding more complicated, not easier. Selection decisions will be based on more pieces and types of information and breeders will have to decide which tests to run and which animals to test. Nonetheless, DNA testing has the potential to increase the accuracy of selection, especially for traits that are expensive to measure, sex-limited, or measured postmortem. It can also make evaluations available at birth or even before. This is an important advantage for traits that are only measured after selection decisions are made.

DNA tests fall into the two general categories of linked marker tests and direct tests. Direct tests detect differences in DNA sequence of genes that affect traits. Linked marker tests detect differences in the sequence of DNA segments that are linked to (located in the same chromosomal region and tend to be inherited in conjuction with) genes that affect the traits of interest. It is safe to assume that direct tests will be used by the beef industry. Although they are much less expensive to develop, linked marker tests may or may not be used commercially. This is because linked marker tests have been used extensively in research and the challenges to implementing them in the beef industry are quite obvious. Direct tests are newer and, although they have some distinct advantages over linked marker tests, they present challenges in implementation of their own that have not yet been widely recognized. The mythical scenario in Figure 2 is the result of dreaming about the advantages of direct tests without taking their limitations into consideration.

One limitation of direct tests is that they only detect *alleles* that have been previously discovered, characterized, and specifically included in the testing protocol. The term "allele" means *form* of a gene. It is the different alleles of genes that cause individuals to be different genetically.

Figure 4 shows an example of two animals with partial sequences of the myostatin gene that causes double muscling. Each animal has one active and one inactive allele of the gene, but the inactive alleles are caused by different mutations. The test in the illustration detects only one of the two mutations. It is not necessary to understand all of the technical aspects of the diagram. The important point is that while both animals are actually carriers of double muscling, only the top animal is detected as such by the test. In this case, the test could easily be improved to detect the additional allele, but only because we know about the second allele. However, it is much more difficult to find additional alleles in genes that have less distinctive phenotypes.

Consequently, some direct tests will not detect all of the functionally different alleles in the population. Undetected alleles are likely to be common and will only be detected if phenotypes continue to be collected and associated with DNA test results. Undetected alleles may result in decreased accuracy of the tests, depending on the frequency of the undetected alleles. They may also cause underestimation of the effect and degree of dominance of the gene in populations with undetected alleles.



Undetected mutation causes same phenotype as animal above

Figure 4. Undetected Functionally Different Allele

Each individual has two copies of every gene. The combination of the two alleles is called the genotype. The results of DNA tests are expressed as genotypes. For example, the possible genotypes for a DNA test could be represented as +/+ for two copies of the favorable allele, -/- for two copies of the unfavorable allele, and +/- for one copy of the favorable and one copy of the unfavorable allele.

Another challenge in implementing direct tests is that we need to know the effect of the test on each trait, but the effect is unlikely to be the same in all breeds, environments and management systems. For example, in Breed A, animals with the +/+ genotype might average 0.40 marbling units higher than animals with the -/- genotype, but in Breed B, the difference between +/+ and -/- might be only 0.25 marbling units. Furthermore, if the same set of animals of Breed A had been fed 30 days longer, their difference between genotypes might have been 0.50 marbling units. The point is that although the size of the effect of a DNA test is important information, it is not constant across all situations. The question of how to obtain this information will be explored in the next section.

How should breeders decide which DNA tests they will use?

Breeders should obtain answers to a number of questions about a DNA test before deciding whether to use it or not. These questions include:

- What is the effect associated with the test on each trait of interest? This should be the difference between +/+ and -/- animals expressed in units of the trait and it should include the standard error (accuracy) of the estimate. Answers such as "The + allele increases the trait" or "The test has no effect on other traits" are not sufficient.
- What populations have been used to characterize the test? This should include the breeds, environments and production systems, number of animals, and traits measured.
- Does the effect of the gene differ depending on breed, environment, or production system?
- What is the direction and degree of dominance?
- How many alleles does the test detect? Has a search for additional alleles been conducted?
- What are the allele frequencies in the breed or composite in which the test will be applied? For recessive genes, the allele frequencies in the commercial cow population in which bulls of this breed or composite are typically used may also be important.
- Is it a direct test or a linked marker test?
- There are several other questions that are rather technical, but are important for including the test in NCE.

Most breeders will be able to interpret the magnitude of effects on various traits appropriately. However, some of the other information is rather technical. In time, and with experience, breeders will become increasingly familiar with the technical questions. Until then, breeders should obtain technical advice from university or extension personnel, breed association technical staff, or consultants.

Some of the information required for breeders to decide whether or not to use a DNA test can only be provided by the company that is providing the testing service. It would help if the information was provided in a standard format so that comparable information could be compared between different DNA tests. The format for this "label" could be included in the BIF Guidelines.

Breeders can ensure that the necessary information about DNA tests is available by exerting influence in the marketplace. The information will become available if it becomes a prerequisite to sell a DNA test. Breeders should recognize that it is important for this information to be available, even though they may not understand all of the technical aspects of it, because much of this information will be necessary in order to include DNA test data in National Cattle Evaluation.

Other information required for breeders to decide whether or not to use a DNA test could be provided by an independent institution using standard resource populations with phenotypes for the desired traits in cooperation with the testing company. Under this approach, the institution would provide DNA to the DNA testing company, which would run the test on the DNA and send the test results back to the institution. The institution would then analyze the data and report the results publicly in a standardized format as described above.

The benefits of independent characterization of commercialized DNA tests are that breeders would have better information from which to decide which tests to use and DNA testing companies could market tests more effectively and with greater confidence. The process would also generate information (such as the effect of the test) that is needed in order for DNA testing data to be included in national cattle evaluation.

Successful implementation of independent characterization would require the cooperation of a number of groups. Breed associations and/or research institutions would need to provide DNA and phenotypes on appropriate groups of animals. The DNA testing companies would need to provide the testing services. A research institution would need to conduct the data analysis. This could be done through the National Beef Cattle Evaluation Consortium. The BIF should provide guidelines for the implementation. Finally, none of this is likely to happen unless the breeders provide motivation and encouragement for it.

Should breeders be storing DNA for future use?

This depends on how DNA testing technology and its application in beef cattle will evolve. As indicated above, this is a point that should be actively debated because there is not any real consensus. The price structure of DNA testing will have to ensure that the cost of technology development is recovered. Initially, it is likely that the price of DNA testing will be high enough that relatively few animals will be tested. If many animals were tested, the cost of technology development could be spread across the large numbers so that the price could be decreased substantially.

However, making this transition equitably is not trivial. Breeders and breed associations should work with DNA testing companies to make it happen. If the industry can make the transition, then at that point in time, it will be beneficial for breeders to have ancestral DNA stored. If breeders want to be ready with ancestral DNA at that time, they need to begin collecting DNA on important animals now.

The question of storing DNA also depends on how the infrastructure for using and sharing information derived from DNA testing will evolve. Breeders, breed associations, and BIF all have substantial influence on this point.

In view of the uncertainties just discussed, my recommendation is that it is time to begin storing DNA for future use because some of it will probably become very useful. However, it should be done in a cost-effective manner because some of the samples will probably never be used. But, if breeders wait until tests are widely available and inexpensive, they are unlikely to have sufficient animals with both DNA samples and phenotypes to be able to use the tests effectively.

This does not mean that all seedstock breeders should be storing DNA for future use, but elite seedstock breeders, research institutions, AI organizations, and breed associations should consider it. Animals that are candidates for DNA storage are sires, dams of sires, relatives of bulls in the Carcass Merit Project or other QTL projects, and any progeny groups on which expensive or extensive phenotypes are collected. In some elite herds, it may be appropriate to store DNA on the entire cow herd, but only if an inexpensive storage and collection protocol is used.

How can breeders store DNA/tissue samples?

DNA (the genetic material upon which genetic tests are performed) is present in most tissues of the body. Traditionally, genetic tests have been performed on DNA that has been purified from the tissue. Purification can be relatively expensive, but usually results in enough DNA to run a large number of tests. Research institutions typically work with purified DNA.

DNA can be stored either in the form of tissue or as purified DNA. Purified DNA can be stored in aqueous solution for a few years, but tissue generally can be stored longer. Genetic tests can be performed directly on some types of tissue with little or no purification steps. This is the direction that DNA testing laboratories are moving at the moment. However, when large batteries of DNA tests become available to run simultaneously, it may be more efficient to use purified DNA.

Breeders could store tissue samples either at a commercial laboratory or on the ranch. Storage at a commercial laboratory has advantages in terms of preservation, identification, inventory management and systems to locate specific samples easily. Once extracted, DNA could be stored in a format that facilitates low-cost testing of groups of animals. It would also be more convenient provided that the company storing the tissue is also performing the DNA testing, or is willing to transfer part of the DNA or tissue sample to DNA testing labs that offer different tests.

Breeders could maintain complete control of their samples by storing them on the ranch. This would require an investment of time, but probably relatively little expense. However, it would require a good system for sample identification and inventory management. Eventually, storage at a commercial facility is likely to be advantageous, but until facilities are well established, storage of part or all of the tissue samples on the ranch has significant advantages as well.

There are a number of tissues that could be stored on the ranch in a variety of ways. The following discussion of tissue sample types should not be taken as authoritative, but could be used as a starting point for evaluating tissue collection protocols.

- Frozen semen is a good source of DNA. One straw is adequate to perform many DNA tests. Therefore, it is a good practice to keep the last few straws of semen on any bull. Live cells are not required for a DNA source. Therefore, it is not necessary to store the semen in liquid nitrogen, but such straws should be clearly labeled as not for breeding purposes.
- Tail hairs are becoming a popular tissue for DNA testing. They must be pulled with the hair roots intact, but can be stored at room temperature. Each test requires several follicles, but does not require DNA purification. Kits for storing tail hairs on cards are available or they could be stored in plastic zipper bags. Breeders could send only the amount of hair required for one test and keep the rest, but labeling and sample handling could be an issue. Special care must be exercised to prevent cross-contamination of samples. This method seems better suited to performing one test at a time, as is likely to be the case for the next few years, than to performing a large number of tests, as we hope will be feasible in the future.
- Blood can be stored on FTA cards. A few drops of whole blood are spotted and dried on a special card, which can be stored at room temperature. Each test requires that a small punch be taken out of the blood spot. Roughly 100 tests could be performed per card. This method does not require DNA purification. The card could be sent to a testing lab and then returned to the breeder or breed association. The card costs roughly $1.25/animal. A new needle would also be needed for each animal.
- Frozen whole blood could be stored in a deep freeze. Storage containers and purification protocols are still being developed. This is a less convenient, but potentially inexpensive storage protocol. Breeders could send only the amount of blood required for the test and keep the rest, but sample handling and labeling would be an issue. Most DNA testing labs are not currently set up to use frozen whole blood as a DNA source, so arrangements would need to be made ahead of

time to ensure that the samples could be used later.

- Ear notches are easy to collect and can be stored in plastic tubes that cost about $0.15 each. The cost of other expendables is negligible. The ear notches could be stored in a deep freeze or, possibly, they might be desiccated so they could be stored at room temperature. One ear notch produces enough DNA for hundreds of tests. However, DNA purification from ear notches is relatively expensive and most DNA testing labs are probably not set up to use ear notches. Nonetheless, ear notches may be a cost effective alternative for archiving tissue from an entire herd when it is uncertain whether most of it will be used or not.

Fresh blood has long been the standard tissue for DNA testing in cattle. However, the usual procedure is to isolate and freeze the white cells prior to DNA extraction. Isolation of white cells requires some laboratory equipment and skills that make it unattractive for on-the-ranch tissue storage.

Tissues that can be stored at room temperature have lower storage costs and are not subject to the risk of freezer failure.

Although DNA can be purified from a wide variety of tissues, the extraction methods also vary widely. It should not be assumed that any of the storage formats discussed above would be accepted by all DNA testing labs five years from now. It would be discouraging to collect and store samples, only to find out later that the testing labs either would not accept the samples or that they added a substantial surcharge for a nonstandard purification method. It would help if BIF recommended specific tissue collection protocols, perhaps as part of the BIF Guidelines. This would require dialog with the DNA testing labs and a commitment that they would accept the recommended tissue types.

Breeders need to be careful not to spend too much money per sample up front for DNA purification and/or storage. They should also avoid collecting a separate tissue sample from the same animal every time a new tests hits the market. In other words, beware of sending the entire tissue sample to a laboratory that uses it for one or a few tests and discards the rest of the sample.

Which animals should have DNA/tissue samples stored for future use?

A few straws of semen (or some other tissue) should be saved from any bull used in AI. This is easy and usually inexpensive to do. Natural service sires in leading herds and dams of sires, especially dams of AI sires, should also be considered candidates for tissue storage.

Tissue should also be stored (in an inexpensive format) for any large progeny groups on which expensive or extensive phenotypes are collected. It could be very beneficial to have tissue stored on common ancestors and influential descendants and colateral relatives of the sires used in the Carcass Merit Project or other similar projects.

In some elite herds, it may be beneficial to collect tissue from all animals in the herd, provided the cost of doing so is minimal. Given the uncertainty about how the technology and its costs will evolve, it is difficult to predict how much of this tissue will eventually be feasible to use, but it may become quite valuable and after the cattle are gone, it is too late to collect tissue.

Will trait phenotypes continue to be necessary when DNA testing technology develops more fully?

There is a common misperception that DNA tests will eliminate the need for phenotypes, especially for traits like tenderness that are expensive to measure. However, phenotypes will continue to be very important. Although DNA testing can increase the amount of information that each phenotype contributes and thus reduce the number of phenotypes needed, DNA testing cannot replace phenotypic data.

How should breeders use information from DNA testing?

The availability of DNA testing will bring, along with all of the advantages, misuse of information, especially in the early years when only a few DNA tests will be available. We have all heard about the sin of "Single Trait Selection," which no one has ever confessed to, but which many of us have accused our friends and neighbors of committing. Breeders must now face the temptation of "Single Gene Selection," which may have far greater consequences.

For example, a bull with one of the top EPDs in his breed for a trait, had the least desirable (and most common) genotype for a DNA test for one of the genes affecting the trait. Semen sales on this bull dropped off sharply following the release of the test result. Apparently, breeders have decided that they cannot use bulls with the less favorable allele of this gene, a prime example of "single gene selection." This is understandable, but is not good use of DNA test information for several reasons:

- Applying this much selection pressure to one gene, greatly reduces the selection intensity that can be applied to the other genes that affect this trait and others. Selection is more efficient when applied to all genes simultaneously, in proportion to the size of effects of the genes and the relative economic importance of the traits.
- Few animals have two copies of the desired allele. Restricting the choice of herd sires to only those with the desired genotype (test result) of the "single gene" would put the breed through a bottleneck that would reduce the effective population size and increase inbreeding.

- When tests for more genes become available, very few animals will have the desired genotype at each of ten genes. It is extremely unlikely that we would ever find an animal that had the desired genotype at each of 50 genes that we might test for. If we did, we might be tempted to think that he must be a super-bull, but that might or might not be the case. He would be superior at 50 important genes out of the 30,000+ genes that determine his total genetic makeup, but there would be no reason to expect him to be better than average at the other 29,950+ genes.
- Given that the bull's EPD is very high in accuracy (presumably due to numerous progeny with phenotypes), a DNA test result should not greatly influence our opinion of his overall genetic merit for the trait. This may sound counterintuitive, but it is an important point. His EPD estimates his total genetic merit at all genes that influence the trait. The DNA test predicts his genetic merit at one of those genes. Therefore, an unfavorable DNA test result should be interpreted to mean that he is even better at the other genes affecting the trait than we would have guessed without the DNA test. Consequently, our estimate of the high accuracy bull's breeding value is not influenced much by his DNA test. The DNA test does suggest that we might want to breed the bull's daughters to sires with the desired genotype.

The information generated by DNA testing will be used much more effectively if a system for incorporating this data into national cattle evaluation is developed. This will require the cooperation of breeders, breed associations, and DNA testing companies.

Which animals should be tested with currently available tests?

When a breeder or breed association decides to begin using a DNA test, the next logical question is "which animals?" A good place to start is usually the influential sires in the herd or breed. This will allow the frequencies of the various test alleles in the population to be estimated and also provides the most information about which untested animals are most likely to have the desired allele. For sires that have either no EPDs or low accuracy EPDs for the traits associated with the DNA test, the test will provide some information about the genetic merit of sires for those traits. For sires that have high accuracy EPDs for the traits associated with the test, the test results should have little influence on the evaluation of genetic merit of the sires, but could be used to validate or estimate the effect of the test within the breed of interest.

The next set of animals to consider testing would be herd sire and donor prospects. Selection among these candidates has a large effect on genetic progress, but they typically have lower accuracy EPDs, especially for traits that require progeny testing or that are measured later in life. Therefore, the improved accuracy of evaluation that DNA testing could provide could be very beneficial. However, it is important that the DNA test results be used only to adjust evaluations or influence decisions among animals that would otherwise be close decisions. The DNA test results should not be used as any kind of "litmus test" that animals must pass before being considered further.

A natural extension to testing herd sire and donor prospects could be testing all candidates to become replacement females, but this would involve testing considerably more animals. In some situations, it might be beneficial to test some or all of the bulls offered for sale. The ideal situation is that it would become cost-effective to test all of the calves produced. How far down this priority list breeders can afford to go will depend on the cost of testing. The cost of testing should decrease as the number of animals tested goes up, but the number tested may not increase sufficiently until the cost goes down. It is likely to require a coordinated effort from testing laboratories, breeders, and breed associations to move beyond this impasse.

What should the role of breed associations be?

Breed associations can play an important role in encouraging the flow of DNA testing information into NCE and reporting the MA-EPDs that result back to the breeders. They will need to provide education on how to use this technology effectively and on how not to misuse it.

Breed associations may also participate in negotiating contracts for DNA storage and testing to protect the interests of their members. For example, who owns DNA or tissue that is left over after a DNA test is performed? What happens to stored tissue samples if the storage company goes out of business?

The data processing requirements for DNA testing data are likely to be substantial enough that it may not be practical for each association to expand its data processing software to handle such data. Instead, it may be more efficient for the breeds to work together to jointly contract out the data processing to one, or at most a few, organizations.

It may be beneficial for breed associations to collect sets of ancestral DNA that tie the most heavily used sires in the breed together and fund DNA testing on those ancestors.

Breed associations could also ensure that DNA is collected and stored from animals in future progeny testing projects so that they can serve as resources to tie DNA test data to phenotypes so that DNA test effects can be estimated directly in NCE. The NCBA Carcass Merit Project is a great start, but to be most effective, it should be followed up periodically with more current sires.

Conclusions

It is time to begin preparing for widespread use of DNA testing by storing tissue on influential animals and building systems for evaluating the various DNA tests that will become available. It is also time to begin developing systems for sharing DNA testing data and including it in NCE so it can be used appropriately for selection decisions.

The big challenge is to migrate to a price structure in which breeders can afford to test a large number of animals for many loci while testing companies are able to recover development costs and earn a profit.

DNA testing should allow us to obtain evaluations earlier in the life cycle, which should increase the accuracy of selection, especially for traits that are expensive to measure, sex-limited, or measured postmortem. It should also provide more benefit from each phenotype that is measured and greater opportunity to select for traits with antagonistic genetic relationships (e.g., birth weight and growth rate).

DETERMINING FEED INTAKE AND FEED EFFICIENCY OF INDIVIDUAL CATTLE FED IN GROUPS

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Introduction

The beef industry in the United States is developing programs to minimize excess fat produced, increase consistency of product and to identify and reward individual owners for superior performance in the feedlot. In the U.S., Strategic Alliances between cow-calf, feedlot and packer segments of the industry are being developed to accomplish this goal. Integrated production and marketing systems are being developed that can make Strategic Alliances work. Their objective is to market animals at their optimum economic endpoint, considering live and carcass incremental cost of gain and carcass prices for various grades, and avoiding discounts. To accomplish this, cattle are marketed as individuals when at their optimum carcass composition, which typically requires having cattle with different owners in the same pen. This requires allocating and billing feed fed to a pen to the individual animals in the pen. To make individual animal management work, the method used to allocate the feed consumed by animals from different owners that share the same pen must accurately determine cost of gain of each animal in a pen.

We (Perry and Fox, 1997, and Guiroy et al., 2001a) developed and validated a model to predict the composition of gain, feed requirements for maintenance and growth and carcass composition of individual animals. This model is being used to allocate feed fed to a pen to the individuals in the pen, based on their body size, rate and composition of growth and effects of environment. This information can be used by beef herd owners to account for differences in mature size, rate and composition of gain and finished weight in selecting for feed efficiency.

The objective of this paper is to discuss the variables that must be accounted for in determining individual animal feed requirements and feed efficiency, and the models we have developed that are being used in feedlots to allocate feed to individual cattle fed in pens.

Economic importance of selecting for feed efficiency

The average steer in the U.S. is approximately 1170 lb when marketed (National Research Council Nutrient Requirements of Beef Cattle Update 2000; NRC, 2000), with approximately 50% grading choice. Table 1 shows the effects of growth rate and feed efficiency for this steer on cost to gain 600 lb (570 lb initial weight to 1170 lb at low choice grade), based on simulations performed with our computer program called Cornell Value Discovery System (Tedeschi et al., 2001a). This computer program is based on the growth model of Fox et al. (1992) and Tylutki et al. (1994) as applied in the NRC (2000), and the models developed by Guiroy et al. (2001a,b).

Table 1. The effect of improvement in rate of gain and feed efficiency on profits[1]

	Average steer	Effect of 10% higher ADG	Effect of 10% higher feed efficiency
Dry matter intake, lb/day	18.7	20.0	18.7
Daily gain, lb	3.21	3.53	3.61
Feed/gain ratio	5.82	5.67	5.18
Feed cost, $	176	172	157
Non feed cost, $	98	91	89
Total cost of gain, $	274	263	246
Profit, $	65	77	93

[1]Computed with Cornell Value Discovery System (Tedeschi et al., 2001a).

This table shows that a 10% improvement in rate of gain alone, as the result of a 7% increase in appetite, improved profits 18%, primarily as the result of fewer days on feed and thus less non feed costs. The reduction in feed cost was due to a reduction in feed required for maintenance due to fewer days required to gain 600 lb. When the intake remained the same but efficiency of Metabolizable Energy use by the animal was improved by an amount that resulted in a 10% improvement in feed efficiency, profits were improved by 43%.

The impact of selecting for growth rate alone to improve feed efficiency

The observation that increased growth rate was associated with reduced cost of gain has led us to select for growth rate over the last 40 years since it is relatively easy to measure. Koch et al. (1963) concluded that "selecting for gain should be effective and lead to both increased feed efficiency and increased feed consumption". The observation that increased growth rate was associated with reduced cost of gain has led us to select for growth rate over the last 40 years since it is relatively easy to measure. The question is: has selecting for growth alone led to improved feed efficiency? Keep in mind that until the late 1960's, our national beef cow herd was predominately Angus and Hereford breeds and their crosses, with most of the steers grading choice within the range of 1000 to 1100 lb.

One of the most complete studies to look at the results of this approach was conducted over several years at Michigan State University in the 60's and 70's (Harpster et al., 1978). Four types of cattle were developed from a herd of Hereford cows through the use of selection for weaning and feedlot growth rate. The types included Unselected Herefords, Selected Herefords, Angus x Hereford x Charolais (AHC), and Angus x Hereford x Holstein. At weaning, steer calves were finished in the feedlot on all corn silage or high grain based rations to the low choice grade, and heifer calves not kept for herd replacements were fed all corn silage rations to the low choice grade. Table 2 shows the results of that study.

Table 2. The effect of selecting for growth rate[1]

Item	Unselected Hereford	Selected Hereford	Angus x Hereford x Charolais	Angus x Hereford x Holstein
		Steers fed high grain rations		
Initial weight, lb	379	438	537	563
Final weight, lb	1043	1136	1268	1241
Daily gain, lb	2.82	2.96	3.09	2.86
Daily DM intake, lb	15.7	16.8	18.8	19.3
Feed/gain ratio	5.58	5.66	6.08	6.76
		Carcass weight at 29% carcass fat (lb)		
Steers	588	665	733	768
Heifers	468	552	584	627

[1] Harpster et al., 1978. Cattle were harvested when estimated to be at low Choice grade.

Differences in initial weights reflect differences in weaning weights, since the calves were placed on the feedlot trial within 30 days of weaning. The following were our conclusions from that study (Harpster et al., 1978):

1. Selection for growth rate increased cow mature weights and steer and heifer weaning weights, and weights at a similar degree of body fat (low choice grade).
2. Selection and crossbreeding based on growth rate alone did not improve feed efficiency in the feedlot-finishing phase.
3. Crossbreeding with dairy to improve milk production increased weaning weights but reduced feed efficiency in the feedlot-finishing phase.
4. Heifers reach the same degree of body fat at about 80% of the weight of their steer mates.

Using today's criteria for window of acceptability for carcasses in many markets (minimum of 600 and a maximum of 850 lb at low choice grade) selection for growth rate was beneficial in that carcass weights across both steers and heifers were the most acceptable in weight in the selected and crossbred groups. Thus, selection for growth rate until the mature size is reached where carcass weights are of an optimum size is beneficial. Then other criteria must be considered if feed efficiency is to be improved.

Model for predicting feed requirements of individual animals fed in pens

Because of the wide variations in breed types and their crosses used for beef production in North America and environments in which they are fed prior to marketing as finished beef, modeling systems to predict feed requirements and cost of gain must be able to account for differences in basal maintenance requirement, the effect of environment on maintenance requirement, and differences in body size, implant program and feeding system. Table 3 contains a glossary of terms we use in describing our model developed to accomplish this objective.

Table 3. Glossary of terms

Term	Description
ADG	Shrunk weight average daily gain, kg/d
AFBW	Final SBW adjusted to 28% EBF, kg
BW	Body weight, kg
EBF	Empty body fat, %
EBG	Empty body gain, and is 0.956 ADG, kg/d
EBW	Empty body weight, kg
EQSW	Equivalent shrunk, kg
EQEBW	Equivalent empty body weight, kg
FT	12th rib fat thickness, cm
FFG	Feed for gain, kg/d
FFM	Feed for maintenance, kg/d
HCW	Hot carcass weight, kg
LMA	Longissimus muscle area, cm^2
NE_g[a]	Net energy for gain
NE_m[a]	Net energy for maintenance
RE	Retained energy, Mcal/d
SBW	Shrunk body weight, and is 0.96 full BW, kg
QG	USDA quality grade, 4 = Select, 5 = Choice-, 6 = Choice, 7 = Choice +, and 8 = Prime

[a] Mcal/kg if diet energy concentration or Mcal/d if animal requirements. Diet NE_g and NE_m can be calculated using CNCPS 4.0 or NRC (2000) models level 2.

Accounting for body composition at the marketing target. The critical first step for predicting feed required for the observed growth and incremental cost of gain and body composition as cattle grow is to identify the body composition at the marketing target. Carcass value in most markets and cost of gain can be related to proportion of protein and fat in the carcass. Body fat in finished cattle when marketed typically varies from 16 to 21% empty body fat (EBF) in the French (INRA, 1989) and Brazilian (Leme et al., 2000) markets to over 30% EBF in segments of the Japanese and Korean Markets. Most other markets range between these two. The single most recognizable quality grade in the world is USDA choice. Premium brand name products typically utilize the prime and upper 2/3 of the Choice grades and are increasing the value of U.S. beef products. Table 4 shows a summary of data from our experiments (Guiroy et al., 2001a) that support the value of the Choice and prime grades level of fatness to minimize the percent of the beef that is unacceptable to consumers in the U.S.

Table 4. Relationship of carcass and empty body fat to quality grade (total of 1,355 animals; Guiroy et al., 2001a). Values in a row are means for that grade.

Number of animals	USDA Quality Grade[a]	Mean carcass fat, %	Mean EBF, %[b]	EBF SEM	Taste panel score[c]	Percent unacceptable[c]
45	3.5	23.55	21.13^{u}	0.63	5.3	40
470	4.5	28.98	26.15^{v}	0.19	5.6	13
461	5.5	31.64	28.61^{w}	0.20	5.8	8
206	6.5	33.02	29.88^{x}	0.29	6.2	0
90	7.5	34.23	31.00^{xy}	0.44	-	-
51	8.5	35.24	31.94^{y}	0.59	-	-
32	9.5	35.80	32.45^{z}	0.74	-	-

[a] Standard = 3 to 4; Select = 4 to 5; low Choice = 5 to 6; mid Choice = 6 to 7; high Choice = 7 to 8; low Prime = 8 to 9; mid Prime = 9 to 10.

[b] Column means with different superscripts are significantly different at $P < 0.05$.

[c] Taste panel scores (from 1 to 8) and percent unacceptable values are from a subset of this data base.

These data show that EBF was significantly ($P < 0.05$) higher with each incremental increase in grade up to the mid Choice grade. Taste panel scores and percent unacceptable followed the same trend. This data also indicate we can correlate grade to changes in body composition as cattle grow. **The most critical factor in this table for our model is the percent EBF at Standard (21.1%), Select (26.2%), and low Choice grade (28.6%) grade since these are the body composition endpoints for different marketing targets used to identify feed requirements during growth.**

The National Beef Quality Audit (Smith et al., 1995) reported the percent of steaks with low eating quality for the USDA Prime, Choice, Select, and Standard grades were 5.6, 10.8, 26,4, and 59.1 percent, respectively in data collected from typical feedlot cattle. The percent unacceptable values were lower for the Cornell data, likely because they were uniform calves fed a 90% concentrate diet beginning at approximately 7 months of age. The 1995 National Beef Quality Audit also reported that up to 20% of all beef does not pass U.S. consumer satisfaction in eating quality and recommends that the percentage of cattle grading low Choice and above be increased. Based on a survey of retailers, purveyors, and exporters, the ideal mix would be 62% low Choice or better and 38% Select, with no Standard grade beef. This compares to the current 51% low Choice or better, 42% Select and 7% Standard grade and lower (McKenna et al., 2001). The 10% of U.S. beef that is exported would have none below low Choice. The strong message from our consumers is that the external fat must be removed from beef, but intramuscular (marbling) fat is required in the edible product. This is likely due at least in part to the method of cookery commonly used compared to what is common in most other countries (Dikeman et al., 1987).

Accounting for differences in requirements for growth. Numerous studies, including those discussed previously, have indicated that cattle of different genotypes are at different weights when they are at the same degree of fatness. Based on these and other studies, we (Fox et al., 1992) developed the following relationship between frame size and weight at 28% body fat (low Choice grade), which can be used to develop the target frame size in breeding programs, based on weight desired at low choice grade (Table 5).

Table 5. The relationship between frame size and 28% body fat or mature weight[1]

Frame size[2]	Weight at 28% body fat in kg		Weight at 28% body fat in lb	
	Steers[3]	Heifers[4]	Steers	Heifers
1	400	320	882	705
2	433	346	954	763
3	467	374	1029	824
4	500	400	1102	882
5	533	426	1175	939
6	567	454	1250	1001
7	600	480	1322	1058
8	633	506	1395	1115
9	667	534	1470	1177

[1] Adapted from Fox et al. (1992).

[2] Can be computed from The Beef Improvement Federation Guidelines (1991); Frame size for bulls = -11.548 + 0.4878 x (hip height, inches) - 0.0289 x (age, days). + 0.00001947 (age, days)^2 + 0.0000334 x (hip height, inches) x (age, days). It is assumed in this paper to be the same for implanted steers.
Frame size for heifers = -11.7086 + 0.4723 x (hip height, inches) - 0.0239 x (age, days) + 0.0000146 x (age, days)^2 + 0.0000759 x (hip height, inches) x (age, days).

[3] Steer weight at 28% body fat or cow mature weight (kg) = 33.35 x frame size + 366.52.

[4] Heifer weight at 28% body fat (kg) = 26.7 x frame size + 293.2.

We also determined that cattle of different mature sizes had different fat and protein content of the weight gain at the same weight during growth (Fox and Black, 1984). Therefore we developed a size scaling procedure to account for differences in energy and protein requirements for growth among cattle of different frame sizes and sexes (Fox and Black, 1984; Fox et al., 1988; Fox et al., 1992, Tylutki et al., 1994; Fox et al., 1999) which was adapted by the National Research Council Nutrient Requirements of Beef Cattle (2000) and Dairy Cattle (2001). In this model, the animal's weight at 28% fat is divided into the weight of the standard reference animal at that composition. This ratio is then multiplied by the animal's actual weight to adjust it to the standard reference animal for use in the energy requirement equation. The standard reference animal represents the cattle body size used to develop the equations to predict the net energy content of weight gain. Table 6 shows requirements for growth computed with this model for 3 mature sizes of cattle. This table shows that as mature size increases, weight at the same energy content of gain increases, because larger size animals are at an earlier stage of growth at the same weight and therefore have more protein and less fat in the gain. It also shows that energy requirements increase with increasing stage of growth and rate of gain.

Table 6. Relationship of stage of growth and rate of gain to body composition

28% fat weight, lb	Weight during growth, lb		
1100 lb	600	800	1000
1300 lb	708	944	1180
% of 28% fat wt.	55	73	91
ADG, lb/day	Net energy required, Mcal/day		
2.0	3.23	4.01	4.74
3.0	5.04	6.26	7.40
4.0	6.92	8.58	10.14

Three data sets were used to test this system (NRC, 2000). With two of the data sets (82 pen observations of *Bos taurus* implanted steers and heifers varying in breed type, body size and diet type and 142 serially slaughtered nonimplanted steers, heifers and bulls varying in body size aggregated into "pens" by slaughter groups), this system accounted for 94% of the variation in energy retained with only a 2% underprediction bias. However, it cannot be assumed that this accuracy will apply to individual animals at a particular point in time during growth, since these results were obtained from pen averages and total energy retained. Many factors can alter estimates of finished weight of individuals, such as previous nutrition, implant programs, level of intake and energy derived from the diet, limits in daily protein and fat synthesis, and daily energy retained. The problem is to be able to predict those effects in individual animals based on information that will be available and is practical to apply.

Accounting for differences in requirements for maintenance. The model used for this purpose is described by Fox and Tylutki (1998). The effects of breed type are accounted for by adjusting the base NE_m requirement of 77 kcal/kg MBW (metabolic body weight) for *Bos indicus* and dairy types (-10 and +20% compared to *Bos taurus*). The effects of previous nutrition are accounted for by relating body condition score to NE_m requirement. On a 1 to 9 scale, maintenance requirement is reduced 5% for each condition score below 5 and is increased 5% for each score above 5. The effects of acclimatization are accounted for by adjusting for previous month's average temperature (ranges from 70 kcal/kg MBW at 30 °C to 105 kcal/kg MBW at -20 °C). This adjustment is continuous, with no effect at 20 °C. Current environmental effects are accounted for by computing heat lost vs heat produced, based on current temperature, internal and external insulation, wind, and hair coat depth and condition. This becomes important when the animal is below the computed lower critical temperature, and can range from no effect at 20 °C to twice as high (thin, dirty hide at -12 °C and 1 mph wind).

System of equations to predict individual feed requirements. The system of equations we developed (Guiroy et al., 2001a) to predict individual animal feed requirements is summarized in Table 7. A computer program (Cornell Value Discovery System) has been developed to implement this model (Tedeschi et al., 2001a).

Table 7. Equations to predict individual dry matter requirements

(1) EBW = 1.316 HCW + 32.29; from Garrett et al. (1978)
(2) EBF% = 17.76207 + 4.68142 FT + 0.01945 HCW + 0.81855 QG – 0.06754 LMA
(3) AFBW = (EBW + ((28 - EBF%) x 14.26)) / 0.891
(4) EQSW = SBW (478/AFBW); from NRC (2000)
(5) RE = $0.0635 EQEBW^{0.75} EBG^{1.097}$; EQEBW is 0.891EQSW; from NRC (2000)
(6) FFG = RE/diet NE_g
(7) FFM = NE_m required/diet NE_m; NE_m required can be calculated as described by Fox et al. (1992) and NRC (2000)
(8) Individual DM required is FFM + FFG
(9) Adjusted individual DM required = individual DM required x (total actual pen DM consumed/ total pen DM required)

Individual feed required is the sum of the feed required for maintenance (FFM), and the feed required for growth (FFG). Feed for maintenance is a function of the NE required for maintenance and the NE_m concentration of the diet. Similarly, FFG is a function of the energy retained in the weight gain and the NE_g concentration of the diet. Animal differences in mature body size are accounted for as described previously. Perry and Fox (1997) and Guiroy et al. (2001a) presented a detailed description of the development of these equations. Table 8 shows a summary of the calculations for an Angus steer fed in a group pen.

Table 8. Example calculation with the feed allocation model[1]

Inputs	Results
Initial shrunk weight = 713 lb	Daily gain = 4.64 lb
Final shrunk weight = 1265 lb	28% fat weight = 1241 lb
Days on feed = 119	Net energy for gain = 10.82 Mcal/day
Hot carcass weight = 803 lb	Feed DM for gain = 17.64 lb/day

Quality grade = 5.0
Rib eye area = 79.4 cm^2
Backfat depth = 1.5 cm
Diet NEm = 0.91 Mcal/lb
Diet NEg = 0.61 Mcal/lb

Net energy for maintenance = 6.83 lb/day
Feed DM for maintenance = 7.49 lb/day
Total feed DM required = 25.16 lb/day
Feed efficiency = 5.42

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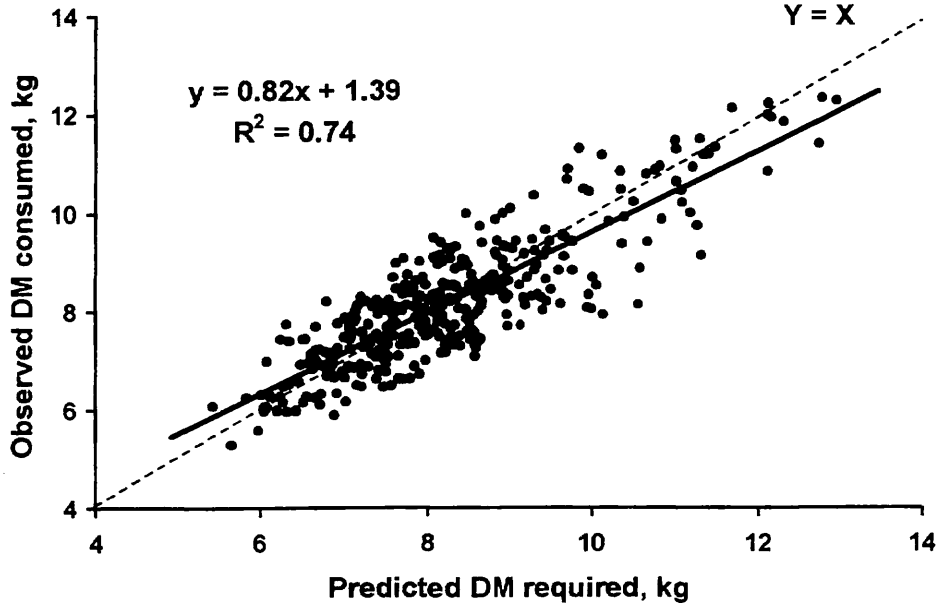
[1] Group inputs included pen dry matter intake for the entire feeding period, and ration NE_m and NE_g values.

Evaluation of the Cornell Value Discovery System

The set of equations to predict dry matter consumed by individuals (Table 7) was evaluated with data from the studies of Nour (1982), Perry et al. (1991), Perry and Fox (1997) and Guiroy et al. (2000). This data used included 365 individually fed steers of diverse biological types in which chemical body composition was determined and carcass measurements were taken, and complete information on feeds fed were available to accurately predict diet net energy values in each experimental group. Guiroy et al. (2001a) presented a complete description of this data base.

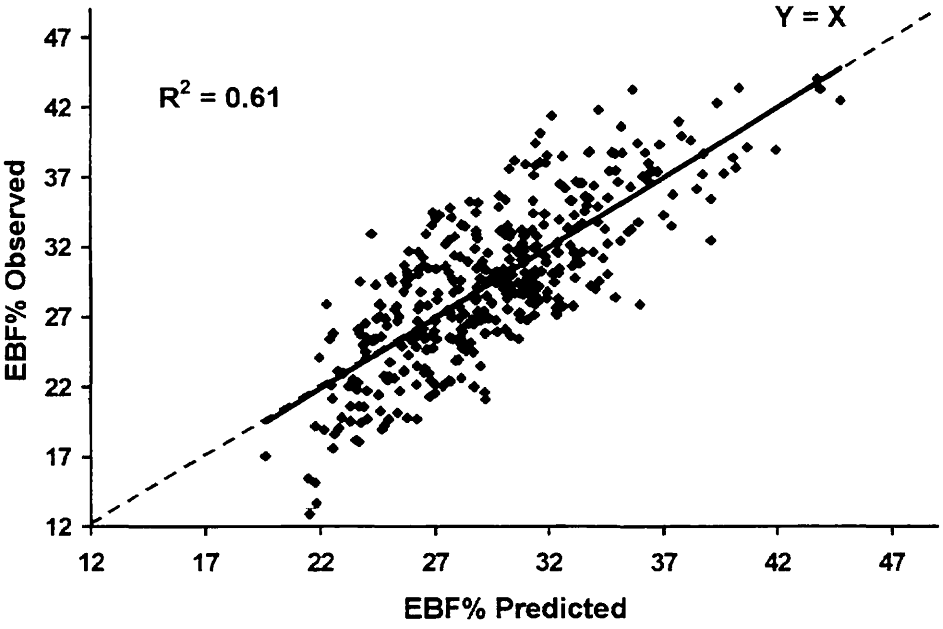
Figure 1 shows the regression plots of DM requirements predicted by the Cornell Value Discovery System against actual DM consumed. The equations presented in Table 7 accounted for 74% of the variation in actual DM consumed, with essentially no bias (0.34%) and a coefficient of variation of 8.18%.

Figure 1. Evaluation of prediction of feed requirements (DM) of individual animals. Data include 365 individually fed steers.



To compute EBF under feedlot conditions, we developed a new equation to predict EBF percentage from carcass measurements commonly taken in U.S. packing plants with a large database. Figure 2 shows the regression of predicted values compared to observed values.

Figure 2. Predicted vs observed values for EBF%. The prediction equation is: $\text{EBF\%} = 17.76207 + 4.68142\ \text{FT}_{(\text{cm})} + 0.01945\ \text{HCW}_{(\text{kg})} + 0.81855\ \text{QG}_{(4 = \text{Select},\ 5 = \text{Choice-},\ 6 = \text{Choice},\ 7 = \text{Choice +},\ \text{and}\ 8 = \text{Prime})} - 0.06754\ \text{LMA}_{(\text{cm}^2)}$

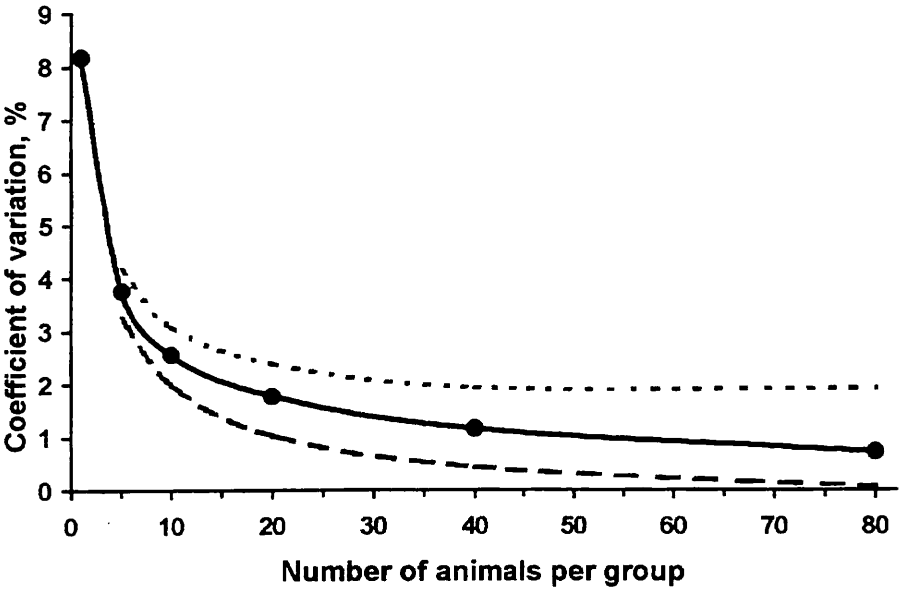


This equation accounted for 61% of the variation in EBF with a coefficient of variation of 11.9% and no bias since the intercept and the slope of the regression equation were not different ($P > 0.10$) from zero and one, respectively. This equation was validated with 951 animals including steers and heifers from a variety of breeds and diets fed and explained 51% of the variation in EBF%, with a coefficient of variation of 10.7% and no bias. The 39% of the variation in EBF in the development data base and 49% of the variation not explained by this equation in the evaluation data base can be explained by the variation in the carcass measurements used by the equation at a similar empty body fat (Guiroy et al., 2001a).

When the same analysis to predict individual feed requirements shown in Figure 1 was evaluated using this predicted rather than the observed EBF%, the variation accounted for by the model was not reduced. This result indicates that we can accurately predict individual feed requirements using a prediction of EBF from carcass measurements available from U.S. packing plants.

In common feedlot situations, each owner owns more than one animal in a pen. Therefore, they will be concerned with knowing the accuracy of predicting the total of all of their animals' share of the total feed consumed by the pen. A reduction in the error of prediction of DM required is expected when predicting groups of animals instead of individuals within a pen. To measure this reduction, the predicted and observed individual DM requirements of the 365 individually fed animals used to validate our feed allocation model were summarized by groups of 5, 10, 20, 40, or 80 animals; these groups were randomly created for this analysis. Figure 3 shows the result of this analysis.

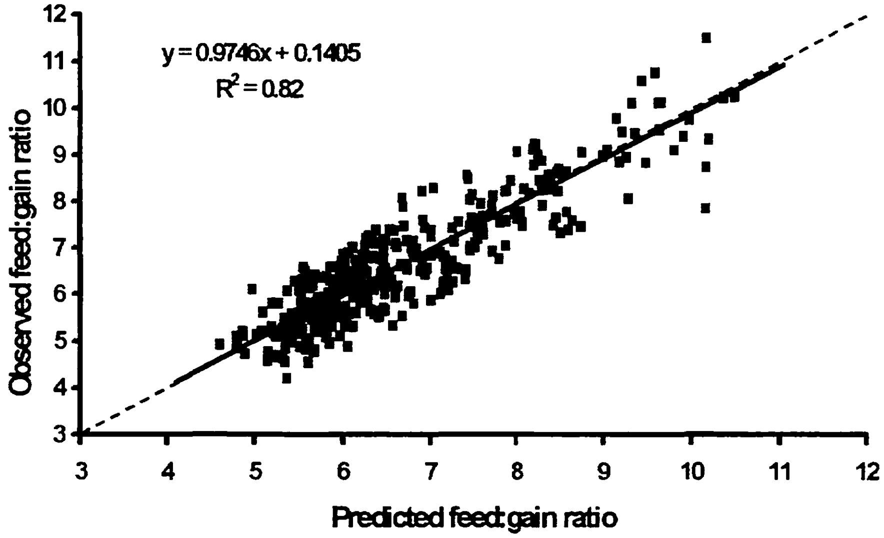
Figure 3. Reduction in the coefficient of variation of predicting DM required from an individual animal to groups of animals with increasing number of animals per group.



The coefficient of variation was reduced more than 50% (from 8.18 to 3.76%) when predicting DM required for groups of 5 animals instead of individuals, and was less than 2% in groups of more than 20 animals. This analysis shows that even though we can account for 74% of the variation in individual animal feed requirements with a coefficient of variation of 8.18, the error in our prediction is greatly reduced when predicting groups of animals, which is an important concept for producers using this system to allocate feed consumed among groups of cattle within a pen.

Figure 4 shows predicted vs measured feed efficiency in this data set. The model accounted for 82% of the variation in actual feed efficiency. We conclude the use of Cornell Net Carbohydrate and Protein System model (Fox et al., 2000) predicted energy values for the diet and pen feed intakes along with individual measurements that can be obtained (individual body weight and ADG, and carcass measurements) accounted for 82% of the differences in feed efficiency. The variation not accounted for in this system is due to individual animal variations that the system cannot fully account for, including differences in maintenance requirements, diet digestibility and metabolizability, and body composition. Predicted DM requirements also contain all of the accumulated errors in predicting each component. However, all of the feed is allocated by multiplying the ratio of the total actual pen DM consumed to the total pen DM required times each animal's DM required (Equation 9 in Table 7). Therefore, this system provides a fair method for allocating feed to individuals fed in a group on a biological basis, considering differences known to affect requirements (breed type, body size, stage and rate of growth).

Figure 4. Evaluation of prediction of feed efficiency of individual animals.
Data include 365 individually fed steers.



Predicting growth, carcass weight, body fat, quality and yield grade during growth

We have developed a model to predict daily gain, feed required, body fat, and quality and yield grade on a daily basis as an animal grows (Guiroy et al., 2001b; Tedeschi et al., 2001a,b; Guiroy et al., 2001c). This model (DAYSTEP) has been incorporated into the Cornell Value Discovery System (Tedeschi et al., 2001a). Equations to predict carcass weight and composition, and the above prediction of DM required in live cattle during growth must rely on estimates of AFBW, and data that can be obtained on individuals during growth, such as current weight, ADG and ultrasound estimates of fat depth, marbling and rib eye area. Perry and Fox (1997) developed equations for utilizing ultrasound measurements for this purpose, and the reader is referred to that paper for details of those equations.

Two example applications of the Cornell Value Discovery System

***Application in large commercial feedlots to market cattle at the most profitable endpoint*.** A computerized Electronic Cattle Management sorting and tracking system (Accu-Trac® ; Micro Beef Technologies, Inc., Amarillo, TX) is being marketed to predict the most profitable endpoint in feedlot cattle. The objective of the Accu-Trac® system is to predict carcass and empty body weight and composition so that incremental live and carcass cost of gain, quality and yield grade can be predicted as cattle progress during the feeding period to determine optimum profitability sale point. The application of the Cornell Value Discovery System involves allocating feed post harvest, as well as during growth to predict the optimum time to market. The equations in Table 7 are used in this system post harvest to accurately allocate feed, based on final EBF predicted from carcass measurements. The equations from Fox et al. (1992) and NRC (2000) are used to predict feed requirements during growth and optimum time to market.

The key components of the Accu-Trac® system are:

1. Cattle are processed on arrival through a series of low stress stations in a processing snake where they are measured for frame size by video imaging to predict body size, are weighed, vaccinated, implanted and given an electronic ear tag, and ultrasound backfat depth between the 12th and 13th rib measurements are taken. Cattle are measured again at re-implanting and are re-sorted based on new predicted finished dates. This data is processed and stored in a computer database that automatically places them in one of seven pens according to their projected optimum finish date. The computer analyzes the animal, opens the gate to the destination pen, senses when the animal passes the gate and automatically closes it.

2. The model described is used to determine each animal's share of pen feed consumption, based on predicted shrunk body weight at 28% empty body fat to determine composition of gain, and actual body weight and daily gain.

The Accu-Trac® system contains two key components to predict optimum endpoints:

- The Cornell Value Discovery System equations are used to predict energy requirements and carcass weight and chemical composition.

- Ultrasound technology developed at Cornell University and backfat deposition rates developed at Kansas State University are used to predict carcass fat depth during growth.

A feedlot data set of 12,105 steers and heifers (Table 9) was developed to evaluate the system. The feedlot data was provided by Micro Beef Technologies, Inc. (Amarillo, TX), which was collected with the computerized electronic cattle-tracking system described above. Total feed DM delivered vs the sum of each individual animal predicted DM required was compared using our model. Results from this comparison (Table 5) shows DM required was predicted with very little bias with our modified model (underprediction of –0.91% for steers, and overprediction of 0.89% for heifers). The small bias for each sex indicates the model works equally well for steers and heifers. An underprediction bias of up to 2% in the total DM consumed by feedlot cattle can be expected due to feed fed that was lost and not consumed by cattle (bunk cleaning, wind, etc). A bias is also expected by using a theoretical maintenance requirement of 0.077 Mcal/d/kg $SBW^{0.75}$, which likely varies within and between feedlots due to animal interactions with actual environmental conditions. However, in this data set evaluated, the effects of environment are accounted for in the diet NE_m and NE_g provided by the feedlot consultant, since those values reflect diet NE values required to have predicted and observed ADG agree in the historical data base used to develop their performance projection program.

Table 9. Prediction of individual feed requirements with actual feedlot data[1]

Variable	Steers (n = 8,624)	Heifers (n = 3,481)	Total (n = 12,105)
Predicted EBF percentage	28.22 ± 2.25	28.37 ± 2.26	28.26 ± 2.25
Predicted AFBW, kg	529 ± 56	492 ± 57	519 ± 59
Observed feed DM consumed, kg	9.97	9.47	9.83
Predicted DM required, kg	9.88 ± 1.50	9.56 ± 1.51	9.79 ± 1.51
Bias, %	-0.91	0.89	-0.41

[1] Values are mean ± SD.

An evaluation of the Accu-Trac® system was conducted under commercial feedlot conditions with 735 steers (unpublished data supplied by Thomas Eck and Max Garrison; test sponsored by Allflex USA, Inc. and Micro Beef Technologies, Inc.). The cattle were allowed to continue on feed until the maximum carcass weight or the maximum back fat thickness reached 0.5 inches as predicted by the Accu-Trac® system. As a result, the cattle finished at an average predicted 29.4 (SD of 2.3) percent body fat, which was above the target of 28% body fat. Actual backfat depth averaged 0.47 (SD of 0.15) inches. Ninety three percent of the Cattle achieved the targeted yield grade of 3 or better, 73% of the cattle were YG 2 or better, and 99% of the cattle had a YG of less than 3.99. The cattle graded 73% Choice or better and 98.5% of the carcasses were within the targeted hot carcass range (550 to 950 lb). The carcass discounts ($/cwt) were $7 for select, $12 for yield grade 4, $10 for carcasses under 550 lb, $5 for carcasses 950 to 1000 lb and $25 for carcasses over 1000 lb. The economic benefit was $23.69/head for using the Accu-Trac® system to avoid these discounts.

This data was used to demonstrate how a historical database can be used to establish diet NE_m and NE_g values for a particular feedlot. The diet contained 79.7% flaked corn, 2.3% cottonseed meal, 2.5% cottonseed hulls, 6.5% alfalfa hay, 4% sugarcane molasses and 5% supplement. Diet ME was used to predict NE_m and NE_g (NRC, 1996), and was adjusted until actual and predicted ADG agreed, using actual DMI. The apparent feed NE_m and NE_g values resulting were 0.927 and 0.628, compared to initial calculated values of 0.961 and 0.624. These apparent net energy values reflect feedlot feed processing, environmental and seasonal effects not accounted for in the system or any tabular values. An alternative approach is to use the Cornell Net Carbohydrate and Protein System version 4.0 (Fox et al., 2000) to predict diet net energy values. The values predicted by this model are diet and location specific, by accounting for animal, environmental, feed composition, and level of intake effects.

Application in evaluating a breeding herd. We use the Cornell Value Discovery System to provide feeder calf producers with information on individual animals from their herd for use in selection programs. In the fall of 1997, feeder steers (74) of seven sire breeds from different herds in New York were used in our first group to be evaluated with this system. The steers were implanted with Synovex-S and were re-implanted 70 days later with Revalor, placed on a high-energy diet, and were weighed every 28 days. The research center manager estimated final shrunk body weights at low Choice grade for each steer; some of these estimates were corrected during the study. It was not possible to send each steer to slaughter when they were at their optimum finished point, because of the cost of trucking and collecting the carcass data. For these reasons, we sent the steers to slaughter at Taylor Packing Co. at Wyalusing, PA in two groups. Those chosen for the first group were expected to be at the fatness of low Choice grade. All remaining steers were sent in the second group. The NCBA carcass data service was utilized to obtain complete carcass data. The carcass data was entered into the computer program to compute adjusted final 28% fat weight and feed requirements.

Table 10 summarizes the performance of that year's program. The total feed DM consumed by all cattle was within 1% of the sum of individual predicted feed requirement. The summary in table 10 is based on computing the feed required by each individual, based on the averages (SBW, ADG, and expected final SBW) during the entire trial. The range (minimum and maximum) and standard deviation (SD) are provided to evaluate the variation within this group. The SD added and subtracted from the average gives the range in values that includes two thirds of the cattle.

The days on feed averaged 183 days, with an ADG of 3.47 lb. The weight at slaughter averaged 1235 lb; the average estimated weight at low choice was 1250 lb. The cattle varied widely in finished weight, with the extremely large steers having carcass weights outside of the range desired by the industry. The individual feed requirement varied from 2652 to 4616 lb, depending on total weight gain, composition of gain, and feed efficiency. Feed required per lb of gain varied from 4.77 to 7.19; the most efficient required 20% less than the average and the least efficient required 20% more than the average. Part of this variation is due to differences in stage of growth when started on feed. However, much of it is due to differences in rate of gain relative to average body size. Those that gain faster relative to their body weight use a higher proportion of the feed consumed for growth.

The quality grade indicates on the average, the target of low choice grade was achieved; 86% graded choice or above. None were below select and some were prime grade. The yield grades, which indicate trimmable fat, varied greatly, with the average being above the target of three. Base choice carcass price was $1.12/lb for group 1 sold on May 14, 1997 and $1.09 for group 2 sold on June 2, 1997. Carcass discounts $/lb) were $0.05 for carcass weight (over 929 lb or under 599 lb), $0.10 for grade (select), and $.12 for yield grade (above 4). The prices paid for different weights and grades varied, depending on differences between the USDA grader and grades taken by the carcass data service, and needs of the packer for different markets.

Table 10. Performance of the 1997 herd evaluation steers

Variables (n = 71)	Average	Min	Max	SD
Days on feed	183	174	193	13.4
Initial SBW, lb	592	412	741	79
Final SBW, lb	1235	960	1536	108
ADG, lb	3.47	2.25	4.62	0.40
Individual feed requirement, lb	3815	2652	4616	411
Feed conversion lb DM/lb Gain	5.97	4.77	7.19	0.45
Individual feed cost, $	191	133	231	20
Feed cost per lb ADG	0.3	0.24	0.36	0.02
Carcass weight, lb	803	596	1027	73
Marbling Score[a]	5.2	4	8	0.78
Quality Grade[b]	5.2	4	8	0.78
Yield Grade	3.4	1.9	4.7	0.61
Price, $/lb carcass weight	1.08	0.99	1.12	0.04
Initial Value, $/head	355	247	445	48
Profitability, $/head	251	59	411	48

[a] 3 = traces; 4 = slight; 5 = small; 6 = modest; 7 = moderate; 8 = slightly abundant; 9 = abundant.

[b] 3 = Standard; 4 = Select; 5.0 = Choice-; 6.0 = Choice0; 7.0 = Choice+; 8 = Prime-; 9 = Prime0; and 10 = Prime+.

Average profits per head were high, because of the dramatic improvement in the market during the trial. However, individual profitability range ranged from $59 to $411, with a SD of $48. To identify factors most associated with profitability, prices paid for each category (base price adjusted for yield and quality grade and carcass weight) were averaged to allow the data to be pooled over both slaughter groups to compute correlation coefficients. Correlations of various factors with profitability were: carcass weight, 0.57; total live weight gain, 0.54; average daily gain, 0.42; and feed efficiency, 0.41. Thus the most profitable steers in each group were characterized by maximum carcass weight without discounts that would grade choice at less than yield grade 4 and a high rate of gain and feed efficiency during feedlot finishing. The range in carcass weights without discounts is wider than industry standards, which are more typically 650 to 850 lb. We encourage producers to target that weight range to insure that their cattle size will be acceptable in various markets.

Summary

A modeling system is presented that provides a method for allocating feed to individuals fed in a group on a biological basis, considering differences known to affect requirements (breed type, body size, stage and rate of growth). Post harvest, feed can be accurately allocated based on prediction of final EBF from carcass measures. This modeling system along with additional equations developed by Perry and Fox (1997) to predict carcass weight and compositional changes during growth can be used to market cattle on an individual basis at the optimum time, considering incremental cost of gain and carcass weight and composition discounts. The data can also be used in selecting for feed efficiency that accounts for differences in body size and rate and composition of gain. However, when allocating feed to animals fed in groups, it does not account for differences in efficiency of use of metabolizable energy; to make this calculation, actual individual intake must be known.

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UPDATE ON THE CARCASS MERIT PROJECT

E. John Pollak[1], Michael Dikeman[2], Clare Gill[3], Dan Moser[4], Tom Holm[5], and Elizabeth Westcott[6]

Introduction

The Carcass Merit Project (CMP) is an industry-wide effort to characterize bulls in U.S. beef breeds for carcass characteristics. Traits of interest include traditional carcass measures, Warner-Bratzler shear force measures, and sensory panel observations. The two preeminent objectives of the CMP are:

1) To generate appropriate data for the estimation of expected progeny differences (EPD's) for tenderness on bulls deemed by each breed to be legacy bulls for the next decade.
2) To seek to validate the segregation of quantitative trait loci (QTL) for selected carcass characteristics within each breed.

Each of fourteen breeds participating in the project were asked to identify bulls that were felt would have the largest genetic impact on the breed over the next decade. Ten of these bulls were then identified as "DNA" bulls for which analysis of the bull and fifty of each bull's progeny would be for validation of the QTL under study in this project. Five of the 10 DNA bulls were also designated to obtain sensory panel observations on their progeny. The validation component of this project consists of scoring a bull and his progeny for markers in regions of the bovine chromosomes suspected of containing a QTL based on results from the Texas A & M Angleton project. In that project, QTL were sought using informative families consisting of Angus and Brahman cross and backcrossed cattle. Eleven of the QTL from that project are under investigation in the CMP. Six of the 11 QTL are for Warner Bratzel shear force (WBSF) measures, one for tenderness scores assigned by panelists, three for marbling, and one for rib eye area (REA).

Additional bulls were allocated to each breed in accordance with their number of annual registrations. These additional bulls are referred to as EPD bulls. Twenty-five progeny from each of these bulls were measured for traditional carcass traits and for WBSF. No biological material for DNA analysis of these bulls or their progeny was captured.

Data

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[1] Cornell University, Ithaca, NY
[2] Kansas State University, Manhattan
[3] Texas A&M University, College Station
[4] Kansas State University, Manhattan
[5] Celera AgGen, Davis, CA
[6] National Beef Cattlemen's Assoc., Englewood, CO

The 14 breeds participating in the project and number of progeny harvested and processed into the CMP database as of June 2001are shown in Table 1. These numbers do not include a large number of animals (approximately 1000) harvested in the spring and still in the process of being recorded.

Along with these phenotypic data, genotypic information on 110 bulls for six markers around each of the 11 QTL (three proximal and three distal predicted location of the QTL) has been obtained. Of these bulls, 11 have produced enough harvested progeny to have their progeny genotyped. Each progeny was genotyped for two marker loci around each of the 11 QTL. The markers used for each progeny within a bull family were those found to be heterozygous in their sire, chosen such that one was proximal and one distal to the predicted location of the QTL associated with those markers. As well, a small meat sample was obtained from the carcass to verify that the carcass sample was consistent with the blood sample for the progeny. As such, two types of errors were detectable, mispaternity (the genotype of the calf blood sample was not consistent with the sire identified in the data for that calf) and misidentity (the meat sample genotyped was not consistent with the calf blood sample genotype). In this update, I will focus on the results of the analysis of the 11 bulls having completed the DNA marker testing.

Results

Mispaternity and Misidentity

Two sires were eliminated from the validation analysis due to large numbers of both mispaternity and misidentity of their calves. Of the nine remaining sires, there was 5.5% mispaternity and 8.6% misidentity among the 396 total progeny analyzed.

Validation

Table 2 shows the results of within-family analysis of the association of markers to the segregation of progeny for QTL. The analysis was to separate the progeny into two groups based on their genotypes at the marker loci and a t-test was run on the phenotype data from the calves across the two groups. Phenotypes were deviated from contemporary group averages for this analysis. The probabilities shown in the table are that there was a statistically significant difference in the means of calves sorted for each QTL based on their marker genotypes for those QTL. This implies that the bull is heterozygous for the QTL, and hence that at least two alleles for that QTL are segregating in that breed.

None of the bulls were detected to be heterozygous for any of three marbling QTL or the REA QTL. Reasons for not detecting segregation in these bull half-sib families are:

1. The QTL found in the research phase were false positives.
2. The QTL had a distinct allele in either Angus or Brahman cattle used for discovery.
3. The QTL are segregating but that the sample of bulls completed thus far were simply homozygous.

4. There were heterozygous bulls but the effects were too small to detect with our sample size.

Five of the six QTL for WBSF were found to be segregating in at least one bull (QTL 2 was not), and some were found to be segregating in more than one bull (QTL 3, 4 and 5). Only one bull was implicated as being heterozygous for the tenderness phenotype provided from the sensory panel results. The nine bulls are from four breeds so a more comprehensive breed analysis could not be done at this time. The effect of the QTL found segregating has not been estimated.

Table 1: Breeds participating in the CMP and progeny record counts by breed

Breed	EPD Sires	DNA Sires	Total by Breed
Angus	304	426	730
Brahman	9	238	247
Brangus	12	144	156
Charolais	282	229	511
Gelbvieh	80	139	219
Hereford	354	274	628
Limousin	141	49	190
Maine-Anjou		122	122
Red Angus	31	196	227
Salers		188	188
Shorthorn	48	87	135
Simbrah		138	138
Simmental	387	322	709
South Devon		213	213
Total			4413

Table 2: Analysis of bull progeny groups for segregation within family of 11 QTL. Probabilities are those for the bull in question to be heterozygous for the QTL associated with the marker analysis.

		Bull								
QTL	Trait	1	2	3	4	5	6	7	8	9
1	WBSF					P<.02				
2	WBSF									
3	WBSF						P<.04			P<.03
4	WBSF	P<.03	P<.0				P<.02			
5	WBSF	P<.01						P<.01	P<.03	
6	WBSF						P<.02			
7	Tenderness					P<.02				
8	Marbling									
9	Marbling									
10	Marbling									
11	REA									

Whole Herd Analysis Committee Meeting Minutes

BIF 2001 MEETING
July 13, 2001

The Whole Herd Analysis Committee meeting was called to order at 2:00 p.m. as part of the BIF Annual meeting held in San Antonio, TX. The agenda was as follows:

Research Update and Guidelines Proposal for Animal Identification Systems – Dr. Bruce Golden, Colorado State University and Optibrand, Ltd. LLC., Fort Collins, CO.

Research Update on the Development of a Cow Maintenance Genetic Prediction – Dr. John Evans, Oklahoma State University.

Review of Red Angus' Total Herd Reporting System – Ms. Kenda Ponder, Customer Service Manager, Red Angus Association of America.

Guidelines Proposal for Whole Herd Reporting – Dr. R.L. Hough, Red Angus Association of America.

After each presentation there was a lively discussion period. The first presentation discussed the content for a proposed appendix for the new BIF Guidelines. Likewise, the last presentation covered the proposed material for the Whole Herd Reporting section, which will be included within the Breeding Herd Analysis chapter of the new BIF Guidelines. The proposed guidelines utilized a two-inventory system, one for spring calving cows and one for fall calving cows, and the merit of utilizing only a single inventory was discussed. Dr. Roger Hunsley asked if he could present a written alternative for consideration utilizing a single inventory. The group agreed with this request. At the conclusion of the discussion, those present voted to recommend the Whole Herd Reporting proposal for inclusion into the Guidelines as presented. After a busy afternoon, the Whole Herd Analysis Committee meeting was adjourned at 5:00 p.m.

Respectfully submitted,

Robert L. Hough, Chair

CATTLE IDENTIFICATION

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Introduction

Consumer's increasing awareness of food safety concerns and an increase in the amount of information available for management decision has resulted in an increase in the need and options for livestock identification. The requirements of individual cattle identity preservation fall into two general categories:

1) *Identify animals for management decisions.* This includes identity preservation for tasks such as performance data collection, and sorting for treatment or management.

2) *Preserve identity for secure transactions.* This includes ownership verification (e.g., collateral on operating loans), movement control (e.g., disease epidemic control such as FMD), contaminated product recall (e.g., source of bacterial or other contaminant), litigation of responsibility for a contaminant in the raw material food supply, accountability for processes in specialty markets (e.g., hormones in EU export, or for branded beef production programs), accountability for processes in required circumstances (e.g., FMD vaccination).

Preserving identity for food safety issues, specifically, has provided the cattle industry with a unique opportunity to use data normally lost in the production chain because of ownership changes. It is anticipated that in the future a majority, if not all commercial cattle will have their identity preserved for food safety and disease control. This will give seedstock and commercial producers better access to commercial production data for genetic improvement and management decisions analysis.

Below is a discussion of the most common currently available conventional technologies for animal identification and an analysis of their suitability for meeting each of the needs just mentioned. The method used to preserve individual identity must meet the requirements of either 1 or 2 above in a cost effective way.

Additionally, identity for *management decisions* must be easily read from a reasonable distance, have a relatively low rate of transcription errors, have a relatively low failure rate, and often be suitable for high volume cattle handling situations such as at a feedlot.

Because all the reasons for *secure identity preservation* have a legal consequence, either civil (e.g., contract violation) or criminal (e.g., fraud, or regulatory compliance) the method must meet the requirements for admissibility as evidence in a court of law or for use by a regulatory agency. Often admissibility requirements are dependent on the circumstances of the litigation and can be poorly defined or understood for certain types of transactions. For example, identity preservation using DNA can be admissible for parent verification but does not guarantee source of origin. Therefore DNA based identity would not provide conclusive evidence of an animal being at a specific contamination source at a given time.

Branding

Currently, 16 states have hot iron branding regulations for animal ownership identity. This type of branding does not typically provide individual identity. However, branding animals with individual identification numbers is still done. However, with the loss in hide value documented in the National Beef Quality Audit, along with humane considerations, the industry appears to be moving away from branding as a common practice or at least reducing its reliance on large brands.

The greatest shortcomings of brands include difficulty to read, they are alterable, and they do not assure uniqueness of identity or ownership (i.e., they can be easily duplicated). Also, branding does not provide conclusive evidence of a source of origin.

Conventional Ear Tags

Plastic ear tags provide an effective and low cost method for identity for management decisions and data recording in most situations. They can be prone to transcription errors in high volume data recording situations, especially when large, complex numbering systems are used.

Several countries have tried to adopt a countrywide identity number for conventional ear tags. The USDA APHIS has proposed their AIN system (American identification number). Repeatedly these types systems have failed in the countries that have tried them. Problems with fraud prone transactions and the difficulty in reliably reading large numbers can result in numbered ear tags not being suitable for more than on farm management.

Countries such as New Zealand have attempted to add a barcode for automated reading of conventional tags to improve the read reliability. However, in the second quarter of 2001 the New Zealand organization responsible for administering the system, Meat New Zealand, requested comments for a replacement system. The tags may get dirty, or scuffed, and the ink can fad to a degree that makes the bar code difficult to acquire.

Because tags can be moved or removed, they do not meet the requirements for admissibility as evidence for most secure transaction.

Tattoo

Tattooing has been used for brucella vaccination assurance, as a backup to the metal brucella band ear tag. Tattoos can be very difficult to read, rendering them unsuitable for management decisions and high volume secure transactions such as contaminated product recall. In extreme cases of unclear tattoos they do not allow for reliable identification for secure transactions. Tattoos can be altered and do not guarantee uniqueness so other types of secure transactions such as claims of ownership cannot be assured.

Radio Frequency Tags and Implants

Radio Frequency (RF) devices in ear tags can be a useful solution to the need for individual identity preservation in high volume data collection or animal sorting environments such as feedlots. Ear tag costs are dropping to levels where it may be a sensible alternative in some operations.

Many in the packing industry, because of the food contamination risk, have resisted subcutaneous RF implants. More importantly RF tags or implants do not meet the requirements of admissibility for most secure transactions. It is easy to remove or replace an RF device.

DNA Based Methods

Several alternatives are available for animal identity based on DNA. The advantage to using DNA identification is that it can potentially identify product all the way to the retail meat case. However, DNA is expensive and slow. Developments of the technology that include high-speed DNA processors may reduce both the time and price in the future.

At least two DNA based animal identification systems are being used for ownership traceability, presumably to support contaminated product recall and investigation of food safety violations. However, both the Irish industry system and the system used by a meat packer in New Zealand only archive tissue samples from animals at the point of slaughter. If an investigation of a food safety violation were actually implemented and a contaminated product recall were required, including recall of potentially collaterally contaminated product, it would take a great deal of time and expense to perform the chemistry and analysis necessary to use the tissue archives. It is likely with current technology that the time required would eliminate the utility for an effective product recall.

DNA can be useful as evidence of parentage and association with products such as a unit of frozen semen. However, DNA and none of the previously discussed methods support evidence of ownership, location, or animal association in a situation such as where identification of collaterally contaminated product is required. The following methods cover a wider range of suitability requirements for secure transactions including location and association assurance.

Paper Based Methods – Animal Passports

Countries in the European Union have adopted a verity paper based method for cattle commonly called "animal passports". In most of these programs, each animal is associated with a booklet containing multiple pages. When an ownership or movement of the animal occurs the owner is required to fill out a page of the passport and send it to an organization responsible for centrally processing the movement data.

Combined with effective oversight, this system can provide a higher degree of admissibility as evidence, especially when location and association to other animals is necessary as it is in contaminant and disease control.

However, the direct costs of managing passport systems are high. The British Cattle Identification Agency indicates that their cost is $11.25US per animal. The hidden costs to the farmers and industry in general have not yet been quantified. Additionally, the British system did not prove effective in controlling the 2001 Foot and Mouth disease outbreak. However, this was likely due to the fact that sheep did not have a system and were potentially smuggled, spreading the disease beyond the borders of the UK.

Biometric Identity

Biometric identity verification has been used in human applications for many years and could satisfy the requirements of identity preservation for secure transactions. Biometric measures of identity for humans include finger printing, voice recognition, face recognition, iris scanning, and retinal imaging. Of these only retinal imaging is suitable in livestock applications. Iris scanning, using the patterns of the animal's iris, has certain technical problems for use in high volume situations. Recent work in retinal imaging shows a great deal of promise as a reliable, unalterable method of identity preservation. Retinal vascular patterns are permanent and unique in livestock. Also, retinal vascular pattern images support high speed searching of very large databases of animals.

Biometric measures by themselves do not provide completely admissible evidence for all food safety investigations and product recall situations. However, combining a biometric measure such as a retinal image with a securely encrypted time and location signal taken from a global positioning satellite (GPS) receiver provides a very compelling and low cost solution for identity preservation for secure transactions.

Commercial implementations of livestock systems are imminent. These systems promise to be fast, low cost, and easy to use.

A NEW GENETIC PREDICTION FOR COW MAINTENANCE ENERGY REQUIREMENTS

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The average maintenance requirements for a mature cow represent approximately 70 percent of her feed expenses. In order to be profitable and sustainable, it is important that cattle producers be able to select animals that fit their production environment. Many producers probably have at least one cow that always rebreeds, seems to always be fatter than others in the herd despite poor feed conditions, and will produce a calf each year no matter what the environmental conditions. Some animals simply have lower energy requirements for maintenance and are able to maintain their body tissues with fewer calories.

What is Maintenance Energy?

The maintenance energy requirement of an animal is the energy required to sustain their body tissues with no net change in body tissue. Simply stated, it is the amount of feed required so an animal is not gaining or losing weight. This level of energy does not include the additional energy needed for an animal to grow, sustain a pregnancy, lactate, or withstand changes in weather.

Previous research has reported maintenance energy requirements in beef cattle to be heritable and differences are present between breeds. A 1985 study by Meat Animal Research Center (MARC) scientists, Ferrell and Jenkins, compared several breeds and measured their requirements for maintenance energy (Table 1). Their results showed that maintenance energy needs are different across breeds, especially breeds with above average milk production. Having genetic predictions for maintenance energy requirements could provide cattle producers with an additional selection tool to manage costs; however, collecting and recording large volumes of individual feed intake and calorimetry data is both an expensive and time consuming process and is not practical on a breed-wide basis.

In the past, mature size has been used as an indicator trait of maintenance energy requirements. In comparison to a smaller mature weight animal, on average, animals with heavier mature weights will require more energy intake to maintain their basic body functions. Using the relationship between mature size and maintenance energy, an animal's body weight can be used to estimate their maintenance energy requirements. Previously, research has shown that mature weight alone is not the most accurate for this purpose; however, it is more practical than other methods, such as calorimetry.

Table 1. Estimates of metabolizable energy required for maintenance (MEm) of various breeds or breed crosses[a]

Breed or breed cross	Physiological state	MEm, kcal/(kg$^{.75}$.d)
Angus-Hereford	Non-pregnant, non-lactating, 9-10yr	130
Charolais X	" " "	129
Jersey X	" " "	145
Simmental X	" " "	160
Angus	Non-pregnant, non-lactating, 5-6yr	118
Hereford	" " "	120
Simmental	" " "	134

[a] Adapted from Ferrell and Jenkins, 1985

Maintenance energy requirement is more properly estimated when the mature weight is adjusted to account for differences in body size (surface area) to obtain what is known as metabolic body weight. Metabolic body weight is calculated as a fractional power of shrunk body weight, with the most commonly agreed upon adjustment being body weight to the three quarter power (BW$^{.75}$). Previous work has shown that BW$^{.75}$ is proportional to an animal's fasting energy expenditure; therefore, an individual's maintenance energy requirement will scale with weight. All other factors being equal, this means that a small animal will be expected to have a higher metabolism per pound than a larger animal.

Another important source of variation for maintenance requirements is an animal's visceral organ mass, including the stomach, liver, intestines, and cardiac tissue. Additional research by Ferrell and Jenkins showed differences were present between breeds for visceral organ mass because of specialized functions within breed, such as lactation, which places a higher physiological demand on energy requirements. Therefore, differences in visceral organ mass should be associated with differences in level of milk production. If all factors except visceral organ mass are equal, individuals with genes for higher milk production are more likely to have a larger visceral organ mass compared to individuals with genes for lower levels of milk production. In a 1988 Texas A & M study, researchers found that the differences among individuals for milk potential will also manifest as differences in visceral organ mass. Therefore, an animal with genetic merit for higher milk production will often have higher maintenance requirements as is demonstrated in Table 1 with the Jersey and Simmental crosses. In fact, a 1990 study done at University of Nebraska estimated that milk production was responsible for 23 percent of the variation for maintenance energy requirements.

Mature Cow Maintenance Energy EPD Development

Unlike an indicator trait such as mature weight, an EPD for maintenance energy requirements in beef cattle would fit very well into a developing list of economically relevant traits because of its direct effect on the profitability of a cow-calf enterprise. A genetic prediction for maintenance requirements would enable cattle producers to effectively select animals with increased feed efficiency, better match cattle to their forage and production environment, and provide additional insurance for harsh weather conditions.

The development of an economically relevant EPD for cow maintenance energy requirements was feasible because of research at Colorado State University and the USDA-ARS Fort Keogh Laboratory in Miles City, MT. We used equations from the current version of the National Research Council guidelines for beef cattle nutrition and research results of Dr. MacNeil with the USDA-ARS Lab. We combined this information with available genetic predictions in national cattle evaluation for mature weight and milk (maternal weaning weight) to construct the prototype maintenance energy requirement EPD.

Maintenance Energy EPD

The equations used in this study to predict maintenance energy requirements include mature weight and milk EPD. Using known relationships between mature weight and maintenance energy requirements, we calculated the maintenance requirement using metabolic body weight or weight to the three quarter power and converted it to megacalories (Mcal).

Using mature weight to explain differences in cow maintenance energy requirements is a good place to start; however, mature weight alone might be insufficient to explain differences among animals for maintenance energy requirements. Previously reported research shows that animals of the same mature size are not always equivalent for maintenance energy, especially when we evaluate them at different production levels (i.e. lactation).

Although the milk EPD is not derived directly from milk production and is determined from the maternal component of weaning weight, it is well documented the EPD adequately represents actual milk production. These differences in milk producing potential can be related to differences in energy requirements for lactation and variation in visceral organ mass. Interestingly, this higher energy demand does not dissipate when a cow is in the dry period of production. Even though a cow is not milking, she still must maintain the body tissues that drive her higher milk production.

Researchers have also determined how animals lactate over time and what the energy values are for milk components. Using this information, we are able to represent lactation with a mathematical function and use milk EPD to predict an animal's milking ability. The genetic merit of an individual for higher or lower milk production would affect their prediction for cow maintenance energy requirements. Therefore, animals of the same size but different levels of milk production would consequently have different maintenance energy requirements. This approach to predicting maintenance energy helps explain additional differences among animals in a population and improves the accuracy of each maintenance energy requirement prediction.

Expression of the Trait

Currently, the trait for mature cow maintenance energy is expressed as megacalories per year (Mcal/yr). Because this is a relatively new trait, we are still determining if this is the most appropriate way to express the trait. The benefits of using megacalories instead of other units of measure are that it is easy to translate to other energy units and it conforms to what is accepted by the nutrition community and National Research Council guidelines for nutrition in beef cattle. Additionally, people are familiar with calories on nutrition labels, so expressing the trait in these units is not completely foreign.

Multiple ways to express units of energy are available and we should consider each of these alternatives before selecting a method. A few of the units include: animal unit monthly (AUM), megacalories (Mcal), total digestible nutrients (TDN), kilocalories (Kcal), and megajoules (MJ). Some of these units are unique to an application and others are functions of other units (e.g. 1 Mcal = 1000 Kcal).

It will be important to express the trait of maintenance energy requirements in such a way that cattle producers will thoroughly understand the interpretation and correctly apply it in their breeding programs. One way to enhance the understanding of a maintenance energy EPD would be to use example diets (i.e. pasture grass, grain, or hay) to provide a frame of reference for producers to interpret and compare animals for maintenance energy requirements. Using an example diet and reasonable estimates of feed prices, a cattle producer could assess the economic benefit of using one sire over another sire in a breeding program.

Research Results and Discussion

A prototype EPD for cow maintenance energy requirements has been completed for the Red Angus breed. There is a summary of the results in Table 2 and the EPD are expressed on an annual scale (Mcal/yr). The results of our analysis show that differences are present among all animals and sires for maintenance energy requirements. For all animals, there is greater than a 1000 Mcal per year difference between the highest and lowest animal. A cattle producer could use this EPD in a selection program to modify maintenance energy needs in his/her herd and select cattle whose maintenance energy requirements are most appropriate for the environment in which they will be managed.

How does this maintenance EPD work? For example, we have a herd of Red Angus cows and two sires available at breeding time. Sire A has a maintenance energy EPD of 400 Mcal/yr and sire B has an EPD of 0 Mcal/yr. On average, we expect the progeny from Sire B to require 400 fewer Mcal per year for maintenance energy requirements relative to sire's A. You might be asking yourself how many days on feed does that value equal? If we take an average Red Angus cow, she will require 11 Mcal per day or 4,015 Mcal per year of energy. Reducing her energy needs per year by 400 Mcal would result in a 10% reduction in annual feed inputs. If all other factors remain constant, this reduction in the number of calories should result in fewer feed inputs and a lower cost of production.

Table 2. Mean, standard deviation, and range of EPD (Mcal/yr) for mature cow maintenance energy for Red Angus cattle

	All Animals (N = 56,582)	Sires (N = 5,912)
	EPD	EPD
Mean	22.4	23.8
Standard Deviation	102.1	94.8
Minimum	-427.9	-381.9
Maximum	581.9	434.0

A change in maintenance energy requirements for any one animal might be viewed as unimportant; however, these changes do accumulate across an entire herd and over multiple generations. Selecting animals to reduce maintenance energy requirements could impact a producer's profitability through a reduction in production costs given all other performance indicators were unaffected.

Future Directions

The EPD that we proposed for maintenance energy requirements is a prototype. More research is necessary to improve the accuracy of the genetic predictions. Currently, we are just using mature weight and milk (maternal weaning weight) to predict mature cow maintenance energy requirement. We selected these traits because the genetic predictions and methods were available to develop an EPD for the trait. Alternative indicator traits and direct measures of maintenance energy are needed to improve the accuracy of our prototype EPD. Other candidates for indicator traits might include body condition, visceral organs (i.e., liver size), and cell-level indicators of maintenance energy requirements. Additional research will be required to determine how these sources of information can be incorporated into our existing genetic prediction.

Summary

A predictor for mature cow maintenance energy requirements should provide both commercial and seedstock producers with a selection tool for a trait that directly impacts cost of production. If adopted by the industry, producers will need to continue their efforts to collect mature weight information and other indicator trait information. Furthermore, researchers will need to continue to research and enhance this new economically relevant trait.

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TOTAL HERD REPORTING

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Total Herd Reporting is an important concept, and is the cornerstone of producing unbiased reliable EPDs. Without Total Herd Reporting, Contemporary Group differences are only partially evaluated because not all the data is collected for analysis. Therefore, THR is vitally important for producing unbiased reliable EPDs in the areas of growth, reproduction and carcass traits; allowing breeders and their customers the opportunity to fully evaluate the cattle available. With THR, the production or non-production of all females in the herd for a 12-month period will be reported. Consequently, the production of females is more credible, which reflects also on bulls.

In 1995, the Red Angus Association of America implemented the concept of THR. Over the last six years much has been tried and learned about how to implement a reporting calendar, which emphasizes reporting for all females within a herd as opposed to a per calf basis. The method of reporting on a per calf basis emphasizes selection and bias, but in a herd based fee structure, each cow in the breeding herd is charged an "annual assessment". The amount of assessment is derived based on a breeder registering a percentage of the annual calf crop. The costs of processing information are charged to the animals in the breeding herd rather than to the calves registered.

A calendar is a set guideline for both the breed association and the breeder to know when reports are sent out and when they are due back. The Red Angus Association of America's THR calendar is based on a two-inventory system: a spring inventory and a fall inventory. The spring inventory includes those females which calve between January 1st and June 30th; and the fall inventory includes those females which calve between July 1st and December 31st. These times were selected because, for most producers, it is between weaning/pregnancy check time and the time they start calving. It is at this time that producers can accurately determine which animals will be in their herd for the coming year. The cow herd inventory lists females which are 16 months of age as of January 1st for the spring inventory, and those which are 16 months of age as of July 1st for the fall inventory. The herd inventory also consists of a bull herd inventory; bulls may be carried on either inventory. Differing from cows, a bull can be removed from inventory without penalty from one year to the next, if the bull will not sire calves during a given year. A heifer herd inventory is also included, and the heifers listed are those of a member's previous yearling heifer inventory that are now of assessment age. In addition, barn sheets are included with the mail out of herd inventories for the collection of ultrasound data. The analysis of ultrasound information improves the accuracy of carcass EPDs, without animals being harvested for carcass data. The barn sheets are provided to the breeder in order to submit information to the Centralized Ultrasound Processing (CUP) lab regarding the animals that have been scanned. Barn sheets should not be returned to the breed association. At this time, the collection of ultrasound data on Red Angus breeder's yearling animals is taken on a voluntary basis.

The purpose of the herd inventory is to provide a list to the breed association of the animals that the breeder will be collecting performance and production data on for the next 12 months. The inventory consists of the animals carried over from the previous year's inventory, as well as any new natural or purchased additions that have entered the herd over the last 12 months. The list may also contain animals from the previous year's inventory, which will not be carried on the coming year's inventory. The herd inventory allows the breeder to dispose of animals they will not be collecting performance or production data on, through a list of disposal codes, as well as reporting a change in inventory seasons for females –Spring to Fall or Fall to Spring.

Disposal Codes
7 = died after weaning due to disease
8 = died after weaning due to other reasons
9 = died due to age
10 = culled -- physical defect
11 = culled -- fertility
12 = culled due to performance or productivity
13 = culled due to temperament
14 = culled due to age
15 = culled -- other including sold but not transferred
16 = alive, but not active (Bulls only)
17 = sold unexposed (Heifers only)
18 = sold exposed open (Heifers only)
19 = sold exposed bred (Heifers only)

For those breeders who winter calve or summer calve the Red Angus Association of America initiated the 45-day window for females, in order to avoid females changing inventory every year. Therefore, a spring inventory female may calve as early as November 15th or as late as August 15th, without changing inventory. Similarly, a fall inventory female may calve as early as May 15th or as late as February 15th, without changing inventory.

Animals sold and transferred to another breeder are denoted in the system and should not be marked as disposed on the herd inventory. The responsibility of collecting performance and production information now lies with the new owner. Although reporting responsibility changes to the new owner, the animal's annual assessment must be paid by the owner on record at the time of inventory.

The yearling heifer inventory (Heifer Exposure Inventory) is important for the data collection towards the heifer pregnancy EPD. The heifer pregnancy EPD describes the percent probability differences of a sires' daughters becoming pregnant if exposed. At this time, the data collection for the heifer pregnancy EPD is optional for Red Angus members. It is a simple procedure with a heifer exposure inventory consisting of a member's yearling heifers mailed in May for spring herds and November for fall herds. The breeder designates exposure information, yes or no for exposed (palpation results should not be included); the breeding season, start and end dates; management group designation; and disposal information. The following January or June, the Herd Inventory will include the active heifers, which are now of assessment age.

An annual assessment is one fee to cover routine services. Payment of the assessment makes the animal active for the next 12 months. Routine services would include reporting/registration of the natural calf, printing of the first registration certificate and first time transfer on young animals (heifers under 24 months and bulls under 30 months). Free initial transfers on young animals promote an accurate bull inventory of commercial customers. Assessment age is defined as females 16 months of age or older on January 1st for spring herds, and July 1st for fall herds. Assessment age for bulls are those 30 months of age or older on January 1st for spring herds, and July 1st for fall herds, unless a bull has progeny recorded or non-owner bull permits/A.I. certificates purchased prior to 30 months of age when the bull will be subject to the annual assessment. The association will send the billing report for annual THR assessments based on the Spring or Fall Herd Inventory. The total amount is billed at 20% per month, five monthly installments. A member with less than eight head, will be billed the total amount on the monthly statement.

Pre-listed weaning worksheets begin the process of collecting performance and production data for all the assessment age females that were listed on a person's inventory. Weaning worksheets for spring inventory animals are sent out the first week in August; fall inventory animals are sent out the first week in March. Either a calf record, reason code or disposal code is necessary to fulfill data requirements for THR. The details are as follows:

1. A calf record, weigh date and weaning weight, or for calves born dead or that die before weaning, a disposal code. Applicable disposal codes would be:

- 2 = stillborn/full term
- 3 = died at birth due to a birth defect
- 4 = died at birth for other reasons
- 5 = born alive, but died before weaning due to disease
- 6 = born alive, but died before weaning due to other reasons

OR

2. Reason code for the cows with no calf record. Applicable reason codes would be:

- 1 = open / missed calving opportunity
- 2 = ET program / donor dam
- 3 = Moved to next calving season (ex. Spring to Fall)
- 4 = ET program / recipient cow
- 5 = Aborted premature – use this reason code for the cow rather than disposal of calf.

OR

3. Disposal code on the cow (listed on the second page of this article)

The THR concept encourages calves not be reported until weaning time, hence the pre-listed weaning worksheets. By submitting all production records at weaning time, a breeder avoids the disadvantage of a per calf base structure, where a breeder must decide at an early age whether or not to register a calf in order to take advantage of reduced fees. With THR, performance data for all calves is reported, but the decision remains with the breeder whether or not to register the calf. If a calf is reported and not registered, the female is at least given credit for having had a calf. With incomplete reporting, it is impossible to distinguish between cows that did not conceive and cows that did not produce a registered calf. With complete reporting, the accuracy of the Stayability calculation improves directly because all calves will be accounted for in the herd. The Stayability EPD is a measure of sustained fertility and is expressed as the percent probability differences of sires' daughters remaining in the herd past six years of age, given that they entered the breeding herd.

The No Progeny Report is a reminder to breeders that one of the requirements for THR has not been received for the previous 12-month period for females that appeared on the initial inventory. No Progeny reports for spring inventory animals are sent out around March 15th; while fall inventory animals are sent out around August 15th. The purpose of the report is to collect production records, which may have been overlooked. It is not the time to report disposal codes for cows. If a record for the previous year is not received for the females on this report, they are subject to inactivation.

If one of the THR requirements is not received during the 12-month period on either the weaning worksheets or the no progeny report, the animal is inactivated in May for Spring herds and in October for Fall herds. Any animal, which is inactivated, is subject to the reactivation fee plus the current year assessment in order to reinstate the animal to active status. This fee strongly encourages the concept of TOTAL Herd Reporting, regardless of the data being submitted.

In summary, just three steps can complete the requirements for Total Herd Reporting (dates will vary with respect to Spring or Fall Inventory).
1) Herd Inventory – determines cow herd inventory for the year;
2) Annual THR billing – assessment per animal;
3)Weaning worksheets – required reporting for each female on inventory.

However, if the three steps are not completed according to the calendar, additional steps will need to be taken to avoid incomplete reporting, including the No Progeny Report and possibly the Inactivation Report.

The last two steps, Heifer Exposure Inventory and Barn sheets for Ultrasound collection are voluntary components to the Red Angus Association's Total Herd Reporting system, however breeder participation is encouraged.

In order to track performance records on a herd from year to year, a schedule is needed as well as requirements to meet that schedule. By the association maintaining a consistent schedule every year, reporting timetables will become second nature both to the association and to the members.

Spring Calendar

January	Association mails Herd Inventory with barn sheets
February	Member returns Herd Inventory
March	Association mails No Progeny Report
April	Member returns No Progeny Report
May	Association runs inactivation report Association mails Heifer Exposure Inventory
July	Association bills annual assessments
August	Member returns Heifer Exposure Inventory Association mails Pre-listed weaning worksheets

Fall Calendar

June	Association mails Herd Inventory with barn sheets
July	Member returns Herd Inventory
August	Association mails No Progeny Report
September	Member returns No Progeny Report
October	Association runs inactivation report
November	Association mails Heifer Exposure Inventory
December	Association bills annual assessments
February	Member returns Heifer Exposure Inventory
March	Association mails Pre-listed weaning worksheets

PROPOSED WHOLE HERD REPORTING GUIDELINES

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Whole Herd Reporting (WHR) is a simple, straightforward system designed to promote collection of performance records on all registered cattle produced. Rather than a calf-based fee structure that discourages complete reporting, the WHR fee, or annual assessment, is charged on each animal in the breeding herd.

The objective of WHR is to record production and performance information on all animals in the breed. The responsibility of selecting which animals to register remains with the breeder. In other words, performance records (or disposal or reason codes) are required on all calves produced by each member, but whether any or all of those calves receive registration papers is the breeder's decision.

Herd Inventory.

The annual inventory will be sent out in early January for spring calving herds (January 1st – June 30th) and in June for fall calving herds (July 1st – December 31st). Each member will identify those animals to be removed from inventory and add any new animals of breeding age not found on the inventory report (new purchases, etc.) and return the completed inventory report to the national office. The inventory should list all animals the breeder will be collecting performance and production data on for the next 12 months.

Assessment Age.

Assessment age is defined as females at least 16 months of age and males at least 30 months of age or older on the date of inventory—Spring calving: January 1; Fall calving: July 1. Payment of the annual assessment makes that animal "active" for the following 12 months and entitles the breeder to: 1) register one calf born to each female during that 12-month period; and 2) transfer that calf to a new owner if the transfer occurs before the animal reaches 24 months of age, if female, or 30 months, if male.

- Assessment paid on a bull allows the owner to register calves sired by that bull and purchase non-owner bull permits from the Association for that bull. The bull permit fee remains a separate charge.
- Bulls under assessment age, which are kept for sale will not be assessed. However, annual assessments must be paid on bulls that are younger than 30 months of age on the inventory date before any progeny can be registered or A.I./non-owner bull permits purchased.
- Cattle entering the inventory during the 12 months following the inventory date will be charged the full annual assessment.

Requirements.

During each 12-month period one of the following must be received for each cow on inventory:

- Calf record, include calves that die before weaning with disposal code for calf
- Disposal code on cow
- Reason code (Open, ET program, Moved to next calving season)

Any cow on inventory will be inactivated unless one of these three items is reported. A reactivation fee will be required for reinstatement. If a cow goes off a member's inventory and subsequently reappears in later years, the reinstatement fee plus the current annual assessment will be required to reinstate the cow.

Data to record on individual cows:

1. Breeding date(s)
2. Pregnancy status
3. Calving date
4. Calf's survival status
5. Cow disposal status
6. Cow reason code
7. Prolificacy (singles, twins, etc)

Breeding Dates.

Record dates of artificial insemination (A.I.) services or of observed natural matings. For pasture matings, record natural service exposure (start and end of breeding season) dates.

Pregnancy Status.

Record a score of 0 for open and 1 for pregnant. When females are 50 to 150 days into their pregnancies, rectal palpation for pregnancy should be done by trained personnel.

Calving Date.
Each calf's birthdate is also his dam's date of calving. As a trait of the cow, this date is very useful for calculating gestation length and days to rebreeding.

Calving Difficulty or Ease. Record with the following scores:

Score 1 – No difficulty, no assistance
Score 2 – Minor difficulty, some assistance
Score 3 – Major difficulty, usually mechanical assistance
Score 4 – Caesarean section or other surgery
Score 5 – Abnormal presentation

Scores 1 through 4 may be averaged for data summarization (such as national cattle evaluations), but Score 5 should not be included in averages. Although they contribute to calving difficulty, abnormal presentations do not appear to be related to the genotypes of the calf (sire and dam direct contributions) or the dam. Thus, inclusion of abnormal presentation would bias to some degree any genotypic evaluation.

From this data, expected progeny differences for calving ease-direct and calving ease-maternal could be calculated, and reported as percentage of unassisted births.

Disposal Codes.

his history of each cow for the calf crop just weaned identifies when a failure occurred in weaning a live calf, as well as disposal of potential breeding stock post-weaning or after they have successfully entered the breeding herd.

Disposal Codes: Birth to Weaning.
Record as follows:
1 – Stillborn/full term
2 – Died at birth - defect
3 – Died at birth - other
4 – Born alive, died before weaning - disease
5 – Born alive, died before weaning - other

Disposal Codes: Post-weaning to Two-Year Old.
Record as follows:
10 – Died after weaning – disease
11 – Died after weaning – other
12 – Culled – feet and legs
13 – Culled – performance
14 – Culled – temperament
15 – Sold exposed – open
16 – Sold exposed – pregnant

Disposal codes: Mature cowherd.
Record as follows:
30 – Sold – certificate not transferred (if seedstock)
31 – Culled – teat and udder
32 – Culled – feet and legs
33 – Culled – fertility
34 – Culled – productivity/progeny performance
35 – Culled – temperament
36 – Culled – age
37 – Died – age
38 – Alive but not active in members inventory (bulls only)

Reason Codes.
Reason codes should be utilized to account for the production of a cow that does not raise a natural calf.

Record as follows:
50 – Open – missed calving opportunity
51 – ET program – donor dam
52 – ET program – recipient dam
53 – Moved to next calving season
54 – Aborted / premature

Multiple Births.
In the case of multiple births; twins, triplets, etc., no additional assessment beyond the cow's annual assessment will be incurred on a dam.

ET calves.
The annual assessment must be paid on each ET calf unless the recipient dam is 'active (i.e. current year assessment paid), in which case no additional assessment is due. If the annual assessment on the donor dam has been paid, the owner of the donor dam is allowed one calf registration, whether natural or E.T. Conditions governing registrations and transfers on these calves will be identical to those for single, natural-birth calves.

Whole Herd Reporting Annual Schedule

Spring Calving Dates	Description	Fall Calving Dates
January 1	Association sends out preliminary Herd Inventory.	June 1
February	Member returns the inventory to the Association with all changes.	July
March 15	Association sends "No Progeny Report" females missing THR requirements.	August 15
April	"No Progeny Report" due back to Association.	September 15
May	Association runs inactivation program.	October
May 15	Association sends preliminary inventory for heifer exposure information.	November 15
July	Association bills for annual THR	December

	assessments based on herd inventory.	
August 1	Association sends Pre-listed Weaning Worksheets.	March 1
August 15	Member returns heifer exposure inventory with all exposure and disposal information.	February 15
November	THR assessment must be paid in full.	May

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COMPARISON OF MASS SELECTION BY INDEPENDENT CULLING LEVELS FOR BELOW AVERAGE BIRTH WEIGHT AND GREATER YEARLING WEIGHT WITH SINGLE-TRAIT MASS SELECTION FOR GREATER YEARLING WEIGHT IN LINE 1 HEREFORD CATTLE[1]

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Selection for increased production tends to decrease fitness (Meuwissen et al., 1995). Simultaneous improvement of antagonistically correlated traits poses a significant challenge for beef cattle breeders. Reducing calf mortality by controlling birth weight while increasing subsequent growth is an important applied illustration of this problem (Dickerson et al., 1974). Excessive calf birth weight was shown to be an important causative agent affecting the incidence and severity of dystocia (Bellows et al., 1971; Laster et al., 1973). Because birth weight has a positive genetic correlation with weights at subsequent ages (e.g., Brinks et al., 1964; Smith et al., 1976), selection for reduced birth weight may compromise production efficiency through prolonged feeding to reach market weight. It was thus hypothesized that a selection strategy with negative emphasis on birth weight and positive emphasis on subsequent growth might be effective in reducing the incidence and severity of dystocia while minimally affecting the rate of genetic progress in post-natal growth. The objective of this research was to compare mass selection, by independent culling levels, for below average birth weight and high yearling weight (YB subline) with single-trait mass selection for high yearling weight (YW subline).

This research was conducted using the Line 1 Hereford population at the USDA-ARS Fort Keogh Livestock and Range Research Laboratory at Miles City, Montana. There were 4.2 generation of selection in both the YB and YW sublines. Heritability estimates for the base population derived from

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[1] This research was conducted under a cooperative agreement between USDA, ARS and the Montana Agric. Exp. Sta. USDA, Agricultural Research Service, Northern Plains Area, is an equal opportunity/affirmative action employer. All agency services are available without discrimination.

multiple-trait REML were 0.28 and 0.31 for direct effects and 0.16 and 0.06 for maternal effects on birth weight and yearling weight respectively. Mid-parent cumulative selection differentials for birth weight of YB and YW were -2.9 and 8.2 kg, respectively. Correspondingly, the associated genetic trends for direct effects on birth weight diverged (-0.014 kg/yr vs 0.105 kg/yr). Mid-parent cumulative selection differential for yearling weight in YB (102.1 kg) was 64% of that attained in YW (160.7 kg). Likewise response in yearling weight of YB (0.91 kg/yr) was 61% of the response attained in YW (1.5 kg/yr). For both birth weight and yearling weight, genetic trends in maternal effects were similar across selection lines. Assistance at parturition of first parity 2-yr-old heifers was consistently less frequent in YB than in YW. However, genetic trends in calving ability were similar in the two selection lines.

Breeding values of sires resulting from selection either for reduced birth weight and increased yearling weight (n = 8) or for increased yearling weight alone (n = 9) were compared with each other and with sires representative of the population before selection began (BS, n = 12) using progeny testing. Reference sires (n = 6) connected these Line 1 sires with the Hereford international genetic evaluation. Thirty-five sires produced 525 progeny that were evaluated through weaning. After weaning, 225 steer progeny were individually fed, slaughtered, and carcass data collected. Data were analyzed using restricted maximum likelihood procedures for multiple traits to estimate breeding values for traits measured on the top-cross progeny while simultaneously accounting for selection of the sires. Results of the progeny test substantiate within line results for traits upon which sires were selected. Breeding values for gestation length were greater in YB sires than in YW sires which were unchanged relative to BS sires. Breeding values for growth rate and feed intake of both YB and YW sires were greater than BS sires. Predicted breeding values for indicators of fat deposition tended to be greater in YB sire and less in YW sires relative to BS sires, although YB and YW sires had similar breeding values for marbling score. Selection based on easily and routinely measured growth traits, although achieving the intended direct responses, may not favorably affect all components of production efficiency. Further, divergence of selection lines may not be easily anticipated from preexisting parameter estimates, particularly when selection is based on more than one trait.

After allowing five years to elapse, such that heifers born in 1993 could attain mature size, a three parameter growth curve [$W_t = A(1 - b_0e^{-kt})$] was fitted to age (t, d)-weight (W, kg) data for cows surviving past 4.5 years of age (n = 738). The resulting parameter estimates were analyzed simultaneously with birth weight and yearling weight using multiple trait restricted maximum likelihood methods. To estimate maternal additive effects on calf gain from birth to weaning (MILK) the two-trait model previously used to analyze birth weight and yearling weight was transformed to the equivalent three-trait model with birth weight, gain from birth to weaning, and gain from weaning to yearling as dependent variables. Heritability estimates were: 0.32, 0.27, 0.10, and 0.20 for A, b_0, k, and MILK, respectively. Genetic correlations with direct effects on birth weight were: 0.34, -0.11, and 0.55 and with direct effects on yearling weight were: 0.65, -0.17, and 0.11 for A, b_0, and k, respectively. Genetic trends for YB and YW respectively were: A (kg/generation), 8.0 ± 0.2 and 10.1 ± 0.2; b_0 (x1,000), -1.34 ± 0.07 and -1.16 ± 0.07; k (x1,000), -14.3 ± 0.1, and 4.3 ± 0.1; and MILK (kg), 1.25 ± 0.05 and 1.89 ± 0.05. Beef cows resulting from simultaneous selection for below average birth weight and increased yearling weight had different growth curves and reduced genetic trend in maternal gain from birth to weaning relative to cows resulting from selection for increased yearling weight.

Summary

Selection for below average birth weight and high yearling weight simultaneously is a selection strategy that may appeal to beef producers. While this strategy can result in improved post-natal performance relative to random selection, growth performance is compromised somewhat with the resulting cattle becoming earlier maturing, smaller, and fatter at all ages than under selection for high yearling weight alone. However, hastening maturation and reducing cow size and milk production may improve efficiency of beef production by reducing energy required by the cow herd in some production systems. The popular appeal of selecting for low birth weight and high yearling weight may stem from the perception that this strategy should change the relationship between cow size and calf birth weight and thus continually improve calving ability while maintaining an increasing genetic trend in juvenile growth. Based on the results of this research, this perception may be flawed. Direct selection may be more effective in reducing dystocia than pressure applied to indicator traits.

Further details pertaining to these studies can be found in MacNeil et al. (1998, 1999, 2000;

MacNeil and Mott, 2000).

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Assessing Industry-wide Impact of Beef Cattle Genetic Technologies

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Introduction

In the beef cattle industry, genetic change relies on ranking animals followed by selecting genetically superior individuals and culling poorer ones (Garrick et al., 2000). Genetic change is initiated by selection decisions made within many different seedstock herds with improved genes being disseminated (via bull sales and AI) to many commercial producers. Generally, individual breeders and producers are interested in their own welfare or that of their clients. For example, a seedstock breeder may want to develop a sustainable market for his bulls while improving the profitability of his clients herds.

Some organizations such as Universities, Breed Associations, the Beef Improvement Federation and companies that sell technologies to the livestock industry are more interested in the sector or industry-level impact of animal-genetic technologies. Animal-genetic technologies include but are not limited to: defining breeding goals, producing EPDs, choice of breeds (and crossbreeding systems) and allocation of mates. These organizations might well ask genetic questions such as: "How will my Breed Association benefit from a new EPD for cow maintenance energy?" "How many potential customers will use a gene marker for marbling?" Similarly, non-genetic questions (but with genetic consequences) may be asked: "Will the impact of sexed sperm lead to more or fewer seedstock herds?" "Why do alliances form?"

Anyone who pays at least cursory attention to these types of problems has surely divined what Wall Street analysts have in common with meteorologists, evolutionary biologists, astrologers and political observers: no one can say with certainty that he has any idea what will happen tomorrow. That's a big problem if you're trying to predict how a technology will be adopted in the US beef cattle industry. All these problems underscore a single phenomenon: complex, self-organizing systems continuously adapt to and change with their environments but do so in ways that are impossible to predict. This essay will introduce a framework for evaluating the sector or industry-wide impact of animal-genetic technologies in the beef industry. This framework is to think of the beef industry as a Complex Adaptive System (CAS).

Layers of elephants

The level of complexity inherent in any problem depends at which level we wish to investigate it. As Rick Bourdon reminded us graduate students at Colorado State University, the amount of complexity (detail) at which you want to assess the problem depends on how many elephants deep you want to go (Box 1). The deeper into the problem you want to explore, the more you will find. Take multiple trait selection for beef cattle as an example. At first glance, the problem seems pretty simple, select bulls that are genetically superior for those traits influencing enterprise profitability.

Box 1. How many elephants deep?
A student asked the teacher what holds up the world? The teacher replied – the world is supported on the back of an elephant. The student left the room fully satisfied only to return a few minutes later with another question. What supports the elephant? –the teacher replied two elephants. The student then asked what holds them up, the answer as expected was that four elephants hold up these two elephants. And so on, indeed it's elephants all the way down.

A multiple trait selection decision implies that one or more animals are selected for a combination of desirable traits– such as bulls with desirable genes for days to finish, cow maintenance energy requirements, heifer fertility and sustained cow fertility. At present we do not have EPD that cover the range of traits influencing enterprise profitability. Bruce Golden and co-authors emphasized the importance of producing new EPD for these economically relevant traits (ERT) at last years BIF Symposium and Annual Meeting (Golden et al., 2000). This paper will not dwell on the need for ERT in beef cattle genetic evaluation, the argument in favor of publishing fewer but more relevant EPD is overwhelming. Lets assume we are ranching in "bovine nirvana" (Bourdon, 1988) and our selection decisions are made on the basis of EPD for economically relevant traits.

Since EPD are mainly used within-breeds, their use implies that choices of breed(s) and crossing system were made before individual sires were selected on the basis of EPD. In reality, breeding decisions are made on a number of bulls (not necessarily of the same breed) for multiple traits. Breeding decisions are never made in isolation, the wealth of experience and knowledge gained from previous years are used to refine successive breeding decisions. Now, lets assume we wish to understand not just how one rancher makes selection decisions, but we are interested in the outcomes of decisions made by many individuals. We now have multiple trait selection decisions made on many bulls/breeds/crossing systems specific to many individual ranches. These decisions are made over many years. Metaphorically, we cannot see the woods for the elephants.

An easy way to tackle the problem is to develop an "average rancher" and assume actions made by this average rancher are representative of actions made by the whole. In practice, technological change is driven by decisions made by many unique individual ranchers.

Technological change in agricultural systems

Two types of variables that describe technology adoption are: 1. quantifiable financial benefits and 2. costs which include an objective component and subjective component including the managerial ability of the farmer (Berger, 2001). A number of variables affect the likelihood of technology adoption by individual ranchers, these include the rancher's goals, age, personal previous experience with the technology, perceived profitability and riskiness (Abadi Ghadim and Pannell, 2000) as well as attributes of the technology itself (Batz et al., 1999). These beliefs or attitudes are shaped by endogenous ranch characteristics such as ranch size, capital for investment and current livestock policies. External, environmental influences on technology adoption include: economic climate, market requirements and the presence of other farmers adopting the technology (Axelrod and Cohen, 2000). The adoption of animal-genetic technologies may also be influenced by databases, statistical technology, research and extension support (Garrick, 1997).

Three types of rancher can be classified according their speed of technology adoption (Berger, 2000) namely: 1. non-adopters with no net benefit from technology adoption 2. potential adopters who, at present, face high adoption costs and 3. actual adopters with positive net benefits from technology adoption. Across an agricultural industry, technological change occurs when a greater portion of the population becomes actual adopters. The uptake of genetic improvement is driven by innovative ranchers who capture the benefits from profit maximizing genetic improvement before the laggards (Amer and Fox, 1992).

There are two conceptual computer modeling approaches for evaluating technological change, these are termed "top-down" and "bottom-up". In a nutshell, the top-down approach assumes we specify changes that occur at a macro-level (i.e. on the whole beef industry) while the bottom up approach specifies action made by individual ranchers and any macro-level outcomes are the result of actions made by individuals.

Top-down approaches

Systems' modeling has, as its goal, the desire to make an inference about some state of nature or to predict the future (Csaki, 1985). A common approach is to reduce a system into a number of subsystems, describe these subsystems and make some inference about the entire system from these subsystem descriptions (Baldwin, 1995). A reductionist would maintain that a system is simply the sum of its parts (Odell, 2000). This reductionist approach is top-down in nature. The modeler overlooking or "on top" of the system specifies parameters and relationships for the system, say for an economy or for a population of livestock. Due to complete specification of model parameters, deductions can usually be readily made on the described system.

A parameter forms some part of our question, for example, if we wish to estimate annual revenue form sales of Simmental bulls in the US. Useful parameters to start with would be the number of Simmental breeders and average number of bulls sold per breeder per year. Relationships are used to link parameters together (e.g. number of breeders x number of bulls sold per breeder), the relationship in this case the multiplier. A common relationship used among beef cattle geneticists is the genetic correlation- a statistical measure of the strength of association between any two traits. More complex relationships (such as the multiple interactions between ranch management and cow fertility) are best handled using computer simulation rather than (relatively) simple mathematical models.

Top-down models form a continuum in terms of how well they describe the underlying relationships between parameters. For many beef cattle technological change problems there two approaches can be applied – a non-mechanistic approach and a mechanistic one (Bourdon, 1998).

Non-mechanistic approaches

A non-mechanistic approach to evaluating technological change usually occurs through a highly aggregated model of the system. These models describe the magnitude of relationship between parameters but the underlying relationship between them remains undefined (Baldwin, 1995; Bourdon, 1998). In animal breeding, these models are frequently mathematical models that describe population-level genetic and environmental parameters (such as heritabilities, genetic and environmental variances). Frequently these models, of which profit equations are an example, are mathematically tractable but if improperly parameterized can be simplistic or poor representations of the system.

In the animal breeding literature, the most common measure of financial outcome(s) of some animal genetic technological change are economic values (EV). Within a single livestock enterprise EV describe the financial consequences of a marginal change in a trait, holding all other traits constant (Hazel, 1943; Hazel and Lush, 1943). These EV are usually derived as the partial derivative of a profit equation with respect to the trait of interest and are relevant to a single farm or company (Brascamp et al., 1985; Smith et al., 1986).

A common assumption in animal breeding is that profit equations are linear, in other words the extra revenue from some marginal change in a trait does not depend on the average value for that trait in the herd. In practice, due to changes in market requirements and intermediate trait optima (an average value for a trait is more desirable than the extremes) EV are frequently sensitive to changes in trait value (Burdon, 1990). The use of profit equations should be strictly applied within a single enterprise. Consequently, any assumption that profit equations remain invariant between populations, regions or within a breeding program as production and marketing circumstances change would be false (Bourdon, 1998; Brascamp et al., 1985; Hazel, 1943). Many studies (Amer et al., 1997; Amer et al., 1996; Charteris et al., 2000) have shown EV for beef cattle traits are sensitive to changes in production and marketing environment.

The sector or industry-wide financial response from genetic change can be calculated by multiplying EV across the number of animals benefiting from genetic change after accounting for the size of seedstock and commercial livestock populations and the number of bulls sold annually from seedstock to commercial herds (Nitter et al., 1994). Jason Archer and Steve Barwick from Australia used this approach. The goal of their analysis was to determine the most profitable investment strategy for genetic improvement of net feed intake in the Australian beef cattle industry (Archer and Barwick, [in press]). These models imply that EV derived for a single enterprise are representative of a sector or an industry, i.e. they assume animal genetic technologies act on some average animal or ranch even if the results have been extrapolated to multiple enterprises (Kinghorn, 1993). Typically, these deterministic models do not attempt to capture differences between individuals in a population (whether that population be individual farmers or livestock). In contrast, stochastic models allow heterogeneity in the population (such as differences between ranchers) to be explicitly accounted for (Kinghorn, 1993).

An approach for estimating EV for genetic improvement neoclassical economic theory of the firm was proposed by (Amer and Fox, 1992). They extended their results using industry-level supply and demand curves to measure the aggregate industry benefits of genetic improvement. The neoclassical model assumes: perfect competition, decision makers are rational with perfect foresight and the market is in equilibrium (supply equals demand). In recent years, this view is eroding. Modern economic theory assumes bounded rationality, that is, decision-making is never perfect and involves a combination of experience and fresh reasoning and can be influenced by emotion, intuition and irrationality (Farmer, 1999). Equilibrium is rarely attained in markets; a drought can cause an undersupply of beef while a crisis such as BSE would result in a huge oversupply as consumer confidence plummets.

Mechanistic simulation

An alternative to mathematical representations of a system is the use of more sophisticated computer models that describe relationships between multiple parameters. As an example, a bioeconomic simulation model comprises a series of equations that include physiological, production, management and economic parameters (Bourdon, 1998). Economic values are obtained from simulations by changing the genetic component of the desired trait. This approach has been used to derive EV for beef cattle (Hirooka et al., 1998a; Hirooka et al., 1998b). The plausibility of such models is greater than for more simple mathematical representations for a system since a greater number of equations can represent complex biological, management and economic parameters including their interactions can be represented with greater precision. A cost of this greater precision may be that the model is less readily interpretable (Balmann, 1997).

Regardless of their degree of aggregation, top-down approaches provide a view of the system as a whole, they allow questions to be asked about changes in genetic merit, population structure, pedigree relationships, product flows and economic outcomes. When trying to describe technological change in agricultural systems, the top-down approach allows deductions to be made with relative ease. However, their ability to capture the dynamics of technological change is frequently poor. In particular top-down models do not: 1. capture the attributes of individuals and their interactions that allow complex new entities to emerge in a system (Grimm, 1999) or 2. account for the spatial dimensions of an agricultural system (Berger, 2001). As a consequence, a top-down approach has limitations for describing technological change in agricultural systems where the behavior of individuals is important. A new modeling approach for describing such systems is described in the next section.

Bottom-up Approaches

Some systems cannot be represented as the sum of their parts and cannot be easily described using a reductionist approach. Such systems usually contain many diverse inhabitants that interact with their surroundings and with their environment in intricate ways (for example, ranchers within the US beef industry). The attributes of these inhabitants and the way they respond to their surroundings may change over time in response to past experiences and in anticipation of future events. There exist many complicated interactions among members of the system so that small events may dramatically change the probability of many future events (Axelrod and Cohen, 2000). Importantly, entities in the system may emerge that did not exist in the system at some previous point in time. A new paradigm is required to define these complex systems and a new modeling approach required to describe them. The bottom-up approach starts with the parts (i.e. ranchers) of a system (i.e. the US beef industry) and then tries to figure out how the systems properties emerge from the attributes of and interactions among these parts.

Complex Adaptive Systems

Complex systems have many independent entities that interact with each other in a great many ways (Waldrop, 1992). Systems that evolve over time as individuals within the system interact with each other and respond to their environment are called Complex Adaptive Systems, CAS (Holland and Miller, 1991). It is difficult to formulate the overall behavior of CAS, even when all of its components and their interactions are known (Edmonds, 1999). The participants of CAS are termed agents, they interact in intricate ways to reshape their collective future (Axelrod and Cohen, 2000). The study of behaviors of CAS is called Complexity. Many researchers disagree on a common definition of a CAS. No one disagrees that CAS comprise a heterogeneous population of agents, these systems can self-organize and show emergent structures (Bunk, 2001). Examples of CAS include biological evolution, learning and the operation of the human scientific enterprise (Gell-Mann, 1995). Human consciousness is a popular example of a CAS. Consciousness is the result of action and interactions between millions of synapses and neurons in the human brain.

Complex adaptive systems comprise a heterogeneous population of agents. An agent is a colloquial term for nearly any component in an bottom-up model (Daniels, 1999). These agents are autonomous entities that have the ability to interact with and respond to their environment, including other agents, and can do things more or less purposefully (Axelrod and Cohen, 2000; Stefansson, 2000). Most commonly an agent represents a single person but can be extended to describe a population such as a business comprising many individuals or a large agricultural cooperative. Some key properties of agents are shown in Table 1. The key properties of CAS such as adaptation, of agents, selection, strategy formation and emergence of new features arise from entirely from attributes of and interactions between agents and their environment.

Table 1: Some key properties of agents (Franklin and Graesser, 1996; Hood, 1998)

Property	Meaning
Goal-oriented	does not simply act in response to the environment
Strategic	has a way it responds to its environment to achieve goals
Interactive	communicates with other agents via direct spatial interaction or indirectly via ownership or resource depletion
Reactive	responds in a timely fashion to changes in the environment
Autonomous	exercises control over its own actions
Temporally continuous	is a continuously running process
Learning (adaptive)	changes its behavior based on previous experience
Mobile	able to transport itself from one machine to another
Flexible	actions are not scripted
Rational	Some well defined or logical set of rules govern behavior
Character	believable "personality" and emotional state

Variance among agent attributes (particularly in the strategies employed by agents) allows the agent population to change over time (Axelrod and Cohen, 2000). This is analogous to additive genetic variance for traits in livestock populations that provides a basis for genetic change. Poorly adapted agents, on average, would exit the system with greater frequency than agents more responsive to changes in their environment such as new technologies or marketing opportunities. The analogy with selection in livestock populations is imperfect, since agents act autonomously and purposefully to affect their own future welfare while livestock are selected or culled on the basis of decisions made by breeders or producers. Agents can purposefully change their own attributes over time, for example a rancher can sell land or use a new technology. On the other hand, livestock do not make conscious decisions to change themselves.

Unlike representations of evolutionary systems, a model of agents, especially when applied to social systems such as economies, usually assumes some more complicated measure of success than transmission of genes to the next generation. Agents are frequently goal-oriented. In order for a model to be successful, these goals need to be clearly defined and meaningful (Railsback, 2001). In economic models, these goals are frequently represented by individual utility functions (Batz et al., 1999). The implications of utility functions in beef cattle breeding decisions were discussed by (Charteris, 2000).

A strategy is the way in which an agent responds to its surroundings and pursues its goals (Axelrod and Cohen, 2000). Strategies arise in CAS when agents learn they can be more successful by switching their approach to achieving their goals (Railsback, 2001). A central interest of bottom-up modelers is how agents adapt their strategies over time especially in relation to other agents each of whom are adapting. When multiple populations of agents are adapting to each other, the result is a coevolutionary process. Frequently, strategies are rule-based- i.e. if A happens then do B. Two approaches for representing farmer investment strategies are genetic algorithms (Balmann and Happe, 2000) and Bayesian learning rules (Abadi Ghadim and Pannell, 2000).

An emergent structure is something that arises from the interaction of many agents, none of whom necessarily intend this aggregate outcome (Holland and Miller, 1991; Johnson, 2000). Alliances emerge in agricultural industries due to presence of favorable marketing circumstances and industry infrastructure that may not have previously existed. Emergence embodies several properties (Odell, 2000):

1. Agents organize into a whole emergent structure that is greater (more complex or capable) than the sum of its parts (Railsback, 2001).
2. Rules and interactions that are very simple (for example buy and sell on the basis of maximizing utility) can create coherent, emergent phenomena such as an economy.
3. Persistent emergent structures can serve as components for more complex emergent structures. For example, cooperation and trust emerge from interaction patterns between agents in a trading environment (Klos and Nooteboom, 2001). Trust and cooperation, in turn, provide a basis for networks and alliances.
4. The emergent structure can influence its component agents just as the component agents themselves develop the emergent structure.

Events within CAS typically arise as a result of interactions between agents. Proximity factors determine how agents come to be likely to interact with each other. Activation factors determine the sequence of interactions. Taken together, proximity and activation factors determine interactions over space and time. Agents have a greater probability of interacting if they are closer together in some conceptual space. Agents have a greater chance of interacting (than any two agents chosen at random from the population) if they are of a similar type or exist within some relatively well defined economic or social network. These non-random interaction patterns are important for predicting diffusion of innovations or for prediction the transmission of a disease such as HIV in human populations (Axelrod and Cohen, 2000). A key feature of CAS is that they represent systems where behavior will change over time due to interaction, learning or adaptation (Parrott and Kok, 2000).

Bottom-up Modeling

Bottom-up models are computer simulations that describe the workings of CAS. Synonyms for bottom-up modeling include: emergence-based modeling and modeling of self-organizing systems. These models are generally concerned with the macro (system) level properties that emerge from the actions and interactions of individual agents (Axtell and Epstein, 1999; Holland and Miller, 1991; Hood, 1998). These agents are conceptually the bottom of the model and system level properties are built up from these individual agents as they respond to each other and their environment. Agent-based models are inherently mechanistic, stochastic (many agents) and dynamic (agents interact and react over time).

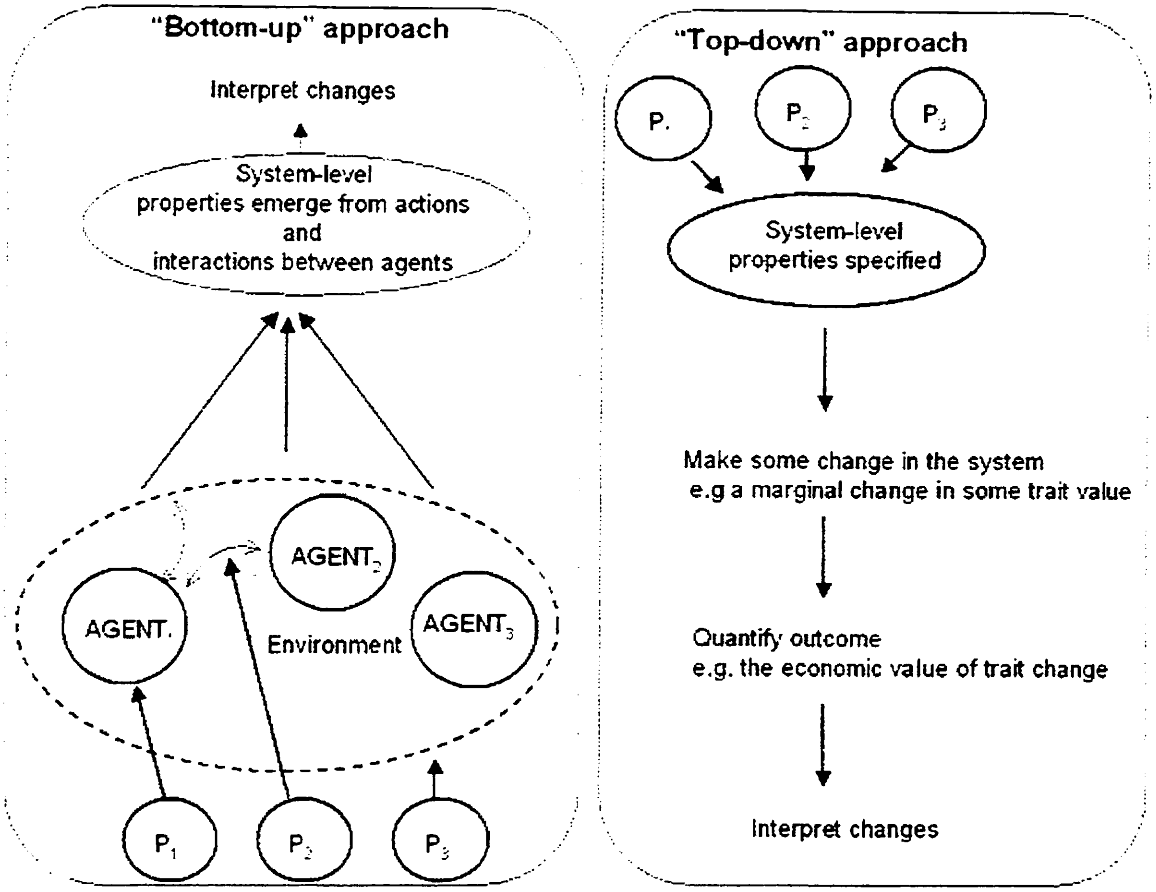
Bottom-up models can be used in problem solving and optimization or in systems analysis. Within the first field of application, genetic algorithms (GA) (Holland, 1975) have been used to: optimize a herd dynamics problem (Mayer et al., 1999), derive EV for genetic improvement (Meszaros et al., 1999), allocate matings (Hayes et al., 1997), optimize breeding program design (Meszaros, 1999) and to search for multiple interactive Quantitative Trait Loci (Carlborg et al., 2000). A recent study by (Lopez-Villalobos et al., [in press]) used a differential evolutionary algorithm to derive EV for dairy cattle production in New Zealand. Their derived EV corresponded closely with those obtained as partial derivatives of profit functions for the same industry.

This discussion will focus on complex systems approaches to systems modeling rather than optimization applications. There are a number of bottom-up systems modeling approaches including cellular automata (CA), individual-based modeling, agent-based modeling (ABM) and agent-based computational economics (ACE). Each of these modeling approaches includes to some extent, concepts drawn from the disciplines of: evolutionary biology, computer science and social design (Axelrod and Cohen, 2000).

For CA, the basic units for modeling are cells on a grid, such models assign attributes to each cell including the ability to interact with adjacent cells in complex ways. Cellular automaton are frequently used for modeling the systems with discrete spatial attributes such as trees in a forest or farms in an agricultural community (Balmann, 1997). Ecologists frequently employ individual-based models (Grimm, 1999; Parrott and Kok, 2000; Railsback, 2001) where individual organisms are modeled to interact with each other and their environment. In ABM, providing agents with strategies and mechanisms permitting adaptation and learning extends the individual-based model concept. The study of economies modeled as evolving systems of autonomous interacting agents is called agent-based computational economics (Tesfatsion, 2001). A key feature of ACE is to understand how global regularities such as trading networks and arise from actions of individuals.

The basic development of a bottom-up model is to define a population of heterogeneous, autonomous interacting agents. Parameters are specified at the agent level (i.e. one agent = one ranch). The model is allowed to run to some endpoint and observations are made on system-wide entities that emerge from the actions and interaction of these agents over time. The basic construction of a bottom-up model is shown in Figure 1. The parameters $P_1 \ldots P_3$ are assigned to individual agents ($A_1 \ldots A_3$) and also to the environment. Parameters also describe interaction between agents and interactions between agents and their environment. System-level properties occurs as a result of these local interactions and interpretations of the system are made on the macro-level system properties. The top-down approach, in contrast, specifies parameters at the level of the system of interest and these changes are interpreted.

Figure 1: Conceptual differences between bottom-up and top-down modeling approaches



Bottom-up models are exploratory in nature and should be viewed as a complement to top-down approaches with tend to be predictive (Hood, 1998). The "up path" of a bottom-up modelling is usually difficult to follow if one has no idea of what questions to ask at the system level. These questions are answered by the framework of the top-down approach (Railsback, 2001). Top-down and bottom-up modeling approaches are complementary to many answering many problems. Differences between bottom-up and top-down modeling approaches are shown in Table 2.

Table 2. Characteristics of bottom-up and top-down modeling (Holland and Miller, 1991).

Bottom-up	Top-down
Begins with behaviors through which individuals interact with each other	Behaviors between individuals are not explicitly stated
The individuals interact and direct relationships among the observables are an output of the modeling process, not an input	Develops a set of equations that express the relationships among observables
Simulation driven by specification of behaviors of agents that are developed in a recursive manner	Simulation driven by algebraic representations or system dynamics (stochastic models). Partial differential equations capture change over time and space
Define agent behavior in terms of parameters accessible to the individual agent, which leads to reliance away from system-level parameterization. Evolution of system level parameters arises from running the model	Tends to make system-level observations since it is easier to develop closed form equations using such quantities.
Easier to define physical and temporal space in addition to interactions	Difficult to define physical and temporal space in addition to interactions

One of the key strengths of ABM is that the system as a whole is not constrained to exhibit any particular behavior. System-level properties emerge from agent interactions so that assumptions of equilibrium and linearity are not required. Bottom-up modeling is superior to top-down approaches for describing systems when; we are concerned with synthesis of individuals, their interactions and resultant the outcome(s) of the whole system, and when we are interested in the dynamic processes occurring within the system.

Current Agricultural Applications of Agent-based Simulation Models

Models in which complex and realistic system level responses emerge naturally from individual behavior of ranchers should be appealing to agricultural scientists because such models can capture basic decisions driving innovation. Agent-based models have a number of features that make them amenable to the study of agricultural economies (Balmann, 2000). First, ABM allow flexible parameter settings, for example, individual agents may have goals and skills that change over time reflecting changes in technology or markets. Second, self-organization of industries can emerge from the behavior of individuals. Finally, individual agents may be modeled that have a sense of space, enabling individual ranches and interaction between ranches (in terms of communication and financial transactions) to be represented.

There are some potential obstacles to implementing ABM in agriculture. One obstacle is that this approach is new and the framework for analysis of CAS has not been established. At the same time, this lack of structure probably attracts may researchers to the field. Possibly the greatest obstacle to implementing ABM in agricultural settings is the greater difficulty of parameterizing human decision making processes than for physical, biological or economic variables. The application of ABM in agriculture is new, however three excellent examples were found in the literature and are described in greater detail.

A CA-ABM model of hydrological and cropping technology adoption among Chilean farmers was developed by (Berger, 2001). His model comprised an economic and a hydrologic submodel within a CA-ABM framework. Individual agents acted so as to maximize their own income while not depleting farm resources. Farmers were able to interact with each other including exchange of information, land and water. The effect of several policy interventions related to credit and subsidies to farm production were evaluated for their effect on technology adoption.

A CA model was constructed to simulate the effect of possible EU government intervention in agricultural policy on structural change and land use of farms over a fifty-year period (Balmann, 2000). His model framework comprised a number of agricultural plots which were explicitly spatially defined for some fictitious region. Farmers acted autonomously to maximize their individual income. A production environment with clearly defined technologies was established with individual farmers deciding on continuing in farming, founding new farms, renting and giving up land, asset investments (livestock policies, buildings) and production programs. Farms closed down if they were illiquid and new farms were created stochastically. An agent-based simulation of land use change in rural Scotland is described by (Gotts, 2001). A major motivation for his project, FEARLUS (Framework for Evaluation and Assessment of Regional Land Use Scenarios), is to more accurately forecast patterns of land-use based on the attributes of individual farmers and interactions between farmers rather than rely on industry-level parameters. A similar project to model land use change in Australia was described by (Hood, 1998).

Summary

A livestock production sector contains a number of farmers, each with different physical, social and economic attributes and so can be represented by an ABM approach. The application of ABM in animal breeding research will be for testing hypotheses that cannot readily be answered through other modelling approaches. In general, ABM will be amenable to hypotheses concerning sector or industry-level outcomes of animal-genetic decisions made by many different ranchers. Specifically, animal breeders will use this modeling approach to; 1) evaluate the dynamics of technology uptake such as new EBV or 2) describe the dynamics of emergent structures such as nucleus, multiplier and commercial populations as well as alliances. Testing these hypotheses will be of great interest to research providers and developers of new technologies who wish to predict how animal genetic technologies will impact a livestock industry.

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AN OVERVIEW OF THE 1999 ANGUS SIRE ALLIANCE[1]

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Summary

Expected progeny differences (EPD) have been used for improvement in individual traits. However, strategies are needed to aid producers in efficient multiple-trait selection. The Angus Sire Alliance was formed to identify bulls that produce the most profitable progeny and market those sires based upon the research results. Therefore, the objective of this project was to develop a multiple-trait selection index to improve profit for a defined production scenario and then subsequently rank sires based on results of a multi-trait genetic evaluation for profit. Angus sires were randomly mated to commercial Angus females in a designed progeny testing program. Data were included from the 1996, 1997, 1998, and 1999 Angus Sire Alliance progeny test programs. EPD and associated accuracies were calculated for birth weight, weaning weight direct, weaning weight maternal, post-weaning average daily gain, marbling score, yield grade, and dry matter intake. To estimate relative economic values (REV) for each trait, a bio-economic simulation was performed using a modified version of the software SIMUMATE 3.0. Sire differences in profit per progeny were then estimated as the product of each trait EPD with its respective REV. There was a range of $41.65 profit per progeny between the highest and lowest ranking sires that were evaluated.

Introduction

With the widespread use of Expected Progeny Differences (EPD), the identification of candidates to become parents has centered primarily on growth as shown by published genetic trends (AAA, 2001). Single trait selection for growth traits could lead to undesirable correlated responses in mature cow size (Bullock et al., 1993;

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[1] This research was conducted under a collaborative agreement between USDA-ARS and the Montana Agricultural Experiment Station (MAES). Mention of a proprietary product does not constitute a guarantee or warranty of the product by USDA, University of Florida, MAES, or the authors and does not imply its approval to the exclusion of other products that may be also suitable. USDA, Agricultural Research Service, Northern Plains Area, is an equal opportunity/affirmative action employer and all agency services are available without discrimination

Meyer, 1993) and thus, reproductive inefficiencies (Buttram and Willham, 1989; Fiss and Wilton, 1992). Although Hazel (1943) outlined a multi-trait selection procedure that weighted each trait by its relative effect on profit, producers have not had readily available tools to quantify the economic importance of various traits or rank bulls based upon the expected differences in progeny profitability. Therefore, the objective of this project was to determine genetic differences in profitability of progeny from Angus sires in such a manner that those differences could be repeated in subsequent matings under a similar production scenario.

Experimental Procedures

Matings used to create steer progeny were consistent with the protocol recommended by the American Angus Association for evaluation of carcass traits using sire progeny testing programs. Test sires were nominated to the Angus Sire Alliance from Angus breeders throughout the United States. At the Circle A Angus Ranches in Huntsville, Iberia, and Stockton, Missouri, commercial Angus females were randomly mated to Angus test candidates and reference sires using artificial insemination. Test and non-test sires were also used for natural-service matings. Calves were born each year from January to April over no more than 112 days in any given calving season across the three ranches. Progeny information was collected beginning at birth and included birth, weaning, backgrounding, and yearling weights. Calves were weaned at an average of 204 days. Steers born in 1997 were backgrounded for 104 days before being transported to Supreme Cattle Feeders, Inc., Liberal, Kansas. Steers born in 1998, 1999, and 2000 were backgrounded for 95, 108, and 131 days, respectively, before transport to Platte Valley Feeders, Kearney, Nebraska. Before transport, whole contemporary groups were assigned to feedyard pens. A contemporary group was defined as steers that had been together since birth and given an equal opportunity to perform. When the steers averaged approximately one year of age, ultrasound measurements for fat thickness, ribeye area, and marbling were taken by an AUP Certified ultrasound technician. Steers remained in their initial feedyard pens until slaughter.

Harvest date was determined to target a contemporary group to average .5 in. fat depth at the 12-13 rib and to avoid any light or heavy carcass discounts. Regression equations of age on ultrasound fat depth were used to assist with determining harvest date. All steers from a given contemporary group were harvested on the same day. For the 1997 born steers, three groups were harvested at National Packing, Liberal, KS, on April 22, May 7, and June 1, 1998. The 1998 born steers were harvested on May 12 and 26, 1999, at Conagra Beef, Grand Island, NE. The 1999 born steers were harvested on April 19, May 17, and May 24, 2000, at Conagra Beef, Grand Island, NE. The steers born in 2000, were harvested on May 2 and May 9, 2001, at IBP, Lexington, NE. Carcass data collected included: harvest date, hot carcass weight, marbling score, fat depth, ribeye area, and percentage kidney, pelvic, and heart fat. Carcass data were collected by experienced personnel from the University of Florida and USDA Grading Service.

Feed Intake

In the fall of 1998, Circle A Angus Ranch installed a Calan Broadbent Feeding System to measure individual animal feed intake on 96 animals. This system allows automated measurement of individual feed intake on a daily basis. Whole contemporary groups of steers from the 1997, 1998 and 1999 Sire Alliance were evaluated for feed intake.

Steers had to be trained and acclimated to the feeding system. After seven days, all steers were trained to eat through their own feeding door. Therefore, initial weights were taken at this time and daily feed intake was recorded from this day to the end of the feeding period. A stepwise series of five finishing rations that were identical to the series of rations fed to the remaining test cattle at Platte Valley Feeders were used throughout the finishing period. The afternoon before harvest, steers were weighed and then transported overnight to the packer for carcass data collection.

Genetic Evaluation

In previous years of the Sire Alliance, a series of single and multi-trait mixed models were used to estimate genetic differences among animals. However, in 2001, a 6-trait multivariate animal model was implemented to estimate genetic differences among sires evaluated in the Sire Alliance as well as all other animals that existed in the Circle A performance and carcass database. While cows used in the Sire Alliance are "commercial Angus", most have pedigrees and their own performance data. Circle A has now developed a real-time database among its commercial operations that includes comprehensive pedigree and performance information on not only animals evaluated in the Sire Alliance, but includes all animals in the ranching operations. Thus, this approach should result in a more accurate and comprehensive genetic evaluation program.

As a result of this change, expected progeny differences and accuracies were computed for birth weight, weaning weight direct, weaning weight maternal, post-weaning average daily gain, marbling score, yield grade, and daily dry matter intake on 30,123 animals. For birth weight, the model included fixed effects for birth contemporary group, sex, and age of dam with a random direct genetic effect. For weaning weight, the model included weaning contemporary group and sex fixed effects, a weaning age covariate, random direct and maternal genetic effects, and a permanent environmental effect of the dam. For post-weaning average daily gain, the model included a fixed contemporary group effect and a random direct genetic effect. For daily dry matter intake, the model included a covariate of on-test age, fixed effect of contemporary group, and a random direct genetic effect. For marbling score and yield grade, the model included fixed effects of harvest contemporary group and a harvest age covariate with a random direct genetic effect. Post-weaning average daily gain was derived using estimates of final live weight from dressed weight of steers (assuming a 62% dressed weight; Boggs and Merkel, 1984) and weaning weight. Daily intake was converted to a 100% dry matter basis.

Genetic parameters used for the analysis are provided in table 1. Genetic and environmental parameters were compiled from various sources including estimation from these data using MTDFREML programs developed by Boldman et al. (1993) and estimates reported by other researchers including AAABG Genetic Parameters (http://www.gparm.csiro.au), MacNeil et al. (1984), Wilson et al. (1993) and Bertrand (*personal communication*).

Contemporary groups were genetically tied through repeated records of dam and sire progeny over years. Even though most cows and several sires did not have progeny with feed intake observations in 1997, 1998, and 1999, the genetic model used to calculate feed intake EPD relied on the existing relationships of intake with post-weaning gain, weaning weight with post-weaning gain, and the numerator relationship matrix to compute intake EPD for all animals in the data. Following the same logic, all animals including cows have EPD for carcass traits.

Table 1. Genetic parameters used for genetic evaluation analyses[1]

Random effect	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Birth weight	.41							
2. Weaning weight direct	.48	.23						
3. Weaning weight maternal		-.26	.27					
4. Weaning permanent environment				.05				
5. Post-weaning daily gain		.26			.36			
6. Daily dry matter intake					.52	.41		
7. Marbling score		-.07					.26	
8. Yield grade							.15	.22

[1] Heritabilities on the diagonal and genetic correlations below the diagonal.

Economic Simulation

Relative economic values (REV) were defined as the marginal change in expected profit per progeny from increasing a particular trait by one unit. The derivation is equivalent to differentiating a profit equation with respect to each parameter separately. To estimate REV, a bio-economic simulation was performed using a modified version of the computer software SIMUMATE 3.0 described by MacNeil et al. (1994). The principle modification applicable to this research was stochastic generation of phenotypes at endpoints where cattle are marketed. Thus, at slaughter, the steers were valued based on a multivariate normal distribution of marbling, yield grade, and carcass weight. There were a total of 76 production and economic variables used in this simulation model for a straight-bred Angus system. Growth and carcass inputs were taken from the mean performance of the steer progeny. Cow reproduction, lactation and size inputs were taken from Gregory et al. (1993a, 1993b).

The model requires a number of assumptions about expected costs and returns for a production system over a planning horizon. Cull cow price estimates were determined from USDA Market News ten year average from Sioux Falls and the Food and Agricultural Policy Research Institute ten year forecast for utility cows. Feeder steer price estimates were determined from ten year average Oklahoma City price estimates and forecasted ten year average, based on USDA Market News reports. Carcass quality grade, yield grade, and off-grade price estimates were based on National Carcass Premiums and Discounts For Slaughter Steers And Heifers as reported by USDA Market News service. Backgrounding and feeding cost estimates were based on ten year average Kansas State University Extension Monthly Performance, Cost of Gain, and Breakeven Prices.

After parameterizing the model with these inputs, REV were then estimated by approximating the partial derivatives of the profit equation with respect to each variable. These variables included birth weight, weaning weight, post-weaning average daily gain, daily dry matter intake, marbling score, and yield grade. The estimation procedure included simulating the base herd and then comparing outputs to subsequent simulations, increasing the variable of interest by one unit and comparing the differences in profit. Sire differences in profit were then estimated by computing the product of sire EPD and the REV for each trait and summing across all traits to produce the resulting index values.

Results

After data edits and pooling data from the 1996 (n=675), 1997 (n=981), 1998 (n=929), and 1999 (n=827) Sire Alliance, there were 3,412 steers evaluated with weaning weight records from the progeny test program. Another 1,998 weaning weights from the commercial operations were included in the genetic evaluation. A phenotypic characterization of the data used in the genetic evaluation is provided in table 2. Fat depth ranged from .1 to 1.4 in. and marbling score from Practically Devoid^{10} to Abundant^{00}. Hot carcass weight ranged from 476 to 993 lbs. and calculated USDA Yield grade ranged from .5 to 6.4.

Table 2. Characterization of production and carcass data used in genetic evaluation

Variable	Mean	Std. Dev.	Minimum	Maximum
Birth weight, lbs.	79	11	50	150
Weaning weight, lbs.	488	87	154	798
Weaning age, d	204	24	108	277
Post-weaning gain[a], lbs.$\cdot d^{-1}$	2.91	.38	1.06	4.54
Slaughter weight[b], lbs.	1208	118	768	1601
Slaughter age, d	445	24	364	503
Hot carcass weight, lbs.	749	73	476	993
Fat depth, in.	0.55	.18	.10	1.4
Marbling score[c]	5.7	1.0	2.1	10.0
Ribeye area, in^2	11.8	1.4	6.2	18.2
Yield grade[d]	3.4	.7	.5	6.4

[a] (Finishing weight - weaning weight) / days.

[b] Slaughter weight estimated using a 62% dressed weight.

[c] 4.0=Slight^{00}; 5.0= Small^{00}; etc.

[d] Yield grade = 2.5 + (2.5 * fat thickness) + (.0038 * carcass weight) + (.2 * %KPH) - (.32 * ribeye area).

A characterization of the production and carcass data from the 269 steers for which intake data were gathered is provided in table 3. Feed conversion ranged from 4.3 to 8.9 lbs dry matter / pound of gain, emphasizing that combinations of post-weaning gain and intake performance varied widely.

Table 3. Description of feed-gain test steers

Trait	Mean	Std.	Minimu	Maximu
On-test wt., lbs.	844	81	624	1118
Off-test wt., lbs.	1244	114	940	1668
ADG, lbs.·d^{-1}	3.65	.51	2.04	5.00
Mean daily dry matter intake, lbs.·d^{-1}	20.6	2.1	14.7	26.2
Feed conversion, lbs. dry matter ·	5.7	.7	4.3	8.9

The EPD ranges for the 302 sires that have been evaluated over the four years are represented in table 4. These EPD were calculated only from data produced in this study and are not to be confused with other EPD published by the American Angus Association. The large EPD ranges indicate that bulls did possess a great variation in genotypes for all of the economically important traits.

Table 4. Characterization of Sire Expected Progeny Differences[1] (n=302)

EPD	Minimum	Maximum	Range
Birth weight, lbs.	-7.8	7.2	15.0
Weaning weight, lbs.	-27.5	18.7	46.2
Post-weaning gain, lbs.·d^{-1}	-.27	.12	.39
Daily dry matter intake, lbs.·d^{-1}	-.74	.62	1.36
Marbling, score	-.26	.59	.85
Yield grade, units	-.33	.24	.57

[1] These EPD are calculated based only on data produced in this study and should not be confused with EPD published for the same bulls by the American Angus Association.

Table 5 shows the actual and standardized economic weights estimated from the bio-economic simulation. The REV were standardized by the genetic standard deviations to evaluate relative selection emphasis, removing scale differences among traits. Based on these data, weaning weight, post-weaning average daily gain, daily dry matter intake, and yield grade received the most emphasis followed by marbling and birth weight.

Table 5. Economic weights for selection index for profit

	Economic Weights	
Trait	Actual, $·trait unit^{-1}	Standardized, $
Birth weight	-.844	-4.320
Weaning weight	.408	11.615
Post-weaning average daily gain	47.305	11.078
Daily dry matter intake	-10.000	-10.909
Marbling	13.536	5.645
Yield grade	-35.279	-10.741

Table 6 shows the progeny profitability differences for the top eight sires that have been tested over the four years. Of the 302 sires tested, there existed a range of $41.65 from the highest to the lowest ranking bull. This indicates that if the highest and lowest indexing bulls were used in a production system similar to the one described in the economic simulation, a difference in profitability of $41.65 per calf would be expected.

Table 6. Sire rankings for progeny profitability

Ran	Sire	Profitability, $
1	Circle A 216 LTD 6517	46.66
2	Circle A 216 LTD 6563	46.25
3	GDAR SVF Traveler 234D	44.92
4	Generation Band 505	38.00
5	JLB Exacto 416	36.92
6	Circle A 6807 5011	32.01
7	G A R Explosive 6313	30.43
8	Creekstone Austin LTD 812	30.22

Implications

If these bulls provide a sample of, at least, the average genetic profile that exists within the Angus breed, it is evident that large differences exist in profit potential. In fact, by using such an approach as the one described it can easily be shown that attaching added value to certain herd sire prospects is warranted if the genetics of the prospect can be accurately described. Commercial cattlemen should be encouraged to utilize a more comprehensive approach to genetically alter profit than single trait selection.

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Genetic Correlations: Effects on Multiple Trait Selection

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Introduction

In today's beef industry, producers are challenged with the task of making simultaneous genetic progress in the economically important traits of reproductive efficiency, maternal ability, growth performance, and end product merit. With the shift of the industry away from a commodity and toward a consumer-driven business, resulting pricing structures have placed increasing economic incentives (and disincentives) on carcass merit. At the same time, reproductive efficiency continues to be the single most economically important aspect of the cow-calf enterprise, along with growth and maternal performance. However, financial incentives that reward end product specifications have shifted the balance of these traits relative to their economic importance. In the past, it was thought that reproductive efficiency was twice as important as growth performance, which in turn was five times as economically important as carcass merit. Under a value-based marketing system, the ratio of 10:5:1 for reproduction, growth, and carcass may be closer to 2:1:1 (Melton, 1995). This ratio will certainly vary from one operation to the next, depending on the marketing and production system. However, it is clear that our selection focus has changed and will continue to change as economic signals in our industry change. Considering the number of specific traits that are economically relevant, the question becomes: How can multiple trait selection be practiced without a setback in performance in one or more areas?

Due to the large number of traits that we measure and have accurate estimates of genetic differences between animals for (EPDs), it is nearly impossible to find an animal that excels in all traits of interest. Therefore, we are resigned to the fact that we need to focus on a few traits in order to do an effective job in a task such as bull selection. Since there are genetic relationships that exist between a large number of these traits, effectively we are changing nearly all traits even though our selection emphasis may only be on a limited number of traits (birth weight, weaning weight, and milk for example). These genetic relationships between traits are important to understand, as they assist us not only in understanding why cattle with specific EPDs for two or more traits are unique, but also how selection for a particular trait results in a correlated change in one or more other economically important traits.

Genetic Correlations

A correlation is a statistical measure of the relationship between two variables. Correlations range from –1 to +1, with a positive correlation indicating that the two variables both move in the same direction (ie. as one trait increases so does the other). A negative correlation indicates the two traits move in opposite directions. Correlations that are closer to –1 and +1 are considered stronger than correlations that are close to 0. Specifically, genetic correlations exist because some of the same genes affect the two traits of interest, or the genes are closely linked. As an example, weaning weight and yearling weight have a high positive genetic correlation. Therefore, selection for cattle that weigh more at weaning also results in cattle than tend to weigh more at a year of age (since some of the same genes that influence weaning weight also influence yearling weight). Genetic correlations may also be defined as the correlation between EPDs for two traits. In the previous example, bulls with high WW EPDs also tend to have high YW EPDs (and vice-versa). For weaning and yearling weight, the genetic correlation is generally considered favorable as more growth is generally desired. However, the sign of a genetic correlation does not necessarily indicate if the relationship between the traits is favorable or antagonistic. The positive genetic correlation between birth weight and weaning weight indicates that selection for cattle with heavier weaning weights also tend to have higher birth weights (or cattle with lower birth weights tend to have lighter weaning weights). Although this correlation is positive, we would generally characterize the relationship as antagonistic or unfavorable.

Relationships Between Growth and Maternal Traits

Table 1 lists genetic correlations for growth and maternal traits, as adapted from a review by Koots et al. (1994). As mentioned previously, growth traits are generally positively related from a genetic standpoint. Selection for increased weight at a particular age (birth, weaning, or yearling) normally is associated with a correlated genetic advantage in weights at all ages. Birth weight EPD is the most commonly used tool for managing calving difficulty in heifers. The success of this selection practice can be attributed to the strong negative correlation between birth weight and direct calving ease. In contrast, the genetic relationships between milk and weaning or yearling weight growth are negative and antagonistic/unfavorable. These relationships suggest that selection for increased growth would come at the expense of improvement in milk production. However, the magnitude of this genetic correlation is lower than for the relationships among the individual growth traits.

Table 1. Genetic Correlations Among Growth and Maternal Traits[a]

	Birth Wt.	Weaning Wt.	Yearling Wt.
Weaning Wt.	+.50		
Yearling Wt.	+.55	+.81	
Milk	-.14	-.16	
Calving ease direct	-.74	-.21	-.29

[a] Correlations represent weighted mean estimate across studies as reported by Koots et. al., 1994

Growth and Mature Size Relationships

Mature size is an economically relevant trait from several aspects. Mature size is measured in weight and/or height (frame score), and these two measures are highly correlated (genetic correlation = .86) (Bullock et al., 1993). Mature cow size influences nutritional requirements- at the same stage of production (90 days post-calving) and moderate milk production, 1200 pound cows (frame score ~ 5-6) have a 10% higher energy requirement and 7% higher protein requirement than 1000 pound cows (frame score ~ 4). As cow size increases to 1400 pounds (frame score ~ 7), energy and protein requirements increase 19% and 13%, respectively, compared to 1000 pound cows (NRC, 1996). These differences are due in large part to higher maintenance requirements of larger cows, as they simply have more body mass to maintain. Increased nutritional requirements result in higher cow carrying costs throughout the production cycle. Similarly, mature cow size impacts stocking rates and supplemental feed resource needs. Mismatches between cow size and nutritional resources may compromise reproductive efficiency.

Mature size has a strong positive genetic correlation with birth weight (.64), weaning weight (.80), and yearling weight (.76) (Bullock et al., 1993). These relationships would suggest that selection for growth will result in a corresponding increase in mature cow size. Selection for extremes in growth traits can be detrimental. At the same time, small mature size- that may be advantageous in terms of costs of production, is associated with reduced growth. Therefore, optimization of growth and mature size is key. Optimum mature size will vary with production system and feed resources.

Growth and Carcass Trait Relationships

Genetic correlations of carcass traits with growth traits are presented in Table 2. Measures of growth generally have positive genetic correlations with carcass weight, ribeye area, and carcass fat thickness. These relationships would suggest that selection for increased growth rate would result in heavier carcasses at a given age, with increased weight of both muscle and fat.

Genetic correlation estimates between growth and carcass cutability have been more variable. Marshall (1994) reported relatively weak negative genetic correlations between pre and postweaning growth rate and cutability (r_g = .-12 and -.13, respectively) . However, others have indicated positive genetic correlations between cutability and weaning or yearling weight (Koots et al., 1994). The small magnitude of these genetic correlation estimates between growth and cutability suggest that improving carcass weight and ribeye are feasible, without a proportional correlated increase in carcass fat.

The genetic correlations between marbling and various growth measures reported by Koots et al. (Table 2) indicate birth weight and post-weaning gain have favorable genetic correlations with marbling, whereas weaning and yearling weight have negative and antagonistic relationships with marbling. As with cutability, genetic correlations between growth and marbling have been quite variable across studies (Marshall, 1994). Correlations of Gelbvieh sire EPDs generated through the National Cattle Evaluation analysis indicate small negative genetic correlations between marbling and growth (American Gelbvieh Association, 2001).

Table 2. Genetic Correlations Between Growth and Carcass Traits[a]

	Carcass Wt.	Fat Th.	REA	Marbling
Birth Wt.	+ .60	- .27	+ .31	+ .31
Weaning Wt.	+ .71	+ .24	+ .49	- .09
Yearling Wt.	+ .91	+ .32	+ .51	- .33
Post-Weaning Gain	+ .87	+ .19	+ .32	+ .11

[a]Correlations represent weighted mean estimate across studies as reported by Koots et. al., 1994. Carcass traits adjusted to an age-constant basis.

Relationships Among Carcass Traits

Age-constant genetic correlations among carcass traits are presented in Table 3. Examination of these correlations reveals some important favorable and antagonistic relationships between carcass traits of interest.

These genetic correlations indicate that selection for increased carcass cutability would favorable impact carcass ribeye and fat thickness, without a correlated response in carcass weight. In contrast, marbling and cutability exhibit an antagonistic genetic relationship. The negative genetic correlation between these traits indicates that high marbling genetics are generally associated with unfavorable genetics for carcass leanness and muscularity. However, national cattle evaluations indicate potential breed differences for the genetic correlation between marbling and fat thickness. This relationship is essentially 0 (r_g = .05) for the Angus breed (American Angus Association, 2001), whereas Gelbvieh reports this relationship to be antagonistic (r_g = .25, American Gelbvieh Association, 2001).

Table 3. Genetic Correlations Among Carcass Traits[a]

	Fat Th.	REA	Cutability	Marbling
Carcass Wt.	+ .29	+ .48	+ .00	+ .25
Fat Thickness		+ .01	- .56	+ .35
Ribeye Area			+ .45	- .21
Cutability				- .25

[a]Correlations represent weighted mean estimate across studies as reported by Koots et. al., 1994. Carcass traits adjusted to an age-constant basis.

Relationships Between Carcass and Maternal Traits

With increased focus on carcass traits in today's beef breeding programs, the logical question arises- how does selection for carcass merit affect maternal traits? Specifically, does selection for improved carcass characteristics result in undesirable correlated responses in important maternal traits? Unfortunately, few selection experiments have been conducted that directly address these relationships although studies have been initiated in recent years (Rouse and Wilson, 2001).

Tables 4 and 5 present genetic correlations between selected carcass measures and maternal traits as reported by MacNeil et al. (1988) and Splan et al. (1998). Both studies were conducted utilizing data generated through the germplasm evaluation studies at the U.S. Meat Animal Research Center. MacNeil et al. (1988) evaluated the genetic relationship between fat trim weight and total retail product weight of steers and maternal traits of their female herdmates. All genetic correlation estimates for fat trim weight were antagonistic with female traits. Thus, selection for reduced fat trim (i.e. improved retail product % and yield grade) would be associated with a correlated increase in age at puberty, increased weight at puberty, reduced fertility, larger mature size, and more calving difficulty in females. Similarly, selection for enhance retail product weight (more saleable product) was found to have an undesirable genetic relationship with the female traits of age at puberty, weight at puberty, mature weight, and calving difficulty. Genetic correlations reported by Splan et al. (1998) also indicate that selection for decreased carcass fat (fat thickness, carcass % fat, and retail product %) would negatively affect fertility (calving rate) and maternal calving difficulty. In these same studies, neither ribeye area nor marbling was negatively associated with calving rate or calving difficulty. Thus, it appears the undesirable associations between maternal traits and carcass merit are mediated through reductions in carcass fat thickness.

Genetic Correlations for Maternal Traits with Carcass Fat and Retail Product Weight[a]

Female Trait	Fat Trim Wt.	Retail Prod. Wt.
Age at Puberty	- .29	+ .30
Weight at Puberty	- .31	+ .08
Conceptions/service	+ .21	+ .28
Mature Wt.	- .09	+ .25
Calving Difficulty	- .36	- .02

[a]Adapted from MacNeil et al. (1988). Carcass traits adjusted to an age-constant basis.

Table 5 Genetic Correlations Between Carcass Traits and Selected Maternal Traits

	Calving Rate	Calving Difficulty
Fat Thickness	+ .19	- .14
Fat %	+ .18	- .23
REA	+ .15	- .04
Retail Product %	- .13	+ .18
Marbling	- .05	- .09

[a]Adapted from Splan et al. (1988). Carcass traits adjusted to an age-constant basis.

These genetic antagonisms present great challenges to beef producers. Traits such as age at puberty, fertility, mature size, and calving ease all contribute significantly to the economic viability of the cowherd. At the same time, we are challenged to produce a high quality, consistent end product with consumer appeal. Due to the unfavorable correlations between these maternal traits and carcass measures, these goals tend to be in contrast to each other. Further troubling selection for a proper balance between maternal and carcass traits is the general lack of genetic predictors (EPDs) for important maternal traits such as fertility. This leads to the question: Can we genetically design a low-cost female that is adaptable and low-cost in our environment, while at the same time produce cattle that have carcass merit attributes desired by our customers?

Genetic Improvement in Multiple Traits

In summary, the major genetic antagonisms that exist include those between:

a) growth rate and calving ease
b) growth rate and mature size
c) carcass cutability and marbling
d) carcass cutability and maternal traits
e)

The difficulty becomes simultaneously making genetic improvement in these important traits. To do so successfully, several tools for genetic improvement need to be considered:

1) Crossbreeding System- Due to the undesirable relationship between maternal traits and carcass characteristics, breeding systems that enable selection to occur somewhat independently for these two areas of importance seems advantageous. A terminal crossbreeding system, which can be used to balance economically important traits in the cow herd as well as end product traits in the calf crop is one such system. Maternal lines that are composed of breeds selected for production characteristics (reproduction, growth, milk, mature size, calving ease) that match the environment, can be tailored to the resources of the operation. To compliment these maternal lines, terminal-cross lines (or breeds) can be selected with primary emphasis on growth performance, efficiency, and carcass specifications. With such a system, compromises between maternal and end product genetics can be largely avoided. Certainly, since the cowherd contributes to the growth efficiency and carcass merit of the calf crop, minimum genetic thresholds for these traits are necessary. However, selection criteria in the maternal lines for carcass merit may focus on achieving acceptable minimums and avoiding extremes, while enhancing uniformity.

2) Heterosis- Our biggest ally in overcoming the genetic antagonisms that affect reproduction in a negative fashion is heterosis. Specifically, maternal heterosis (the crossbred cow) has been documented to have pronounced favorable effects on productivity and profitability of the cowherd. Research has shown an increase of 20-25% in pounds of calf weaned per cow exposed as a result of heterosis in a terminal crossbreeding system (Cundiff et al., 1999). With the lack of genetic predictors

(EPDs) available to select directly for reproduction, heterosis is our best tool to genetically improve reproductive efficiency.

3) Breed Complimentarity- Since no one breed simultaneously excels in all traits, utilizing multiple breeds to mix and match strengths and weaknesses allows for balanced performance. Furthermore, breed strengths and weakness have been well defined (Cundiff and Gregory, 1993). For carcass traits, coupling the general superiority of the British breeds for marbling potential with the red meat yield advantages of the Continental breeds offers the opportunity to optimize quality grade and cutability (yield grade). Similarly, optimizing reproduction, milk potential, mature size, growth, and adaptability of the cowherd to the environment will likely require the resources of more than one breed.

4) EPDs- Selection of genetics within breed is equally important as choice of breed, as variability within breed may be as great as between breeds for many traits (Cundiff et al., 1999) EPDs are the most accurate selection tool for identifying desirable genetics within a breed population. At the same time, breed strengths and weaknesses and the genetic merit of a particular breed as a whole for specific trait also warrant consideration when bulls are selected for use in a crossbreeding system. In other words, EPDs need to be considered on both a within and across-breed basis to effectively balance selection in a crossbreeding program. EPDs allow for the identification of individual animals that have favorable genetics for traits that tend to be antagonistic (i.e. low birth weight and high growth). Fortunately, for many of the antagonistic relationships that have been discussed, the genetic correlations are relatively low. Genetic correlations that are small enhance the likelihood that animals exist in the population that have a desirable combination of genes for these traits. As an example, there are a number of bulls in several breeds that have favorable EPDs for both marbling and cutability. Several of these animals are also superior for growth. Similarly, mature height and weight EPDs in conjunction with weaning weight and yearling weight EPDs are necessary to balance growth and mature size. With these tools, significant genetic progress can be made in growth traits without compromising cow size.

In summary, the number of economically important traits involved in beef production coupled with the unfavorable relationships that exist between many of these traits make multiple trait selection in beef cattle challenging. Proper use of existing tools such as crossbreeding and EPDs are necessary to optimize performance in multiple traits. Future development of genetic predictors for traits such as reproduction and efficiency, as well as the application of selection indexes for specific production and marketing systems, will enhance our ability to overcome these challenges.

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POTENTIAL CAUSES OF NEGATIVE DIRECT – MATERNAL GENETIC CORRELATIONS IN WEANING WEIGHT ANALYSES

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INTRODUCTION

Accurate genetic evaluations require accurate estimates of the genetic parameters. One genetic parameter that has been found to be significant in beef cattle evaluations, particularly those involving growth traits, is the correlation between direct and maternal genetic effects. This correlation has often been shown to be negative in growth data, such as preweaning growth (Deese and Koger, 1967), weaning weight (Koch and Clark, 1955; Lee et al., 1997), yearling weight (Lee et al., 2000), and mature weight (Rumph, 2000).

Typically, a negative direct-maternal genetic correlation would indicate that there is some sort of antagonistic relationship between the two genetic components, and more specifically for weaning weight, this indicates that selection for fast growing heifers should result in slower growing progeny of those heifers and vice versa. However, the magnitude of many of these negative estimates of the genetic correlation reported for a large number of weaning weight data sets (e.g., -.79, Hohenboken and Brinks, 1971; -.72 , Baker, 1980; -.57 to -.79, Cantet et al.; 1988; -.80, Meyer, 1993) have led some researchers to believe that there may be another explanation for these seemingly unreasonable estimates of this parameter.

One hypothesis for the cause of these negative estimates is the presence of a negative dam-offspring environmental correlation (Baker, 1980), primarily due to fatty udder syndrome (Griggs, 1986). Additional explanations include effects that have not been accounted for in the model, such as extra variation associated with sire x year effects or that these large negative values can simply be attributed to misidentification of sires.

Regardless of the origin of these estimates, when a negative direct-maternal correlation is present, it has a large impact on estimates of both direct and maternal heritabilities (Deese and Koger, 1967; Robinson, 1996; Rumph, 2000). Currently, this correlation is being ignored by some breed associations (AAA, 2000), which may cause some bias in the estimation of the direct and maternal heritabilities because the heritabilities will respond by compensating for the missing correlation between the two genetic effects, affecting the entire evaluation. On the other hand, some breed associations are using an estimate of -.32 (ASA, 1998) for the direct-maternal genetic correlation, which is considerably smaller in magnitude than some of the estimates that have been found in literature. Once the source of this relationship is better understood, reasonable estimates can be used in genetic evaluations.

REVIEW OF LITERATURE

Negative Dam-Offspring Environmental Correlations

Replacement females are typically raised in a high growth situation so that they can be bred to calve as two-year-olds. The high level of nutrition that is required for heifers as they develop into breeding females has been shown to have detrimental effects on their maternal abilities (Hansson, 1956; Young and Legates, 1965; Plum and Harris, 1968; Totusek, 1968) due to a phenomenon commonly referred to as fatty udder syndrome. Faster growing females generally accumulate more fat than their slower growing contemporaries, some being deposited in the mammary gland, which causes subsequent milk production to be decreased and ultimately fewer pounds of calf weaned. The negative environmental correlation brought about by this condition is thought to contribute, partially or wholly, to the negative direct-maternal genetic correlation that is found in weaning weight analyses (Hohenboken and Brinks, 1971; Magnus and Brinks, 1971; Hohenboken, 1973).

As an example, Robinson (1996) analyzed three simulated data sets to investigate the effect of this environmental correlation on the direct-maternal genetic correlation. The first data set was simulated to be a control (C0), the second (B2) simulated a negative dam-offspring environmental correlation that would be reasonable for breeds where fatty udder syndrome occurs, and the third data set (B4) imposed a correlation that was also negative, but greater in magnitude to that in B2. A summary of the results from analyses of these data sets is shown in Table 1. When the model included heritabilities of direct genetic effects (h^2_a), maternal genetic effects (h^2_m), and the correlation between the two genetic effects (r_{am}), the direct-maternal genetic correlation was estimated at -.520 and -.787 for the B2 and B4, respectively. Expanding the model to also include variation due to permanent environmental effects of the dam (c^2), these correlations decreased in magnitude, but not significantly, to -.481 and -.752. Including the phenotypic value of the dam as a fixed effect, all three data sets were analyzed and the direct-maternal genetic correlation was found to decrease in magnitude to -.258, -.280, and -.160, for C0, B2, and B4, respectively. With the added variation from the permanent environmental effects of the dam included in the model, these estimates again decreased, but not significantly to -.236, -.266, and -.139. The latter model, which included dam phenotypic value, was found to be a better fit to the data statistically, and decreased the magnitude of the estimate of direct-maternal genetic correlation considerably.

Inclusion of Sire x Year Variation in the Model

If significant causes of variation are not accounted for in the model, the variance components that are being estimated may be affected. To investigate this, Robinson (1996) analyzed three simulated data sets, different from those discussed above. This model also included heritabilities of direct genetic effects (h^2_a), maternal genetic effects (h^2_m), and the correlation between the two genetic effects (r_{am}). The control data set (C) was simulated with no direct-maternal genetic correlation or sire x year interaction effects and estimated the direct-maternal genetic correlation to be -.092, as shown in Table 2.

Data set G simulated a sire x year interaction effect to account for 6.25% of the phenotypic variation. When this variation was not included in the model, as shown in Table 3, the estimate of the direct-maternal genetic correlation was estimated to be -.539. When the appropriate missing effect (sire x year) was included in the model, the model was determined sufficient without inclusion of the direct-maternal genetic correlation.

Furthermore, a simulation study by Lee and Pollak (1997b) showed that when data (D1) that had been simulated with a sire x year interaction effect, but no direct-maternal correlation, were analyzed using a model that did not include sire x year interaction, the direct-maternal genetic correlation was estimated to be -.228 ($P < .01$) as shown in Table 3. When the model used for analysis included both the sire x year interaction and the direct-maternal genetic correlation, this estimate became .031, which was not considered significantly different from zero. Additionally, the estimate of direct-maternal genetic correlation when the sire x year interaction was excluded from the model altered both the direct and maternal heritability estimates, increasing direct heritability from .260 when sire x year was included to .381 ($P < .01$) when it was not and maternal heritabilty from .147 to .175 ($P < .01$).

Similarly, when considering a simulated data set that included a direct-maternal genetic correlation, but no sire x year interaction effects (D2), the estimates of heritability were significantly reduced when sire x year was included in the model, but the direct-maternal genetic correlation was excluded. These results are summarized in Table 4. Direct heritability was estimated at .215 ($P < .01$) when the correlation was excluded compared to .291 when the direct-maternal genetic correlation was included in the model, but the sire x year interaction was included (the true model) or .289 when both the genetic correlation and the interaction effect were included in the model. Maternal heritability estimates were .122 ($P < .01$) compared to .165 and .160 for the same models.

The direct-maternal genetic correlation did not differ significantly between the model that included only the correlation (-.336) and the model that included both the correlation and the sire x year interaction effect (-.306) and neither estimate was significantly different from the input value of -.320.

With a third simulated data set that included both a direct-maternal genetic correlation as well as a sire x year interaction (D3), exclusion of the sire x year interaction significantly altered the estimates of the genetic parameters, compared with the starting values. The direct-maternal genetic correlation was estimated at -.476 ($P < .01$) when sire x year was excluded, compared with -.299 ($P > .05$) when it was included in the model. Additionally, heritability estimates increased with direct heritability estimates of .414 ($P < .01$) when sire x year interaction was excluded compared with .278 ($P > .05$) when the effect was included in the model (true model) and maternal heritability estimates increased to .179 ($P < .01$) compared with .146 ($P > .05$). These results are summarized in Table 5.

Using field data provided by the American Simmental Association, Lee and Pollak (1997b) found that if sire x year interaction was excluded from the model, the resulting estimate of the direct-maternal genetic correlation was -.29 and decreased in magnitude 52% to -.14 when the sire x year interaction was included in the model, which only accounted for 3% of the phenotypic variation. The heritability estimates also decreased with the latter model with the direct heritability estimate decreasing from .28 to .21 and the maternal heritability estimate decreasing from .11 to .10. Additionally, based on the –2 log likelihood ratio (-2logL) test, the latter model was determined to be a significantly better fit to the data ($P < .01$). The results from these analyses are shown in Table 6.

Similarly, using field data supplied by the American Angus Association, Dodenhoff et al. (1999) analyzed Angus records from Iowa, Montana, and Nebraska with the results being shown in Table 6. Analyzing three random samples of data from each state, their results were similar to those reported above with the model including both the direct-maternal genetic correlation and the sire x herd year interaction effect being a significantly better fit to the data. The estimates obtained from this model for the direct-maternal genetic correlation ranged from -.32 to +.02 and the sire x herd year interaction accounted for 2 to 10% of the phenotypic variance.

These results indicate that ignoring sire x year interactions may be causing the direct-maternal genetic correlation to be estimated as a negative value of greater magnitude than is the true value and consequently, may be causing heritabilities to be estimated at greater values to compensate for the extreme negative correlation.

Misidentification of Sires

There is some speculation that these sire x year interaction effects are simply caused by sire misidentification and are not a true genotype by environment interaction. Misidentification of parents is a serious problem because it does not allow for an accurate knowledge of genetic ties for estimation of variance components. The problem is particularly severe if sires are misidentified because sires have, on average, a greater number of progeny than dams. Furthermore, if sires of parents are misidentified, this situation is critical because of further breaks in the genetic ties across generations.

Additionally, misidentification has been shown to reduce genetic gain and/or increase the size of groups needed for progeny testing, as well as biasing the rank of sires in genetic evaluations (Van Vleck, 1970; Geldermann, 1986)

In a study with weaning weight records, Lee and Pollak (1997a) simulated a group of data sets with a direct-maternal covariance of zero (D0) and a second group with a direct-maternal correlation of -.32 (D32). In the first group of data sets, when 20% of the sires of nonparent animals were misidentified, r_{am} was estimated to be .115 for a model including only the direct-maternal genetic covariance and .418 for a model including both the direct-maternal genetic covariance and the sire x year variance. When 20% of the sires of all animals were misidentified, r_{am} was estimated to be .211 and .434 for the same two models. These estimates also caused heritabilities to increase, particularly the maternal heritability and estimated the maternal genetic component to have a larger effect than the direct genetic component, as shown in Table 2.

For the data set with the simulated negative correlation, r_{am} was estimated to be -.090 when 20% of sires of all animals were misidentified in the model where the direct-maternal genetic covariance was included and .080 with the model including both the sire x year variance and direct-maternal genetic covariance as shown in Table 4. Although these estimates are not as extreme negative as have been shown in literature, and often times are positive, these results indicate that misidentification can bias the estimate of the direct-maternal genetic correlation. Conversely, because these estimates tend to be positive, it is unlikely that misidentification is the sole reason for the spurious negative direct-maternal genetic correlations that are found in weaning weight data, but it possibly is a contributing factor.

Being the only explanation for this direct-maternal genetic correlation that producers can control, one way to minimize the amount of sire misidentification would be through molecular methods. Although determining the exact sire may not always be possible, simple DNA analysis can exclude sires that are obviously misidentified. The negative aspect of this process, however, is the cost. Such a procedure is most appropriate for producers that already utilize DNA identification for other purposes, such as identifying certain sires or sire groups for use in selection. A small producer might not be able to incorporate DNA fingerprinting into the management system without losing money. Additionally, because using the records of the animal themselves can make effective genetic progress in growth traits, producers who select strictly based on growth would not benefit from DNA confirmation of parentage (DeNise, 1999). Larger producers who select for carcass traits, which cannot be measured on parent animals (excluding the use of ultrasound), could benefit because they will see a profitability benefit due to marker analysis for carcass traits and then also take benefit of detecting any misidentified sires.

CONCLUSIONS AND IMPLICATIONS TO GENETIC IMPROVEMENT OF BEEF CATTLE

More studies are needed in order to better understand the origin(s) of extreme negative estimates of the direct-maternal genetic correlation. Such estimates are most likely caused by a combination of the factors above and possibly other factors that have not yet been identified.

Those individuals that are involved with genetic evaluations must determine what the correct model is for the data so that accurate estimates of the genetic parameters can be determined. Additionally, breed associations need to acknowledge that there is a correlation between the direct and maternal genetic components of weaning weight and this parameter should be considered when computing genetic evaluations.

On the producer level, altering the environmental antagonism caused by high growth heifer development programs is unlikely and unrealistic. What the producer can manage and control is the correct identification of sires. Misidentification of parents is inevitable due to honest human error, but if producers pay careful attention in order to keep these mistakes to a minimum and if large producers additionally utilize molecular technology to identify obvious misidentifications, the proportion of erroneous variance component estimations due to sire misidentification should be minimal.

In summary, although many estimates in literature appear to be unreasonable for direct-maternal genetic correlation, this parameter is part of current data sets for weaning weight and therefore should not be ignored in genetic evaluations. Proper models must be fit to the data in order to obtain more reasonable estimates that can be included in genetic evaluations. Currently, accounting for sire x year interaction effects in the model for weaning weight appears to decrease the magnitude of this estimate, but the origin of significant sire x year interaction effects are unclear.

TABLE 1. Summary of analyses with a simulated negative dam-offspring environmental correlation

	Genetic Parameters[c]			
Data & Model[b]	h^2_a	r_{am}	h^2_m	c^2
B2	.261	-.520	.368	-
B2 – MPE	.256	-.481	.254	.080
B4	.309	-.787	.550	-
B4 – MPE	.243	-.752	.166	.240
	Phenotypic Value of Dam[d]			
C0	.227	-.258	.293	-
C0 – MPE	.227	-.236	.225	.055
B2	.256	-.280	.301	-
B2 – MPE	.260	-.266	.240	.048
B4	.231	-.160	.256	-
B4 – MPE	.236	-.139	.197	.052

[a] Adapted from Robinson, 1996

[b] C0 is the control data set; B2 was simulated with a negative dam-offspring environmental correlation similar to what can be found when fatty udder syndrome is occurring. B4 was simulated with a negative dam-offspring environmental correlation that is of greater magnitude than in B2, and MPE indicates models that included the maternal permanent environment random effect.

[c] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, h^2_m is maternal heritability, and c^2 is maternal permanent environment.

[d] Phenotypic value of dam included as a fixed effect

TABLE 2. Summary of analyses comparing results of various models when data was simulated to exclude both sire x year interaction effects and direct-maternal genetic correlation

		Genetic Parameters[b,c]		
Data & Model[a]		h^2_a	r_{am}	h^2_m
Robinson (1996) – C				
	DM	.217	-.092	.240
Lee and Pollak (1997a) – D0			Input Values	
		.277	-	.147
			No Misidentification	
	Control	.268 NS	-	.149 NS
			20% of Nonparent Sires Misidentified	
	Control	.094**	-	.222**
	DM	.087**	.115**	.212**
	SY	.098**	-	.208**
	DM + SY	.075**	.418**	.178**
			20% of All Sires Misidentified	
	DM	.100**	.211**	.180**
	SY	.132**	-	.188**
	DM + SY	.102**	.434**	.147 NS

[a] Control indicates models that included neither sire x year interaction effects or the direct-maternal genetic covariance; SY indicates models that included sire x year interaction effects, but no direct-maternal genetic covariance; DM indicates models that included direct-maternal genetic covariance, but no sire x year interaction effects; DM + SY indicates models that included both the sire x year interaction effects and the direct-maternal genetic covariance.

[b] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, and h^2_m is maternal heriability

[c] Statistical significance, if provided in the paper, when compared with the input values (NS = $P > .05$, * = $P < .05$, and ** = $P < .01$)

TABLE 3. Summary of analyses comparing results of various models when data was simulated to include sire x year interaction effects, but no direct-maternal genetic effects

	Genetic Parameters[b,c]		
Data & Model[a]	h^2_a	r_{am}	h^2_m
Robinson (1996) – G			
DM	.579	-.539	.292
SY	.131	-	.198
Lee and Pollak (1997b) – D1			
Input values	.264	.000	.140
DM	.381**	-.228**	.175**
SY	.260 NS	-	.147 NS
DM + SY	.252 NS	.031 NS	.145 NS

[a] SY indicates models that included sire x year interaction effects, but no direct-maternal genetic covariance; DM indicates models that included direct-maternal genetic covariance, but no sire x year interaction effects; and DM + SY indicates models that included both the sire x year interaction effects and the direct-maternal genetic covariance

[b] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, and h^2_m is maternal heriability

[c] Statistical significance, if provided in the paper, when compared with the input values (NS = $P > .05$, * = $P < .05$, and ** = $P < .01$)

TABLE 4. Summary of analyses comparing results of various models when data was simulated to include a direct-maternal genetic correlation, but no sire x year interaction effect

	Genetic Parameters[b,c]		
Model[a]	h^2_a	r_{am}	h^2_m
Lee and Pollak (1997a) – D32			
Input Value	.296	-.320	.157
DM	.291 NS	-.336 NS	.165 NS
All Animals – DM	.104**	-.090**	.157 NS
SY	.108**	-	.135**
DM + SY	.104**	.080**	.128**
Lee and Pollak (1997b) – D2			
Input values	.296	-.320	.157
DM	.291 NS	-.336 NS	.165 NS
SY	.215**	-	.122**
DM + SY	.289 NS	-.306 NS	.160 NS

[a] SY indicates models that included sire x year interaction effects, but no direct-maternal genetic covariance; DM indicates models that included direct-maternal genetic covariance, but no sire x year interaction effects; and DM + SY indicates models that included both the sire x year interaction effects and the direct-maternal genetic covariance

[b] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, and h^2_m is maternal heriability

[c] Statistical significance when compared with the input values (NS = $P > .05$, * = $P < .05$, and ** = $P < .01$)

TABLE 5. Summary of analyses comparing results of various models when data was simulated to include both a direct-maternal genetic correlation and sire x year interaction effects

	Genetic Parameters[c,d]		
Data & Model[b]	h^2_a	r_{am}	h^2_m
D3			
Input values	.281	-.320	.149
DM	.414**	-.476**	.179**
DM + SY	.278 NS	-.299 NS	.146 NS

[a] Adapted from Lee and Pollak (1997b)

[b] SY indicates models that included sire x year interaction effects, but no direct-maternal genetic covariance; DM indicates models that included direct-maternal genetic covariance, but no sire x year interaction effects; and DM + SY indicates models that included both the sire x year interaction effects and the direct-maternal genetic covariance

[c] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, and h^2_m is maternal heriability

[d] Statistical significance when compared with the input values (NS = $P > .05$, * = $P < .05$, and ** = $P < .01$)

TABLE 6. Summary of analyses comparing results of various models for field data

	Genetic Parameters[b,c]			
Model[a]	h^2_a	r_{am}	h^2_m	s^2
Dodenhoff, et al. (1999)				
Iowa 1 – DM	.41	-.55	.16	-
DM + SY	.21	-.27	.11	.08
Iowa 2 – DM	.48	-.57	.14	-
DM + SY	.31	-.32	.09	.07
Iowa 3 – DM	.50	-.57	.16	-
DM + SY	.20	-.11	.08	.10
Montana 1 – DM	.25	-.25	.16	-
DM + SY	.18	-.07	.13	.04
Montana 2 – DM	.26	-.32	.14	-
DM + SY	.17	-.14	.12	.04
Montana 3 – DM	.24	-.07	.17	-
DM + SY	.20	.02	.16	.02
Nebraska 1 – DM	.30	-.41	.15	-
DM + SY	.17	-.14	.11	.07
Nebraska 2 – DM	.26	-.31	.11	-
DM + SY	.19	-.18	.10	.03
Nebraska 3 – DM	.33	-.40	.17	-
DM + SY	.21	-.22	.14	.04
Lee and Pollak (1997b)				
DM	.28	-.29	.11	-
DM + SY	.21	-.14	.10	.03

[a] SY indicates models that included sire x year interaction effects, but no direct-maternal genetic covariance; DM indicates models that included direct-maternal genetic covariance, but no sire x year interaction effects; and DM + SY indicates models that included both the sire x year interaction effects and the direct-maternal genetic covariance

[b] h^2_a is direct heritability, r_{am} is the direct-maternal genetic correlation, h^2_m is maternal heriability, and s^2 is the proportion of the phenotypic variance that can be attributed to sire x year effects.

[c] Statistical significance when compared with the input values (NS = $P > .05$, * = $P < .05$, and ** = $P < .01$)

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GENETIC PARAMETERS FOR SEX-SPECIFIC TRAITS IN BEEF CATTLE: FEMALE MATURE WEIGHT AND MALE CARCASS TRAITS

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Introduction

Although major changes have occurred in size of farm animals since the beginning of scientific animal production, physical laws of nature dictate the limits within which various body dimensions or physiological functions of animals may vary (Brown *et al.*, 1983). Identification of an optimal size for all production situations is therefore not possible (Fitzhugh, 1978). Large or small body size may have important biological advantages for adaptation to climate, feed resources, seasonal grazing and marketing (Dickerson, 1978).

Animal breeders are beginning to wonder if the size of the beef cattle is not too large? Modern selection practices in beef cattle have placed emphasis on increased growth as indicated by live weight. Genetic relationships among weights at different ages and among growth and production traits make growth important to all segments of the beef industry. However, increasing growth rate tends to be accompanied by an increase in mature weights, which may not be desirable for the breeding herd because of increase in maintenance cost associated with heavier mature cow weights (Urick *et al.*, 1971; Buttram and Willham, 1989; Fiss and Wilton, 1992; Bullock *et al.*, 1993; Meyer, 1993).

Whereas increased total growth (weaning, yearling and market weights) results in more dollars per animal for the producer, lean growth production is of more fundamental importance owing to its influence on market trends and prices because it is the product that consumers purchase. Breeding objectives for beef cattle have evolved over the years to meet production standards, resources, consumer demands, and marketing practices. Historically, the packing industry has purchased cattle on a "grade and yield" basis, with premium prices paid for a choice carcass of high yield or high dressing percentage. These buying standards require a relatively high level of fat in the carcass. The cost of waste fat on beef sold to retailers has been in turn passed to the consumer as higher prices for lean meat. However consumer preferences have changed over time, calling for the production of larger and leaner cattle. During the late 1960's, the red meat industry recognized the need to produce leaner, faster-gaining cattle, which led to much emphasis on frame size or height in purebred cattle to produce later-maturing, leaner market cattle (Humes and Munyakazi, 1989). During the following years, increasing demand for lean meat implied that the beef cattle improvement objectives should be broadened to include carcass traits.

Although there are numerous estimates of genetic parameters for many pairs of growth and carcass traits (reviews by Mohiuddin, 1993; Koots *et al.*, 1994a,b), there is a paucity of information on how change in mature weights of cows over the years is related to carcass traits. Speer (1993), for example, indicated that carcass weight, fat thickness, rib eye area and yield grade are positively associated with female mature weight, but negatively correlated with quality grades. Speer (1993) further noted that breeds that excel solely for carcass leanness tended to have females that are older at puberty and exhibit lower levels of reproductive efficiency. Also, steers from those breeds characterized by females with high fertility and maternal ability tend to be intermediate for carcass composition. Splan (1994) and Theron (1997) also noted that selection for some traits measured in one sex of beef cattle may yield undesirable responses in traits measured in the opposite sex.

Profitability of a beef cattle enterprise depends to a large extent on the opportunity available to genetically alter economically important traits through selection, which is determined by genetic variation and correlations among different traits. Effectiveness of selection for a single trait depends importantly on the heritability of the trait, while the magnitude and direction of total change through selection is determined by the genetic correlations among traits. If mature weight and carcass traits relate in an undesirable way, producers of beef cattle would need to appropriately modify their breeding programs to incorporate such relationships to optimize genetic progress through selection.

The preceding arguments suggest the need to study the genetic relationship between mature cow weight and carcass traits (especially quality traits) of beef cattle. This paper presents a review of research on mature weights and carcass traits and discusses implications of their correlations to genetic improvement of beef cattle.

Mature weight

Genetic predictions for mature size (weight and/or height at maturity) would be valuable to beef cattle breeders to change mature size of their cowherd or to put emphasis on homogenizing cow size for a particular production environment. Such predictions may also be of particular importance for maternal breeds used in crossbreeding programs that use specialized sire and dam lines (MacNeil *et al.*, 1994). A commercial cow-calf producer could use expected progeny differences (EPD's) for mature size in selecting bulls that sire replacement heifers to function efficiently under the producer's production and management environment (Northcutt and Wilson, 1993).

Defining mature size

Mature size is indicated by the closely related measures of weight and height at a specified "mature" age. Mature body weight has received several definitions. The literature shows an unlimited range of procedures by which mature weight can be measured. The most obvious measure is the average of all weights taken on the animal after it has stopped growing. Although this procedure would give an accurate assessment of mature weight, its limitation stems from difficulty in determining when an animal has stopped growing (Bullock *et al.*, 1993). The choice of that standard would also limit the number of animals that could be included in data sets for calculating EPD. Another approach is to use growth curve functions that provide biologically interpretable parameters. The most commonly used functions for estimating growth curves are the von Bertalanffy, Gompertz, logistic, Brody and Richards models. The Brody (1945) and Richards (1959) models usually are preferred to other nonlinear functions owing to ease of estimation and simplicity of interpretation (Brown, 1970; Stewart and Martin, 1981; DeNise and Brinks, 1985; Doren *et al.*, 1989). The Brody function is $W_t = A\ (1 - Be^{-kt})$, and the Richards function is $W_t = A\ (1 - Be^{-kt})^m$, where W_t is weight at age t, A is asymptotic mature weight, B is the integration constant (parameter for early growth), k is the relative growth rate (rate of approach to mature weight), m is a shape parameter that allows for a variable inflection point, and e is the base of natural logarithms. Two parameters (A and k) of these growth curves have important biological interpretations relevant to beef cattle. The A parameter provides an estimate of mature size that is independent of short-term fluctuations in weight due to temporary environmental effects of climate, feed availability, and pregnancy/lactation status. The k parameter is the ratio of maximum growth rate to mature size, and serves both as a measure of growth rate and rate of change in growth rate. Large k values indicate an early approach to mature weight.

Growth curves are limited in usefulness because of the "lateness" of availability of information. To fit growth curves, records on the animal are needed to a point when the animal is no longer growing, approximately 4.5 year of age for beef cattle (Morrow et al., 1978). Several studies have estimated genetic parameters for mature cow weight and weights taken on the beef cow early in life (birth, 205-d and 365-d weights). Relating these immature weights to subsequent mature cow weight would be of use to beef cattle breeders for making selection decisions on heifers based on weights before maturity. Northcutt and Wilson (1993) estimated genetic correlations between mature and immature weights to be 0.57 with birth weight, 0.62 with 205-d weight, and 0.45 with 365-d weight. Kaps *et al.* (1999) reported an estimate of genetic correlation between mature weight and weaning weight of 0.85. Other researchers have also explored this genetic association. Bullock *et al.* (1993) reported an estimate of the genetic correlation between mature and weaning weights of 0.80 for polled Hereford cattle. Meyer (1993) reported a range of 0.83 to 0.90 for Australian Angus cattle. Earlier estimates have been 0.40 by Brinks *et al.* (1964) and 0.60 by Smith *et al.* (1976).

Researchers have shown that estimates of genetic parameters for mature weight, being expressed late in life, can be biased by selection. Genetic variances may change as a result of selection or culling (Bulmer, 1971; Meyer and Thompson, 1984; Henderson, 1986). To account for culling in field data, mature weight can be considered in a multiple-trait model with some genetically related trait measured earlier in life, which is less subjected to selective reporting (e.g., birth or weaning weight). Meyer (1994) and Kaps *et al.* (1999) observed that variance components and heritabilities from bivariate analysis of final weight and some early growth measurements were markedly increased over univariate analyses of final weight. Univariate analysis assumes that missing

weights are random, whereas multivariate analysis accounts for culling by employing genetic and environmental correlations between earlier measurements on which selection was based and subsequent missing mature weights.
Mature weight can be greatly influenced by body condition score (Klosterman *et al.*, 1968; Northcutt *et al.*,1992). Northcutt *et al.* (1992) reported that body condition score accounted for 16% of the total variation in Angus cow weight. Northcutt and Wilson (1993) studied genetic parameters of mature size of Angus cattle using repeated measures of mature weight with a sire model. They compared heritability estimates with and without adjustment for body condition score and did not find important differences (.48 vs .45), although adjusting for body condition score reduced both additive genetic and error variances. However, body condition scores have not been accounted for in many studies since body condition score can be very subjective and such data are often not routinely available in field records. Requiring cow weight to have a corresponding condition score would limit the number of records available for analysis, which could lead to a selected set of daughters representing a sire. Kaps *et al.* (1999) argued that non-genetic differences in body condition score between mature weight contemporary groups (MWCG) should be accounted for by the MWCG fixed effect. Therefore, defining contemporary groups for mature weight to account for these differences is imperative.

Recently, interest has grown in use of random regression (RR) models for analysis of longitudinal data (repeated measures). With regression on age at weighing (or functions thereof such as orthogonal polynomials), each measurement is used at the age it is taken, nullifying the need for age corrections (Meyer, 1999). Covariances among RR coefficients then give rise to a covariance structure for the complete range of ages in the data, even for pairs of ages for which there are no observations. Kirkpatrick *et al.* (1994) demonstrated that a covariance function analysis allows permanent and temporary environmental effects to be separated. The application of covariance functions in animal breeding was reviewed by Meyer and Hill (1997). Meyer (1998) showed that covariance functions could readily be estimated directly from the data by REML with a RR animal model. Meyer (1999) has analyzed mature weight records of beef cows with a RR model.

Although mature weight has been defined in several ways, estimates of genetic parameters for mature weight have consistently revealed mature weight to be moderately to highly heritable, irrespective of which definition was used. Implications for a selection program would be similar whether or not breeding values were estimated from a repeated measures model for mature weight or from nonlinear functions.

Genetic parameters for mature size

Of the growth curve parameters for mature weight, the biologically most important relationship is between asymptotic mature weight (*A*) and rate of approach to maturity (*k*). Previous research suggests that both *A* and *k* parameters will respond to selection. Estimates of heritability for mature weight (*A*) ranged from .34 to .61, whereas estimates of heritability for mature rate (*k*) ranged from .19 to .75 (Brown *et al.*, 1972; Franke and Burns, 1975; DeNise and Brinks, 1985; Johnson *et al.*, 1990; Jenkins *et al.*, 1991; Bullock *et al.*, 1993; Kaps *et al.*, 1999). Although these studies have used asymptotic weight as a measure of mature weight, these results are comparable to those obtained in studies using repeated measures of mature weight. Kaps *et al.* (1999) obtained estimates of heritability for mature weight of 0.53 using a two-trait model with repeated measures of mature weights and weaning weight. Meyer (1992, 1994) reported heritability estimates ranging from 0.46 to 0.50 for final weight in Australian Angus cattle. Meyer (1995) latter obtained estimates of heritability of 0.38 for 600-d weight and 0.28 for weight with repeated measures using data from an experimental Hereford herd in Australia. These estimates are comparable with those in the review by Koots *et al.* (1994a) who reported a weighted heritability estimate for mature cow weight from 25 studies to be .50.

A consensus of published estimates is that relationship between asymptotic mature weight and maturation rate is negative. Estimates of the genetic correlation between asymptotic mature weight and maturation rate ranged from -.29 to -.95 (Brown *et al.*, 1972; Franke and Burns, 1975; DeNise and Brinks, 1985). This consensus led to the dogma that animals genetically heavier at maturity require a longer time to reach mature body weight. Thus if large animals are allowed the advantage of growing more rapidly, a compensatory allowance must be made for the longer time they take to mature, to attain puberty or to reach an optimal slaughter weight (Johnson *et al.*, 1990). Fitzhugh (1976) listed reasons for altering the shape of the growth curve: (1) to resolve the genetic antagonism between desired early growth and desired small mature size, (2) to reduce maintenance costs of parental stock, and (3) to improve intrinsic efficiency through increased maturing rate. He argued that a restricted selection index (e.g., selection for increased yearling weight while holding weight constant at birth and at maturity) or alternatively, judicious matching of complementary sire and dam lines could strategically alter the shape of the growth curve.

Relationship between growth curves and productivity traits

The relationship of animal size and production efficiency has been reviewed by Morris and Wilton (1976), Dickerson (1978), Fitzhugh (1978) and Andersen (1978). Currently, numerous reports are available in the literature on the relationship between growth curve parameters and economic efficiency. Fitzhugh and Taylor (1971) suggested that individual differences in rate of maturing are likely to be associated with differences in productive efficiency. Jones *et al.* (1984) reported that large crossbred animals had higher average daily gains in feedlot and heavier slaughter weights, although with longer time spent on feed than small crossbred animals. Rate of maturing is more rapid for skeletal measurements than for weight, with many skeletal measurements reaching 80% of the mature measurement by 12 months of age (Brown *et al.*, 1983).

Johnson *et al.* (1990) studied the relationship among growth curve parameters and lifetime maternal performance. Lifetime productivity of cows was measured in several ways; as years in the herd, number of calves born, average birth weight of calves born, total birth weight of calves, number of calves weaned, average weaning weight of calves, total weaning weight, weaning weight per year, total beef produced, and lifetime conversion efficiency. For Angus cows, results suggested that early maturing cows tended to have lower values for these measures of productivity than later maturing cows and that early maturing cows required more net energy per kg of beef produced than later-maturing cows. Brown and Brown (1972) however reported that early-maturing cows had greater net return over energy costs to five years of age. For Hereford cows, a quadratic relationship was found (Johnson *et al.*, 1990) between maturing rate and total beef produced, number of calves weaned, total weaning weight of calves, weaning weight of calves per year and lifetime efficiency. These results support the concept of an optimum mature size for each cattle population within a production environment and for each production trait within such production environment.

In a study conducted by Humes and Munyakazi (1989), the relationship of rate of maturing and mature weight with cow productivity suggested that as mature weight of cows increased, total productivity (production of calf weaning weight) tended to decrease. However, they also indicated that most of the productivity advantage of smaller cows could probably be attributed to their higher calving rates. Stewart and Martin (1981) reported that total weight weaned, years in the herd and weight weaned per year tended to decrease with increasing mature weight. They noted, however, as cow weight increased, that although average calf weaning weight increased, the number of calves produced decreased, resulting in a decrease in total weight of calf produced. They also showed that as the maturation rate parameter increased, there was a similar pattern of increased average weight weaned but with decreased longevity and number of calves produced resulting in less total calf weight weaned. Similar results were obtained by Hawkins *et al.* (1965) with Hereford cattle, Marshall *et al.* (1984) with Red Poll cattle and by Lopez de Torre *et al.* (1992) with Retinta cattle.

In general, productivity may be reduced with cows of relatively large mature weights, and that early-maturing animals would be more efficient. Effective application of this information in selection procedures requires knowledge of the genetic relationships between mature cow weights and other traits of economic importance, including carcass traits.

Carcass Traits

Several years ago beef cattle production scenarios led breeders to focus their attention on improving growth even as packers placed emphasis on lean meat content as well as marbling and quality grade. In recent years, the primary objective for beef cattle breeding seems to have been to maximize muscle tissue and minimize fat; both of which are consistent with consumer demands (Pariacote *et al.*, 1998). Genetic parameters (heritabilities and correlations) among carcass traits from designed experiments and from field data (mostly with limited data) are available in the literature

(Cundiff *et al.*, 1964; Benyshek, 1981; Wilson *et al.*, 1993; Splan, 1994; Moser *at al.*, 1998; Pariacote *et al.*, 1998). Breeding strategies that maximize profit would seem to warrant a balance between genetic potential for carcass yield with possible adverse correlated changes in quality of the product. The following sections review studies of some of the carcass traits.

Hot carcass weight (HCWT)

Hot carcass weight reflects the actual weight of the carcass immediately after slaughter before the carcass is chilled. At a constant age at slaughter, HCWT is the greatest determinant of carcass value (Pariacote *et al.*, 1998). Literature estimates of heritability of HCWT adjusted to a constant slaughter age suggest that selection for HCWT would be effective. Estimates of heritability for HCWT include .54 reported by Benyshek (1981), .44 by MacNeil *et al.* (1984), .37 by Splan (1994), .59 by Moser *et al.* (1998) and .60 by Pariacote *et al.*, (1998). Koots *et al.* (1994a) reported an average heritability estimate of .45 in their extensive review of many studies.

Dressing percentage (DP)

Dressing percentage is calculated by expressing chilled carcass weight as a percentage of the live animal weight prior to slaughter. Dressing percentage should respond well to selection. Benyshek (1981) estimated the heritability for DP to be .29 while Pariacote *et al.* (1998) reported an estimate of .49. Koots *et al.* (1994a) reported a weighted estimate of heritability for DP from 13 studies to be .39. Dressing percentage and HCWT would be expected to be highly interrelated genetically. Pariacote *et al.* (1998) estimated the genetic correlation between DP and HCWT to be 0.65.

Retail product percent (RPP)

Retail product percent is determined by separating one side of a carcass into wholesale cuts followed by processing into closely trimmed, boneless retail cuts. Expressed as a percentage of the entire carcass side, RPP therefore reflects the total percent of roast and steak meat plus lean trim. The fact that RPP is directly related to lean tissue (lean cuts) makes RPP one of the most economically important traits. Variation in retail product weight at a constant age is greater than variation in proportion of retail product weight at a constant carcass weight (Cundiff and Gregory, 1977; Splan, 1994). Koch *et al.* (1982) reported an estimate of heritability of RPP at a constant age of .63, as compared to .58 of RPP at a constant weight. These estimates were consistent with the results of Splan (1994) who reported a heritability estimate of .64. Retail product percent should, irrespective of kind of adjustment, respond well to selection.

Bone percentage (BP)

Once a carcass side is processed into retail cuts, weight of bone is determined and expressed as a percentage of that side. Literature estimates of heritability of BP indicate that the trait would respond to selection. Splan (1994) reported a heritability estimate of .47 for BP, which was comparable to the .53 estimated by Koch *et al.* (1982). Koch *et al.* (1982) also reported genetic and phenotypic correlations between BP and RPP of .73 and .50, respectively. Selection for leaner animals would therefore result in animals with greater percentage of bone.

Fat percentage (FP)

Fat percentage is the fat trim expressed as a percentage of the carcass side. While retail cuts are generally trimmed to no more than 8 mm of fat on the surface of the cut, fat trim is the sum of fat trimmed from all retail cuts, plus the kidney, pelvic and heart fat. Fat percentage could be changed by selection as indicated by moderate to high heritability estimates. Koch *et al.* (1982) reported an estimate of of .57 for FP. A negative correlation between RPP and FP is desirable because selection for decreased fatness in the carcass would increase the percentage of carcass weight represented by muscle (Cundiff and Gregory, 1977). Koch *et al.* (1982) reported a favorable phenotypic correlation (-.98) between RPP and FP. They also obtained estimates of genetic and phenotypic correlations of -.51 and -.65 between BP and FP, respectively.

Rib eye area (REA)

Rib eye area expresses the cross-sectional area of the longissimus dorsi muscle at the 12th rib. Rib eye area is a major determinant of beef yield grades and hence is of great economic importance. Literature estimates of the heritability of REA suggest that REA would respond well to selection. Heritability estimates for REA include the following: .25 by Dinkel and Busch (1973), .39 by Moser *et al.* (1998), .42 by Wilson *et al.* (1976), .45 by Benyshek (1981), .46 by Arnold *et al.* (1991), .56 by Koch *et al.* (1982), .57 by Splan (1994) and .97 by Pariacote *et al.* (1998). Koots *et al.* (1994a) reported a weighted average estimate (weighted by the inverse of the estimated sampling variance for each estimate) from 16 studies of .42. Koch *et al.* (1982) and Pariacote *et al.* (1998) reported favorable estimates of the genetic correlations (.53 and .79, respectively) between REA and DP. Moser *et al.* (1998) estimated the genetic correlation between longissimus muscle area and HCWT to be .12, in agreement with that obtained by Arnold *et al.* (1991). Wilson *et al.* (1993), Gregory *et al.* (1995) and Pariacote *et al.* (1998) reported even higher positive estimates of the genetic correlation (.38, .66 and .70, respectively). Koch *et al.* (1982) estimated genetic correlations between REA with bone and fat percentage to be -.48 and -.04, respectively.

Adjusted fat thickness

Measurements of fat thickness are taken over the longissimus dorsi muscle at the interface of the 12th and 13th rib, after the carcass has been chilled. This measure of carcass fatness partially determines carcass yield grades, which indicate the projected amount of boneless, closely trimmed retail cuts that may be obtained from a carcass. Adjustments are made after measurement by considering fat thickness over other cuts, e.g., round or chuck. Measurements of fat thickness are also adjusted for damage done by pulled hides, as removal of hide from a carcass often distorts the subcutaneous layer of fat. Heritability estimates for both actual fat thickness and adjusted fat thickness are available in the literature. Among literature estimates of heritability for actual fat thickness are the following: .41 by Wilson *et al.* (1976) and Koch *et al.* (1982), .50 by Benysheck (1981) and .57 by Dinkel and Busch (1973). Koots *et al.* (1994a) reported a weighted average estimate of heritability for carcass fat to be .44, from 26 studies. Moser *et al.* (1998) reported an estimate of heritability for adjusted fat thickness of .27, which was in agreement with .26 reported by Wilson *et al.* (1993) but less than .43 and .46 obtained by Splan (1994) and Pariacote *et al.* (1998), respectively. The genetic relationship between actual fat thickness and FP would be expected to be large. For example, Koch *et al.* (1982) obtained an estimate of .78 for this correlation. Actual fat thickness has a favorable genetic correlation (-.74 and -.47) with RPP (Koch *et al.*, 1982) and with REA (Wilson *et al.*, 1976), respectively. Pariacote *et al.* (1998) estimated genetic correlations between fat thickness and HCWT, REA and DP to be -.22, -.31 and -.16, respectively. Other studies that have estimated the genetic correlation between fat thickness and longissimus muscle area also reported favorable estimates, such as -.37, -.44 and -.59 reported by Koch *et al.* (1982), Arnold *et al.* (1991) and Dinkel and Busch (1973), respectively. Noteworthy is that since 1982, significant increases in frame size and growth rate of slaughter cattle have been made, while fat thickness has remained unaltered (Lorenzen *et al.*, 1993).

Estimated kidney, pelvic and heart fat percentage (EKPH)

A measure of total fatness is often determined by the amount of fat deposited around the kidney, pelvic area and heart. A visual estimate of kidney, pelvic and heart fat is made from a chilled carcass and converted to a percentage of the total carcass weight. The EKPH is also used in determining beef quality grades. Koch *et al.* (1982) estimated heritability of EKPH to be .83, while Splan (1994) and Pariacote *et al.* (1998) obtained moderate estimates (.43 and .45, respectively). Koch *et al.* (1982) reported a strong genetic association between kidney fat percentage and both RPP (-.43) and FP (.46). Pariacote *et al.* (1998) estimated the genetic correlations between EKPH and fat thickness, HCWT, DP, and REA to be -.21, -.30, -.10, and -.31, respectively.

Marbling score

The primary quality trait used as an indicator of meat tenderness is marbling, i.e., amount and distribution of intramuscular fat. The amount of intramuscular fat has some influence on eating quality (Dikeman, 1990; Koch *et al.*, 1992; Jones & Tatum, 1994; Wheeler *et al.*, 1994). Taylor (1984) observed that marbling is an important criterion which consumers use to select beef products. Consumers believe that a high degree of marbling indicates increased tenderness. However, research has shown that marbling accounts for only 10-15% of the variation in tenderness (Taylor, 1984; Palmer *et al.*, 1958). Marbling may, however, contribute to the juiciness and flavor of the meat (Forrest *et al.*, 1975). Marbling has economic importance and is a major component in USDA quality grades. Marbling is visually evaluated from the rib eye between the 12th and 13th rib, and classified in one of 24 discrete categories, ranging from low traces to abundant (BIF, 1996). Marbling may be changed by selection as indicated by moderate to high heritability estimates reported in the literature. The literature estimates for heritability of marbling include the following: .23 by Woodward *et al.* (1992), .31 by Dinkel and Busch (1973), .35 by Arnold *et al.* (1991), .40 by Koch *et al.* (1982), .56 by Benyshek (1981), .71 by Splan (1994) and .88 by Pariacote *et al.* (1998). Unfavorable estimates of the genetic correlation between marbling and REA (-.14, -.17, and -.38) were obtained by Koch *et al.* (1982), Dinkel and Busch (1973), and Wilson *et al.* (1976), respectively. Pariacote *et al.* (1998) reported estimates of the genetic correlations between marbling with HCWT, DP, fat thickness, REA and EKPH to be -.10, .08, .26, -.17 and .10, respectively. Koch *et al.* (1982) also reported a possible antagonistic relationship between marbling score and FP, as suggested by their genetic correlation.

Warner-Bratzler shear force

The Warner-Bratzler shear force test is an objective measure of meat tenderness. Cooked meat sample cores, usually 1.27 to 2.56 cm in diameter, are subjected to a Warner-Bratzler shear force device, which measures amount (kilograms) of force needed to cut through the core. More force required to cut the core implies that the steak is less tender. Lower shear force values are therefore desirable because they indicate tenderness of the product. Koch *et al.* (1982) reported a heritability estimate of .31 for shear force, while Splan (1994) estimated heritability to be .24. Koots *et al.* (1994a) reviewed many studies and reported an average estimate of heritability of .43 for shear force. Heritability estimates of these magnitudes indicate that selection for reduced shear force would be effective. Wilson *et al.* (1976) noted that estimates of the genetic correlations between Warner-Bratzler shear force and other carcass traits are generally small. Koch *et al.* (1982) reported averages of estimates of genetic correlations between Warner-Bratzler shear force and FP, BP, RPP, REA and marbling to be .16, -.01, -.16, -.28 and -.25, respectively.

Ultrasound measurements

The fact that carcass evaluation of sires require slaughter of their progeny to obtain carcass measurements has led to development of alternative procedures to obtain measurements of carcass quality from live animals. Ultrasound measurements of carcass traits on yearling seedstock bulls and heifers have been proposed as traits for inclusion in national cattle evaluation programs (Wilson, 1992). Estimates of genetic parameters for live-animal ultrasound measurements of carcass traits, such as 12th-to-13th rib fat thickness (USFAT) and longissimus muscle area (USLMA) are available in the literature. Literature estimates for heritability of USFAT include: .11 reported by

Moser *et al.* (1998), .14 by Johnson *et al.* (1993), .15 to .42 by Robinson *et al.* (1993), .26 by Arnold *et al.* (1991), .50 by Evans *et al.* (1995) and .56 by Shepard *et al.* (1996). Heritability estimates for USLMA are in the following range: .11 by Shepard *et al.* (1996), .21 by Robinson *et al.* (1993), .26 by Arnold *et al.* (1991), .29 by Moser et al. (1998), .40 by Johnson *et al.* (1993), and .50 by Evans *et al.* (1995). Koots *et al.* (1994a) reported a weighted average estimate from the literature of .33. Moser *et al.* (1998) reported a genetic correlation between USFAT and USLMA of .13, which was comparable to those obtained by Johnson *et al.* (1993) and Robinson *et al.* (1993) of .12 and .05, respectively. Evans *et al.* (1995) and Arnold *et al.* (1991) estimated the genetic correlation to be much larger (.38 and .48, respectively). Genetic correlation between carcass fat and ultrasound fat is expected to be positive and strong. A positive relationship is also expected between CARCLMA and USLMA. Kriese (1996) estimated the genetic correlation between carcass fat and USFAT to be .76, while Moser et al. (1998) obtained an estimate of .69. Selection of breeding animals based on yearling ultrasound measurement of fat thickness and longissimus muscle area should result in genetic change for these traits in progeny. Estimates of the genetic correlation between CARCLMA and USLMA have been reported to be .66 and .48 by Moser *et al.* (1998) and Kriese (1996). Genetic relationships between carcass and ultrasound measurements although positive and strong, are considerably different from unity.

Implications

Estimates of genetic correlations among economic important traits are required inputs for design of breeding programs and for many methods of genetic evaluations. Since genetic improvement programs should consider selection for a combination of traits, accurate estimates of genetic correlations are a necessity. Genetic correlations are also useful in calculating expected responses to selection. Producers need to be aware of possible antagonistic relationships among traits so that they may account for these relationships in designing breeding programs. Various methods have been proposed to resolve the problem of economically important, but antagonistic, traits in beef cattle. MacNeil *et al.* (1984) proposed the use of selection indexes, which incorporate both female productivity and male carcass value. Producers may alternatively choose to restrict change in one trait while improving another (e.g., Niebel and Van Vleck, 1982). Specialized sire and dam lines may also be a viable option (Smith, 1964).

Researchers have shown that selection for traits measured in one sex of beef cattle may yield undesirable responses in traits measured in the opposite sex (Speer, 1993, Splan, 1994; Theron, 1997). Currently, there is little information on the relationship between mature weight and a variety of carcass traits, with Speer (1993) having the only report on the relationships between mature weight and some carcass traits. Correlations between direct components of mature weight (MW) and carcass traits (measured on a weight adjusted basis) were -.54, -.18, -.18, and .41 for fat thickness (FT), rib eye area (REA), yield grade (YG) and quality grade (QG), respectively (Speer, 1993). These results suggest that selection for improved carcass cutability on a weight constant basis (increase leanness and decreased YG) would increase MW while selection for increased REA and decreased QG scores (favorable) would result in decreased MW of females. Strong selection pressure for leanness may be antagonistic to profit of commercial beef producers since sires selected on the basis of reducing fat in steer progeny will also produce females that are larger at maturity when cattle are slaughtered at a constant weight endpoint.

Some antagonistic relationships between female mature weight and carcass quality traits seem plausible. Producers trying to improve carcass traits without taking female mature weight into consideration would increase (decrease) mature cow size beyond (below) levels acceptable by their production standards, with consequent decline in productivity. Selection on female mature weights alone may also have adverse effects on carcass merit. Increased knowledge of relationships among traits of economic importance is needed by the beef industry to more efficiently improve both carcass merits and female productivity.

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Minutes

BIF Mid-Year Meeting
October 20 –21, 2000
Kansas City, MO

Galen Fink called the meeting to order at 6:05 P.M. The order of agenda items was changed to fit in those that would work for the night meeting.

Connee Quinn gave the program committee report and reviewed the proposed program with the board. Background information was given on proposed speakers. A motion was made by Evans and seconded by Chase to accept the program as presented. Motion carried. Speakers will be set by December 15 and committee outlines are due by February 15. Program needs to be available by the end of February.

Fink explained the policy on speaker expenses. Details are in the October 2000 minutes. A motion was made by Hough and seconded by Williams that the executive committee (President, Vice President, Exec. Director) can give approval of additional committee speaker expenses. During discussion Paschal expressed concern that the additional speaker expenses be limited only to special cases. Motion carried.

Cundiff asked about the Wednesday program. Doug Frank indicated that NAAB wanted to sponsor the Wednesday program.

Joe Paschal reported on 2001 convention plans. The conference will be held at the Omni Hotel in San Antonio. Wednesday afternoon will be a mixer and the NAAB symposium. Thursday evening will be a tour of Texas ranches followed by a meal at one of the locations. Friday night will probably be open. Two tours will be offered on Saturday. Costs for registration are planned at about $75. Room rates should be about $90. Rick Machen will assist Paschal and Paschal will be the primary contact. Pelton suggested that the Texas group visit with Kansas for hints. Publicity will begin in February 2001.

Fink appointed the following committees:

Nominating: Williams, Lloyd, Hough

Awards: Crouch, Bullock, Evans, Pelton

Minutes of the 2000 meeting were reviewed. A motion to accept was made by Quinn and seconded by O'Neill. Motion carried.

Silcox presented the financial report. He indicated that about $50,000 was in the checking account to be invested. A surplus is shown as a result of the proceedings not being printed. Proceedings should be ready for printing by late November. Discussion was held regarding the time frame for printed proceedings. Suggestions were made to print without awards materials and to have proceedings available at the meeting. A motion was made by Williams to close proceeding submission at 60 days following the meeting. Christensen seconded the motion. Motion carried.

Evans asked about the audit of BIF books. Fink asked about the investment of cash in checking accounts. A motion was made by Evans and seconded by Pelton to accept the financial statement.

Silcox discussed the completion of proceedings in more detail. Discussion was held. Williams asked if proceedings could be made available on CD. Evans asked how many copies are typically printed. Silcox indicated that enough were printed to send one to each attendee plus about 100 extras.

Board of director elections was described in a handout. Weaber's position was discussed. Hough made a motion that Patrick Doyle fill the rest of the term. The motion was seconded by Doubet and carried.
Bullock gave a report on ICAR regarding the upcoming meeting in South Africa. ICAR is an international organization with a similar mission as BIF. ICAR sent out a survey to countries regarding standardization. BIF Guidelines were returned from us. Evans asked if BIF could be a member. Bullock indicated that he would research membership when he attended the meeting.

The Board held a discussion of the role of BIF.

The Board meeting resumed at 8:00 am on Saturday with standing committee reports. Each year two of the standing committees are to be reviewed. This year those were Genetic Prediction and Producer Applications.

Green reported on Emerging Technology.

Cundiff reported that Genetic Prediction would focus on guidelines revisions work at the next meeting. Frank moved to retain Genetic Prediction. Pelton seconded. Motion carried.

Bullock reported on Multiple Trait. Hough suggested topics including economically relevant traits. Fink suggested including convenience trait work in both Multiple Trait and Producer Applications. Ropp suggested that BIF needs to be involved in multiple trait work so it does not just become a marketing index.

Williams reported on Live Animal, Carcass and Endpoint. He indicated that there was an interest in feed efficiency at the Wichita meeting.

Dolezal reported on Producer Application attendance and input on topics. O'Neill moved and Quinn seconded to retain Producer Application. Motion carried.

Hough reported on Whole Herd. Next year's program will focus on guidelines revision including a whole herd section. Animal ID needs to be included in the guidelines. Bullock asked for discussion of ultrasound information for guidelines. Crouch and Cundiff suggested a workshop on ultrasound to address the guidelines issue.

The Frank Baker Essay Contest was summarized by Cundiff. He indicated that this was the best ever with nine essays. Cundiff indicated that the $500 award was part of the reason for the success. Paschal suggested that Texas subsidize the award to increase it to $750. Williams asked if travel should be covered rather than a flat award.

Evans summarized the Membership committee results. He reviewed the details of membership in the BIF bylaws. CA, OR, MT, WA were a few of the states that there has been questions about. International interest has been expressed for potential membership. Focus should continue with breed associations and state BCIAs as members.

Fink asked if efforts could be made to encourage nominations for seedstock/commercial producer awards. State Extension specialists in each state should be encouraged to help nominate these producers. Regional secretaries can be players in increasing membership participation. Lloyd agreed to provide a reference list of contacts used by NCBA.

Regional secretaries were discussed. Hough indicated that no changes were wanted in the current secretary positions. He said that he hope BIF would look toward academia first in replacing these positions. Bullock suggested that a separate group of academics be put together to select an appointment. Representation of industry groups was also mentioned. Green suggested a representative from the national center for evaluation as an ex officio. Silcox said that adding a voting member would require a by-law change, but the board can appoint a nonvoting member. Hough moved to invite a representative from the National Cattle Evaluation Center to participate in the BIF board as an ex officio member and Doubet seconded. In discussion, Crouch suggested the need for a committee to study additional options. Motion carried.

Discussion was held on compensation of the executive director for services. Discussion was held. Silcox indicated that $1000 was budgeted for travel of the executive director. Silcox discussed the regular expenses of his position and the need for periodic part-time clerical assistance.

Silcox described the 2001 budget worksheet as presented. Evans suggested Silcox provide the board a proposed expense summary for BIF support.

Dolezal reported on the web site. Silcox described the current Internet service provider. Discussion was held. Modifications to the site were suggested. O'Neill moved to budget $2000 to update the web site. The motion was seconded by Quinn and carried.

Williams gave the Guidelines committee report. Editors were suggested : Bill Hohenboken, Roger McCraw, John Comerford. Compensation for the editor would be $2500 to be paid at the completion of the project. $2500 was also budgeted to cover potential travel and other costs. The budget reflected $2500 for 2000 –2001 and $1500 - $2000 for the 2001-2002 expenses. Assignments to sections in Guidelines and coordinating authors were presented. Coordinators will work with contributing authors as well as editor to meet deadlines. Silcox indicated that about 1000 copies would need to be printed. Cundiff and O'Neill indicated that ordering of BIF materials needs to be available on the web site. Doubet suggested hot links to breed associations for selling guidelines. Discussion was held on handling updates. Web site could be utilized for update notification.

O'Neill moved (seconded by Holliman) to proceed with guidelines as outlined by committee report. Motion carried.

Silcox described the 2001 budget worksheet in more detail. Evans moved (seconded by Christensen) to accept proposed budget as presented.

O'Neill moved to have the 2001 Mid-Year Board meeting at the same place on 10/19-20, 2001. Lloyd seconded and motion carried.

Discussion was held on new business. The topic of inviting guests to visit with the board prior to the board meeting was discussed. O'Neill moved to invite guests from the industry and to appoint a committee to do the program. Lloyd seconded and the motion carried. O'Neill, Lloyd and Quinn were appointed.

Frank suggested a workshop on DNA technology and bringing about discussion with DNA companies. Discussion was held. A joint session with National Pedigreed Livestock Council was suggested. Huffhines discussed the benefits of the multi-species interest in this topic. A motion was made by Williams and seconded by Evans to have Green's Guidelines committee attend the National Pedigreed Livestock Council. Discussion was held. Green and Cundiff could attend.

Fink read a letter from Bill Able regarding introduction of producer award nominees. Discussion was held.

Fink asked about coverage and use of press release related to the convention. Pre and post-press release work was discussed. Lloyd suggested she would check to see if NCBA's publicity contact list could be provided to BIF for use, since NCBA is a member organization of BIF.

A motion to adjourn was made by Evans and seconded by Holliman. The meeting adjourned at 11:00 am.

Minutes
Beef Improvement Federation
Board of Directors Meeting
San Antonio, Texas
July 11, 2001

Galen Fink called the meeting to order at 2:00 p.m. at the Omni Hotel in San Antonio and indicated that the agenda would be shifted to accommodate schedules of guests.

Hans Schild gave a report from ICAR. He described the items discussed during their meetings on international guidelines for beef recording. It is a difficult task to get guidelines developed that will accommodate all needs. He stated the need for a common session with BIF to collaborate on the discussion of recording guidelines.

Bruce Golden reported for the National Beef Cattle Evaluation Consortium. CSU, UGA, Cornell and ISU are involved. Monies to establish this group were received in June. A board has met and an advisory committee has been established. One of the biggest issues do date is seeking enhanced appropriations in the 2002 budget.

Minutes of the last meeting were distributed. A motion was made by Sheri Doubet to approve the minutes and seconded by Connee Quinn. The motion passed.

Ronnie Silcox presented the financial report. He explained the differences in interest amounts. Checking and Money Market accounts have been established. A motion to accept the financial report was made by Huffines and seconded by Lloyd. The motion carried.

Silcox reported on the membership list. Regional Secretaries were asked to visit with those organizations that have not paid 2001 dues. States that usually do not pay dues should also be encouraged to participate.

Silcox updated the board on election of new board members.

Robert Williams gave the Nominating committee report. Connee Quinn was nominated as President and Richard McClung was nominated as Vice President. A motion was made by Doubet to accept the slate of officers and was seconded by Pelton. The motion carried.

Darrh Bullock gave the awards committee report. Awards to be presented were as follows: Ambassador – Greg Henderson, Pioneer – Tom Cartwright, Larry Benyshek, and M. L. Bradley, Continuing Service – Don Boggs, Willie Altenburg and Kent Anderson. There were 11 nominations for seedstock producer awards and 5 nominations for commercial.

The midyear board meeting was set for October 19-20 at the Airport Holiday Inn in Kansas City, MO. Robert Williams indicated that the Charolais building could be used for some of the meetings. An invited speaker was suggested and animal identification was identified as a topic that needed to be addressed. Williams agreed to coordinate contacting the person to present information.

Jim Gosey of the University of Nebraska and Greg Rule of Nebraska Catttlemen reported on 2002 convention plans. The convention is planned for July 10-13 at the Holiday Inn in Omaha. A symposium on Wednesday is planned in honor of Gordon Dickerson. The Nebraska Cattlemen will handle funds for the convention.

Ronnie Silcox indicted that Florida had declined to host the 2003 convention. Darrh Bullock indicated that there might be an interest in Kentucky. Galen Fink indicated that Ohio had expressed some interest. Terry O'Neill indicated that he would visit with the Montana producers. It was agreed that a location needs to be identified soon.

Larry Cundiff reported that there were eight entries in the Frank Baker Scholarship contest. One of the winners was a repeat winner and there is no policy on this. There was no objection to giving the award to the same person twice.

Committee chairs gave a brief report and agenda for their sessions.

Robert Williams and Bill Hohenboken gave a report on Guidelines development. About two-thirds of initial drafts were in to the editor. The goal is to have final documents at the midyear meeting. Hohenboken has done an initial review of the existing documents. Silcox will get cost estimates for printing.

Sally Dolezal reported that there had been 1426 hits on the web site as of today. Web site development is under the amount budgeted.

Larry Cundiff reported that Richard Willham was nominated for the Saddle and Sirloin. A motion to support the nomination of Willham was made by Crouch and seconded by S. R. Evans. The motion carried.

Darrh Bullock commented on his attendance to the ICAR meeting in South Africa. He indicated that the European group would like to set tough standards. The US and Australia gave their opinion about the inability to have such strict guidelines. The European group was accommodating. Their guidelines tend to be in line with the US group. The next meeting will be held in Hungary. McClung moved that Bullock might attend these meetings again. The motion was seconded by Willams and passed.

Paschal reported on the convention. There were 321 full registrations, 41 additional and 20+ students. Details of rooms and meeting needs were discussed.

The meeting adjourned at 3:55 and was reconvened at 5:15 on Friday afternoon.

New board members were announced:

Laura Rose – West
Richard McClung – East (second term)
Jimmy Holliman – At Large (second term)
Bob Weaber – Simmental
Loren Jackson – Brangus

A program committee was appointed for the 2002 convention consisting of Bullock, Cundiff, Dolezal, Green, Frank, Pelton, Lloyd, Williams and chaired by McClung.

The 2002 convention was discussed. The Wednesday symposium will be covered by Nebraska with the Dickerson symposium. Printing of proceedings was discussed at length. Sally Dolezal, Renee Lloyd, Bob Weaber and Connee Quinn will look into possibilities for printing proceedings to hand out at the meeting.

The meeting was adjourned

Beef Improvement Federation
State of Revenues and Expenditures
Cash Basis
January 1 - July 1, 2001

Revenue:

Guidelines and Proceedings	$ 60.00
Interest Income - Money Market	101.13
Dues	7,300.00
TOTAL REVENUES	$ 7,461.13

EXPENDITURES:

Clerical Assistance	$ 200.00
Postage and Freight	1,584.40
Printing	4,328.11
Homepage Development	468.70
Office Supplies	138.89
Proceedings Expenses (Labor)	116.00
Conference Calls	273.60
TOTAL EXPENDITURES	$ 7,109.70

EXCESS REVENUES OVER EXPENDITURES	$ 351.43

Beef Improvement Federation
State of Fund Balance
As of July 9, 2001

ASSETS:

Cash in Checking Account (SD)	$ 90.17
Cash in Checking Account (GA)	12,147.74
Cash in Money Market Savings Account	46,910.87
TOTAL ASSETS	$59,148.78

LIABILITIES AND FUND BALANCE:

Fund Balance - January 1, 2001	$ 58,797.35
Current Year Excess (Deficit)	351.43
FUND BALANCE - July 9, 2001	$ 59,148.78
TOTAL LIABILITIES AND FUND BALANCE	$ 59,148.78

BEEF IMPROVEMENT FEDERATION
Statement of Fund Balance
As of December 31, 2000

ASSETS:	
Cash in Checking Account (SD)	$ 90.17
Cash in Checking Account (GA)	51,897.44
Cash In Money Market Savings Account	6,809.74
TOTAL ASSETS	**$ 58,797.35**
LIABILITIES AND FUND BALANCE:	
Fund Balance - January 1, 2000	$ 55,748.92
Current Year Excess (Deficit)	3,048.43
FUND BALANCE - DECEMBER 31, 2000	**$ 58,797.35**
TOTAL LIABILITIES AND FUND BALANCE	**$ 58,787.35**

BEEF IMPROVEMENT FEDERATION
Statement of Revenue & Expenditures
Cash Basis
January 1, 2000 - December 31, 2000

REVENUES:	
Guidelines and Proceedings	$ 552.50
Interest Income - Money Market	1,651.90
Convention (for proceedings from VA Tech)	5,280.00
Convention (for proceedings for KS)	6,090.00
Genetic Prediction Workshop	925.00
Dues	11,192.00
Total Revenues	**$ 25,691.40**
EXPENDITURES:	
Bank Fees	$ 92.85
Clerical Assistance	1,250.00
Legal and Accounting	385.00
Postage and Freight	2,295.96
Printing	6,809.67
Homepage Development	371.02
Genetic Prediction Workshop	2,604.89
Office Supplies	260.60
CAR Travel	2,212.80
Executive Director Travel	1,496.98
Scholarships	1,000.00
Awards	2,249.80
Mid Year Meeting	227.79
Proceedings Expense	393.00
Emerging Tech Comm.	737.28
Conference Calls	255.33
Total Expenditures	**$ 22,642.97**
EXCESS REVENUES OVER EXPENDITURES	**$ 3,048.43**

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American Brahman Breeders Assn.
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United Braford Breeders
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2001 BIF
AWARDS PRESENTATIONS
SEEDSTOCK PRODUCER HONOR ROLL OF EXCELLENCE

John Crowe	CA	1972
Dale H. Davis	MT	1972
Elliot Humphrey	AZ	1972
Jerry Moore	OH	1972
James D. Bennett	VA	1972
Harold A. Demorest	OH	1972
Marshall A. Mohler	IN	1972
Billy L. Easley	KY	1972
Messersmith Herefords	NE	1973
Robert Miller	MN	1973
James D. Hemmingsen	IA	1973
Clyde Barks	ND	1973
C. Scott Holden	MT	1973
William F. Borror	CA	1973
Raymond Meyer	SD	1973
Heathman Herefords	WA	1973
Albert West III	TX	1973
Mrs. R. W. Jones, Jr.	GA	1973
Carlton Corbin	OK	1973
Wilfred Dugan	MO	1974
Bert Sackman	ND	1974
Dover Sindelar	MT	1974
Jorgensen Brothers	SD	1974
J. David Nichols	IA	1974
Bobby Lawrence	GA	1974
Marvin Bohmont	NE	1974
Charles Descheemacker	MT	1974
Bert Crame	CA	1974
Burwell M. Bates	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chestnut	WA	1975
George Chiga	OK	1975
Howard Collins	MO	1975
Jack Cooper	MT	1975
Joseph P. Dittmer	IA	1975
Dale Engler	KS	1975
Leslie J. Holden	MT	1975
Robert D. Keefer	MT	1975
Frank Kubik, Jr.	ND	1975
Licking Angus Ranch	NE	1975
Walter S. Markham	CA	1975
Gerhard Mittnes	KS	1976
Ancel Armstrong	VA	1976
Jackie Davis	CA	1976
Sam Friend	MO	1976
Healey Brothers	OK	1976
Stan Lund	MT	1976
Jay Pearson	ID	1976
L. Dale Porter	IA	1976
Robert Sallstrom	MN	1976

M.D. Shepherd	ND	1976
Lowellyn Tewksbury	ND	1976
Robert Brown	TX	1977
Glen Burrows	NM	1977
Henry, Jeanette Chitty	NM	1977
Tom Dashiell	WA	1977
Lloyd DeBruycker	MT	1977
Wayne Eshelman	WA	1977
Hubert R. Freise	ND	1977
Floyd Hawkins	MO	1977
Marshall A. Mohler	IN	1977
Clair Percel	KS	1977
Frank Ramackers, Jr.	NE	1977
Loren Schlipf	IL	1977
Tom & Mary Shaw	ID	1977
Bob Sitz	MT	1977
Bill Wolfe	OR	1977
James Volz	MN	1977
A. L. Frau		1978
George Becker	ND	1978
Jack Delaney	MN	1978
L. C. Chestnut	WA	1978
James D. Bennett	VA	1978
Healey Brothers	OK	1978
Frank Harpster	MO	1978
Bill Womack, Jr.	AL	1978
Larry Berg	IA	1978
Buddy Cobb	MT	1978
Bill Wolfe	OR	1978
Roy Hunt	PA	1978
Harold Anderson	SD	1977
William Borror	CA	1977
Del Krumwied	ND	1979
Jim Wolf	NE	1979
Rex & Joann James	IA	1979
Leo Schuster Family	MN	1979
Bill Wolfe	OR	1979
Jack Ragsdale	KY	1979
Floyd Mette	MO	1979
Glenn & David Gibb	IL	1979
Peg Allen	MT	1979
Frank & Jim Wilson	SD	1979
Donald Barton	UT	1980
Frank Felton	MO	1980
Frank Hay	CAN	1980
Mark Keffeler	SD	1980
Bob Laflin	KS	1980
Paul Mydland	MT	1980
Richard Tokach	ND	1980
Roy & Don Udelhoven	WI	1980
Bill Wolfe	OR	1980
John Masters	KY	1980
Floyd Dominy	VA	1980
James Bryany	MN	1980
Charlie Richards	IA	1980
Blythe Gardner	UT	1980
Richard McLaughlin	IL	1980
Bob Dickinson	KS	1981
Clarence Burch	OK	1981
Lynn Frey	ND	1981

Harold Thompson	WA	1981
James Leachman	MT	1981
J. Morgan Donelson	MO	1981
Clayton Canning	CAN	1981
Russ Denowh	MT	1981
Dwight Houff	VA	1981
G. W. Cronwell	IA	1981
Bob & Gloria Thomas	OR	1981
Roy Beeby	OK	1981
Herman Schaefer	IL	1981
Myron Aultfathr	MN	1981
Jack Ragsdale	KY	1981
W. B. Williams	IL	1982
Garold Parks	IA	1982
David A. Breiner	KS	1982
Joseph S. Bray	KY	1982
Clare Geddes	CAN	1982
Howard Krog	MN	1982
Harlin Hecht	MN	1982
William Kottwitz	MO	1982
Larry Leonhardt	MT	1982
Frankie Flint	NM	1982
Gary & Gerald Carlson	NS	1982
Bob Thomas	OR	1982
Orville Stangl	SD	1982
C. Ancel Armstrong	KS	1983
Bill Borror	CA	1983
Charles E. Boyd	KY	1983
John Bruner	SD	1983
Leness Hall	WA	1983
Ric Hoyt	OR	1983
E. A. Keithley	MO	1983
J. Earl Kindig	MO	1983
Jake Larson	ND	1983
Harvey Lemmon	GA	1983
Frank Myatt	IA	1983
Stanley Nesemeier	IL	1983
Russ Pepper	MT	1983
Robert H. Schafer	MN	1983
Alex Stauffer	WI	1983
D. John & Lebert Shultz	MO	1983
Phillip A. Abrahamson	MN	1984
Ron Beiber	SD	1984
Jerry Chappel	VA	1984
Charles W. Druin	KY	1984
Jack Farmer	CA	1984
John B. Green	LA	1984
Ric Hoyt	OR	1984
Fred H. Johnson	OH	1984
Earl Kindig	VA	1984
Glen Klippenstein	MO	1984
A. Harvey Lemmon	GA	1984
Lawrence Meyer	IL	1984
Donn & Sylvia Mitchell	CAN	1984
Lee Nichols	IA	1984
Clair K. Parcel	KS	1984
Joe C. Powell	NC	1984
Floyd Richard	ND	1984
Robert L. Sitz	MT	1984
Ric Hoyt	OR	1984

J. Newbill Miller	VA	1985
George B. Halterman	WV	1985
David McGehee	KY	1985
Glenn L. Brinkman	TX	1985
Gordon Booth	WY	1985
Earl Schafer	MN	1985
Marvin Knowles	CA	1985
Fred Killam	IL	1985
Tom Perrier	KS	1985
Don W. Schoene	MO	1985
Everett & Ron Batho	CAN	1985
Bernard F. Pedretti	WI	1985
Arnold Wienk	SD	1985
R. C. Price	AL	1985
Clifford & Bruce Betzold	IL	1986
Gerald Hoffman	SD	1986
Delton W. Hubert	KS	1986
Dick & Ellie Larson	WI	1986
Leonard Lodden	ND	1986
Ralph McDanolds	VA	1986
W.D. Morris/James Pipkin	MO	1986
Roy D. McPhee	CA	1986
Clarence VanDyke	MT	1986
John H. Wood	SC	1986
Evin & Verne Dunn	CAN	1986
Glenn L. Brinkman	TX	1986
Jack & Gini Chase	WY	1986
Henry & Jeanette Chitty	FL	1986
Lawrence H. Graham	KY	1986
A. Lloyd Grau	NM	1986

Matthew Warren Hall	AL	1986
Richard J. Putnam	NC	1986
R.J. Steward/P.C. Morrissey	PA	1986
Leonard Wulf	MN	1986
Charles & Wynder Smith	GA	1987
Lyall Edgerton	CAN	1987
Tommy Branderberger	TX	1987
Henry Gardiner	KS	1987
Gary Klein	ND	1987
Ivan & Frank Rincker	IL	1987
Larry D. Leonhardt	WY	1987
Harold E. Pate	IL	1987
Forrest Byergo	MO	1987
Clayton Canning	CAN	1987
James Bush	SD	1987
R.J. Steward/P.C. Morrissey	MN	1987
Eldon & Richard Wiese	MN	1987
Douglas D. Bennett	TX	1988
Don & Diane Guilford & David & Carol Guilford	CAN	1988
Kenneth Gillig	MO	1988
Bill Bennett	WA	1988
Hansell Pile	KY	1988
Gino Pedretti	CA	1988
Leonard Lorenzen	OR	1988
George Schlickau	KS	1988
Hans Ulrich	CAN	1988
Donn & Sylvia Mitchell	CAN	1988
Darold Bauman	WY	1988
Glynn Debter	AL	1988

William Glanz	WY	1988
Jay P. Book	IL	1988
David Luhman	MN	1988
Scott Burtner	VA	1988
Robert E. Walton	WA	1988
Harry Airey	CAN	1989
Ed Albaugh	CA	1989
Jack & Nancy Baker	MO	1989
Ron Bowman	ND	1989
Jerry Allen Burner	VA	1989
Glynn Debter	AL	1989
Sherm & Charlie Ewing	CAN	1989
Donald Fawcett	SD	1989
Orrin Hart	CAN	1989
Leonard A. Lorenzen	OR	1989
Kenneth D. Lowe	KY	1989
Tom Mercer	WY	1989
Lynn Pelton	KS	1989
Lester H. Schafer	MN	1989
Bob R. Whitmire	GA	1989
Dr. Burleigh Anderson	PA	1990
Boyd Broyles	KY	1990
Larry Earhart	WY	1990
Steven Forrester	MI	1990
Doug Fraser	CAN	1990
Gerhard Gueggenberger	CA	1990
Douglas & Molly Hoff	SD	1990
Richard Janssen	KS	1990
Paul E. Keffaber	IN	1990
John & Chris Oltman	WI	1990
John Ragsdale	KY	1990
Otto & Otis Rincker	IL	1990
Charles & Rudy Simpson	CAN	1990
T.D. & Roger Steele	VA	1990
Bob Thomas Family	OR	1990
Ann Upchurch	AL	1991
N. Wehrmann/R. McClung	VA	1991
John Bruner	SD	1991
Ralph Bridges	GA	1991
Dave & Carol Guilford	CAN	1991
Richard/Sharon Beitelspacher	SD	1991
Tom Sonderup	NE	1991
Steve & Bill Florshcuetz	IL	1991
R. A. Brown	TX	1991
Jim Taylor	KS	1991
R.M. Felts & Son Farm	TN	1991
Jack Cowley	CA	1991
Rob & Gloria Thomas	OR	1991
James Burns & Sons	WI	1991
Jack & Gini Chase	WY	1991
Summitcrest Farms	OH	1991
Larry Wakefield	MN	1991
James R. O'Neill	IA	1991
Francis & Karol Bormann	IA	1992
Glenn Brinkman	TX	1992
Bob Buchanan Family	OR	1992
Tom & Ruth Clark	VA	1992
A. W. Compton, Jr.	AL	1992
Harold Dickson	MO	1992
Tom Drake	OK	1992

Robert Elliott & Sons	TN	1992
Dennis, David, Danny Geffert	WI	1992
Eugene B. Hook	MN	1992
Dick Montague	CA	1992
Bill Rea	PA	1992
Calvin & Gary Sandmeier	SD	1992
Leonard Wulf & Sons	MN	1992
R. A. Brown	TX	1993
Norman Bruce	IL	1993
Wes & Fran Cook	NC	1993
Clarence/Elaine/Adam Dean	SC	1993
D. Eldridge & Y. Adcock	OK	1993
Joseph Freund	CO	1993
R. B. Jarrell	TN	1993
Rueben, Leroy, Bob Littau	SD	1993
J. Newbill Miller	VA	1993
J. David Nichols	IA	1993
Miles P. "Buck" Pangburn	IA	1993
Lynn Pelton	KS	1993
Ted Seely	WY	1993
Collin Sander	SD	1993
Harrell Watts	AL	1993
Bob Zarn	MN	1993
Ken & Bonnie Bieber	SD	1994
John Blankers	MN	1994
Jere Caldwell	KY	1994
Mary Howe di'Zerega	VA	1994
Ron & Wayne Hanson	CAN	1994
Bobby F. Hayes	AL	1994
Buell Jackson	IA	1994
Richard Janssen	KS	1994
Bruce Orvis	CA	1994
John Pfeiffer Family	OK	1994
Calvin & Gary Sandmeier	SD	1994
Dave Taylor / Gary Parker	WY	1994
Bobby Aldridge	NC	1995
Gene Bedwell	IA	1995
Gordon & Mary Ann Booth	WY	1995
Ward Burroughs	CA	1995
Chris & John Christensen	SD	1995
Mary Howe de'Zerega	VA	1995
Maurice Grogan	MN	1995
Donald J. Hargrave	CAN	1995
Howard & JoAnne Hillman	SD	1995
Mack, Billy, Tom Maples	AL	1995
Mike McDowell	VA	1995
Tom Perrier	KS	1995
John Robbins	MT	1995
Thomas Simmons	VA	1995
D. Borgen & B. McCulloh	WI	1996
Chris & John Christensen	SD	1996
Frank Felton	MO	1996
Galen & Lori Fink	KS	1996
Cam, Spike, Sally Forbes	WY	1996
Mose & Dave Hebbert	NE	1996
C. Knight & B. Jacobs	OK	1996
Robert C. Miller	MN	1996
Gerald & Lois Neher	IL	1996
C. W. Pratt	VA	1996
Frank Schiefelbein	MN	1996

Ingrid & Willy Volk	NC	1996
William A. Womack, Jr.	AL	1996
Alan Albers	KS	1997
Gregg & Diane Butman	MN	1997
Blaine & Pauline Canning	CAN	1997
Jim & JoAnn Enos	IL	1997
Harold Pate	AL	1997
E. David Pease	CAN	1997
Juan Reyes	WY	1997
James I. Smith	NC	1997
Darrel Spader	SD	1997
Bob & Gloria Thomas	OR	1997
Nicholas Wehrmann & Richard McClung	VA	1997
James D. Bennett Family	VA	1998
Dick & Bonnie Helms	NE	1998
Dallis & Tammy Basel	SD	1998
Duane L. Kruse Family	IL	1998
Abigail & Mark Nelson	CA	1998
Airey Family	MB	1998
Dave & Cindy Judd	KS	1998
Earl & Nedra McKarns	OH	1998
Tom Shaw	ID	1998
Wilbur & Melva Stewart	AB	1998
Adrian Weaver & Family	CO	1998
Kelly & Lori Darr	WY	1999
Kent Klineman & Steve Munger	SD	1999
John Kluge	VA	1999
Kramer Farms	IL	1999
Noller & Frank Charolais	IA	1999
Lynn & Gary Pelton	KS	1999
Rausch Herefords	SD	1999
Duane Schieffer & Terry O'Neill	MT	1999
Tony Walden	AL	1999
Ralph Blalock, Sr., Blalock, Jr. & David Blalock	NC	2000
Larry & Jean Croissant	CO	2000
John C. Curtin	IL	2000
Galen, Lori & Megan Fink	KS	2000
Harlin & Susan Hecht	MN	2000
Banks & Margo Herndon	AL	2000
Kent Klineman & Steve Munger	SD	2000
Jim & Janet Listen	WY	2000
Mike & T.K. McDowell	VA	2000
Vaughn Meyer & Family	SD	2000
Blane & Cindy Nagel	SD	2000
John & Betty Rotert	MO	2000
Alan & Deb Vedvei	SD	2000
Bob & Nedra Funk	OK	2001
Steve Hillman & Family	IL	2001
Tom Lovell	AL	2001
McAllen Ranch	TX	2001
Kevin, Jessica, & Emily Moore	TX	2001
Blane & Cindy Nagel	SD	2001
Don & Priscilla Nielsen	CO	2001

George W. Lemm, Marvin & Katheryn Robertson	VA	2001
Dale, Don & Mike Spencer	NE	2001
Ken Stielow & Family	KS	2001
Eddie L. Sydenstricker	MO	2001

SEEDSTOCK PRODUCER OF THE YEAR

John Crowe	CA	1972
Mrs. R. W. Jones	GA	1973
Carlton Corbin	OK	1974
Leslie J. Holden	MT	1975
Jack Cooper	MT	1975
Jorgensen Brothers	SD	1976
Glenn Burrows	NM	1977
James D. Bennett	VA	1978
Jim Wolfe	NE	1979
Bill Wolfe	OR	1980
Bob Dickinson	KS	1981
A.F. "Frankie" Flint	NM	1982
Bill Borror	CA	1983
Lee Nichols	IA	1984
Ric Hoyt	OR	1985
Leonard Lodoen	ND	1986
Henry Gardiner	KS	1987
W.T. "Bill" Bennett	WA	1988
Glynn Debter	AL	1989
Doug & Molly Hoff	SD	1990
Summitcrest Farms	OH	1991
Leonard Wulf & Sons	MN	1992
R. A. "Rob" Brown	TX	1993
J. David Nichols	IA	1993
Richard Janssen	KS	1994
Tom & Carolyn Perrier	KS	1995
Frank Felton	MO	1996
Bob & Gloria Thomas	OR	1997
Wehrmann Angus Ranch	VA	1997
Flying H Genetics	NE	1998
Knoll Crest Farms	VA	1998
Morven Farms	VA	1999
Fink Beef Genetics	KS	2000
Sydenstricker Angus Farms	MO	2001

SYDENSTRICKER ANGUS FARMS RECEIVES THE 2001 BIF OUTSTANDING SEEDSTOCK PRODUCER AWARD

San Antonio, Texas – Sydenstricker Angus Farms was named the Beef Improvement Federation Outstanding Seedstock Producer of the Year at the thirty-third annual convention in San Antonio, Texas on July 13, 2001.

Sydenstricker Angus Farms is owned by Eddie L. Sydenstricker and managed by Ben Eggers. Ralph E. Sydenstricker, Eddie's father, established Sydenstricker Angus Farms (SAF) in 1952 at Paris, Missouri. They have been producers of registered Angus seedstock since that time.

The herd was enrolled in Angus Herd Improvement Records in 1977 and Angus Information System (AIMS) software is currently being used to facilitate better access to herd data.

SAF have utilized the same headquarters location south of Mexico, Missouri, in north central Missouri, for 41 years. They are currently calving about 500 head, of which 22% are embryo transplant calves. They also produce some ET calves in cooperator herds. Utilizing heat synchronization, SAF have a 90-day spring-calving season and a 60-day fall-calving season. The herd is maintained on 2,500 owned acres and 750 leased acres. The farm is a combination farm with 25% in a crop rotation of corn, soybeans, and wheat. The remainder of the farm is pasture and hay.

Most of the production is marketed through an annual production sale held each year in November. All fall yearling bulls, and the older two-thirds of the spring bull calf crop are sold at this time, as well as a cross-section of females and embryos. SAF began carcass evaluation of herd sires in 1988, and own or co-own 34 sires with carcass EPDs, based on 1268 of their progeny evaluated, as well as 12 more sires in some stage of carcass evaluation. They have marketed semen and AI certificates of herd sires since 1981. Their semen directory, printed annually since 1992, now contains information on 53 sires. These sires are responsible for over 30,000 progeny with weights recorded in the AHIR database, and 3,174 progeny on Australia's Breedplan. Although many are young sires, seventeen of them have 5,135 daughters in production on AHIR.

SAF was awarded the Certified Angus Beef Seedstock Commitment to Excellence Award in 1997. At and early age, Eddie Sydenstricker was involved with the formation of the first junior Angus association in the country and has served on the American Angus Association Board of Directors. Ben Eggers is currently a director of the American Angus Association and serves on the board of Angus Productions, Inc.

2001 SEEDSTOCK PRODUCER AWARD NOMINEES

Bar S Ranch, Inc.
Ken Stielow and Family, Paradise, Kansas

Bar S Ranch is located in north central Kansas, with headquarters near Paradise. The topography is rough grassland interspersed with areas of non-irrigated cropland. Ken's grandfather, Frank Stielow Sr., a teenage German immigrant homesteaded on what is now ranch headquarters in 1903. Ken's father, Frank Jr., took over in 1945 and Ken moved back to the ranch in 1975 after working 6 years as a Farm Management Specialist for the Kansas State University Extension Service. Frank Jr. began a commercial Angus cowherd in 1945. In 1975, registered Angus cows were added on a small scale. The registered herd was increased in 1985. In the spring of 2001, 250 registered Angus cows, 50 registered Charolais cows, 120 registered Angus heifers, and 150 commercial Angus cows are scheduled to calve. In fall 2000, 100 registered Angus cows and heifers were calved. Calving seasons are January 20 to March 20 and September 1 to October 31. In addition to the registered Angus and Charolais cattle, a small registered Red Angus cowherd was developed by Bar S Ranch and sold to a cooperating breeder who furnishes approximately 15 Red Angus bulls each year.

In 1991, Bar S Ranch held its first production sale. The sale has grown from 40 bulls in 1991 to 150 bulls and 120 females in 2001. In addition, 20 to 50 bulls are sold privately each year. In 1998, the production sale was moved from the local auction market to a new sale facility at the ranch.

All calves raised on the ranch are either sold as breeding stock or retained through the finishing phase and carcass data is collected. Since 1989, 2,244 individual carcasses have been evaluated and added to the Angus database for carcass EPDs. Most years, several calves are purchased from genetics customers, backgrounded in the ranch growing lot and finished at commercial feedlots. In 2000, a minority interest was purchased in a commercial feedlot to facilitate further alliances.

Brecher Angus Farm
Steve and Cheryl Hillman & Family, Groveland, Illinois

The purebred Angus firm of Homer Brecher and Steve Hillman from Groveland, Illinois was the recipient of the Illinois Beef Association Seedstock Breeder Award during the Illinois Commodity Conference in Urbana on Tuesday, November 23.

The Angus seedstock farm was started by the partnership of Homer and Roy Brecher in1962 and became known as Brecher Brothers. Prior to the introduction of Angus cattle, the farm has long been known for their herd of purebred Brown Swiss dairy cattle. Prior to the availability of AI, quality breeding stock was diligently sought after. The Brecher Farm found this foundation bull at the Illinois Futurity Sale in the early 1970's. This foundation bull was purchased from Dave Gibb for $8000.00. When AI breeding was later introduced to the Angus breed, Brecher's utilized AI extensively to continue moving herd performance and continue supplying quality genetics to commercial breeders throughout Illinois.

In 1978, their nephew Steve Hillman became interested in the Angus business and started to develop his own herd of Angus cattle. The herd was initially found from purchasing heifers from the Brecher herd and breeding to some of the best performance bulls in the Angus breed. Following graduation from Illinois State University, Steve returned to the farm and has since acquired the total Angus herd. Currently there are 120 brood cows in the herd and 30replacement heifers. Cattle are now marketed throughout Illinois and across multiple state lines.

The Brecher farmstead has long been known for its neatness and well kept large farm buildings. However, this was all changed this past June of 1998 when a tornado took dead aim at the farmstead and almost completely wiped out the existing buildings. Sixteen months have been spent rebuilding the farmstead and preparing for the new millennium in the Angus business.

Over the years performance testing has been a major force behind the selection of cattle in the operation. Initially, the Illinois Performance Tested Program was used as a basis. This was later replaced with the Angus herd Improvement Records System. The Illinois Performance Tested Bull Sale has been the vehicle that provided the firm's visibility to the beef industry. On numerous occasions the Brecher firm has had high indexing and/or high selling Angus bulls.

In recent years bulls have been placed in an Illinois or Nebraska Test facility for genetic evaluation. At the completion of the test, the firm has cooperated with other seedstock breeders to host a spring bull production sale. The firm has also offered superior genetics to other purebred herds in their fall female sale known as Performance Alliance Production Sale.

In order to increase the rate of genetic improvement, embryo transfer has been employed. This has been done by partnering with other well-known seedstock firms or by contracting with firms to place embryos in their recipient cowherd. Annually there are approximately 50 calves produced through the firm's embryo program.

The firm has hosted numerous groups including college classes and judging teams. International groups have visited the farm to evaluate their available genetics. Also, the firm was the site of an Area Cow-Calf Field Day. Steve is currently serving on the Illinois Angus Association board of directors.

Brecher Angus Farm nomination will represent Illinois in national competition at the 2001 National Beef Improvement Federation annual meeting that will be held in Lincoln, Nebraska.

Express Ranches
Bob and Nedra Funk, Yukon, Oklahoma

Express Ranches has been actively involved in the seedstock industry since the early 1900's. Owners, Bob and Nedra Funk have built a program with operations headquartered in Yukon, Oklahoma and sub-divisions in Shawnee, Oklahoma; Onida, South Dakota; and Ute Park, New Mexico.

The size and scope of Express has increased dramatically since origination with quality not being compromised by quantity. Funk started out with 52 fullblood Limousin cows and 180 acres of land, and in 1996, Funk added an Express Angus Division. Funk's drive, combined with sound business sense. Vision and integrity has expanded Express to the sixth largest seedstock producer in the United States. Express Ranches now has a herd of 4,000 head of Limousin and Angus cattle, over 20,000 acres of land and annual sales on cattle, semen, and embryo's that total in excess of $4.5 million. Mr. Funk is always quick to point out that anything is possible when one combines a vision with outstanding personnel. Express Ranches has over 20 full-time employees and additional help as needed throughout the year. Express Ranches is considered the largest purebred Limousin breeding operation in the world, and one of the largest Angus operations in the United States.

January 1998 marked the beginning of "Express Ranches Premium Beef," a branded beef program merchandising retail product in Oklahoma and Texas. The company will harvest up to 40,000 cattle annually.

Express ensures consistent performance through ultra-sounds, EPD research and a constant genetic improvement strategy. The Embryo Transplant Center, located in Yukon, generates genetic improvement at a rapid pace. A total of 400 Limousin and Angus flushes take place each year. Through our genetic program Express Ranches can design cattle that bend the curve on low birth weight, rapid performance and outstanding carcass and maternal characteristics.

Recently, Express Ranches teamed up with Future Beef Operations, L.L.C. (FBO). FBO recognizes the power of identification and proper use of genetics in facilitating provisions of high quality, consistent products to their primary customer, Safeway. Express will work with established customers and other producers to produce quality meats that FBO and Safeway can market to consumers. Express' role as a master supplier, is primarily focused on genetics, but will function as a "Cattle locator and Deal Maker" for FBO.

A total of seven annual bull and female sales are the main source of income to the ranch. In addition to semen and embryo sales, the income from Express Cattle Feeding and Express Ranches Consulting round out the remainder of the annual income. Express Ranches is also a leader in world exports with live cattle, beef products and semen shipped around the world to Russia, China, Brazil, Australia and Mexico. Bob funk and the Express Ranches' staff is challenging the "sameway"mentality with many new and innovative ideas. Express is constantly improving the operation through integrity, value, and vision, the way it began.

M6 Charolais

Kevin, Jessica & Emily Moore, Alvarado, Texas

Intense selection and customer driven may be the best way to describe M6 Charolais. Ranching is a serious business for the Moore family as it is our only source of income. We are second-generation Charolais breeders. M6 Charolais has been breeding Charolais seedstock and commercial cattle for over 30 years in North Central Texas (Alvarado). Four years ago, we were managing M6 Charolais, at which time Kevin's parents made the decision to sell out due to age and health reasons. We took on the problem of no land, very little money, one part-time job, and debt service on thirty-six Charolais cows and fifty crossbred cows. Over the past four years M6 Charolais has grown to seedstock business that today incorporates all segments of the beef industry from conception to consumption.

Since 1998, we have devoted all our efforts to M6 Charolais. The business operates entirely with leased land, very little equipment, and one full time employee. In 1996 M6 Charolais became a total AI and ET operation. No clean up bulls for the registered Charolais females. We are working with two other cooperative commercial herds as well as using our own crossbred cows as recipients in the ET program. We have formed a mutually beneficial and profitable relationship with cooperator herds to utilize the commercial producers' land and management. In 2001 we will have approximately 400 ET calves and 85 AI calves. In October 2001 M6 Charolais will host their 16th Annual Production Sale by offering 180 Charolais bulls, 30 Angus bulls (consigned by a reputation Angus breeder) and 150 Charolais females. High accuracy sires dominate the breeding program and all pedigrees are stacked several generations deep to increase consistency and predictability for customers. To give customers more selection and a higher volume of top quality seedstock, we work with progressive minded Charolais breeders who are also good customers by helping them develop and market their better bulls and females. This is a "win, win" opportunity for both our commercial bull buyers and our purebred buyers. Since 1999, M6 has had a customer service business for ET-Donor care management, heifer development and AI service to assist purebred coop herd producers generate a higher quality product.

M6 Charolais' sincere desire is for the commercial producer using M6 genetics to receive the maximum return on their investment. We are seedstock suppliers for many value added beef alliances and have a working relationship with various feedlots. M6 assists many of our customers with marketing their calves if the owner does not decide to retain ownership. In the fall of 1999, M6 adopted a Holistic Resource Management approach in our grazing plan. This has increased our lands production and enabled us to withstand prolonged drought without cattle performance suffering as well as protecting sod from any serious or permanent set back. This practice has allowed us to increase numbers on 1000 leased acres during a time of record setting drought four of five years, in addition to being beneficial for the wildlife.

McAllen Ranch
Edinburg, Texas

The McAllen Ranch, located in northern Hidalgo County in the Lower Rio Grande Valley of Texas, originated in 1791 when José Manuel GFmez received the Santa Anita land grant from the crown of Spain. Over the next 210 years, the heirs of the land grant kept the land in the family, comprising what is now known as the McAllen Ranch. The ranch consists of over 38,000 acres, and located on the edge of the neotropical area, where the flora and fauna of desert and tropical species mix to create a unique environment. The unpredictable weather creates seasonal challenges in the realm of livestock improvement. Through careful management, the Spanish cattle evolved in to one of the best Beefmaster herds in the industry. Herd improvements intensified in 1906, the ranch imported Hereford bulls from the Welder Ranch in 1938 to mix with the herd. Shorthorns were introduced in1936, and Brahmans from J.D. Huggins Ranch in 1938. This three way cross proved successful. In 1942, the Lasater Ranch crossbred bulls were first used. Oddly enough, the ranch never bought outside females. The cows were crossed with nearly every known breed, but none achieved the same results as the Hereford, Brahman, Shorthorn cross. When Argyle A. McAllen decided to explore performance testing in 1955, record keeping intensified and the ranch began rate of gain tests. After that purchased bulls were required to have performance information. As the bull information requirements grew more demanding, the first full time herdsman was hired in 1980 to mange the registered.

Nagel Cattle Company
Blane and Cindy Nagel, Springfield, South Dakota

Nagel Cattle Company (NCC) is located in the southeastern corner of South Dakota along the Missouri River. Nagel Company is a family run operation that derives all of its income from cattle and agriculture. NCC is a diversified seedstock operation that specializes in purebred Mine-Anjou cattle. The Nagels started their operation in1990 on a full time basis after Blane graduated from South Dakota State University. Blane and Cindy have four children (Landon 14, Shayna 6, Cheysney 4, and Cheylee 8 months). In addition to their purebred and cattle finishing operations, Cindy Nagel owns and operates Midwest Sonatech, which is a livestock ultrasound business. Blane's father John Nagel owns and operates a 1500 head feedlot. The majority of cattle fed through the feeding operation are home raised but they do custom feed a percentage of the cattle. They specialize in feeding heifers with in-weights in that 600-700 range and out-weights typically ranging from1150-1250. Blane's brother, Bryan Nagel also owns and operates a 1500 feedlot. In this feedyard Nagel's custom feed steer and heifers. The Nagel operation is somewhat unique in that each member of the family owns his own operation but they work together on day-to-day activities and farming. Blane's primary focus is the cow/calf side of the operation. Currently, he runs 200 registered Maine-Anjou cows and about 100 commercial cows mostly Angus or Angus/Maine cross. The Nagels start calving heifers the end of January and cows start calving about the second week in February. Both groups are AI'd for one cycle the exposed to cleanup bulls for 45 days. The Nagels host two production sales. A female sale is held in conjunction with two purebred Maine-Anjou operations in November. The bull sale is held the last of February.

Oak Bowery Farms
Tom Lovell, Opelika, Alabama

I own and manage a 560-acre purebred Angus operation, located 9 miles north of Opelika, Alabama on US Highway 431. I purchased the land in 1980 and spent 3 years clearing, fencing, filling gullies, building barns and corrals, planting pasture grasses and establishing coastal Bermuda hay fields. For 10 years the farm was managed as a commercial cow-calf operation with approximately 125 crossbred brood cows.

Procurement of purebred Angus females began in1993 and continued for 3 years before any cattle were sold. Criteria for selecting were modern pedigree, strongEPDs, from dams with good performance records and structural soundness. Three years ago an embryo transfer program was iniated and donor cows were purchased from Wehrmann, Gardiner and Leachman herds. Presently there are 60 registered brood cows, 6 donor cows, and 28 commercial recipient cows on the farm. All purebred cows are AI bred; no bulls are used on the registered cattle. Approximately 35 embryos are implanted in commercial cows on the farm, which are then put with bulls, and approximately 30 embryos implanted in cows on coop farms nearby.

Female cattle are marketed in the Southeast Angus Classic, a sale that I helped organize, and Alabama Angus Association fall and spring sales. Bulls are marketed through five Beef Cattle Improvement Association (BCIA) bull evaluation tests and sales.

Quailridge Farm
Don and Priscilla Nielsen, La Junta, Colorado

This is a registered Angus operation in Otero County near Cheraw, Colorado. Foundation of the Angus herd goes back to 1951. For the first 30 years, Don operated in partnership with his brother, Alfred, under the name of Nielsen Brothers. In 1982, the partnership was dissolved and the herd divided. During the past year; a son, Steve, has entered the organization and cattle are now being marketed under the name of Quailridge Angus, LLP.

The herd consists of 50 head of brood cows. Calving season is January 20 through March. Bull and heifer calves are developed and sold as yearlings. The operation is carried out on 160 acres with 120 acres of intensively managed pasture and hay land (under irrigation).

The program is centered on production and sale of commercial range bulls.

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Spencer Herefords
Dale, Don and Mike Spencer, Brewster, Nebraska

- Spencer Herefords is located in the Sandhills of Nebraska, a vast expanse of predominantly privately owned grassland in Northern and Western Nebraska. The Spencer Ranch was homesteaded in the late1880's and was recognized as a Centennial Homestead in the 1990's.
- Spencer Herefords will host their 42nd annual bull sale in the fall of 2001. The ranch has a long history of commercial Hereford production in the Sandhills, and for years was a respected source of top Sandhill's feeder cattle.
- Spencer Herefords currently runs around 300 head of cows, most of the registered. Don Spencer, the founder of Spencer Herefords divided the original Spencer Ranch with his brothers and sister's in the early 70's. Present headquarters exist on the North Loup River and this ranch base was purchased in the 1950's. The ranch consists of about 5,600 acres private and leased.
- The ranch is strictly forage based with 97% of the acres being native grass. Two center pivots exist on the operation. Corn, alfalfa, millet and other annual forages have been used in the past, but now pivots are being returned to cool season grass production. We have taken pride in our reliance on grass production with little inputs, as we feel it has produces a cowherd dependent on efficiency and optimum production. The luxury of a large crop base does not exist, as the soil and environment do not lend to extensive farming.
- The cowherd is a spring calving herd and calves in late March through May. A large percentage of the heifer crop is retained for replacement heifers, and recently the ranch started purchasing heifers from customers to be bred and resold. Sales are held in the fall and spring of each year.

Sydenstricker Angus Farms
Eddie L. Sydenstricker, Mexico, Missouri

Ralph E. Sydenstricker, Eddie's father, established Sydenstricker Angus Farms (SAF) in 1952 at Paris, Missouri. They have been producers of registered Angus seedstock since that time. The herd was enrolled in Angus Herd Improvement Records in 1977.

SAF have utilized the same headquarters location south of Mexico, Missouri, in north central Missouri, for 41 years. They are currently calving about 500 head, of which 22% are embryo transplant calves. They also produce some ET calves in cooperator herds. Utilizing heat synchronization, SAF have a 90-day spring-calving season and a 60-day fall-calving season. The herd is maintained on 2,500 owned acres and 750 leased acres. The farm is a combination farm with 25% in a crop rotation of corn, soybeans, and wheat. The remainder of the farm is pasture and hay.

Most of the production is marketed through an annual production sale held each year in November. All fall yearling bulls, and the older two-thirds of the spring bull calf crop are sold at the time, as well as a cross-section of females and embryos. SAF began carcass evaluation of herd sires in 1988, and own or co-own34 sires with carcass EPDs, based on 1268 of their progeny evaluated, as well as 12 more sires in some stage of carcass evaluation. They have marketed semen and AI certificates of herd sires since 1981. Their semen directory, printed annually since 1992, now contains information on 53 sires. These sires are responsible for over 30,000 progeny with weights recorded in the AHIR database, and 3,174 progeny on Australia's Breedplan. Although many are young sires, seventeen of them have 5,135 daughters in production on AHIR.

Whitestone Farm

George W. Lemm, Marvin & Katheryn Robertson, Aldie, Virginia

Whitestone Farm is one of the largest registered Angus operations in the eastern half of the United States. Currently Whitestone manages over 400 head of producing females. These registered cows consist of an elite group of donor females, which represent the most popular and productive cow families of the breed. For the past five years Red Angus have been introduced into the Whitestone Farm program in order to provide the customer base a wider selection of genetics. Also, 2100 head of commercial Angus females are managed as a recipient herd for embryos generated from the elite donor line-up at Whitestone. The current size of Whitestone Farm today is 2200 acres of owned and leased land. A very intense grazing program is utilized in order to maximize carrying capacity while maintaining environmentally sound practices. Much of the forage needed to maintain the Whitestone herd is grown and produced on Whitestone Farm. This consists of alfalfa and grass hays as well as alfalfa haylage. We take great pride at Whitestone in producing a high quality feedstuff, which enables us to have an overall low annual maintenance cost per cow. Today Whitestone utilizes both a spring and fall calving program, this is done in order to provide our customers with a selection of both bulls and heifers that will match their particular breeding programs. With this in mind, Whitestone also includes a forage management system that allows us to match our cow nutrient requirements with the current forage on a month-to-month basis. Whitestone Farm is located in Aldie, Virginia, which is just outside of Washington D.C. Our primary customer base is purebred cattle operations from coast to coast. Whitestone's close proximity to both Dulles International Airport and Ronald Reagan International allows our customers easy access to the Whitestone Farm production sales, which are held every fall and spring.

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 Kilgore	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
Lloyd Mygard	MD	1974
Dave Matti	MT	1974
Eldon Wiese	MN	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 D. 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. Station	MT	1976
John Blankers	MN	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 & Malcolm 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
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. Romersberger	IL	1982
Milton Krueger	MO	1982
Carl Odegard	MT	1982
Marvin & Donald Stoker	IA	1982
Sam Hands	KS	1982
Larry Campbell	KY	1982
Lloyd Atchison	CAN	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 Freitag	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	1985
Bob & Sheri Schmidt	MN	1985
Delmer & Joyce Nelson	IL	1985

Harley Brockel	SD	1985
Kent Brunner	KS	1985
Glenn Harvery	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 Richardson	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 J. Forster	CA	1986
Danny Geersen	SD	1986
Oscar Bradford	AL	1987
R. J. Mawer	CAN	1987
Rodney G. Oliphant	KS	1987
David A. 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. & 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 A. 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 McAvoy, 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 J. Chrisman	WY	1990
Les Herbst	KY	1990
Jon C. Ferguson	KS	1990
Mike & Diana 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 & Wendy Sweetland	CAN	1990
Swen R. Swenson Cattle	TX	1990
Robert A. Nixon & Son	VA	1991
Murray A. Greaves	CAN	1991

James Hauff	ND	1991
J. R. Anderson	WI	1991
Ed & 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
Lloyd & 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 Beitelspacher	SD	1993
Glenn Calbaugh	WY	1993
Oscho Deal	NC	1993
Jed Dillard	FL	1993
Art Farley	IL	1993
Jon Ferguson	KS	1993
Walter Hunsuker	CA	1993
Nola & Steve Kleiboeker	MO	1993
Jim Maier	SD	1993
Bill & Jim Martin	WV	1993
Ian & Alan McKillop	ON	1993
George & Robert Pingetzer	WY	1993
Timothy D. Sutphin	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
Olafson Brothers	ND	1995
Henry Stone	CA	1995
Joe Thielen	KS	1995
Jack Turnell	WY	1995
Tom Woodard	TX	1995
Jerry & Linda Bailey	ND	1996
Kory M. Bierle	SD	1996
Mavis Dummermuth	IA	1996
Terry Stuart Forst	OK	1996

Don W. Freeman	AL	1996
Lois & Frank Herbst	WY	1996
M/M 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 Petik	SD	1996
Ken Risler	WI	1996
Merlin Anderson	KS	1997
Joe C. Bailey	ND	1997
William R. "Bill" Brockett	VA	1997
Arnie Hansen	MT	1997
Howard McAdams, Sr & Howard McAdams, Jr.	NC	1997
Rob Orchard	WY	1997
Bill Peters	CA	1997
David Petty	IA	1997
Rosemary Rounds & Marc & Pam Scarborough	SD	1997
Morey & Pat Van Hoecke	MN	1997
Randy & Judy Mills	KS	1998
Mike & Priscilla Kasten	MO	1998
Amana Farms Inc.	IA	1998
Terry & Dianne Crisp	AB	1998
Jim & 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 and 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 & Mary Klintworth	NE	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 & Claudia Tucker	VA	2000
Wayne & Chip Unsicker	IL	2000
Billy H. Bolding	AL	2001
Mike & Tom Endress	IL	2001
Henry & Hank Maxey	VA	2001
Paul McKie	KS	2001

COMMERCIAL PRODUCER OF THE YEAR

Chan Cooper	MT	1972
Pat Wilson	FL	1973
Lloyd Nygard	ND	1974
Gene Gates	KS	1975
Ron Blake	OR	1976
Steve & Mary Garst	IA	1977
Mose Tucker	AL	1978
Bert Hawkins	OR	1979
Jess Kilgore	MT	1980
Henry Gardiner	KS	1981
Sam Hands	KS	1982
Al Smith	VA	1983
Bob & Sharon Beck	OR	1984
Glenn Harvey	OR	1985
Charles Fariss	VA	1986
Rodney G. Oliphant	KS	1987
Gary Johnson	KS	1988
Jerry Adamson	NE	1989
Mike & Diana Hopper	OR	1990
Dave & Sandy Umbarger	OR	1991
Kopp Family	OR	1992
Jon Ferguson	KS	1993
Fran & Beth Dobitz	SD	1994
Joe & Susan Thielen	KS	1995
Virgil & Mary Jo Huseman	KS	1996
Merlin & Bonnie Anderson	KS	1997
Randy & Judy Mills	KS	1998
Mike & Priscilla Kasten	MO	1998
Giles Ranch	KS	1999
Mossy Creek Farm	VA	1999
Bill Tucker	VA	2000
Maxey Farms	VA	2001

MAXEY FARMS RECEIVES 2001 BIF OUTSTANDING COMMERCIAL PRODUCER AWARD

San Antonio, Texas – Maxey Farms was named the Beef Improvement Federation (BIF) outstanding Commercial Producer of the Year at the thirty-third Annual Convention in San Antonio, Texas on July 13, 2001.

The town of Chatham in Southside Virginia's Pittsylvania is home to Maxey Farms. Henry and Linda Maxey started Maxey Farms in the mid-1960's as a livestock and grain operation. The operation grew over the years adding vegetables and tobacco, but always maintaining a commercial cow-calf operation as part of the diversified farming operation. In1990, Hank, the middle child and only son returned to the family farm with his wife Debbie. They added more cattle, land, and tobacco and created the family partnership as it is today.

Maxey Farms consists of approximately 1250 owned and rented acres that support a tobacco and wheat rotation, and from 240 to 280 fall- calving commercial crossbred cows. The cowherd consists of primarily Angus- cross cows with about 40% of the cows being one-quarter Gelbvieh. The calving season begins in mid- October lasting 75-80 days and coinciding with the end of the tobacco season. Eighty-five percent of the 2000 calf crop was born in the first 30 days of the calving season. For the past 10 years, all heifers and cows have been synchronized and bred one service AI to highly proven Angus sires, and performance-tested bulls have been utilized for the past 30 years. Comprehensive record keeping is an instrumental tool in assisting the Maxeys attain their goals of maximizing percent calf crop weaned, weaning weights, and cow carrying capacity while being a low –cost producer.

Progressive feeder cattle marketing is a cornerstone of the Maxey program. Steer calves are marketed in early August through the Virginia Cattlemen's Association Tel-O-Auction sales under the VQA program. All cattle are sold with available information- including calving date, weights, health and management program, genetics, and past feedlot and carcass performance.

The Maxeys also participate in the Virginia Retained Ownership Program and the bottom 20% of the heifers are sold through the Virginia Feeder Cattle Sales. In 1995, carcass data was received on the entire calf crop. Routine visits are made to feeder cattle buyers to assess the health and performance, as well as likes and dislikes of the cattle sold. Females not retained in the herd are sold as commercial replacements private treaty.

In addition to this full-time, highly progressive cattle operation, Hank serves the Virginia Cattlemen's Association as a board member and is Past President of VCA. Henry is a retired Farm Management Agent with the Virginia Cooperative Extension Service. They are members of the Pittsylvania and Buckingham County Cattlemen's Associations and the Virginia Angus Association.

2001 COMMERCIAL PRODUCER AWARD NOMINEES

Billy H. Bolding Farm
Mr. Billy H. Bolding, Randolph, Alabama

The Billy H. Bolding Farm is located on the Chilton, Bibb County border just north of Maplesville in central Alabama. This 600 acre farm has been in the Bolding family for three generations. Billy Bolding assumed management of the cattle operation in1980. At that time, the cow herd consisted of Poled Hereford and Angus genetics. Since 1980, Brown Swiss, Simmental and Angus genetics were incorporated to develop a 95 head cow herd. Today, the cow herd is primarily a Simmental-Angus composite with one-fourth or less Brown Swiss. Simmental-Angus composite bulls are used to maintain desired percentages of each breed. The cow herd is on a 90 day calving season, with the majority of cows calving in November and December.

The Billy H. Bolding Farm has collected and utilized performance records for the past 18 years. Adjusted weight has increased from 473 to 580 pounds with an average weaning frame score of 5.7. Carcass data indicate cattle will fit industry targets (HCW: 702 lbs; .31 in; REA: 13.4 sq in; YG: 2.04; QG: Select +). At Bolding Farm, this level of performance optimizes cow efficiency.

Steer calves are marketed through a local board sale. With this marketing opportunity, producer's pool cattle together, invite buyers to examine calves on the farm and then auction the cattle over the phone. Cattle are picked up from the farm one to four weeks later. Generally, 1000 to 1500 head of cattle are sold through this type of sale. The top 15 replacement heifers are marketed through the Chilton County BCIA Heifer Sale. Heifers have averaged $125 per head over auction prices the past 19 years.

Mike and Tom Endress
Mike and Tom Endress, Tremont, Illinois

The partnership of Mike and Tom Endress of Tremont, Illinois was the recipient of the Outstanding Commercial Cow-Calf Producer Award at the Illinois Beef Association's Annual meeting held during the Illinois Commodity Conference in Urbana on Tuesday, November 23.

Endress Farms operates one of the most progressive, better-managed commercial cow-calf operations in Illinois. The cowherd consists of 100 mother cows and 15 bred heifers. Their cropping operation involves 750 acres in Tazwell County.

The Endress brothers took over the commercial cow operation in 1985 from their father Frank Endress who has farmed and raised cattle in the Tremont area since 1940. During the past 12 years the operation has incorporated the latest technologies of genetics, management and nutrition to increase overall production efficiency.

This is verified by their cowherd consistently weaning at least 96% calf crop with an adjusted weaning weight of 605 pounds. They have synchronized their cowherd and bred via AI to bulls that excel in calving growth, milking ability and carcass traits. A performance testing program is used to identify superior replacement heifers and cull females from the herd. The current breeds of Angus and Gelbvieh are used in a two-breed rotation- crossbreeding program.

The Endress' retain ownership in their calf crop by feeding out their own cattle and marketing on a grade and yield basis. This allows the firm to capture the superior genetics that they have incorporated into their herd. Their cattle are marketed at 14 months of age with over 80% grading choice or prime and over 85% yield grading 1 or 2.

In order to get a handle on cost the Endresses were one of the pioneer farms in the Illinois IRM-SPA Program. These records along with the information it provides have allowed the farm to make adjustment in their pastures and winter feeding program. Even though they have rotated pastures for numerous years, they are setting up a more intense pasture management program by subdividing existing pastures and moving water to the cattle. They have also lowered winter feeding cost by utilizing seed corn residue in their winter feeding rations. Their farm is one of four farms that will be used in a number of SPA Case Study meetings held throughout Illinois

The Endress brothers have hosted pasture tours and area cow-calf field days. Just this past September there were over 100 cow-calf producers in attendance to view their operation. They are also members of the Central Illinois IRM Cow-Calf Team that allows producers to share ideas about their operations.

Endress Farms nomination will represent Illinois in national competition at the 2001 National Beef Improvement Federation's annual meeting that will be held in Lincoln, Nebraska.

Maxey Farms
Henry and Hank Maxey, Chatham, Virginia

The town of Chatham in Southside Virginia's Pittsylvania is home to Maxey Farms. Henry and Linda Maxey started Maxey Farms in the mid-1960's as a livestock and grain operation. The operation grew over the years adding vegetables and tobacco, but always maintaining a commercial cow-calf operation as part of the diversified farming operation. In1990, Hank, the middle child and only son returned to the family farm with his wife Debbie. At this time they added more cattle, land, and tobacco and created the family partnership as it is today.

Maxey Farms consists of approximately 1250 owned and rented acres that support a tobacco and wheat rotation, and from 240 to 280 fall- calving commercial crossbred cows. The forage base is primarily fescue and clover, and all acres are divides into rotational blocks for optimum grazing management. Grazing of stockpiled forage limits dependence on harvested and purchased feedstuffs, and wheat and hairy vetch are rotated with tobacco for harvested hay.

The cowherd consists of primarily Angus- cross cows with about 40% of the cows being one-quarter Gelbvieh. The calving season begins in mid- October lasting 75-80 days and coinciding with the end of the tobacco season. Eighty-five percent of the 2000 calf crop was born in the first 30 days of the calving season. For the past 10 years, all heifers and cows have been synchronized and bred one service AI to highly proven Angus sires, and performance-tested bulls have been utilized for the past 30 years. Strict EPD specifications are employed for selection of both AI and natural service sires. A balance of superior growth, optimum calving ease, moderate mature size and milk production, along with superior carcass merit are the focus of sire selection criteria. Females with superior fertility and the ability to perform profitably in the limited feed resource environment of the operation are key. Comprehensive record-keeping is an instrumental tool in assisting the Maxeys attain their goals of maximizing percent calf crop weaned, weaning weights, and cow carrying capacity while being a low –cost producer.

Progressive feeder cattle marketing is a cornerstone of the Maxey program. Steer calves are marketed in early August through the Virginia Cattlemen's Association Tel-O-Auction sales under the VQA program. All cattle are sold with available information- including calving date, weights, health and management program, genetics, and past feedlot and carcass performance.

The Maxeys also participate in the Virginia Retained Ownership Program and the bottom20% of the heifers are sold through the Virginia Feeder Cattle Sales. In 1995, carcass data was received on the entire calf crop. Routine visits are made to feeder cattle buyers to assess the health and performance, as well as likes and dislikes of the cattle sold. Females not retained in the herd are sold as commercial replacements private treaty.

In addition to this full-time, highly progressive cattle operation, Hank serves the Virginia Cattlemen's Association as a board member and is Past President of VCA. Henry is a retired Farm Management Agent with the Virginia Cooperative Extension Service. They are members of the Pittsylvania and Buckingham County Cattlemen's Associations and the Virginia Angus Association.

Tailgate Ranch Company

Paul McKie, Tonganoxie, Kansas

Tailgate Ranch is a commercial cow-calf operation consisting of approximately 1,500 acres cool season grass and legume pastures, 390 acres brome hay meadows, and 60 acres alfalfa. Paul McKie founded Tailgate Ranch in 1962. The ranch is headquartered near Tonganoxie, Kansas, which is approximately 30 minutes west of Kansas City, Kansas. The ranch runs about 270 females (including 50 replacement heifers) in a spring calving herd and 120 cows in a fall calving herd. The ranch's focus the last 5 years has been to develop and breed high quality replacement females following a strict culling regime in order to build a superior maternal cowherd. Feedlot and carcass data have been collected to improve feed efficiency and end product quality.

Heifers are estrous synchronized and AI'd one cycle. Cleanup breeding is done by easy calving Angus or Red Angus bulls, allowing for a 45-day calving season, beginning February 10. Spring cows, mostly Red Angus or Angus crossbreds, calve in 60 days, beginning March 1. Calves are prewean vaccinated, the weaned September 20. All calves are kept on pasture and supplemented with a growing ration until all steers are either sold or sent to a feedlot, while heifers continue developing on pasture until Aling. Fall calving cows, mostly straight Angus begin calving September 1 and finish October 15. Fall calves are generally creep fed 90 days, weaned at 150 days, preconditioned and sold as grass cattle. Angus, Red Angus and Red Angus x Simmental bulls are used on the spring herd while Angus, Red Angus and Braunvieh bulls are used on the fall cows.

AMBASSADOR AWARD RECIPIENTS

Warren Kester	Beef Magazine	MN	1986
Chester Peterson	Simmental Shield	KS	1987
Fred Knop	Drovers Journal	KS	1988
Forrest Bassford	Western Livestock Journal	CO	1989
Robert C. DeBaca	The Ideal Beef Memo	IA	1990
Dick Crow	Western Livestock Journal	CO	1991
J. T. "Johnny" Jenkins	Livestock Breeder Journal	GA	1993
Hayes Walker, III	America's Beef Cattleman	KS	1994
Nita Effertz	Beef Today	ID	1995
Ed Bible	Hereford World	MO	1996
Bill Miller	Beef Today	KS	1997
Keith Evans	American Angus Association	MO	1998
Shauna Rose Hermel	Angus Journal & Beef Magazine	MO	1999
Wes Ishmael	Clear Point Communications	TX	2000
Greg Hendersen	Drovers	KS	2001

Henderson Selected for BIF Beef Ambassador Award

The selection of Greg Henderson, editor and associate publisher of Drovers magazine, as winner of the Beef Improvement Association's 2001 Ambassador Award has been announced by Dr. Darrh Bullock, University of Kentucky beef geneticist and chairman of the Association's Awards Committee.

Henderson becomes the 15th recipient of the Ambassador Award, which was established in 1986 to recognize livestock journalists whose efforts further the mission of the Beef Improvement Association. The Association is a federation of organizations in the beef industry concerned with the performance enhancement of cattle.

Henderson serves as only the fifth editor of Drovers, which was established as the Drovers Journal in Chicago, Ill. in 1873, and is the second Drovers editor to win the award. Former editor, Fred Knop, was the winner of the third Ambassador Award in 1987.

A native of Sedan, Kansas, Henderson was reared on a crop and livestock farm, and carried an interest in beef cattle into his years in higher education. Henderson received an Associate of Arts degree from Coffeyville Community College, Coffeyville, Kan. in 1977. He received a Bachelor of Science degree in Agricultural Journalism from Kansas State University in 1980, where his studies included a minor in agricultural economics. Henderson also holds a Master of Science degree from Kansas State University.

Henderson joined Drovers as an assistant editor in 1984 after holding editorial positions at Grass and Grain, Manhattan, Kan. and Beef Progress, the official publication of the Iowa Beef Improvement Association. Henderson served as markets editor of Drovers 1987 to 1990 and managing editor from 1990 to 1992 before being named editor in 1992. He has served as associate publisher of this publication since 1995.

The long tradition of Drovers for supporting beef improvement initiatives has been continued strongly under Henderson's editorship. The publication continues to emphasize thought-leading subjects concerning cattle genetics and marketing. In 1993, Drovers was the winner of the Oscars in Agriculture award for magazines which is administered for the Agricultural Editors Association by the University of Illinois. Drovers was also winner of the Livestock Publications Council's annual award for *general excellence* in 1999.

Henderson has been an active participant in the program of the Livestock Publications Council, a national organization of magazines and newspapers serving the livestock industry. He currently serves as this organization's president.

Writing continues to be an active part of Henderson's activities. He authors Drover's thought-leading lead editorials every month and has also authored award-winning in-depth articles and feature stories. As a grassland owner near Sedan, Kan., he frequently runs stocker cattle and feeds out cattle in Kansas feed yards.

Henderson has been a member of the Agricultural Editors Association since 1992, is a member of the National Honor Society and has also held membership in Agricultural Communicators of Tomorrow and the Acacia Fraternity.

Henderson and his wife, Ruth, are parents of two young children, Lisa and Jared. The family resides in Olathe, Kan.

PIONEER AWARD RECIPIENTS

Jay L. Lush	IA	1973
John H. Knox	NM	1974
Ray Woodward	ABS	1974
Fred Wilson	MT	1974
Charles E. Bell, Jr.	USDA	1974
Reuben Albaugh	CA	1974
Paul Pattengale	CO	1974
Glenn Butts	PRT	1975
Keith Gregory	MARC	1975
Braford Knapp, Jr.	USDA	1975
Forrest Bassford	WLJ	1976
Doyle Chambers	LA	1976
Mrs. Waldo Emerson Forbes	WY	1976
C. Curtis Mast	VA	1976
Dr. H. H. Stonaker	CO	1977
Ralph Bogart	OR	1977
Henry Holsman	SD	1977
Marvin Koger	FL	1977
John Lasley	FL	1977
W. L. McCormick	GA	1977
Paul Orcutt	MT	1977
J. P. Smith	PRT	1977
James B. Lingle	WYE	1978
R. Henry Mathiessen	VA	1978
Bob Priode	VA	1978
Robert Koch	MARC	1979
Mr. & Mrs. Carl Roubicek	AZ	1979
Joseph J. Urick	USDA	1979
Bryon L. Southwell	GA	1980
Richard T. "Scotty" Clark	USDA	1980
F. R. "Ferry" Carpenter	CO	1981
Clyde Reed	OK	1981
Milton England	TX	1981
L. A. Moddox	TX	1981
Charles Pratt	OK	1981
Otha Grimes	OK	1981
Mr. & Mrs. Percy Powers	TX	1982
Gordon Dickerson	NE	1982
Jim Elings	CA	1983
Jim Sanders	NV	1983
Ben Kettle	CO	1983
Carroll O. Schoonover	WY	1983
W. Dean Frischknecht	OR	1983
Bill Graham	GA	1984
Max Hammond	FL	1984
Thomas J. Marlowe	VA	1984
Mick Crandell	SD	1985
Mel Kirkiede	ND	1985
Charles R. Henderson	NY	1986
Everett J. Warwick	USDA	1986
Glenn Burrows	NM	1987
Carlton Corbin	OK	1987
Murray Corbin	OK	1987
Max Deets	KS	1987
George F. & Mattie Ellis	NM	1988
A. F. "Frankie" Flint	NM	1988
Christian A. Dinkle	SD	1988
Roy Beeby	OK	1989

Will Butts	TN	1989
John W. Massey	MO	1989
Donn & Sylvia Mitchell	CAN	1990
Hoon Song	CAN	1990
Jim Wilton	CAN	1990
Bill Long	TX	1991
Bill Turner	TX	1991
Frank Baker	AR	1992
Ron Baker	OR	1992
Bill Borror	CA	1992
Walter Rowden	AR	1992
James W. "Pete" Patterson	ND	1993
Hayes Gregory	NC	1993
James D. Bennett	VA	1993
O'Dell G. Daniel	GA	1993
M. K. "Curly" Cook	GA	1993
Dixon Hubbard	USDA	1993
Richard Willham	IA	1993
Dr. Robert C. DeBaca	IA	1994
Tom Chrystal	IA	1994
Roy A. Wallace	OH	1994
James S. Brinks	CO	1995
Robert E. Taylor	CO	1995
A. L. "Ike" Eller	VA	1996
Glynn Debter	AL	1996
Larry V. Cundiff	NE	1997
Henry Gardiner	KS	1997
Jim Leachman	MT	1997
John Crouch	MO	1998
Bob Dickinson	KS	1998
Douglas MacKenzie Fraser	AB	1998
Joseph Graham	VA	1999
John Pollack	NY	1999
Richard Quaas	NY	1999
Robert R. Schalles	KS	2000
J. David Nichols	IA	2000
Harlan Ritchie	MI	2000
Larry Benyshek	GA	2001
Minnie Lou Bradley	TX	2001
Tom Cartwright	TX	2001

Minnie Lou Bradley Receives BIF's Pioneer Award

Minnie Lou Ottinger Bradley of Memphis, Texas was selected to receive the Beef Improvement Federations Pioneer Award. Bradley was raised n a wheat and stock farm in west-central Oklahoma. She attended Oklahoma State University where she majored in Animal Science and minored in Agriculture Journalism. She was a member of the livestock judging team and was high individual beef cattle judge at the American Royal and high overall judge at the international in Chicago.

Upon graduation, she became assistant executive secretary of the Texas Angus Association and remained in that position until her marriage to Bill Bradley in 1955. They moved to Childress County, Texas where she still manages approximately 300 registered Angus cows. The Bradleys started performance testing before the Angus Herd Improvement Records (AHIR) program was introduced and were charter members of Performance Registry International. The ranch has been on AHIR since its inception.

Bradley has been general manager of the cattle operation for the past 13 years and is active on committees with the National Cattlemen's Beef Association (NCBA); Board member of the American Angus Association; is a member of the Texas Cattle Feeders Association (TCFA), the Texas and Southwestern Cattle Raisers Association (TSCRA), and the Beef Improvement Federation (BIF).

Bradley is a pioneer in the branded beef business and value-based marketing. In 1986 she and her family built and opened a USDA processing plant which merchandises beef across the nation. The plant exclusively processes cattle for Bradley's All Natural Premium Beef. The Bradleys' B3R Beef was the featured menu item at the Texan Black Tie and Boots Ball prior to President Bush's inauguration. The beef for the program is provided by retained owners and fed in one approved Texas feedlot. The Bradleys have worked with produces to provide feedlot and carcass performance information necessary to make selection and management decisions to improve returns.

Ultrasound studies and training of technicians have been occuring at the Bradley Ranch since 1986. The ranch hosted a training session for technicians in the early years of ultrasound, and Texas Tech University had two students use the Bradley 3 Ranch for work on their graduate studies. Since 1995 the ranch has been using DNA to determine the sires of their calves.

Minnie Lou Bradley has promoted beef improvement through example and through many speaking engagements. It is a rare opportunity to honor one of the cattle industries current front runners with the BIF Pioneer Award, but Ms. Bradley certainly fits that scenario.

Tom Cartwright receives BIF Pioneer Award

Thomas Campbell Cartwright, born March 8, 1924, in York, South Carolina, graduated with honors in Animal Husbandry in 1948 from Clemson University. He received the M.S. degree in Genetics in 1949 and the Ph.D. degree in Animal Breeding in 1954 from Texas A&M College. He was Instructor of Genetics in 1949, Atomic Energy Commission Fellow from 1949 to 1951, and Associate Animal Husbandman and Geneticist at the Texas A&M Agricultural Research Center at McGregor from 1952 to 1958. He was appointed Professor, Animal Husbandry Department, Texas A&M College, in 1958. He received the Association of Former Students Distinguished Achievement Award in Teaching at Texas A&M in 1962, was selected as a Fellow of the American Association for the Advancement of Science in 1965, and received the Animal Breeding Award from the American Society of Animal Science in 1973 and the International Agriculture Award from the American Society of Animal Science in 1983. He was recognized in 1987 with the title of Professor Emeritus of the Animal Science Department, Texas A&M University, and received the Distinguished Alumni Award from Clemson University in 1989.

His early research at the McGregor Center involved performance testing (growth and reproduction) and crossbreeding. The crossbreeding research had the original intent of developing two synthetic breeds (3/4 Hereford-1/4 Brahman and 3/4 Brahman-1/4 Hereford) adapted to different Texas conditions. Producing the F_1 crosses needed to make the foundation crosses provided cattle that were well suited to the study of heat tolerance. The heat tolerance research was the topic of his Ph.D. dissertation, and was the first documentation of the levels of heterosis in the Hereford-Brahman F_1. Continuation of this crossbreeding research led to the recognition that the net productivity of the F_1 cross was clearly superior to the straightbreds. In an "editorial" written in a report to the cooperating breeders, Tom predicted that the future would see hybrid beef cattle in almost the same proportion as hybrids in hogs. This upset several breeders to the point of terminating their participation as cooperators. The development of the two Hereford-Brahman composite breeds was terminated in the early 1960's, but important crossbreeding research was continued.

The thrust of the early performance testing research was to objectively document the variability of performance within and between beef breeds. Tom's first assignment as an employee of the Texas Agricultural Experiment Station (TAES) was to draft a journal article summarizing the results of gain tests that had been conducted at the TAES Substation at Balmorhea, where a program of winter feeding of bull calves from cooperating breeders was carried out beginning in 1942. In this article, the heritability of rate of gain in young growing bulls was reported to be moderately high. Gain testing bulls from cooperating breeders was continued at McGregor and corroborated the heritability estimates from Balmorhea. The work done at Balmorhea and McGregor, reinforced by an earlier journal article from the USDA Station at Miles City, MT, set off the gain testing and selection race.

While gain testing was continued at McGregor, meaningful data were accumulated on the variability of the efficiency of production of the cowherd. Major effort was devoted to the study of growth curves in order to develop a better understanding of the relationships of growth to cow productivity. Systems analysis tools were used to develop mathematical models to study trait level impacts on system efficiency, elucidate such phenomena as complementarity, and to account for the trade offs associated with antagonisms between traits. The McGregor breeding research was redesigned starting in 1970 with the objective of gaining more basic information on how cattle grow and reproduce. The systems research was continued and expanded during the 1970's and 80's, and Tom became a world leader in the application of systems analysis techniques to livestock breeding.

LARRY BENYSHEK RECEIVES BEEF IMPROVEMENT FEDERATION PIONEER AWARD

San Antonio, Texas- The Beef Improvement Federation (BIF) honored Dr. Larry Benyshek with the Pioneer Award at the thirty-third Annual Convention on July 13, 2001 in San Antonio, Texas. The purpose of this award is to recognize individuals who have made lasting contributions to the genetic improvement of beef cattle.

Larry Benyshek was born February 26, 1947 in Concordia, Kansas and grew up on a livestock and grain farm. He received his B.S. Degree from Kansas State University in 1969 and completed his M.S. and Ph.D. Degrees in Animal Breeding at Virginia Polytechnic Institute in 1971 and 1973, respectively. Upon graduation he joined the staff of the North American Limousin Foundation as Director of Research and Education. He became a faculty member at Fort Hayes State College (Kansas) in 1974, and in 1976, he was appointed to the faculty at the University of Georgia with teaching and research responsibilities in Animal Breeding. In 1993, he was appointed Head of the Animal and Dairy Science Department at the University of Georgia.

From 1975 to 1983, along with his colleagues and graduate students, he conducted research to refine the use of sire models in across-herd evaluation of beef cattle. In 1984, the group applied a sire-dam model with numerator relationship to beef cattle field records. The experience led to the application in 1985 of the reduced animal models to Limousin and Brangus field data, the first application in the United States of this model using large datasets of beef cattle field records. In 1994 the Group provided the first joint Canada-U.S. genetic evaluation with the application of multi-trait animal models to Hereford performance records in both countries. Since 1976, the Animal Breeding Group at the University of Georgia has developed genetic evaluation procedures and provided genetic values (EPDs) on millions of cattle from 17 different breeds in Argentina, Canada, Uruguay and the United States.

Dr. Benyshek has written numerous articles and made countless presentations both nationally and internationally on genetic evaluation procedures and the use of EPDs. Larry Benyshek did not coin the term AExpected Progeny Difference@, but few will argue that anyone has done more than he to spread the AEPD Concept@ and to put this technology into the hands of U.S. producers.

Dr. Benyshek has received BIF=s Continuing Service Award and in 1994, he was recipient of the American Society of Animal Science Rockefeller Prentice Memorial Award in Animal Breeding and Genetics. His family includes his wife Ruthann, daughters, Tasha and Kelly, a son, James, and one granddaughter, Elizabeth.

CONTINUING SERVICE AWARD RECIPIENTS

Clarence Burch	OK	1972
F. R. Carpenter	CO	1973
E. J. Warwick	DC	1973
Robert DeBaca	IA	1973
Frank H. Baker	OK	1974
D. D. Bennett	OR	1974
Richard Willham	IA	1974
Larry V. Cundiff	NE	1975
Dixon D. Hubbard	DC	1975
J. David Nichols	IA	1975
A. L. Eller, Jr.	VA	1976
Ray Meyer	SD	1976
Don Vaniman	MT	1977
Lloyd Schmitt	MT	1977
Martin Jorgensen	SD	1978
James S. Brinks	CO	1978
Paul D. Miller	WI	1978
C. K. Allen	MO	1979
William Durfey	NAAB	1979
Glenn Butts	PRI	1980
Jim Gosey	NE	1980
Mark Keffeler	SD	1981
J. D. Mankin	ID	1982
Art Linton	MT	1983
James Bennett	VA	1984
M. K. Cook	GA	1984
Craig Ludwig	MO	1984
Jim Glenn	IBIA	1985
Dick Spader	MO	1985
Roy Wallace	OH	1985
Larry Benyshek	GA	1986
Ken W. Ellis	CA	1986
Earl Peterson	MT	1986
Bill Borror	CA	1987
Daryl Strohbehn	IA	1987
Jim Gibb	MO	1987
Bruce Howard	CAN	1988
Roger McCraw	NC	1989
Robert Dickinson	KS	1990
John Crouch	MO	1991
Jack Chase	WY	1992
Leonard Wulf	MN	1992
Henry W. Webster	SC	1993
Robert McGuire	AL	1993
Charles McPeake	GA	1993
Bruce E. Cunningham	MT	1994
Loren Jackson	TX	1994
Marvin D. Nichols	IA	1994
Steve Radakovich	IA	1994
Dr. Doyle Wilson	IA	1994
Paul Bennett	VA	1995
Pat Goggins	MT	1995
Brian Pogue	CAN	1995
Harlan D. Ritchie	MI	1996
Doug L. Hixon	WY	1996
Glenn Brinkman	TX	1997

Russell Danielson	ND	1997
Gene Rouse	IA	1997
Keith Bertrand	GA	1998
Richard Gilbert	TX	1998
Burke Healey	OK	1998
Bruce Golden	CO	1999
John Hough	GA	1999
Gary Johnson	KS	1999
Norman Vincil	VA	1999
Ron Bolze	KS	2000
Jed Dillard	FL	2000
William Altenburg	CO	2001
Kent Andersen	CO	2001
Don Boggs	SD	2001

William "Willie" A. Altenburg Receives BIF's Continuing Service Award

William "Willie" Altenburg is a native of southern Wisconsin growing up on a diversified livestock farm. Willie is a 1973 graduate of the University of Wisconsin-Platteville with a Bachelor of Science in Animal Science. Following graduation, Willie worked for American Breeders Service in the area of semen production, Beef bull care and housing, and in 1977 moved into A. I. sales and field training with a transfer to Nebraska. He also worked in the Beef Division in a management role before ending his nearly 30 year career with ABS. He is currently Beef Program Manager for Alta Genetics. Beef A.I. is his love and passion.

He and his wife, Sharon and family also own a 75 cow herd comprised of registered Simmental, Angus/Red Angus and "Super Baldy" composites in Fort Collins, Colorado. Utilizing the performance tools in a "real-world" environment of selling and promoting cattle to commercial producers is a challenge he enjoys.

His beef industry experience and service includes serving as a Trustee for 6 years on the American Simmental Association Board including Breed Improvement Chairman and a member of the FOCUS 2000 committee. Willie served as first chairman of the Progress Through Performance (PTP) committee where incorporation of EPDs and performance data were utilized as show ring judging criteria. While accepted today, it was controversial at the time.

He served as president of the Beef Improvement Federation (BIF) in 2000. Willie is a member of the National Cattlemen's Beef Association (NCBA) Board of Directors and is immediate past chairman of the NCBA Seedstock Council.

Willie is a member of the Spirit of Joy Lutheran Church and is active in local 4H activities. Hobbies include cattle, hunting and grand children.

Serving two terms on the BIF Board has been one of the highlights of Willie's career. Willie says, "Having served on numerous boards, I have seen a difference on the BIF Board. I notice the unselfishness of a large group of talented, hard-driving, and aggressive BIF Board members. It was refreshing to me. They look at every decision as to what is "right for the industry", not what is "right for their own interests". It has been my pleasure and honor to be associated with the caliber of people represented on the BIF Board and its membership."

KENT ANDERSEN RECEIVES BIF CONTINUING SERVICE AWARD

San Antonio, Texas - The Beef Improvement Federation (BIF) is pleased to recognize Dr. Kent Andersen with the Continuing Service Award at the 33rd Annual Meeting and Research Symposium in San Antonio, Texas on July 13, 2001.

Dr. Andersen was raised on a diversified livestock and farming operation in central Nebraska, where he continues to be involved in the cattle portion of the family business. He received his B.S. in Animal Science in 1985 from the University of Nebraska and his M.S. and Ph.D. degrees in Beef Cattle Breeding and Genetics from Colorado State University in 1987 and 1990, respectively. Upon graduation, Kent joined the North American Limousin Foundation (NALF) as Director of Education and Research. In 1999, Kent assumed the position of Executive Vice President of the Foundation.

While in the capacity of Director of Education and Research for NALF, Dr. Andersen coordinated the performance program for the Limousin breed and helped to execute the breed's plan for genetic improvement. This plan involved the incorporation of EPDs for eight additional traits into the breed's genetic evaluation program. As well, under the guidance of Dr. Andersen, experimental genetic predictions for Limousin cattle were produced for heifer pregnancy, calving ease direct and maternal, ultrasound carcass traits and traits related to mature cow size. Dr. Andersen has authored numerous educational articles and public presentations regarding the interpretation and use of EPDs by producers to help make selection decisions.

From 1994 to 2000, Dr. Andersen served on the BIF Board of Directors. During his second term on the BIF board, Kent served as chairman of the multiple trait selection committee, and served for several years on the BIF program planning committee. Kent also authored the section in the BIF Guidelines for Uniform Beef Improvement Programs entitled "Behavior", which provides an evaluation system for temperament of beef cattle.

Dr. Andersen has also been actively involved in the National Cattlemen's Beef Association, where he has served on the National Animal I.D. Task Force, the Product Enhancement committee and the Seedstock Council program planning committee. Additionally, Kent currently serves on the Board of Directors of the National Pedigreed Livestock Council and the International Limousin Council.

BIF is pleased to recognize Kent Andersen for his contributions to beef improvement by presenting him with the BIF Continuing Service Award.

Don Boggs Receives BIF Continuing Service Award

Don Boggs is the Head of the Department of Animal and Range Sciences at South Dakota State University. Don was raised on a grain and livestock farm in Central Illinois. He received his B.S. degree from the University of Illinois, M.S. from Kansas State University and a Ph.D. from Michigan State University. While at MSU, he co-authored the widely used text, *Livestock and Carcasses: An Integrated Approach to Evaluation, Grading and Selection*, which is now in it's fifth edition, and he also coached the livestock judging team to the 1980 National Championship at the North American International Livestock Exposition. Don was on the research and teaching faculty at the University of Georgia for six years before becoming the Extension Beef Specialist at South Dakota State University in Brookings in 1988. He has served on numerous industry committees and organizations and he has judged numerous state, regional and national beef cattle shows in both the U.S. and Canada.

Dr. Boggs has been very active in the Beef Improvement Federation. He served as the Central Region Secretary and on the Board of Directors from 1991 through 1998. At that time he assumed the role of BIF Executive Director until 1999. Don has also contributed to the BIF's Guidelines for Uniform Beef Improvement Programs and co-authored a BIF Factsheet. Through Don's support and leadership BIF has continued to increase its role to support beef cattle improvement.

Don and his wife, Rosemary, have two daughters and stay active in the beef business with their own small herd of Angus cows.

Seedstock Producer of the Year
Sydenstricker Angus Farms

Commercial Producer of the Year
Maxey Farms

Frank Baker Memorial Scholarship
K.A. Nephawe

Frank Baker Memorial Scholarship
Janice M. Rumph

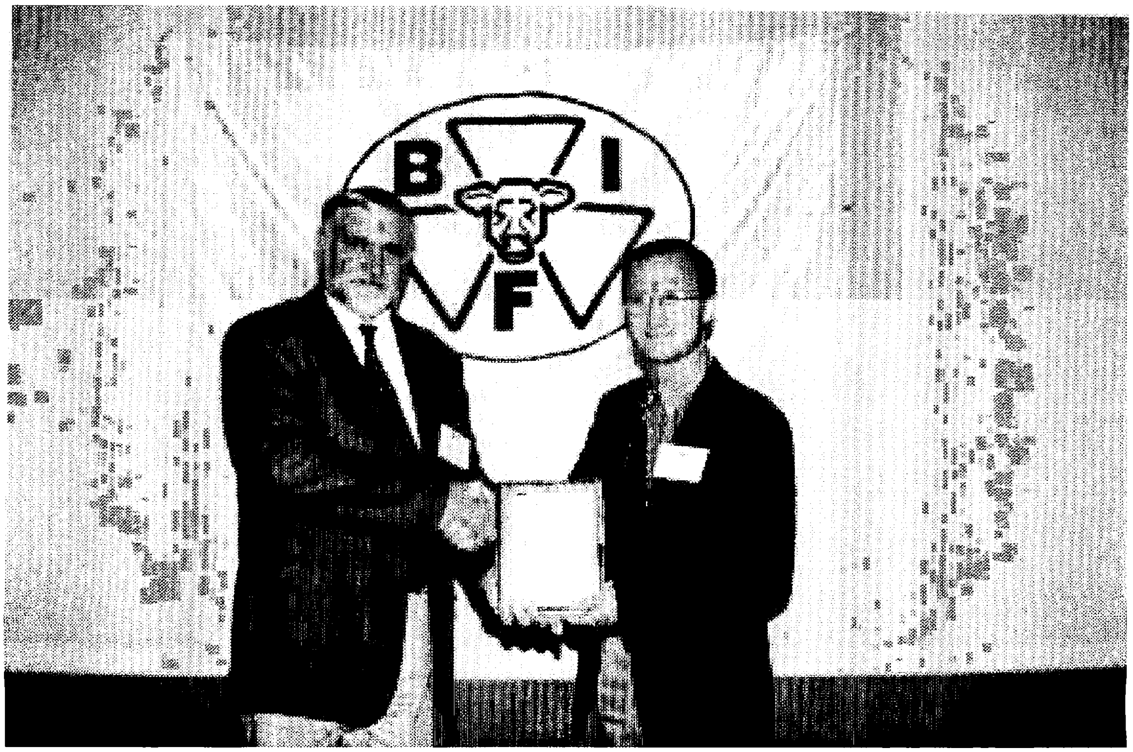
Pioneer Award Winner
Larry Benyshek

Pioneer Award Winner
Minnie Lou Bradley

Pioneer Award Winner
Tom Cartwright

Ambassador Award Winner
Greg Henderson

Continuing Service Award Winner
Willie Altenburg



Continuing Service Award Winner
Kent Andersen

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