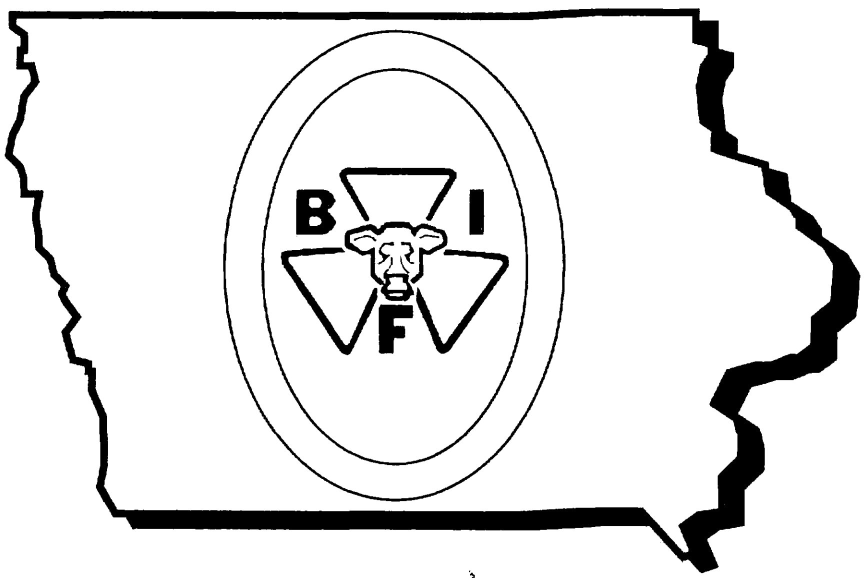
PROCEEDINGS

BEEF IMPROVEMENT FEDERATION

26TH RESEARCH SYMPOSIUM & ANNUAL MEETING



HOLIDAY INN - UNIVERSITY PARK
WEST DES MOINES, IOWA
JUNE 1-4, 1994

1994 BEEF IMPROVEMENT FEDERATION BOARD OF DIRECTORS

NAME	YEAR TERM EXPIRES	REPRESENTING
Willie Altenburg	1996	Western BCIA
Kent Anderson	1997	Breed Association
Paul Bennett	1995	Eastern BCIA
Glenn Brinkman	1995	Central BCIA
John Crouch	1995	Breed Association
Jed Dillard	1995	Eastern BCIA
Burke Healey	1995	At-Large
John Hough	1996	Breed Association
Roger Hunsley	1995	Breed Association
Doug Husfeld	1997	Breed Association
Gary Johnson	1997	Central BCIA
Lee Leachman	1996	At-Large
Craig Ludwig	1996	Breed Association
Roy McPhee	1995	Western BCIA
Marvin Nichols	1995	Past President

Don Boggs	Central Region BIF Secretary
Ron Bolze	Executive Director
Larry Cundiff	USDA ARS
Paola de Rose	Agriculture Canada
Doug Hixon	Western Region BIF Secretary
Dan Kniffen	NCA
Ronnie Silcox	Eastern Region BIF Secretary
Norman Vincel	NAAB
Gary Weber	USDA - Extension
Richard Willham	BIF Historian

1994 Beef Improvement Federation Conference
Holiday Inn, University Park
Atrium Hotel & Convention Center
West Des Moines, Iowa
June 1-4, 1994

WEDNESDAY, June 1, 1994

3:00 - 8:00 PM **REGISTRATION**

3:30 - 7:00 PM **Board of Directors Meeting** - Chambers Room

FUTURE GENETICS SYMPOSIUM: SETTING THE STAGE FOR A NEW BIF COMMITTEE
Des Moines Room - Burke Healey, Moderator

7:00 PM **Gene Mapping, Marker Assisted Selection, QTLs- Boiling it Down to Cowboy Lingo**
Sue DeNise, University of Arizona, John Pollak, Cornell University

7:45 PM **What Can We Learn From Our Competing Industries?**
Arnel Hallauer (Corn), Max Rothschild (Swine) and
Sue Lamont (Poultry), Iowa State University; Paul Miller, ABS (Dairy)

THURSDAY, June 2, 1994

7:00 - 5:00 PM **REGISTRATION**

ENHANCING UNIFORMITY, PREDICTABILITY AND CONSUMER ACCEPTABILITY OF BEEF PRODUCTS
Des Moines Room
Marvin Nichols, Moderator

8:00 AM **WELCOME**
Dennis Marple - ISU, Head of Animal Science,
Lee Faris - President, Iowa Cattlemen's Association

8:15 **National Initiatives to Enhance the Safety, Quality, Consistency and Competitiveness of Beef**
Harlan Ritchie - Michigan State University

9:00 AM **Advances in Meat Processing Technology That Will Impact Beef Breeding**
Mohammed Koohmaraie, USDA-ARS

9:45 AM **Attacking the Value Based Dilemma from a Seedstock, Commercial and Feedlot Perspective**
Henry Bergfeld, Summitcrest Angus, Summitville, OH
Jack Maddux, Maddux Cattle Company, Wauneta, NE
Mark Armentrout, Mill Park Feedlot, Roswell, Georgia

10:45 AM **BREAK** - Atrium

11:00 AM **ISU Ultrasound Demonstration**
Doyle Wilson and Gene Rouse, Iowa State University

12:30 AM **LUNCHEON**
Seedstock & Commercial Producer Award Nominees Introduction
Emcee: Paul Bennett

COMMITTEES 2:00 - 5:00

GENETIC PREDICTION COMMITTEE
Des Moines Room
Larry Cundiff, Chairman

International Cattle Evaluations
Doyle Wilson, Iowa State University

Body Composition EPD's
Ronnie Green, Colorado State University

Use of Ultrasound for EPD's
Gene Rouse, Iowa State University

Data Preparation and Editing Considerations
Robert Schalles, Kansas State University

Improving the Quality of Performance Records
Robert Scarth

Proposed Interbreed Data Interchange Format
Bruce Golden & Rick Bourdon, Colorado State University

Procedures for Calculating Interim Expected Progeny Differences
Bruce Cunningham, American Simmental Association

Breed Comparisons for Growth and Maternal Traits Adjusted to a 1992 Base
Dale Van Vleck, University of Nebraska

National Cattle Evaluation
Keith Bertrand, University of Georgia

Guidelines for Genetic Prediction

REPRODUCTION COMMITTEE
Clayton - Webster Rooms
Bruce Cunningham, Chairman

Subcommittee Report - Genetic Evaluation of Reproductive Traits
Bruce Cunningham, American Simmental Association

Genetic Analysis of Calving Date in Line 1 Herefords
Michael MacNeil, USDA-ARS, LAARS

Stayability Evaluation in Red Angus Cattle
Bruce Golden, Colorado State University

Age Adjustment Factors for Scrotal Circumference Growth
Robert Schalles, Kansas State University

INTEGRATED GENETIC SYSTEMS
Marion Room - John Hough, Chairman

Update on SPA - Seedstock Program
Lee Leachman, Leachman Cattle Company

Seedstock SPA and Breed Association Data Processing
Dan Kniffen, NCA

How Do We Improve Product Quality and Consistency?
Brent Woodward, University of Minnesota

5:00 - 7:00 **RECEPTION** - Atrium

6:00 - 7:30 **TOUR - LIVING HISTORY FARMS**

FRIDAY, JUNE 3, 1994

7:00 - 5:00 P.M. **REGISTRATION**

ADAPTING BREEDING SYSTEMS FOR IMPROVED PRODUCT QUALITY AND CONSISTENCY
Des Moines Room
Don Boggs, Moderator

8:00 AM	**Beef Task Force Report - Establishing Industry Targets** Rich Shuler, Syntex Animal Health
8:30 AM	**Crossbreeding With A New Target** Don Kress, Montana State University
9:00	**Composites: An Alternative** Jim Gosey, University of Nebraska
9:30	**BREAK**
9:45	**Breed Roles in Hitting a New Target** Rick Bourdon, Colorado State University
10:15	**Questions, Answers and Panel Discussion**
11:00	**Annual Meeting & Caucus for New Directors** Des Moines Room - Marvin Nichols, Presiding
12:00	**LUNCHEON AND AWARDS** Emcee: Steve Radakovich - Benton Room
2:00 - 5:00	**COMMITTEES**

BIOTECHNOLOGY COMMITTEE
Clayton - Webster Rooms
Burke Healey, Chairman

Committee Priorities and Functions
Sue DeNise, University of Arizona
Daniel Pomp., Oklahoma State University
Richard Willham, Iowa State University

Open Discussion of Committee Responsibilities

Open Discussion of Need for Standing Sub-Committees

Other Business

CENTRAL TEST AND GROWTH COMMITTEE
Marion Room
Ronnie Silcox, Chairman

Beef Steer Feedout Programs
Robert Stewart, University of Georgia
Wayne Shearhart, Oklahoma Coop Extension Service
Joe Paschal, Texas Agricultural Extension Service

Range Bull Evaluation Versus Central Gain Test
Sally Northcutt, OBI, Oklahoma State University

Discussion on Revision of BIF Guidelines

LIVE ANIMAL AND CARCASS
EVALUATION COMMITTEE
Des Moines Room
John Crouch, Chairman

Iowa State University - BIF Ultrasound Certification Program: Progress Report
Gene Rouse, Iowa State University

Use of Real-Time Ultrasound in Determining Marbling - % FAT in Live Cattle
Doyle Wilson, Iowa State University

Standardization of Disposition Scoring
Kent Anderson, North American Limousin Foundation

Standardization of Body Condition Scoring
Sally Northcutt, Oklahoma State University

TOUR 5:15

IOWA STATE UNIVERSITY

COOKOUT, CARCASS VIEWING AND

IRRADIATION PLANT

SATURDAY, JUNE 4, 1994

6:00 AM **BOARD OF DIRECTOR'S MEETING**
Chambers Room

8:00 - 12:00 **PRODUCTION TOUR**

Douglas Center Stock Farm
Ralph & Joyce Neill, Corning, IA

Nichols Farms, Ltd.
Bridgewater, IA

1:00 - 5:30 **HERITAGE TOUR**

Amana Colonies
Amana, IA

TABLE OF CONTENTS

SYMPOSIUM: ADAPTING BREEDING SYSTEMS FOR IMPROVED PRODUCT QUALITY AND CONSISTENCY

INTEGRATED GENETIC SYSTEMS COMMITTEE
(John Hough - Chairman)

GENETIC PREDICTION COMMITTEE (Larry Cundiff - Chairman)

CENTRAL TEST AND GROWTH COMMITTEE
(Ronnie Silcox - Chairman)

Beef Steer Feedout Programs

LIVE ANIMAL AND CARCASS EVALUATION COMMITTEE
(John Crouch - Chairman)

GENE MAPPING, MARKER-ASSISTED SELECTION, QTLs- BOILING IT DOWN TO COWBOY LINGO

Sue DeNise, University of Arizona; and John Pollak, Cornell University

Molecular biology offers a new set of tools for understanding performance characteristics. We are still in the preliminary stages of understanding the scope of the new technology's impact on the beef industry, but there are already examples of how this new technology will affect the way in which animals are identified and selected.

Commercial companies can provide producers with parentage information from multiple sire breeding pastures and determine carriers of certain genetic diseases. Researchers from around the world are developing genetic linkage maps to learn more about areas of chromosomes that affect economic traits. As we learn more about the genes that underlie genetic variation, we will be able to produce animals that fit specific environments and markets. We may also be able to improve accuracy of selection for traits that are lowly heritable or difficult to measure on breeding stock.

Basic Genetic Principles

Selection for quantitatively inherited performance characteristics has always relied on the underlying principles of Mendelian genetics. Cattle have 30 pairs of chromosomes, the pair representing inheritance from sire and dam. A chromosome resembles beads on a string; the beads are molecules called nucleotides. There are only four nucleotides, and the uniqueness of the chromosome comes from the order of the nucleotides. When nucleotides are linked together with a sugar, the structure is called deoxyribonucleic acid or DNA.

Genes are groups of nucleotides located along the length of the chromosome, that "code" for a protein needed by an animal. Each chromosome probably contains tens of thousands of genes that may be grouped together or separated for long stretches by "garbage" DNA that does not have any meaning to the cell. Because each gene has two copies, one from each chromosome, the two copies of the genes can interact. Thus, when only one copy of the gene is sufficient to see an effect, then we say that a gene is "dominant" to another (like the dominant gene for black coat color). If two copies of the gene are necessary to see the effect, we say that a gene is "recessive" (like the gene that results in the horned phenotype).

Genes contain the pattern for making a protein. First the gene is "transcribed" into a template called messenger RNA (mRNA), then the mRNA moves into another region of the cell where it is "translated" into amino acids to become a protein. The order of every three nucleotides represents a new amino acid, the amino acids link together to become a protein. Proteins can be enzymes, hormones, or structures that are critical for the mechanics of the cell.

The underlying theory of traits that are quantitatively inherited, like milk production, growth rate, reproduction, carcass characteristics, is that many genes affect the outcome, each contributing to the overall phenotype. If a trait has a heritability of 40%, then 40% of the differences we see among animals is due to genes that can be passed from parent to progeny. We may be able to more accurately match cattle to their environment, the market requirements, or the management parameters that need to be met, if we could identify the *specific genes* that contribute to performance characteristics.

The Molecular Toolbox

DNA has several characteristics that we can use to identify unique genotypes. When DNA is heated, it unwinds or denatures. When cool, DNA likes to be attached (or annealed) to a complimentary piece of DNA. Since DNA is only constructed of 4 possible nucleotides arranged in a linear fashion, it is relatively easy to work with. We can use these characteristics of DNA to determine differences between genes.

Polymerase Chain Reaction (PCR) is one technique used to create billions of copies of a single gene. PCR reaction mixture contains a small amount of an animal's DNA to serve as a template, small pieces of DNA called primers to locate the specific gene under study, heat-stable polymerase (that joins nucleotides to make a complimentary copy of DNA), and free nucleotides. The reaction mixture is heated and the DNA denatures, as it cools the primers anneal to complimentary strands. Then the polymerase produces a complimentary copy of the DNA using the animal's DNA as a template. After each round of heating and cooling, you theoretically double the number of copies of the genes that you began the procedure; thus, one copy becomes two, two becomes four, four becomes eight, etc. After approximately 30 cycles, a billion copies of the gene are in the mixture.

The PCR reaction mixture allows visualization of the gene, but does not tell the difference between two genotypes without further analysis. One method used to determine the differences between genotypes is restriction-fragment length polymorphism (RFLP) technique. Hundreds of restriction enzymes have been discovered in bacteria. These enzymes are produced by bacteria to defend against invading pathogens by digesting foreign DNA at very specific locations. These enzymes usually recognize a 4 to 8 base sequence of nucleotides and only cut the DNA when this sequence exists. We can use these enzymes to cut amplified DNA at the recognition sequence from a mutation. For example, bovine leucocyte adhesion deficiency (BLAD), a genetic disease found in Holstein cattle, is determined by using a restriction enzyme called Taq I that recognizes the sequence TCGA. Every location on a chromosome that has the TCGA sequence will be cleaved between the T and C. Normal animals have this sequence and the DNA is cut into two smaller pieces, while homozygous animals have a different sequence at this site and the DNA is not restricted. Carrier animals have one large piece of DNA (deleterious gene) and two small pieces (normal gene). Thus we can determine the difference in genotypes when an electrical field is pulsed through a gelatinous material used to separate DNA. Larger pieces of DNA do not migrate as far as smaller pieces of DNA. Thus it is relatively easy to determine the differences in genotype.

Can We Use this Technology now?

There are several way in which we can use the technology today. For example, we could determine the parents of individuals in a multi-sire breeding system using DNA from the bulls and their progeny. To take it a step further, you could also identify sires of commercial calves that have unacceptable meat characteristics if given the appropriate starting information. The meat industry may be interested in identifying the original location of an animal infected with E. Coli 0157H7. Molecular tools could be used in two ways: first the offending E. Coli could be identified using PCR (amplify the genes that produce a toxin), then with the appropriate starting parameters, DNA analysis could help trace the animal back to its origins. The infection could then be eradicated at the source.

Some genes with major effects could be incorporated into selection programs now. DNA level markers of genes for sex-determination and several genetic diseases have already been developed. Other examples such as the genes coding for horned vs. polled, black vs. red coat color, and muscle hypertrophy are obvious candidates for future studies. For deleterious genes, such as genetic diseases, the primary selection criteria might be on carrier genotypes.

Bovine Leukocyte Adhesion Deficiency (BLAD) is a severe combined immunodeficiency disease found in Holstein cattle. Calves that are homozygous for the gene die at young ages from normally nonlife-threatening bacterial infections because they lack a functional MAC-1 protein necessary for leukocytes to penetrate the walls of blood vessels and travel to the site of infection. When the top A.I. bulls in the country were tested with the polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) procedure, 15% of the top bulls were carriers with an estimated incidence of the disease of 1/200 calves born homozygous (Marc Kerhli, private communication). The National Association of Animal Breeders (NAAB) and the Holstein Association implemented control programs for BLAD: identification of carriers, pedigree identification of animals tested for BLAD, and elimination of BLAD carriers from progeny testing programs. They proposed that the gene should be eliminated in virtually one generation. It is difficult to estimate how the frequency of the BLAD gene has changed, since not all animals are tested. In our laboratory, we have been testing animals with suspect pedigrees for a single bull stud and the incidence dropped from 10% carriers (N=68) in 1992 to 4% carriers in the last half of 1993 (n=69).

The Genetic Map.

Several genetic maps have been reported in the last year providing about 1000 markers (Barendse et al., 1994, and Bishop et al., 1994). Genetic maps pinpoint the location of a gene on a chromosome in relation to other genes. The closer two genes are to each other, the more likely they are to be inherited together, so it is important to know their interrelationship. We measure the distance between DNA sequences in centimorgans (cm). A centimorgan is equivalent to 1% recombination (1 time in 100 the two DNA sequences on the same chromosome are not inherited together). The cattle genome is comprised of approximately 3000 cm, or about 3 billion bases. The genetic maps give directions of where we are in an animal's genotype and provide hints on genes that may be important in production.

What Does the Future Hold?

Research is being conducted all over the world to identify the genes that contribute to performance traits. It has been estimated that the bovine genome contains 50,000 to 100,000 genes. The protein products from most of those genes have not been identified as yet; thus, we have little information about the actual structure of genes affecting traits of economic importance. Researchers are developing genetic maps that will be the key to specific genes that contribute to genetic variation. We will be able to use genetic markers on the linkage maps to locate sections of chromosomes that contribute to quantitative traits (quantitative trait loci, QTL), and as an aid in selection (marker-assisted selection, MAS).

We understand so little about actual genes that we are going to rely on the properties of DNA to help pinpoint locations on chromosomes that are important for production. DNA is linear, thus, chunks of DNA are inherited together. Geneticists say that two genes are "linked" if they are close together because they always seem be inherited together. We can use DNA markers that are linked to important genes or QTL to tell us whether a gene has been passed on to progeny. To find QTL, families must be developed in which markers linked to QTL can be followed through generations. An example of this type of study was reported by Andersson et al. (1994) in swine using crosses between European wild boar and Large White sows. In the second generation of crossing, they were able to identify markers from the purebreds that were important for production traits. They reported that QTL for growth from birth to 70 kg, average backfat depth and percentage fat appear on chromosome 4 and growth from birth to 30 kg has associations with genes on chromosome 13.

After chromosomal locations have been identified that contribute to performance characteristics, the goal is to find the actual gene causing the effect. At that point the gene could be selected for throughout the population. Different breeds may have an entirely different set of important genes.

Implications to Seedstock and Commercial Cattle Producers

Any time new technology is made available to the livestock industries, the question is raised about how the information that is generated will impact the current mode of operation for cattle producers? Quite often we get caught up in the complexities of new technology and lose sight of the simplicity of its application. In reality, the potential information available from DNA analysis will not greatly alter how cattle producers approach their selection programs but may have a tremendous impact on the amount of information available to them.

Let's examine how genetic improvement programs currently operate. Information obtained on animals and their relatives is used to calculate EPDs for several but not all important beef characteristics. Each EPD is reported with an associated accuracy, which reflects the amount of information available for that animal. The EPDs provide cattle producers with a description of the genetic potential of prospective parents.However, EPDs are not the only source of information used in selection decisions. For example, in the Simmental breed, Mendelian characteristics, such as coat color and polled versus horned, are considered in some selection programs. Other traits such as soundness or reproductive ability are considered even though EPDs are not available for them. Commercial cattle producers using crossbreeding have the added decision of what breeds to include in their program and make this decision based on important breed characteristics. Given the current programs, where will the new technology play a role?

If one considers the new technology of DNA analysis as a source of new information, its role in selection programs and its impact on current modes of operation for cattle producers are easy to deduce. First, improved parent identification is possible. A small fraction of blood analyses lead to inconclusive results regarding parentage. The large number of discriminating loci available through DNA analysis allows for far greater accuracy in parent identification. Estimated progeny differences are based in part on relatives' information, hence,the value of better identification to EPD programs is obvious. Second, if the DNA analysis leads to the identification of a particularly useful gene (or marker), then options to select for that gene exist. Selection could be directly for the gene, or that information could be included in the estimation of the EPD if the locus influences a trait for which EPDs are computed. One could envision, for example, information on a bull's genotype for the gene (or marker) presented along with its EPDs in the sire summary. Selection for the gene would then be exactly like that for color or polledness now. The difference between knowing the location of the gene or knowing a marker for the gene is in the accuracy of selecting for the gene. If the gene location is known, the accuracy of selecting for it is one. If it is marked,the accuracy of selecting for the gene is influenced by the recombination frequency. The probability of getting the desired gene from marker selection could be provided to producers much the same way as accuracy is provided when selecting for EPDs. Regardless of whether the new information is used in EPD calculations or supplied through the animal's genotype, producers would continue to select as they now do considering the new information available. They would select either on the EPDs calculated using the information on the gene or on the genotype directly. In some instances, for example, selecting for black coat color, time-consuming progeny tests for homozygosity can be avoided.

The greatest potential impact of DNA analysis is in supplying information on traits for which EPDs 1) are not available, 2) become available late in an animal's life, or 3)are difficult to obtain information on. Examples of the above situations include the following: 1) carcass data are limited due to difficulty in obtaining information, 2) EPDs for reproductive traits not available, and 3) accurate evaluations for maternal ability of bulls' daughters require time for those daughters to have progeny themselves. Supplying genotype information on QTLs or markers would allow for enhanced selection programs for these traits, and producers would chose appropriate animals based on this Mendelian information.

The economics of genetic programs will surely be impacted by the new technologies. The laboratory analysis of DNA will carry with it an expense. Not all animals will need to have DNA analysis, especially commercial cows. The greatest value will be analyzing the DNA of potential sires and bull dams. In this context, seedstock producers will find themselves involved in some aspect of DNA analysis. Artificial insemination organizations will surely use the technology.

Literature Cited

Andersson, L. C.S. Haley, H. Ellegren, S.A. Knott, M. Johansson, K. Andersson, L Andersson-Eklund, I. Edfors-Lilja, M. Fredholm, I. Hansson, J. Hakansson and K. Lundstrom. 1994. Genetic mapping of quantitative trait loci for growth and fatness in pigs. Science 263:1771.

Barendse, W., S.M. Armitage, L.M. Kossarek, A. Shalom, B.W. Kirkpatrick, A.M. Ryan, D. Clayton, L. Li, H.L. Neibergs, N. Zhang, W.M. Grosse, J. Weiss, P. Creighton, F. McCarthy, M. Ron, A.J. Teale, R. Fries, R.A. McGraw, S.S. Moore, M. Georges, M. Soller, J.E. Womack and D.J.S. Hetzel. 1994. A genetic linkage map of the bovine genome. Nature Genet. 6:227.

Bishop, M.D., S.M. Kappes, J.W. Keele, R.T. Stone, S.L.F. Funden, G.A. Hawkins, S.S. Toldo, R. Fries, M.D. Grosz, J. Yoo and C.W. Beattie. 1994. A genetic linkage map for cattle. Genet. 136:619.

QUANTITATIVE GENETICS AND CORN BREEDING

Arnel R. Hallauer
Department of Agronomy
Iowa State University
Ames, IA 50011

Dramatic changes have occurred during the past 70 years in the breeding and selection methods used for the genetic improvement of corn. Corn is a cross-pollinated crop species that originated in the Western Hemisphere, and corn became a very important crop species to sustain the early colonists of North America. With the westward migration of settlers into the areas west of the Allegheny Mountains during the 19th century, corn assumed greater importance as a feed for livestock. The settlers brought strains of corn with them, and the intercrossing of Northern Flints and Southern Dents led to the eventual development of the present-day U.S. Corn Belt dents. The U.S. Corn Belt dent race is recognized as one of the most productive races of corn in the world.

Corn became an important farm commodity throughout the north-central area designated as the U.S. Corn Belt. Adequate, dependable supplies of corn were needed for the livestock industry, and farmers and seedsmen practiced selection within their fields of corn to provide seed supplies for the following year. Selection method was mass selection procedures; i.e., selection was based on the phenotype of the individual plants and ears. Selection was effective to develop strains of corn that were different for kernel color and type, plant stature, prolificacy, and maturity. But the average U.S. corn yields exceeded 30 bushels per acre in only two years from 1865 to 1935. Although selection methods were effective in developing different strains of corn (e.g., Reid Yellow Dent, Lancaster Sure Crop, Leaming, Midland, Boone County White, Bloody Butcher, etc.), they were not effective for increasing grain production.

Two significant developments occurred in the first two decades of the 20th century that were to have profound effects on the future of corn production in the United States: 1) the concepts of Shull (1909) and Jones (1918) for the development of double-cross hybrids; and 2) the change in emphasis of the types of research conducted by the state agriculture experiment stations (SAES) and the U. S. Department of Agriculture (USDA). There was a desire to increase corn productivity, and it was obvious the breeding and selection methods used previously were not effective. The concepts presented by Shull (1909) and Jones (1918) seemed to have possibilities for increasing corn productivity, and, starting in 1922, a concentrated effort was made by the SAESs and by the USDA to thoroughly test the concept of hybrid corn. The cooperative USDA-SAES program at Iowa State University also was initiated in 1922.

The testing and implementing of the concept of double-cross hybrid corn was successful. It required time to develop lines and identify superior hybrids, but by 1935 seed of double-cross hybrids was available to interested growers. By 1950, nearly 100% of the corn acreage in the U.S. Corn Belt was planted to double-cross hybrids. The impact of hybrids on corn production has been obvious. Whereas average U.S. corn production from 1865 to 1935 was 30 bu/acre or less, U.S. corn yields have averaged 32.7 (1945), 40.6 (1955), 74.1 (1965), 86.4 (1975), 118.0 (1985), 132.0 (1992) bu/acre. It has been estimated that 60% of the improved grain yields was due to genetic improvement of the hybrids.

Successful implementation of the hybrid concept of corn led to the development of a successful and competitive seed industry. Proprietary inbred lines and hybrids were developed, produced, and sold to the corn growers by the private seed industry. Although the SAES and USDA corn breeders were instrumental in developing breeding methods and hybrids, it was obvious by 1960, that the SAESs and USDA corn breeding programs could not, and should not, compete with private seed corn companies. Because there was some evidence that the yield levels of the double-cross hybrids had plateaued in the 1950s, more research was needed to understand the genetic basis of heterosis, inheritance of complex traits, types of genetic variability within corn populations, more effective and efficient selection methods to identify superior inbred lines, and genetic improvement of corn germplasm. Although the primary research objectives between present-day commercial and public (SAES and USDA) corn breeding programs are not always clear and distinctive, the commercial breeding programs emphasize inbred line development whereas SAES and USDA corn breeding programs emphasize fundamental studies for genetic improvement of corn.

Most economically important traits of corn have a complex inheritance, and these traits are frequently referred to either as quantitative or as polygenic traits. Traits that are inherited in a quantitative manner infers that trait expression is determined by a large, unknown number of genes, each gene having a small effect on total trait expression, and the expression of each gene depends on the environment in which it is measured. An understanding of the inheritance of quantitative traits is essential in developing efficient and effective breeding and selection methods. Since 1950, the main focus of the cooperative Iowa State University-USDA corn breeding research program has been to gain a better understanding of the inheritance of quantitative traits and how the information can be used for genetic improvement of germplasm and developing more efficient and effective selection and breeding methods. Based on resources available to conduct the research, nearly 85 to 90% of our efforts have been allocated to these fundamental studies.

The application of the information obtained from the fundamental studies to the genetic improvement of germplasm are interrelated and ongoing. Germplasm is the critical component of any breeding program: breeders having superior germplasm will be more successful than those breeders having inferior germplasm. Hence, breeding programs that improve germplasm in a systematic manner will realize systematic genetic improvement of their lines and hybrids. Selection methods conducted recurrently within corn germplasm sources are designed to increase the frequency of alleles that contribute to the improvement of a trait (e.g., increase grain yield) and maintain genetic variability by intermating superior individuals or progenies. Effectiveness of selection depends on the types of genetic effects important in the inheritance of traits under selection. Studies conducted within corn populations have shown that the genetic variance due to the additive effects was 2 to 4 times greater than variance due to dominant deviations in all corn populations, except Iowa Stiff Stalk Synthetic (BSSS) where the variances due to additive effects and deviations due to dominant effects were nearly equal. Attempts to quantify the epistatic effects within corn populations have not been successful. Recurrent selection methods, including mass selection, that emphasize selection for additive genetic and dominant effects should be successful. Selection studies conducted during the past 50 years have shown genetic gains of 2 to 4% for intrapopulation (half-sib, full-sib, inbred, and mass) and 5 to 6% for interpopulation (half-sib and full-sib) selection. It has been demonstrated that recurrent selection procedures genetically enhance corn germplasm, and should, therefore, provide improved germplasm sources for applied breeding programs. Unfortunately, the subdivision of research emphasized by the privately and publicly supported corn research programs also is subdivided by selection methods for germplasm improvement (public) and selection methods for line and hybrid development (private). The benefits of germplasm improvement are maximized only if germplasm improvement is integrated with line and hybrid development.

The corn breeding program at Iowa State University emphasizes research related to germplasm (85 to 90%), but lines are released to private breeders that are "spin-offs" from the germplasm enhancement research. The integration of germplasm enhancement (85 to 90%) with line development (10 to 15%) ensures systematic genetic advance; i.e., genetically superior lines are developed from the genetically improved germplasm. Integration of the two aspects of selection has been successful in the Iowa program. Improved sources of germplasm are released for use by the privately and the publicly supported breeding programs. Inbred lines from the improved sources of germplasm also are released for use either as germplasm in line development programs or as parent seed stocks to produce hybrids.

Systematic genetic enhancement of germplasm is an imperative if continued genetic advance of hybrids is to be realized in the future. Genetic enhancement of germplasm has long-term goals and is not attractive to breeding programs with short-term goals. In order to give credibility to the goals of germplasm enhancement, the Iowa State University corn breeding program continues to conduct a limited breeding program for line development to demonstrate the potential of germplasm enhancement. Inbred lines B14, B37, B57, B64, B68, B73, B79, B84, B94, B97, etc. have been released from the Iowa corn breeding program and the lines have made significant contributions to the commercial hybrids available to the growers. The contributions of the lines have been both direct (e.g., B14, B37, B73, B79, B84, B94, B97, and B98) and indirect (A632, A634, H84, H93, NC256, and Va95). The lines with the "B" prefix were developed from germplasm enhancement programs; i.e., the superior lines that were intermated to form the next cycle population were included in the breeding nurseries for further inbreeding, selection, and testing and are a direct contribution of the germplasm enhancement programs. Indirect contributions are equally impressive. Presently, there are 118 recycled (or second cycle) lines for B73, 80 for B14, 31 for B37, and 21 from other BSSS lines that are used to produce hybrid seed corn. The number of second cycle BSSS lines includes only those from SAES, USDA, and foundation seed companies corn breeding programs and does not include the unknown number of proprietary second cycle lines.

It has been estimated that lines from the Iowa program are involved in the parentage of 40 to 45% of all the hybrid seed corn produced in the United States. Iowa Stiff Stalk Synthetic (BSSS) is considered one of the main germplasm sources representative of the important heterotic groups for the U.S. Corn Belt. Individual lines from BSSS have been used extensively to produce hybrid seed for sale to the growers. In 1964, B14 was one parent for 8.2% of all the U.S. hybrid seed corn produced for sale to growers. Similarly, B14 (8.6%) and B37 (25.7%) were one parent for 34.3% of the U.S. hybrid seed corn produced in 1970. In 1979, B73 was the seed parent for 16.31% of hybrid seed corn produced in the United States for sale in 1980. Lines that were either directly (20.62%) or were indirectly (14.64%) derived from BSSS germplasm were included in 35.26% of the hybrid seed corn produced for sale in 1980, which, if planted and harvested by growers, would have a market value of $1.4 billion for Iowa and $8.4 billion nationally; these figures are only for one year.

The commercial hybrid seed corn industry is a very competitive business. Because of competition, short-term breeding goals (i.e., line development) are emphasized by private breeders. Because publicly supported corn breeding programs do not compete for sales, research emphasizes fundamental studies of corn populations, which, by their nature, have long-term goals. This subdivision of research effort between privately and publicly supported corn breeding programs seems appropriate, but it also has been shown that the separate goals of the respective breeding programs (private vs. public) are not mutually exclusive. The maximum benefits of the long- and short-term breeding goals will only be attained if they are integrated with each other. It seems publicly supported breeding programs will continue to release materials that are either directly or indirectly used by the privately supported breeding programs. Or, the alternative is for the privately supported breeding programs to initiate germplasm enhancement programs that supplement their short-term breeding goals of inbred line development.

WHAT CAN BE LEARNED FROM OUR COMPETING INDUSTRIES? LESSONS FROM THE PIG INDUSTRY.

Max F. Rothschild
U.S. Pig Genome Coordinator
Department of Animal Science
Iowa State University
Ames, IA 50011

Introduction

The animal industries are in the business of producing meat, milk and fiber. As is often the case, many of the problems and difficulties that face one animal industry also affect the other animal species. Likewise, solutions for one are also useful for the others. Developments in the swine industry in the areas of gene mapping and gene identification offer new possibilities to discover marker genes and offer new genetic solutions for old problems. Some of our experiences may be of value to those in the beef industry doing similar research.

Why Swine?

President Harry Truman's statement comes to mind when I feel the need to justify what can be learned from the pig industry. He said "See those hogs? No man should be allowed to be president (or anything else) who doesn't understand hogs or hasn't been around a manure pile". My only hope when I finish is that you don't believe this is that pile of manure.

Four areas of the pig industry come to mind which may be informative to the beef cattle industry. These areas are production, products, marketing and research. I will discuss briefly the first three but concentrate on the genetic research primarily dealing with gene identification and gene mapping.

Genetic Production Trends

The swine industry has changed greatly over the past 20-30 years. Pigs are now considerably leaner and more meaty. In fact, pork is 31% leaner than 10 years ago. Pigs are increasingly raised in larger-sized units by people whose business is swine production, not corn raising or cattle feeding. Genetics have always been important but are increasingly so and packers are demanding, in many cases, that producers tighten up on the genetics of their herds. Crossbreeding, a popular tool in swine production, is more sophisticated with larger producers using crosses of company produced synthetic lines. Often these lines and crosses are tailored for level of facilities and management ability. Producers are using A.I. and receiving genetic advice more than ever in the past. These so called customized genetic plans are designed to produce a more uniform, leaner, and cost efficient product. These changes in the production genetics of the swine industry serve as good examples for the cattle industry.

The increasing role of genetics has led to greater control of market share by some corporate swine breeding companies. These companies are interested in new genetic developments and positioned to implement and pay for some of the research developments.

Improved Pork Products and Quality

Breeders and geneticists have worked hard to reduce fat in their product. Today a great deal of emphasis is being placed on muscle and meat quality. Industry groups have marketed new products such as the America's Cut and other recognizable products. The NPPC (National Pork Producers Council) has led a major effort to increase producer awareness of product quality and safety. Packers, breeders and allied companies are emphasizing both food quality and safety. They are also supportive of new molecular genetics research, especially that which will improve muscle and meat quality.

Marketing

The pork industry has led the way in demonstrating the value of new advertising. The use of the "Other White Meat ® brand" approach was remarkable in how it changed opinions. Pork producers have also looked carefully at consumer preference studies. They have invoked a quality assurance program and increased export demand. All of their programs can only work if the product being sold is of high quality and competitively priced.

Research

Investment is the key to any industry. Pork producers have invested in new products, marketing and increasing exports. They have also made a major investment in research. Producer investments in research have helped to set the direction of government funded agricultural research. Genetics is central to much of the research.

According to the annual report from the National Pork Producers Council, approximately 16% of the Pork Checkoff budget is directed toward research and education. While this includes program overhead, extramural funding at universities is sizable. How does this compare to what the NCA spends in research? The NPPC research falls into the general areas of "discovery" and "targeted" research. Discovery research covers many disciplines and is directed towards finding new knowledge which may pay dividends in the future. Targeted research is directed at specific areas. In recent years these areas have often been genetic and environment issues. Where does the cattle industry stand on increased money for research?

This is a future beef cattle genetics symposium. What can be learned from the swine gene mapping and gene identification research that will be valuable for the beef industry? In swine, the oldest and perhaps the most successful gene mapping effort was by the European project called PiGMaP. It now involves 21 labs in 17 countries. While primarily in Europe, labs in the U.S. and Australia are included. Working in a truly collaborative fashion they produced the first swine gene linkage map and now the one with the most functional genes on it. I have heard from some of the cattle gene mappers that they have to compete against those in Europe and Australia. That is a false concept. We gain more from international partners than we do by trying to out compete them. Our real competitors are those that produce cheap lean meat. Other areas of collaboration exist in gene mapping. As the U.S. Genome Coordinator I have produced nearly 125 microsatellite markers, which cover the entire pig genome. These are available free of charge. The costs of the microsatellites were born by the coordination effort. To date seven out of eleven labs in the U.S. have requested them, as have a couple of the swine breeding companies. Some breeding companies, the National Association of Swine Records (purebreds) and the NPPC helped pay for this. The cattle industry could help pay for a similar effort in cattle gene mapping. DNA from reference/resource families is available. Both the PiGMaP and ISU family DNA is available to any interested researcher. Cattle geneticists are working in this area also. We are also trying to foster less competition by sharing ideas in a computer discussion group and newsletter.

Another area that is beginning to bear fruit is the investigation of candidate genes. In pigs the best known is the HAL gene which causes stress susceptibility in pigs. Also, quantitative trait loci (QTL) have been discovered for growth in the pig. These QTL are on chromosome 4 in the pig and affect fat level and growth rate. More recently, it was announced that the Estrogen Receptor (ESR) gene appears to have a significant effect on litter size. The beneficial allele amounts to a 1.5 pig increase in litter size. The lesson that can be learned from this research is that traits thought to be controlled by many genes may be affected by one or a very few genes. It is likely that other genes will be found. Molecular genetic research may find such genes but someone must pay for the research. For the ESR gene research, two private companies, BRDC and PIC, paid for the research and will benefit most from it. Candidate genes for muscle and growth traits are being investigated in swine and also in cattle. More work in these areas should be considered. Identification of disease resistance genes and genes controlling immune response has also occurred in pigs. Resistance to certain forms of diarrhea and improved general resistance has been demonstrated. What could be done to discover similar genes in cattle? This research must involve collaboration between geneticists, veterinarians, statisticians and cattle producers.

Summary

For the cattle industry to remain competitive it must produce and market a product people want. They will need to support research at a greater level. Basic, high risk research should play a larger role. Targeted genetic research which could have a high impact on the cattle industry should be supported. Collaboration with international and domestic partners should be encouraged. Sharing of resources, including genetic markers, and materials from reference and resource families is a must. Companies and universities need to work together. Communication should be open and ideas shared. Competition between labs and individuals should be discouraged.

APPLICATION OF BIOTECHNOLOGY IN THE POULTRY BREEDING INDUSTRY

Susan J. Lamont, Department of Animal Science
Iowa State University, Ames, Iowa 50011

Summary

This paper reviews the application of biotechnology in the poultry breeding industry and speculates on future trends. Unique features of the poultry breeding industry, areas of biotechnology investigation, means of conducting research and transferring information are discussed.

Unique Features of the Poultry Breeding Industry

To put the remainder of this paper into perspective for an audience which is primarily involved in beef improvement, it is necessary to define some essential, unique features of the poultry breeding industry. In this context, then, those factors and strategies which may be generally applicable to animal improvement can be identified by the readers for further consideration and those which are specific to poultry can be dismissed as anomalous curiosities.

The hallmark of the poultry industry is integration. The genetics of virtually all commercial chickens (both egg-type and meat-type or broilers) and turkeys produced in the industrial world are determined by a handful of major, primary poultry breeding companies. Small teams of highly trained (Ph.D.-level) geneticists are in charge of the genetics programs. The genetics development and testing programs are supported by sophisticated data gathering and processing systems, as well as extensive animal performance testing facilities. Most of these companies possess large international markets. Many are owned by pharmaceutical companies. This relationship has the double-edged sword of a parent company which perhaps lacks an understanding of animal genetics, but has a good appreciation of the potential value of expensive, high-risk, long-term research. The latter orientation is a definite benefit in biotechnology research and development.

The concept of pure breeds is important to poultry hobbyists, but is of minor relevance to commercial poultry. Although the breeds which contributed to the foundations of commercial types are known, the emphasis in the poultry industry is on performance. Most commercial birds (turkeys, broilers or egg-layers) are 3-way or 4-way line crosses. In contrast to large livestock species, multiple generations in the pedigree level of a genetic program are less usual and more emphasis is placed upon genetic progress through short generation intervals. The multiplier effect in the poultry industry is enormous. As an example, any genetic decisions made about one single pedigree-level sire may be expected to be transmitted in four generations to about 28 million broilers yielding over 80 million pounds of meat!

Areas of Biotechnology Investigation

The two major themes in biotechnology for poultry genetic improvement are: genetic analysis and gene transfer. The new tools and techniques available in biotechnology allow molecular genetic studies to actually analyze the DNA responsible for trait inheritance as well as linked markers which may be of value in selection programs. Marker-assisted selection can be conducted using markers which are candidate genes for regulating economic traits. But "anonymous" DNA sequences of unknown function can also serve as effective markers if they are closely linked to the quantitative trait loci.

Because of the expense of identifying, validating, and applying DNA markers in marker-assisted selection programs, their application must be carefully evaluated for "value-added" content. The question is not "How big is the marker effect?" but rather "For what testing does this marker now substitute, or what previously unattainable information becomes available?" These criteria focus the interest on traits in four areas:

1) Health (especially resistance to infectious disease)
2) Sex-limited traits
3) Late-expressed or difficult-to-measure traits
4) Traits which are negatively correlated

For health traits, DNA markers may substitute for the undesirable method of direct challenge with pathogens to determine genetic resistance. The advantages of being able to evaluate genetic potential for egg (or milk) production in sires is obvious. Genetic enhancement via MAS for late-expressed (such as persistency of reproduction) or difficult-to-measure (such as carcass composition) traits will improve speed and accuracy. Desirable traits which are negatively correlated at the whole animal level, because of linkage of genes controlling each separate trait, may be able to be individually identified by markers. This opens the possibility to individually select traits and break existing undesirable correlations in the population.

Analysis at the DNA level may also be used to gain a general picture of an individual's or a population's total genome without regard to any specific trait. This "fingerprinting" can be done by using any of several types of probes or primers which recognize sequences that occur in multiple locations throughout the genome, in either Southern blot or polymerase chain reaction (PCR) technology. Besides using these fingerprints to search for markers linked to economic traits, the genetic relatedness of individuals or populations can be estimated. This can be useful in selecting crosses to maximize heterosis. Fingerprints can also be used to maximize retention of a desirable background genome when introgressing specific genes from other lines. This reduces the number of backcross generations needed to restore the desirable background genome.

Once desirable genes are identified and cloned, methods of transfer are the next limiting step. The poultry industry faces the obstacle that single ova are not readily amenable to the usual gene transfer methods that utilize microinjection. They "explode" after insertion of the injection needle! Two methods of gene transfer have met with some success at the research level: retroviral vectors and primordial germ cells. Viral vectors are constructed to contain the genes of interest in a virus which will enter the cell and transfer its own genetic material, as well as the gene of interest, into early embryonic cells. Optimally, some of the infected cells which integrate the gene of interest develop into gametes which are then passed to the progeny in heterozygous form. A second approach involves the isolation of primordial germ cells from early-stage embryos. The genes are microinjected into the germ cells which are then inserted into other embryos in which they migrate to the gonads. If successful, some of the progeny then bear the inserted gene.

Gamete preservation in poultry lags behind that of mammalian species. Fertility rates with stored semen are low and variable. Techniques for embryo freezing are not generally successful.

Conduct of Industry - Supported Research

The conduct of specific research projects to meet the needs of a particular poultry breeding company takes place via one or more of the following ways. Some companies have integrated biotechnology into their programs to the extent that they have in-house biotech departments to address their research and development needs. Some companies support research projects at appropriate university locations. These joint projects run the full range from completely public to totally proprietary in nature. There are also poultry biotechnology companies which perform custom projects for poultry breeding companies. Obviously, many of the research data generated in projects which receive industry support do not come into the public domain. Projects supported by universities, federal research institutions and through competitive granting agencies also generate information of value for application of biotechnology to the poultry breeding industry.

Coordination of Research and Information Transfer

Poultry industry geneticists receive annual updates on advances in genetics by attending two specific events in addition to the usual species-oriented general scientific meeting. The Poultry Breeders of America organizes the National Breeders Roundtable which features speakers on topics of relevance to genetic improvement. Industry geneticists are also allowed to attend the technical sessions of some relevant regional research meetings such as NC-168 "Advanced Technologies for the Genetic Improvement of Poultry" and the National Animal Genome Technical Committee. In these venues, public sector scientists also receive advise from industry personnel regarding appropriate priorities for research to benefit the industry.

Future Directions

Ewart (1993) describes four major driving forces in poultry genetic improvement from the 1960's into the future:

1) Cost
2) Quality
3) Versatility
4) Ethics

Cost always has been and will continue to be the factor of greatest relative importance. Quality of product has increased as a driving force of genetic change, but may decrease slightly in relative importance in the future. Product versatility was a minor factor in the 1960's, but continues a steady, gradual increase in importance. Ethics, incorporating health and welfare, was a minor driving force in poultry genetics decision-making in the past but Ewart projects that the importance of ethics will equal that of cost in the future. These visions of future consumer and producer demands may help prioritize traits for genetic improvement.

Relevant References

Ewart, J. 1993. Evolution of genetic selection techniques and their application in the next decade. British Poultry Science 34:3-10.

Hartmann, W. 1992. Evaluation of the potentials of new scientific developments for commercial poultry breeding. World's Poultry Science Association 48:17-27.

NATIONAL INITIATIVES TO ENHANCE THE SAFETY, QUALITY, CONSISTENCY AND COMPETITIVENESS OF BEEF[1,2]

Harlan D. Ritchie
Department of Animal Science
Michigan State University
East Lansing, MI 48824

Introduction

This paper deals primarily with issues relating to the end-product of the beef industry. While this author feels strongly that the industry has for too long placed too little emphasis on the importance of the end-product, I also believe that we cannot afford to set aside those factors that are known to be the cornerstones of profitability for the cow-calf sector; namely, reproductive efficiency, early growth, and production costs. In today's industry, optimization of these factors within a given production environment is still the key to remaining competitive and sustainable. Obviously, as the industry moves ever closer to true value-based marketing, the end-product must take on greater importance.

Background

Since 1989, four national initiatives have been supported by three of the beef industry's major organizations: the National Cattlemen's Association (NCA), the Cattlemen's Beef Board (CBB) and the Beef Industry Council (BIC). These initiatives were designed to enhance the quality, consistency, and competitiveness of beef. The initiatives are: 1) Beef Quality/Safety Assurance, 2) National Beef Quality Audit, 3) Strategic Alliances Field Study, and 4) National Beef Tenderness Plan.

On the surface, these initiatives may have the appearance of being separate and uncoordinated programs. In reality, however, they have been developed in an orderly fashion, resulting in four closely related and coordinated projects.

During the mid-1980's, the industry's Beef Safety Task Force developed a beef quality/safety assurance program, which was staffed by NCA in 1989. The principles of Total Quality Management (TQM) have served as the driving force behind this initiative. To date, a total of 43 states have established quality assurance programs and others are in the process of developing programs.

---

[1]Presented at Beef Improvement Federation Annual Conference, June 1-4, 1994, Des Moines, IA.

[2]Appreciation is expressed to Dr. Gary C. Smith, Colorado State University, for his generous assistance in preparing this paper.

In August, 1990, the beef industry's Value-Based Marketing Task Force (Cross, 1990) submitted its final report, declaring a "War on Fat" and adopting the following industry goal: "To make beef more competitive, thereby increasing demand." To help accomplish this goal, the Task Force identified the following primary objective: "To improve production efficiency by reducing excess trimmable fat by 20% and increasing lean production by 6%, both by 1995, while maintaining the eating qualities of beef."

In February, 1991, Dr. Chuck Lambert, NCA's Director of Economics, presented an invited paper to the International Stockmen's School, entitled "Lost Opportunities in Beef Production" (Lambert, 1991). This paper along with the Value-Based Marketing Task Force report were forerunners of the National Beef Quality Audit which was conducted in the summer and fall of 1991 (Smith et al., 1992). The goal of the audit was "to conduct a quality audit of slaughter cattle for the U.S. beef industry in 1991, establishing guidelines for present quality shortfalls and identifying targets for desired quality levels by the year 2001." The rationale for the audit was the theory, advanced by noted economist W. Edwards Deming, that an industry cannot manage its quality problems until it can measure them.

The Quality Audit was followed by the Strategic Alliances Field Study, which was conducted from November, 1992 to June, 1993 (Lambert, 1993). The objective of Strategic Alliances was to determine how many costs of known non-conformities identified in the Quality Audit could be reduced or eliminated.

The National Beef Tenderness Plan (Lambert, 1994) was motivated by the need to address the Beef Industry Long Range Plan Task Force goal of "reducing consumer dissatisfaction with beef quality (i.e., primarily toughness) by 50% by 1997" (CBB, 1993). It was also stimulated by results of previous research which had shown that tenderness is the single most important component of eating satisfaction of beef (Savell et al., 1987; Savell et al., 1991) and that the incidence of toughness in the U.S. beef supply is unacceptably high (Morgan et al., 1991).

The objective of this paper is to provide a summary of the three most recent initiatives: National Beef Quality Audit, Strategies Alliances Field Study, and the National Beef Tenderness Plan.

National Beef Quality Audit

The Quality Audit consisted of three phases: 1) face-to-face interviews with 11 purveyors, 11 restaurateurs, 10 retailers, and 7 packers; 2) audit of 28 packing plants, representing 70% of the nation's federally inspected slaughter; and 3) a strategy workshop involving 43 industry experts who prioritized concerns, assigned a dollar value to quality defects, and identified strategies for improvement.

Face-to-Face Interviews

The top ten concerns of the seven packers and a composite of the top ten concerns of purveyors, restaurateurs and retailers are presented in Table 1.

Table 1. Top ten concerns about beef

Packers		Purveyors, Restaurateurs, Retailers	
1.	Hide problems (brands, etc.)	1.	Excessive external fat
2.	Injection site blemishes	2.	Injection site blemishes
3.	Excessive carcass weights	3.	Too large ribeyes & excessive boxed beef wts.
4.	Bruise damage	4.	Excessive seam fat
5.	Reduced quality from implants	5.	Low overall uniformity
6.	Liver condemnations	6.	Low overall cutability
7.	Insufficient U.S. Choice	7.	Dark cutters
8.	Overfat carcasses (YG4's & 5's)	8.	Low overall palatability
9.	Low overall uniformity	9.	Bruise damage
10.	Dark cutters	10.	Insufficient marbling

When one compares these two lists of concerns, it is little wonder that cattlemen have been confused about what's important and what's not important in beef production. For example, the institutions that purchase beef from packers and sell it to consumers were highly concerned about excessive fat (1st and 4th concerns). In contrast, packers ranked fat relatively low (8th). However, a recent NCA survey (Lambert, 1994) indicates that this situation is changing. During the first quarter of 1994, production of close-trimmed (quarter-inch or less) boxed beef was 34% of total boxed beef production, up 6% from the fourth-quarter of 1993. It is predicted that 80% of all boxed beef sold will be close-trimmed by the end of 1996. Until recently, packers traditionally supplied boxed beef with up to 1 inch of external fat. Consequently, they were relatively unconcerned about excess trimmable fat. Now it is clear that the demand for close-trimmed product by the retail sector is increasing at a rapid pace. This will likely lead to increased pressure on the live cattle sector to supply cattle having the genetic ability to produce leaner, higher cutability carcasses.

Packing Plant Audits

Table 2 compares means for carcass traits between 1991 Quality Audit cattle and those in a similar study conducted in 1974.

Table 2. U.S. beef cooler audits, 1991 vs. 1974

Item	Year 1991	Year 1974
Carcass weight, lb	759	679
Fat thickness, in	.59	.58
Ribeye area, sq in	12.9	11.8
KHP fat	2.2	3.0
USDA yield grade	3.2	3.4
Marbling score	Small$^-$	Small$^+$

Compared to 1974, there was an 80-lb increase in average carcass weight, no change in fat thickness, a 1.1 square inch increase in ribeye area, a small improvement in yield grade, and a decline in marbling. On balance, the most significant change has occurred in carcass weight. Approximately 2/3 of the 1991 carcasses fell within the range of 625 to 825 lb, which was the range targeted as being ideal by participants in the strategy workshop.

Table 3 compares today's mix of quality grades with an "ideal" mix as determined by workshop participants.

Table 3. Carcass quality grades, 1991 vs. "ideal" mix

Quality grade	1991 Quality audit	"Ideal" mix
Prime	2.3	7.0
Avg. & High Choice	17.1	24.0
Low Choice	35.6	40.0
Select	36.9	29.0
Standard & hard-boned	8.0	0.0

As shown in Table 3, the "ideal" mix would have 71% of U.S. beef carcasses grading Low Choice or higher. This compares to an actual figure of 55% for today's mix.

Strategy Workshop

After studying all of the information gathered in the face-to-face interviews and the packing plant audits, strategy workshop participants compiled a final top twelve list of concerns:

1. Excessive external fat
2. Excessive seam fat
3. Low overall palatability
4. Inadequate tenderness
5. Low overall cutability
6. Insufficient marbling
7. Too frequent hide problems
8. Too high incidence of injection site blemishes
9. Excessive boxed beef weights
10. Excessive live and carcass weights
11. Inadequate understanding of the value of close-trimmed beef
12. Too large ribeyes

The next step was to assign a dollar value to all quality defects identified in the packing house audits. These values are presented in Table 4.

Table 4. Value of defects identified in packing plant audits

Defect	Loss/head, $
Excess external fat	$111.99
Excess seam fat	$ 62.94
Beef trimmed to 20% fat	$ 14.85
Deficient muscling	$ 29.47
SUBTOTAL, "WASTE"	**$219.25**
Palatability	$ 2.89
Marbling	$ 21.68
Maturity	$ 3.80
Gender	$ 0.44
SUBTOTAL, "TASTE"	**$ 28.81**
Hide defects	$ 16.84
Carcass pathology	$ 1.35
Liver pathology	$ 0.56
Tongue infection	$ 0.35
Injection sites	$ 1.74
Bruises	$ 1.00
Dark cutters	$ 5.00
Grubs, blood splash, calloused ribeyes, yellow fat, etc.	$ 0.38
SUBTOTAL, "MANAGEMENT"	**$ 27.26**
Carcass weight (625-825 lb)	$ 4.50
SUBTOTAL, "WEIGHT"	**$ 4.50**
GRAND TOTAL, ALL DEFECTS	**$279.82**

As shown in Table 4, defects in the "waste" category alone accounted for $220 (78%) of the $280 total loss per head. The "taste", "management" and "weight" categories accounted for 10, 10, and 2% of the total, respectively. Based on these results, workshop participants agreed on four specific industry objectives: 1) attack waste, 2) enhance taste, 3) improve management, and 4) control weight. The final step was to identify strategies for improving the quality, consistency and competitiveness of beef. They were as follows:

1. Encourage quarter-inch as the commodity fat-trim specification
2. Change live: carcass price logic to red meat yield with quarter-inch fat
3. Keep the heat on cutability
4. Go after management practices that create nonconformity
5. Eliminate biological types of cattle (not breeds, per se) that fail to conform
6. Institute value-based marketing
7. Identify outlier values for traits
8. Conduct strategic alliance field studies
9. Repeat the National Beef Quality Audit periodically
10. Use the National Beef Carcass Data Collection Service to make progress

As a final note, the following targets for carcass traits evolved from the 1991 Quality Audit.

• Carcass weight:	
Acceptable range	625-825 lb
Ideal weight	735-750 lb
• Ribeye area	11-15 sq in
• Maximum fat thickness	0.4 in
• % grading Low Choice or higher	71
• % grading Select	29
• % grading Standard	none

Strategic Alliances Field Study

A primary objective of the Strategic Alliances Field Study (SAFS) was to determine whether forming partnerships between industry segments and making every attempt to "do things right" could reduce losses from defects identified in the 1991 Quality Audit.

In developing this national demonstration project, the designers arranged for an equal 3-way partnership between the cow-calf producer, a feedyard (Decatur County Feed Yard, Oberlin, KS), and a packer (Excel Corp., Wichita, KS). The feedyard and the packer each purchased one-third interest in the calves of each of 15 participating cow-calf producers at weaning time. Prices paid were based on actual cash prices during the second week of November, 1992. In order for producers to participate, it was required that they have a herd size of 500 cows or more so that they could readily supply a load of 80-85 head of steer calves representing a "middle cut" of the calf crop.

At weaning time, SAFS calves were processed on the ranch, preconditioned for 35 to 45 days, and shipped to the feedyard during a period ranging from November 10 to December 9, 1992. Interestingly, the winter to follow was one of the most severe in Kansas cattle feeding history. A total of 1253 SAFS calves were consigned to the project. Each producer's calves were fed in a separate feedyard pen. Seven pens were Continental x British crossbreds while eight pens were British and British crossbreds.

Compared to 35 pens of "ranch-fresh" bawling calves and 14 pens of "put-together" calves, the 15 pens of SAFS calves experienced a somewhat lower death loss (1.20% for SAFS calves versus 1.81% and 2.95% for ranch-fresh and put-together calves, respectively). Treatment costs were also considerably lower, averaging $1.92, $6.29, and $4.95 for SAFS, ranch-fresh, and put-together calves, respectively.

SAFS calves were slaughtered when a pen reached an average fat cover of 0.4 inch based upon ultrasound and visual appraisal. A range of 0.3 to 0.5 inch was considered acceptable. Targeted carcass weight range was 625 to 825 lb. The 15 SAFS pens were sold over a 7-week period from April 15 to June 8, 1993. A participating retailer (Safeway, Inc.) did not assume direct ownership of the cattle but contracted with the 3-way partnerships for delivery of quarter-inch trim boxed beef. Returns to the partnership were based on the sale of the close-trim boxed beef to Safeway plus hide value and other credits minus a flat fee paid to Excel for slaughter and fabrication.

Table 5 is a summary of feedyard performance for the 15 SAFS pens of steers.

Table 5. Ranges in pen averages, feedyard performance of SAFS steers

Item	Range in pen average	Overall average
Starting wt, lb	535 to 659	600
Days on feed	133 to 204	166
Death loss, %	0.0 to 2.5	1.2
DM/gain, lb/lb	5.64 to 7.22	6.20
Final pay wt, lb	993 to 1,218	1,097
Avg. da. gain, lb	2.57 to 3.38	2.92
Cost of gain (incl. int.), $/cwt	45.97 to 59.94	50.98
Net profit, $/head	10.71 to 140.96	76.84

As indicated in Table 5, there were relatively wide ranges in pen averages. As part of the study, the SAFS team evaluated ten different factors to establish which best determined profitability. This analysis revealed that the best indicator of profit for the cattle in this study -- cattle targeted for 0.4 inch fat thickness -- was total gain in the feedyard. A further analysis of the data suggested that for all calves to have maximized their profit potential, the 15 pens probably should have been divided into three different management groups according to the following scheme.

- The five pens that reached the 0.4 inch fat target with the least amount of gain (450 lb or less) would have benefitted by being put into a stocker-grower program before being placed on a finishing program. These calves were earlier-maturing, smaller-framed cattle that carried more condition when delivered to the feedyard.

- The five pens in the middle (450 to 550 lb gain at 0.4 inch fat) had more flexibility. If cost of forage is low relative to grain, they could go into a stocker-grower program. If cost of grain is low relative to forage, they could go directly to a finishing yard.

- The five highest gaining pens (over 550 lb gain at 0.4 inch fat) benefitted by going directly to a finishing yard. If they had gone into a stocker-grower program prior to finishing, they would have been too heavy at slaughter.

The preceding analysis provides a good example of the importance of assessing the genetics of cattle in order to adjust management and maximize profits.

Table 6 is a summary of carcass traits for the 15 SAFS pens of steers.

Table 6. Ranges in pen averages, carcass traits of SAFS steers

Item	Range in pen averages	Overall avg.
Carcass wt, lb	613 to 787	694
Dressing percent	61.7 to 64.6	63.4
Fat thickness, in	0.31 to 0.51	0.41
Ribeye area, sq in	9.89 to 13.16	11.26
Yield grade	3.40 to 2.32	2.96
% Choice and higher	31 to 82	51.0
% Select	22 to 87	46.5
% Standard	0 to 10.5	2.5

As was the case with feedyard performance, SAFA steers exhibited relatively wide ranges in pen averages for carcass traits. Nevertheless, all but one pen met the target range for carcass weight (625 to 825 lb). Eleven of the 15 pens averaged at or near the targeted endpoint of 0.4 inch external fat. Six of the 15 pens met the minimum Quality Audit standard of 11.0 sq in for ribeye area. Three of the 15 pens met the "ideal" Quality Audit standard of 71% Choice grade.

All carcasses were subjected to an evaluation of palatability. There were some significant differences among breedtypes/grades, as shown in Table 7.

Table 7. Palatability among breedtypes/quality grades of SAFS steers

	Sensory panel rating			Shear
Breedtype x quality grade	Flavor	Tenderness	Overall palatability	force (lb)
British Choice	4.58^{a}	5.07^{a}	4.73^{a}	6.89^{a}
British Select	4.57^{a}	5.17^{a}	4.76^{a}	7.68^{bc}
Continental Choice	4.46^{ab}	5.11^{a}	4.67^{ab}	7.45^{b}
Continental Select	4.31^{b}	4.85^{b}	$4{,}51^{b}$	8.04^{c}

[abc]Means within a column lacking a common superscript letter differ significantly (P<.05).

In general, British Choice, British Select, and Continental Choice had improved palatability over Continental Select cattle.

Table 8 presents a comparison of the losses due to defects between SAFS cattle and those evaluated in the 1991 National Beef Quality Audit (NBQA).

Table 8. Comparison of quality defects, SAFS vs. 1991 NBQA cattle

	Loss per head, $	
Defect	SAFS	NBQA
"Waste" defects	$188.00	$219.25
"Taste" defects	$ 28.88	$ 28.81
"Management" defects	$ 18.60	$ 27.26
"Weight" defects	$ 0.84	$ 4.50
TOTAL	**$236.32**	**$279.82**

As shown in Table 8, there were important reductions in "waste", "management" and "weight" defects in SAFS cattle relative to 1991 NBQA cattle. "Taste" defects were essentially equal. Overall, SAFS cattle showed a reduction of $43.50 per head in losses due to quality defects.

To summarize the Strategies Alliances Field Study, it would appear that the following points could be made.

- Value-based marketing can reward/discount cattle relative to their true market value
- Existing genetics and carcass composition can be managed to meet quarter-inch trim specifications
- It is possible to reduce carcass non-conformities
- Strategic alliances and sharing of information has the potential to enhance profitability and product quality
- Genetic variation has the potential for improving the quality and consistency of beef

National Beef Tenderness Plan

Sixty-eight beef industry leaders -- meat scientists, geneticists, nutritionists, seedstock breeders, cow-calf producers, feeders, beef processors, and beef industry executives -- met in Denver, CO on April 22-23, 1994, to attend the National Beef Tenderness Conference. The objective of the conference was to construct a plan to address the industry's tenderness issue. The following sections represent an attempt to summarize the strategies reviewed at the conference that have potential for improving beef tenderness.

Short-term Strategies -- Live Animals

- Achieve a proper balance between tenderness, cutability and environmental adaptability. Use adapted pure breeds or use crossbreeding programs that optimize percentage of British, Continental and *Bos indicus* breeding.
- Castrate at a relatively young age.
- Use growth promotant implants properly.
- Slaughter prior to 30 months of age (before reaching "B" maturity).
- Identify and eliminate sires whose progeny produce tough beef and/or grade U.S. Standard.

Short-Term Strategies -- Postmortem

- Improve and standardize in-plant procedures for electrical stimulation of carcasses.
- Standardize Warner-Bratzler shear force procedures and establish a maximum shear force value when selecting seedstock for acceptable tenderness.
- Standardize carcass chilling procedures to minimize cold-toughening.
- Establish a standard for minimum aging time.
- After conducting market research, if it is determined that consumer perception is favorable, consider calcium chloride treatment, at the processor or purveyor level, for cuts anticipated to have a tenderness problem.
- Use needle (blade) tenderization for cuts anticipated to have a tenderness problem and that are sold at retail as well as at food-service (HRI)
- Discourage cutting of steaks from tougher cuts traditionally used as roasts.
- Encourage rapid cookery of steaks to reduce cooking loss and improve tenderness.
- Educate food-service patrons and consumers on the effect of degree of doneness on tenderness.
- Establish the economic value of improving consistency of tenderness at the retail level.
- Adapt shear force measurements for on-line carcass tenderness classification.

Longer-Term Strategies

- Intensify the search for a rapid test of tenderness in live animals.
- Continue to study methods of evaluating tenderness in the carcass.
- Evaluate breeds and breeding systems, searching for cattle that offer extraordinary combinations of tenderness and leanness, and of tenderness and environmental adaptability.
- Attempt to identify DNA markers that will account for a significant amount of variation in tenderness.
- Continue to develop a comprehensive bovine genome map.
- Encourage progeny testing of sires to identify those that are superior, as well as inferior, in tenderness as well as those which produce progeny that grade U.S. Standard.

A final task of conference participants was to develop specific recommendations that could address the Beef Industry Long Range Plan Task Force goal of reducing consumer dissatisfaction with beef palatability by 50% by 1997. Following are eleven recommendations that received consensus approval by those in attendance.

1. Establish and test a series of PACCP (Palatability Assurance Critical Control Points) models for beef tenderness variability.
2. Establish the value of improved tenderness and reduced variation in tenderness at retail.
3. Incorporate tenderness variation reduction values into the existing CARDS program.
4. Establish and implement educational programs for all production segments in the use of existing technology and management in reducing tenderness variation.
5. Encourage the commercialization of calcium and sodium salt solution injections as a solution to reducing tenderness variation in selected cuts and quality grades.
6. Encourage the development of a rapid test for tenderness in carcasses.
7. Continue and accelerate efforts to find new predictors of genetic potential for tenderness in live cattle.
8. Encourage breed associations to collect progeny data relating to carcass traits and palatability.
9. As technology becomes available, encourage producers to use it to select against toughness.
10. Standardize Warner-Bratzler shear force measurement protocols.
11. Once Warner-Bratzler shear force measurement protocols are standardized and the Customer Satisfaction Study is complete, establish minimum threshold standards for beef tenderness.

By the time these proceedings are published, a National Beef Tenderness Plan will have been presented at the National Cattlemen's Association Midyear Conference.

Summary

In summary, I wish to leave the BIF membership with two recent quotes that have implications for our industry.

- "We are the only industry in the world who can sell an inconsistent product that is loaded with waste fat" (Miguel Achaval, Vice President, Cactus Feeders)

- "The food seller who consistently delivers value for dollars spent, who consistently furnishes food that is safe and reliable with nourishment that sustains health and provides satisfaction and pleasure when consumed, will always find a ready market." (Jean Kinsey, Food Marketing Specialist, University of Minnesota).

Literature Cited

CBB. 1993. Beef Industry Long Range Plan Task Force Report. Cattlemen's Beef Board Winter Meeting, December 10, 1993, Phoenix, AZ.

Cross, H.R. 1990. The war on fat! Final Report of the Value-Based Marketing Task Force. National Cattlemen's Association, Beef Industry Council and Cattlemen's Beef Board.

Lambert, C. 1991. Lost opportunities in beef production. International Stockmen's School, February 14, 1991, Houston, TX.

Lambert, C. 1994. Full Report, National Beef Tenderness Conference, April 22-23, 1994, Denver, CO.

Lambert, C. 1994. Close-trimmed boxed beef demand up. National Cattlemen's Association. Beef Business Bulletin. Vol. 17, No. 34.

Lambert, T. 1993. Executive Summary, Strategic Alliances Field Study. National Cattlemen's Association, Colorado State University, Fort Collins and Texas A & M University, College Station.

Morgan, J.B., J.W. Savell, D.S. Hale, R.K. Miller, D.B. Griffin, H.R. Cross and S.D. Shackelford. 1991. National beef tenderness survey. J. Anim. Sci. 69:3274.

Savell, J.W., R.E. Branson, H.R. Cross, D.M. Stifler, J.W. Wise, D.B. Griffin and G.C. Smith, 1987. National consumer retail beef study: Palatability evaluations of beef loin steaks that differed in marbling. J. Food Sci. 52:517.

Savell, J.W., J.J. Harris, H.R. Cross, D.S. Hale and L. Beasley, 1991. National beef market basket survey. J. Anim. Sci. 69:2883.

Smith, G.C., J.W. Savell, R.P. Clayton, T.G. Field, D.B. Griffin, D.S. Hale, M.F. Miller, T.H. Montgomery, J.B. Morgan, J.D. Tatum and J.W. Wise. 1992. The Final Report of the National Beef Quality Audit -- 1991. Colorado State University, Fort Collins and Texas A & M University, College Station.

BEEF TENDERNESS: REGULATION AND PREDICTION

M. Koohmaraie, T. L. Wheeler, S. D. Shackelford, and M. Bishop

USDA-ARS U. S. Meat Animal Research Center, Clay Center, NE 68933

Introduction

Consumers consider tenderness to be the single most important component of meat quality. This fact is easily confirmed by the positive relationship between the price of a cut of meat and its relative tenderness (Savell and Shackelford, 1992). Unfortunately, inconsistency in meat tenderness has been identified as one of the major problems facing the beef industry (Morgan et al., 1991; Morgan, 1992; Smith, 1992; Savell and Shackelford, 1992). Uniformity, excessive fatness, and inadequate tenderness/palatability were all part of the top 10 quality concerns of the beef industry (Smith, 1992). A recent survey reported that consumers were dissatisfied with the eating quality of beef prepared at home more than 20% of the time (Miller, 1992). One supermarket chain that asks customers to return any meat they are not satisfied with got $364,000 worth of meat returned in a three year period, 78% of which was due to tenderness problems (Morgan, 1992). The real magnitude of the tenderness problem is realized by considering the fact that only .1% of unhappy customers actually complain or return the product (Wilkes, 1992). This happens despite the technology that has been developed to improve the consistency of meat tenderness (e.g., postmortem aging, mechanical tenderization, electrical stimulation, and addition of plant enzymes).

The beef industry relies on the USDA quality grading system to segment carcasses into groups based on varying levels of expected meat palatability. However, the results of numerous investigations of the relationship between marbling and beef palatability indicate that, although there is a positive relationship between marbling degree and tenderness, juiciness, and flavor, this relationship is weak at best (reviewed by Parrish, 1974). There are far too many carcasses with tender meat that are discounted and far too many with tough meat that are not discounted under the current USDA Quality Grade system (Wheeler et. al., 1994; Figure 1). Thus, the inconsistency in meat tenderness is due to a combination of our inability to: 1) routinely produce tender meat and 2) identify carcasses producing tough meat. In addition, as the beef industry moves toward leaner slaughter animals, the resulting genetic and management modifications could cause additional tenderness problems. It is sobering to recognize that the only time the tenderness of meat is known is when the meat is eaten by the consumer, and if the meat is tough, then it is too late. Because consumers consider

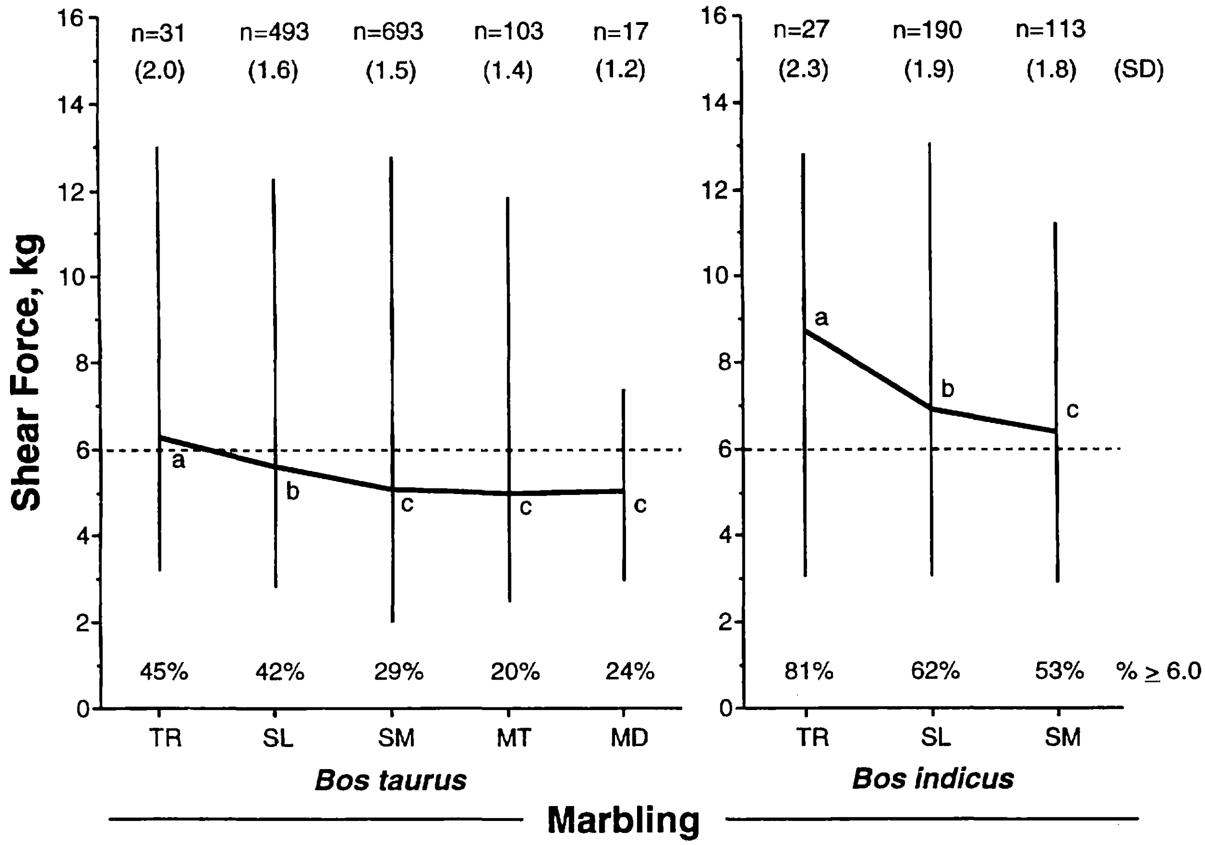


Figure 1. Warner-Bratzler shear force by breed-type and marbling score. The thickest line connects the means for each marbling score. The vertical lines show the range in shear force for each marbling score. The numbers at the top are the number of animals with each marbling score. The numbers in parenthesis are standard deviations adjusted for year effects for each marbling score. The percentages at the bottom represent the percentage of animals with shear force of greater than or equal to 6.0 kg. Means without a common superscript, within breed-type, differ ($P < .05$; Adapted from Wheeler et al., 1994).

tenderness to be the major determinant of eating quality of meat, it is essential to develop methodologies to objectively predict meat tenderness as a supplement to USDA Quality Grade prior to its marketing/consumption. The objective of this manuscript is to summarize our research results and plans relating to regulation and prediction of aged beef tenderness.

What are the Causes of Tenderness Variation?

To reduce variation in tenderness of aged beef, one must understand the causes of it. If the causes of variation are identified, then it may be possible to manipulate the process advantageously. Therefore, it is imperative to determine the biological factors regulating meat tenderness. Over the years a number of parameters, including amount and solubility of connective tissue, and amount of intramuscular fat (marbling), have been associated with meat tenderness. Utilizing the data collected from the Germplasm Evaluation project (GPE), Crouse and coworkers (unpublished data) determined that connective tissue and marbling combined only accounted for 20% of the observed variation in meat tenderness (Figure 2). Therefore, we could not account for 80% of the variation in meat tenderness. In 1984, a project was initiated at the MARC to determine factors regulating

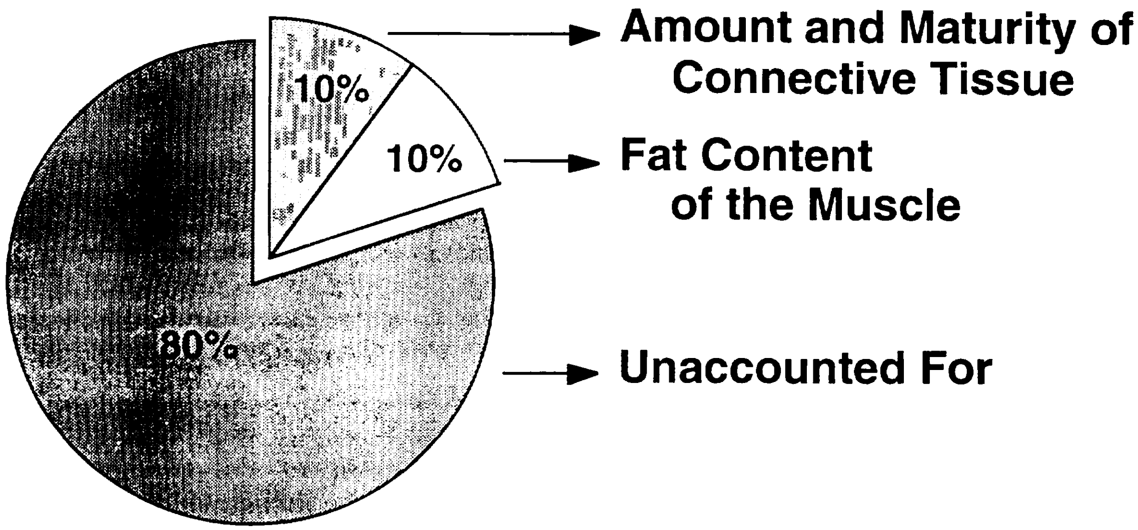


Figure 2. Factors accounting for variation in tenderness of aged beef (Adapted from Crouse et al. (unpublished data)).

tenderness of aged beef. A graphic illustration of the results is reported in Figures 3 and 4 (For review see Koohmaraie 1988, 1992ab, 1994a; Koohmaraie et al., 1994). Based on these results, we hypothesized that differences in the rate and extent of postmortem tenderization were responsible for variation in the tenderness of aged beef. Hence, it was decided that progress toward identifying factors regulating meat tenderness was dependent upon understanding how meat tenderizes during postmortem aging.

The phenomenon of the improvement in meat tenderness with postmortem storage were first described over a century ago. For many decades, meat scientists from throughout the world have conducted research to identify the mechanism(s) of improvement in meat tenderization with postmortem storage. Collectively, these results indicate that there are small, but significant, changes

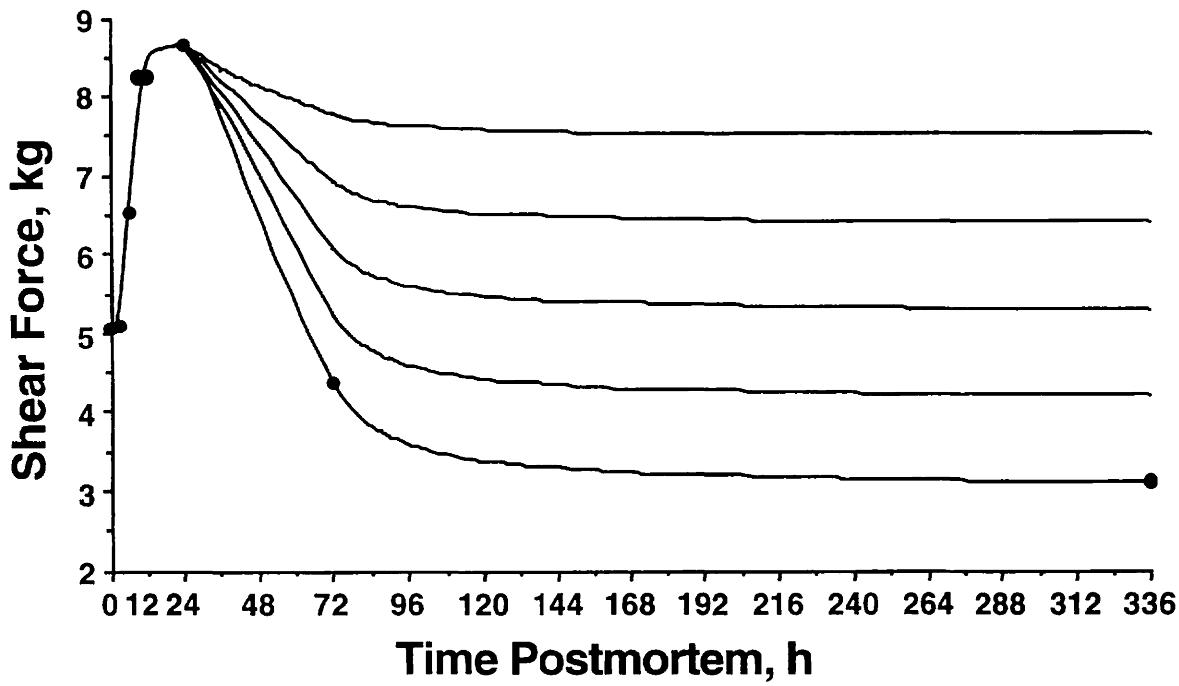


Figure 3. Effect of postmortem storage at refrigerated temperatures on shear force. The bottom curve depicts mean values. The other curves represent the variation that can occur in the extent of postmortem tenderization of meat from individual animals.

that occur in the muscle that result in tenderization. The following are known about meat tenderization during postmortem aging:

1) Tenderization occurs because of degradation of a few structural proteins by endogenous enzymes (this process is called postmortem proteolysis and is the reason for aging meat). These proteins are responsible for maintaining the structural integrity of the muscle.

2) Differences in the rate and extent of postmortem proteolysis is the major source of variation in the tenderness of aged beef (Figures 3 and 4).

3) Current data suggest that of all the proteolytic systems endogenous to skeletal muscle, the only enzyme system involved in meat tenderization is the calpain (calcium-dependent) proteolytic system.

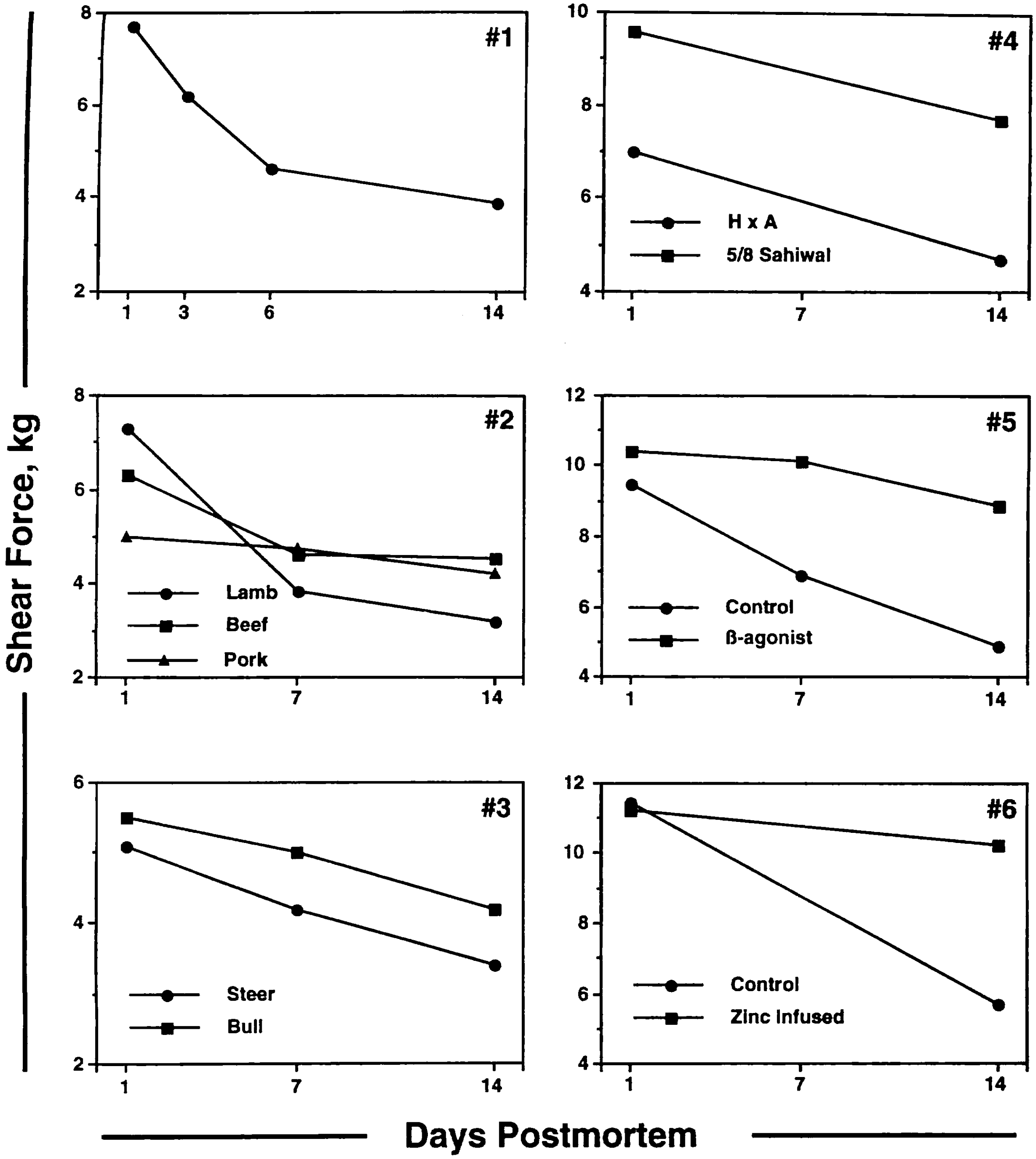


Figure 4. Effect of postmortem storage at refrigerated temperatures in beef (#1), different species (#2), bulls and steers (#3), *Bos taurus* and *Bos indicus* (#4), lambs fed ß-adrenergic agonist, L644,969 (#5), and control and lamb carcasses infused with zinc chloride.

4) The calpain system has three components: a low-calcium-requiring enzyme (μ-calpain), a high-calcium-requiring enzyme (m-calpain), and an inhibitor, (calpastatin), which specifically inhibits the activity of the calpains. Calpains have an absolute dependency on calcium for activity.

5) Postmortem tenderization occurs fastest in pork followed by lamb and then beef (Figure 4, Item #2).

6) Although most beef responds to postmortem storage (i.e., tenderization) the rate and extent of tenderization varies such that some beef does not benefit from extended postmortem storage.

7) To improve the consistency of meat quality with respect to tenderness, if at all possible, beef should be aged at least 14 days, lamb 10 days, and pork 5 days.

Based on our knowledge of the mechanism of postmortem tenderization, we have developed a process that ensures meat tenderness (for review see Koohmaraie et al., 1993). Calpains require calcium for activity. But conditions in postmortem muscle are not always optimum for calcium to be available to activate calpains. But exogenous calcium can be added to meat, thus, activating calpains and inducing more rapid and extensive tenderization. The process, known as Calcium-Activated Tenderization (CAT), consists of injecting cuts of meat (either pre-rigor or post-rigor) with 5% (by weight) of a 2.2% solution of food-grade calcium chloride. The process is more effective in prerigor (the first 3 hours after slaughter) meat, but can be used up to 14 days postmortem. It will not effect meat that is already tender, thus, it will not make tender meat "mushy". At the recommended levels of calcium chloride, the process has little effect on other meat quality traits. The process is effective in all cuts of meat regardless of species, breed or sex-class. The process is also effective in cuts of meat expected to be unusually tough. These include meat from sheep and cattle fed ß-agonist, old cows, Brahman cattle, and rounds muscles from bulls. It has been tested under commercial conditions in a large beef processing facility.

Restaurant and supermarket consumer evaluation studies (1001 participants) have indicated that consumers prefer calcium-injected beef over non-injected control beef due to improved tenderness with no change in flavor desirability or juiciness. Consumer perception of calcium-injected meat should not be a concern. Supermarket shoppers given the option of selecting steaks labeled "tenderness and juiciness enhanced with the addition of up to 5% of a solution of water and calcium chloride" or control steaks with the same label without the above statement chose the calcium added steaks 85% of the time. Fresh pork and chicken products are routinely injected with various ingredients to improve tenderness, juiciness and flavor. The CAT process has enormous potential to help the beef industry in its effort to reduce variation in beef tenderness. We continue to work closely with interested parties to help them implement this process. Meanwhile, we continue to seek a long-term solution to tenderness variation problems by looking for ways to produce tender meat and identify tough meat.

Direct Methods of Predicting Beef Tenderness

1. **Shear force-Based Classification of Beef.** We have determined that the tenderness of beef longissimus muscle at 1 day postmortem is strongly related (r = .75) to tenderness of longissimus muscle at 14 days postmortem (i.e., if a carcass is tough initially, it will be tough after aging). Over the course of the last several years, we have collected day-1 shear values on 268 steer carcasses. Analysis of these data indicated that we can accurately segregate cattle into expected aged longissimus muscle tenderness groups (day-14 shear force < 6.00 kg vs day-14 shear force ≥ 6.00 kg). The success rate of this procedure was 85% which was much higher than the present quality grading system (60%). This procedure allows for the creation of a tenderness grade which contains 100% tender beef. In contrast, 20% of upper Choice carcasses (Modest and Moderate marbling scores) are relatively tough.

Shear force could be used to segregate carcasses into any number of expected tenderness groups. But if the industry were to use a tenderness-based classification system, we suggest a system that includes three tenderness grades (Figure 5). The highest grade would consist of carcasses that are already acceptably tender before aging. These carcasses, which had a mean day-14 shear value of 4.1 kg, could be identified as "Guaranteed Tender" and would be appropriate for the HRI trade. The middle grade would consist of carcasses that are not tender before aging but that will probably be tender after aging. These carcasses, which had a mean day-14 shear value of 5.1 kg, could be identified as "Probably Tender" and would be appropriate for the retail trade. The lowest grade would consist of carcasses that are extremely tough before aging and that will probably still be tough even after extensive aging. These carcasses, which had a mean day-14 shear value of 7.2 kg, could be identified as "Probably Tough" and would require tenderization before marketing.

Because day-1 shear is a much better predictor of aged longissimus shear force than any visual, physical, or chemical measurement heretofore examined, we believe that day-1 shear force could be used as a tenderness grading criterion. Thus, we have outlined an automated system for measuring shear force at 1 day postmortem at commercial beef processing speeds (Figure 6). This automation would require some changes to the current shear force measurement protocol and, thus, a series of experiments would have to be conducted to determine if accuracy is lost with automation. This procedure would decrease the value of a portion of the product and would be much more expensive than the present quality

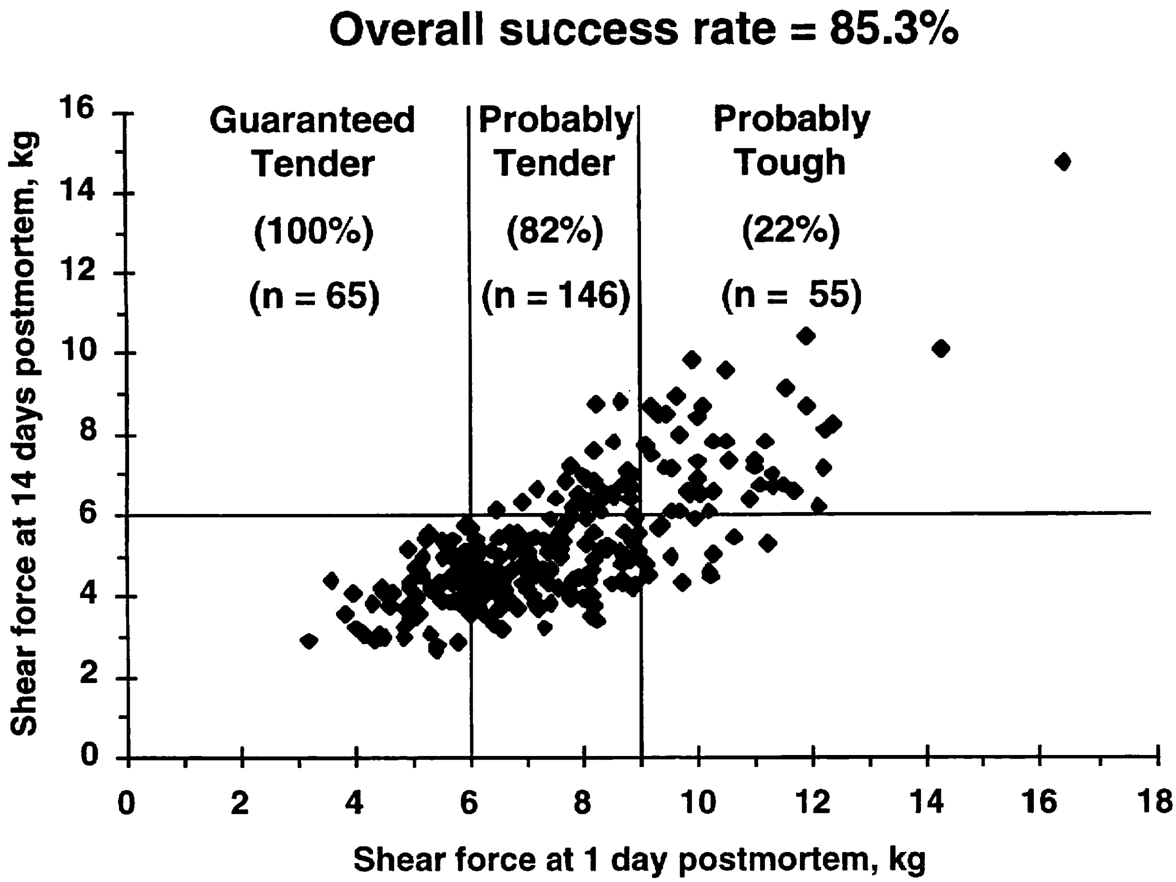


Figure 5. Relationship of tenderness at one day postmortem to tenderness at fourteen days postmortem.

grading system. Based on a rough cost estimate this procedure would require a $9/cwt increase in the price of ribeye and striploin to recoup reduced value on a portion of the product.

Indirect Methods of Predicting Beef Tenderness

1. Predicting Beef Tenderness with Carcass Traits. After studying sources of variation in tenderness of youthful, grain-fed beef (the majority of block beef in the United States), we, and others, have found that marbling will account for at most 15% of the variation in aged beef tenderness. Other carcass traits, proposed to be related to beef tenderness such as skeletal and lean maturity, fat thickness, carcass weight, and lean color, texture, and firmness, are even more weakly related to aged beef tenderness. Concomitantly, our data indicate live animal performance traits such as slaughter weight, weight per day of age, average daily gain, and time-on-feed will not account for a significant portion of the variation in aged beef tenderness. The

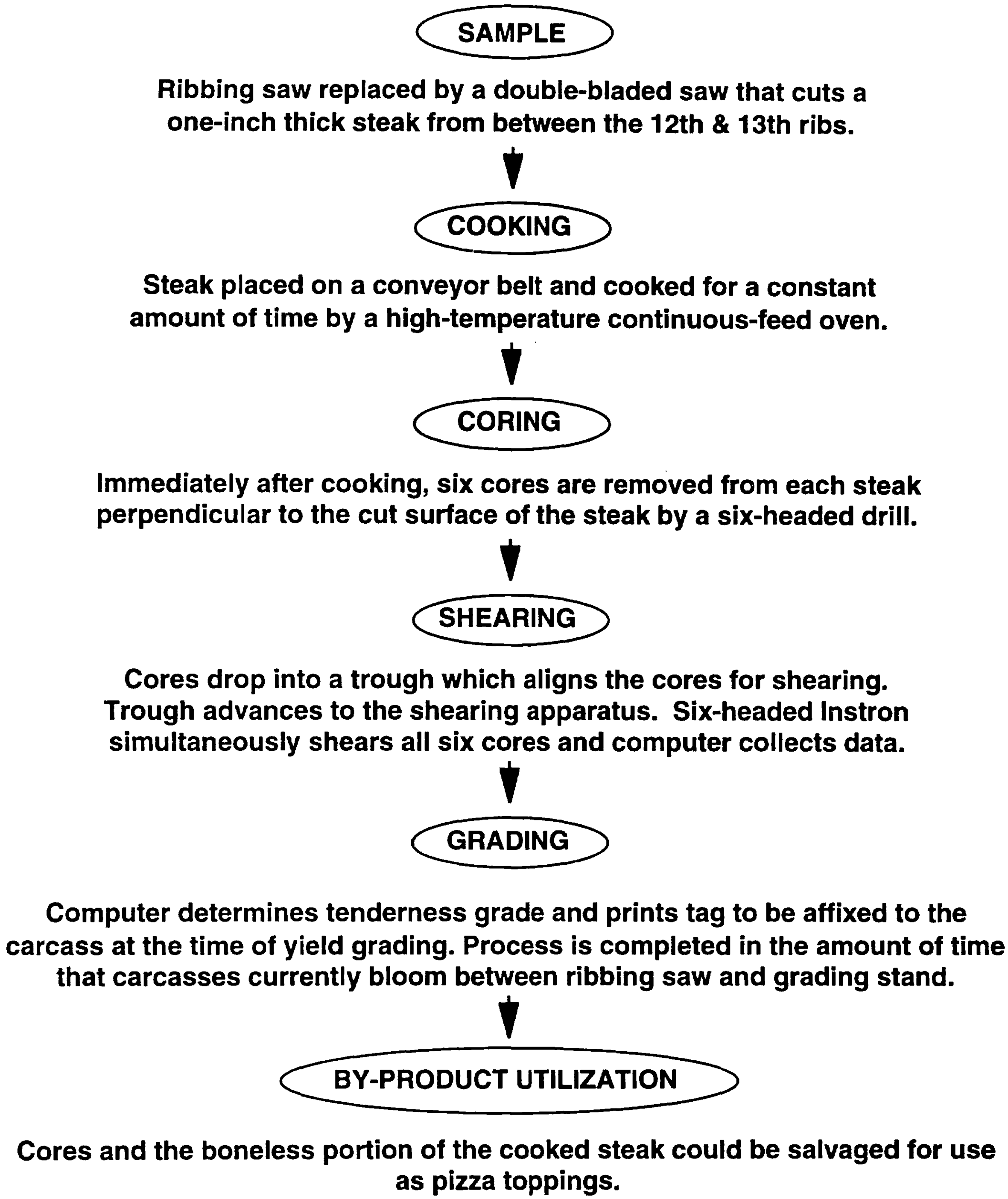


Figure 6. Outline of system for tenderness-based classification of beef.

one historical trait that will consistently explain a large percentage of the variation in aged beef tenderness is the percentage of *Bos indicus* inheritance in the cattle. Numerous experiments have demonstrated that the frequency of unacceptably tough meat is greater for cattle possessing high levels of *Bos indicus* inheritance (Koch et al., 1982; Crouse et al., 1989; Cundiff et al., 1993). However, most research indicates that cattle containing 25% or less *Bos indicus* inheritance are similar to their *Bos taurus* counterparts in palatability (Crouse et al., 1989; Johnson et al., 1990). Thus, if one adheres to sound crossbreeding principals, the production advantages of *Bos indicus* crossbred cattle may be reaped without compromising product quality.

2. Calpastatin-Based Methods of Predicting Beef Tenderness. As noted above, our studies have indicated that differences in the rate and extent of postmortem tenderization are responsible for variation in tenderness of aged beef. Furthermore, our results have demonstrated that the calpain enzyme system is responsible for the changes that result in meat tenderization. Thus, our approach to tenderness prediction has been to identify a trait that measures the capacity of this enzyme system. The principal regulator of the calpain enzyme system, in postmortem muscle, is its endogenous and specific inhibitor called calpastatin. In several studies (Whipple et al., 1990ab; Shackelford et al, 1991ab) designed to determine the biological reason for differences in meat tenderness between *Bos indicus* and *Bos taurus* cattle, it was determined that calpastatin activity at 24 hours postmortem (referred to as postrigor calpastatin) would explain a greater proportion of the variation (up to 44%; Figure 7) in aged beef tenderness than any other trait measured in those experiments. In a subsequent experiment (Shackelford et al., 1994), postrigor calpastatin was shown to be highly heritable (heritability = 0.65). Furthermore, the genetic correlation between postrigor calpastatin and Warner-Bratzler shear force was 0.50. Collectively, these results demonstrate that selection against postrigor calpastatin activity could result in improved meat tenderness. Furthermore, it suggests that postrigor calpastatin activity could be used as a predictor of beef tenderness. Unfortunately, current methods of calpastatin quantification are laborious and time consuming. Presently, in cooperation with the National Live Stock and Meat Board, we are in the process of developing a rapid method (ELISA) for quantification of calpastatin. This method will then be used to test the efficacy of postrigor calpastatin as a predictor of beef tenderness.

Because of the apparent importance of calpastatin in regulating the tenderness of aged beef, we initiated a project in which we, for the first time, successfully cloned and sequenced bovine skeletal muscle calpastatin. Additionally, we have localized the calpastatin gene to chromosome 7 of the beef genome, and more importantly, we have demonstrated that the calpastatin gene is polymorphic. It may be possible to exploit the

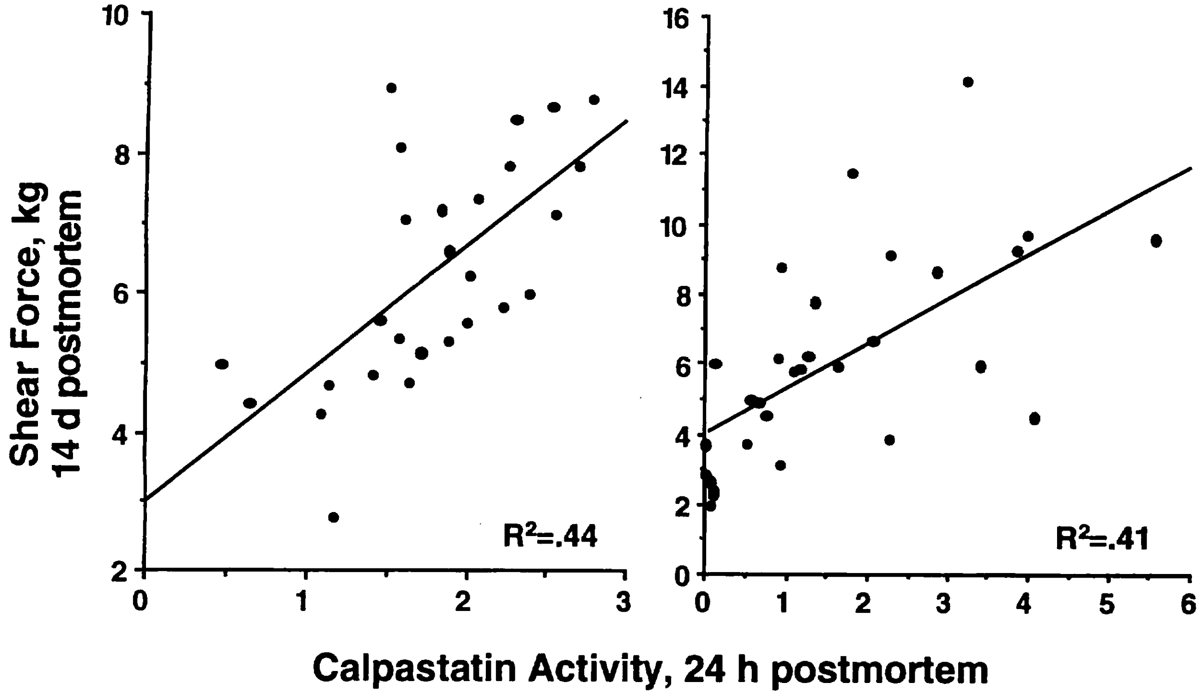


Figure 7. Relationship between calpastatin activity at 24 hours postmortem and shear force at 14 days postmortem.

polymorphisms in the calpastatin gene to develop methodology for predicting tenderness of aged beef and to genetically select for tenderness. These goals can be accomplished only if the polymorphisms in the calpastatin gene are associated with variation in tenderness of aged beef. If the polymorphisms in the calpastatin gene, are not associated with variation in tenderness, then the polymorphisms would not provide us with any useful information. Unfortunately, data collected in our laboratory during the last year indicated that there was no association between polymorphisms at the calpastatin loci and tenderness of aged beef. It is important to recognize that lack of an association between a polymorphism in the calpastatin gene and tenderness of aged beef does not mean that calpastatin is not related to meat tenderness. It simply means that there are different forms of the calpastatin gene and that they all produce the same protein. The level of this protein, however, is highly related to tenderness of aged meat We also have a project underway to determine the genomic organization of the calpastatin gene. These studies should provide information about the regulation of calpastatin gene expression and how to manipulate it.

A third calpastatin measure that may be useful for predicting meat tenderness is calpastatin mRNA abundance. This measure quantifies the amount of calpastatin protein that will be made in the muscle. Preliminary data indicate calpastatin mRNA abundance was highly correlated with shear force of aged meat (r = .64) Further studies are underway to test this relationship.

Unlike the current quality grading system, a calpastatin-based tenderness grade would likely include only three grades, unacceptably tough, average and desirably tender. It appears that any individual consumer has a threshold for acceptable meat tenderness. Meat below the threshold would be unacceptable and above acceptable. However, this threshold may vary with the eating circumstances (i.e., restaurant or at home). In addition, the threshold for acceptable tenderness will vary for different consumers. For these reasons a simple acceptable/unacceptable grading system is not sufficient. More than three grades may attempt greater classification than is needed or feasible. Three grades would allow the identification of meat that is clearly unacceptable in tenderness that would be discounted in price or targeted for the CAT treatment. The top grade would represent meat that would be acceptably tender to almost everyone. The middle grade would be for meat that encompasses the range between individual consumers for acceptably tender meat (i.e., the lower boundary would be equal to the least tender meat that a consumer considers the threshold for acceptable and the upper boundary would be the most tender meat that a consumer considers the threshold for acceptable).

3. Whole-Genome-Linkage-Scanning for Markers Associated with Beef Tenderness. Genetic maps are rapidly being constructed as a basis for identification of markers associated with Quantitative-Trait-Loci (QTLs) for use in Marker-Assisted-Selection (MAS) in cattle breeding programs. Several hundred markers spaced randomly throughout the cattle genome have been identified, sequenced and used to trace the inheritance of DNA segments from parent to offspring in cattle families designed for development of a linkage map. A linkage map characterizing heterozygous, well-spaced markers enable efficient selection of markers for identification of QTLs segregating in cattle resource populations. Resource populations are well defined large families of animals having traceable heritage through pedigree analysis and segregating alleles of genes affecting phenotypic characteristics of interest (i.e., meat tenderness, carcass retail yield, marbling, and so on). These resource populations may be derived from within breed, breed crosses or interspecies crosses. However, the type of resource population used or constructed will influence the level of heterozygosity within parental genomes. Several hundred more markers must be available for parental screening for a within breed (such as Angus or Hereford) search of QTLs than for an interspecies cross (such as Brahman x Angus) search due to the lower level of heterozygosity in the purebred genome. The fact that the markers are heterozygous is inconsequential to the putative heterozygosity of the QTL itself. Depending on the objectives for use of the marker information, resource populations must either be created in a research setting or identified in the field from cattle populations currently in production.

Evidence is growing that we will be successful in identifying markers with proximity to loci having substantial affect on economically important traits. For instance, in plants (tomatoes, corn, soybeans), several QTLs have been identified and markers implemented through MAS to improve disease resistance and drought tolerance in breeding programs. Markers for several debilitating human diseases have been discovered and are used for genetic screening and parental identification purposes. Recently, a region on pig chromosome 4 was shown to contribute to breed difference in growth rate, fatness and length of the small intestine. A region on cattle chromosome 1, flanked by two microsatellite markers, may contain genes responsible for "polledness". Information will soon be released detailing the identification of markers flanking QTLs responsible for milk component and yield variation within elite dairy families. Based on these discoveries, and those that are sure to follow, it is reasonable to assume that MAS for economically important traits will be implemented in both beef and dairy cattle selection programs in the very near future.

Strategies for identifying loci affecting economically important traits, in the examples cited above, have relied on the concept of "whole-genome-linkage-scanning" (Figure 8). This concept is contrary to the "candidate gene" approach in that it allows, at the DNA level, an assessment of genetic variation at multiple intervals simultaneously with phenotypic records across all regions of the genome flanked with markers. Because of their ease of use, high utility and high throughput, microsatellites are the current marker of choice in whole-genome-linkage-scanning. They allow rapid efficient dissection of a plant or animal genome into interval parts for determining their direct contribution to variation in quantitative and disease related traits. The strategy begins with identification of a set of heterozygous microsatellite markers (from fully developed linkage maps) which span the parental genomes with reasonable interval distance between them. Once a set of markers have been selected, linkage scanning for chromosomal regions in the progeny genomes contributing to the variation of a phenotype can begin. Depending on the structure and size of the population used for dissection of a particular quantitative trait, statistical analysis techniques have been derived which yield conclusive results. Those techniques involve the use of linkage analyses along with maximum-likelihood and simple regression methodologies to identify regions of the genome contributing to the variation of a given trait. The search for markers associated with tenderness of aged beef will involve the use of a large number of half-sibs from interspecies backcrosses involving only a few sire families. To discover what region(s) of the genome are contributing to meat tenderness, phenotypic observations on tenderness (i.e., shear force) will be collected and associated with variation at the DNA level. Once

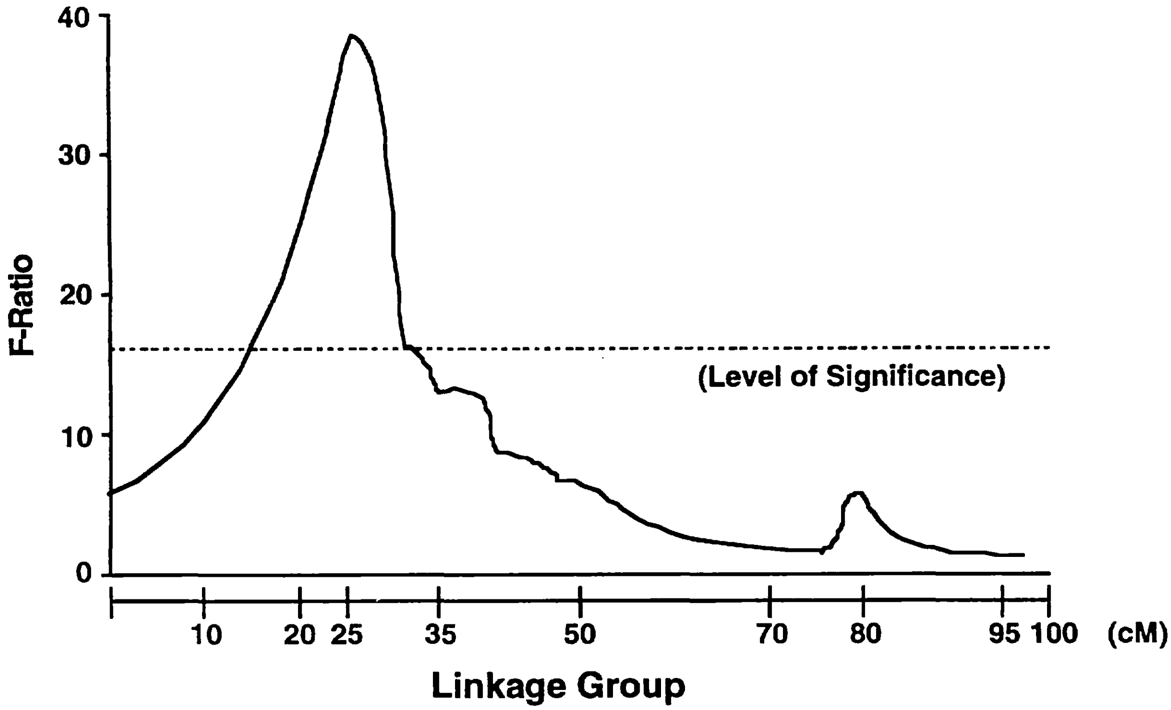


Figure 8. Tenderness-loci mapping using whole-genome-linkage-scanning.

found, markers for muscle tenderness can be implemented in various MAS schemes and the gene(s) responsible determined.

4. Predicting Beef Tenderness with Multiple Traits. As mentioned previously, based on current knowledge, no single trait consistently explains greater than 50% of the observed variation in tenderness of aged beef. To improve our chance of developing a method for predicting beef tenderness, we are using several approaches in addition to those based on calpastatin. We are currently collecting data on a large number of carcasses in order to develop an accurate tenderness prediction model. Because the value of the loin and rib drive the value of beef carcasses, we chose to predict the tenderness of top loin (longissimus muscle) steaks. Moreover, because most rib and loin cuts are aged for at least 10 days postmortem with the national average being about 19 days, we chose tenderness at 14 days postmortem as our endpoint for prediction. For this project, we are using Warner-Bratzler shear force, an objective measure of tenderness, as our index of tenderness. Ultimately, models will have to be tested against trained sensory panel data and consumer ratings.

The dependent variables that we are using to predict meat tenderness include historical data about the cattle (age, time-on-feed, dietary energy density, percentage *Bos indicus* inheritance, etc.), live animal performance data (average daily gain and weight per day of age), pH and temperature at 3, 6, 9, 12, and 24 hours postmortem, and the following traits determined at 24 hours postmortem: calpastatin activity, myofibril fragmentation index, fragmentation index, osmotic pressure, water-holding capacity, sarcomere length, and standard carcass grade traits (quality and yield grade factors). These traits were selected because they are the traits which are most commonly thought to be responsible for animal-to-animal variation in the tenderness of youthful, grain-fed beef. Other traits, such as collagen (connective tissue) amount and solubility and fiber type and size, were not included in this experiment because we have a substantial amount of data that indicates that variation in these traits is not related to variation in the tenderness of youthful, grain-fed beef. Some combination of these traits may allow us to explain additional variation not accounted for by calpastatin measures.

Conclusions

Undoubtedly variation in tenderness of aged-beef at the consumer level must be controlled. Several steps can be taken to reduce this variation, some processes can be implemented immediately while others require further research. Many scientists and producers have suggested that controlling the genetics of the slaughter cattle population would entirely solve the beef industry's tenderness problem. We agree that genetics makes a large contribution to the total variation in tenderness as tenderness is a moderately heritable trait (30%). However, because 70% of the variation in the tenderness of aged beef is due to environmental factors (Figure 9), management and processing procedures should receive more attention than genetics.

What we should be doing: Over the years, numerous factors have been reported to affect tenderness of aged beef. We must sort through those factors and determine which factors are most relevant. Additionally, we must determine acceptable ranges for each of these Critical Control Points. Critical Control Points will likely include genetics, male sex-condition, age, time-on-feed, type of ration, implant protocol, preslaughter handling procedures, slaughter/dressing, electrical stimulation, chilling, postmortem tenderization technologies ($CaCl_2$-injection, blade tenderization, etc.), and aging. Hazard analysis for these critical control points could be implemented immediately.

What needs to be done: Our data suggest that even if all critical points are controlled, we will still have tough beef. Within all breeds there are animals that will not produce tender meat even when the best processing procedures are followed. We must develop methodology to identify such animals. Thus, we must be able to predict tenderness of aged beef prior to of within 24

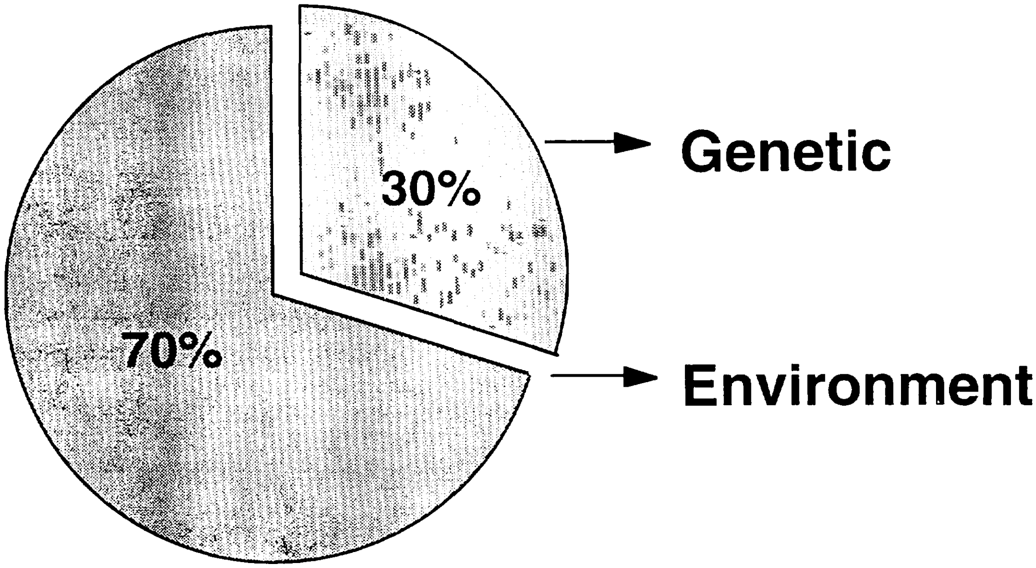


Figure 9. Sources of variation in the tenderness of aged beef.

hours of slaughter. As indicated previously, shear force at one day after slaughter can be used to segregate carcasses into aged beef tenderness groups with an 85% degree of accuracy. Because, this method is invasive and results in devaluation of one top loin steak per carcass, some have argued against this method of tenderness-based classification. Thus, we must continue to develop other methods for predicting beef tenderness.

Genome mapping and other projects to identity markers associated with tenderness of aged beef are progressing rapidly. Once these marker are identified they could be used to: 1) select for tenderness, 2) sort feeder cattle to optimize quality and yield, and 3) to predict tenderness. However, markers are only useful within the family that were generated. But, by sequencing the location of these markers in the cattle genome the identity of the gene(s) affecting beef tenderness will be determined. It is only at this level of knowledge that we truly can maximize the genetic effects on beef tenderness. One never knows what the future holds, maybe the identity of these genes will allow us to sort cattle into expected tenderness groups prior to slaughter.

Literature Cited

Crouse, J. D., L. V. Cundiff, R. M. Koch, M. Koohmaraie and S. C. Seideman. 1989. Comparisons of *Bos indicus* and *Bos taurus* inheritance for carcass beef characteristics and meat palatability. J. Anim. Sci. 67:2661

Cundiff, L. V., R. M. Koch, K. E. Gregory, J. D. Crouse and M. E. Dikeman. 1993. Characteristics of diverse breeds in Cycle IV of the cattle germplasm evaluation program. Beef Research Progress Rep. No. 4, USDA, ARS, Clay Center, NE.

Johnson, D. D.,R. D. Huffman, S. E. Williams and D. D. Hargrove. 1990. Effects of percentage Brahman and Angus breeding, age-season of feeding and slaughter end point on meat palatability and muscle characteristics. J. Anim. Sci. 68:1980.

Koch, R. M., M. E. Dikeman and J. D. Crouse. 1982. Characterization of biological types of cattle (Cycle III). III. Carcass composition, quality and palatability. J. Anim. Sci. 54:35.

Koohmaraie, M. 1988. The role of endogenous proteases in meat tenderness. Proc. Recip. Meat Conf. 41:89.

Koohmarie, M. 1992a. Role of the neutral proteinases in postmortem muscle protein degradation and meat tenderness. Proc. Recip. Meat Conf. 45:63.

Koohmaraie, M. 1992b. The role of Ca2+-dependent proteases (calpains) in post mortem proteolysis and meat tenderness. Biochimie. 74:239.

Koohmaraie, M. 1994. Muscle proteinases and meat aging. Meat Sci. 36:93.

Koohmarie, M, T. L. Wheeler, S. D. Shackelford, and M. Bishop. 1994. Beef tenderness: Regulation and Prediction. Proc. NCA Cattleman's College, Reno, NV.

Koohmarie, M, T. L. Wheeler, and S. D. Shackelford. 1993. Eliminating inconsistent beef tenderness with calcium-activated tenderization. Proc. Nebraska Cattleman's Assoc. Workshop, Kearney, NE.

Miller, B. 1992. Understanding consumers. Beef Today. 8:40.

Morgan, J. B. 1992. Tenderness problems and potential solutions. In: The Final Report of the National Beef Quality Audit--1991, pp 180-187.

Morgan, J. B., J. W. Savell, D. S. Hale, R. K. Miller, D. B. Griffin, H. R. Cross and S. D. Shackelford. 1991. National beef tenderness survey. J. Anim. Sci. 69:3274.

Parrish, F. C. 1974. Relationship of marbling to meat tenderness. Proc. Meat Ind. Res. Conf. p 117-131.

Savell, J. and S. D. Shackelford. 1992. Significance of tenderness to the meat industry. Proc. Recip. Meat Conf. 45:43.

Shackelford, S. D., M. Koohmaraie, L. V. Cundiff, K. E. Gregory, G. A. Rohrer, J. D. Crouse, and J. W. Savell. 1994. Heritabilities and phenotypic and genetic correlations for bovine postrigor calpastatin activity, intramuscular fat content, Warner-Bratzler shear force, retail product yield, and growth rate. J. Anim. Sci. 72:857.

Shackelford, S. D., M. Koohmaraie, M. F. Miller, J. D. Crouse, and J. O. Reagan. 1991a. An evaluation of tenderness of the longissimus muscle of Angus by Hereford versus Brahman crossbred heifers. J. Anim. Sci. 69:171.

Shackelford, S. D., M. Koohmaraie, G. Whipple, T. L. Wheeler, M. F. Miller, J. D. Crouse, and J. O. Reagan. 1991b. Predictors of beef tenderness: Development and verification. J. Food Sci. 56:1130.

Smith, G. C. 1992. Improving the Consistency and Competitiveness of Beef. The Final Report of the National Beef Quality Audit--1991.

Wheeler, T. L., M. Koohmaraie, and S. D. Shackelford. 1994. Effect of marbling degree on beef palatability in *Bos taurus* and *Bos indicus* cattle. J. Anim. Sci. Submitted.

Whipple, G., M. Koohmaraie, M. E. Dikeman, and J. D. Crouse. 1990a. Predicting beef-longissimus tenderness from various biochemical and histological muscle traits. J. Anim. Sci. 68:4193.

Whipple, G., M. Koohmaraie, M. E. Dikeman, J. D. Crouse, M. C. Hunt, and R. D. Klemm. 1990b. Evaluation of attributes that affect longissimus muscle tenderness in Bos taurus and Bos indicus cattle. J. Anim. Sci. 68:2716.

Wilkes, D. 1992. Introductory remarks; issuance of the challenge to the workshop participants. In: G. C. Smith (Ed.) Improving the Consistency and Competitiveness of Beef. The Final Report of the National Beef Quality Audit--1991. p 92.

ATTACKING THE VALUE BASED DILEMMA FROM A SEEDSTOCK PERSPECTIVE

HENRY BERGFELD

1994 BIF CONVENTION
JUNE 2, 1994

This spring at Summitcrest we are breeding over 1800 head of cattle (290 commercial females used as a test herd and 1550 head of purebred Angus). With annual bull sales of well over 300 head and an equal number of fat cattle fed and marketed, Summitcrest is very close to the pulse of the industry. This all occurs at three ranch locations: Broken Bow, NE, Fremont,IA and our home unit at Summitville, OH.

Summitcrest's interest in carcass traits didn't just begin with the Beef Quality Audit in 1991 nor in the founding of the Certified Angus Beef Program in 1978 for that matter. Our first carcass data was collected in 1973 on progeny of bulls Marshall Pride 665 and Camilla Chance 2W. These bulls became 100% Certified Meat Sires under the BIF program. Several other bulls didn't make 100% Certified Meat Sire status and this made us very aware of the differences in carcass by sire. About this time USDA lowered the grade standards. That was 1976 and as a result, no breeder, feeder, nor commercial cattleman had any reason to produce a quality carcass. It was this fact that greatly enhanced the start of the CAB program. As many producers, feeders, and packers knew, Angus cattle would marble better than most breeds.

Armed with this fact and the strong belief that we needed to develop a better market for the quality Angus carcass, four Angus breeders, including Fred Johnson, owner of Summitcrest, began developing the CAB program.

Dr. Gary Smith's 1991 Beef Quality Audit awakened the industry. Value Based Marketing and carcass trait articles became headline stories for many major publications. As purebred breeders we have an obligation to the industry to produce the right kind of seedstock for our customers, both purebred and commercial. With the work we have done I am strongly led to the conclusion that all purebred breeders should feed out their own steers and those sired by their herd bulls, following them onto the rail. But this is the exception and not the norm.

Today more than ever purebred breeders are being challenged to produce the right genetics in seedstock. The Beef Quality Audit points out genetic related non-conformities or quality defects account for $248.32 or almost 88% of the industries total economic loss per animal slaughtered. Dr Smith further states that marbling alone can affect the value of a carcass as much as $180.00

What have we learned over the years from our own carcass data? Being Angus is not enough. There is a wide variation within the breed. CAB acceptance is lower than we would like to see. The number one reason that cattle fail to make CAB is lack of marbling. With data on over 1200 carcasses let's see how Summitcrest and Industry Averages compare.

	INDUSTRY	SUMMITCREST
CHOICE	55	86
CAB	17	38

CAB acceptance since 1983 ranges from 15.7% to 24% Since 1987 Summitcrest's averages have ranged from a high of 43.9% to a low of 21.8% So far this year, Summitcrest is again running a 38% CAB acceptance. The high years were driven by bulls such as SA Direct Drive, the number one bull in the breed today at a +.39 and a .70 accuracy and Premier Independence KN, the breed's number five ranked marbling sire at +.28 and a .90 accuracy. It was more luck than anything that these two bulls were being used at the same time. Since 1989 Summitcrest has been testing other sires and hasn't identified any one bull nearly as strong for marbling. (Hyline Nickel posts a +.25) 1991's drop was influenced mainly by Hoff Prototype, one of the breeds low marbling sires with a -.24 and an accuracy of .89 With Prototype calves out of daughters of PS Power Play, another bull with strong accuracy (.92) for marbling, but an EPD of -.12, the CAB acceptance falls to 8.82%, a rate well below average.

With Prototype out of daughters of BR Monopoly whose marbling EPD is -.05, acceptance improves to 14.81% Prototype progeny out of daughters of Premier Independence, whose marbling EPD is +.28, show acceptance rates jumping way above national average to 32.43%

Chart number 4 shows PS Power Play again repeats facts observed in the Prototype chart. We have a significant number of carcasses here to make this study, a total of 97. With a marbling EPD of -.12 we find Power Play above industry average at an acceptable rate of 28.3% When Power Play carcasses were out of BR Monopoly daughters, his acceptance only improves slightly to 28.6% However, if the Power Play carcasses were out of Premier Independence daughters, we found again a marked increase to a 40.71% acceptance.

From chart number 5 we can make some interesting observations. This shows percentage of CAB acceptance rate by sire with over 20 carcasses from our data, again starting with Prototype, a negative .24 marbling sire. We see he still has an acceptance rate of 17.8% which is just about industry average.

CAB ACCEPTANCE BY SIRE:

Prototype	17.8%	
PS Power Play	28.3%	*** Note error on chart***
GT Vector	27.3%	
BR Monopoly	37.9%	
Leachman Prompter	47.4%	
QAS Traveler 23-4	62.5%	
Premier Independence	71.6%	
SA Direct Drive	85.0%	

Chart number 6 compares the same bulls's industry acceptance with their EPD's for marbling. Our acceptance rate coincides with the EPD's nearly 100%. This is just what we should expect. Note Traveler is about 15% higher in our program than you might normally expect.

(SRC SYSTEM SLIDE)

With time and a breeding program which emphasizes high marbling bulls, purebred breeders can definitely improve the marbling genetics of bulls sold to the commercial cattleman and ultimately improve the CAB national acceptance rate and the overall image of beef.

Conclusion: you can improve marbling by breeding and stacking positive traits and this will result in higher CAB acceptance.

Where do we go from here? We, at Summitcrest, are convinced we can breed and improve carcass quality in our herd and thus for our customers in the bulls we sell. The best longterm fix for our industry must begin with the seedstock producers, not at the trim table in the packing plant nor any other short term fix. Value based marketing will come. Today it's basically lip service paid by the major publications or the output of academia. However, as Dr. Jim Males's study at South Dakota shows, not all will profit. Under value based marketing one-third of the producers would lose money, another third would break even and only the remaining third would benefit. Just as importantly we need to improve our product if we are going to continue to compete for our market share. Again as the Quality Audit points out, since 1975 we have lost 2/3 of a grade in the cattle we are producing. Bill Miller's article in a 1992 issue of BEEF TODAY tells us consumers were disatisfied with the eating quality of beef prepared at home more than 20% of the time. J B Morgan's 1991 Survey reported when one supermarket chain allowed customers to return any meat with which they were not satisfied, $364,000. worth returned in a three year period -- and 78% was due to lack of tenderness. The point has been strongly made that just being an efficient fast-gainer in the feedyard isn't enough. Some of these critters are the source of our problem.

Like most we are looking for a quicker, more economical way to identify positive carcass bulls. This year for the first time we ultrasounded our set of bulls at the Fremont, IA, ranch. The work was carried out by Dr. Gene Roush who is on this program later this morning. We think a lot can be gained here and plan further ultrasound along with other testing. A colpastatin test by Dr. Brent Woodward planned for this year has been put on hold until a less time-consuming test is developed. Hopefully we will be doing new testing on next year's steers.

In our breeding program carcass traits carry as much importance as weaning weights, milk and yearling weights. Positive carcass traits for us mean more than just marbling although this is the most important trait. Being positive carcass for us includes positive for ribeye since Angus in general could use more muscle, and being negative for fat. Yes, negative for fat. Waste fat not taste fat. As Dr Rick Rasby's work at Nebraska points out and we strongly believe, there is no correlation between external fat and marbling.

Two years ago Summitcrest began identifying bulls in our catalogs as SCS and DBCS SIRES. A Summitcrest Superior Carcass Sire bull is sired by a high marbling EPD sire of .35 or more, who is positive for ribeye, and negative for fat. Or whose Sire and Maternal Sire have a sum total of .50 marbling EPD or more, and both are positive for ribeye and negative for fat. A Summitcrest Double Bred Carcass Sire bull has both Sire and Maternal Sire positive for marbling, positive for ribeye, and negative for fat.

In the last two years we have purchased five bulls with high carcass traits:

Finks 5522 6148
GT Expo
Hyline New Trend 382
Minerts Fortune 312
Gardens Traveler 3246

Two of these have been leased: Finks 5522 to Integrated Genetics and GT Expo to ABS. Two others have attracted like interest. Gardens Traveler 3246 is sired by RR Traveler 5204, a positive carcass sire, and was one of the three highest bulls with marbling potential (as identified by ultrasound) at Green Gardens, Kansas.

We are using a number of our own young potential carcass sires as identified by their Interim EPD's:

S/C Guideline

S/C Hi Flyer 3B18
S/C Scotch Cap 0B45
S/C Valiant 2B44
S/C DRCT Drive C189
S/C Spade 274B

Note their positive marbling and ribeye, and negative fat. These are not the only bulls being tested. Starting last year, Summitcrest began testing every young bull that we maintain an interest in or purchase. Over 750 commercial females in test herds calved this spring and over 1200 commercial females outside our own commercial cows are being bred, some right as we speak. Our commitment is to completely evaluate their progeny all the way through to the rail. Gary Smith best summed it up in his remarks to the group of breeders, ranchers, and feeders last March, the night before our sale in Broken Bow, when he said, "You don't have to worry about the carcass trait genetics in your herds, but you will have to compete with those who do."

At Summitcrest, we are committed to improving the quality of cattle we produce. After all, it's our motto, Improve the land, improve the breed.

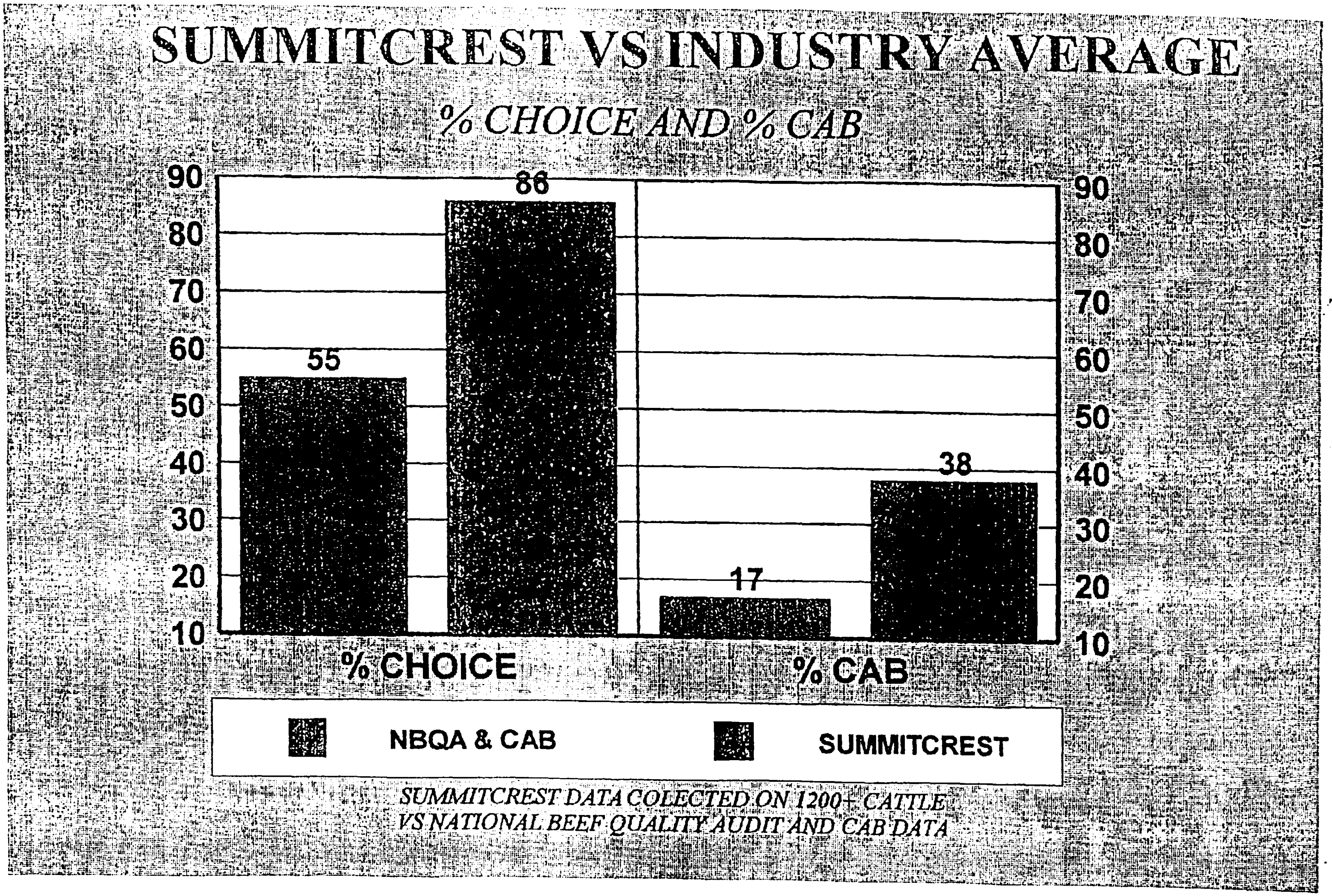

SUMMITCREST VS INDUSTRY AVERAGE
% CHOICE AND % CAB
90
80
70
60
50
40
30
20
10
55
86
17
38
% CHOICE
% CAB
NBQA & CAB
SUMMITCREST
SUMMITCREST DATA COLECTED ON 1200+ CATTLE
VS NATIONAL BEEF QUALITY AUDIT AND CAB DATA

CHART 1

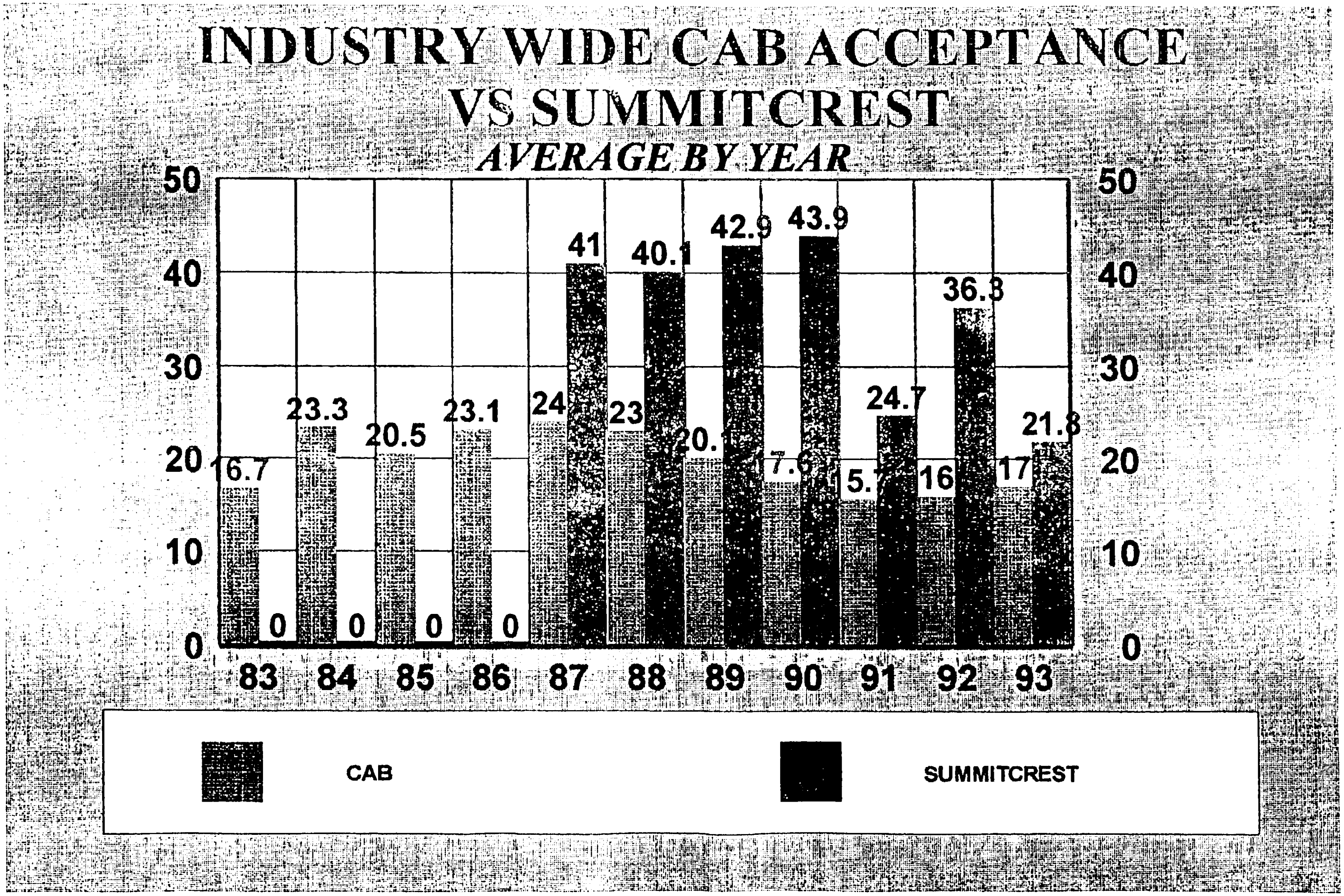

INDUSTRY WIDE CAB ACCEPTANCE
VS SUMMITCREST
AVERAGE BY YEAR
0
10
20
30
40
50
83
84
85
86
87
88
89
90
91
92
93
23.3
20.5
23.1
24
41
23
40.1
42.9
43.9
24.7
36.3
21.8
16
17
0
CAB
SUMMITCREST

CHART 2

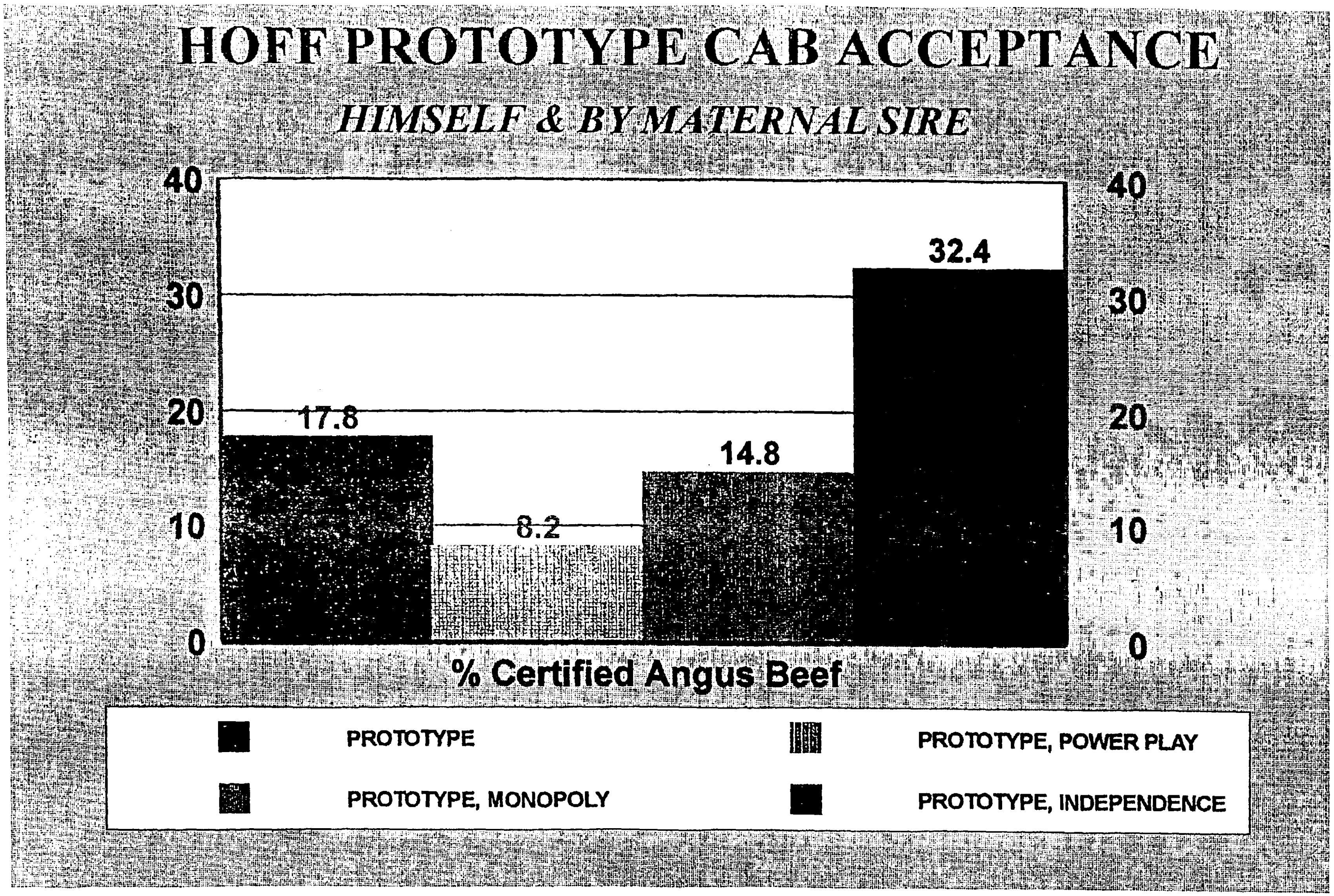

HOFF PROTOTYPE CAB ACCEPTANCE
HIMSELF & BY MATERNAL SIRE
40
30
20
10
0
17.8
8.2
14.8
32.4
% Certified Angus Beef
PROTOTYPE
PROTOTYPE, POWER PLAY
PROTOTYPE, MONOPOLY
PROTOTYPE, INDEPENDENCE

CHART 3

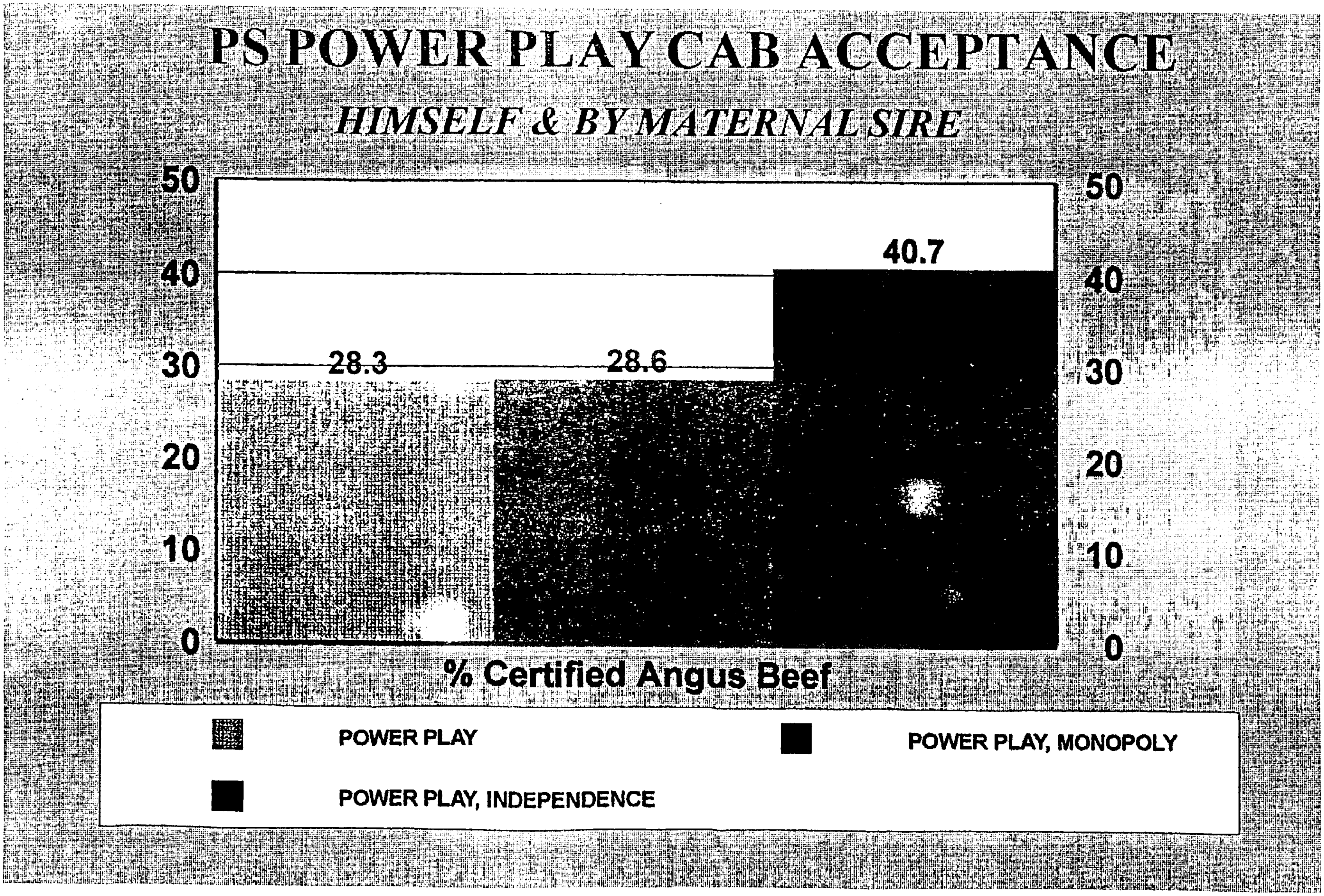

PS POWER PLAY CAB ACCEPTANCE
HIMSELF & BY MATERNAL SIRE
50
40
30
20
10
0
28.3
28.6
40.7
% Certified Angus Beef
POWER PLAY
POWER PLAY, MONOPOLY
POWER PLAY, INDEPENDENCE

CHART 4

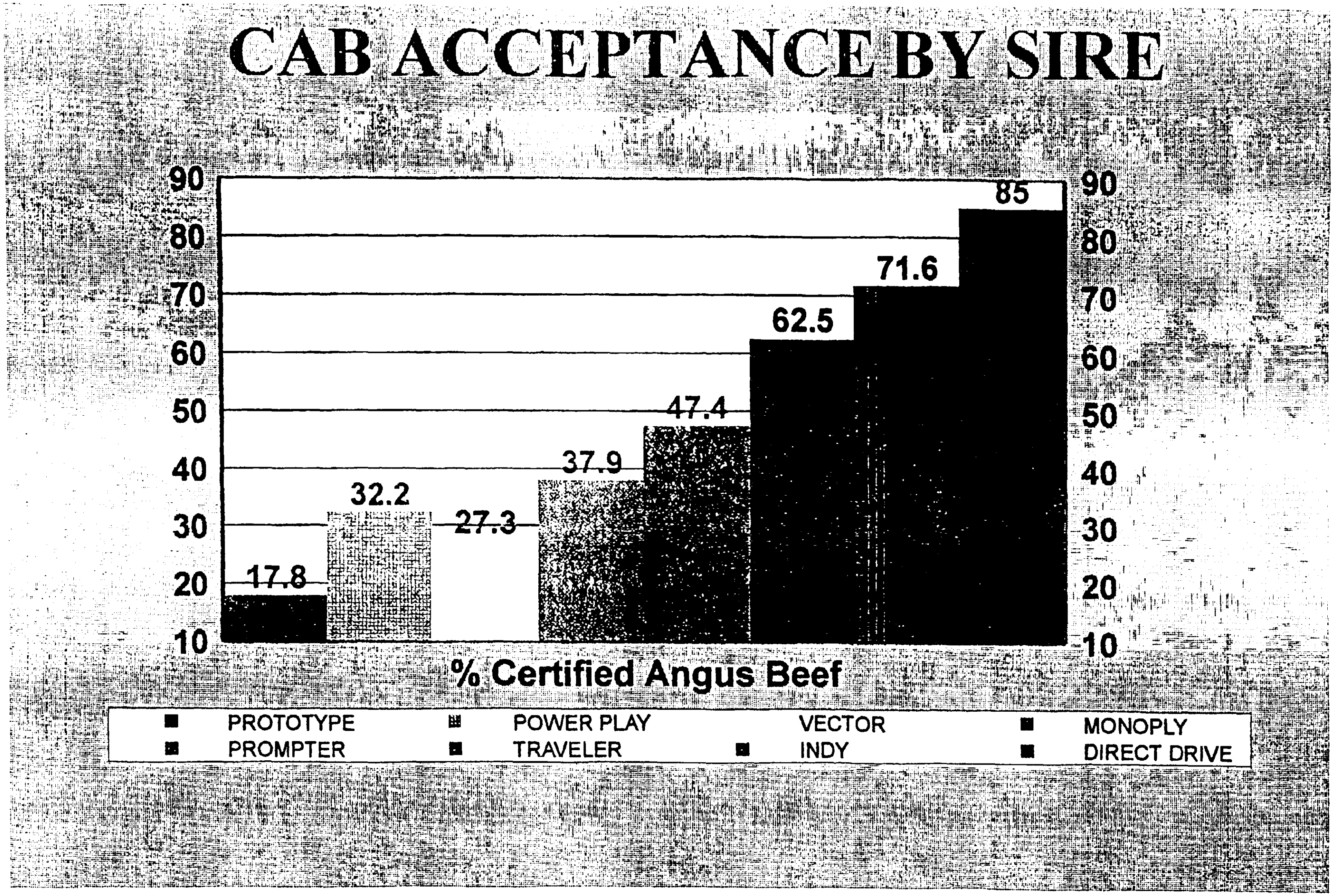

CAB ACCEPTANCE BY SIRE
90
80
70
60
50
40
30
20
10
85
71.6
62.5
47.4
37.9
32.2
27.3
17.8
% Certified Angus Beef
PROTOTYPE
POWER PLAY
VECTOR
MONOPLY
PROMPTER
TRAVELER
INDY
DIRECT DRIVE

CHART 5

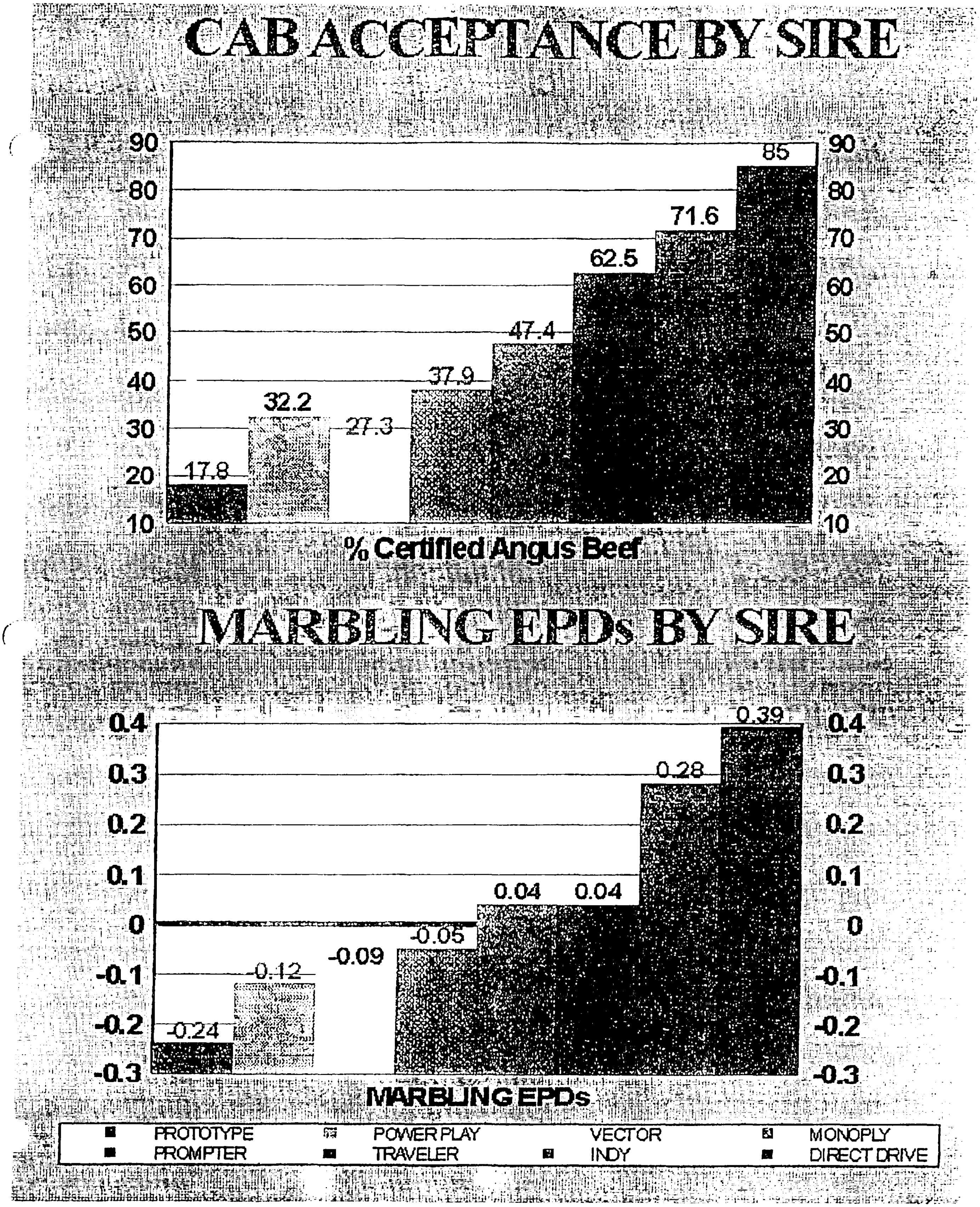

CAB ACCEPTANCE BY SIRE
90
80
70
60
50
40
30
20
10
17.8
32.2
27.3
37.9
47.4
62.5
71.6
85
% Certified Angus Beef
MARBLING EPDs BY SIRE
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.24
-0.12
-0.09
-0.05
0.04
0.04
0.28
0.39
MARBLING EPDs
PROTOTYPE
POWER PLAY
VECTOR
MONOPLY
PROMPTER
TRAVELER
INDY
DIRECT DRIVE

CHART 6

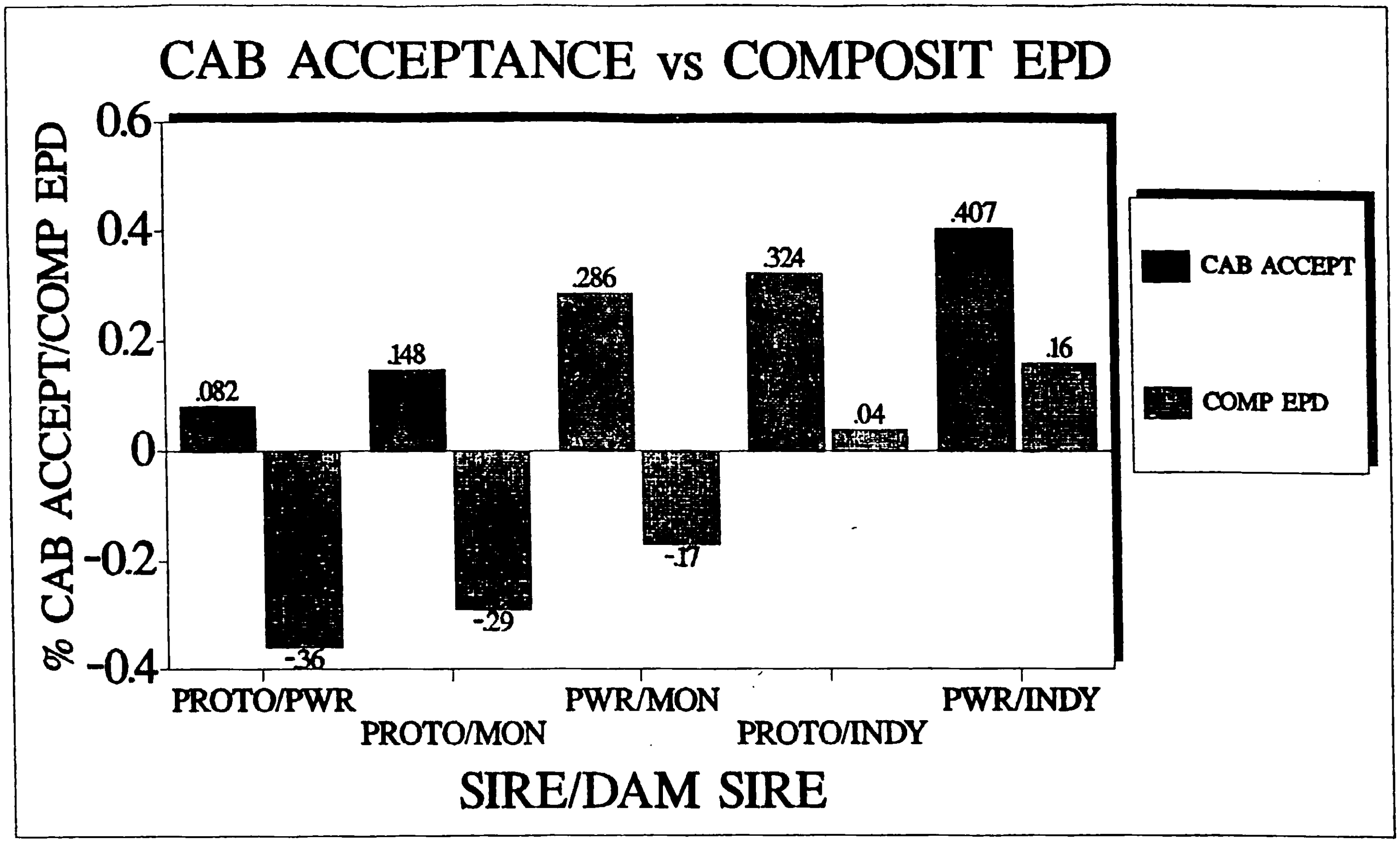


CHART 7

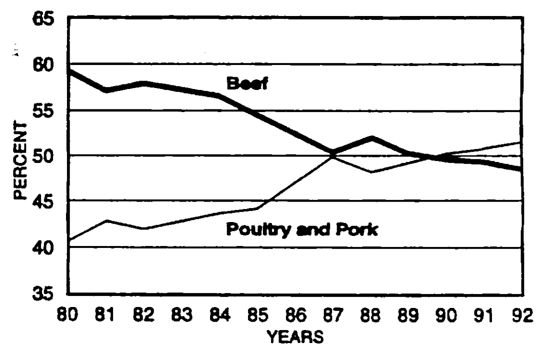
This chart relates the simple arithmetic sum of the marbling EPD's of the sire and the dam's sire ("COMP EPD") to the percent CAB acceptance (shown in fractions of 100).

Executive Summary

Rick Shuler

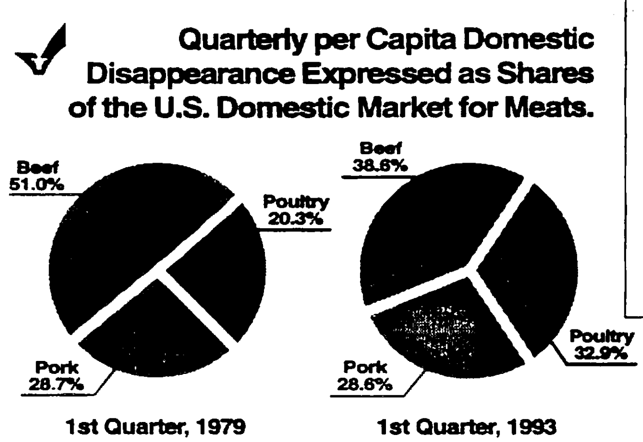
The U.S. beef industry has, for too long, been focused inwardly — production-driven, not consumer-driven. We have demonstrated neither the ability nor the inclination to respond adequately to consumer signals in the market place. Beef has lost market share to poultry and pork for a number of years. In 1992, poultry actually surpassed beef as the animal protein market share leader.

The bottom line is that the poultry industry has done a better job of meeting consumer demands with a product that is consistently high quality, high value, economically priced, effectively promoted and packaged for convenience. The pork industry, as well, is strengthening its ability to meet consumer needs and has declared it will be the meat of choice by the 21st century.



Share Of Consumer Meat Expenditures

Source: USDA



Quarterly per Capita Domestic Disappearance Expressed as Shares of the U.S. Domestic Market for Meats.

Currently there are four major national organizations serving the U.S. beef industry — the Cattlemen's Beef Board, the Beef Industry Council of the Meat Board, the National Cattlemen's Association, and the U. S. Meat Export Federation.

Recognizing that the decade of the '90s is crucial for the beef industry, the elected producer leaders of these organizations saw the need for a unified effort in developing a plan to better position beef in the marketplace and improve organizational efficiency and effectiveness. With that in mind, they submitted an Authorization Request to the Cattlemen's Beef Board to fund an industry-wide Long Range Planning Task Force. The Task Force's charter was to develop a long range strategic plan for the beef industry that focused on domestic marketing, international marketing, issues management, public relations, efficient and effective use of resources, and industry governance.

THE PLANNING PROCESS

The 14-member Task Force was comprised of the presidents/chairmen of the four organizations and 10 at-large members from the industry, plus a project leader and a facilitator. The executive officers of the four national organizations served as advisors.

The challenge for the Task Force was to develop a long-range plan and, ultimately, a structure that would enable the beef industry to make more effective and efficient use of its human and financial resources, with the overall objective being to better meet consumer demands and expectations. An important first step in the process was an open, honest assessment of problems and opportunities currently facing the beef industry. The Task Force heard more than seventy (70) presentations and conducted interviews with key representatives of various sectors within the beef industry and competing industries.

Among the most significant findings from all these presentations were:

- Negative consumer perception of beef's quality and consistency.
- Negative consumer perceptions about the convenience and "customer-friendliness" of beef.
- Growth opportunity for U.S. beef in the international market.
- Social/political issues that disrupt the beef industry and create negative consumer attitudes.
- Challenges to beef production efficiency and ultimately product cost compared to costs of other meats.
- An "island mentality" among the various segments — seedstock, cow/calf, stocker, dairy beef, feeder, packer, distributor, retailer, and food service operator.
- Adversarial relationships among various segments, particularly the relationship between producers and packers, which prevents the industry from understanding and satisfying changing consumer needs.

LEVERAGE POINTS AND OUTCOMES

The Task Force identified eight leverage points (strategic points of impact) and outcomes (desired results) that will enable the beef industry to stop the decline and ultimately increase beef's market share. The leverage points were then discussed with various industry organizations.

From the feedback received, the Task Force identified the ***Quality and Consistency*** leverage point to be the most critical. The plan calls for reducing consumer dissatisfaction with beef quality (i.e., primarily toughness) by 50 percent by 1997. Other leverage points and desired key results include:

- **Domestic Marketing:** Stop the decline in market share by the year 1997.
- **International Marketing:** Increase U.S. beef's share of the international market from 9 percent to 18 percent by 1997.
- **Issues Management:** Identify and effectively manage potentially disruptive issues before they adversely affect consumers' purchases of beef.
- **Public Relations:** Present a strong, positive image of the beef industry and its products.
- **Production Efficiency:** Make beef more price-competitive by reducing production costs by 10 percent by 1997.
- **Producer/Packer Alliances:** Enhance product value and profit opportunities through better communication and cooperation with the packer segment.
- **Strategic Alliances:** Develop programs that focus on the consumer at every stage of the beef production cycle.

RECOMMENDED STRUCTURE

To ensure that the leverage points and desired results are attained as quickly, effectively, and efficiently as possible, the Task Force reviewed the current organizational structure and found that it presented a number of challenges to the overall success of the beef industry. Some of the major issues and challenges include:

- The beef industry doesn't have a single, unified plan with definable, measurable results.
- Multiple organizations, boards, and directors result in inefficient utilization of time and resources.
- The existence of multiple organizations creates confusion over which organization is the primary spokesman for the beef industry today.
- There is a lack of coordination and cooperation between state and national organizations.

The Task Force analyzed the current organizations and found that, as an industry, the structural criteria of focus, coordination, control, and cost effectiveness cannot be met. Without these structural criteria, we cannot achieve the outcomes of the plan. The Task Force, therefore, recommends a single consolidated national organization. The new organization should be structured in such a way that:

- People can focus on results rather than activities.
- Areas of responsibility are identified and delineated.
- The entire beef industry focuses on the same objectives.
- There is coordination and cooperation within the industry.
- The organization and its activities are managed cost-effectively.
- There is control and accountability to stakeholders for results.

The basis for the new national organization will be the stakeholders — members of state cattlemen's associations; state beef councils, the beef breed associations; Cattlemen's Beef Board; American National CattleWomen; packers, processors, and purveyors; and individual dues-paying cattlemen and women. These stakeholders or members will elect a Board of Directors. In short, board members will represent the stakeholders and reflect a "grass-roots" ownership of the new national organization.

The Task Force envisions an elected Executive Committee to be responsible for updating and maintaining the long range plan; for achieving the results outlined in the plan; for resource allocation; and for hiring/firing the Chief Executive Officer. The staff of the new organization will be drawn primarily from the existing talent pool currently within the industry.

The Task Force has developed a suggested timetable to make the transition from the current organizational structure to the new structure. It has also recommended an oversight committee to ensure that the transition from decentralized to centralized management goes smoothly.

A COMMITMENT TO SUCCESS

If the beef industry is to remain viable into the 21st Century, all segments of the industry must focus on consumer demands for quality, consistency, and convenience at a competitive and affordable price. To meet these demands, the industry must structure itself to provide **focus around specific objectives, a mechanism of control to assure results, coordination among all industry participants, and cost- effectiveness**. With this commitment to success, the goals that follow can be achieved by the end of this decade.

Leverage Point: Quality And Consistency

QUALITY:

Those standards and practices that improve the value of beef products to the consumer: eating properties (tenderness/ taste/palatability), affordability (value for price), eye appeal, safety, packaging, and shelf-life.

CONSISTENCY:

Repeatability of *desired* characteristics of beef products, such as eating quality, carcass size, portion size, and convenience.

OUTCOMES:

1. Reduce consumer dissatisfaction due to toughness by 50 percent by 1997 (measured by the consumer market basket survey.)
2. Successful control of pathogens in beef products.
3. Keep beef free of violative residues.
4. Reduce carcass defects by 50 percent by 1997.
5. Achieve 100 percent 1/4" trim in boxed beef by 1997.
6. Extend average shelf life by 7 days by 1997.
7. Produce an industry standard carcass size requiring a minimum of trim by 1997.
8. Achieve 15 percent of fresh beef volume as branded or case-ready product by 1997.
9. Increase consistency of eating quality within each grade of beef by 1997.

ASSUMPTIONS:

1. Processors will provide branded products singularly or in partnerships with retailers.
2. Retailers will move to case-ready beef.
3. The industry will successfully manage food safety challenges.
4. The industry will develop methodology and instrumentation to measure product quality.
5. Industry will make changes necessary to achieve quality and consistency goals.

ACTION POINTS:

1. Identify carcass and product specifications that will provide consumer-preferred products - products with desired tenderness, taste, palatability, and portion size.
2. Develop and implement HACCP methods and research to control pathogens on beef and beef products.
3. Establish a consumer feedback system.
4. Expand dissemination of consumer cooking and handling instructions.
5. Support and encourage the introduction of branded beef products.
6. Support the development of an economical, rapid assay test to detect vitamin E levels.
7. Identify and develop methods of making beef products more convenient and user-friendly.
8. Support the development of instrument carcass evaluations.
9. Develop an economically feasible on-line tenderness test.
10. Continue research to develop gene marker identification for carcass tenderness/taste and to develop effective carcass EPD's.

Leverage Point: Domestic Marketing

DOMESTIC MARKETING:

Provide products that better meet consumer demands and aggressively promote their positive attributes.

OUTCOMES:

Stop the decline in market share by 1997:

- By better satisfying consumer needs through a set of achievable product specifications.
- By making measurable annual improvements in consumer acceptance of beef as a convenient, nutritious, versatile, and consumer-friendly product.
- By enhancing consumers' price/value perception of beef.

ASSUMPTIONS:

1. Value of beef can be improved for the consumer.
2. U.S. economy will remain stable.
3. All segments will be responsive to beef industry marketing efforts.
4. The beef checkoff will continue or alternative funding sources will be found.
5. Beef will continue to be the meat with the taste consumers prefer.
6. The price of beef related to pork and poultry will remain stable.
7. Expanded production and marketing by competing meats will make it more difficult for beef to maintain market share.

ACTION POINTS:

1. Develop a feedback system that transmits consumer preferences and specifications back through the production chain.
2. Implement a plan to increase beef consumption by one more serving in each two-week period.
3. Leverage product development, promotion, and market research dollars by partnering with major companies:
   - That are successfully marketing branded products,
   - that are successfully identifying consumer trends and needs,
   - that are experts in packaging,
   - that have a proven record of product enhancement,
   - that have expertise in extending product shelf life,
   - that are developing successful pricing strategies.
4. Develop peer-reviewed, measurable tests to evaluate the effectiveness of generic, branded, and targeted beef promotions.
5. Foster the introduction of five significant branded products by 1997.

6. Increase beef's share of retail featuring by 4 percent and beef's share of food service menus by 2 percent by 1997.
7. Continue to deliver positive, relevant information about beef's attributes to our targeted customers.
8. Develop and encourage pricing strategies that are more favorable to beef and particularly value-added products.
9. Pursue and coordinate beef marketing and consumer research efforts within the major beef, dairy, and food organizations.
10. Increase and focus merchandising efforts to the retail and food service channels (recipes, in-store demos, cooking instructions, training materials, customer contacts, etc.).

Leverage Point: International Marketing

INTERNATIONAL MARKETING:

Enhance profitability by increasing foreign demand for U.S. beef, cattle, and other products. Expand exports to existing markets and develop new export opportunities.

OUTCOMES:

1. Increase value of beef exports to $4 billion by 1997.
2. Increase the U.S. share of the world market for beef and beef by-products from 9 percent to 18 percent by 1997.
3. Establish a presence in emerging world markets (China, Latin America, Taiwan, and ASEAN), enabling the United States to become the significant exporter of beef to those markets.
4. Expand annual market share growth for U.S. beef by the following amounts: Japan, one percentage point; Korea, two points; Mexico, two points; and Canada, one point.

ASSUMPTIONS:

1. NAFTA and GATT will be approved.
2. No new major trade barriers will arise.
3. No adverse diet, health, or food safety issues of significance will develop.
4. Adequate funding will be provided by industry/government in 1994, but funding will be a challenge thereafter.
5. Economic and population growth trends in targeted export countries will make possible the expansion of U.S. beef exports.
6. The U.S. will remain the world's premier supplier of grain-fed beef.

ACTION POINTS:

1. First priority in use of international market resources will continue to be the expansion of existing markets (Japan, Canada, Korea, and Mexico).
2. Initiate and implement a beef presence as part of world trade negotiations.
3. Support international market development by utilizing a Total Quality Marketing program.
4. Build producers' support and obtain approval of NAFTA and GATT by 12/94.
5. Develop strategic partnering initiatives (government, domestic and international business, and producers) to leverage available resources.
6. Improve the perception of and increase the value of U.S. beef, cattle, and products worldwide by emphasizing product quality and utilizing effective marketing techniques.
7. Cultivate U.S. exports to emerging world markets (EEC, China, Latin America, FSU, ASEAN).
8. Increase funding from all sources.

Leverage Point: Public Relations

PUBLIC RELATIONS:

Public relations is a proactive effort to improve the industry's image by implementing credible communications programs that create positive perceptions of the beef industry and its products.

OUTCOMES:

1. Influencers and thought leaders in the media, government agencies, educational institutions, health organizations, and public interest groups will have an informed, positive opinion of beef and beef production based on factual, credible information from the industry and third-party sources.
2. Consumers will have a strong, positive image of cattlemen and of beef production and will have confidence in beef as a healthful, nutritious, safe, wholesome, and environmentally-friendly product.
3. Research will reflect positive attitude trends among thought leaders and consumers.
4. The *beef industry* will speak with a single voice.

ASSUMPTIONS:

1. Beef producers will be willing to modify production practices to make the industry less vulnerable.
2. Attacks from activists and opponents will become stronger as they network with other influential groups, (e.g., nutritional, food safety, environmental, animal welfare, vegetarian), resulting in the need for additional resources to successfully counter-attack.
3. Anti-beef public interest groups and activists will continue efforts to reach young people through the public education system.
4. The beef industry will continue to have numerous positive messages to counter the attacks by activists using misinformation.
5. Schools, government, media and other influential groups will continue to allow access for beef's message.

ACTION POINTS:

1. Expand and continue to implement a comprehensive school information program designed to educate children about the positive aspects of beef and beef production.
2. Identify and train additional third-party spokespersons who can speak on behalf of the entire industry.
3. Develop a comprehensive public relations program for beef marketers, equipping them to answer consumer questions about the beef industry.
4. Expand the network of trained industry spokespersons and mobilize grassroots efforts to promote industry messages, e.g., Myth Busters.

5. Develop coalitions and partnerships with beef marketers, public interest groups and health organizations in order to leverage public relations efforts.
6. Develop and implement a comprehensive public relations program about beef and beef production targeted at the general public and thought leaders and influencers, including the media, government agencies, health professionals and health organizations, and public interest groups.
7. Develop baseline data on issue areas in order to provide "fuel" for positive, pro-active public relations programs.
8. Use issues management policies and priorities to guide public relations and image improvement initiatives.

Leverage Point: Issues Management

ISSUE:

An unsettled matter that generates discussion and debate, and may ultimately lead to decisions and actions which affect individuals and industries.

ISSUES MANAGEMENT:

The process of participating in the definition, discussion, debate, and resolution of an issue.

OUTCOMES:

1. Potentially disruptive issues are identified, defined on industry-acceptable terms, and resolved before they adversely affect the marketing climate for beef or the business climate for cattle producers.
2. Government actions (legislative, judicial, and regulatory) that adversely affect cattle producers are prevented or minimized.
3. Government actions are taken that maintain or enhance the business opportunities for cattle producers.
4. The beef industry speaks with one voice, developing messages that are consistent, complementary, and positive for consumers.
5. All components of issues management (policy development, government affairs, public relations, producer awareness, research/intelligence, third-party experts, coalitions, industry initiatives, partner communications) are effectively coordinated at all levels (state and national.)

ASSUMPTIONS:

1. Issues requiring management will continue to arise.
2. Proposed legislation and regulations that adversely affect cattle producers will continue to increase in frequency and severity.
3. The beef industry will continue to have a strong, broad-based, grass-roots, policy development process to provide direction for issues management.
4. Agribusiness will be hesitant to develop controversial, new technologies.
5. Current mega-marketers of beef (i.e. McDonalds, etc.) will continue to promote beef products despite attacks by special interest groups.

ACTION POINTS:

1. Utilize a single issues management team for each issue category. Teams will cover all components of issues management and will be accountable to cattle producers.
2. Conduct attitude research and economic research in order to facilitate issue priority-setting by the industry.
3. Identify and train additional third-party experts.
4. Successfully place facts regarding industry issues in the media.
5. Use coalitions, appropriate for specific issues, to improve public attitudes.
6. Establish and implement rapid, coordinated, effective industry response plans for major issues.
7. Gather and develop data to support the role of the bovine in the environment.
8. Utilize a strong grassroots policy process to develop, guide, and prioritize issues management initiatives, including a strong, effective legislative, regulatory, and judicial affairs effort to protect the business, marketing, and free enterprise climate for beef producers.

Leverage Point: Production Efficiency

PRODUCTION EFFICIENCY:

Optimum use of renewable resources, capital, land, management, and technology to produce a consistent, high-quality, competitively-priced food product.

OUTCOMES:

1. Reduce average production costs by 10 percent.
2. Achieve efficiency improvements identified in the Beef Quality Audit.
3. Industry acceptance and implementation of standardized economic and production evaluation systems.

ASSUMPTIONS:

1. Recommendations of the Beef Quality Audit will be adopted by the industry.
2. Current and future technological advances will be acceptable to producers and consumers.
3. Social/animal activists' agendas will continue to affect production/processing practices.

ACTION POINTS:

1. Update, expand, and communicate the value of the Beef Quality Audit.
2. Encourage the utilization of strategic alliances to reduce costs.
3. Increase coordination and triple the use of a national Integrated Resource Management/Standardized Performance Analysis program by 1997.
4. Implement pricing systems between packers and feeders that are based on retail values.
5. Eliminate duplication of animal processing between segments.
6. Develop a process for animal identification from birth to consumption.
7. Increase, coordinate, and evaluate research and development that focus on cost savings, efficiency, and product quality, with emphasis on the cow-calf segment.
8. Establish genetic guidelines — based on feed efficiency, reproductive efficiency, and carcass characteristics — that recognize environmental conditions while meeting consumer needs.

Leverage Point: Strategic Alliances

STRATEGIC ALLIANCES:

An arrangement between two or more business entities to achieve/enhance efficiencies and profitability while shifting from a production-driven to a consumer-driven industry.

OUTCOMES:

1. Share information regarding product values as seen by the consumer with the entire production system.
2. Reduce the dollar losses identified in the Beef Quality Audit by 25 percent by 1997.
3. Improve the quality of end products and increase consumer demands.
4. Establish consumer-driven product specifications.
5. Establish an industry environment that fosters market driven alliances.
6. Create a positive shift in genetics that provides a consumer-driven end product.

ASSUMPTIONS:

1. Strategic Alliances will be accepted and will result in increased efficiencies, i.e., cost containment.

ACTION POINTS:

1. Identify and communicate information on successful strategic alliances to the industry.
2. Encourage the development of cost-effective technology to provide for animal and carcass identification.
3. Incorporate livestock marketing groups in the development of strategic alliances.
4. Facilitate programs that encourage small producers to participate in strategic alliances.
5. Facilitate strategic alliances among retailers, packaging companies, and processors in order to develop packaging innovations and other case management techniques that reduce retailers' handling costs.
6. Mobilize allied groups, such as National Associates Council members, to facilitate development of strategic alliances.

Leverage Point: Producer/Packer Alliance

PRODUCER/PACKER ALLIANCE:

Mutually beneficial relationships that require communication and cooperation and enhance product value and profit opportunities.

OUTCOMES:

1. Successful packer participation in the long range plan of the beef industry.
2. Cooperation from the packer segment to better communicate consumer demands back to producers.
3. Value-based marketing system that reflects consumer demands.
4. Mutual cooperation, creating positive relationships.
5. Adopt a uniform standard of consumer-responsive, post-slaughter technologies.
6. Identify and communicate price signals that will guide genetic decisions.

ASSUMPTIONS:

1. Packers and producers will cooperate, adopt technology, and share information.
2. Packers recognize the value of a stable beef industry, with a consistent supply.
3. Packers will recognize individual opportunities for a competitive advantage by actively participating in long range plan activities.

ACTION POINTS:

1. Implement a pricing system between packers and feeders that reflects retail values.
2. Bring packers into the ongoing industry planning process so that packers and producers have a mutual vision.
3. Establish a formal communications process from consumer to packer to feeder to producer in order to make the entire beef industry consumer-driven.
4. Help develop industry-wide carcass standards.
5. Jointly develop tools to measure quality, consistency, and safety.
6. Help develop an industry-wide cattle/product identification system.

Structure

The structure must provide the mechanism for the industry to achieve the outcomes outlined in the plan.

After analyzing the current organizational structure, the Task Force concluded that the current structure could not achieve the outcomes in the plan.

WHAT'S WRONG WITH TODAY'S STRUCTURE	HOW TO MAKE IT RIGHT
1. The industry today is production-driven, not consumer-oriented.	1. Listen to our customers — develop a market/consumer orientation.
2. The industry does not have a unified, clearly-defined plan with measurable objectives.	2. Develop a unified national planning process, with accountability driving that process.
3. There is confusion about who speaks for the U.S. Beef Industry.	3. Establish one spokesperson (organization) for the beef industry.
4. There is a lack of accountability when things go bad.	4. Establish line of authority and assign responsibility, with emphasis on accountability for achieving the plan goals and objectives.
5. The industry has an excess of organizations, meetings, administrative costs, and directors, resulting in a lack of efficiency, cooperation/coordination, and effectiveness.	5. Develop an organizational structure that will provide focus, control and coordination, and will be cost effective.
6. There is a lack of coordination and cooperation between state and national organizations and activities.	6. Do fewer things, but do these things better at all levels (focus on priorities).
7. We spend too much time selling the "organization", not enough time selling the product and serving the paying beef producers.	7. Develop an organization which will implement the elements of the plan to the benefit of the paying beef producers.
8. There is concern about multi-species organizations. ■ Can they work in a highly competitive environment?	8. Address the need and role for the multi-species organizations in terms of how best to represent red meat.
9. Board members — organizations often don't provide sufficient orientation and training to enable members to rapidly contribute; nor are skills and talents always properly matched.	9. Match skills and talents of individuals with Board needs and offer orientation and training to help members more rapidly and effectively serve.

Structure: Criteria

Any organizational structure must provide certain benefits to paying beef producers. The following structural criteria assure that results are achieved:

A. **Focus:** The industry must be able to **focus** on the achievement of outcomes (desired results) specified in the eight leverage points (strategic points of impact) defined in the plan.

B. **Coordination:** The structure must provide for better **coordination and cooperation** among all industry participants as well as among organizational staff in achieving the outcomes of the plan.

C. **Control:** The structure must ensure that flexible and appropriate mechanisms (**controls**) are established within the organization. These controls should cause self-correcting actions that enable results to be achieved in a rapidly changing and highly competitive environment.

D. **Cost Effectiveness:** The structure must achieve the outcomes of the plan in a **cost-effective** manner.

The existing structure within the industry does not meet the above criteria. Without the benefits of focus, coordination, control and cost effectiveness, the outcomes cited in the plan cannot be met.

Alternatives to the existing structure were examined by the Task Force. Options included structures which were based upon geographical regions, customer segments, functions or end-products. **The conclusion reached was that the best structural alternative is a unified national organization built around the eight leverage points outlined in the plan.**

Structure: Parameters

STAKEHOLDERS	*Stakeholders are the backbone of the U.S. cattle industry. They are in the beef business and their livelihood depends on its success. They pay money in dues, checkoffs, and other funding.*
BOARD	*Drawn from a representation of stakeholders.*
EXECUTIVE COMMITTEE	*Small, talented group determined by Board—hires CEO, ensures that results are attained.*
CEO	*Implements plan. Hires staff.*
Functions of the structure below will be based on leverage points	*These will be developed by the Oversight Committee, Transition Team(s), and C.E.O.*

Parameters Continued

STAKEHOLDERS

- State Cattle Associations
- Breed Associations
- Qualified State Beef Councils
  - Dairy
  - Veal
  - Livestock Marketers
- Cattlemen's Beef Board
  - Dairy
  - Veal
  - Livestock Marketers
  - Importers
- American National CattleWomen
- Individual dues-paying cattlemen and cattlewomen
- Packers/Processors/Purveyors

BOARD COMPOSITION AND FUNCTION

- Membership "formula based"
  - Financial contributions
  - Cattle numbers
  - Geographic
  - Segment - sector
- Actual composition will result from a Transition Team's study and recommendations.
- "Board Members" will reflect broad-based, grassroots ownership of the organization.
- Board sets policy and establishes Executive Committee membership

EXECUTIVE COMMITTEE

- Working-size group
- Update and carry on strategic planning function
- Resource allocation
- Accountability for results
- Hire and fire CEO
- Power to act on behalf of the board in accordance with board policy

CHIEF EXECUTIVE OFFICER

- Ensures that the plan is implemented and key objectives are achieved
- Staff selection
- Manages the organization

Goals For The Decade

1. To establish U. S. beef as the world standard for food quality and safety.

2. To create a single, unified industry organization that is lean, responsive, efficient, and effective.

3. To increase market share while maintaining industry profitability.

4. To foster strategic alliances which enable all segments and sizes of operations to enjoy profits and consistently produce what consumers want.

5. To ensure that grassroots-driven policies are effectively developed and managed to position the industry with one voice, as an influential force in public affairs.

6. To adopt efficiencies throughout the beef industry that allow the industry to provide its customers a quality, yet cost-competitive product.

7. To instill confidence among consumers and key influencers that beef is a safe, wholesome, nutritious food product that meets consumer taste preferences and is produced under environmentally-friendly conditions.

8. To increase access and acceptance of U.S. beef in international markets.

9. To base production and processing management decisions on consumer preferences from conception to consumption.

10. To provide a business environment that stimulates quality beef production at a profit.

CROSSBREEDING WITH A NEW TARGET

Don D. Kress
Animal and Range Sciences Department
Montana State University
Bozeman, MT 59717

Crossbreeding in the beef industry has changed dramatically from the early 1970's by becoming a more thoughtful, purposeful, objective, mature adult. There are many crossbreeding systems (Gregory and Cundiff, 1980; Kress and Nelsen, 1988; Tess and Lamb, 1992), but we will not review them all. We will focus on those crossbreeding systems, and modifications to those systems, that will help breeders meet targets for the end-product. Note that composites are discussed in the next paper by Dr. Gosey, so I will avoid discussing composites here even though there are some obvious places where composites would work well.

Some Basic Principles

There is an **inverse relationship between heterosis and heritability** for different classes of traits. For example, reproductive traits normally have high heterosis and low heritability, while end-product traits have low heterosis and high heritability. Production traits tend to be intermediate for both heterosis and heritability. Therefore, we utilize crossbreeding in the cow herd to take advantage of heterosis for reproductive traits. And, we utilize crossbreeding for end-product traits by optimizing contributions from different breeds so that traits are properly balanced.

It is important that commercial producers use crossbred cows, but it is perhaps even more important that these **crossbred cows are matched to the production environment and feed resources** (Baker and Carter, 1982; Hearnshaw and Barlow, 1982; Kress, 1993). Thus, as we discuss crossbreeding for new targets, we must not forget the old target - matching the biological type of the cow to the available resources. If focusing on a new target causes us to have a mismatch between cow type and resources, then it will not be a successful crossbreeding system. In fact, focusing on end-product targets should take place within the context of already having the cow type matched to the enterprise resources.

It is desirable to produce a **consistent product**. We need to remember, however, that absolute consistency will never happen due to the fact that there is normal variation among animals that are bred exactly the same. As Cundiff et al. (1994) and others have shown, this normal variation can be depicted as a bell-shaped curve. We can design systems that reduce variation, but it can not be eliminated. As we evaluate different sectors of the beef industry, we want consistency or a smaller amount of variation in the feeder, packer, retailer and consumer sectors. However, we **need a large amount of variation in the seedstock and commercial cow-calf sectors** so that we are positioned to match biological types of cows to environments and resources. Thus, the real challenge is to design effective crossbreeding systems that allow for diversity in the cow-calf sector and that deliver consistency of the end-product.

There are some important **genetic antagonisms** that need to be considered when implementing a crossbreeding system designed to meet end-product targets. Genetic antagonisms are the result of unfavorable genetic correlations between traits. They may be nature's way of forcing cattle breeders to keep traits in balance. The primary genetic antagonism within the cow-calf sector is the undesirable relationship between rapid growth and calving ease. The primary genetic antagonisms between the cow-calf sector and the feedlot-packer sectors are the unfavorable relationships between fertility/reproduction and low fat/high yield and between cow mature size and rapid growth. The primary genetic antagonism among end-product traits is the undesirable relationship between carcass marbling and carcass lean yield. Cundiff et al. (1994) have concluded from the MARC carcass data that an optimum trade-off between marbling and yield can be achieved with a 50% English - 50% Continental carcass. Results from Lamb et al. (1992) indicate that 50% English - 50% Continental breed combinations were more efficient at all end points. Thus, we will use **50% English - 50% Continental as a rule of thumb target** for breed combinations to optimize the balance between marbling and yield.

There are many crossbreeding systems and I believe that there is a crossbreeding system that will work well for every operation, but that the best crossbreeding system will differ from one enterprise to another. The key to successfully choosing a crossbreeding system is to remember that a **crossbreeding system is a package deal** and that a breeder must take into account all of the above basic concepts, interactions, and antagonisms. This usually means that breeders have to make some trade-offs and that individual traits are at optimums rather than at extremes.

We could list many potential advantages of crossbreeding, but the very **basic properties of an effective crossbreeding system** are that it 1) provides heterosis, 2) matches cows, 3) provides uniformity within each cow herd, 4) yields consistency of product, 5) deals with antagonisms, and 6) meets the end-product target. So, it is essential that a crossbreeding system provide heterosis, especially maternal heterosis, but note that several of the above properties involve using optimum contributions from different breeds.

Crossbreeding Systems to Meet New Targets

There are two types of crossbreeding systems that will be very effective in taking into account the concepts listed above and in meeting new targets for the end-product. These two crossbreeding systems are the **rotational system using F_1 sires** and **terminal sire systems**. We will discuss these systems, and various modifications to these systems, relative to how well they can meet our objectives.

Let's start by discussing the **rotational system using F_1 sires** and we will initiate the discussion by reviewing the two-breed rotation as shown in Figure 1. The two-breed rotation has many desirable attributes (such as producing replacement heifers and being relatively easy to manage) and these are listed in the figure. However, there are two primary disadvantages of the two-breed rotation: 1) lack of complimentarity (i.e., limited ability to deal effectively with genetic antagonisms) and 2) intergenerational variation both in the cow herd and in the end-product. For example, in a two-breed rotation with Angus and Simmental after equilibrium has been reached part of the cow herd is two-thirds Angus and the other part of the cow herd is two-thirds Simmental, creating lack of uniformity for cow size and level of milk production. This intergenerational variation is also observed in feedlot and carcass traits of the market animals.

These disadvantages of the two-breed rotation can be minimized by using F_1 sires that are 50% English - 50% Continental (50E-50C). Thus, the **rotational system using F_1 sires** has the following advantages over the tradional two-breed rotation: 1) increase in heterosis (i.e., turns a two-breed rotation into a three-breed rotation in terms of amount of heterosis), 2) decreases intergenerational variation both for cows and end-product, 3) reduces some of the genetic antagonisms, and 4) meets the 50% English - 50% Continental target for market animals. I believe that this is a very good system and definitely superior to the tradional two-breed rotation. However, it does have the disadvantages of 1) not being able to completely avoid the genetic antagonisms between the cow-calf sector and the end-product and 2) matching the biological type of the cow to the production environment and resources may cause an unavoidable compromise of the target for the end-product. This last situation is most likely to occur in the arid west (where 100% English cows are desirable) or in the south (where 50% *Bos indicus* is desirable).

Figure 2 shows some of the ways to modify the two-breed rotation using F_1 sires that incorporate the above advantages. The first modification is the **rotational system using F_1 sires** where the only modification is to use the F_1 sires (completely different breeds contributing to the two types of sires but maintaining the 50E-50C goal) in place of the straightbred sires in the two breeding pastures. A second modification would be to use F_1 sires as above, except that the two F_1 sire types would have one breed in common. This could be called **F_1 sires with a breed in common in a 2-pasture rotation** (as in Figure 2) or **periodic rotational system using F_1 sires** after Bennett's periodic rotation where one breed is repeated more often in a periodic manner (Bennett, 1987). This would be especially useful where the breed in common had some very desirable qualities for either the market animals or the cow herd. Examples of this might be Red Angus for matching the cow herd to particular resources and for marbling or Brahman for matching cow types to southern environments. For the Brahman (B) example, it would also be possible to use 25B-25C-50E or 25B-25E-50C sires in locations where having 25% Brahman in the cow herd is sufficient. Another modification would be to **rotate F_1 sires in one breeding pasture**, which is the last system illustrated in Figure 2. This is patterned after the rotate sire breed system. It is very easy and simple to use and retains many of the advantages listed above. However, the easiest way to use F_1 sires would be to **continuously use the same type of F_1 sire** in the same breeding pasture (not illustrated in Figure 2). This would maintain 50% of the possible heterosis (as compared to 67% for the two-breed rotation), provide uniformity and meet the 50E-50C target.

We will initiate discussion of terminal sire systems by reviewing the **rotational-terminal sire** system as illustrated in Figure 3. This system combines the best parts from the tradional rotational systems and the static terminal sire systems. It was favored by Dr. Dickerson (1969) when he stated "Thus, the efficient commercial breeding systems probably are: ...... , terminal sire with rotation cross dams in beef cattle." The rotational part of the system provides replacement heifers while the terminal sire part of the system allows most of the marketed calves to be sired by growth/carcass type terminal sires. This type of system has many advantages such as 1) complementarity for matching cows to environment and resources while at the same time matching the terminal sire progeny to the market, 2) avoiding genetic antagonisms between the cow-calf sector and the end-product, 3) consistency of the terminal sire progeny, 4) ability to quickly change the terminal sire type to meet changing markets, and 5) all terminal sire progeny can be 50E-50C even in environments where the cow herd is all or primarily English. However, this system requires a larger herd size (at least 100), more management, three breeding pastures and roughly 30% of the marketed progeny are not from the terminal sire (making them less likely to meet the end-product target).

Figure 4 illustrates some ways in which the rotational-terminal sire system can be modified to make it more manageable and yet retain most of the advantages. The first modification that is illustrated is the **buy bred F_1 females** system. This system bypasses all of the management problems and retains all of the advantages (it even has more advantages because <u>all</u> animals that are marketed are progeny of terminal sires!). Hearnshaw et al. (1991) stated that "The use of first cross cows, and terminal sires is one of the best options to tailor production enterprises to meet market specifications." The only potential disadvantage is that all replacements must be purchased. The second modification that is illustrated in Figure 4 is the **rotational-terminal sire using F_1 sires in a 2-pasture rotation.** This system does not reduce the level of management or number of breeding pastures, but does add the advantages of F_1 sires as discussed earlier. The third modification in Figure 4 combines **rotate F_1 sires in one pasture with terminal sire.** This system requires two breeding pastures, but allows matching of cows, takes advantage of F_1 sires and takes advantage of terminal sires.

An overall comparison of the two types of systems boils down to this: the **rotational system using F_1 sires** maximizes consistency of both the cow herd and the product while **terminal sire systems** maximize the ability to simultaneously match cows to resources and product to market. Thus, if an enterprise is located where either the environment or the resources are quite limiting, a breeder may favor some form of a terminal system in order to optimally match cows. On the other hand, if the enterprise is located in a less extreme environment, a breeder may favor a rotational system using F_1 sires to maximize consistency of all market animals.

References

Baker, R.L., and A.H. Carter. 1982. Implications of experimental results with beef cattle in New Zealand. Proc. World Congr. Sheep and Beef Cattle Breeding. Dunmore Press, Palmerston North, New Zealand. Vol. 1, Technical, pp. 87-99.

Bennett, G.L. 1987. Periodic rotational crosses. II. Optimuzing breed and heterosis use. J. Anim. Sci. 65:1477.

Cundiff, L.V., K.E. Gregory, and R.M. Koch. 1994. Breeding cattle for improving product consistency. National Cattlemen's Convention and Trade Show, Jan. 26-29, Reno.

Dickerson, G.E. 1969. Experimental approaches in utilizing breed resources. Anim. Breed. Abstr. 37:191.

Gosey, Jim. 1994. The role of hybrid bulls in defying genetic antagonisms. Northwest Kansas Cattlemen's Seminar, February.

Gregory, K.E. and L.V. Cundiff. 1980. Crossbreeding in beef cattle: evaluation of systems. J. Anim. Sci. 51:1224.

Hearnshaw, H., W.R. Shorthose, D. Harrison, P. Stephenson, R.E. Darnell, and D.A. Johnston. 1991. Tailoring breeding programmes to meet consumer preferences for beef. Research Report 1989-1991, Grafton Agr. Res. and Advisory Sta., NSW Agriculture, pp. 10-13.

Hearnshaw, H., and R. Barlow. 1982. Genotype x environment interactions in crosses among beef cattle. Proc. World Congr. Sheep and Beef Cattle Breeding. Dunmore Press, Palmerston North, New Zealand. Vol. 1, Technical, p. 469.

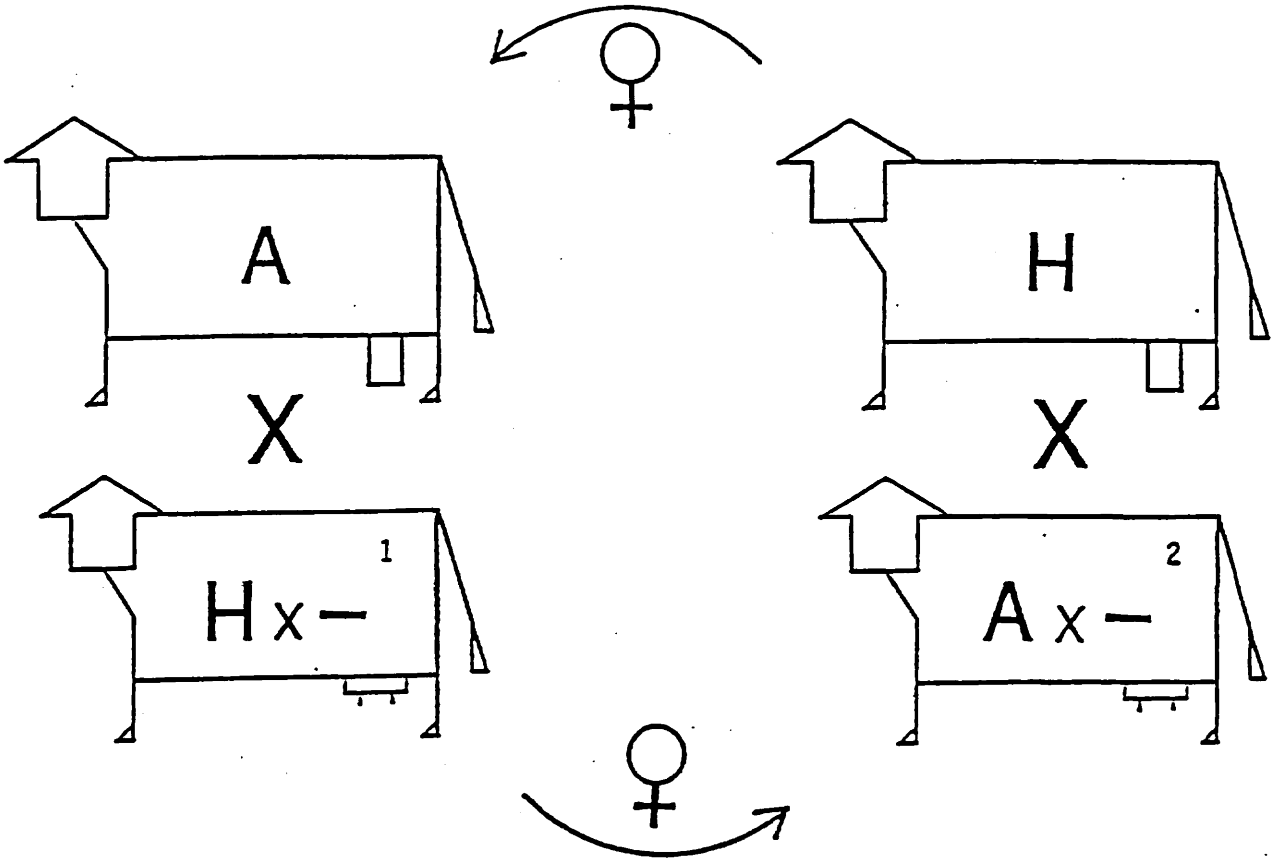
Kress, D.D., and T.C. Nelsen. 1988. Crossbreeding Beef Cattle for Western Range Environments. TB-88-1, Nevada Agr. Exp. Sta., Reno.

Kress, D.D. 1993. Matching cattle to feed resources. Proc. Matching Beef Cattle to Western Environments. (Ed. R.P. Gilbert). Gilbert Publishing, Inc., Saskatoon.

Lamb, M.A., M.W. Tess, and O.W. Robison. 1992. Evaluation of mating systems involving five breeds for integrated beef production systems: III. Integrated system. J. Anim. Sci. 70:714.

Tess, M.W., and M.L. Lamb. 1992. Crossbreeding I. Concepts and systems. *In* Genetic Aspects of Beef Cattle Production in the Southern Region (Ed. M.W. Tess and F.A. Thrift). Bull 367, Alabama Agr. Exp. Sta.

2-BREED ROTATION



1. Requires two breeding pastures or AI.
2. Utilizes individual and maternal heterosis (67% of maximum).
3. Allows limited use of complementarity.
4. Replacement females produced within the system and need to be identified by breed of sire.
5. Genetic improvement determined primarily by genetic potential of A and H sires.
6. Breeds should be similar for size and milk production.
7. Expected to increase calf production per cow exposed by 16%.

Beginning with a foundation herd of Hereford cows, breed all cows to Angus bulls. The Angus x Hereford daughters are saved for replacements and mated to Hereford bulls. The H x (AH) replacements are moved to the herd mated with Angus bulls. This continues such that daughters born in the A sire herd are bred in the H sire herd and vice versa. In any one year there are two breeding pastures with Angus bulls in one and Hereford bulls in the other.

Figure 1. Illustration of traditional two-breed rotational crossbreeding system using straightbred sires. A = Angus and H = Hereford; A x – = Angus-sired female and H x – = Hereford-sired female.

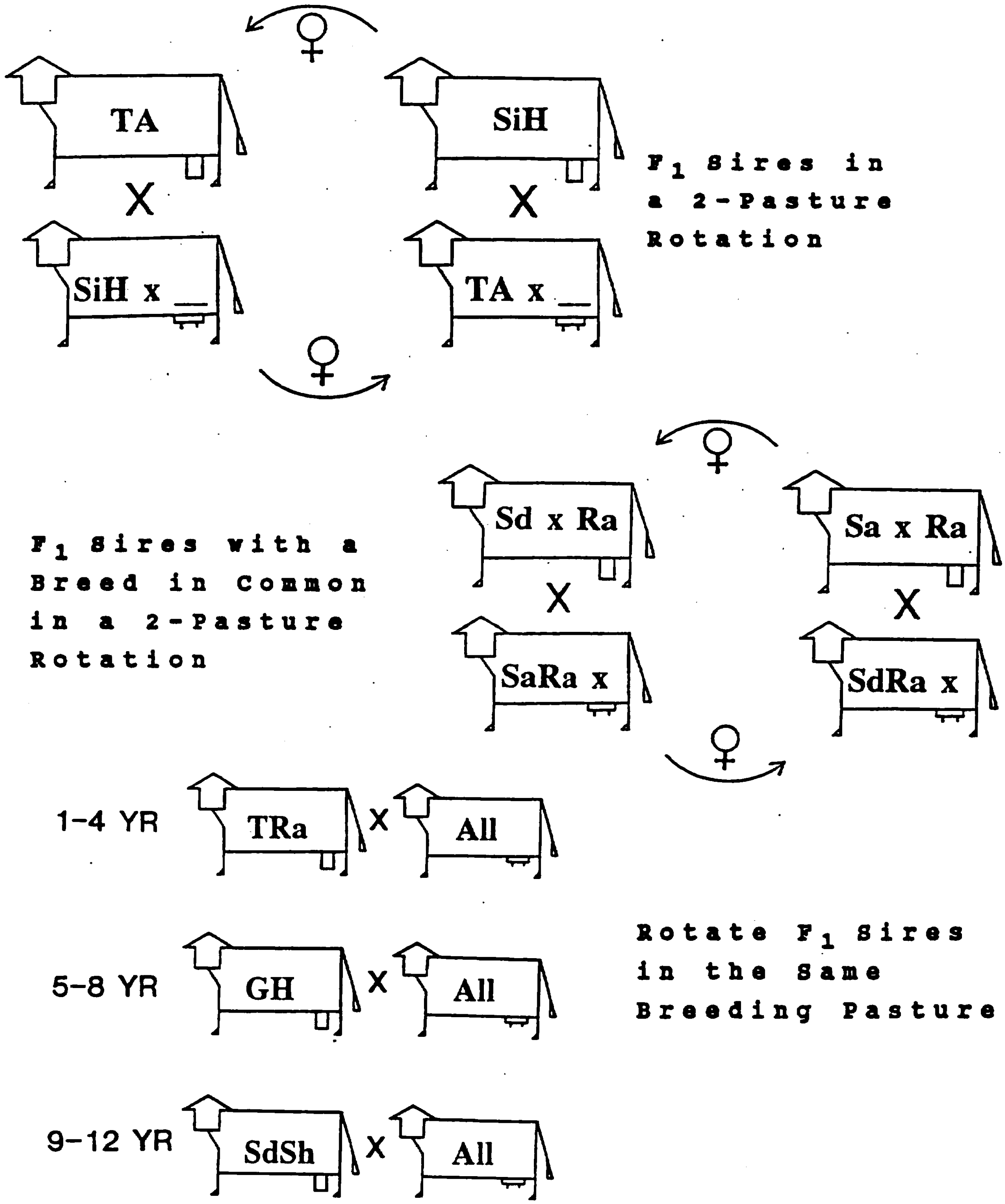
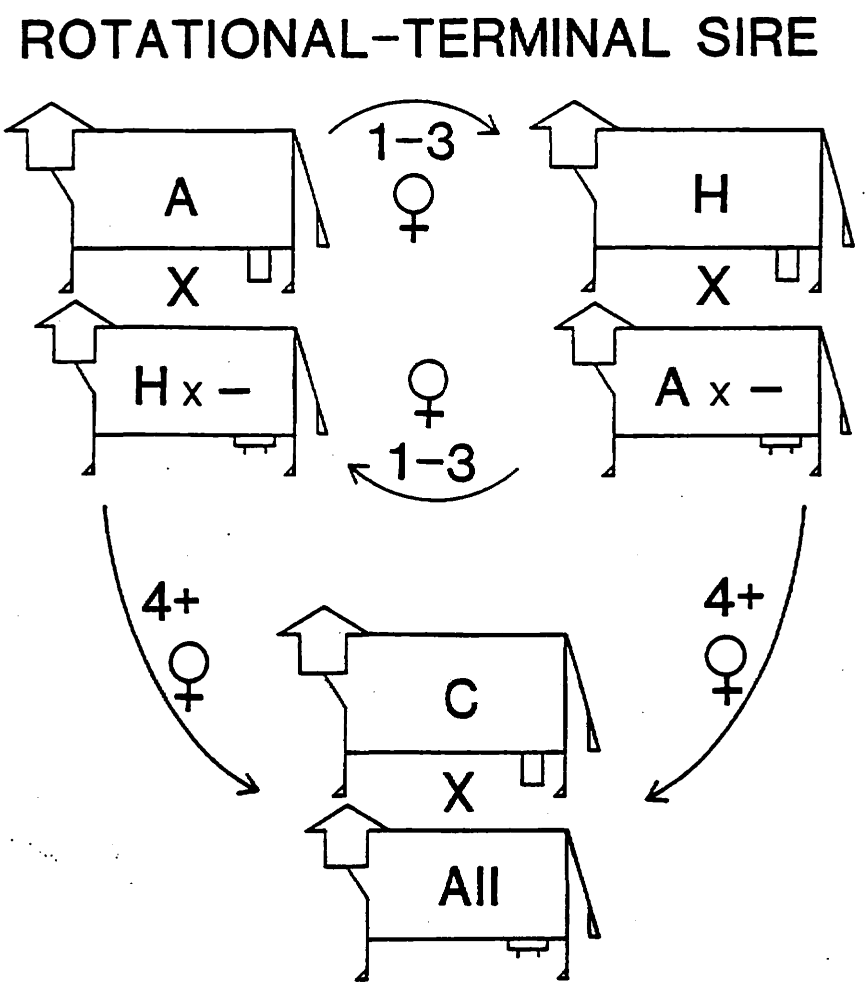


Figure 2. Illustration of modifications to a two-breed rotation using F_1 sires. A = Angus, G = Gelbvieh, H = Hereford, Ra = Red Angus, Sa = Salers, Sd = South Devon, Sh = Shorthorn, Si = Simmental, and T = Tarentaise.



1. Requires three breeding pastures or AI.
2. Approximately 45% of females in rotation and 55% of females in terminal portion of system.
3. Utilizes individual and maternal heterosis.
4. Maximizes complementarity in 55% of herd.
5. Roughly 70% of progeny marketed are from terminal sire breed.
6. AI and sexed semen would make this system more efficient.
7. Genetic improvement determined primarily by genetic potential of A, H and C sires.
8. 1- to 3-year-old females are bred in the rotational part of the system and 4-year-old and older cows are bred in the terminal part of the system.
9. Expected to increase calf production per cow exposed by 21% for 2-breed rotation and 24% for 3-breed rotation.

Figure 3. Illustration of traditional rotational-terminal sire crossbreeding system. A = Angus, H = Hereford, C = Charolais, and All = either A- or H-sired older (4+ yr) cows.

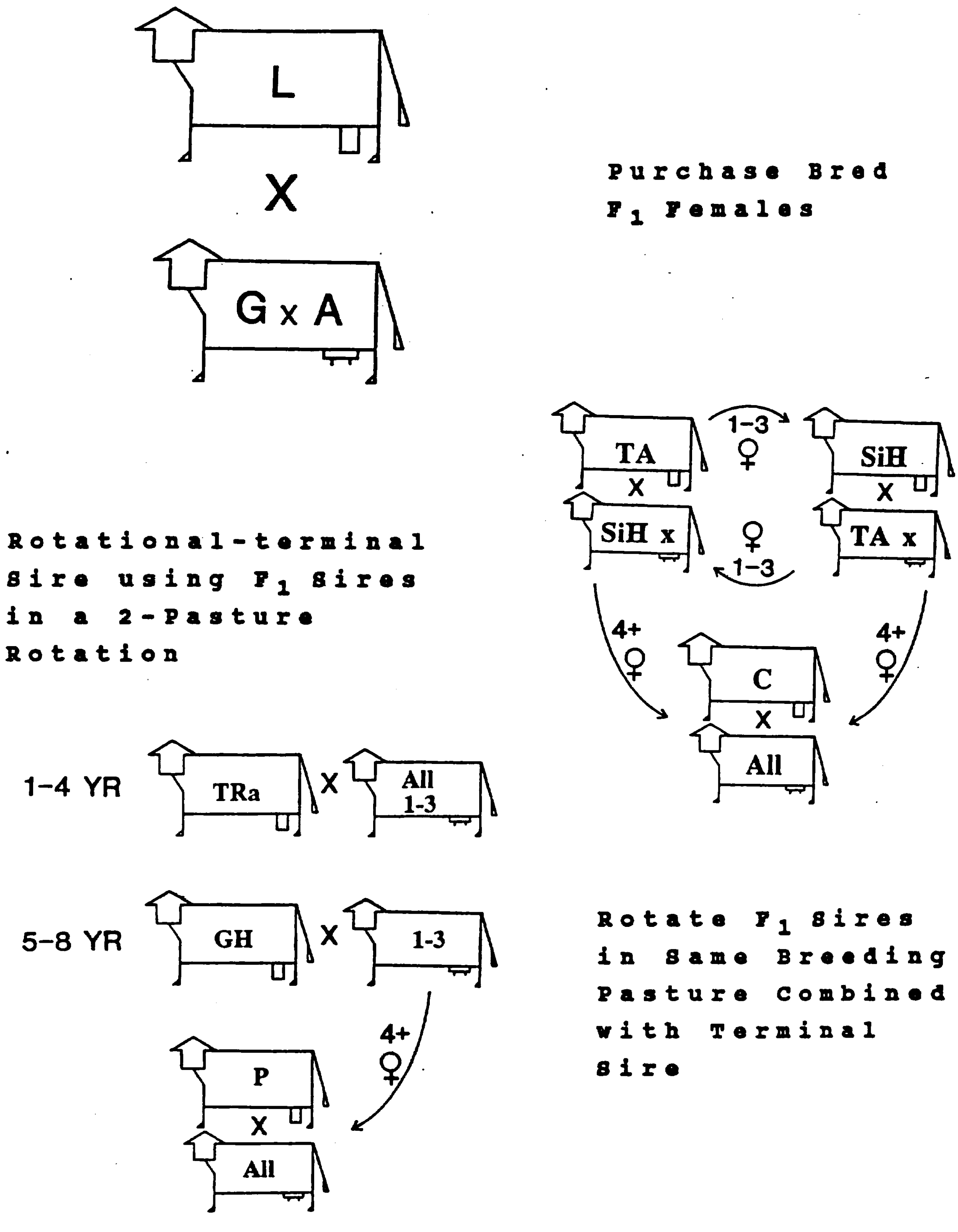


Figure 4. Illustration of modifications to terminal sire crossbreeding systems. A = Angus, C = Charolais, G = Gelbvieh, H = Hereford, L = Limousin, P = Piedmontese, Ra = Red Angus, Si = Simmental, and T = Tarentaise.

COMPOSITES: A BEEF CATTLE BREEDING ALTERNATIVE

Jim Gosey
Animal Science Department
University of Nebraska-Lincoln

Beef cattle are selected for performance in a wide range of biologically and economically important traits. Unlike the narrow selection goals of the dairy industry (pounds of milk) the beef industry is "blessed" with great diversity of selection goals. Genetic antagonisms or unfavorable genetic correlations between traits are nature's way of protecting the physiological balance needed to ensure long-term survival. Recent history has taught us the errors of single trait selection for such traits as larger size which resulted in increased calving difficulty and higher maintenance costs.

Selection for a balance of biologically and economically important traits so as to avoid extremes in any one trait seems to be the most logical approach. Crossbreeding, along with selection against extremes, offers a method to blend desirable characteristics of several breeds in an effort to use both heterosis and complimentarity while avoiding unfavorable genetic antagonisms. Composites may be the preferred tool in some commercial herds to implement such a crossbreeding/balanced trait selection program.

MAJOR GENETIC ANTAGONISMS

GROWTH/SIZE VS. CALVING EASE

Perhaps this antagonistic relationship is the most dramatic of all since the potential outcome is a dead calf or dead first-calf heifer or both. The substantial positive genetic correlation between birth weight and other weights (particularly yearling and mature weight) results in a clear conflict between growth rate/mature size and calving ease; i.e., calving ease decreases as birth weight increases. With few exceptions, the larger mature size breeds experience a greater degree of calving difficulty.

The use of higher growth cattle and calving heifers first at two years of age likely has increased calving difficulty, but the use of "heifer bulls", increased nutritional development of heifers and intensified calving attention has allowed producers to keep calving difficulty at manageable levels and calf deaths low.

GROWTH/SIZE AND MILK VS. FERTILITY

High milk and large mature size cows often have greater difficulty rebreeding, especially in short breeding seasons (< 45 days). Curiously, higher milk production has been positively associated with greater fertility; however, fertility must compete for energy along with the higher priority demands of maintenance, lactation and growth. If large, high milk cows get enough feed, they likely will not be less fertile; thus, abundant feed (or cheap feed) allows us to feed our way out of this antagonism.

Maintenance requirements are not just a function of body weight, but are a function of the relative weight of vital organs (liver, heart, lungs, gut and blood) in the cow. Cows of faster growth and higher milk production (or have genes for more milk) have greater maintenance requirements.

Generally larger cows are favored where feed availability is good and quality is restricted. Larger cows can eat more readily available low quality feed and their larger intake exceeds their increased requirements. Smaller cows are favored where feed availability is limited, even though quality may be good. Under sparse grazing conditions, large cows cannot find much more feed than small cows but have to work just as hard in the search.

Some environments provide abundant feed most of the time but sometimes fall short, such as in a drought. Highly productive cows incur greater risk of lowered fertility in years of reduced feed availability. Higher milking cows are at a fertility disadvantage when feed is limited regardless of the reason. Producers should be cautious to not breed more milk into their beef cows than their native forage will support. Some areas have the ability to produce abundant supplemental feed (corn silage, alfalfa) at reasonable cost; thus, making it possible for them to support more productive cows than their native forage base would.

Unlike calving difficulty, where a dead or damaged calf has no value; a non-pregnant (open) cow has substantial salvage value. In fact, some loss in fertility may not be particularly damaging economically if replacement costs are low and cull cow prices are good. When prices are reversed; however, the economic impact of each open cow can be substantial.

CARCASS LEAN YIELD VS. CARCASS MARBLING

Breeds that rank highest for retail product percentage (leanness) rank lowest for marbling (intramuscular fat). Also, high negative genetic correlations between retail product percent and marbling have been found within breeds.

Traditionally, marbling has been emphasized because it was believed to be associated with beef palatability. Some studies have shown a positive relationship between marbling and palatability measures, such as tenderness, while other studies have shown little or no relationship. Concern with the antagonism between marbling and retail product percentage may be justified to the extent that a certain degree of marbling is required to ensure palatability.

Significant genetic variation exists between and within breeds for marbling. Within breed, marbling is approximately 40 percent heritable; however, the heritability of between breed differences for marbling (and other traits) is much higher--approximately 100 percent.

Judicious choice of breeds and bulls with progeny carcass data will be increasingly important in dealing with this major antagonism. This antagonism can be partially managed in market cattle by controlling age, weight and days on feed. Within each breed/biological type, some optimum combination of the above factors should minimize this antagonism. At the packer-processor level this antagonism can be dealt with by trimming some of the excess fat off the carcass, but we may not be able to afford this expensive solution in the future. Some shift in consumer preferences and improved cooking methods could also lessen the importance of this antagonism to breeding programs.

BREED AND BIOLOGICAL TYPE DIFFERENCES

Table 1 shows relative differences in growth rate and mature size, lean to fat ratio, age at puberty, and milk production for a large number of breeds whose crosses have been evaluated in the Germ Plasm Evaluation (GPE) project at the Meat Animal Research Center (MARC). It is apparent from study of this table that no single breed or biological type of cattle is perfect, rather each breed has some strengths and some weaknesses.

TABLE 1. BREED CROSSES GROUPED IN BIOLOGICAL TYPE ON BASIS OF 4 MAJOR CRITERIA

Breed group	Growth rate and mature size	Lean to fat ratio	Age at Puberty	Milk production
Jersey-X	X	X	X	XXXXX
Hereford-Angus-X	XX	XX	XXX	XX
Red Poll-X	XX	XX	XX	XXX
South Devon-X	XXX	XXX	XX	XXX
Tarentaise-X	XXX	XXX	XX	XXX
Pinzgauer-X	XXX	XXX	XX	XXX
Sahiwal-X	XX	XXX	XXXXX	XXX
Brahman-X	XXXX	XXX	XXXXX	XXX
Brown Swiss-X	XXXX	XXXX	XX	XXXX
Gelbvieh-X	XXXX	XXXX	XX	XXXX
Simmental-X	XXXXX	XXXX	XXX	XXXX
Maine-Anjou-X	XXXXX	XXXX	XXX	XXX
Limousin-X	XXX	XXXXX	XXXX	X
Charolais-X	XXXXX	XXXXX	XXXX	X
Chianina-X	XXXXX	XXXXX	XXXX	X

Number of X's indicate relative amount of each trait.

For example, Jersey crosses reach puberty quickly and have substantial milk production but have relatively poor growth and low lean to fat ratio. Conversely, Chianina crosses have excellent growth and leanness but are slow to reach puberty and have low milk. Zebu cattle (Brahman and Sahiwal) are unique due to their slowness to reach puberty and other factors not shown (calving ease of females and poorer carcass tenderness).

Using the four major criteria, the breeds presented in Table 1 can be grouped into six biological types which approximate the way they can be used in crossbreeding programs. The Jersey represents small size and high milk (maternal type) while the Limousin, Charolais and Chianina group represents high lean growth and low milk (terminal type). Other biological types in between represent varying definitions of a General Purpose type with some leaning more toward a maternal type and some more toward a terminal type.

MATCHING GENETICS TO RESOURCES

Table 2 presents an important attempt by the Systems Committee of the Beef Improvement Federation (BIF) to characterize production environments and estimate optimum productivity within those environments. Production environments are feed availability and environmental stress. Feed availability refers to the quantity and quality of native forage and supplemental feed. Environmental stresses include heat, cold, humidity, parasites, altitude, mud and disease. For each of the six traits listed in the table either a Low, Medium or High level is recommended for each production environment. For example, a typical range for low, medium and high levels of cow mature size might be 800-1000 lbs, 1000-1200 lbs and 1200-1400 lbs, respectively.

TABLE 2. MATCHING GENETIC POTENTIAL FOR DIFFERENT TRAITS IN VARYING PRODUCTION ENVIRONMENTS[1]

Production environment: Feed Availability	Environmental stress[2]	Milk production	Mature size	Ability to store energy[3]	Adaptability to stress[4]	Calving ease	Lean yield
High	Low	M to H	M to H	L to M	M	M to H	H
	High	M	L to H	L to H	H	H	M to H
Medium	Low	M+	M	M to H	M	M to H	M to H
	High	M-	M	M	H	H	M
Low	Low	L to M	L to M	H	M	M to H	M
	High	L	L	H	H	H	L to M
Breed role in terminal crossbreeding systems							
Maternal		L to H	L to M	M to H	M to H	H	L to M
Paternal		L to M	H	L	M to H	M	H

[1]L = Low; M = Medium; H = High.
[2]Heat, cold, parasites, disease, mud, altitude.
[3]Ability to store fat and regulate energy requirements with changing (seasonal) availability of feed.
[4]Physiological tolerance to heat, cold, parasites, disease, mud, and other stresses.

The optimum trait levels shown in Table 2 are appropriate for General Purpose type cattle, cattle that are usually used in rotational crossbreeding programs. The lower part of the table lists optimum trait levels for both the maternal and paternal sides of a terminal crossbreeding program.

Greater feed availability and lower degree of stress results in a wider optimum range of milk. Optimum range of mature size also changes with range of feed availability. Environmental stress probably only limits mature size when feed availability is low.

Cows without the ability to store energy, when feed availability is low, often do not have enough body condition to rebreed quickly. Cows that do well in low feed environments may be fat cows in high feed-low stress environments. Since lean yield and ability to store fat are antagonistic, the optimum level of leanness varies with feed availability. A lean cow may be acceptable when feed is good but with limited feed, cows need to fatten easily.

Resistance to stress is always important, especially in high stress environments. For example, heat tolerance is critical in hot, humid regions. Calving ease may become increasingly important as stress level increases or other resources (labor) decline.

Recommendations for optimum trait levels for sires and dams in terminal crossbreeding systems vary somewhat from General Purpose types. Maternal cattle generally need more adaptability, more ability to store fat and less lean yield than General Purpose types. Milk production should be about the same but size should be less to take advantage of the complimentary effects of using growthier terminal sires. Calving ease is very important. Traits emphasized in terminal types are growth rate and lean yield. Milk production and ability to store energy are not very important in terminal types. Calving ease and adaptability in Terminal types is not as critical as in maternal types but should not be ignored.

CROSSBREEDING

Crossbreeding (the mating of animals of different breeds) is similar to outcrossing (the mating of unrelated and, thus, genetically unlike animals within the same breed). Breeders have long used outcrossing to incorporate specific traits and increase performance levels within a breed by mating animals from different families or bloodlines. Results from crossbreeding are more pronounced than outcrossing because breeds are more genetically unlike than families within the same breed.

1. **INDIVIDUAL HETEROSIS.** Heterosis (hybrid vigor) is the degree to which crossbred calves deviate from the average of calves of the parental breeds. The amount and percentage of heterosis can be calculated as follows where straightbred Angus (A), straightbred Hereford (H), and crosses between Angus and Hereford (AH and HA) were raised as contemporaries:

$$\text{Amount of Heterosis} = \frac{AH + HA}{2} - \frac{A + H}{2}$$

$$\text{Percent of Heterosis} = \frac{\text{amount of heterosis}}{\frac{A + H}{2}} \times 100$$

As an example for weaning weight, if A = 400 lb, H = 450 lb, AH = 440 lb and HA = 450 lb, then

$$\text{Amount of Heterosis} = 445 \text{ lb} - 425 \text{ lb} = 20 \text{ lb}$$

$$\text{Percent of Heterosis} = \frac{20}{425} \times 100 = 5\%$$

Note that heterosis may be positive or negative and that there may be positive heterosis even when one of the parental breeds performs better than the average of crossbreds.

2. **MATERNAL HETEROSIS.** Maternal heterosis arises from using crossbred cows. A maternal heterosis value of 6 percent for calf weaning weight means that crossbred cows wean calves that weigh 6 percent more than

if those same calves had been raised on straightbred cows. Maternal heterosis is usually greater than individual heterosis for maternally influenced traits and, as a result, crossbreeding programs should include use of a crossbred cow.

3. **COMPLEMENTARITY OF MALE AND FEMALE TRAITS.** Certain crossbreeding systems allow the breeder to match traits of the bull breed to traits of the crossbred cow. Normally this means that the breeder chooses a bull breed that will transmit rapid growth and desirable carcass traits to progeny while the crossbred cow provides ample milk for the rapidly growing calf and produces a live, healthy calf every year. Complementarity can work in a negative way in poorly designed crossbreeding programs where large, terminal sire breeds are bred to small, young, hard-calving cows.

4. **"BUILDING" THE BEST MATCH OF CROSSBRED COW TO ENVIRONMENT.** This advantage has been overlooked by some breeders. But, in many different range environments, this may be the most important consideration. There are many beef breeds available to the producer and some combination of these breeds should result in a desirable match of crossbred cow genotype to the particular range environment.

5. **EFFECTS OF CROSSBREEDING ACCUMULATE.** Crossbreeding may result in relatively small levels of heterosis (4 percent for each trait, but these heterosis effects accumulate so that there can be large increases (25 percent) in overall productivity!

6. **RAPID ADAPTATION TO CHANGING MARKET OR RESOURCES.** Terminal sire systems give the breeder an opportunity to change sires rapidly so that calves can be changed according to market demands or resources.

GENETICS OF CROSSBREEDING

Genetic effects of crossbreeding are the opposite of genetic effects of inbreeding. Whereas inbreeding tends to increase the number of gene pairs that are homozygous (both members of a gene pair are alike; AA or aa) in the population, crossbreeding tends to increase the number of gene pairs that are heterozygous (members of a gene pair are different; Aa). Livestock producers have long known that when animal populations are subjected to inbreeding, the performance level of certain traits tends to be reduced below that of the non-inbred population (inbreeding depression). It is inevitable that existing breeds of beef cattle become mildly inbred lines, and to the extent that heterosis is due to the dominance effects of genes, heterosis is the recovery of accumulated inbreeding depression. There are two basic genetic requirements for a trait to exhibit heterosis:

1. There must be genetic diversity between the breeds crossed, and

2. There must be some non-additive gene effects present for the particular trait involved.

The failure of either one of these conditions being fulfilled for a particular cross for some trait would result in that trait exhibiting no heterosis. In such a case, expected performance of the crossbred offspring would simply be the average of the performance levels of the particular straightbred parents involved in the cross. For those traits that express heterosis, the magnitude of heterosis will be dependent upon how much genetic diversity exists between the two breeds crossed and the relative importance of non-additive gene effects that are involved in the genetic determination of that trait.

GENETIC DIVERSITY

Genetic diversity refers to the degree of genetic similarity or dissimilarity that exists between the two breeds. Two breeds will be quite similar genetically for a trait if the gene frequencies are about the same at most of the loci (gene pairs) that control a particular performance trait. On the other hand, if two breeds have quite different gene frequencies at the majority of the loci controlling a trait, they will be quite dissimilar genetically. Breeds having similar origins and that have been subjected to similar types of selection pressure during their development will be expected to be much more alike genetically (small amount of genetic diversity) than would breeds that have quite different origins and have been selected for different purposes during their development.

NON-ADDITIVE GENE EFFECTS

Non-additive gene effects refer to the kinds of gene actions that exist with regard to the many gene pairs that are involved in determining a particular performance trait. Non-additive gene effects are expressed by individual gene pairs due to level of dominance that exists between different genes present at that particular locus. The non-additive gene effects at individual loci (gene pairs) can be caused by complete dominance, partial dominance or overdominance. If gene effects are strictly additive, the effect of the heterozygote (Aa) is exactly intermediate between the effects of the two homozygous genotypes (AA and aa). Loci (gene pairs) with this kind of gene action will not make any contribution to heterosis. Complete dominance is a very common genetic property that exists when the effect of the heterozygote is closer to that of one of the homozygotes without being exactly the same. Overdominance describes the situation whereby the heterozygote has a more extreme effect than with homozygote. To whatever extent they occur, gene pairs that exhibit overdominance would have a relatively large effect on the amount of heterosis exhibited by a trait. It is not really known, however, how prevalent gene pairs exhibiting overdominance are among the many loci that control livestock performance traits. Although some examples of overdominant gene pairs are known, this phenomenon is not nearly as frequently encountered as is partial and complete dominance.

COMPLEMENTARITY AND BREED DIFFERENCES

In addition to heterosis, crossbreeding allows cattlemen to combine the strengths of two or more breeds, thus achieving a higher frequency of desirable traits among crossbreds than that found in a single breed. Breed complementarity simply means that strengths of one breed can complement or cover up weaknesses of another breed. This effect of breed differences is very powerful. Poor choices of breeds and bulls within a breed will have a lasting impact on the success of any crossbreeding plan.

CONVENTIONAL CROSSBREEDING SYSTEMS

TWO-BREED ROTATION

The two-breed rotation is initiated by mating cows of breed A to bulls of breed H, with the resulting heifers mated to bulls of breed A for their entire lifetime. In each succeeding generation, replacement heifers are bred to bulls of the opposite breed than their sire as shown in figure 1.

A minimum of two breeding pastures are required for this system and replacement heifers must be identified by breed of their sire. Two breeds of bulls are required after the first two years of mating and the breeds chosen should be comparable in birth weight, mature size and milk production in order to minimize calving difficulty in first-calf heifers and stabilize nutrition and management requirements in the cow herd. The two-breed rotation does generate replacement heifers within the herd and restores a substantial level of heterosis from one generation to the next. The level of heterosis in a two-breed rotation is, on the average, expected to stabilize after a few generations at 67 percent of maximum for both the individual and maternal components of heterosis.

THREE-BREED ROTATION

The three-breed rotation follows the same pattern as is followed with the two-breed rotation, but a third breed is added to the rotation as indicated in figure 2.

The management requirements for the three-breed rotation are similar to those for the two-breed, with the obvious exceptions being an increase from 2 to 3 in number of breeding pastures needed and breeds of bulls needed. Identifying three sources of bulls from breeds which are comparable has proven to be difficult for some producers who don't wish to use artificial insemination. The three-breed rotation does sustain a higher level (86 percent of maximum individual and maternal heterosis) of heterosis than the two-breed rotation because the relationship of bulls and cows mated is more remote, thus less backcrossing is involved.

The level of heterosis in rotational systems fluctuates in the early generations, but once crossbred cows enter the system, this fluctuation is negligible in terms of performance, because a relatively lower level of heterosis in calves in one generation is offset by a higher level of heterosis in cows and vice versa for succeeding generations.

Rotational systems appeal to many people because replacement heifers are produced within the system. This is an important point, but genetic improvement within the herd is still largely determined by the bulls selected. Several research experiments have demonstrated that 80 to 90 percent of genetic improvement within a herd is attributable to sire selection.

ROTATIONAL-TERMINAL SIRE SYSTEM

This system (figure 3) involves the use of rotational matings of maternal or all-purpose breeds in a portion of the herd to provide cross-bred replacement females to the entire herd; the older (4 years old and older) crossbred cows are then mated to a terminal sire breed for the remainder of their productive life. The rotational portion of the herd would require about 45 percent of the cows, leaving about 55 percent of the cows to be mated to the terminal sire breed.

The maternal rotation portion of this system can be run with either two or three breeds. Two or three breeds in the maternal rotation would require 3 or 4 breeds of bulls and 3 or 4 breeding pastures, respectively. Cows must be identified by breed of sire and year of birth.

The rotational-terminal system is a very productive system because about 70 percent of the calves marketed are by the terminal sire breed, the remaining 30 percent being steers from the rotational maternal breed matings. This system would sustain a higher level of production than either the two- or three-breed rotation, however both the two- and three-breed rotational-terminal sire systems require a high level of management.

Table 3 illustrates the expected cow productivity from a wide variety of different crossbreeding systems. The measure of cow productivity is the pounds of calf weight weaned per cow exposed to breeding and refers to the crossbred advantage relative to straightbreds.

SIMPLIFIED CROSSBREEDING SYSTEMS

In many herds the level of management required to use some of the conventional crossbreeding systems which maximize heterosis, utilize complimentarity through terminal sire breeds and reduce costs of production most efficiently are simply not feasible. It is possible, with some modification, to use the basic principles from the crossbreeding systems previously discussed to design some simplified crossbreeding systems which produce some of the benefits of crossbreeding, yet avoid many of the limitations of the conventional systems.

For some cattlemen, artificial insemination (A.I.) could be used to simplify a conventional crossbreeding system. An example would be, all cows and heifers bred A.I. to two maternal breed bulls for 21 days, then the cows bred naturally to a terminal breed for the remainder of the breeding season.

SIRE BREED ROTATION

A simple alternative to conventional crossbreeding options is a sire breed rotation as illustrated in Figure 4. This one-pasture system involves one sire breed being used on all females for one to four years. Small herds with only one or two bulls should consider rotating sire breeds every two years to avoid inbreeding. A sire-breed rotation using three breeds would yield a 16 percent advantage compared to a 20 percent advantage for a conventional three-breed rotation and 15 percent for a three-breed composite. This sacrifice in heterosis may be very acceptable to many cattlemen in order to simplify management of the breeding program.

COMPOSITE BREEDS

Another alternative to the more complex crossbreeding systems is the development of composite breeds based on matings among crossbred animals resulting from crosses of two or more breeds (Figure 5). The management of a composite breed system is simple, especially for producers who have limitations on herd size and number of breeding pastures. Only one breeding

TABLE 3. COMPARISON OF CROSSBREEDING SYSTEMS[1]

Type of system	Advantage (%)[2]
Conventional Crossbreeding Systems	
Rotation	
2 - breed	16
3 - breed	20
4 - breed	22
Static terminal sire (3-breed)	20
Static terminal sire (2-breed)	9
Rotational terminal sire	
2 - breed	21
3 - breed	24
Simplified Crossbreeding Systems	
Rotate sire breed	
2 - breed	12
3 - breed	16
2 - breed rotation with F_1 sires	19
Multiple sire breed with crossbred females	
2 - breed	10
3 - breed	15
Multiple sire breed with straightbred females	
2 - breed	7
3 - breed	7
Composite[3]	
2 - breed	13
3 - breed	15
4 - breed	17
8 - breed	20
Static terminal sire	
- buy straightbred females	24
- buy crossbred F_1 females	28
- buy composite or rotational	20 to 27
Combinations of Crossbreeding Systems	
2 - breed rotation and rotate sire breed (2)	19
2 - breed rotation and multiple sire breed (2)	20
Rotate sire breed (2) and multiple sire breed (2)	19
Static terminal sire with crossbred male	20 to 25
Rotate sire breed (3) with terminal sire	24

[1]After Gregory and Cundiff (1980), Baker (1982), Kress (1985) and others.

[2]Percentage advantage for pounds of calf weaned per cow exposed when compared to the average of the breeds involved in the crossbreeding system. Assumes 80% calf crop weaned, 20% replacement rate, individual heterosis = 8.5%, maternal heterosis = 14.8% and 5% increase in calf weight due to terminal sire. Also, assumes that cow breed type has been adequately matched to environment and sire genotype and that proper advantage has been taken of complementarity of sire genotype and dam genotype in terminal sire systems.

[3]Breeds in equal or nearly equal proportion.

pasture would be required and no identification of females by sire or year of birth would be required. Replacement females would be generated within the system.

Composite breeds do not sustain as high of level of heterosis as do rotational systems, however composite breeds do allow for more complementarity between breeds to be utilized. For example, breeds which vary considerably in mature size, milk production and carcass merit could be utilized in forming a composite breed fitted to specific feed resources, environmental and climatic conditions.

Also to be considered is the importance of paternal heterosis, since bulls in a composite system are crossbreds too. Utilizing composite breed bulls may serve as an extra bonus, since some studies have indicated evidence for paternal heterosis in some semen traits, libido and mating vigor of crossbred bulls.

Thus, the formation of composite breeds based on a multi-breed foundation is an attractive alternative to conventional crossbreeding systems. Once a new composite breed is formed, it can be managed as a straightbred population, and the management problems that are associated with small herd size and with fluctuations between generations in additive genetic composition in rotational crossing systems are avoided.

GENETIC BASIS OF COMPOSITE BREEDS

Retention of initial heterozygosity after crossing and subsequent random (inter se) mating within the crosses is proportional to (n-1)/n, where n is the number of breeds involved in the cross. This loss in heterozygosity occurs between the F_1 and F_2 generations. If inbreeding is avoided, further loss of heterozygosity in an inter se mated population does not occur. This expression, (n-1)/n assumes equal contribution of each breed used in the foundation of a composite breed. Table 4 provides information on level of heterozygosity relative to the F_1 that is retained after equilibrium is reached for two-, three- and four-breed rotation crossbreeding systems and is presented for two-, three-, four-, five-, six-, seven- and eight-breed composites, with breeds contributing in different proportions in several of the composites. Existing breeds of cattle are mildly inbred lines, and to the extent that heterosis is due to the dominance effects of genes, heterosis is the recovery of accumulated inbreeding depression.

If retention of heterosis is linearly associated with retention of heterozygosity, composite breed formation offers much of the same opportunity as rotational crossbreeding for retaining individual and maternal heterosis, in addition to heterosis in male reproductive performance (Table 4). Further, composite breeds offer the opportunity to use genetic differences among breeds to achieve and maintain the performance level for such traits as climatic adaptability, growth rate and size, carcass composition, milk production and age at puberty that is most optimum for a wide range of production environments and to meet different market requirements. Further, composite breeds may provide herds of any size with an opportunity to use heterosis and breed differences simultaneously.

TABLE 4. HETEROZYGOSITY OF DIFFERENT MATING TYPES AND ESTIMATED INCREASE IN PERFORMANCE AS A RESULT OF HETEROSIS

Mating type	Hetero-zygosity percent relative to F_1	Est increase in calf wt wnd per cow exposed[a] (%)
Pure breeds:	0	0
Two-breed rotation at equilibrium	66.7	15.5
Three-breed rotation at equilibrium	85.7	20.0
Four-breed rotation at equilibrium	93.3	21.7
Two-breed composite:		
F_3 - 1/2A, 12/B	50.0	11.6
F_3 - 5/8A, 3/8B	46.9	10.9
F_3 - 3/4A, 1/4B	37.5	8.7
Three-breed composite:		
F_3 - 1/2A, 1/4B, 1/4C	62.5	14.6
F_3 - 3/8A, 3/8B, 1/4C	65.6	15.3
Four-breed composite:		
F_3 - 1/4A, 1/4B, 1/4C, 1/4D	75.0	17.5
F_3 - 3/8A, 3/8B, 1/8C, 1/8D	68.8	16.0
F_3 - 1/2A, 1/4B, 1/8C, 1/8D	65.6	15.3
Five-breed composite:		
F_3 - 1/4A, 1/4B, 1/4C, 1/8D, 1/8E	78.1	18.2
F_3 - 1/2A, 1/8B, 1/8C, 1/8D, 1/8E	68.8	16.0
Six-breed composite:		
F_3 - 1/4A, 1/4B, 1/8C, 1/8D, 1/8E, 1/8F	81.3	18.9
Seven-breed composite:		
F_3 - 3/16A, 3/16B, 1/8C, 1/8D, 1/8E, 1/8F, 1/8G	85.2	19.8
Eight-breed composite:		
F_3 - 1/8A,1/8B,1/8C,1/8D,1/8E,1/8F,1/8G,1/8H	87.5	20.4

[a]Based on heterosis effects of 8.5% for individual traits and 14.8% for maternal traits and assumes that retention of heterosis is proportional to retention of heterozygosity.

Gregory, K.E., et al. 1990

With 55 percent of the U.S. beef breeding herd and 93 percent of the operations that have beef cows represented by units of 100 cows or fewer, there are obvious limitations on feasible options for optimum crossbreeding systems. The limitations are most significant if female replacements are produced within the herd and natural service breeding is used. Further fluctuation between generations in additive genetic (breed) composition in breed-rotation crossbreeding systems restricts the extent to which breed differences in average additive genetic merit can be used to match climatic adaptability and performance traits to the climatic and feed environment.

COMPLEMENTARITY IN COMPOSITES

Composite breeds do not permit the use of different genotypes (complementarity) for male and female parents. However, specialized paternal and maternal composite breeds may be developed for use in production systems in which the production resource base and market requirements favor the exploitation of complementarity. Between-breed selection is highly effective for achieving and maintaining an optimum additive genetic composition for such specialized populations by using several breeds to contribute to the foundation population for each specialized composite breed. There is the potential to develop general purpose composite breeds through careful selection of fully characterized candidate breeds to achieve an additive genetic composition that is better adapted to the production situation than is feasible through continuous crossbreeding or through intra-breed selection.

MINIMUM HERD SIZE FOR COMPOSITE BREEDERS

The maintenance of effective herd size sufficiently large that the initial advantage of increased heterozygosity is not dissipated by early re-inbreeding is essential for retention of heterozygosity (heterosis) in composite breed seedstock herds. Thus, the resource requirement for development and use of composite breeds as seedstock herds is high, and from an industry standpoint requires a highly viable and creative seedstock segment. Early re-inbreeding and a small number of inadequately characterized parental breeds contributing to the foundation of composite breeds have likely been major causes for failure of some previous efforts at composite breed development.

For the breeders of composite breeds, it is suggested that the number of females be sufficient for the use of not less than 25 sires per generation. Use of 25 sires per generation would result in a rate of increase in inbreeding of about .5 percent per generation. Further, a large number of sires of each purebreed contributing to a composite breed should be sampled in order to minimize the rate of inbreeding in subsequent generation of inter se mating. Inbreeding may be viewed as the "other side of the coin" to heterosis and must be avoided in order to retain high levels of heterozygosity (heterosis) in composite breeds. It should be pointed out that this constraint on minimum herd size only applies to seedstock breeders of composite breeds and no such constraint is applied to users of composite bulls which could be large or small herds. Another advantage of composites over rotations is the elimination of inter-generation variation. Advantages of rotations over composites are theoretically lower intra-generation variation, greater genetic diversity among parent populations and the ability to rapidly respond to industry/market changes.

ALTERNATIVE MATING SYSTEMS

Genetic variation in alternative mating systems is shown in Figure 4 expressed in genetic standard deviation units. Panel 1 (Figure 6) shows that genetic variation between breeds is approximately equal to genetic variation within breeds for some bioeconomic traits. For example, mean percentage retail product of Hereford or Angus is approximately six genetic standard deviation units less than mean percentage retail product for Charolais, Limousin and Chianina.

Panel 2 (Figure 6) shows the difference between generations at equilibrium in rotation crosses of two pure breeds that have a mean difference in a bioeconomic trait of six genetic standard deviation units. The optimum varies in different production and market situations for such traits as: (1) growth and size, (2) milk production, (3) carcass composition, and (4) age at puberty and is reflected by zero in Figure 6. If the mean of the two breeds is optimum, then one-half of the cattle would be more than one genetic standard deviation from the optimum in a rotational crossbreeding system of two pure breeds whose means differ by six genetic standard deviation units. Retained heterosis at equilibrium for a continuous two-breed rotation crossbreeding system is 67 percent of the F_1 level.

Another alternative is rotational crossbreeding of F_1 males. This alternative has some inherent long-term advantages. Inter-generation variation (Figure 6, panel 2) can be minimized in commercial production if breeds chosen to produce F_1's are selected to optimize performance levels in the F_1 cross. Panel 3 (Figure 6) reflects the genetic variation expected with rotational crossing of AB and CD F_1's where A and C represent a common biological type and B and D another common biological type. Then, performance is optimized in each F_1 (AB-CD). Panel 3 (Figure 6) also depicts the genetic variation expected in rotational crossing of F_1 males having one breed in common (e.g., AB-CD or AB-AD) or a composite breed based on equal contribution by each of four breeds (e.g., ABCD) can result in populations that have about two-thirds of the animals within one genetic standard deviation of the optimum. The retained heterosis at equilibrium in a continuous rotation of sires using two different F_1's (e.g., AB-CD) is 83.5 percent of the F_1 level. The retained heterosis at equilibrium in continuous rotation of sires from two F_1's having one breed in common (e.g., AB-AD) is 67 percent of the F_1 level. The retained heterosis in a four breed composite with breeds contributing equally (e.g., ABCD) is 75 percent of the F_1 level provided the population is sufficiently large to avoid inbreeding.

Genetic variation in a composite breed with equal contributions by four breeds is approximately equal to continuous rotation of sires using two different F_1's that are approximately equal (e.g., AB-CD or AB-AD), (Panel 3).

Thus, a rotational crossbreeding system using F_1 males produced from different breeds (e.g., either AB-CD or AB-AD) is preferred to a rotational crossbreeding system using two pure breeds for using breed differences to achieve a more optimum additive genetic (breed) composition. It is either superior or equal to a continuous two-breed (67%) rotational crossbreeding system for using heterosis. Similarly, a continuous rotational crossbreeding system using F_1 males of different breeds can be competitive with a composite breed based on equal contribution by four breeds for using both heterosis and breed differences to achieve an optimum additive genetic (breed) composition.

SUMMARY

The variation that exists in biological traits of economic importance to beef production is vast and under a high degree of genetic control. The range for differences between breeds is comparable in magnitude to the range for breeding value of individuals within breeds for most bioeconomic traits important to beef production. Thus, significant genetic change can result from selection both between and within breeds.

Between breed differences are more easily exploited than genetic variation within breeds because they are more highly heritable. Also, use of genetic variation within breeds is often complicated by difficulties of measurement for characteristics such as carcass and meat traits, age at puberty, and milk production. Breeds can be selected to optimize performance levels for important bioeconomic traits with a high level of precision much more quickly than within-breed selection.

However, breeds that excel in output should not necessarily be substituted for breeds with less genetic potential because of trade-offs resulting from antagonistic relationships among traits. Breeds (and sires) that excel in retail product growth potential also: (1) sire progeny with heavier birth weights and increased calving difficulty; (2) produce carcasses with lower marbling but very acceptable meat tenderness; (3) tend to reach puberty at an older age: and (4) generally have heavier mature weight. Heavier mature weight increases output per cow, but also increases nutrient requirements for maintenance. Thus, differences in output tend to be offset by input differences for maintenance and lactation so that differences in life cycle efficiency are generally small.

Because of trade-offs resulting from antagonistic genetic relationships among breeds, it is not possible for any one breed to excel in all characteristics of economic importance to beef production. Nor is it possible to expect simultaneous improvement in all characteristics by within-breed selection since similar relationships exist within breeds. Use of crossbreeding systems that exploit complementarity by terminal crossing of sire breeds noted for lean tissue growth efficiency with crossbred cows of small to medium size and optimum milk production provide an effective means of managing trade-offs that result from genetic antagonisms.

Crossbred sires (F_1's, hybrids or composites) offer the commercial breeder a simplified system of crossbreeding which will ease demands on labor and management compared to traditional crossbreeding systems. Specialized paternal and maternal crossbred lines (F_1's, hybrids or composites) could be used to exploit complementarity and overcome some of the detrimental effects of unfavorable genetic antagonisms.

ACKNOWLEDGEMENTS/REFERENCES

This paper has been adapted in part from the following references:

Bourdon, Rick. 1992. Prioritizing trait selection. Proc. Beef Improvement Federation Annual Meeting. May 6-9, Portland, OR. p. 103.

Cundiff, L.V., K.E. Gregory and R.M. Koch. 1989. Evaluation of maternal, growth and carcass characteristics of diverse breeds. Proc. Applied Animal Breeding Seminar. Meat Animal Research Center. August 23-25, Hastings, NE. p. 33.

Gosey, J.A. 1991. Crossbreeding systems and the theory behind composite breeds. Proc. Range Beef Cow Symposium XII, December 3-5, Fort Collins, CO. p. 33.

Gosey, J.A. 1987. Breeding specification cattle for the future. Proc. Range Beef Cow Symposium X, December 8-10, Cheyenne, WY. p. 218.

Gregory, K.E., L.V. Cundiff and R.M. Koch. 1993. Germplasm utilization in beef cattle. Beef Research Progress Report No. 4. Meat Animal Research Center. p. 7.

Gregory, K.E., L.V. Cundiff and R.M. Koch. 1993. Use of crossbreeding and breed differences to meet specific targets for production and carcass traits of beef cattle. Beef Research Progress Report No. 4. Meat Animal Research Center. p. 20.

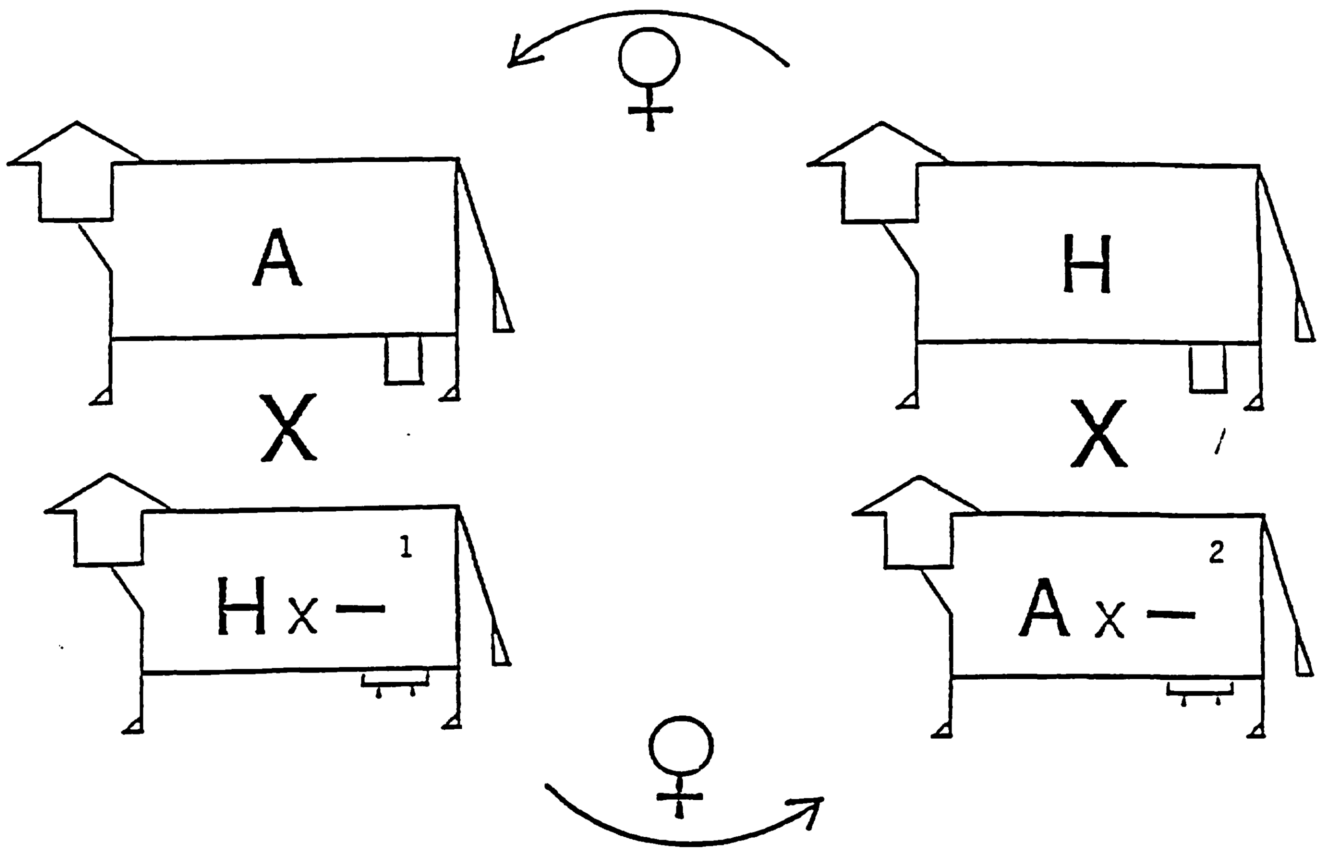
Kress, D.D. 1989. Practical breeding programs for managing heterosis. Proc. Range Beef Cow Symposium XI. Rapid City, SD. p. 44.

Kress, D.D. and T.C. Nelsen. 1988. Crossbreeding beef cattle for western range environments. Nevada Agr. Exp. Sta., TB-88-1. p. 31.

Using the systems concept for beef improvement. 1990. Beef Improvement Federation Guidelines. pp. 70-71.

Figure 1

2-BREED ROTATION



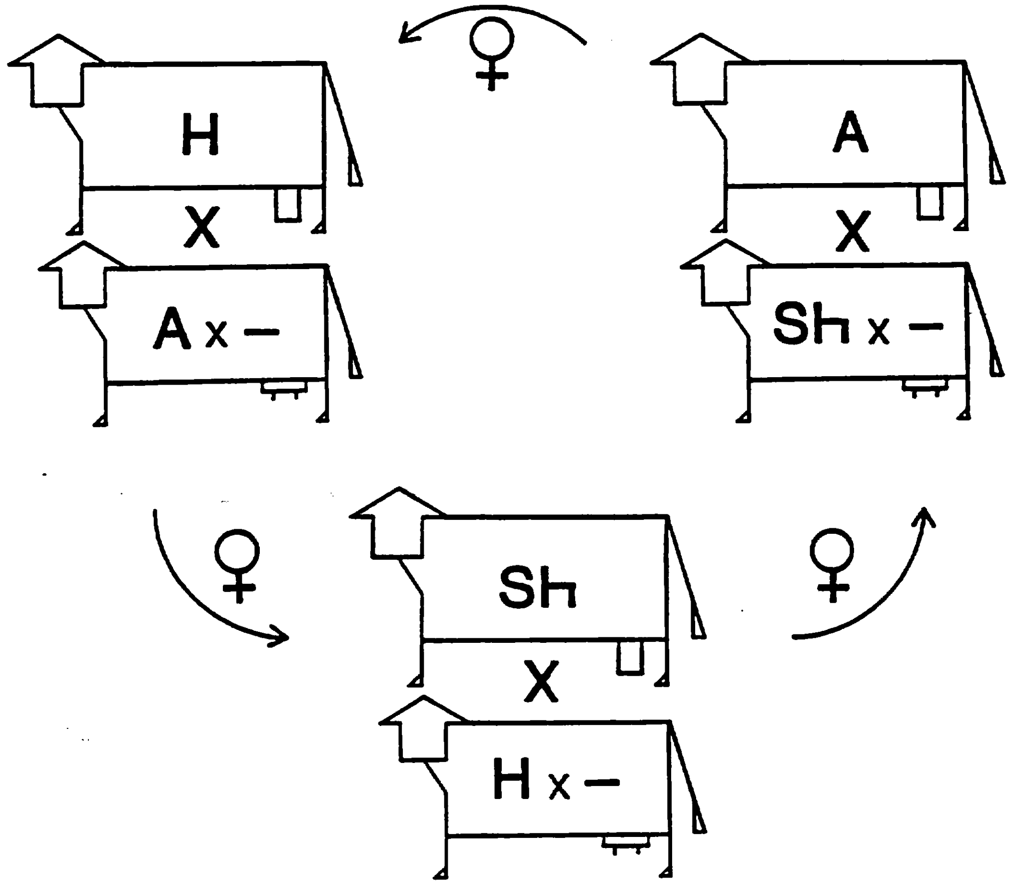
1. Requires two breeding pastures or AI.
2. Utilizes individual and maternal heterosis (67% of maximum).
3. Allows limited use of complementarity.
4. Replacement females produced within the system and need to be identified by breed of sire.
5. Genetic improvement determined primarily by genetic potential of A and H sires.
6. Breeds should be similar for size and milk production.
7. Expected to increase calf production per cow exposed by 16%.

Beginning with a foundation herd of Hereford cows, breed all cows to Angus bulls. The Angus x Hereford daughters are saved for replacements and mated to Hereford bulls. The H x (AH) replacements are moved to the herd mated with Angus bulls. This continues such that daughters born in the A sire herd are bred in the H sire herd and vice versa. In any one year there are two breeding pastures with Angus bulls in one and Hereford bulls in the other.

A - Angus
H - Hereford

Figure 2

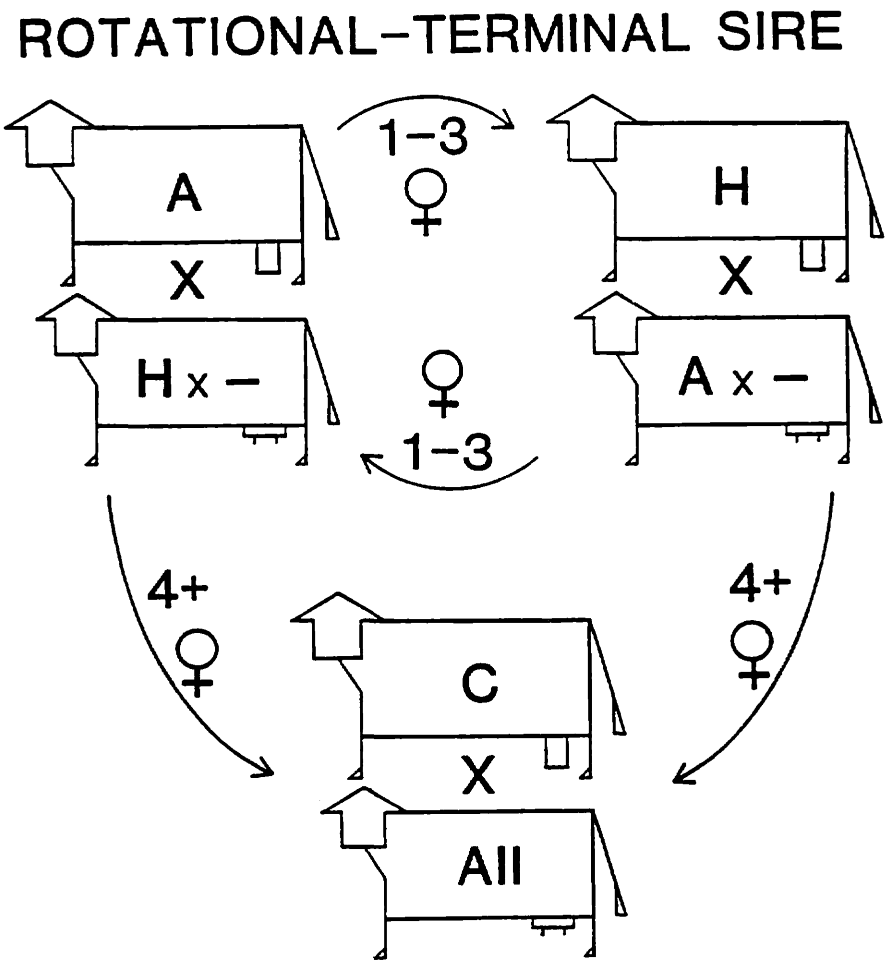
3-BREED ROTATION



1. Requires three breeding pastures or AI.
2. Utilizes individual and maternal heterosis (86% of maximum).
3. Allows limited use of complementarity.
4. Replacement females produced within the system and need to be identified by breed of sire.
5. Genetic improvement determined primarily by genetic potential of H, A and Sh sires.
6. Breeds should be similar for size and milk production.
7. Each crossbred cow should be mated to the breed of sire to which she is most distantly related.
8. Expected to increase calf productivity per cow exposed by 20%.

H - Hereford
A - Angus
SH - Shorthorn

Figure 3

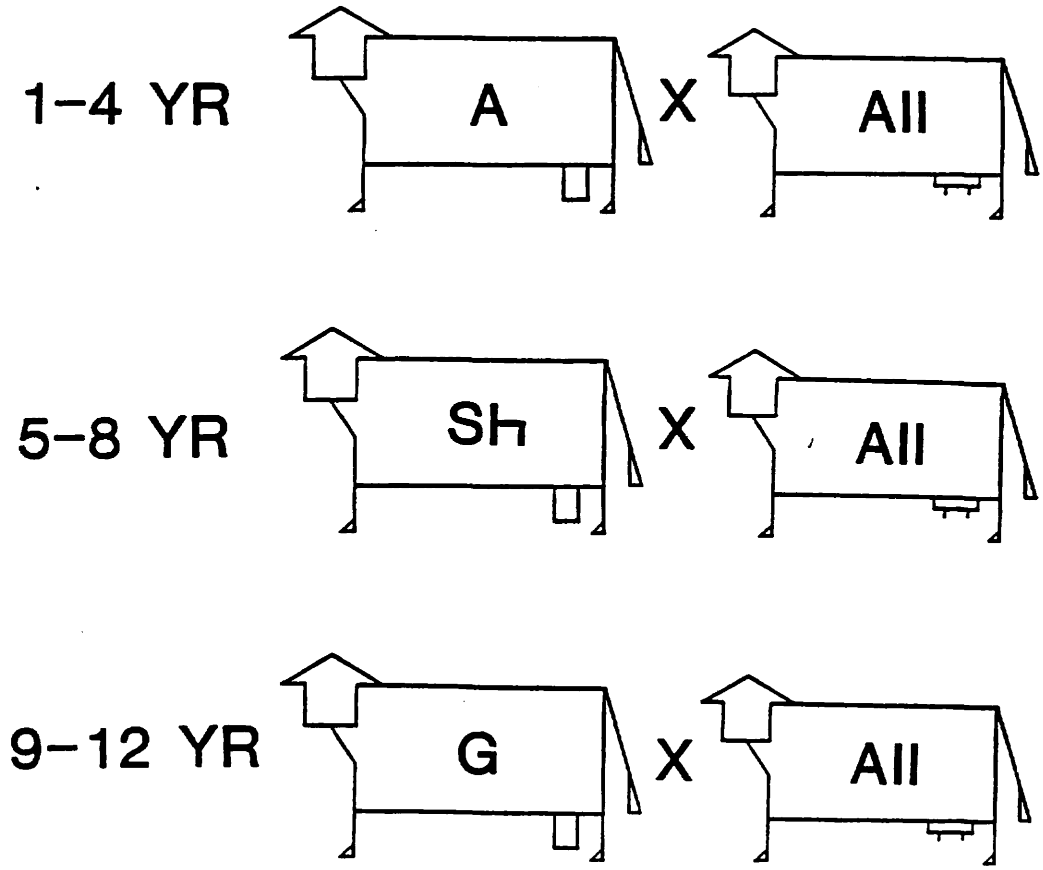


1. Requires three breeding pastures or AI.
2. Approximately 45% of females in rotation and 55% of females in terminal portion of system.
3. Utilizes individual and maternal heterosis.
4. Maximizes complementarity in 55% of herd.
5. Roughly 70% of progeny marketed are from terminal sire breed.
6. AI and sexed semen would make this system more efficient.
7. Genetic improvement determined primarily by genetic potential of A, H and C sires.
8. 1- to 3-year-old females are bred in the rotational part of the system and 4-year-old and older cows are bred in the terminal part of the system.
9. Expected to increase calf production per cow exposed by 21% for 2-breed rotation and 24% for 3-breed rotation.

A - Angus
H - Hereford
C - Charolais

Figure 4

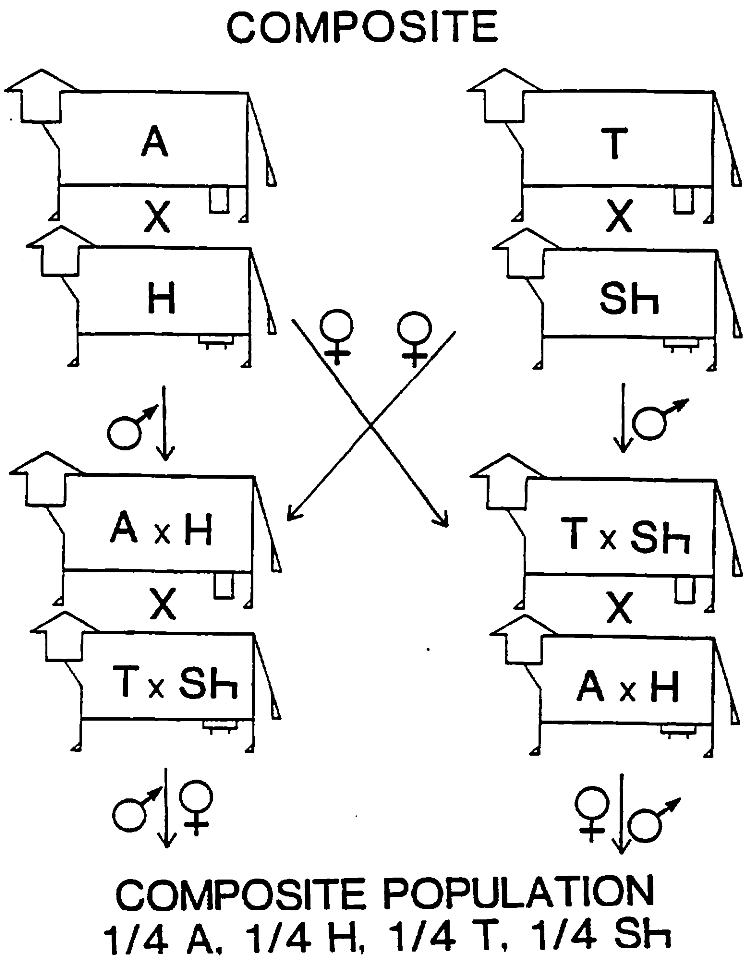
ROTATE SIRE BREED



1. Requires one breeding pasture.
2. Start with available and adapted female breed (H for example).
3. Utilizes individual and maternal heterosis.
4. Allows limited use of complementarity.
5. Replacement females from within the system and do not need to identify cows by breed of sire.
6. Genetic improvement determined primarily by genetic potential of A, Sh and G sires.
7. Each sire breed could be used two to four years.
8. This system can be considered an approximation to a 3-breed rotation.
9. Expected to increase calf production per cow exposed by 16%.

A - Angus
SH - Shorthorn
G - Gelbvieh

Figure 5

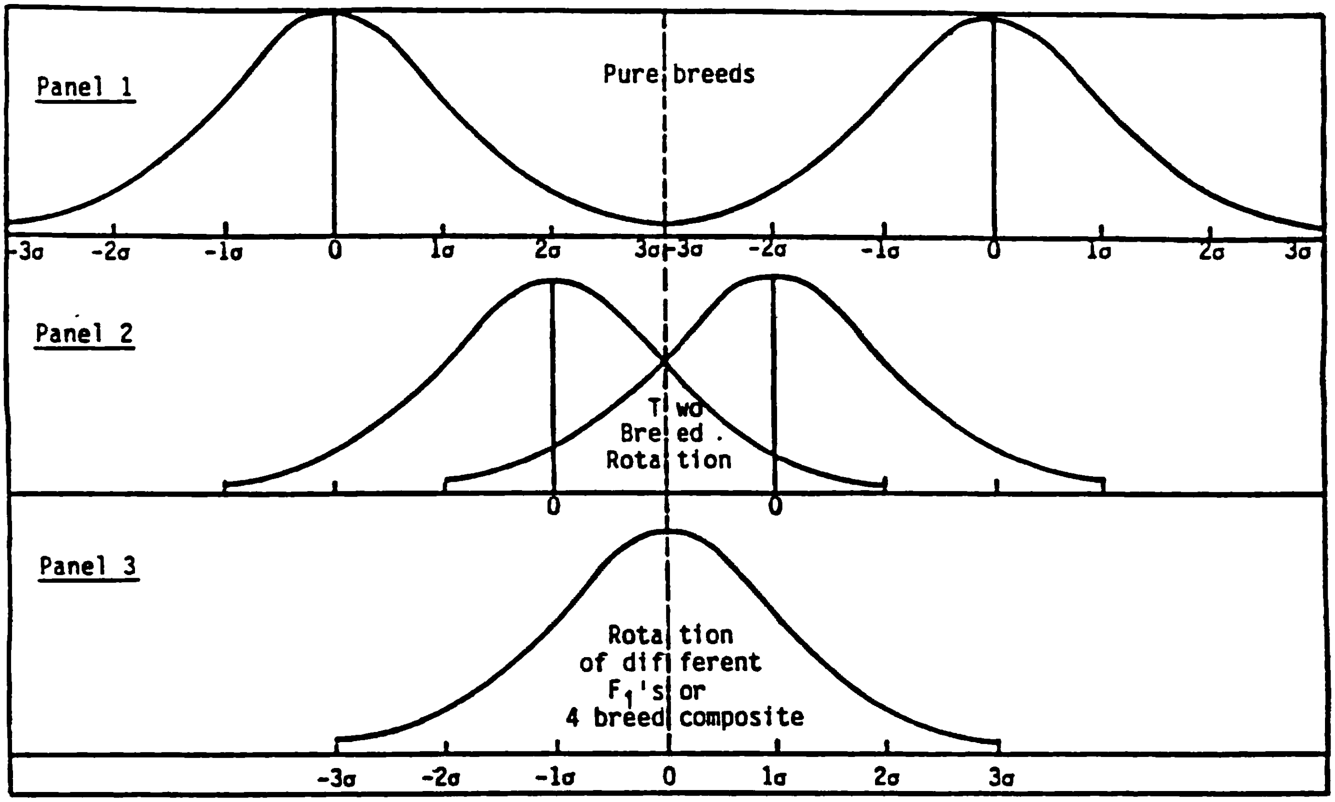


1. Requires one breeding pasture after composite development.
2. Utilizes individual and maternal heterosis.
3. Allows limited use of complementarity.
4. Replacement females and bulls from within the system and do not need to be identified by breed of sire.
5. Genetic improvement determined primarily by genetic potential of selected sires in composite.
6. Expected to increase calf production per cow exposed by 17%.

A - Angus
H - Hereford
T - Tarentaise
SH - Shorthorn

Figure 6

GENETIC VARIATION IN ALTERNATIVE MATING SYSTEMS



OPTIMUM

ASSUMES THAT THE TWO F_1's USED
ARE OF SIMILAR GENETIC MERIT.

BREED ROLES IN HITTING A NEW TARGET

Rick Bourdon
Colorado State University

Introduction

Beef has an image problem. Some people consider it unhealthy. Others are upset by the amount of fat they pay for and then discard. Still others consider beef too expensive. Perhaps the biggest problem, however, is the perception that beef is unreliable, that its eating quality is inconsistent. Beef *is* inconsistent, especially when compared to the competition -- assembly line produced chicken and pork. Breeds have played a role in fostering product inconsistency, and they can play an important role in reducing it. Intelligent use of breeds can go a long way toward solving the problem biologically, and if seedstock breeders and breed organizations are willing to put the long-term health of the beef industry before short-term competitive gains, the inconsistency problem (or at least the genetic portion of it) can be solved much faster.

Biological Roles of Breeds

Product inconsistency is commonly perceived to have become a problem since the adoption of crossbreeding and the importation of *bos indicus* and continental European cattle to this country. Cattlepersons lament "mongrelization" and complain that there are "just too many breeds." One proposed solution, then, is to go back to the way things were, to return to the days of just two or three breeds and purebred commercial cattle.

A purebred commercial industry involving a handful of breeds (or maybe just one breed) might actually solve the inconsistency problem, but at what cost? We need to ask whether there is a single breed that produces the perfect product. Can a single breed achieve uniformly acceptable meat quality without producing too much waste fat? Just as importantly, is one breed adaptable to the diverse environments found in this country? Long experience with Brahman cattle and their derivatives would suggest otherwise. And can we tolerate the loss of hybrid vigor that would follow a return to purebred commercial cattle?

Table 1 is a summary of individual and maternal heterosis estimates from studies conducted on primarily British cattle from the 1930s through the 1960s. The trait is weaned calf crop, probably the single most economically important trait in beef production. The results are not perfectly consistent, but a large majority of the studies show a distinct advantage for crossbreds, with weighted average increases in calf crop of over four percent for crossbred calves and almost five percent for crossbred dams.

Hybrid vigor effects from *bos taurus* x *bos indicus* crosses are generally even larger. Differences of this size are sure to affect profitability.

Table 1. Heterosis Estimates for Weaned Calf Crop[a]

Location	% Individual Heterosis	Location	% Maternal Heterosis
Montana	5.1	Nebraska	6.8
Nebraska	3.0	Montana	-.6
Nebraska	-2.3	Virginia	.4
Virginia	13.0	Louisiana	5.8
Montana	6.2	Georgia	4.0
California	25.0		
Weighted average	4.1		4.7

[a]From Cundiff, 1970, JAS 30:694.

I have no doubt that there are purebred commercial programs that can and do work. In low stress environments the advantages of hybrid vigor may be small enough that purebreds can compete successfully. On an industry-wide basis, however, a policy encouraging purebred commercial cattle would be a grave mistake. Hybrid vigor is simply too important to cow-calf production to be abandoned in the hope of a more reliable product.

A second solution to the inconsistency problem would be to have a crossbred slaughter animal, but to return to the tried and true genetics that worked in the past, in other words, the black baldy. The black baldy is a formidable animal and benefits greatly from heterosis. Again, however, we have to ask if this is the perfect slaughter animal. Does it have the kind of cutability we would like? Are baldies adapted everywhere? Are they appropriate in the subtropics or the corn belt?

I would consider the return to one or a few crosses of cattle an improvement over purebred commercial cattle, but I question whether we can afford to ignore the variety of germ plasm represented in breeds and the associated opportunities for between-breed selection and breed complementarity. Listed in Table 2 are 26 breeds grouped into biological types according to four criteria: growth rate and mature size, lean to fat ratio, age at puberty, and milk production. Notice the tremendous variety in the available breeds. Breed differences like these can be blamed for product inconsistency, but they can also be exploited to produce adapted animals and a consistent product.

Table 2. Breeds Grouped into Biological Types for Four Criteria[ab]

Breed Group	Growth Rate and Mature Size	Lean to Fat Ratio	Age at Puberty	Milk Production
Jersey	X	X	X	XXXXX
Longhorn	X	XXX	XXX	XX
Herf-Angus	XXX	XX	XXX	XX
Red Poll	XX	XX	XX	XXX
Devon	XX	XX	XXX	XX
Shorthorn	XXX	XX	XXX	XXX
Galloway	XX	XXX	XXX	XX
South Devon	XXX	XXX	XX	XXX
Tarentaise	XXX	XXX	XX	XXX
Pinzgauer	XXX	XXX	XX	XXX
Brangus	XXX	XX	XXXX	XX
Santa Gert.	XXX	XX	XXXX	XX
Sahiwal	XX	XXX	XXXXX	XXX
Brahman	XXXX	XXX	XXXXX	XXX
Nellore	XXXX	XXX	XXXXX	XXX
Braunvieh	XXXX	XXXX	XX	XXXX
Gelbvieh	XXXX	XXXX	XX	XXXX
Holstein	XXXX	XXXX	XX	XXXXX
Simmental	XXXXX	XXXX	XXX	XXXX
Maine Anjou	XXXXX	XXXX	XXX	XXX
Salers	XXXXX	XXXX	XXX	XXX
Piedmontese	XXX	XXXXXX	XX	XX
Limousin	XXX	XXXXX	XXXX	X
Charolais	XXXX	XXXXX	XXXX	X
Chianina	XXXX	XXXXX	XXXX	X

[a]From Cundiff *et al.*, 1993 BIF Proceedings
[b]Increasing number of X's indicate relatively higher values.

If we are unwilling to forgo the advantages of hybrid vigor and want to maintain breed diversity, then there is a third solution to the inconsistency problem—combine breeds sensibly to produce a more moderate, economically raised product with both carcass quality and yield. Impossible? Not at all. There are many examples of groups of cattle that have met these criteria. Here is one.

One Pen's Record (70 Steers)

Year: 1987
Origin: Montana
Age: 16 to 18 months
Days on feed: 120
Breed composition: crosses among Red Angus, Gelbvieh, Simmental, and South Devon

% Choice: 64.3
% Select: 35.7
% Yield grade 1: 15.7
% Yield grade 2: 82.8
% Yield grade 3: 1.5

Most of us would be very happy with this pen of cattle. What makes these cattle all the more remarkable is that they derive from essentially maternal breeds; they were not selected specifically for carcass traits. There were no carcass EPDs available in 1987, and carcass traits were not a top priority for the owner. However, the animals were sensibly bred in that they combined British and continental breeds in a way that achieved both carcass quality and yield.

If there is a lesson to be learned from this pen of cattle, it is that the inconsistency problem is not a result of having too many breeds or of mongrelization. These cattle contained a number of relatively new breeds and were certainly mongrels. Inconsistency results from making unwise crossbreeding decisions, from the production of extreme animals that contain too much of a particular biological type.

Most cooks like to experiment from time to time. If, however, you want to create a dish that is reliably good every time, you follow a recipe. Here is my recipe for "Sensible Beef Stew."

SENSIBLE BEEF STEW

1 part female adaptability
- Appropriate amounts of:
  - Growth and milk production
  - Fertility
  - Calving ease
  - Maintenance requirements
  - Fleshing ability

Resistance to specific stresses
Convenience characteristics (soundness, temperament, etc.)
Hybrid vigor
(Specific ingredients will vary.)
1 part carcass quality in slaughter animals
1 part carcass yield in slaughter animals
(Season to taste.)

There are number of breeding systems that can be used to produce sensible beef stew. Conventional rotational systems using purebred sires will work if the sire breeds are very similar in biological type. If they are not, then both slaughter animals and replacement females will vary with breed composition, the end-product is no longer consistent, and female management becomes problematic.

The use of F_1 bulls in a rotation can help solve inconsistency and management problems. We can create F_1s of very similar biological type by judiciously crossing pure breeds that are potentially quite diverse. This allows us to make use of a whole array of breed resources, take advantage of breed complementarity, and avoid big swings in the biological type of the animals in the rotation. As an added bonus, there is even an increase in heterosis in a rotation using F_1 as opposed to purebred bulls.

Another alternative is the use of composite cattle. Composites will typically exhibit somewhat less hybrid vigor than, say, three-way rotational cattle, but they are constant in breed composition and can be managed like purebreds. For many operations, both large and small, composites make sense from an ease of management standpoint, particularly when compared with pasture rotations. A point that may have escaped many of us in the course of the product inconsistency debate is that the use of composite breeds takes crossbreeding decisions out of the hands of commercial breeders and places them under the control of those who design the composites—the composite seedstock producers. This could be good or bad. I am not convinced that seedstock breeders necessarily have any better sense than commercial breeders; there are too many obvious counter-examples. However, if we take the optimistic view that those seedstock producers willing to put in the effort and take the risks needed to create composite breeds are likely to be knowledgeable and conscientious, then composite cattle provide a way to avoid the crazy crosses and extreme biological types that are the problem cattle today.

Breeding systems need not be limited to conventional systems, F_1 bulls, and composites. Systems can be combined in creative ways. Listed in Table 3 are a number of crossbreeding systems, the minimum and maximum percentage of a single breed within each system (a measure of consistency in breed composition), and the expected proportion of F_1 heterosis expected from each system.

Table 3. Example Systems for Sensible Beef Stew

System	Min % Breed A	Max % Breed A	% F_1 Heterosis
Two-way rotation using purebred A and B bulls	33	67	67
Three-way rotation using purebred A, B, and C bulls	14	57	86
Two-way rotation using F_1 AxB and F_1 CxD bulls	17	33	83
Four-breed AxBxCxD composite	25	25	75
Two-way rotation using F_1 AxB and F_1 AxC bulls	50	50	67
Three-breed Ax(BxC) composite	50	50	63
Two-way rotation using F_1 or composite Ax(BxC) and Ax(DxE) bulls	50	50	71
Five-breed Ax(BxCxDxE) composite	50	50	69

The first two crossbreeding systems in Table 3 are traditional rotations using purebred bulls. They retain an acceptable amount of hybrid vigor, but notice the relatively large shifts in breed composition. Unless the breeds used in these rotations are very similar in biological type, we can expect significant variation in end-product. The next two systems in the table, a two-way rotation using F_1 bulls and a four-breed composite, are improvements over the traditional rotations in terms of consistency of breed composition. These kinds of systems should help reduce variation in end-product.

What if you are convinced that a relatively high percentage of a specific breed is necessary for carcass merit and you want to keep a fixed (and rather large) percentage of that breed in the mix—say, 50%? Is this possible without losing too much hybrid vigor? The four systems in the bottom half of Table 3 represent ways to get the job done. All involve the use of hybrid bulls. In fact, there is no self-contained (in terms of replacement production) system using purebred bulls that can maintain both a constant proportion of a given breed and hybrid vigor.

What if the parts of the recipe for females and for slaughter animals are incompatible? What if the only biological types that can be adapted to a particular environment cannot successfully combine carcass quality and yield? This situation calls for the use of terminal sires. I am persuaded that terminal sire systems make sense from a production efficiency standpoint under most conditions, but their case is the strongest when there is a clear conflict between adaptability and carcass merit. The advantage of terminal systems, of course, is that an adapted female that is less than optimal from a carcass standpoint can be mated to a complementary sire to produce a near optimal slaughter offspring. Terminal systems come in a number of flavors, the major ones being static terminal (purchase replacements), rotational/terminal, and composite/terminal. To make terminal systems work well, breeders should be careful to match the carcass characteristics of sire and dam types. This too may be easier with hybrid bulls than with purebreds.

Whatever the crossbreeding system chosen, commercial producers will come closest to hitting the end-product target if they follow three rules: (1) remember the recipe for sensible beef stew, (2) avoid biological extremes, and (3) avoid having too much of any one breed in the mix.

Breed Roles in Policy Making

What can seedstock breeders and breed organizations do to solve the product inconsistency problem? The first thing they can do is to become aware and accepting of the new realities of beef production, namely, a more moderate slaughter animal raised by an adapted dam and having both carcass quality and yield, a growing need for hybrid seedstock, and a need for better information on breed composition, feedlot performance potential, and carcass potential of commercial cattle.

If we are looking for a more moderate, more consistent slaughter animal, then purebred breeders and organizations would be well advised to increase the emphasis they place on the value of their cattle in contributing to the hybrid recipe. This necessarily means decreasing emphasis on the value of their cattle as complete answers in themselves. A certain reality check may be required here; breeders may have to relinquish the notion that their animals can "do it all."

I hope I have made a case for hybrid seedstock. Purebred breeders can choose to fight the hybrid seedstock movement, help it along, or even join it. The first choice is likely to be a losing battle and to hinder the industry's efforts to increase product consistency. The second and third choices are more likely to increase the long-term health of the beef industry, the viability of breed associations, and the profitability of individual breeders.

Breed organizations can help hybrid seedstock breeders by providing data management and EPDs on hybrid cattle. The technology for hybrid EPDs is available now. The only missing elements are the requisite numbers of animals with identifiable data or pedigree connections in more than one breed and protocols for sharing data among associations.

The great value of breed organizations lies in their ability to provide information. Today we need more information than ever before. Carcass EPDs, whether from live animal or slaughter data, would be tremendously helpful. If breeds could find ways to document the breed composition of commercial cattle, then we could get away from the stone age practice of pricing cattle on the basis of coat color. Breeds could create databases documenting the past feedlot performance and slaughter characteristics of similarly bred and managed cattle. And ultimately, if breeds could keep track of the ancestral EPDs of commercial cattle (presumably across-breed EPDs), then the performance of those cattle could be predicted with much greater accuracy, pricing would be easier, and management could be better tailored to the cattle's potential.

The breed policies I have advocated will require an unprecedented level of cooperation among breeds. Since breed organizations have typically thought of each other as competition, not as allies, they need a new outlook. Unless breeds become more aware of their interdependence, we may experience a modern day "tragedy of the commons," each breed looking out for itself as the beef industry is crippled by consumer mistrust.

BIF Systems Committee

June 2, 1994

The meeting was called to order by Chairman John Hough at 2:00 p.m. Lee Leachman discussed the current status of the Seedstock SPA program. Development of the program was sponsored by NCA, and it is now ready for application. A training session was held last March for those interested in application of the program. There is now a need to make the program more user friendly and get is distributed to producers.

Dan Kniffen from NCA conducted a further discussion of Seedstock SPA with an emphasis on data processing. Dan suggested that breed associations maintain inventories and summaries under SPA guidelines. This would enhance consistency of reporting and evaluation of data from purebred herds. There was considerable discussion about how and where this data could be maintained, particularly related to confidentiality.

Brent Woodward provided a discussion of methods to improve beef product quality. There was considerable discussion of the relationship between palatability and tenderness.

Chairman Hough seeked input on the direction the committee should take. Points under discussion included creating standards for value-based marketing and definition of the interrelationships of production, genetics, and profitability in beef production.

Hough will appoint a committee by phone to review/change the Systems section of the guidelines.

Meeting adjourned at 5:00 p.m.

SEEDSTOCK BEEF CATTLE
STANDARDIZED PERFORMANCE ANALYSIS (SPA)

Leland Leachman
General Manger
Leachman Cattle Company
P.O. Box 2505
Billings, MT 59103

The U.S. cattle industry is in transition. Modern day producers find themselves trying to convert their way of life into a business. During the last 50 years, producers have made great strides by increasing production per animal -- but increases in efficiency or in profitability have been minor. For most producers, profitability remains more a function of cyclical markets and environmental influences than a function of informed management decisions and investment strategies. While most agricultural sectors have long since realized that maximization of output does not lead to maximum profits, beef producers have only recently began to shift their emphasis away from maximization and towards optimization. Global trends including population growth, liberalization of international trade, and an increasing detachment between end users and agricultural production is forcing increased emphasis on efficiency and profitability.

Today, beef must compete against alternative protein sources for consumer dollars. Beef is no longer a required staple for all consumers. The competing meats -- namely poultry and pork -- are increasingly produced by large corporate entities which are for more cost conscious and competitive than are traditional beef cattle producers. In light of these challenges facing the modern beef producer, the Integrated Resource Management Subcommittee of the National Cattleman's Association began an effort to assist producers in determining their unit cost of production. This program was to merge production data and financial data to assist producers in making management decisions which led to greater efficiency and profitability. This program was dubbed "Standard Performance Analysis" or SPA.

The SPA program began by developing a standard terminology and methodology for the analysis of simple Cow/Calf operations. A team of NCA member producers and university scientists volunteered time and effort to formulate these guidelines. They were then field tested and the guidelines were finalized. While the primary goal of SPA was to provide an integrated production and financial analysis, another goal was to provide a standard basis for comparisons between producers. To be competitive, beef producers must have a clear understanding of how their costs compare to those of other producers in the industry. Thus, a long-range goal of the SPA program is the development of a nation-wide data base.

Agriculture in general, with the exception of the swine and poultry industries, is currently one of the only major industries without such a resource. It is likely that this type of an information service has not previously been made available to the beef cattle industry partially because of the lack of general uniformity in agricultural production and financial analysis and reporting. It also could be attributed particularly to the widely diversified nature of the beef cattle industry. Creation of a national data base specifically for beef cattle production and financial performance will provide producers with an additional means to effectively evaluate the efficiency of an operation and also to potentially improve the overall competitive position of the beef cattle industry.

Participation in the data base is strictly voluntary. All individual producer summary data will remain confidential. The data base will allow producers to access comparative standards from similar operations and resource environments. SPA will then facilitate a comparative analysis among the production years, regions, production and marketing systems, and among the different phases and sectors of the cattle industry. The use of standardized performance ratios is viewed as the first step in the building of this data base. As a result of this effort, Cattle Fax, the market reporting wing of the National Cattleman's Association, is now maintaining a national data base which producers can use for comparative analysis.

As a result of the utility and success of the Cow/Calf SPA, in 1992 the United States Beef

Breeds Council requested that NCA pursue the development of a Seedstock SPA (SPA-SB). Utilizing NCA, Beef Improvement Federation, and Breed Association resources, the SPA-SB was developed. SPA-SB is a recommended set of production and financial performance analysis guidelines developed specifically for the seedstock cow-calf, replacement heifer, and the sale bull enterprises. SPA guidelines have been developed to be consistent across all phases of beef cattle production, from seedstock cow-calf through sale bull and commercial cattle enterprises from seedstock cow-calf through finishing. This consistency enables the comparison of the different phases of production, as each phase is dealt with as a completely separate enterprise. Seedstock breeders will be able to compare their cow/calf enterprise on equal footing with commercial cow/calf enterprises.

In varying degrees, many producers keep two separate sets of records - production records and financial records. Seedstock breeders have been particularly adept at maintaining and utilizing extensive performance and lineage records to select their stock. However, given the premiums received for seedstock, such producers have been far less cost conscious and generally do a poor job of maintaining and utilizing financial records. While the Beef Improvement Federation was formed to standardize performance records, no similar effort to standardize financial records was attempted prior to SPA-SB. Differences have been evident not only among operations, but also among different regions of the country as well as the various users of information (such as managers, lenders, accountants, educators, etc.). The SPA guidelines integrate information from both the production and the financial record systems. In addition, SPA *standardizes the* calculation of specific production and financial performance parameters. This provides a comprehensive measure not only of the overall performance of the whole operation, but also of the performance of the individual enterprises that make up the operation.

Production (or financial) analysis alone cannot be considered adequate in determining profitability. SPA-SB combines production and financial data to calculate the per unit cost of production, return on assets, and other important performance measures. SPA measures enterprise profitability by allocating all expenses and revenues to the appropriate enterprise and by matching revenues with those expenses incurred to produce them. Cash records provide one meaningful perspective for a specific fiscal year and are significant for tax accounting purposes. In addition to cash basis records, enterprise accounting provides management with a meaningful overview of the financial performance of the business enterprises or profit centers. The use of enterprise accounting for SPA analysis and managerial considerations does not conflict with the use of the cash based system for tax records.

SPA-SB looks specifically at four types of enterprise performances: (1) cattle performance (production efficiency), (2) land performance (grazing, raised feed and grazing land use efficiency), (3) marketing performance, and (4) financial and economic performance. Having the ability to determine the actual costs and returns for each individual enterprise will help producers identify and address specific problem areas. Analytical skills can also be enhanced which will result in a means to better utilize data, make more informed decisions, and increase production and financial efficiency.

The financial statements utilized by SPA to develop enterprise information include: the total farm or ranch balance sheet, income statement, statement of owner equity, and statement of cash flows. SPA's financial enterprise analysis is developed directly from the total farm or ranch fiscal year income statement. The financial analysis uses the actual accounting revenues and expenses of the enterprise that can be generated from allocation of total farm or ranch revenue and expenses to the enterprise, or through enterprise or profit center accounting that provides the enterprise revenue and expenses. The economic analysis adds the opportunity cost of owned land (cash lease rate), raised feed (net market value), and invested equity capital (three month treasury bill rate) to each enterprise cost and income analysis.

The standardized performance analysis for the seedstock cattle can be an extremely valuable management tool for those operators committed to investing the time necessary to collect the information and data needed and to thoughtfully and accurately allocate all income and expenses to the appropriate enterprise. SPA can also play an important role in risk management as it easily facilitates a "what if" style of analysis. In addition, SPA can also be useful for investment decisions and seedstock purchase decisions.

SPA analysis can be performed by anyone. Producers can attempt the analysis themselves, but often times the complexity of the calculations combined with their unwillingness to delve into financial records prevents them from performing the analysis alone. Trained resource personnel have proved vital in performing the analysis and can greatly facilitate the process. SPA training sessions have been organized by Texas A&M in conjunction with NCA. If you are interested, please call (409) 845-8012.

Seedstock cattle enterprises, as opposed to commercial cattle, do present some unique methodological issues that must be addressed. Seedstock enterprises require additional capital and costs to produce sale bulls and replacement heifers. Breeding cows and bull values are higher than those of commercial animals, reflecting the increased potential value of their productions. The SPA seedstock committee recommends that the higher capital investment and seedstock costs associated with the "seedstock cow-calf activities" be allocated to the replacement heifer and sale bull activities. This means that the seedstock cow-calf enterprise will be evaluated from a financial and economic standpoint much like that of a commercial cow-calf enterprise. Details on specific methodological issues associated with this enterprise are presented in the guidelines.

Summarized below are the SPA performance measures selected for each seedstock enterprise. Reports for illustrative purposes are included, but only those which illustrate financial and economic performance.

The NCA-IRM Guidelines for Production and Financial Performance Analysis for the Seedstock Beef Enterprise presents standardized analysis terminology, calculation procedures, interpretations, and limitations of the performance measures for the cow-calf enterprise. Reports are illustrated for all performance measures. Performance measures include both production and financial analysis measures in the following areas:

1. Reproduction Performance
2. Production Performance
3. Grazing and Raised Feed Land Use and Productivity
4. Marketing - Price and Method
5. Financial and Economic Performance

Table 1. SPA Seedstock Cow-Calf Investment, Financial and Economic Performance Summary

Type of Enterprise:
State of Origin:
Geographic Area of Origin:
Time:

Fiscal Year:
File Name:
Date:

– INVESTMENT PER BREEDING COW (Average Asset Values) –

	COST BASIS	MARKET VALUE
Total Current Assets	$125.31	$125.31
Non-current Assets		
Livestock	898.72	865.13
Machinery & Equipment	51.81	71.92
Real Estate Land & Improvements	436.25	3,356.71
Other Non-Current Assets	0.00	0.00
Total Investment per Breeding Cow	1,512.09	4,419.06
Debt per Breeding Cow (Enterprise Liabilities)	547.40	1,280.22
Equity to Asset or Percent Equity (%)	63.80 %	71.03 %

– FINANCIAL & ECONOMIC PERFORMANCE –	FINANCIAL $/COW	FINANCIAL $/Cwt[1]	ECONOMIC $/COW	ECONOMIC $/Cwt[1]
Total Raised/Purchased Feed Cost	$123.02	$22.12	$127.73	$22.96
Total Grazing Cost	31.51	5.67	115.28	20.73
Gross Cow-Calf Enterprise Accrual Revenue	559.69	100.63	559.69	100.63
Total Cow-Calf Enterprise Operating Cost	387.49	69.67	475.96	85.57
Total Financing Cost & Economic Return	59.04	10.62	111.23	20.00
Total Cost Before Non Calf Revenue Adj.[2]	446.53	80.28	587.19	105.57
Net Income[3]	113.16	20.34	(27.50)	(4.94)

Percent Return on Enterprise Assets (ROA)

Cost Basis	11.39 %
Market Value	3.90 %

– UNIT COST OF WEANED CALF PRODUCTION (Break-even Economic Cost)[2] –

Total Non Calf Revenue	$137.79	$24.77
Total Calf Cost (Non-calf Revenue Adjusted)	$449.40	$80.80

– ECONOMIC RETURN –

Rate of Economic Return on Real Estate Investment at Market Value 2.14 %

[1] Dollars per cwt of weaned calves.
[2] These are pre-tax costs, thus they do not include income tax payments. Withdrawals are included in the cost calculation.
[3] The net income is pre-tax income, but is not equal to IRS taxable income.

Table 2. SPA Investment, Financial and Economic Summary
Replacement Heifer Enterprise - Weaning To Breeding

This example is only to show a report content.

Type of Enterprise: Fiscal Year:
State of Origin: File Name:
Geographic Area of Origin: Date:
Time:

Investment per Repl. Heifer (Avg. Value Of Assets)	Cost Basis $/Head/Year	Market Value $/Head/Year
Total Current Assets	$50	$50
Non-Current Asset		
Livestock	$421	$421
Machinery & Equipment	$105	$126
Real Estate Land & Improvements	$63	$105
Other Non-Current Assets	$105	$126
Total Investment per Head	$745	$829
Debt per Head (Enterprise Liabilities)	$526	$526
Equity to Asset or Percent Equity %	29.3	36.5

—Financial and Economic Performance—	Financial		Economic	
Values Based On Exposed Replacement Heifers[1]	$/Head	$/Cwt Gain	$/Head	$/Cwt Gain
Heifer Calf Valuation or Purchase Cost	$426.32			$426.32
Total Feed and Grazing Cost	$48.42	$19.27	$58.95	$23.46
Total Non-feed Cost	$19.21	$7.64	$33.21	$13.21
Total Cost of Gain	$67.63	$26.91	$92.16	$36.67
Total Raised/Purchased Feed Cost	$30.00		$38.00	
Total Grazing Cost	$18.42		$20.95	
Values Based On Exposed Replacement Heifers[1]	$/Head	$/Cwt Sales	$/Head	$/Cwt Sales
Gross Enterprise Accrual Revenue	$581.98	$80.27	$581.98	$80.27
Total Enterprise Operating Cost	$483.42	$66.68	$493.95	$68.13
Total Financing Cost & Economic Return	$10.53	$1.45	$24.53	$3.38
Total Cost[2]	$493.95	$68.13	$518.47	$71.51
Net Income[3]	$88.04	$12.14	$63.51	$8.76

	Cost Basis	Market Value
Percent Return on Enterprise Assets (ROA)[3]	13.24	11.89

Unit Cost Of Production[2]	
Cull Heifer Sales and Other Revenue	$40.00
Pregnant Replacement Heifer Cost (economic break-even price)	$478.47

Financial Analysis - Inventory Valuation Method:	
Cattle Beginning and Ending Inventory	Cost
Cattle Transfers In and Out	Market
Raised Feed Inventory and Use	Cost

1 Based on pregnant replacement heifers sold as pregnant.
2 Pre-tax costs do not include income tax costs.
3 Net pre-tax income but not equal to IRS taxable income.

Table 3. Seedstock Bull Sales SPA Investment, Financial and Economic Summary

Type of Enterprise:
State of Origin:
Geographic Area of Origin:
Time:

Fiscal Year:
File Name:
Date:

Investment Per Head (Average Value Of Assets)[1]	Cost Basis	Market Value
	$/Head/Year	$/Head/Year
Total Current Assets	$1,020	$1,224
Non-Current Assets		
Livestock	$0	$0
Machinery, Equipment & Vehicle	$1,020	$1,020
Real Estate Land & Improvements	$0	$0
Other Non-Current Assets	$0	$0
Total Investment Per Head	$2,041	$2,245
Debt Per Head (Total Enterprise Liabilities)	$510	$510
Equity to Asset or Percent Equity %	75.0	77.3

—Financial and Economic Performance[2]—	Financial		Economic	
Values Per Head	$/Head[2]	$/Hd./Day	$/Head[2]	$/Hd./Day
Bull Calf Initial Valuation or Purchase Cost	$561.22		$561.22	
Total Feed Cost	$618.37	$2.41	$618.37	$2.41
Total Non-feed Other Than Sales Cost	$296.94	$1.16	$375.00	$1.46
Total Sales Costs	$204.08		$204.08	
Total Non Cattle Cost[3]	$1,119.39		$1,197.45	

Values Based On Bull Sales[2]	$/Head[2]	$/Head[2]
Gross Enterprise Accrual Revenue[4]	$1,900.00	$1,900.00
Total Enterprise Operating Cost	$1,628.57	$1,628.57
Total Financing Cost & Economic Return	$52.04	$130.10
Total Cost[3]	$1,680.61	$1,758.67
Net Income[4]	$219.39	$141.33
	Cost Basis	Market Value
Percent Return on Enterprise Assets (ROA)[4]	13.30	12.09
Unit Cost of Production		
Cull Bull Sales and Other Revenue		$200.00
Sales Bull Cost of Production (economic break-even price)		$1,558.67

[1] Based on annual head equivalence or head days divided by 365.
[2] Based on bull sales and transfers out for breeding plus culls ending inventory.
[3] These are pre-tax costs, thus they do not include income tax payments. Withdrawals are included in the cost calculation.
[4] Net pre-tax income is not equal to IRS taxable income.

REFERENCES:

1. McGrann, James M., "Seedstock Beef Cattle Enterprise -- Standardized Production and Performance Measures and Summary Description," Texas A&M University, Department of Agricultural Economics, May, 1994. Call (409) 845-8012 to order.

2. National Cattlemen's Association - National Integrated Resource Management Standardized Performance Analysis Purebred Subcommittee. "Purebred Beef Cattle -- Guidelines for Puroduction and Financial Performance Analysis for the Purebred Beef Enterprise -- Draft," Texas Agricultural Extension Service, Texas A&M University, Department of Agricultural Economics, March 2, 1993.

BREED ASSOCIATION IMPLEMENTATION OF STANDARDIZED PERFORMANCE ANALYSIS

By: Dan Kniffen

The development of the cow-calf Standardized Performance Analysis (SPA) program is the first attempt by the beef industry to uniformly determine a consistent unit cost-of-production. For many years the industry has operated on the premise "If I can pay all the bills the farm/ranch must be profitable." That may not have been a bad measure years ago; however, the industry now needs to step up one level, operate like other businesses, and measure its performance.

The industry individually and collectively must accurately measure its current position, establish some short and long term goals and determine a good plan of action to achieve these goals. So what's new? This is exactly what producers have been told and have been doing for years. Admittedly, that is somewhat accurate; however, it has become quite obvious that not everything is measured by the same standards. Given the same data on one herd of cows everyone would agree that there is only one correct set of answers for the standard production measures such as: pregnancy percentage, calving percentage and weaning percentage. Unfortunately, this is not the case. The range of answers will be as diverse as the people making the evaluations. Such diversity provides a strong indication that there is a need to standardize our methodology on the calculations.

Having recognized this disparity, NCA producers initiated the process to develop guidelines to standardize the methodology by which the industry is measured. This process led to the Standardized Performance Analysis (SPA) guidelines.

The first set of guidelines developed were for the commercial cow-calf enterprise. Recognizing the value of standardized information measured by a similar methodology stimulated the interest of all the segments of the industry. This interest provoked the development of SPA programs for the stocker/feeder and seedstock segments of the industry. These two programs are currently being field tested and should be ready for general use this summer.

The next step in the process is to develop a means to reduce the producer effort necessary to complete an analysis. The SPA programs have two major components--production and financial. Many producers already record and submit individual animal production information to their association. Most of the information required for the production component of SPA is ascertainable from data that is currently being submitted to breed associations. Most associations provide processed records from this data to the producers. The reports contain information about the average birth weights on calves, indexing of cows and calves, reports on sires and other pertinent facts about the herd. An adjustment of the forms would allow for a minimal amount of additional data to be recorded that will facilitate the generation of the SPA production values.

One data requirement is an accurate accounting of the cow herd inventory at two specific times during the year--at the beginning of the fiscal year and the day the bulls are turned in with the cows. To make the production calculations requires the exposed cow number with adjustments for transfers in and out of the herd. Once the initial cow herd inventory is established, all that is required is an adjustment to this number each year. Perhaps a SPA column can be added to the cow herd data sheets that asks several linked questions. If the cow has a calf you have the data. If the cow did not calve, was she sold or did she die? If she did not die and was not sold, then she remains in the herd inventory. If the producer's desire is not to register some of the calves, at least the reproduction and production performance for the cow can be recorded for the SPA report. This format can provide several positive returns to the associations, the breed and for all cattle producers. Under an ideal scenario, the best information that can be generated about a breed or individuals with a breed would include as much of the valuable production data as possible. As the foundation for the beef industry, it is important for seedstock producers to provide the best available genetics, leadership and information as is possible.

As an alternative to individual production information, a cow can be recorded as having produced a calf and then the data for calves that are not intended to be registered can be pooled together and reported as a group. The general data requirements for an analysis is number of exposed cows, number of calves and total pounds weaned. Additional information can be utilized in the report, and *obviously the* more complete the data the more comprehensive the report that is sent back.

As the industry goes through this next correction cycle, there is no better time to identify areas of sub optimal performance and make improvements. Adjustments during this phase will only improve the health of the industry as we rebuild in the future. Breed associations need to take the leadership to provide the best management information available back to their members. Without much additional effort this new production information can be generated and made available during a critical time for the industry.

BEEF QUALITY AND CONSISTENCY ISSUES: HOW DO WE AFFECT CHANGE?[1]

Brent Woodward
University of Minnesota
Department of Animal Science
St. Paul, MN 55108

Introduction

Most of the recent studies and surveys conducted in the beef industry with the intent of evaluating the declining position of beef in the market place had a common outcome: beef quality and consistency has not kept up with pork and poultry. At the same time, retail price of beef has increased. The reason was stated very clearly in the opening sentences of the Beef Industry Long Range Plan Task Force Report (1993), "The U.S. beef industry has, for too long, been focused inwardly -- production driven, not consumer driven. We have demonstrated neither the ability nor the inclination to respond to consumer signals in the market place." Hopefully, the beef industry has not realized the obvious too late to prevent pork from becoming the meat of choice by the 21st century as the pork industry claims will occur. Various plans of action for the problems we face have been or are being developed. It is imperative that individuals, businesses, and organizations within our industry break down the barriers to change so that progress can begin immediately.

In an effort to determine the role BIF should play in addressing beef quality and consistency problems, the Integrated Genetic Systems Committee decided to explore this committee giving leadership to an issue affected by numerous factors from conception to consumption. Initially, a large survey was discussed as a means for assessing the problems on which BIF, and specifically this committee, could focus. Later, it was decided a small-scale survey of selected animal scientists and agriculture economists would be a more appropriate first step. A short-answer questionnaire format was used because of the limited number of respondents chosen.

The purpose here is to present an overview of the primary contributors to beef quality and consistency problems, potential industry improvements from a genetics perspective, and to provide suggestions on how BIF and the Integrated Genetic Systems Committee can play a role in affecting positive change. Hopefully, these suggestions will be a starting point for discussion.

Procedures

John Hough assisted the author initially with devising the format and focus of the questionnaire. The final version had 28 questions and was mailed to only 21 animal scientists (including two working at breed associations) and agriculture economists. A request was made for them to answer as many questions as possible. Some of the questions were intentionally

---

[1] Presented at the Beef Improvement Federation 26th Annual Conference, June 1 to 4, 1994, Des Moines, Iowa.

broad so as not to limit/bias their responses. Eight people took some of their valuable time to present their views to most of the questions. Their responses along with my thoughts are summarized in the following paragraphs. The focus throughout will be on genetic factors associated with beef quality and consistency.

Issues of Primary Importance

Excess Fat. Consumers have supposedly wanted leaner red meat for 20 years, but the beef industry has seen little change in fat content of fed steers and heifers. The amount of excess fat produced on U.S. fed cattle is estimated to be over 5 billion pounds annually. Actual cost of this waste fat to the industry was estimated in 1991 to be $4.4 billion -- $2.0 billion to produce and another $2.4 billion to ship and trim (Lambert, 1991). Subsequently, the National Beef Quality Audit (NBQA, 1992) indicated $190 of the $280 lost for every fed heifer and steer is attributable to excess waste fat. The "war on fat" was launched in 1990, but only a few small battles have been won to date. However, research indicates and the Strategic Alliances Field Study (SAFS, 1994) demonstrated that cattle can be managed for a lower external fat end point and yet attain a desirable grade. Unfortunately, end point determination is not normally assessed in any scientific manner, resulting in considerable variation. In addition, selling cattle on averages does not discourage feeders from marketing pens of cattle that are highly variable in quality and consistency as long as the average is acceptable.

Variation in Tenderness/Palatability. Perhaps the largest single factor contributing to beef quality and consistency problems is the variation in product tenderness and palatability. The Beef Industry Long Range Plan Task Force Report (1993) cited eight "leverage points" to regain market share. Quality and consistency were identified as the most critical and the plan calls for reducing consumer dissatisfaction (related primarily to toughness) by 50% by 1997.

Both the NBQA (1992) and SAFS (1994) indicated that as many as 1 out of every 4 steaks is unacceptably tough. The National Beef Tenderness Survey (1990) suggested that the problem may be greater for other cuts of beef -- 20% of middle meats, 40% of chucks, and 50% of round steaks/roasts were rated as "slightly tough" or tougher. While genetics of fed cattle play a role, there also are numerous management, nutrition, and processing factors that contribute to tenderness and palatability variation. SAFS results showed that doing "everything right" will not always correct tenderness problems. In the end, our inability to measure tenderness objectively, either ante- or post-mortem, presently suggests that significant research efforts are needed to meet the Long Range Plan tenderness goals by 1997. To determine how the beef industry should address these tenderness goals, the National Beef Tenderness Conference was organized by the National Cattlemen's Association (NCA) in April, 1994. The final report gives a broad overview of the genetic, nutrition, management, and processing factors that the industry must confront to improve beef tenderness.

Because tenderness is most likely influenced by more than one gene, we have to be careful in assuming any one measure will solve all problems. We may also need to consider measuring tenderness in muscles other than the longissimus because this muscle is reported to be the most variable in tenderness and because there are tenderness problems in other retail cuts.

Lastly, the industry should not expect a premium for improving tenderness and palatability. It should be considered a minimum requirement for retail beef; the return will come in the form of increased market share.

Variation in Carcass/Retail Cuts Size. There has been a long-term trend toward larger frame size cattle, starting with the introduction of Continental European breeds of cattle in the 1960s. Larger frame size cattle naturally led to larger carcasses and larger retail cuts. While beef consumption initially increased, later during the 1980s the average (and especially urban) consumer began to reduce their preferred portion size due to a more sedentary life style, health concerns (unfounded or not) and America's growing obsession with not being fat and reducing consumption of saturated fats.

The introduction of boxed beef for 600 to 800 lb carcasses revolutionized the sale and distribution of beef. However, the decrease in cattle numbers that came in the 1970s and 1980s put demand ahead of supply and packers began to expand their specifications. The result is that the accepted carcass weight range is now 550 to 900 or 950 lb. Therefore, essentially no incentive to control carcass size exists as part of commodity marketing channels. However, the chase for production maximums that coincided with large frame size cattle caught up with the cow/calf segment a few years ago in terms of efficiency and cost of production. Today, as optimums are sought rather than maximums and with the next price-cycle downturn starting, inefficient cattle and producers of all sizes will be significantly reduced in number.

Outdated Marketing and Quality Grading Systems. Although there have been some changes to the way cattle have been marketed and graded over time, it has become fairly obvious that major changes are yet necessary. The fact that packers still buy the majority of their cattle on averages based on visual assessment of when a pen of cattle is 70% Choice suggests that the beef industry really only talks about change and meeting consumers' preferences. The message sent to feeders and cow/calf producers is that "cattle are cattle" and almost all types will eventually reach the 70% Choice target.

Not only is there a problem with predicting when cattle have enough finish to grade Choice, the subjective nature of evaluating the ribeye for marbling compounds the problem. In addition, we have known for years that marbling accounts for only about 10% of the variation in tenderness. SAFS results clearly showed considerable variation in fat thickness, carcass weight, and yield grade of carcasses grading Select and also for those grading Choice (Woodward, 1994).

Although many packing plants offer formula pricing as an alternative, some surveys suggest that less than 20% of fed cattle are sold in this manner. Formula pricing systems are generally dependent on quality and yield grade subjective determinations. Some producers have an added fear of selling cattle in this manner because they cannot (usually) be there to witness the grading process, whereas they usually are present when their cattle are weighed. Whether justified or not, they feel they cannot trust large packing companies to be completely fair in pricing their cattle after they are in the cooler and no one else is around.

If improvements are to occur in the quality and consistency of beef provided to the consumer, a quality assessment and pricing system based on discounts and premiums related to consumer preferences must be implemented. Value-based marketing is being touted as the system that will send the appropriate signals from the consumer all the way through the chain to the cow/calf producer, hence, creating a link from conception of the animal to consumption of the product.

Other Contributing Factors. Although a complete list of factors contributing to beef quality and consistency problems is not possible here, there are several others worth mentioning that have a genetic component. The segmented nature of the beef industry results in a structure that is not conducive to quality control in the first place. Overcoming the boundaries that block information flow between segments and the reluctance to change within and between segments continues to contribute to loss of market share. In addition, responses to the survey suggest that the large number of small producers (<50 cows) is a major contributor to industry structure problems because they are not motivated by economics as much (or at all) as medium or large producers. However, these latter two groups also contribute to beef quality problems.

Another contributing factor is poor crossbreeding programs that often translate into no program at all or one that is based more on personal preferences than market options and profitability of the resulting calves. Very little selection pressure is put on carcass characteristics because few breeds have carcass EPDs and there is little if any incentive, regardless of whether the producer is selling feeder calves or fed cattle. The expense of collecting carcass records and the additional effort necessary to maintain contemporary groups from birth to slaughter does not help. Finally, breed associations generally spend more money on shows and promotion than research, resulting in very low priority for work towards improving beef quality and consistency.

Potential Industry Improvements

Survey responses are summarized in the following paragraphs. Eleven improvement areas/headings are used and often cover more than a single survey question.

1. Change the Quality Grading System. There was unanimous agreement that the beef industry must change the way beef quality is assessed. The large volume of ungraded beef and the extremely slow development of markets for Select beef are some indicators that the current system is inadequate and should be abandoned or changed. NCA has put forth their support to exclude B maturity (30 to 42 months) cattle from Select and low Choice and to divide yield grades 2 and 3. While responses indicate agreement with the changes NCA suggest, we also think a measurement of tenderness needs to be incorporated and a new system should be developed to reflect value of end products. An objective measure of quality is essential. One response suggested restricting *Bos indicus*-influenced cattle from grading Prime and Choice.

2. Instrument Grading. Although instrument grading is a potential solution to reducing part of our quality and consistency problems, there is concern and skepticism with regard to the three primary research projects currently being conducted in this area. In brief, those projects involve 1) ultrasound techniques to predict tenderness or marbling, 2) ultrasound to predict ether extractable fat (as an indicator of marbling) in live cattle and carcasses moving at chain speeds, and 3) an ultrasound technique from human medicine mammograms (known as elastography) to predict tenderness in carcasses and live animals. The primary reason for this skepticism stems from the amount of emphasis yet placed on intramuscular fat (marbling). Secondly, the question remains of whether an instrument grading system for "quality" will solve consumer acceptability problems without also having a measure of tenderness/palatability. Therefore, considerable research is needed. We must be open and willing to consider technology being developed in other countries and by private industry.

3. Measuring Tenderness. There was general consensus that we definitely need an objective measure of tenderness. "How" is the million dollar question. Warner-Bratzler shear force has been used for years, but can it be done consistently, rapidly, and inexpensively given one steak per carcass would be lost to retail sale? U.S. MARC scientists proposed just such a system at the National Beef Tenderness Conference in April, 1994. Research has also shown certain enzyme systems may be used to predict tenderness. Higher levels of calpastatin activity in one-day postmortem muscle is associated with tougher meat. While the current assay procedure is very time consuming, a more rapid test is being developed that may be possible to use in a commercial slaughter facility. Molecular genetic techniques continue to be used in attempts to identify gene markers associated with differences in beef tenderness. However, it must be understood that tenderness is most likely controlled by a number of genes. Even if all of those genes could be identified, we must keep in mind that research to date indicates more of the variation in tenderness is due to non-genetic rather than genetic effects. Most importantly, to make rapid genetic change in the end product a live-animal measure of tenderness is needed. University of Minnesota and Arizona researchers are investigating several options in this area. Finally, two questions worth noting here were raised:

- Will one measure of tenderness work for all consumer preferences?
- Will one measure work for different markets and retail cuts?

The goal of the beef industry should be predictability, not perfect uniformity. Such a goal should be achievable within the near future if sufficient research funding is made available to scientists.

4. Value-Based Marketing. The survey first asked each person to define value-based marketing. As expected, the concept of value-based marketing has been discussed for several years, but ideas of what it is does vary. Following are some definitions to indicate the extent of the variation:

- Being paid for the quality of product produced and discounted less for product meeting consumer preferences.

- Selling of a product based on its actual value to the buyer, rather than its visually apparent value.

- Pricing finished cattle based on quality and value of the retail cuts produced.

- "It's about identifying where the biggest [pricing] inefficiencies occur and reducing them."

- Cattle and beef products are valued on the basis of their conformity (or lack of) to generally accepted industry standards.

- Value of final product is passed in an appropriate manner to each stage of the production/marketing process (i.e., the final value of each animal is the basis for payment to the producer, feeder, and packer).

It may only sound good in theory, but true value-based marketing is envisioned as a system in which payment to each production, processing, and retail segment is influenced by how well the end products conform to industry standards that are based on consumer preferences. We only have to look to the pork industry to see that a value-based system can be put into practice. The most optimistic time frame given for implementation of value-based marketing in the beef industry was 3 years, followed by responses of 5, 10+, and 50 years. Three people said it would never exist because packers and retailers are too resistant to change, and more and more cattle fit the "window of acceptability." While both statements are fairly accurate, the window of acceptability has increased in size in recent years to ensure that more cattle fit. Value-based marketing should result in more narrow windows of acceptability for different target markets, especially during times of lower fed cattle prices.

Value-based marketing was considered to be at least a partial solution and a big step in the right direction to encourage change in the form of improved beef quality and consistency. A large part of its potential positive effect is dependent on how quality will be assessed, which will probably depend heavily on our ability to identify an appropriate measure of tenderness and palatability. Packers/processors must make changes but the general perception is that they are unwilling. Even if dramatic improvement occurs, the retail price of beef may be too high in comparison to other meats. Although it is difficult to say how the consumer would react, the cow/calf producer will finally have the opportunity to be paid for quality genetics that result in higher quality beef.

5. Industry Structure and Information Flow. The structure of the beef industry is not unlike a giant funnel with hundreds of thousands of cow/calf producers at the top and a handful of packing companies processing fed cattle at the bottom. Conflicting objectives/goals and measures of value from one segment to the other promote the lack of information flow, thereby enabling one segment to use information as a source of control over others. At some point the beef industry must wake up and realize the only way to make positive change is to cooperate and communicate more. The Strategic Alliance Field Study (1994) showed the positive impact that communication between segments of the beef industry have on our goal of meeting consumer needs. It is time to eliminate the "island mentality" that has been so pervasive among the various segments. In order to implement value-based marketing, some type of tracking system for quality control and pricing will have to be developed and could also serve as a way to transmit general information on groups of cattle between segments. To some extent, information flow between segments will naturally increase as integration, contracts and alliances are formed among industry segments. Continued education within each segment and about other segments of the industry is necessary if beef quality and consistency is to improve.

6. Frame Size and Breed Type. Although supply and demand affect packers' ability to be selective, respondents to this survey felt substantial discounts are necessary for extreme cattle in order to send a signal that carcasses on either extreme are not desirable. Many seedstock and commercial producers have already begun breeding more moderate frame, uniform cattle;

however, there are producers out there who swear by their extreme cattle. Often they are fortunate to be within the current broad carcass weight range of 550 to 900 or 950 lb. They also may be selling to a small packer who is using small or large retail cuts to fill a niche market. Large packers may adopt a premium/discount system and narrow their window of acceptability as beef prices decline and/or as they move toward value-based marketing. The result should then be more moderate frame cattle and potentially a more consistent product (relative to size). Additional education on the effects of size and type on beef quality and consistency is needed.

7. Breeding Systems. Discussion of crossbreeding systems seems to always be a popular topic even though the discussion started primarily with the introduction of Continental European breeds in the 1960s. Although reams of research results indicate there is no single best crossbreeding system, the research goes on in search of answers to new questions and/or using new breeds. The current hot topic is the use and/or development of composite breeds. While composites can be beneficial, especially for small breeders, they are not for everyone to use or develop. The development of across-breeds EPDs has also renewed some interest in crossbreeding systems. The unfortunate result of crossbreeding over time, which is quite likely to continue, is the production of "rainbow" or "mongrel" cattle. Variation is to be expected, but extreme lack of uniformity within a herd should be corrected. Additional education is needed on traditional crossbreeding systems as well as the use of composite breeds and across-breed EPDs along with education on how these "unknown" breed type cattle impact the industry.

Education within the beef industry will be necessary as specialized breeding lines are developed and become popular, similar to the poultry and swine industries. All but one person thought specialized breeding lines should be encouraged and made available to producers as one more tool to use for optimizing production and increasing profitability as they have in the poultry and swine industries.

8. Selection for Carcass Traits. Unfortunately, the beef industry frequently calls on the cow/calf producer to make changes without any economic incentive, but rather a slap on the back and thanks for doing it for the good of the beef industry. While it seems that is once again the case with the industry calling for improved beef quality and consistency, other areas besides genetics are being examined and changes proposed (see National Beef Tenderness Conference Report, 1994). The fact is producers are unlikely to make significant changes in their breeding programs until something like value-based marketing comes along (Woodward et al., 1992). However, one person suggested genetic improvement in the swine industry was not founded on what producers were paid for it, but rather what they saved. In addition, if producers believe value-based marketing will become reality within the next five years, they should begin now to shift some selection emphasis to carcass traits. Also, more breed associations need to take an active role in collecting useful carcass data.

The uncertainty of when the marketing and quality grading system might change was reflected in survey responses regarding which traits to develop carcass EPDs for: fat thickness, marbling, retail product percentage, "tenderness," and carcass weight. Obviously, if desired changes occur in marketing and grading, some of these traits will be omitted and/or replaced by other traits. As carcass EPDs become available, progressive producers will use them. In the case of tenderness, the industry should concentrate on eliminating sires determined to have genes causing toughness. Some care must be taken in selecting for carcass traits because of the genetic antagonisms that exist between them and production and maternal traits that also are critical to the profitability of the cow/calf operation.

Certainly, progressive producers already deal with EPDs for many traits now, yet there are many producers who do not know or use EPDs for genetic selection. At some point, selection index methods may be used with the appropriate economic weights to come up with a single index value for use in selection decisions.

9. Breed Association Priorities. Breed associations play a very significant role in the beef industry in stark contrast to that of poultry and swine. Survey responses indicated breeds should put less emphasis on being all things to all breeders. This suggests encouraging the "focus to shift from the breed as an end, to the breed as a means to an end." The result could be that commercial producers would make better crossbreeding decisions as a result of being better informed on each breeds' strengths and shortfalls. An eventual outcome could be more uniformity within and across herds, increased profits, and several benefits to the industry.

An article in the January, 1994 issue of *Beef Today* reported incomes and expenditures of eight major breed associations. Average expenditures were $6.22 per member for research, $12.93 for shows, and $53.94 for marketing and promotion. Averages for the same categories on a dollar-per-registration basis were $0.62, $1.28, and $5.33 respectively. It is apparent from these numbers what the priorities are for most of these breed associations. The responses suggest strong support and a definite need for breed associations to shift their priorities more toward research in an effort to improve beef quality and consistency. Responses worth noting are: "Conflicts and inconsistencies between shows and commercial business impedes progress" and usually leads the industry astray; marketing and promotion result in quick impact, but have little long-term effect compared to research benefits; and "Livestock shows are an obstacle to progress, not a tool of progress." These responses probably sound strong, but less so if the history of beef cattle production is evaluated from a showring perspective. We all realize shows provide a marketing tool for breeders, but there also are other ramifications.

10. Integrated Resource Management (IRM). Information and technology transfer that occur as the result of state IRM programs suggests that these programs can play a major role in affecting change in beef quality and consistency. Education on optimum resource use, improved breeding, feeding, and management strategies to increase production efficiency, trade-offs that exist when selecting for various traits, and marketing cattle by working with teams of individuals using production and financial records should result in numerous benefits to the industry. Carcass merit programs have also become an integral part of state IRM programs. Producers who have participated in feeding out a sample of their calves get an indication of what type of feedlot performance and end product their breeding program produces. Many more producers need to be exposed to IRM and hopefully better decisions will result in their operations as a result of being better informed through careful examination of their own production and financial records in relation to their available resources.

11. Feedback Mechanisms. Several suggestions for feedback mechanisms, whereby information on or value of the end product would get back to the producer, were included for each person's comments. In the short-term, retained ownership and value-based marketing (if it arrives in the short-term) will provide input back to the cow/calf producer. It is important to keep in mind that carcass merit or steer "feedouts" are only demonstration projects. Electronic identification and a system to cross reference an animal's ear tag and carcass identification are plausible, but the former requires government approval and the latter will require cooperation from packers, which has traditionally been possible only on small groups of research cattle (and even then a researcher normally has to be present). Finally, some breed associations are working to establish a link between purebred and commercial producers to encourage both to track what kind of carcasses result from their breeding programs.

Opportunities for BIF

Encourage R&D Funding for:

- Instrument grading
- Rapid "lab test" for tenderness
- Live-animal measure of tenderness
- Information and ID tracking systems between segments
- Carcass EPDs (new and existing traits)
- Efficient breeding systems
- Trade-offs between selection for carcass and other production traits
- Progeny testing for tenderness research

Go on Record in Support of:

- Changing quality grading system
- Rapid implementation of value-based marketing
- Breed associations spending more on research
- Collection of carcass and palatability data by breed associations
- Public and private funding of state IRM programs
- Development of new quality standards

Educate Producers on:

- Being prepared for value-based marketing
- Impact various management practices have on beef quality
- New genetic technology
- Selecting for carcass traits
- Effect of *Bos indicus* breeding on beef quality and consistency
- Quality and consistency should be the standard without expecting consumers to pay a premium for it

Integrated Genetic Systems Committee

As this Committee discusses the possible areas of focus for its efforts, it is only natural that some areas will cross into activities of other BIF or NCA committees if this Committee is truly focused on integrated genetic systems (conception to consumption). Therefore, this Committee's members may need to coordinate their efforts with others. Based on the proceeding pages, there is more work to be done than is possible through this Committee. Some efforts will most likely have to be accomplished through working sub-committees while some may be achieved through educational presentations and(or) development of educational material for distribution. Following is a list of potential areas for discussion following the presentation:

- Identification/record system from gate to plate
- Set targets for production efficiency: cost, growth, reproduction, and carcass traits
- Provide basic guidelines for state IRM programs
- Industry standards for:
    - State carcass merit programs
    - State strategic alliance programs
    - Carcass quality traits
- How value-based marketing will impact cow/calf producers
- Including quality, consistency, and consumer preferences in production decisions
- How selection emphasis on carcass traits affects the production system
- Necessity of establishing breeding goals and objectives
- Need for cow/calf producers to know carcass traits of calves they raise
- Use of composites in breeding systems vs traditional crossbreeding systems
- Impact small herds have on quality and consistency
- Impact various management practices have on quality and consistency

References

Beef Industry Long Range Plan Task Force Report. 1993. Published by National Cattlemen's Association, Englewood, CO.

Lambert, C. 1991. Lost opportunities in beef production. International Stockmen's School, February, Houston, TX.

National Beef Quality Audit Report. 1992. Published by National Cattlemen's Association, Englewood, CO.

National Beef Tenderness Conference Full Report. 1994. Published by National Cattlemen's Association, Englewood, CO.

Strategic Alliances Field Study Executive Summary. 1994. Published by National Cattlemen's Association, Englewood, CO.

Woodward, B.W., E.J. Pollak, and R.L. Quaas. 1992. Parameter estimation for carcass traits including growth information of Simmental beef cattle using restricted maximum likelihood with a multiple-trait model. *J. Anim. Sci.* 70:1098.

Woodward, B.W. 1994. Value-based marketing: Is it really possible? In: Proc. of Minnesota Cow/Calf Days. Minnesota Extension Service, Univ. of Minnesota, C-107, pp. 59-73.

GENETIC PREDICTION COMMITTEE

Larry Cundiff: Chairman
Richard Willham: Secretary

Chairman, Larry Cundiff opened the committee meeting at 2:00 p.m., in the Des Moines Room of the University Holiday Inn where the 26th Annual Meeting of the Beef Improvement Federation was held from 2:00 until 5:00 p.m., June 2, 1994. Those attending the committee meeting are listed on a separate sheet.

The first speaker was Doyle Wilson. His topic was "International Cattle Evaluations". His presentation appears in the proceedings of the annual meeting. He called for a sub-committee for International Cattle Evaluations Within the Genetic Prediction Committee of BIF. The Hereford and Angus breeds are working on developing such international evaluations. John Crouch again suggested a sub-committee.

The second speaker was Ronnie Green. His topic was "Body Composition EPD's". He discussed retail product. His presentation appears in the proceedings. Information is available to use and develop retail product EPD's.

The third speaker was Gene Rouse on the topic of "Using Ultrasound Data for EPD's". This paper appears in the proceedings. The paper concentrates on beef quality measures that include marbling and tenderness. Objective carcass evaluation using ultrasound was discussed. Number of certified technicians for ultrasound needed was considered. A lively discussion followed.

Larry Cundiff then called for reports of progress from the committees named to develop sections of the Genetic Prediction Guidelines for 1995. Reports were given by Keith Bertrand for National Cattle Evaluation; by Bob Scarth for Edits for Genetic Evaluations; by Dale Van Vleck for Updates on U.S. MARC Tables for Across Breed EPD's; by Bruce Golden on Hereford EPD's; by Bruce Cunningham on Interim EPD's; and by Bob Schalles on Data Collection and Management.

Bruce Golden reported on the western region coordinating committee developments with a possible meeting planned for September of 1994. Jim Brinks proposed such a group at the Genetic Prediction Workshop in January of 1994. This committee has been approved through the standard experiment station procedure.

Proceedings of the 4th Genetic Prediction Workshop were sold for $5.00 at the end of the committee meeting. Larry Cundiff closed the meeting at 5:00 p.m.

Respectfully submitted,

Richard L. Willham
Recording Secretary

1992 AVERAGE EPD'S FOR EACH BREED

For selection of breeding stock, it is important to know how EPD's for an individual animal compare to the current breed average. Mean non-parent expected progeny differences (EPD's) are tabulated for each breed. These are useful for making comparisons within breeds. They cannot be used to compare different breeds because EPD's are estimated from separate analyses for each breed. The means are for all calves born in 1992 from the 1993-94 genetic evaluations. The 1992 calves were chosen because limited data were available on 1993 calves (i.e., yearling weight) in the 1993-94 genetic evaluations.

1992 ALL ANIMAL NON-PARENT MEAN EPD's FROM 1993-94 GENETIC EVALUATIONS

	Birth	Wean.	Yrlg.	Maternal		Yrlg.	Scot.	Calving ease	
	wt	wt	wt	Milk	Total	ht	circ.	Direct	Maternal
Breed	lb	lb	lb	lb	lb	in	cm	%	%
Angus	+3.2	+23.1	+39.4	+8.8	20.35				
Beefmaster	+0.5	+6.23	+12.22	+5.17					
Brahman	+0.95	+7.33	+12.51	+3.38					
Brangus	+1.50	+14.60	+24.55	+0.77	+8.07				
Charolais	+1.47	+7.86	+11.95	-0.87	+3.06				
Gelbvieh	+0.3	+4.5	+8.6	+1.67	4.17			100.2[a]	101.2[a]
Hereford	+2.22	+25.66	+41.08	+7.45	+20.28	+0.65	+0.19		
Limousin	+0.6	+4.3	+8.4	+0.3			+0.03		
Maine Anjou	-0.1	+0.6	+0.7	-0.3	-0.0				
P. Hereford	+3.4	+21.8	+34.6	+1.2	+12.1		+0.04		
Red Angus	+0.4	+19.1	+31.7	+7.5					
Salers	+0.8	+7.3	+11.7	+2.9					
Shorthorn	+1.9	+11.9	+19.5	+1.9					
Simmental	+0.4	+8.3	+14.2	+0.4	+4.6			1.8[a]	1.5[a]
Tarentaise	+3.27	+10.76	+15.9	+0.74					

[a]For Simmental, calving ease is percentage unassisted births in first calf heifers. For Gelbvieh, calving ease is a ratio (%) of calving ease scores in first calf heifers.

INTERNATIONAL CATTLE EVALUATIONS

Doyle E. Wilson
Iowa State University, Ames, IA

There are several reasons for pursuing the development of systems for conducting international cattle evaluations. International evaluations provide breeders, in some instances, with a much expanded gene pool from which to select breeding stock. Such evaluations provide a vehicle for standardization of evaluation procedures and reporting formats. One of the more practical reasons is the removal of multiple (country specific) EPD values that are generated for any one animal. Pooling all performance records from across countries also adds to improvement in evaluation accuracies for the individual animals.

Reference to a country or region in the following paragraphs is in reference to a within country (region) breed organization. It is assumed that this organization has as one of its primary responsibilities that of maintaining the breed pedigree file. It is also assumed that this organization or some affiliate maintains the pedigree and performance file in a computerized data base for purposes of ease in accessing and maintaining the data.

Requirements to Participate

The requirements for any country or region to participate with any other country or region in conducting an international genetic evaluation are basically those same requirements for an in-country performance recording and genetic evaluation program. These requirements are: (1) a viable method of collecting accurate performance measurements on the production traits of interest, (2) a computerized data storage and retrieval system, (3) a set of appropriate fixed effect (age, sex, age-of-dam, etc.) adjustment procedures, and (4) an efficient method of disseminating the results and in servicing the users of these results.

In order to conduct an across-country (region) genetic evaluation, a computerized system is required for merging the independent data sets. There must also be a master cross-reference file to handle individual animals that are identified with different country specific registration numbers. Since combining the data bases will, in many cases, result in a relatively large data base, the software and hardware must be appropriately sized to efficiently and expeditiously process the data.

Considerations and Issues

There are some considerations and/or issues that will be encountered in the development of international genetic evaluations. There is no reason to expect these considerations or issues to be insurmountable or any more significant than those that exist within current national genetic evaluation programs. One of the first questions that generally comes to the minds of animal breeders is whether genotype by environment interactions exist, and if they do exist, are they significant enough to warrant provisions for adjustment in the evaluation procedures. Additionally, only common traits can be adequately evaluated. Do these common traits exist? And, are the end points the same for each common trait? Contemporary group definition differences will probably exist with some of the traits being evaluated. Differences will need to be resolved and consistent definitions agreed upon and implemented by the participating parties. Are fixed effect adjustments made on some of the performance measurements, and what is the consequence of using different adjustment procedures for the same trait? Of a minor consideration, is the provision for conversion between English and metric units for the EPD values.

An essential ingredient for countries participating in an international genetic evaluation is that their data bases be tied together. That is, sufficient direct ties must exist to remove the environmental and management differences that influence the performance of the cattle. With the wide spread use of artificial insemination, it is not expected that this will be a problem with most of the major beef breeds. However, many of the minor beef breeds may not be so fortunate in being adequately tied. The table on the following has been borrowed from the American Angus Association as evidence to support that connectedness will not be a problem with many countries desiring to conduct an international cattle evaluation for the Angus breed.

BIF Role

What role does BIF have in the development and implementation of international cattle evaluations? It is the opinion of this author that BIF can play a very significant role in establishing a forum for developing a set of guidelines for these evaluations. It is recommended that the Genetic Predictions Committee establish a subcommittee to develop these guidelines. It is further recommended that the subcommittee be composed of representation from at least the following organizations: Agriculture Canada, Animal Genetics and Breeding Unit (AGBU) and Breedplan (Australia), Cornell University, University of Georgia, Iowa State University, US Meat Animal Research

Center, and others as deemed appropriate by the Genetic Predictions Chairperson.

There is no free lunch when it comes to conducting international genetic evaluation programs. Each participant will be expected to pay their fair share of the system development and processing. Such programs will also probably be characterized by limited resources to organize and carry out the task. It is for this reason that organizations like BIF, and the expertise that resides corporately within this organization, will be asked to play a role in helping these programs along.

International Cattle Evaluations

World Angus Data Base - Connectedness

	Argentina	Australia	Canada	Rep. of Ireland	New Zealand	Paraguay	U.K.	S. Africa	Sweden	U.S.A.
Percentage AI	50	17	30	60	11	60	25	15	10	37
Imported Semen	CN, US	CN, NZ, US	CN, GB	CN, GB	AU, CN, US	AG, US	GB, US	US, NZ, AU, GB	US, NR, FN	CN, GB, NZ

Source: John Crouch, American Angus Association

Retail Product Percentage EPD: Perceived Status and Needs

R. D. Green[1], H. H. Shepard, J. J. B. Diles, K. E. Hamlin, T. L. Perkins, N. E. Cockett[2], M. F. Miller, D. F. Hancock[3] and L. S. Barrett

Department of Animal Science and Food Technology
Texas Tech University, Lubbock

[1]Department of Animal Sciences
Colorado State University, Fort Collins

[2]Department of Animal and Veterinary Sciences
Utah State University, Logan

[3]Department of Animal Science
Purdue University, West Lafayette, IN

IS MEASUREMENT OF CARCASS PERFORMANCE JUSTIFIED?

The National Beef Quality Audit, conducted by Colorado State, Texas A&M and Texas Tech Universities in 1992, was a "wake-up" call to the beef cattle industry. The results of the audit of the current slaughter cattle population, done in 28 plants spread across the U.S., indicated a total of some $280 in inefficiencies for each fed steer and heifer produced in the business. Furthermore, when these inefficiencies were broken down into various causes, it became apparent that the majority of these losses occur due to excess fat production with lower consistency in taste than desired (table 1). If the industry is to remain a viable sector of the food business, we cannot ignore what these numbers tell us. The challenge could not be clearer: ***the beef cattle industry needs to achieve change at the carcass level, by implementing a combination of changes in feeding and management practices coupled with genetic improvement.***

If one reviews the history of the "carcass merit/value-based marketing" issue, the argument has repeatedly been raised by both industry ***and*** academia that goes something like this: *"I do not get paid on the basis of carcass performance and until I do I see little justification for collecting carcass data. Furthermore, "value-based marketing" is a buzz word made up by the packing industry, for the benefit of the packing industry, that seems to keep getting delayed in its implementation."* While this argument may appear to be historically true, it also reeks of "short-sightedness". The fact of the matter is that the business of selling beef has become more competitive due to our friends in the poultry and pork industries. The response of the beef packing and retail industries is beginning to be seen through the development of new closely-trimmed boxed beef. In the past year, Excel, IBP and Monfort-ConAgra have all developed 1/4 inch trim (or less) boxed-beef specifications. Industry consensus is that 50% of all boxed-beef trade will fall into this category by the end of this year, 80% by the end of 1995 and near 100% by the end of 1996 (NCA, 1993). One does not have to be very astute to realize the impact of this marketing change on the cow-calf industry. ***The need for carcass EPD can no longer be paid lip service, IT IS REAL.***

DEFINING CARCASS MERIT

The definition of "ideal" carcass merit is somewhat elusive under our current USDA yield and quality grade system. Rex Butterfield summed up our objective well when he said:

> *"The ideal carcass is one which yields a maximum percentage of muscle, a minimum percentage of bone and enough fat to meet the minimum quality requirements of the marketplace. It must be produced economically within the limits of functionally efficient cattle."*

TABLE 1. DOLLAR LOSSES ATTRIBUTED TO VARIOUS INEFFICIENCIES IN THE BEEF CATTLE INDUSTRY

Source	Dollar Loss (per hd.)
Waste	
Excess external fat	$111.99
Excess seam fat	62.94
Beef trim to 20% fat	14.85
Muscling	29.47
Taste	
Palatability	2.89
Marbling	21.68
Maturity	3.80
Gender	0.44
Management	
Hide defects	16.88
Carcass pathology	1.35
Liver pathology	0.56
Tongue infection	0.35
Injection sites	1.74
Bruises	1.00
Dark cutters	5.00
Other	0.38
Weight	
Carcass wt. (625-825 lbs)	4.50
Grand Total Losses	***$279.82***

Adapted from National Beef Quality Audit (1992).

This objective coincides with the fact that consumer preferences are "to keep the taste fat and get rid of the waste fat". We know that we can get rid of a lot of our excess fat production by changing feeding practices. We also think, however, that this will reduce the palatability of our product. Industry evolution in recent years has also resulted in specification markets for lean beef versus "white table cloth" niches. While these niche markets provide greater opportunities for matching diverse biological types to economic environments, they do dictate the need for genetic identification of specific components of carcass performance.

Fortunately, we know from collective research results over the past 25 years that genetic variation exists both between and within breeds for measures of carcass merit. Levels of heritability for measures of retail yield and palatability are all in excess of what we generally observe for growth traits (see Table 2). This indicates that we should be able to make genetic improvement from selection within breeds for these measures.

Larry Cundiff and co-workers at the Roman L. Hruska U.S. Meat Animal Research Center have also reported that the magnitude of genetic variability between breeds is roughly equivalent to that within breeds (see Table 3). This infers that we should also be able to make improvement in carcass desirability of slaughter cattle through proper breed selection implemented in designed crossbreeding programs.

TABLE 2. HERITABILITY ESTIMATES OF CARCASS TRAITS IN BEEF CATTLE

Trait	No. Studies	Avg. h^2
Retail yield (%)	7	.42
Retail weight (lb)	6	.53
Carcass weight (lb)	7	.48
Ribeye area (in^2)	10	.40
12th rib fat (in)	10	.43
Marbling (or Quality Grade)	9	.38

(Weighted average of literature estimates)

TABLE 3. RELATIVITY OF VARIATION WITHIN AND BETWEEN BREEDS FOR CARCASS PARAMETERS IN BEEF CATTLE (ADAPTED FROM CUNDIFF ET AL. (1990))

Trait	Number of Additive Genetic Std. Deviations Between Most Divergent Breeds
Retail product (%)	5.8
Retail product weight (458 days)	8.2
Marbling score	5.3

Before talking about how particular types of data might be helpful to us in genetic improvement programs, it is important to provide some framework for what carcass merit EPD might look like. Many times we are prone to attempt to give lots of pieces of information to our producers without giving any suggestion for how the pieces of the puzzle fit together into a picture. The carcass merit area is certainly one that might suffer from this problem.

Since our current USDA grading system is two-pronged for retail yield (or cutability) and palatability (or quality), there are a number of factors we use to estimate differences among carcasses. We can attempt to provide information for all of the components including ribeye area, fat thickness and carcass weight for retail yield and marbling for quality grade. There are strong arguments for including each of these traits as a part of NCE programs including: 1) specification marketing provides impetus for producers to need to know performance in each of the criteria to make sure they "fit the window", and 2) the need exists within some breeds to improve certain components (eg. excess carcass size, inferior muscling, etc.) while they may be acceptable in terms of the composite trait. The other advantage to component trait reporting is that we have more information regarding genetic parameters for the components along with the fact that the prediction error variance of the composite trait (eg. retail yield %) will be a function of the PEV's of the components and the covariance between them. ***Thus, it appears that we should attempt to provide predictions for the components. While this would provide a lot of valuable information, the overall message might fall between the cracks if we do not report the composite trait(s). The question is: how?***

A two or three part system is envisioned for reporting these composite traits. The first EPD needed is one that predicts the retail yield potential of a sire's slaughter progeny at a standard slaughter age. For example, we might have a system based on percentage retail cuts in the four primal regions of loin, rib, round and chuck at a standard slaughter age of 15 to 16 months.

The second part of this system should consist of a breeding value estimate that would tell us the potential of a sire's progeny to have consistently palatable carcasses. In our current USDA grading system we would use intramuscular fatness (i.e. marbling) to place cattle into quality grades. This is probably the most cursed and yet highly praised part of our industry. Any popular press publication you pick up these days has arguments on both sides of the issue. The best summary of the value of the quality grading system comes from work done by Smith et al. (1987) shown in Figure 1. If you are a protagonist on the value of marbling, what you see in these results is the ability of the quality grades to narrow the variation in overall palatability as you move from Standard up through Prime grade classes. The "risk factor" of getting a bad-eating piece of product goes down from 59.1% in Standard to 5.6% in Prime. Thus, the pro- viewpoint is from the perspective of an insurance policy. The antagonist viewpoint is that the system is not nearly "tight" enough because of the overlap of palatability between all four grades. This observation, coupled with the fact that our feedlot industry is driven to overfeed cattle to try to bump them into low Choice as well as increase dressing %, has resulted in several calls from within the industry to either eliminate or change the quality grading system.

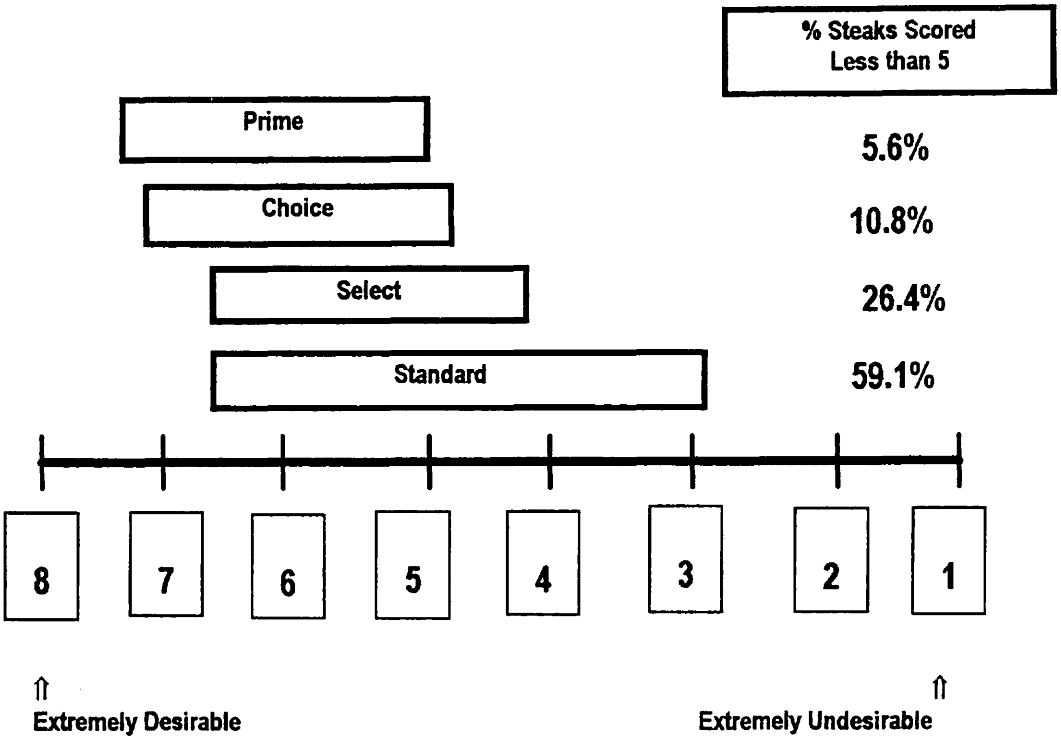


FIGURE 1. RELATIONSHIP BETWEEN PALATABILITY AND U.S.D.A. QUALITY GRADE (SMITH ET AL., 1987)

The real issue here is that we need to be able to directly and objectively estimate tenderness. We have formulated a conceptual hypothesis concerning the importance of the three sensory characteristics across the various quality grades (table 4). Under this model, when in the Prime grade the variability observed in overall consumer acceptance is all due to tenderness since there is adequate marbling there to insure flavor and juiciness. As one moves down in grade, however, the relative importance of the three characteristics shifts. The take home message here is that when you weight the percentage of slaughter cattle falling into the various quality grade classes (based on National Beef Quality Audit (1992)) with the percentage unacceptable within each grade, ***approximately 20% of the slaughter mix is unpalatable. Furthermore, using the model below, 62% of that problem is due to inadequate tenderness.***

TABLE 4. HYPOTHETICAL MODEL OF PALATABILITY AS EXPLAINED BY VARIATION IN SENSORY CHARACTERISTICS

U.S.D.A. Quality Grade	Variability Described by Tenderness	Flavor	Juiciness
Prime	100	0	0
Choice	80	10	10
Select	60	20	20
Standard	40	30	30

Given all of that background on the palatability portion of carcass merit, what do we need to do for a quality EPD? Since we also know from research results that the genetic relationship between percentage retail product yield and marbling is negative and antagonistic (Cundiff et al., 1990), ***we need to couple the EPD for yield to the EPD for quality.*** This can be accomplished by expressing the quality EPD in terms of the potential of an animal's slaughter progeny for quality grade, marbling score or preferably tenderness level ***at a specified industry target yield grade.*** Such a system will allow us to define the animals that excel in both characteristics simultaneously.

WHY DO CARCASS EPD NOT ALREADY EXIST?

Now, if there is such a need for carcass EPD and the genetic bases of these traits is relatively high, why do we not have them? It is almost as if there has been a brick wall up in front of carcass EPD. Some of the factors contributing to this problem were discussed at an ASAS ultrasound symposium in 1990 (Wilson, 1992). Before the collection and use of data to allow these breeding values to become a reality is discussed, it is helpful to reiterate those points and others which have prevented carcass EPD in the past.

The largest hindrance to collecting carcass information is that in the past we have had to solely rely on progeny data. This type of information requires **time**, expense and labor to collect and also requires cooperation in the packing plant for individual, **accurate** identification of carcasses. The combination of these factors has resulted in limited amounts of progeny data being placed into breed performance databases. The American Angus Association has had the most concerted effort in designed progeny testing of sires and according to John Crouch, only around 1.1% of their currently evaluated sires have any carcass information (788 of 68,841 sires, 394 with published EPD). Several other breed programs are attempting to build databases with Simmental and Salers having recently published carcass reports. Programs like the NCA's Carcass Data Collection Service and various state programs (eg. OK Steer Feedout, Texas A&M Ranch to Rail, etc.) are helping in this area. By January of this year, a total of 54,383 steers, 6,937 heifers and 1,891 bulls had been processed by the NCA program since its initiation two years ago. John Stowell, director of that program for NCA, projects a total of 55,000 head to be processed this year.

The second hindrance has been the lack of ability to determine true carcass value differences on the live animal. We now feel like we can do this about as well with ultrasound as with carcass measures for retail yield. ***A third question relates to whether there is adequate variation in breeding cattle for these measures of carcass merit. Fourthly, how much of the variation that we observe in these young breeding cattle is genetically inherited (i.e. how much is heritable)? Additionally, are there antagonisms between some of these traits which we need to pay attention to, particularly in the area of increasing mature size and decreasing reproductive efficiency when selecting for leanness?*** The last question is perhaps the most looming one of all. ***When we measure differences between young, immature breeding bulls and heifers, do these differences relate to those we observe between their slaughter progeny?*** While this may seem to be intuitively true, realistically we do not know. The yearling bull is a physiologically different beast than a 15 to 17 month old slaughter steer.

REAL-TIME ULTRASOUND RESEARCH

We started studying real-time ultrasound for application to the development of carcass merit EPD's late in 1990. At that time there was considerable skepticism regarding the use of this technology for this purpose. Additionally, several commercial firms were busy measuring cattle of all types, ages and backgrounds without any standard protocol. We got involved to attempt to clear the water, so to speak. Since October of 1990 we have obtained measurements on some 3,900 animals. The majority of these animals have been measured serially, making the total database much larger. All of the images were obtained using the Aloka 500V unit (Corometrics Medical Systems, Wallingford, CT) equipped with a 3.5 MHz, 17.2 cm linear transducer. A super-flab guide was used for all 12/13th rib cross sectional imaging with images simultaneously recorded to super-VHS videotape. This allowed recording at roughly twice the resolution of a standard table-top VCR. Images were analyzed in our computer laboratory using computer software (AniMorph, Woods Hole Educational Associates, Woods Hole, MA).

The application of this technology for live animal imaging of carcass traits has seemed to get bogged down over the past ten years from a stated desire to accurately and precisely estimate measures on the carcass. However, one must keep in mind that the real purpose is to describe end value differences, which are not perfectly related to the carcass measurements. In a manner of speaking, when one estimates ribeye area with ultrasound, the attempt is being made to predict a predictor. Data from our program (Hamlin et al., 1994; Perkins et al., 1992b) have indicated ultrasound measurements to be slightly less accurate in predicting retail yield percentage than the same measures made directly on the carcass. Our data has been in general agreement with results from the Iowa State and Georgia programs.

The study that most helped us to define the predictability of retail yield percentage from ultrasound was performed as the master's thesis of Kevin Hamlin cooperatively with Larry Cundiff at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE. In that study we were interested in evaluating slaughter steers (n = 179) representing four biological types (on the basis of lean yield) with ultrasound over the course of their feeding period as calf feds. Steers were measured every 90 days beginning in December of 1990 and in four serial slaughter groups to allow evaluation at age, weight and quality grade endpoints. Figures 2 and 3 show the predictability of ultrasonic fat thickness and ribeye area (at the 12/13th rib juncture) in predicting percentage of retail cuts (trimmed to 8 mm) by date of measurement at constant age and marbling endpoints, respectively. When compared to the same prediction made from carcass fat thickness and ribeye area, the R^2 values were increased an additional 7 to 10%. Furthermore, the interesting thing from these data was that fat thickness controlled almost all of the predictive variation in retail yield. Ribeye area, while statistically significant, only contributed a minor amount to the prediction of cutability. ***This pointed out to us the over-emphasis on ribeye area as an indicator of retail yield in our current system.*** Only when we remove much of the fatness problem will ribeye area begin to play an important role.

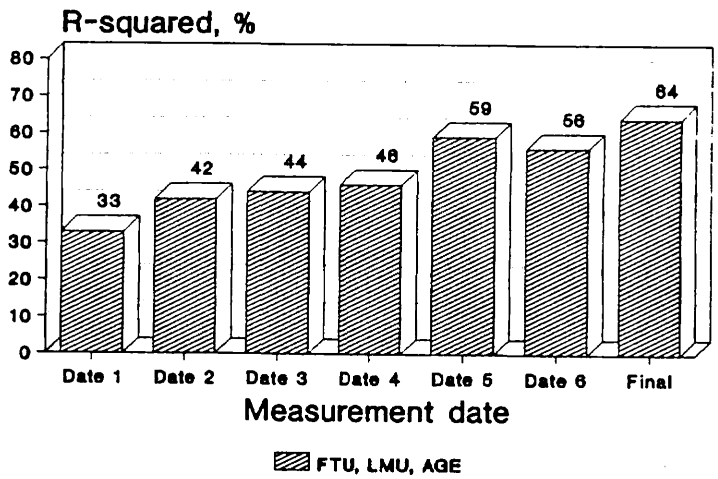


FIGURE 2. PREDICTION OF PERCENTAGE RETAIL YIELD AT 8MM FAT TRIM (AGE CONSTANT) (HAMLIN ET AL., 1994)

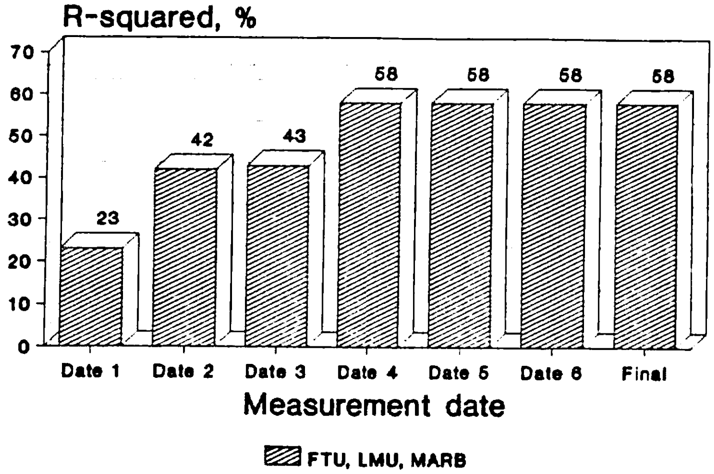


FIGURE 3. PREDICTION OF PERCENTAGE RETAIL YIELD AT 8MM FAT TRIM (MARBLING CONSTANT) (HAMLIN ET AL., 1994)

Considerable discussion has occurred in recent months regarding whether the targeted EPD should be ***percentage retail product*** or ***pounds of retail product weight***. Herring et al. (1994) recently reported much higher R^2 values (65 to 80 as compared to 80 to 92% with carcass traits) when using live weight and ultrasonic ribeye area to predict retail product weight than using the same variables to account for variation in percentage retail product yield (R^2 of 29 to 48% as compared to 56% with YG factors). They furthermore suggested that emphasis might be best placed on pounds of retail product weight at a constant fat thickness or on percentage of trimmable fat as the endpoints to effect increased cutability. The down side of this approach is in the unfavorable genetic relationship of live weight and ribeye area with mature and carcass weights.

We have also evaluated alternative sites of measurement including body wall thickness measured below the ribeye across the *Longissimus costarum* muscle, depth of the *Longissimus dorsi*, fat depth on the rump at the Australian P8 site, longitudinal measures of the *Longissimus dorsi* at the 6-7-8th rib and the *Spinalis dorsi* as a potential marbling depot. None of these measures have improved prediction of retail yield percentage above fat thickness and ribeye area enough to warrant their inclusion in data collection.

TECHNICIAN ACCURACY?

When we start talking about using ultrasound data to estimate retail yield percentage EPD it becomes very important to account for all known environmental factors which may contribute to these measurements. We know from numerous studies that fatter cattle are more difficult to measure, that there are differences in measurement efficacy between sexes and there are differences between technicians, equipment and technique (Duello et al., 1993; Houghton and Turlington, 1992; Perkins et al., 1992a). Robinson et al. (1992) very correctly stated that because of the expectations of small differences between animals of the same sex and management system, technician effects become very important.

The Beef Improvement Federation has recognized this and implemented guidelines for ultrasound technician certification (Green et al., 1992a) to insure that technicians contributing to breed databases are under some measure of quality control. This means that we want these technicians to be highly repeatable and they must correctly rank animals within contemporary groups. Technician differences can then be accounted for as a fixed effect in national cattle evaluation analyses. In the Beef Improvement Federation's Ultrasound Proficiency Examination hosted in June 1993 at Iowa State, eleven individuals were certified as proficient (required to be under .12 in and 1.2 in^2 bias and .10 in and 1.2 in^2 standard errors of prediction and repeated measures for fat thickness and ribeye area, respectively). We feel quite confident of the quality of data generated by technicians using these criteria. A second certification program was just completed at Iowa State resulting in an additional seven people becoming certified.

Technician accuracy does have the opportunity to improve as computer software continues to develop for image analysis at a rapid pace. Digitizing of images to avoid loss of image resolution when recorded to videotape is also a big improvement and is rapidly becoming the method of choice in ultrasound research programs. A final point to remember here: ***a good analogy might be to compare the scrutiny of these evaluations as compared to assessing growth rate differences from body weight field data which contains inherent gut fill differences??***

WHAT ABOUT BREEDING CATTLE?

Given that we can collect this information and remove environmental effects, will we be able to make any progress from selection? Table 5 provides a summary of heritability estimates for ultrasonically measured backfat thickness and ribeye area in breeding cattle. The weighted averages of these studies indicate a heritability of backfat thickness of .36 and of ribeye area of .24. When these are compared to the heritabilities of standard measures of growth such as weaning weight, we can conclude that these measures are under a relatively high degree of genetic control.

TABLE 5. HERITABILITY ESTIMATES OF 12TH RIB ULTRASONIC BACKFAT THICKNESS AND RIBEYE AREA

Source	No.	Breed (s)	Fat Thickness	Ribeye Area
de Rose et al. (1988)	7,667	6 breeds	.49	-
Lamb et al. (1990)	824	Hereford	.24	-
Turner et al. (1990)	385	Hereford	.04	.12
Arnold et al. (1991)	3,482	Hereford	.26	.28
Duello et al. (1993)	208	Angus	.00	.64
		Simmental	.21	.87
Johnson et al. (1993)	1,613	Brangus	.14	.40
Robinson et al. (1993)	9,232	Angus, Hereford	.30	.21
Shepard et al. (1994)	1,556	Angus	.56	.11
		Weighted Average	***.350***	***.239***

The last of these studies was one conducted in our research program as the master's thesis of Ms. Holly Shepard. In that project, we worked cooperatively with the Ankony Angus Corporation, Minatare, NE, as a model. This herd had roughly 2,000 mother cows during the course of this work. We went to their operation on 60 to 90 day intervals and scanned all available bulls and heifers between seven and 18 months of age. This resulted in animals having from three to five measurements over the course of their postweaning growth period, all centered about a year of age. From these data, Holly then developed adjustment equations for age and sex effects. She concluded that linear adjustments to ribeye area for age and backfat differences within sex could be applied to single measures taken within ± 30 days of yearling age. Additionally, she determined that adjustment of ribeye area to a constant age and backfat thickness removed most of the variation due to weight, a necessity to avoid concurrent increases in mature size. Her data also indicated no need for fat thickness measures taken at yearling age to be adjusted since there was no significant relationship of fat thickness with either age or weight within this time period.

Bruce Golden and Colorado State colleagues helped us accomplish the primary objective of this project, estimation of the genetic parameters for these traits in multi-trait REML models with a sire-maternal grandsire model for weaning weight and a sire model for the ultrasonic traits. Table 6 details these parameter estimates and draws attention to the previously mentioned potential problem concerning selection for retail product yield through ultrasonically predicted ribeye area. The genetic correlation between ultrasound ribeye area and weaning direct in these data was .42. This agrees with results from Australian carcass evaluation data (Robinson et al., 1993) and Kansas State work with Brangus bulls (Johnson et al., 1993). Given the high relationship between all measures of growth, this indicates that direct selection for ribeye area will result in a concurrent increase in size. In many breeds and lines of cattle, over-size is already a problem. Thus, ***it must be emphasized that any selection for ribeye area should be done on a restricted basis within weight.***

TABLE 6. HERITABILITIES AND GENETIC CORRELATIONS FOR TRAITS IN ANGUS CATTLE

Trait (T)	h^2	r_g(WWTd, T)	r_g(WWTm, T)	r(EwEst)
Fat thickness	.56	.19	-.69	.55
Ribeye area	.11	.42	.01	.42
Weaning direct	.20	-	-.57	-
Weaning maternal	.27	-.57	-	-
Postwean gain	.51	-.20	.47	.36

[a]Shepard et al. (1994).
[b]WWTd = weaning weight direct, WWTm = weaning weight maternal, T= trait of interest,
Ew = environmental weaning weight, Est = environmental on second trait of interest.

As a last part of this project, responses to a standard selection scheme were simulated. Under a scenario where the top 5% of the males and top 50% of the females are selected for the traits, percentage changes per generation of 21.9, 1.7 and 3.0 were predicted from these data for fat thickness, ribeye area and weaning direct, respectively. These numbers indicate that we should be able to change these traits genetically, much like what we have observed by selection for growth over the past number of years in most breeds.

Perhaps the most important conclusion one can draw here is that there still exists a paucity of genetic parameter estimates for ultrasonically measured traits in breeding cattle. To our knowledge, the only studies reporting genetic correlation estimates between these traits have been Johnson et al. (1993) from Brangus, Duello et al. (1993) from limited data with Simmental and Angus, Robinson et al. (1992) from Australian Hereford and Angus and our data reported above. ***Furthermore, no needed genetic parameter estimates exist for ultrasonically predicted retail yield, cutability or palatability.***

BULLS AND STEERS -- WHAT IS THE DIFFERENCE?

From the beginning of performance programs, we have assumed that differences we observe in young breeding cattle translate into differences of their resulting slaughter progeny. This has been the underlying principle behind central bull tests, herd improvement records and other means of assessment of genetic potential for growth. The question of how well yearling breeding cattle ultrasonic measures relate to slaughter progeny carcass merit remains largely unanswered. The only piece of existing evidence in the literature is from work done in a similar project to our Ankony work between Kansas State and Brinks Brangus. Schalles et al. (1992) provided some early evidence that this relationship is good for ribeye area (table 7).

TABLE 7. SIRE PREDICTED RIBEYE AREA EPD AND CARCASS RIBEYE AREA OF PROGENY

Sire	Ribeye Area EPD (in^2) (est. from ultrasound)	Carcass Ribeye Area (in^2) of Progeny
A	0.277	12.47
B	-0.011	11.85
C	0.875	13.35
D	0.036	12.56
E	0.665	12.39
F	0.527	12.91
G	0.102	12.87

[a]From Schalles et al. (1992), in Brangus animals.
[b]Regression of progeny carcass ribeye area on sire ribeye area EPD was .87.

We recently concluded a project using four groups of Brangus bull clones produced by nuclear transfer to address this question directly. In this project, Jeff Diles took two animals randomly from each of the four genotypes and castrated them at weaning to conduct his M.S. thesis project. The steers were then placed on feed to simulate a standard high-energy calf-feeding type of program while their bull clone-mates were placed on a moderate-energy postweaning gain test. All animals were measured every 28 days (from seven to 18 months of age) with ten linear measures as well as ultrasound measurements obtained at the standard 12/13th rib juncture along with all alternative sites mentioned earlier. Complete carcass dissection data as well as the standard yield and grade information was obtained post-slaughter on the steers. Because the steers and bulls within a cloned genotype were genetically identical (verified by nuclear DNA fingerprint), this project allowed us to see what measures on the yearling bulls were predictive of retail yield percentage attributes on the slaughter steers. When we initially looked at these data (see table 8), we did not see any clear relationships between the fat thickness and ribeye area measurements and percentage retail product yield, although the ultrasonic body wall thickness measurement looked promising.

TABLE 8. SUMMARY OF CARCASS AND LIVE ANIMALDATA FROM BULL-STEER PROJECT

Genotype	No. Bulls	%Lean	%Fat	REA/cwt (in^2/100 lb)	Fat Thickness (in)	Body Wall Thick. (cm)
A	2	63.5	20.3	.93	.74	2.00
B	4	58.8	26.3	.83	.88	2.13
C	3	61.8	19.1	.80	.62	2.07
D	4	66.8	16.4	.81	.79	1.98

Jeff analyzed the serial bull measurements over time for each live trait and adjusted them to a 365-d, 1000 lb weight constant endpoint. Genetic correlations were then estimated using the intra-class correlation method of Yamada (1962) between the age and weight adjusted bull measures and percentage retail product yield (to .25 in trim) of the steers. These estimates are shown in table 9. Significant correlations ($P < .01$) existed for round mass (measured linearly by flexible tape starting from the tuber coxae passing proximal to the hind limb at the gaskin muscle and ending at the sacral/caudal vertrebral juncture), ultrasonic 12th rib fat thickness, and ultrasonic rump depth (depth of the biceps femoris muscle measured at the Australian P8 site). Best step-wise prediction equations using these three variables accounted for 80% of the variation in percentage retail product (RSD = .598%). In these data ultrasonic measurement of fat thickness combined with a linear assessment of round mass in bulls yielded the same level of predictability as the USDA yield grade equation.

TABLE 9. GENETIC CORRELATION COEFFICIENTS BETWEEN AGE AND WEIGHT ADJUSTED MEASUREMENT TRAITS OF BULLS AND PERCENTAGE RETAIL PRODUCT YIELD OF THEIR STEER CLONE-MATES

Bull Trait	Genetic Correlation with % Retail Yield	P-Value
Linear Measurements		
Hip height	.422	.050
Body length	.128	.572
Rump length	.016	.945
Rump width	.424	.050
Shoulder wdth	-.290	.190
Round mass	.568	.006
Ultrasonic Measurements		
12th rib backfat	-.523	.013
12th rib ribeye area	.022	.924
12th rib ribeye depth	.359	.101
Body wall thickness	.186	.408
Rump fat (Australian P8 site)	.173	.442
Rump muscle depth	.532	.011

Adapted from Diles et al., (1994a,b)

SACRIFICES IN REPRODUCTION?

Another point needing emphasis concerns the relationship between ultrasonically predicted carcass measures and measures of reproductive efficiency. There is generally a lack of this type of information in the research literature. In the study by Johnson et al. (1993) referred to above, genetic relationships between scrotal circumference and ribeye area were essentially zero and were negative for fat thickness (-.33). The best existing data relating actual carcass measures to reproductive traits comes from a study by MacNeil et al. (1984) at USMARC. Table 10 provides a summary of that information and indicates antagonistic relationships between selection to increase retail product yield and age at puberty, services required to settle a cow and mature size. When you combine these results with the experiences of our friends in the swine industry with PSE, a definite red flag is raised. ***Use of ultrasound data for the genetic improvement of carcass merit needs to incorporate potential effects on reproduction and maternal ability to prevent the loss of functional efficiency in the cow herd.***

TABLE 10. GENETIC CORRELATIONS BETWEEN MEASURES OF CARCASS MERIT AND REPRODUCTIVE EFFICIENCY (MACNEIL ET AL., 1984)

Female Trait	Postwean Gain	Carcass Weight	Fat Trim	Retail Product
Age at puberty	.16	.17	-.29	.30
Wt. at puberty	.07	.07	-.31	.08
Services/conception	1.33	.61	.21	.28
Gestation length	-.10	.03	-.07	.13
Calving difficulty	-.60	-.31	-.31	-.02
Birth weight	.34	.37	-.07	.30
Mature weight	.07	.21	-.09	.25

WHERE DOES ULTRASOUND LEAVE US?

After three years and a lot of ultrasonic imaging, where are we? We feel that our data combined with all other information coming out of ultrasound research programs at Iowa State, Georgia and Agriculture Canada says that we essentially have the technology to begin performance databases within breeds for derivation of ultrasonically predicted retail yield percentage EPD. This type of approach, along with some redefinition of the way that we finish cattle in the industry, will go a long way toward removing the "waste" portion of the National Beef Quality Audit's inefficiencies. Marriage of ultrasound data with progeny carcass data would then need to be achieved in NCE programs using multi-trait prediction models. The Iowa State group (Duello et al., 1993b) has pointed out the need for exploration of this question. Additional impetus may be given if trace-back of progeny can be accomplished with electronic identification or some other form of new technology on the line of packing plants.

However, there is no doubt that the instrumentation/technology for assessment of "quality" attributes is still not to home plate yet. While results to predict intramuscular fatness (Iowa State) and marbling (Ag. Canada) look very good, we are convinced that the only logical solution to the ***"quality"*** issue is to be able to objectively identify tenderness differences. Efforts to evaluate elastography being pursued by Dale Whittaker and Rhonda Miller's groups at Texas A&M are well directed and producing promising results for instrument assessment of tenderness post-slaughter. A means of predicting genetic potential for tenderness from a live animal measure would certainly enhance our capabilities for a ***"TOTAL QUALITY MANAGEMENT"*** system.

CALPASTATIN??

Work conducted since 1986 by Dr. Mohammed Koohmaraie's research group at the United States Meat Animal Research Center (Koohmaraie et al., 1993) has concluded that the driving force behind tenderness of beef is a system of enzymes called the calcium dependent proteases (also known as the calpains) and their inhibitor ***calpastatin***. The calpains are naturally occurring enzymes which work postmortem to break down muscle proteins. The higher the activity of the calpains during the first 24 to 48 hours post-slaughter, the more tender the resulting product will be due to loss of integrity of the sarcomere at the

Z-disks. However, the problem in genetically "tough" lines of cattle is that the calpains are inhibited by high levels of ***calpastatin*** activity. Recently, work from the Clay Center group (Shackelford et al., 1994) was reported which indicated that calpastatin activity at 24 hours postmortem was 65% heritable and highly genetically correlated to Warner-Bratzler shear force (our best physical measurement of tenderness). This indicated to us that calpastatin activity could be the best chance for genetically predicting tenderness in the live animal.

Our research is now attempting to identify possible methods for improving beef tenderness through genetic screening. This first involves the development of a genetic screening method for the calpastatin enzyme from a blood sample. The work uses a DNA probe developed by Deana Hancock and Chris Bidwell of Purdue University for bovine calpastatin (Sun et al., 1993). This probe is being used to screen for polymorphisms in the calpastatin gene in the lab of Noelle Cockett at the Utah State University Biotechnology Center. We are working with the Utah State group to obtain DNA samples from defined cattle populations and obtain physical and sensory tenderness data to allow definition of the genetic polymorphisms. This work has been made possible by funding support from the American Brahman Breeders Association, Santa Gertrudis Breeders International, Foundation Beefmaster Breeders and a consortium of Brahman, Santa Gertrudis and Simbrah breeders. Work to date has defined five genotypes in a three allele system for the calpastatin enzyme (using *TaqI*) with differences of 21% in overall sensory palatability and 28% in shear force between the extremes (Green et al., 1994). We are currently studying the inheritance pattern of these genotypes to determine codominance of alleles using previously defined reference families at Colorado State (Green et al., 1992b).

We are now in the process of studying this polymorphism in a large resource population as well as the research herd at Texas A&M developed by Dr. Jeremy Taylor and co-workers as a part of the beef industry-funded carcass gene mapping project. This population was developed using Angus and Brahman germ plasm for the specific purpose of defining linkage of genetic markers to traits through reverse genetics and will be invaluable for defining this gene's importance on overall palatability. Dr. Taylor has offered the contribution of this research herd to the project as a collaborative effort. A second gene marker for muscle hypertrophy in sheep (Cockett et al., 1994) will be studied as a potential regulator of the calpastatin gene. This marker is being targeted based upon meat palatability results from sheep with this condition similar to those in *Bos indicus* cattle. By combining genotypes for both markers, we hope to further elucidate the genetic control of this postmortem system.

IMPLICATIONS

Collectively, these facts lead us to the conclusion that we have the opportunity in our current cattle population to produce the kind of cattle desired at the end product level. Terminal sire lines selected for carcass merit matched with maternal dam lines where emphasis is placed on reproductive efficiency and matching of production potential to environmental resources offer the means to this end. ***However, for this type of system to be effective, carcass merit expected progeny differences (EPD) like those described herein must be implemented in national cattle evaluation programs. Real-time ultrasound technology is the solution to this problem for cutability. Instumentation for predicting intramuscular fatness is reaching higher levels of accuracy for slaughter cattle, yet the issue of weak prediction of palatability remains. Advances in predicting tenderness in the carcass and postmortem treatments may temporarily assist in reducing the inconsistency of beef. Molecular genetic information for tenderness may offer a more permanent means of improvement and simultaneously allow us to improve the accuracy of EPD for quality attributes.***

Literature Cited

Arnold, J. W., J. K. Bertrand, L. L. Benyshek and C. Ludwig. 1991. Estimates of genetic parameters for live animal ultrasound, actual carcass data and growth traits in beef cattle. J. Anim. Sci. 69:985.

Cockett, N. E., S. P. Jackson, T. D. Shay, D. Nielsen, S. S. Moore, M. R. Steele, W. Barendse, R. D. Green and M. Georges. 1994. Chromosomal localization of the *callipyge* gene in sheep (*Ovis aries*) using bovine DNA markers. Proc. Natl. Acad. Sci. (in press).

Cundiff, L. V., K. E. Gregory and R. M. Koch. 1990. Growth and carcass characteristics of diverse breeds of cattle used for beef production. In: Proceedings of 2nd Annual Conf. of Amer. Assoc. of Bovine Pract., Kansas City, MO.

de Rose, E. P., J. W. Wilton and L. R. Schaeffer. 1988. Estimation of variance components for traits measured on station-tested beef bulls. J. Anim. Sci. 66:626.

Diles J. J. B., R. D. Green, L. J. Hughes and G. L. Mathiews. 1994a. Variation within and between groups of genetically identical nuclear transfer Brangus bulls and steers for growth measures over time. Proc. Western Section Amer. Soc. Anim. Sci. 45.

Diles, J. J. B., R. D. Green, L. J. Hughes, G. L. Mathiews and M. F. Miller. 1994b. Relationships between body measurements obtained on yearling Brangus bulls and measures of carcass merit obtained from their steer, clone-mates. Proc. Western Section Amer. Sco. Anim. Sci. 45.

Duello, D. A., D. E. Wilson and G. H. Rouse. 1993a. The relationship between real-time ultrasound and carcass measurements of 12-13th rib fat thickness and longissimus muscle area in beef cattle. J. Anim. Sci. (submitted).

Duello, D. A., D. E. Wilson and G. H. Rouse. 1993b. Adjustment procedures and genetic parameter estimates of serial growth and ultrasonically measured carcass traits in performance-tested yearling bulls, J. Anim. Sci. (submitted).

Green, R. D., N. E. Cockett, M. F. Miller, D. F. Hancock, C. Bidwell, L. S. Barrett, J. B. Morgan and J. D. Tatum. 1994. Characterization of *TaqI* polymorphisms in the bovine calpastatin gene. Submitted for presentation at 6th World Congress on Genetics as Applied to Livestock Production, August 1994.

Green, R. D., D. E. Wilson, K. E. Bertrand and R. M. Thallman. 1992a. Ultrasound technician certification guidelines. Proceedings of Annual Meeting of Beef Improvement Federation, Portland, OR.

Green, R. D., N. E. Cockett, J. S. Brinks and R. L. Hennig. 1992b. Association of the bovine major histocompatability system with various measures of immune function in beef cattle. Proceedings Western Sect. Amer. Soc. Anim. Sci. 43:91.

Hamlin, K. E., R. D. Green, L. V. Cundiff, T. L. Wheeler and M. E. Dikeman. 1994. Real-time ultrasonic measurement of fat thickness and *Longissimus* muscle area in diverse biological types of beef steers: II. Relationship between real-time ultrasound measures and carcass retail yield. J. Anim. Sci. (accepted).

Herring, W. O., S. E. Williams, J. K. Bertrand, L. L. Benyshek and D. C. Miller. 1994. Comparison of live and carcass equations predicting percentage of cutability, retail product weight and trimmable fat in beef cattle. J. Anim. Sci. 72:1107.

Houghton, P. L. and L. Turlington. 1992. Application of ultrasound for feeding and finishing animals: A review. J. Anim. Sci. 70:930.

Johnson, M. Z., R. R. Schalles, M. E. Dikeman and B. L. Golden. 1993. Genetic parameter estimates of ultrasound-measured *Longissimus* muscle area and twelfth-rib fat thickness in Brangus cattle. J. Anim. Sci. 71:2623.

Koohmaraie, M., J. Killefer, M. D. Bishop, S. D. Shackelford, T. L. Wheeler and J. R. Arbona. 1993. Calpastatin-based methods for predicting meat tenderness. Book Chapter in *"Expression, Regulation and Role of Proteinases in Muscle Development and Meat Quality"*. (in press).

Lamb, M. A., O. W. Robison and M. W. Tess. 1990. Genetic parameters for carcass traits in Hereford bulls. J. Anim. Sci. 68:64.

Macneil, M. D., L. V. Cundiff, C. A. Dinkel and R. M. Koch. 1984. Genetic correlations among sex-limited traits in beef cattle. J. Anim. Sci. 58:1171.

NCA. 1992. Improving the consistency and competitiveness of beef: Final report of the national beef quality audit – 1991.

NCA. 1993. Issues....affecting the beef industry. August/September 1993.

Perkins, T. L., R. D. Green, K. E. Hamlin, H. H. Shepard and M. F. Miller. 1992a. Ultrasonic prediction of carcass merit in beef cattle: Evaluation of technician effects on ultrasonic estimates of carcass fat thickness and longissimus muscle area. J. Anim. Sci. 70:2758.

Perkins, T. L., R. D. Green and M. F. Miller. 1992b. Evaluation of alternative ultrasound measurement sites as estimators of yield grade factors in beef cattle. Proceedings Western Sect. Amer. Soc. Anim. Sci. 43:294.

Robinson, D. L., C. A. McDonald, K. Hammond and J. W. Turner. 1992. Live animal measurement of carcass traits by ultrasound: Assessment and accuracy of sonographers. J. Anim. Sci. 70:1667.

Robinson, D. L., K. Hammond and C. A. McDonald. 1993. Live animal measurement of carcass traits: Estimation of genetic parameters for beef cattle. J. Anim. Sci. 71:1128.

Schalles, R. R. 1992. Ribeye area EPD's for Brangus cattle. In: Proceedings of "Looking Under the Hide" Symposium, Brinks Brangus Field Day, October 1992.

Shackelford, S. D., M. Koohmaraie, L. V. Cundiff, K. E. Gregory, G. A. Rohrer and J. W. Savell. 1994. Heritabilities and phenotypic and genetic correlations for bovine postrigor calpastatin activity, intramuscular fat content, Warner-Bratzler shear force, retail product yield and growth rate. J. Anim. Sci. 72:857.

Shepard, H. H., R. D. Green, B. L. Golden, W. M. Snelling and C. H. Mallinckrodt. 1994. Genetic parameter estimates for live animal ultrasonic measures of carcass merit in Angus cattle. J. Anim. Sci. (in review).

Smith, G. C., J. W. Savell, H. R. Cross, Z. L. Carpenter, C. E. Murphey, G. W. Davis, H. C. Abraham, F. C. Parrish and B.W. Berry. 1987. Relationship of USDA quality grades to palatability of cooked beef. J. Food Quality 10:269.

Sun, W., S. Q. Ji, C. A. Bidwell and D. L. Hancock. 1993. Cloning partial cDNA's for the calpain proteolytic family from bovine muscle. J. Anim. Sci. 71 (Suppl. 1):125.

Turner, J. W., L. S. Pelton and H. R. Cross. 1990. Using live animal ultrasound measures of ribeye area and fat thickness in yearling Hereford bulls. J. Anim. Sci. 68:3502.

Wilson, D.E. 1992. Application of ultrasound for genetic improvement. J. Anim. Sci. 70:973.

The Use of Ultrasound for Carcass EPD's

Gene Rouse
Iowa State University

Beef has always been regarded as a quality product and is the meat of choice by the American consumers. As a cattle industry we must strive to maintain this position. Currently, the beef industry, a consumer driven industry, is waging a war on fat. The goal by 1995 is to reduce the production of excess trimmable fat by 20% and to increase lean production by 6%. These consumer demands must be met while maintaining consistent eating quality.

How can this goal best be attained? The concept of a value based marketing system offers the beef cattle industry the opportunity to improve beef quality and consistancy. All segments of the industry must think more about marketing a product, rather than slapping a commodity on the market.

What must happen to put a Value Based Marketing System in place?

- All segments of the industry must work together and "communicate". Island mentality must be eliminated.
- Products produced must be evaluated objectively and rewards paid for superior products while discounts are imposed on substandard products at each segment of production.
- Rigid genetic, feeding and carcass specifications must be developed, maintained and implemented.

The format of this report will be to discuss the technology transfer of real time ultrasound to develop carcass EPD's on live cattle and to evaluate hot beef carcasses.

During the past six years our major research thrust has been to make real-time ultrasound measurements on live animals to develop body composition EPD's. Early work was successful in predicting longissimus muscle cross sectional area and fat cover between the 12th and 13th ribs on live cattle and relating these measurements to carcass parameters. This work was summarized recently by Dave Duello in his Ph.D. thesis and relates that ribeye area and fat cover measurements made with real-time ultrasound on 744 live cattle had correlations of 0.86 and 0.78 with carcass fat cover and ribeye area measurements, respectively. Standard errors of prediction were 0.11 in. for fat cover and 0.97 $in.^2$ for rib eye area when live ultrasound measurements were compared to carcass measurements. It has been adequately demonstrated that fat cover and longissimus area can be predicted accurately on live animals. Minor refinements will be adapted to increase accuracy in the future, however, currently with good equipment (an Aloka 500v with a 17 cm, 3.5 MHz transducer) and a certified technician, ultrasound measurements on live animals are as useful in determining body composition as carcass measurements.

During the past two years major emphasis has been placed on the quality attributes of beef. We at Iowa State University have been investigating the potential of using real-time ultrasound imagery and image processing as a means of predicting percent intramuscular fat in the ribeye muscle of live beef cattle. One-hundred-thirty-nine yearling bulls and 134 yearling steers from two different research locations were scanned using an Aloka 500v with a 3.5 MHz 17 cm linear array transducer. Both a cross-sectional and a longitudinal image was collected on each animals. A cross-sectional slice of the longissimus dorsi muscle at the 12th rib on each animal was returned to the ISU Meat Laboratory and used to obtain an n-hexane chemical extraction for determination of percent fat. The images were randomly divided into two groups. The first group was used to develop various percent fat prediction models. The second was used to test the accuracy of the prediction models. Table 1 describes the cattle used in model development and validation to predict percent fat. Table 2 relates the results of four prediction models tested. Recent predictions of percent intramuscular fat on live cattle with real-time ultrasound compared to chemically extracted percent fat have resulted in correlations between 0.62 and 0.87 with a standard error of ± 1.0 percent fat.

Table 1. Description of the steer and bull data used in the development of percent fat prediction models.

	Model Development			Validation Testing		
Item	No.	Mean	SD[a]	No.	Mean	SD
Steers	94			37		
Age, days		456	31		453	32
Weight, kg		527	72		530	62
12-13th ufat, cm		1.14	.38		1.12	.36
Marbling score[b]		1010	80		1030	100
% fat		4.87	1.66		5.16	2.11
Bulls				38		
Age, days	100	460	30		447	37
Weight, kg		541	81		544	61
12-13th ufat, cm		.76	.25		.81	.30
Marbling score		940	70		940	50
% fat		3.65	1.52		3.61	1.27

[a]Standard deviation
[b]900-990 = slight marbling; 1000-1090 = small marbling

Table 2. **Percent fat prediction model results for the development models and for the validation testing.**

	Prediction Model		Validation Testing (Fat_p vs. Fat_a)		
Model	R^2	RMSE[a]	r_{pm}	r_{rank}	Reg[b]
I	.44	±1.46	.62	.59	-075, 1.14
II	.63	±1.21	.74	.69	-0.11, 1.01
III	.67	±1.15	.76	.70	.34, 1.02
IV	.70	±1.14	.77	.72	.31, .95

[a]Root mean square error

[b]Regression intercept and slope for Fat_p on Fat_a; (p - predicted, a - actual)

All data used in the development of these models resulted from storing real-time images on VCR tape. A new system has been developed which includes a portable computer with a frame grabber board mounted internally and was used at the data collection site to digitize ultrasound images and to save them on hard disk. As a result of the new approach, quality of the images was improved, noise introduced by the VCR system was removed, spatial resolution was increased, and the image analysis process was greatly simplified. In addition, digitized images were transferred directly to and from different computers and to workstations for further processing without loss of image quality.

Currently, using this newly developed digitized system, large numbers of yearling bulls and replacement heifers can be scanned to determine percent intramuscular fat. The accuracy of this process allows us to sort a progeny group of yearling bulls into a top third, middle third and low third with respect to percent intramuscular fat.

Combining real time ultrasound images on live cattle to determine fat cover and rib eye area measurements along with the percent intramuscular fat percent makes it possible to determine carcass EPD's, that are currently being calculated from carcass data at a much lower cost, in a shorter time frame and include information on the individual yearling bull himself.

One of the problems associated with the development of carcass EPD's has been the cost and time required to test an individual sire. Estimates indicate $34000 and 3 to 4 years per sire. A recent estimate to test a sire for carcass traits using real time ultrasound measurements was $700 and the results would be available in a much shorter time frame.

Currently under development is a multiple-trait, reduced-animal model that would incorporate both carcass and live animal ultrasound measurements. This model would include carcass data from progeny tests and ultrasound measures on yearling bulls and heifers.

The question than becomes, can sires be identified that transmit heavy muscled lean carcasses with an adequate level of intramuscular fat. Recent analysis of field data for the Angus and Hereford breeds reported by Wilson and Benyshek, respectively, indicates that the genetic correlation between subcutaneous fat and intramuscular fat is very low. This suggests theses two fat depots are controlled by separate genetic mechanisms and it would be possible to select bulls that would sire steers that would deposit subcutaneous fat at a very slow rate while depositing intramuscular at a rapid rate.

The carcass EPD used to determine beef quality is marbling score. Concern has been expressed relative to importance of marbling or intramuscular fat when evaluating beef tenderness.

Table 3. Estimates of heritability (diagonal) and genetic (below diagonal) and phenotypic (above diagonal) correlations with a multiple-trait animal model with REML[a,b,c]

	Trait					
Trait	Longissimus	Shear	Flavor	Juiciness	Tenderness	Marbling
Longissimus	.60	-.05	.05	.07	.00	.00
Shear	-.14	.09	-.26	-.26	-.70	-.18
Flavor	.16	-.82	.03	.16	.34	.12
Juiciness	-.01	-.95	.78	.14	.50	.18
Tenderness	-.04	-.96	.89	.95	.10	.19
Marbling	-.40	-.53	.79	.60	.74	.45

[a]REMLPK programs of Karin Meyer with modified quadratics.
[b]Approximate standard errors: heritability, .05 – .13; genetic correlation, .12 – .94; phenotypic correlation .02 – .04.
[c]Records standardized by dividing by standard deviation for year of measurement.

Certainly tenderness is a complex issue controlled by genetics and environment including a number of pre and post mortem changes that take place at slaughter and during the aging process.

A recent paper in the Journal of Animal Science (1992) relating palatability data from 682 MARC steers over a six year period reveals a high genetic correlation between marbling and tenderness (0.74). This same paper indicates heritability estimates for tenderness and marbling of 0.10 and 0.45 respectively (see table 3). Until technology is developed to evaluate the ultimate tenderness of cooked beef from either live cattle or beef carcasses EPD for percent intramuscular fat or marbling may be the most economically feasible approach.

Technology to determine intramuscular fat on live cattle has recently (within the past 10 months) been adopted to evaluate hot carcasses in the slaughter plant . Results are more accurate than on live cattle since the two largest variables have been removed - the hide and subcutaneous fat. Results from a recently conducted study are shown in table 4. This objective ultrasound system predicted percent intramuscular fat as determined by chemical extraction more accurately than the USDA grader.

Table 4. Model prediction results

Error Magnitude	Number	Percent	Cum. Percent
0 – .5%	44	34.9	34.9 (27.2)[a]
.5 – 1.0%	40	31.7	66.7 (52.9)
1.0 – 1.5%	21	16.7	83.3 (77.9)
1.5 – 2.0%	16	12.7	96 (94.1)
2.0 – 2.5%	3	2.4	98.4 (97.1)
2.5 – 3.0%	2	1.6	100 (98.5)
> 3%			100 (100)

[a]USDA Grader

III. DATA PREPARATION AND EDITING CONSIDERATIONS
Bob Schalles

Data editing is an important part of data management. Proper identification of animals, and their sire and dam, is necessary for the relationship matrix to be correct. Each animal must have a male parent and a female parent, both of which are older than the offspring. An animal can not be it's own parent. If an animal's data is being submitted to a breed other than the one either parent is registered in, the breed and registration number from the other breed association should be recorded. Age of dam is necessary to calculate adjusted weaning and yearling weights. Duplicate records must be removed. Data from multiple births should not be used in the analysis.

Connectiveness between groups of animals is necessary, but when the animal model with a complete relationship matrix is used, few individuals are disconnected. The dam's calving interval must be at least 280 days unless some calves are either ET or multiple birth calves, and they must be indicated as such. Data from ET calves can be used provided the recipient cow is recorded in the breed, and age and identification of recipient cow is known. With out this information, maternal effects can be incorrect.

The contemporary group should consist of calves of the same sex, management, percentage breeding and within acceptable age range. The raw data used to determine the contemporary codes should be maintained in the data bank so future research and possible different groupings could be made. The recommended age for weaning weight is 205±45 (160 - 250) days, and for yearling is 365±45 (320 - 410) days. Animals outside of this range are considered irregulars. Some breeds calculate adjusted weaning and yearling weights for calves outside of this range but the data should not be used in cattle evaluation analysis.

Large ranches have a problem in weighing all calves the same day. Calves weighed within a 5 day period appears to be acceptable to be included in the same contemporary group if all other management has been the same. Central test station data should be used if there are at least two animals that were in the same weaning contemporary group and the animals continue to be contemporary.

Contemporary groups of two are useful in cattle evaluation. Pedigree of single calf contemporary group should remain in the pedigree file but the data does not contribute to the cattle evaluation. Birth weight contemporary groups can be constructed within season, with Jan-June and July-Dec being the most common season designations. However, it is recommended that the birth contemporary groups include calves born within a 90 day period and that birth and weaning contemporary groupings be independent. This facilitates the inclusion of birth weight from calves that died before weaning.

The variation of the trait within contemporary groups should be examined. In some cases there is no variation and the data should be considered as missing for traits such as birth, weaning and yearling weights. Other times records occur that are outside the expected range. Records of extreme magnitude within a contemporary group should be corrected if possible. The outlier records should be regressed back to some predetermined value. Some breeds use a multiple of the standard deviation (i.e. two standard deviation (s.d.) from the contemporary group mean) to determine outliers while others use extreme ratios (i.e. below 60 or above 140). Some breeds do not use the outlier records while others regress the record back to the minimum or maximum allowed (±2 s.d. from the contemporary group mean). If the record is not used, the animal should remain in the pedigree file.

IMPROVING THE QUALITY OF PERFORMANCE RECORDS[1]

Robert D. Scarth[2]

INTRODUCTION

The quality of performance records submitted by breeders will set the upper limit of accuracy of genetic evaluations even with the most advanced prediction methods. Breeders must assign cattle to appropriate contemporary groups to obtain accurate expected progeny differences (**EPDs**). The two following sentences are included in many breed sire summaries. "The proper identification of the contemporary group in which an animal is raised is of utmost importance for an accurate evaluation of that animal and his parents". "Most inaccuracies in today's National Cattle Evaluation programs are found to trace back to misidentification of contemporary groups".

This paper includes a discussion of the main features of a comprehensive computer diagnostic program that was designed to screen and improve the quality performance records. Some useful basic concepts included in the program will be discussed first.

USEFUL BASIC CONCEPTS

1. **Effective progeny numbers (EPNs)** for sires or dams are the crucial numbers rather than actual numbers for the calculation of **EPDs**. Obviously progeny must be compared with progeny of other sires (dams) to useful for predicting **EPDs** for sires (dams). Single sire contemporary groups contribute nothing to sire evaluation and are more likely to occur than single dam groups (excluding single calf groups which are of no predictive value for calf and parents). **EPN** from within a contemporary group equals to the number of progeny of that sire (dam) times the fraction of progeny by other sires (dams) in the group. **EPNs** for parents are totaled for all contemporary groups. The **EPN** for a sire with 10 progeny in a contemporary group of 40 calves is equals 7.5 [10(30/40)]. However, if there are only 12 calves in the contemporary group, 10 progeny of that sire are only equals 1.67 **EPN** [10(2/12)].

When cattle in a contemporary group are predominantly progeny of one sire, their usefulness for sire evaluation is severely limited. Although breeders may have valid reasons for heavy usage of one sire, breeders should expect reduced efficiency of sire evaluation from the resulting progeny. Therefore, this is another reason why breeders should be especially cautious about heavy usage of bulls with low accuracies.

---

[1] Presented at the Beef Improvement Federation Annual Conference, Des Moines, Iowa, June 2, 1994.

[2] Address: "Master Breeder", Animal Breeding Consulting, PO Box 3345, Iowa City IA 52244.

2. Balance of sires' progeny over contemporary groups for each year can be measured by dividing total **EPN** by total progeny for all sires for the year **(Σ EPN/ Σ PN)** where **PN** = progeny numbers. The maximum value for this ratio depends on the number of sires with progeny in a year and is equal to [(s-1)/s] where s equals the number of sires. The maximum value for **(Σ EPN/ Σ PN)** with 2, 5 and 10 sires per year is 0.50, 0.80 and 0.90, respectively. **Therefore, adjusted percentage balance of sires over contemporary groups for a year can be calculated as follows:**

$$(\Sigma \text{ EPN}/ \Sigma \text{ PN}) [s/(s-1)] (100)$$

Of course, perfect adjusted balance of 100% should not be expected but values below 50% result when most progeny of some major sires are compared to few progeny of other sires. In general, increasing the number of sires with progeny in contemporary groups will improve efficiency of sire evaluation and increase adjusted percent balance of sires over groups compared to progeny of only two sires per group. Equal number of progeny of all sires within each contemporary group compared to equal number of progeny of only two sires per group will increase **EPN** by 50%, 72% and 85% with 3, 5 and 10 sires per year, respectively. **The appropriate formula for the increase in EPN** is as follows with equal progeny per sire:

$$6(s-1)/(3s-1) \quad \text{where } s = \text{number of sires}$$

The potential for improved sire comparisons will usually be considerably higher than predicted by this equation when variation in progeny numbers per sire due to chance and design of breeding programs are considered. Also, direct sire progeny comparisons are more efficient than indirect sire comparisons. It may not be practical or possible to have progeny of all sires in each group for a year. **However, the more sires with progeny in each contemporary group, the more accurate will be the EPDs based on a given number of progeny. Of course these progeny must be valid contemporaries.**

3. Sires' EPNs can be partitioned into comparisons with individual sires. When contemporary groups are absorbed in a sire model, **EPNs** will be the result on the diagonal and the partitioned comparisons with other individual sires will be on the off-diagonals of each row of the sire by sire matrix. Within a given contemporary group, these partitioned comparisons are equal to the following:

$$(n_1)(n_2)/n_{group} \quad \text{where } n_1, n_2 \,\&\, n_{group} \text{ are the number of progeny for sire 1, sire 2 \& the group}$$

These values are summed over all groups which contain progeny of sires 1 and 2 to obtain the overall partitioned comparison for these two sires. If progeny of sire 1 are only compared to progeny of sire 2, the two sires will have the same value for their **EPNs** and the off-diagonal between these two sires. For multiple sire comparisons, the partitioned comparisons summarize which sire's progeny are compared with a particular sire and quantify the extent of each overall sire by sire comparison.

OUTPUT FROM DIAGNOSTICS PROGRAM

1. **Yearly sire summaries for progeny numbers (PN), EPN and ratios of EPN/PN are included for each trait.** Sires with adjusted ratios of **EPN/PN** less than 0.50 are flagged as most progeny of these sires are compared to few progeny of other sires. A sample output of fictitious sires is listed below. The efficiency of progeny comparisons are low for sires Top Gun and Cowboy. Both these sires have progeny compared with few progeny of other sires and/or some progeny in single sire groups.

Table 1. SIRE SUMMARIES ABC Farms 205daWT 1993

SIRE	**EPN**	PN	**EPN**/PN %	
Big Boy	9.52	22	43	
Top Gun	7.90	25	32	Low %
Cowboy	7.90	48	17	Low %
Rambo	9.52	20	48	

2. **Summaries for sires and maternal grandsires are produced for each contemporary group.** For each contemporary group, the following is included for the group, each sire and each maternal grand sire (**MGS**): identification, number of progeny, average age and average weight of progeny. Additionally **EPN** and weight deviation from group average for each sire and **MGS** are included along with a flag for each sire and **MGS** progeny group that is outside two standard deviations from the group average. These summaries are useful in spotting potential problems. See Table 2 below for the complete listings of variables included in each trait summary.

Table 2. Summaries for each contemporary groups

Variable	Group	Sire	MGS[a]
Progeny number	X	X	X
Average Age	X	X	X
Average weight	X	X	X
EPN	n.a.	X	X
Average Dev. [b]	n.a.	X	X
Flag ± 2 SD[c]	n.a.	X	X

X = Variable included [a] Maternal grandsires

[b] Average deviation of Progeny from group average

[c] flagged if outside 2 Std Dev from group average

Also, a file listing all individual cattle outside two standard deviations from their group average is produced. This file is useful for studying potential problem cattle.

3. Yearly summaries for balance of sires over contemporary groups are included for each trait. These summaries are useful in highlighting differences in years for sire balance over groups and identifying years where efficiency of sire comparisons is limited (Table 3).

Table 3. SIRE BALANCE/YEAR ABC Farms 205daWT

BIRTH YEAR	88	89	90	91	92	93
% BALANCE[a]	32	57	64	60	75	40
SIRES	5	6	5	7	4	4

[a] Adjusted for number of sires per year

4. Sire and maternal grandsire summaries of overall EPN, progeny numbers and weighted deviations from group averages for age and traits are produced. Big Boy and Top Gun both have above average progeny for 205 day weight (Table 4).

Table 4. OVERALL SIRE SUMMARY ABC Farms 205daWT

SIRE	EPN	PN	AGE-DEV[a]	TRAIT-DEV[a]
Big Boy	53.80	95	3.50	21.50
Top Gun	7.90	25	0.50	15.50
Cowboy	7.90	48	-3.50	-1.50
Rambo	50.10	96	0.90	-10.50

[a] deviations weighted by EPN per group

5. An overall summary is produced for each trait. See Table 5 below.

Table 5. OVERALL SUMMARY FOR 205 DAY WEIGHT (WT)

RECORDS =	GROUPS =	ERROR df =
SIRE df =	ERROR MS =	SIRE MS =
SUM EPN =	NO/% +2SD [a]	NO/% -2SD [a]
APX H^2 =	WT MEAN =	AGE MEAN =
VAR_{WT} =	VAR_{AGE} =	$COV_{WT,A}$ =

df = degrees of freedom MS = Mean Square
[a] = number/percent of sire averages ± SD from group averages
APX H^2 = approximate H^2, VAR = variances, COV = covariance

Unusually high numbers of sire averages outside two standard deviations from the contemporary group average and/or unusually high heritability estimates are indicators of potential sire biases. Unusually high variances are indicators of potential problems with contemporary groupings and unusually covariances indicate inadequate age adjustments.

6. An overall summary is produced for each trait that lists the partitions of each sire's EPN into individual sire by sire comparisons. In this example listed in Table 6, progeny of Top Gun are only compared to progeny of Cowboy. If these two sires are from two different herds and have only very distant relationships with Big Boy and Rambo, accuracy of comparisons of Top Gun and Cowboy with Big Boy and Rambo would be very low. If progeny of all four of these sires had been included in most contemporary groups for 1993 born cattle (see Table 1), the accuracy of among sire comparisons would have been greatly increased.

Table 6. OVERALL SUMMARY OF SIRE-SIRE COMPARISONS for each trait

SIRE	NOS	NOC	EPN	EPN PARTITION FOR SIRE-SIRE [a]
Big Boy	1	4	54	4= 25 5= 18 6= 9 7= 2
Top Gun	2	2	8	3= 8
Cowboy	3	2	8	2= 8
Rambo	4	4	50	1= 25 5= 13 6= 9 7= 3

NOS = Sire NO NOC = NO of Comparisons EPN = Effective Progeny NO
[a] for sire by sire comparisons

For sires with multiple sire comparisons, the partitioned comparisons summarize which sires have progeny that are compared with a particular sire and quantify the extent of each overall sire by sire comparison. Big Boy and Rambo have the equivalent of 50 progeny each in head-on comparisons in contemporary groups with equal numbers of progeny per sire. Sire 5 ranks second in the effective number of progeny compared to Big Boy while sire 6 ranks third. Sire 7 has few effective progeny compared to Big Boy.

THE INFLUENCE OF INCORRECT CONTEMPORARY GROUPING

It is generally agreed that misidentification of contemporary groups can cause serious errors in EPDs for cattle that were preferentially treated and for their parents. Predicted biases listed in Table 7 were calculated from selection index theory for varying heritabilities (.20, .30 & .40) and for varying number of EPN for the bull (20, 50, 200 & 500) and his sire (50, 200 & 5000).

These predicted biases in EPDs/ pound of progeny bias from preferential treatment are the progeny regression values calculated from the amounts of data specified in the previous paragraph. The contribution of a bull's progeny to his EPDs is obtained by multiplying the appropriate regression times the sum of a bull's weighted progeny deviations from contemporary group averages. Even though this selection index method does not account for genetic differences among contemporary groups, it is still useful for predicting overall biases in EPDs.

Table 7. Bias expected in bull's EPDs due to progeny preferential treatment

Bull's EPN	Range in Bias / lb of progeny bias[a]
20	.38 - .51
50	.61 - .72
200	.61 - .72
500	.94 - .96

[a] 1st value when H^2 = .20 & 5000 EPN for bull's sire
[a] 2nd value when H^2 = .40 & 50 EPN for bull's sire

Biases similar to these predicted biases were found in four simulations with Australian data where some progeny of sires (6 to 8 sires) were preferentially treated in four different breed data sets. The average percentage of progeny that were preferentially treated for these four simulations was 16.0 percent. These four simulations each had over 6000 cattle with weaning and/or yearling weights in four herds linked by several sires. The BREEDPLAN multi-trait RAM model was used for these simulations.

The first value in the column of range in bias/pounds of progeny bias is expected when heritability is .20 and the bull's sire has many effective progeny (5000). The second value is the predicted bias in EPDs when heritability is .40 and the bull's sire has 50 EPN. Therefore, the predicted bias in EPDs for a bull with 50 EPN and an average progeny bias of 20 lbs would be expected to be 12 to 14 lbs. EPDs for bulls with 500 EPN are expected to be biased by at least .94 pound/ pound bias in their progeny average.

In these Australian simulations, the milk EPDs were biased downward for the sires with progeny that were preferentially treated and selectively reported even though the genetic correlation was zero between milk and growth (Australian BREEDPLAN evaluations). **With the negative genetic correlations between milk and growth for most breeds in the US, milk EPDs are likely to be substantially biased downward from preferential treatment of a bull's progeny for weaning weight.**

SELECTIVE REPORTING OF DATA

The influence of selective reporting of progeny of some sires was also evaluated in the simulations with Australian data. Progeny of specified sires were omitted from the analyses if their weaning weight ratios were below a specified ratio (100 or 90). Bull progeny of specified sires were omitted if their weaning ratio was below 100 and heifer progeny were omitted if their ratio was below 90 in one simulation and below 100 in a second simulation. The average biases in sire EPDs from omitting bull progeny below 100 and heifer progeny below 90 for the four different breed simulations were 8.82 lb and 8.93 lb, respectively, for weaning and yearling weight (Table 8). Omitting heifer progeny of these sires below 100 for weaning ratio increased the bias in sire EPDs to 12.68 lb and 13.78 lb, respectively for weaning and yearling weight. **The bias of 12.68 is large because it is 80 percent of the genetic standard deviation for weaning weight (15.90 lb).**

Table 8. Bias in sire's EPDs due selective progeny reporting

Not reported if ratio below / % [a]		Bias in sire's EPDs, lb [b]	
Bull calves	Heifer calves	Wean WT	Yrlg WT
100 / 43.2%	90 / 14.0%	8.82	8.93
100 / 43.2%	100 / 44.5%	12.68	13.78

[a] Calves below 100 [90] wean ratio not reported / % not reported
[b] Bias compared to reporting all progeny of these sires

SELECTIVE GROUPING OF DATA

If a breeder castrates some bull calves, the lighter (smaller) bulls and/or those with structural and other faults are generally castrated while the heavier (larger) bull calves are generally left as intact males. This selective castration can result in comparing most of the lighter male calves in steer contemporary groups and most of the heavier male calves in bull groups. Therefore, steers tend to be over-evaluated while bull calves tend to be under-evaluated because bulls are only compared to the average weight of the heavier male calves. Also, superior sires for growth tend to be under-evaluated while inferior sires for growth tend to over-evaluated for their EPDs due the selective groupings.

Simulations were done to evaluate the influence selective grouping of data in two Australian herds where bulls were not castrated prior to weaning (Scarth and Parnell, 1987). The results of these simulations from BREEDPLAN are summarized in Table 9. Unadjusted weaning weight ratio was the selection criteria used to simulate selective castration in one herd and 60 day adjusted ratio was the selection criteria in the research herd.

Selective castration of the bottom half of male calves caused greater bias in EPDs for sires and male calves than selective castration of the bottom one fourth of male calves. Selective castration of the bottom 3/4 of males was also evaluated but was not included because the results were similar to selective castration of the bottom 1/4 of males calves. Biases were generally greater for EPDs for male calves than for sires. As was expected, omitting the low 25% of heifer records increased the bias in EPDs compared to selective castration alone. **Breeders can prevent selection bias by weighing all male calves prior to castration and reporting these weights for bull calves.**

Table 9. Biases in EPDs for weaning weight due to selective castration and omitting some low heifer records

Restrictions imposed	% loss in accountability of EPDs[a]
% steered / % Heifers [b]	Sire EPDs / Male EPDs[c]
Low 25% / 00%	10 to 14 / 18 to 32
Low 25% / 25%	21 to 26 / 29 to 35
Low 50% / 00%	14 to 20 / 26 to 43
Low 50% / 25%	31 to 36 / 41 to 45

[a] Percentage losses = $100(1-r^2)$ where r = correlation between EPDs [regular vs restricted]

[b] % males "steered" & % low heifer records omitted

[c] for most current calf crop of male calves

To evaluate the relative importance of these biases, several additional simulations were completed. Eliminating sire identification resulted in a 25% and 53% loss in accountability in EPDs for males calves. These losses are of a similar magnitude to selective castration of the bottom half of bull calves.

In the research herd, omitting the weaning weight records of the bottom half of bull calves was compared to selective castration of these bull calves. The bottom 1/4 of heifers were also omitted for both these simulations. Omitting the weaning records on the bottom half resulted in a greater loss in accountability for sire EPDs than selective castration of these bulls, 43% and 36%, respectively. **Therefore, it appears that omitting these records will cause greater errors than grouping them into steer groups due to selective castration.** While these results seem logical, additional research should be done to evaluate this conclusion. Breeds with large differences in number of records for bulls and heifers should be especially interested in these results.

PRACTICAL IMPLICATIONS

1. The main features of a comprehensive computer diagnostic program that was designed to screen and improve the quality performance records is presented.

2. Estimates of the magnitude of biases from: a. unreported preferential treatment, b. Selective reporting of data and c. Selective grouping of data are given. All three of these factors can cause serious biases in EPDs and should be avoided.

Literature Cited

Scarth, R. D. and P. Parnell. 1987. Biases in EBVs for growth caused by prior selection at branding. *Proc. 6th Conf. Aust. Assoc. Anim. Breed. Genet.*, Perth, p. 277.

PROPOSED INTERBREED DATA INTERCHANGE FORMAT

B. L. Golden and R. M. Bourdon
Colorado State University, Ft. Collins 80523

Introduction

The exchange of data between beef breed associations would facilitate the production of expected progeny differences (EPD) for animals of multiple breed origin. Additionally, it could improve the quality of EPD produced for pure bred livestock because many breed association's data bases contain large amounts of data on animals with varying breed percentages. Current EPD production procedures do not completely account for the unique properties of data for hybrid animals. Several researchers have proposed methods to account for the effects of heterosis (Arnold et at., 1993; BIF, 1989; Elzo and Famula,1985; Elzo and Bradford, 1985 ; Redman et al., 1993), additive differences between foundation animals from various breeds (Cantet, et al., 1992; Golden, et al. 1994; Quaas, 1988; Van Vleck, 1990) and differences in foundation genetic group variance components (Elzo, 1990; Garrick, et al., 1989). In order to use these methods in national cattle evaluation (NCE), procedures for the exchange of data between associations needs to be efficient and structured.

The objective of this paper is to propose an exchange data structure and procedure. Data that will need to be made available between associations include pedigree, contemporary group, performance and within breed EPD. The breed associations will need to determine policies regarding the appropriate use of data made available.

Data Structure

The Case*Method (Cronin, 1989) was used to analyze the data environment to develop this application. The Case*Method breaks the application development life cycle into six phases 1*) Strategize, 2) Analyze, 3) Design, 4) Build, 5) Transition (debug) and 6) Production (delivery)*. This report is the result of phases one through three. It is anticipated that this paper will yield additional analysis that will be incorporated into phase three through six.

In December 1993, representatives from four beef breed associations met with representatives from Colorado State University (CSU) as part of phases one and two. The application was again discussed at the 4th Genetic Prediction Workshop held February, 1994 in Kansas City. The data for Leachman Cattle were sent from three of the four participating breed associations to CSU. This data exchange illustrated many of the unique properties to be considered when trying to link data from alternative sources. To complete the analyze phase, an Entity-Relationship model (ER) was constructed to describe the data environment (Figure one).

From the ER the data structures were developed that are shown in tables 1 through 5. It is proposed that each participating association make these data structures available through the procedures recommended in the *Exchange Procedures* section, below.

Pedigree Table. Table 1 is the pedigree data structure. The data structure contains both breed association registration numbers and tattoo information because animals of interest will not necessarily be registered in all cases. Table 2 is the data structure used for other breed association registration information appearing in each associations herd book. These data need to be in a separate table because there may be useful many to one relationships between the items (records) in table 2 and the items in table 1.

All leading zeros should be trimmed from the registration numbers appearing in the **Animal Number, Sire Identification** and **Dam Identification** fields. The identification number fields can contain any characters from the ASCII character set in the range of 21h to 7Eh. These fields should contain registration or internal numbers of the current breed when available.

It is likely there will be sires and dams of animals in the current breed that were not assigned current breed registration or identification numbers. The **Sire Identification** or **Dam Identification** (table 1) field should contain the other breed association registration number (if available), followed by an underscore ("_" ASCII 5Fh) and the three character other breed association code listed in table 6. If the sire or dam does not have a current or other breed registration number available, then the identification should be composed of the animals tattoo, an underscore, its year of birth, an underscore and one of the two letter breed codes in table seven.

Every animal that appears as a sire or dam must also have an item in the *Pedigree Table.* This way all birth date information is also made available so that age of dam effects, etc, can be accounted for.

Because the data will be transferred in white space delimited variable length records no field width is specified for any of the fields containing identification numbers.

Foreign Animal Table. The data contained in the **BAC** field of the *Foreign Animal* data table (table 2) must be one of the codes listed in table 6. The codes represent other breed association designations when a known other breed association registration number exists.

If an animal has another breed association registration number and a registration number in the current breed association, then there must be a record in the *Foreign Animal* table indicating this information.

If an animal is of other known breed composition but is not affiliated with another breed association then it should have one of the two character breed designations used by the BIF (1990) in the **BAC** field.

EPD Table. It has been shown that EPD from another association's NCE can be used in a current breed association's NCE when these other association EPD are available (Golden, et al., 1994). Using other association EPD may, in fact, be preferable to using the data because the problems with joining contemporary groups with data from multiple associations can be avoided. Therefore, it is necessary that each participating association make EPD available for other breed associations NCE. Table 3 shows the data structure used for exchanging EPD.

The **Animal Identification** field contains, in order of preference,

- the animals current breed registration number as it appears in the *Pedigree* data table,
- one of the animals **Foreign registration numbers** as it appears in the foreign animal file, an underscore ("_" ASCII 5Fh) and the foreign breed association code as it appears in table 6,
- or the animals *tattoo,* an underscore ("_" ASCII 5Fh), the animals year of birth, an underscore, and the other breed code as it appears in table 6.

Each breed association can supply the **EPD** and **Accuracy** at any precision that makes sense. It is recommended the **Accuracy** values are at two digits to the right of the decimal. Again, no specification for width of any of these fields is given because the data will be white space delimited, variable length ASCII records.

Each entry in the **Trait** field is one of the two character trait designations in table 6. The **Component** field values are either "D", "M", "T" or "P" for additive direct, additive maternal, total maternal or permanent environment respectively.

Performance Table. The **Animal Identification** field is as described for the *EPD* table (table 4). The **Trait** field is the code for the trait being measured in the **Value** field, taken from table 6 or added as needed. The **Measure Date** is the date the measurement was taken.

A mechanism is proposed in order to facilitate the formation of correct contemporary groups when data are reported to more than one breed association for a group of cattle that should be grouped together. The **UFN** field (Universal Firm Number) will allow breed associations to receive data from a breeder and keep continuity with other breed associations. A range of UFN are assigned to each association for assignment to a breeders. This number could take the place of their current member numbering system. Breeders assigned a UFN from another breed association must use that number when reporting to the current breed association. Breeders must not receive more then one UFN. Having a UFN assigned by one breed association does not automatically give membership in all participating associations. Breeders will still be subject to the membership rules of each individual association. The UFN is only designed to allow continuity of the contemporary grouping. All UFN will begin with the letter "U" to distinguish them from current within breed member numbers.

An additional mechanism to keep integrity of contemporary groups across breed associations is the **UMC** (Universal Management Code) field. The values in this field can be any single character. All animals with the same single character in this field and the same UMC value in the **UMC** field and born in the same year, and season should have been managed alike. Many breed associations currently use a similar management code strategy. Breeders need to be informed that when assigning management codes they should use the same management codes assigned to groups of cattle that have records sent to different associations. For many associations this will require changing data entry forms. All associations will need to provide instructions to membership who are sending data to multiple breed associations. These instructions will need to be identical for all associations.

The last field in the *Performance Table* is the **BDIrregular** (Breeder Designated Irregular) field. This field should be non-null if the animal was considered as irregular for the trait. Examples of irregular for a trait are birth weight observations on twins or animals that were sick at the time of a given measurement. This field should be UNKNOWN (a ".", ASCII 2Eh) if the measurement was taken outside of BIF recommended age ranges because this can be determined from the date fields. It is not necessary to standardize the non-UNKNOWN values in this field. Each association can use its own codeing for this information.

Breed Composition Table. Animals that are not purebred for the current breed association should have at least one record in the *Breed Composition Table* (table 5). These records will indicate the other components of the animals breed percentage. For example, if an animal is fifty percent Gelbvieh, twenty five percent Red Angus and twenty five percent Simmental, and the current breed association is the Gelbvieh Association then the AGA should provide two records in this table. The record for the Red Angus percentage would be the animals Gelbvieh identification number, the percent Red Angus and the two character or three character RA or UAR code from table 6. The record for the Simmental percentage would contain the Gelbvieh identification number, the percent Simmental and the two or three character SM, USM or CSM from table 6.

Exchange Procedures

Data exchange will need to be on demand. Most data exchange will occur to facilitate NCE. A requesting association will notify a providing association of its intention to receive data two weeks prior to the time it will access the data base described above. The providing association will then prepare the data base. The preparing association will write the files out in ASCII white space delimited files. Each record will be delimited by a new line character (ASCII 0Ah). A period (ASCII 2Eh) will be used to designate all missing values (UNKNOWN) in each field.

A common access interface will be written by CSU that each participating association will implement. The software will be written for a UNIX environment. Associations not currently on an open systems standard will need to provide an Intel based (read PC) 386 or 486 machine with a IDE disk drive capability. The machine does not need to be dedicated to this task and can be used as an MS-DOS based platform for most of the time it is operational. CSU will supply a hard disk drive for this PC that contains the access software and the Linux (Welsh, 1994) version of UNIX. Linux is a free version of UNIX written for Intel platforms. The Linux system will be booted at the time the receiving association will require access. After the transmission of data is complete, the providing association can reboot the PC to the MS-DOS environment.

The access and transfers will initially occur using telephone lines and high speed modems conforming to the latest VIS standards. Participating associations will need to provide the modem and telephone dial in lines. The transfers and access will occur using compressed serial line internet protocol (CSLIP). There are several free software packages for CSLIP for MS-DOS and UNIX environments. Linux has CSLIP as part of it's standard install. It is anticipated that these systems will migrate to Internet as more associations are connected.

Liturature Cited

Arnold, J. W., J. K. Bertrand and L. L. Benyshek. 1992. Animal model for evaluation of multibreed data. J. Anim. Sci. 70:3322.

BIF, 1991. Guidelines for uniform beef improvement. Beef Improvement Federation.

Cantet, R. J. C., R. L. Fernando, D. Gianola and I. Misztal. 1992. Genetic grouping for direct and maternal effect with differential assignment of genetic groups. Genetics Selection and Evolution 24:211-223.

Cronin, D. J. 1989. Mastering Oracle. Hayden Books ISBN 0-672-48419-6.

Elzo, M. A. 1990. Multiple trait covariance matrix for additive genetic effects with heterogenous covariances accross genetic groups. J. Anim. Sci. 68:1215.

Elzo, M. A. and T. R. Famula. 1985. Miltibreed sire evaluation procedures within a country. J. Anim. Sci. 60:942.

Elzo, M. A. and G. E. Bradford. 1985. Multibreed sire evaluation procedures across countries. J. Anim. Sci.60:953.

Garrick, D. J., E. J. Pollack, R. L. Quaas and L. D. Van Vleck. 1989. Variance heterogeneity in direct and maternal weight traits by sex and percent purebred for Simmental-sired calves. J. Anim. Sci. 67:2515.

Golden, B. L., R. M. Bourdon and W. M. Snelling. 1994. Additive genetic groups for animals appearing in more then one national cattle evaluation. J. Anim. Sci. (accepted, in review).

Redman, K. J., B. L. Golden and R. M. Bourdon. 1993. Multi-breed animal model BLUP with direct and maternal breed groups and regressions on outcrossing. J. Anim. Sci. 71:103 (Suppl. 1).

Quaas, R. L. 1988. Additive genetic model with groups and relationships. J. Dairy Sci. 71:1338.

Van Vleck, L. D. 1990. Breeding value prediction with maternal genetic groups. J. Anim. Sci. 68:3998-4013.

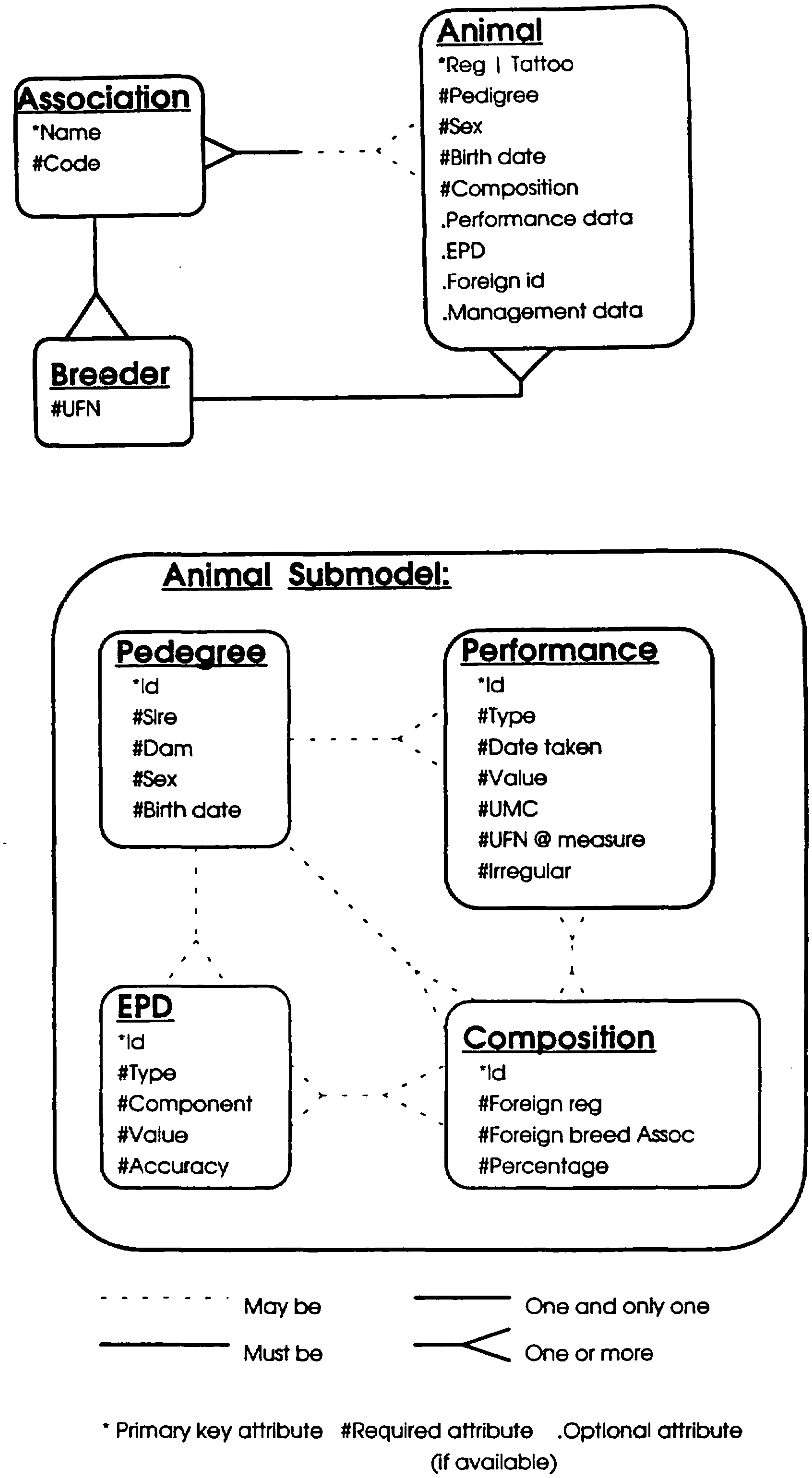


Figure 1. Entity-Relationship model of the data management environment.

Table 1. Pedigree Table data structure.

Field Name	Data Type	Description
Animal Number	Alpha-Numeric	Current breed association registration or internall identification number
Sire Identification	Alpha-Numeric	Current breed association registration number or foreign breed association number, underscore and three character other association id, or tattoo_by_bc
Dam Identification	Alpha-Numeric	Current breed association registration number or foreign breed association number, underscore and three character other association id, or tattoo_by_bc
Sex	Alpha-Numeric	B=Bull, H=Heifer, S=steer
Age of Dam	Numeric	Age in years of the dam at birth of animal
Birth date	Date	the date of birth of the animal in mm/dd/yyyy format.

Table 2. Foreign Animal table data structure.

Field Name	Data Type	Description
Current Association Number	Alpha-Numeric	The registration number or internal number of the animal in the current Association.
Foreign Registration	Alpha-Numeric	Registration number from another breed association
BAC	Alpha-Numeric	Other breed association code as listed in Table 6.

Table 3. EPD Table data structure.

Field Name	Data Type	Description
Animal Identification	Alpha-Numeric	The registration number or internal number of the animal in the current Association.
Trait	Alpha-Numeric	Trait code.
Component	Alpha-Numeric	D=additive direct, M=additive maternal, TM=total maternal or P=permenant environment.
EPD	Numeric	EPD value for the trait component.
Accuracy	Numeric	BIF accuracy of the EPD

Table 4. Performance Table data structure.

Field Name	Data Type	Description
Animal Identification	Alpha-Numeric	The registration number or internal number of the animal in the current Association.
Trait Code	Alpha-Numeric	Trait Code
Date of measure	Date	The date the measure for this trait was taken.
Trait Value	Numeric	The value for the measurement of te trait.
UFN	Alpha-Numeric	Universal Firm Number of person/ranch providing this traits measurement
UMC	Alpha-Numeric	Universal Management Code for the management group within UFN
BDIrrregular	Alpha-Numeric	Breeder Designated Irregular. Any non-null value indicates the observation should not be used for the EPD calculations.

Table 5. Breed Composition Table data structure.

Field Name	Data Type	Description
Animal Identification	Alpha-Numeric	The registration number or internal number of the animal in the current Association.
Percent	Numeric	Actual proportion of breed composition for the breed designated in the BC or BAC field.
BC or BAC	Alpha-Numeric	Breed code or Breed association code.

Table 6. Breed and Breed Association codes*.

Code	Description
CAN	Canadian Angus Association
CCH	Canadian Charolais Association
CSM	Canadian Simmental Association
UAN	American Angus Association
UAR	Red Angus Association of America
UAY	American Ayshire Association
UBM	Beefmaster Breeders of America
UBN	International Brangus Association
UBR	American Brahman Association
UCA	American Chianina Association
UCH	American-International Charolais Association
UGU	American Guernsey Association
UHH	American Hereford Association
UHO	American Holstein Association
UHP	American Polled Hereford Association
USE	American Senepol
USG	Santa Gertrudis Breeders International
UJE	American Jersey Association
ULM	North American Limousin Foundation
UMA	American Main Anjou
UMS	American Milking Shorthorn
UPZ	American Pinzgauer
URB	American Red Brangus
URP	American Red Polled
URR	Red Brahman
USM	American Simmental Association
USS	American Shorthorn Association
UTA	American Tarrentaise
UTL	Texas Longhorn
USA	American Salers Association
UGV	American Gelbvieh Association

Breed codes for animals not affiliated with an association will come from BIF(1991) Table 12.3

*Codes for other associations, such as Australian and European, can be added as needed.

Procedures for Calculating Interim Expected Progeny Differences

Bruce E. Cunningham
American Simmental Association
Bozeman, MT

Most beef cattle breed associations have included genetic evaluation systems as a part of their performance recording programs. These National Cattle Evaluation (NCE) programs provide Expected Progeny Differences (EPD) for sires, dams, and non-parents on an annual or biannual basis. For calves recorded during the time period between NCE runs, interim EPDs are calculated using the calves' pedigree index and within-herd performance. The interim EPDs provide breeders the means of making early selection decisions on calves prior to the next breed NCE run.

The Interim EPD is illustrated as follows:

$$EPD_I = .5*EPD_s + .5*EPD_d + .5*\phi$$

where ϕ is the individual's mendelian sampling effect. The mendelian sampling effect is a prediction of how much the individual's own genetic value deviates from the average value of it's parents ($.5*EPD_s$ + $.5*EPD_d$). Using the individual's own records and current EPDs of the parents from the National Cattle Evaluation, interim EPDs are be calculated as a routine part of an association's record processing program. The interim EPDs will be the individual's current evaluation until the next NCE run.

Interim EPDs can be calculated on a single-trait or multiple-trait basis. Single-trait interim EPDs ignore the possible genetic and environmental correlations that may exist between the traits. The multiple-trait interim EPDs are obtained using information from all evaluated traits to obtain predictions of genetic merit for each individual. Wilson and Willham (1989) developed procedures to calculate single-trait Interim EPDs using results from NCE programs. The methods described to calculate Interim EPDs are based on procedures developed by R. L. Quaas (Personal Communication).

Adjusted Deviations:

Using the animal's own record and information regarding its contemporaries, an adjusted within-group deviation is obtained for each available trait. The adjusted deviations for birth weight, weaning weight, and yearling weight are shown in table 1. The contemporary group mean is adjusted for the average EPD of the sires and dams represented in the group. For weaning weight and yearling weight, the contemporary group is adjusted for the average maternal environment ($2*EPD_{mmk}$ + PE) provided by the dams in the group. The calf's deviation from its adjusted group mean is then adjusted for the expected contribution of its' parents. The adjusted deviation for each trait represents what cannot be explained by the contemporary group and the parents' expected contribution to the calf's performance.

Single Trait Interim EPDs:

The single-trait interim EPD can be represented as follows:

$$EPD_i = .5*EPD_{s,i} + .5*EPD_{d,i} + .5*b_i*\Delta_i$$

where $EPD_{s,i}$ and $EPD_{d,i}$ are the sire and dam EPDs for the i^{th} trait, b_i is the regression coefficient for the i^{th} trait and Δ_i is the adjusted deviation for the i^{th} trait. For each trait, a value for b_i is calculated for each parent combination: Known Parents, Known Sire and Unknown Dam, Unknown Sire and Known Dam, and

Unknown Parents. In the case where a calf does not have a record for a particular trait, the interim EPD for that trait will be the average of the parents' EPDs or the pedigree index.

Ignoring the potential genetic and environmental covariances between the traits in the evaluations, the regression coefficients (b) can be easily calculated and stored for use during processing. If the covariance between direct and maternal effects for weaning weight is assumed to be zero, the interim maternal EPD will be the pedigree index if both parents are known or where the sire is unknown and the dam is known. In the case of a known sire and an unknown dam or the case of unknown parents, the calf's weaning deviation will have an influence on the maternal interim EPD. The b_js are shown in Table 2 for each trait and parent combination.

Multiple-Trait Interim EPDs:

The multiple-trait interim EPDs are be represented as follows:

$$\mathbf{EPD_I} = .5*[\mathbf{EPD_s}+\mathbf{EPD_d}] + .5*\mathbf{B_{ij}}*\Delta$$

where $\mathbf{EPD_I}$ is the vector of interim EPDs, $\mathbf{EPD_s}$ is the vector of EPDs for the sire, $\mathbf{EPD_d}$ is the vector of EPDs from the dam$\mathbf{B_{ij}}$ is a matrix of partial regression coefficients, and Δ is a vector of adjusted deviations (Table 1). The matrix $\mathbf{B_{ij}}$ will be dependent upon the number of known parents and the combination of traits available for a given calf. If a particular trait is missing for a calf, the deviation for that trait will be equal to zero. When multiplied by the calf's adjusted deviations, $\mathbf{B_{ij}}$ provides the predictions of mendelian sampling for each evaluated trait using all available information.

Using a multiple-trait model for birth weight, weaning weight (direct and maternal), and yearling weight, five different models describe the different combinations of known parents required to compute interim EPDs. In table 3, the required design matrices are shown for birth weight (BWT), weaning weight (WWT), and yearling weight (YWT). Each design matrix describes the influence of the sire (S), dam(D), and individual calf (I) on the calf's own performance record for each trait. For the sire, dam, and individual calf, the breeding values are listed for birth weight (b), weaning weight-direct (w), yearling weight (y), and weaning weight-maternal (m). The dam's permanent environment effect for weaning weight is in the last column (D_p). The first design matrix is $\mathbf{Z_f}$ which is the full animal model for a calf with a record, pedigree information, and no progeny data. The following design matrices are for a non-parent model with known parents ($\mathbf{Z_1}$), a known sire and unknown dam ($\mathbf{Z_2}$), an unknown sire and known dam ($\mathbf{Z_3}$), and the case where both parents are unknown ($\mathbf{Z_4}$). These five matrices will needed to compute the various $\mathbf{B_{ij}}$s needed for the multiple-trait interim EPDs.

Using a multiple-trait model of birth weight, weaning weight, and yearling weight, there will be 4 non-parent models (i=1..4)and five possible combinations (j=1..5) of the three traits recorded for a particular calf. As a result, there will be 20 different B_{ij} needed to compute multiple-trait interim EPDs. The matrix of regression coefficients, B_{ij}, can be described as follows:

$$\mathbf{B_{ij}} = \mathbf{Cov}\{(\mathbf{I_b,I_w,I_y,I_m})',(\mathbf{r_b,r_w,r_y})\}_i * \mathbf{R^{-1}}_{ij}$$

where $\mathbf{Cov}\{(\mathbf{I_b,I_w,I_y,I_m})',(\mathbf{r_b,r_w,r_y})\}_i$ ($\mathbf{Cov}\{\mathbf{I',r}\}_i$) is the covariance matrix of the breeding values of the individual with the predicted residuals for each trait obtained from fitting a particular non-parent model and $\mathbf{R^{-1}}_{ij}$ is the residual (co)variance matrix for the i^{th} non-parent model and the j^{th} trait combination.

In order to calculate $\mathbf{B_{ij}}$, several things need to be defined: **V** is the phenotypic (co)variance matrix; **G** is the genetic (co)variance matrix; **A** is the additive relationship matrix describing the relationships between the sire, dam, and individual calf; and **g** is the genetic (co)variance matrix between the breeding values of the sire, dam, individual, and dam's permanent environmental effect. The g matrix is obtained as the direct product of A and G ($A \otimes G$).

For the i^{th} non-parent model, the residual (co)variance matrix ($\mathbf{R_i}$) and the $\mathbf{Cov\{\Gamma',r\}_i}$ need to be calculated as follows:

$$\mathbf{R_i = V - Z_i{*}g{*}Z_i'}$$

and

$$\mathbf{Cov\{\Gamma,r\}_i = g\{(I_b,I_w,I_y,I_m)',(S_b....D_p)\} * (Z_f - Z_i)'}$$

where $\mathbf{g\{(I_b,I_w,I_y,I_m)',(S_b....D_p)\}}$ is the section of **g** containing the genetic (co)variances between the individual calf's breeding values and the sire, dam, and individual effects influencing the animal's record for each trait.

Prior to the calculation of each $\mathbf{B_{ij}}$, the appropriate inverse of the residual (co)variance matrix ($\mathbf{R^{-1}}_{ij}$)must be obtained for each combination of reported traits. The different combinations of traits are BWT only (j=1), WWT only (j=2), BWT and WWT (j=3), WWT and YWT (j=4), and all three traits (j=5). The different $\mathbf{R^{-1}}_{ij}$s are shown in table 4. To calculate $\mathbf{B_{ij}}$ for each combination of i and j, the appropriate $\mathbf{Cov\{\Gamma',r\}_i}$ is multiplied by the appropriate $\mathbf{R^{-1}}_{ij}$. The values in $\mathbf{B_{ij}}$ will weight the adjusted deviations for each trait to provide a prediction of the mendelian sampling effect for each breeding value.

Accuracies for Interim EPDs:

An accuracy value is provided with each EPD to assessing the risk associated with making selection decisions. The accuracy value measures the level of uncertainty removed by the information available for a given animal. For non-parent EPDs and Interim EPDs, the information used to compute EPDs are the animal's pedigree index and the animal's own record. As a routine part of National Cattle Evaluation, accuracies are provided for non-parent EPDs. For the accuracy of interim EPDs, two methods are recommended to provide some measure of reliability: 1) Use of a letter designation to distinguish between interim and non-parent EPDs; or 2) Use of a numerical value for accuracy which accounts for pedigree index only or pedigree index and own record.

A letter designation for interim EPD accuracy can be used to denote pedigree index only or pedigree index and own record for a particular trait. To designate that an Interim EPD was based on just pedigree information, a designation of P or I can be used for the interim accuracy. For animals with an own performance record along with pedigree information, a P+ or an I+ can be used to designate the accuracy of an Interim EPD.

If a numerical value is desired for interim EPD accuracy, the following formula can be used to calculate single-trait interim accuracies (ACC_I):

$$ACC_I = 1 - \{W + W^2{*}[(1\text{-}ACC_{sire})^2 + (1\text{-}ACC_{dam})^2]\}^{.5}$$

where

$$W = .5{*}\{(1\text{-}r\text{-}.75h^2{}_d)/.5{*}h^2{}_d\}/\{1 + .5{*}\{(1\text{-}r\text{-}.75h^2{}_d)/.5{*}h^2{}_d\}\}$$

for direct EPDs and

$$W = .5{*}[(1\text{-}r\text{-}.25h^2{}_d)/.5{*}(h^2{}_m\text{-}.25{*}h^2{}_d)]/[(1\text{-}r\text{-}.25h^2{}_d)/.5{*}(h^2{}_m\text{-}.25{*}h^2{}_d)]$$

for maternal EPDs. The values for r, h^2_d, and h^2_m correspond to the repeatability of the trait, the direct heritabilty of the trait, and the maternal heritability of the trait, respectively. If an animal does not have an performance record for a trait then W is equal to .5.

Recommendations for Computing Interim EPDs:

The following items are recommendations for computing Interim EPDs:

1) The methods used to calculate Interim EPDs should be very similar to the procedures used to calculate non-parent EPDs from the breed's NCE program. The Interim EPDs should use the same genetic and environmental (co)variances that are used in the NCE.

2) For Interim accuracies, a letter designation, such as P or I for pedigree only, and P+ or I+ for pedigree and own performance, should be sufficient to indicate the information used to calculate the Interim EPDs. A numerical accuracy can be used if the Interim accuracies are to reflect the accuracies of the parents used in the mating.

3) Parents with Interim EPDs should not be used in the pedigree index of a calf for calculating Interim EPDs. If either parent is not included in the previous NCE run, they should be assumed to be unknown in the Interim system. For animals that were not evaluated as non-parents in the NCE run that become parents at a later date (embryo-transfer calves), their evaluation from the NCE will be a pedigree index. For these cases, the EPD based on pedigree information could be used in the Interim values of their progeny.

Table 1. Adjusted Deviations for Interim EPDs

Birth Weight

$$BWT_{DEV} = BWT - (CG_{bwt} - \overline{EPD_s} - \overline{EPD_d}) - EPD_s - EPD_d$$

where CGbwt = the contemporary group average; EPDs = sire's EPD; EPDd = dam's EPD.

Weaning Weight

$$WWT_{DEV} = WWT - (CG_{wwt} - \overline{EPD_s} - \overline{PPA_d}) - EPD_s - PPA_d$$

where CGwwt = the contemporary group average; EPDs = sire's EPD; PPA = dam's predicted producing ability (EPDwwt + 2*EPDmmk + PE.).

Yearling Weight

$$YWT_{DEV} = YWT - (CG_{ywt} - \overline{EPD_s} - \overline{EPD_d} - \overline{2*EPD_{mmk}} - \overline{PE})$$
$$- EPD_s - EPD_d - 2*EPD_{mmk} - PE$$

where CGywt = the contemporary group average; EPD_s = sire' EPD; EPDd = dam's EPD; EPD_{mmk} = dam's maternal milk EPD; and PE = dam's permanent environment.

Table 2. Regression Coefficients for Single-Trait Interim EPDs

Birth Weight:

Known Parents:	$b = .5*\sigma^2_a/(.5*\sigma^2_a + \sigma^2_e)$
Known Sire, Unknown Dam:	$b = .75*\sigma^2_a/(.75*\sigma^2_a + \sigma^2_e)$
Unknown Sire, Known Dam:	$b = .75*\sigma^2_a/(.75*\sigma^2_a + \sigma^2_e)$
Unknown Parents:	$b = \sigma^2_a/(\sigma^2_a + \sigma^2_e)$

Weaning Weight:

Known Parents:

$$b_d = .5*\sigma^2_a/(.5*\sigma^2_a + \sigma^2_e)$$
$$b_m = .5*\sigma_{am}/(.5*\sigma^2_a + \sigma^2_e)$$

Known Sire, Unknown Dam:

$$b_d = (.75*\sigma^2_a + .5*\sigma_{am})/(.75*\sigma^2_a + \sigma_{am} + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$$
$$b_m = (.5*\sigma^2_a + .75*\sigma_{am})/(.75*\sigma^2_a + \sigma_{am} + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$$

Unknown Sire, Known Dam:

$$b_d = .75*\sigma^2_a/(.75*\sigma^2_a + \sigma^2_e)$$
$$b_m = .75*\sigma_{am}/(.75*\sigma^2_a + \sigma^2_e)$$

Unknown Parents:

$$b_d = (\sigma^2_a + .5*\sigma_{am})/(\sigma^2_a + \sigma_{am} + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$$
$$b_m = (.5*\sigma^2_a + \sigma_{am})/(\sigma^2_a + \sigma_{am} + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$$

Yearling Weight:

Known Parents:	$b = .5*\sigma^2_a/(.5*\sigma^2_a + \sigma^2_e)$
Known Sire, Unknown Dam:	$b = .75*\sigma^2_a/(.75*\sigma^2_a + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$
Unknown Sire, Known Dam:	$b = .75*\sigma^2_a/(.75*\sigma^2_a + \sigma^2_e)$
Unknown Parents:	$b = \sigma^2_a/(\sigma^2_a + \sigma^2_m + \sigma^2_{pe} + \sigma^2_e)$

Table 3. Design Matrices for Multiple-Trait Interim EPDs

Z_f: Full Model - Sire, Dam, Individual

Trait	S_b	S_w	S_y	S_m	D_b	D_w	D_y	D_m	I_b	I_w	I_y	I_m	D_p
BWT	0	0	0	0	0	0	0	0	1	0	0	0	0
WWT	0	0	0	0	0	0	0	1	0	1	0	0	1
YWT	0	0	0	0	0	0	0	1	0	0	1	0	1

Z_1: Non-parent Model with Known Parents

Trait	S_b	S_w	S_y	S_m	D_b	D_w	D_y	D_m	I_b	I_w	I_y	I_m	D_p
BWT	0.5	0	0	0	0.5	0	0	0	0	0	0	0	0
WWT	0	0.5	0	0	0	0.5	0	1	0	0	0	0	1
YWT	0	0	0.5	0	0	0	0.5	1	0	0	0	0	1

Z_2: Non-parent Model with Known Sire and Unknown Dam

Trait	S_b	S_w	S_y	S_m	D_b	D_w	D_y	D_m	I_b	I_w	I_y	I_m	D_p
BWT	0.5	0	0	0	0	0	0	0	0	0	0	0	0
WWT	0	0.5	0	0	0	0	0	0	0	0	0	0	0
YWT	0	0	0.5	0	0	0	0	0	0	0	0	0	0

Z_3: Non-parent Model with Unknown Sire and Known Dam

Trait	S_b	S_w	S_y	S_m	D_b	D_w	D_y	D_m	I_b	I_w	I_y	I_m	D_p
BWT	0	0	0	0	0.5	0	0	0	0	0	0	0	0
WWT	0	0	0	0	0	0.5	0	1	0	0	0	0	1
YWT	0	0	0	0	0	0	0.5	1	0	0	0	0	1

Z_4: Non-parent Model with Unknown Sire and Dam

Trait	S_b	S_w	S_y	S_m	D_b	D_w	D_y	D_m	I_b	I_w	I_y	I_m	D_p
BWT	0	0	0	0	0	0	0	0	0	0	0	0	0
WWT	0	0	0	0	0	0	0	0	0	0	0	0	0
YWT	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Inverses of the Residual (Co)variance Matrices

$$\mathbf{R}^{-1}_{i1} = \begin{matrix} r^{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$$

$$\mathbf{R}^{-1}_{i2} = \begin{matrix} 0 & 0 & 0 \\ 0 & r^{22} & 0 \\ 0 & 0 & 0 \end{matrix}$$

$$\mathbf{R}^{-1}_{i3} = \begin{matrix} r^{11} & r^{12} & 0 \\ r^{21} & r^{22} & 0 \\ 0 & 0 & 0 \end{matrix}$$

$$\mathbf{R}^{-1}_{i4} = \begin{matrix} 0 & 0 & 0 \\ 0 & r^{22} & r^{23} \\ 0 & r^{32} & r^{33} \end{matrix}$$

$$\mathbf{R}^{-1}_{i5} = \begin{matrix} r^{11} & r^{12} & r^{13} \\ r^{21} & r^{22} & r^{23} \\ r^{31} & r^{32} & r^{33} \end{matrix}$$

BREED COMPARISONS FOR GROWTH AND MATERNAL TRAITS ADJUSTED TO A 1992 BASE

Kristin L. Barkhouse[1], L. D. Van Vleck[2], and L. V. Cundiff[3]

[2]Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, Clay Center, NE 68933 and [1]Department of Animal Science, University of Nebraska, Lincoln 68583-0908

INTRODUCTION

Breed means adjusted for genetic trend and sire sampling using data from the Germplasm Evaluation (GPE) program at the U. S. Meat Animal Research Center (MARC) were reported by Notter and Cundiff (1991), Nuñez-Dominguez et al. (1993), and Cundiff (1993). This report is an update using EPDs from the most recent breed evaluations to adjust MARC breed means to a 1992 all animal (non-parent) basis.

The current analysis differs from previous analyses in that mixed model procedures, not least squares analyses, were used to obtain MARC breed means. A minor difference is that weaning weight was calculated at 205 days rather than at 200 days.

MATERIALS AND METHODS

Analysis of direct genetic effects on birth weight, weaning weight, and yearling weight of F_1 progeny. Data from MARC were obtained on F_1 calves by 13 sire breeds mated to Hereford or Angus dams. Edits to the data resulted in 4,282 records for birth weight (BWT), 3,957 records for 205-day weight (WWT), and 3,672 records for 365-day weight (YWT). Table 1 shows the number of sires with WWT EPDs and the number of F_1 progeny weaned.

Two analyses, similar to those outlined by Notter and Cundiff (1991), were performed. The objective of the first analysis was to obtain MARC sire breed means for BWT, WWT, and YWT. A mixed model was used with fixed effects for breed of dam (Hereford, Angus), birth year (1970-76, 86-90, 92-93), sex of calf (heifer, steer), age of dam (2, 3, 4, or ≥ 5 yr), breed of sire, and a fixed covariate for Julian birth date (BWT, WWT). In contrast to previous analyses, random effects for sires nested within sire breeds, were included in the model. Sire breed means at MARC were obtained using the MIXED procedure of SAS (1992).

The objective of the second analysis was to obtain the regressions of calf performance (BWT, WWT, YWT) on sire EPD. The model included the previous fixed effects as well as a term for the regression of calf performance on sire EPD as reported by the breed association. Pooled regressions of calf performance on sire EPD were used to adjust sire breed means at MARC from the mixed model analysis to a 1992 base as follows (Notter and Cundiff, 1991) for each breed of sire:

$$\text{Adjusted 1992 breed mean (i)} = \text{MARC(i)} + b[\text{EPD(i)}_{1992} - \text{EPD(i)}_{\text{MARC}}] \qquad [1]$$

where,

MARC(i) = estimate of the i^{th} breed mean obtained from mixed model analysis,

b = pooled regression coefficient of calf performance on sire EPD (lb/lb) obtained from the fixed effects analysis including sire EPD as a regression variable, (1.12 for BWT, .99 for WWT, and 1.42 for YWT),

$EPD(i)_{1992}$ = average EPD for all animals of breed i born in 1992, and

$EPD(i)_{MARC}$ = average EPD of bulls of breed i having progeny recorded at MARC weighted by number of progeny at MARC.

Analysis of maternal genetic effects on direct weaning weight and milk of 3-breed-cross progeny. Edited data for weaning weight (MWWT, n=6465) from top cross progeny obtained from mating purebred sires to F_1 cows produced by 13 maternal grandsire breeds and three maternal granddam breeds (Hereford, Angus, MARC III composite) were used in analyses similar to those described above to estimate maternal grandsire breed effects as a step in estimating breed effects for milk. The first analysis used a mixed model which included fixed effects for cycle (C, 1-4), cow age (A, 2, 3, 4, $\geq$ 5), CxA, birth year nested within CxA, sex of calf, breed of maternal granddam (MGD line), breed of maternal grandsire (MGS line), and breed of sire nested within CxA, and random effects for maternal grandsires (MGS) nested within MGS line and for dams nested within MGS. Breed means for MGS line at MARC were obtained from PROC MIXED of SAS (1992).

The second analysis included pooled regressions of calf performance on both direct weaning weight and milk EPDs of the MGS. Pooled regressions of calf performance were used to adjust the MWWT means at MARC to a 1992 base as follows for each breed of maternal grandsire:

$$\begin{aligned}\text{Adjusted 1992 MWWT(i)} = {} & \text{MARC(i)}_{\text{MGS}} \\ & + b_{\text{WW}}[\text{WWT EPD(i)}_{1992} - \text{WWT EPD(i)}_{\text{MARC}}] \\ & + b_{\text{MILK}}[\text{Milk EPD(i)}_{1992} - \text{Milk EPD(i)}_{\text{MARC}}]\end{aligned} \qquad [2]$$

where,

$MARC(i)_{MGS}$ = estimate of the i^{th} MGS line mean obtained from the mixed model analysis,

b_{WW} = .55, the pooled regression of calf weaning weight on WWT EPD of the MGS,

b_{MILK} = 1.15, the pooled regression of calf weaning weight on Milk EPD of the MGS,

$WWT\ EPD(i)_{1992}$ = average WWT EPD for all animals of breed i born in 1992,

$WWT\ EPD(i)_{MARC}$ = average WWT EPD of bulls of breed i having grand progeny recorded at MARC weighted by number of progeny at MARC,

$MILK\ EPD(i)_{1992}$ = average MILK EPD for all animals of breed i born in 1992,

and

$MILK\ EPD(i)_{MARC}$ = average MILK EPD of bulls of breed i having grand progeny recorded at MARC weighted by number of progeny at MARC.

Adjusted means for maternal milk were obtained as follows:

$$\text{Adjusted milk (i)} = [MWWT_{adj}(i) - MWWT_{adj}] - .5[WWT_{adj}(i) - WWT_{adj}]$$

where, as obtained from equations [1] and [2],

$MWWT_{adj}(i)$ = mean maternal weaning weight adjusted to a 1992 base for the i^{th} breed (equation [2]),

$MWWT_{adj}$ = mean maternal weaning weight adjusted to a 1992 base over the 13 breeds (unweighted),

$WWT_{adj}(i)$ = direct weaning weight mean adjusted to a 1992 base for the i^{th} breed (equation [1]), and

WWT_{adj} = direct weaning weight mean adjusted to a 1992 base over the 13 breeds (unweighted).

RESULTS AND DISCUSSION

Mean EPDs of sires (BWT, WWT, YWT) and maternal grandsires (WWT,MILK) from the most recent breed association evaluations of the MARC sires as well as mean 1992 EPDs (all animal, non-parent) are shown in Table 2 by breed. The 1992 means were generally larger than the MARC EPDs except for Maine Anjou and Salers, which had lower 1992 mean EPDs for BWT, WWT, and YWT. Current Pinzgauer EPDs were unavailable; therefore EPDs from 1993 were used, but with accuracies assumed to be zero (Table 3).

MARC sire breed means obtained from the mixed model analyses are shown in Table 4. Rankings were similar to those reported by Cundiff et al. (1986) and Nuñez-Dominguez et al. (1993).

Pooled regression coefficients of calf BWT, WWT, and YWT on respective sire EPDs were 1.12 $\pm$ .08, 0.99 $\pm$ .09, and 1.42 $\pm$ .08, respectively. These regression coefficients are similar to those reported by Nuñez-Dominguez et al. (1993), Cundiff (1993), and Notter and Cundiff (1991). As in previous years, the pooled YWT regression was significantly different from the expected value of 1.0 ($P < .05$). The test for homogeneity of regressions across sire breeds was not significant, but regressions across dam breeds were heterogenous for WWT and YWT, and also across sexes for YWT. In contrast to results reported by Nuñez-Dominguez et al. (1993), heifers had a higher regression coefficient (1.6) than steers (1.3) for YWT.

Pooled regression coefficients for calf weaning weight on direct WWT and MILK EPDs of the MGS were .55 and 1.15, respectively. These estimates are slightly greater than previous estimates (Notter and Cundiff, 1991; Nuñez-Dominguez et al., 1993; and Cundiff, 1993), but are not significantly different from their theoretical values (.5 and 1.0, respectively). The tests of heterogeneity of regressions across maternal grandsire and dam breeds for both weaning weight and milk were not significantly different from the null hypothesis of homogeneity.

MARC sire breed means adjusted to a 1992 base are shown in Table 5. Breed means generally increased with adjustment for trend and sires sampled at MARC. These adjustments narrowed the range in BWT and MILK means slightly, while the range increased by 38% for WWT and 53% for YWT.

The adjusted means can be used to calculate adjustment factors (Table 6) to calculate across breed EPDs (see Cundiff, 1994):

$$A_j = (M_{ij} - M_{ib}) - [EPD(i)_{1992} - EPD(b)_{1992}],$$

where,

A_j = adjustment factor to add to EPD of a bull of j^{th} breed,
M_{ij} = adjusted 1992 breed mean (i) (equation [1] or [2]),
M_{ib} = adjusted 1992 base breed mean (equation [1] or [2]),
$EPD(i)_{1992}$ = average EPD for all breed i animals born in 1992, and
$EPD(b)_{1992}$ = average EPD for all base breed animals born in 1992.

Variances of across breed EPDs. Two alternatives for calculating differences in progeny expected for pairs of bulls of different breeds are: 1) add the difference in within breed EPDs to the difference in adjusted breed means from Table 5, and 2) add the difference in within breed EPDs to the difference from the base breed in Table 5. The prediction error variance for the first case can be approximated as shown by Van Vleck and Cundiff (1994) from the variance of the breed contrast from the mixed model analysis of MARC progeny after accounting for adjustment for trends. These adjustments for variances of mixed model contrasts are shown in Table 7 using variances estimated from MARC data and used in estimating breed means (Table 8). Tables 9a and 9b show the variances due to breed differences to be added to the within breed prediction error variances for a pair of bulls of different breeds. The standard error of prediction for the difference expected in progeny of the two bulls is the square root of that sum. With the alternative of a base breed, an easily applied procedure is to add the variance of the adjusted difference from the base breed to the within breed prediction error variance of each bull (Van Vleck, 1994); that is, each bull will have a total prediction error variance much as is usually done within breed. Bulls of the base breed will not have anything added to the prediction error variance within the base breed. This procedure needs to use the entries from the column and row for the base breed. For example, if a Polled Hereford bull has PEV of 300 for YWT, then the PEV for his EPD as a difference from an Angus bull with zero EPD is calculated as 81.6 + 300 = 381.6 with corresponding standard error of prediction, 19.5.

LITERATURE CITED

Cundiff, L. V., K. E. Gregory, R. M. Koch, and G. E. Dickerson. 1986. Genetic diversity among cattle breeds and its use to increase beef production efficiency in a temperate environment. Proc. 3rd World Congr. Genet. Appl. Livest. Prod. 9:271.

Cundiff, L. V. 1993. Breed comparisons adjusted to a 1991 basis using current EPDs. Proc. BIF Research Symposium, Asheville, NC, May, 1993.

Cundiff, L. V. 1994. Procedures for across breed EPDs. Proc. Fourth Genetic Prediction Workshop, Beef Improvement Federation, Kansas City, MO, Jan. 1994.

Notter, D. R., and L. V. Cundiff. 1991. Across-breed expected progeny differences: Use of within-breed expected progeny differences to adjust breed evaluations for sire sampling and genetic trend. J. Anim. Sci. 69:4763.

Nuñez-Dominguez, R., L. D. Van Vleck, and L. V. Cundiff. 1993. Breed comparisons for growth traits adjusted for within-breed genetic trend using expected progeny differences. J. Anim. Sci. 71:1419.

SAS Institute INC. SAS Technical Report p. 229, SAS/STAT Software. Changes and enhancements (release 6.07). Cary, N.C.: SAS Institute INC, 1992. 620 pages.

Van Vleck, L. D., and L. V. Cundiff. 1994. Prediction error variances for inter-breed genetic evaluations. J. Anim. Sci. (In press).

Van Vleck, L. D. 1994. Prediction error variances for inter-breed EPDs. Proc. Fourth Genetic Prediction Workshop, Beef Improvement Federation, Kansas City, Mo, Jan. 1994.

Table 1. Number of sires and maternal grandsires (MGS) having weaning weight EPDs and number of progeny and grand progeny weaned

Breed	Direct		Maternal	
	Sires	F_1 Progeny	MGS	Top-cross grand progeny
P. Hereford	27	281	21	479
Hereford	38	383	28	567
Angus	68	489	36	584
Shorthorn	25	170	22	219
Brahman	18	222	6	186
Simmental	26	353	25	770
Limousin	20	338	20	764
Charolais	58	478	52	797
Maine-Anjou	14	145	13	334
Gelbvieh	25	355	25	638
Pinzgauer	11	376	11	478
Tarentaise	7	191	6	341
Salers	27	176	25	308
Total	369	3957	286	6465

Table 2. Mean EPDs (lb) of sires used at MARC and mean EPDs of all animals born in 1992 from most recent evaluation for each breed[a]

	BWT		WWT		YWT		MILK		MWWT[b]
Sire breed	1992	MARC	1992	MARC	1992	MARC	1992	MARC	MARC
P. Hereford	3.40	2.46	21.8	11.1	34.6	19.8	1.2	1.0	.9
Hereford	2.22	0.54	25.7	8.7	41.1	11.3	7.5	-1.6	5.6
Angus	3.20	1.80	23.1	12.0	39.4	19.1	8.8	1.9	4.5
Shorthorn	1.90	1.03	11.9	8.1	19.5	15.7	1.9	7.6	8.5
Brahman	0.95	0.76	7.3	5.0	12.5	7.8	3.4	0.6	1.0
Simmental	0.40	-0.01	8.3	-14.8	14.2	-26.2	0.4	-1.2	-14.7
Limousin	0.60	-0.60	4.3	-6.6	8.4	-10.1	0.3	-0.2	-6.6
Charolais	1.47	1.50	7.9	1.1	12.0	3.1	-0.9	0.1	-0.3
Maine-Anjou	-0.10	0.92	0.6	2.6	0.7	3.7	-0.3	-0.6	1.6
Gelbvieh	0.30	-1.50	4.5	-1.8	8.6	-4.3	1.7	-0.2	-1.8
Pinzgauer	-1.10	-0.08	-.5	-6.4	-1.0	-12.7	-.3	9.3	-4.3
Tarentaise	3.27	2.46	10.8	-2.5	15.9	-2.6	0.7	4.5	-3.4
Salers	0.80	1.22	7.3	7.7	11.7	12.3	2.9	6.4	5.9

[a]Pinzgauer EPDs obtained from the Spring, 1993 evaluation.
[b]Mean EPD for WWT of maternal grandsires weighted by the number of grandprogeny at MARC.

Table 3. Mean accuracies (BIF) for birth weight (BWT), weaning weight (WWT), yearling weight (YWT) and milk (MILK) for bulls used at MARC

	Mean accuracies			
Breed	BWT	WWT	YWT	MILK
P. Hereford	.63	.57	.42	.43
Hereford	.58	.62	.53	.51
Angus	.58	.58	.53	.45
Shorthorn	.77	.77	.63	.72
Brahman	.46	.56	.37	.40
Simmental	.96	.96	.96	.96
Limousin	.95	.95	.93	.92
Charolais	.75	.75	.73	.71
Maine-Anjou	.34	.37	.19	.24
Gelbvieh	.66	.67	.60	.70
Pinzgauer	..... Not available			
Tarentaise	.96	.95	.95	.95
Salers	.82	.75	.60	.72

Table 4. Estimates (lbs) of sire breed effects for birth weight (BWT), 205-day weight (WWT), 365-day weight (YWT), and maternal grandsire effects for 205-day weight (MWWT) from mixed model analyses of MARC records (least squares means)

Sire breed	BWT	WWT	YWT	MWWT[a]
P. Hereford	84.5	457	803	457
Hereford	82.6	449	787	477
Angus	77.9	446	791	480
Shorthorn	85.8	467	826	515
Brahman	90.7	468	765	528
Simmental	86.7	469	817	518
Limousin	82.1	457	783	480
Charolais	87.4	472	833	500
Maine-Anjou	89.1	468	826	517
Gelbvieh	84.1	471	813	522
Pinzgauer	85.0	449	779	505
Tarentaise	83.0	454	781	512
Salers	84.3	472	825	515

[a]Maternal grandsire breed.

Table 5. Breed means (lb) from mixed model analyses of MARC records adjusted for genetic trend to 1992 base

				Maternal	
Breed	BWT	WWT	YWT	MWWT	Milk
P. Hereford	85.5	467	824	469	-38
Hereford	84.5	466	829	498	-8
Angus	79.4	457	820	499	-3
Shorthorn	86.8	471	832	510	2
Brahman	90.9	470	772	534	26
Simmental	87.1	492	874	533	14
Limousin	83.4	467	809	487	-20
Charolais	87.4	479	845	503	-9
Maine-Anjou	88.0	466	821	517	11
Gelbvieh	86.1	477	831	528	17
Pinzgauer	83.8	455	796	496	-5
Tarentaise	83.9	467	807	516	9
Salers	83.8	472	824	512	3

Table 6. Factors (lb) to adjust within breed EPD's to Angus base[a]

Breed	BWT	WWT	YWT	MILK
Angus	0	0	0	0
P. Hereford	5.9	11.3	8.8	-27.4
Hereford	6.1	6.4	7.3	-3.7
Shorthorn	8.7	25.2	31.9	11.9
Brahman	13.8	28.8	-21.1	34.4
Simmental	10.5	49.8	79.2	25.4
Limousin	6.6	28.8	20.0	-8.5
Charolais	9.7	37.2	52.4	3.7
Maine Anjou	11.9	31.5	39.7	23.1
Gelbvieh	9.6	38.6	41.8	27.1
Pinzgauer	8.7	21.6	16.4	7.1
Tarentaise	4.4	22.3	10.5	20.1
Salers	6.8	30.8	31.7	11.9

[a]Table 5 difference from Angus minus 1992 mean EPD difference from Angus from Table 2.

Table 7. Adjustments (lb^2) for variances of adjusted breed means due to accuracy of EPDs and number of bulls at MARC having EPDs

Breed	BWT	WWT	YWT
Angus	-.1	-2.3	-7.6
P. Hereford	-.2	-4.6	-14.7
Hereford	-.1	-3.7	-7.6
Shorthorn	-.5	-8.1	-29.5
Brahman	-.4	-9.6	-27.5
Simmental	-.4	-8.3	-30.5
Limousin	-.5	-9.5	-34.9
Charolais	-.1	-2.7	-9.3
Maine Anjou	-.5	-8.3	-21.6
Gelbvieh	-.3	-5.3	-17.8
Pinzgauer	NA	NA	NA
Tarentaise	-.5	-13.6	-32.0
Salers	-.5	-7.8	-28.3

Table 8. 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/Component	BWT	WWT	YWT	MWWT
Direct				
Sire within breed	13.7	209	903	
Residual	93.3	2559	5667	
Maternal				
MGS within MGS breed				181
Dam within MGS				858
Residual				1238

Table 9a. 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 EPD's for bulls of two different breeds.[a] Birth weight above diagonal and yearling weight below diagonal.

Bre	PH	HH	AN	SH	BR	SI	LI	CH	MA	GE	PI	TA	SA
PH	-	1.5	1.2	1.8	1.6	1.9	2.0	1.5	2.7	1.7	2.7	3.6	1.7
HH	102.8	-	1.1	1.4	1.7	1.5	1.5	1.1	2.4	1.3	2.5	3.3	1.4
AN	81.6	75.7	-	1.2	1.3	1.3	1.4	0.9	2.1	1.1	2.2	3.1	1.2
SH	120.4	101.0	86.6	-	2.0	1.8	1.9	1.2	2.6	1.4	2.7	3.6	1.2
BR	117.9	124.0	98.9	148.0	-	2.1	2.1	1.7	2.8	1.8	2.6	3.3	1.9
SI	129.3	102.7	92.5	126.1	152.9	-	0.9	0.9	2.7	1.7	2.8	3.6	1.7
LI	130.8	103.6	94.0	128.4	153.8	66.4	-	1.0	2.7	1.7	2.8	3.7	1.8
CH	97.8	73.9	62.6	83.3	122.4	66.1	68.4	-	2.3	1.2	2.4	3.2	1.1
MA	190.2	171.0	157.0	186.9	210.7	192.7	193.9	162.3	-	1.8	3.4	4.3	2.5
GE	117.3	95.4	83.8	102.8	137.7	119.0	119.6	82.5	140.1	-	2.5	3.4	1.4
PI[b]	190.1	174.7	160.3	190.9	191.5	198.4	199.7	167.3	251.0	180.7	-	3.7	2.6
TA	251.3	236.2	223.7	257.3	249.2	260.7	261.9	231.5	312.2	244.7	268.2	-	3.5
SA	116.7	97.9	83.8	88.7	145.2	123.4	125.7	80.8	184.1	101.3	188.2	254.4	-

[a]For example, a Polled 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 EPD's for the two bulls is 120.4 + 300 + 200 = 620.4 with SEP=24.9.

[b]Not adjusted for accuracy of Pinzgauer bulls used at MARC.

Table 9b. 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 (weaning weight) below the diagonal[a].

	PH	HH	AN	SH	BR	SI	LI	CH	MA	GE	PI	TA	SA
PH	-	30.8	26.5	42.0	34.5	42.1	43.0	32.5	61.3	38.1	54.3	69.1	40.5
HH	58.6	-	23.0	34.1	34.7	31.7	32.5	23.0	53.4	29.4	48.0	63.1	32.9
AN	55.3	48.7	-	31.4	29.1	30.6	31.3	21.4	50.8	27.6	45.3	61.0	30.2
SH	74.1	66.1	61.5	-	48.6	44.5	45.7	30.8	64.1	36.5	59.4	75.9	32.8
BR	120.0	110.6	109.5	134.6	-	47.1	47.8	37.9	65.4	42.1	50.8	64.9	47.5
SI	70.9	58.0	56.0	80.8	129.0	-	20.9	20.6	64.0	39.7	59.2	74.9	43.3
LI	73.0	59.9	58.3	83.0	131.0	45.4	-	21.9	64.7	40.2	60.0	75.7	44.6
CH	53.1	42.2	39.0	58.6	112.1	40.0	42.2	-	54.2	28.1	49.6	65.7	29.7
MA	94.5	85.2	81.4	105.1	149.8	101.0	103.0	83.4	-	42.9	76.1	91.4	63.0
GE	60.5	51.9	47.3	65.8	118.1	66.8	68.8	46.9	71.2	-	53.3	69.6	35.8
PI[b]	87.6	77.4	75.5	98.9	107.9	94.6	96.7	77.1	115.4	83.0	-	68.5	58.2
TA	122.8	112.1	111.1	135.5	138.3	129.9	132.0	113.0	150.4	119.0	106.3	-	74.7
SA	66.0	57.6	53.9	65.4	126.5	72.8	75.0	50.7	97.1	58.0	91.0	127.5	-

[a]Adjustments for accuracy of MILK EPD's of bulls used at MARC not yet worked out. Variances probably will be somewhat smaller for MILK than shown.

[b]Not adjusted for accuracy of WWT EPDs of Pinzgauer bulls used at MARC.

Tentative Outline For BIF Guidelines Chapter on National Cattle Evaluation

Chapter Title: National Cattle Evaluation

I Preamble - Keith Bertrand

II Performance Traits - Rick Bourdon

III Data Preparation and Editing Considerations - Bob Schalles

- a) Errors encountered with Field Data
- b) General Edits
- c) Contemporary Group Formation

IV Analysis Procedures

- a) General Model Discussion
  - i) Animal Model - Keith Bertrand
  - ii) Sire-Maternal Grandsires Model - Dick Quaas
  - iii) Multiple Trait Model - Bruce Golden
  - iv) Threshold Model - Dick Quaas
- b) Solution Methods - Bruce Golden
- c) Interim Predictions - Bruce Cunningham

V Reporting of Results - John Pollak

- a) Accuracy Values
- b) Possible Change Values
- c) Base

VI Genetic and Environmental Parameters - John Pollak

Appendix: Models in Matrix Notation

- a) Animal Model and Reduced Animal Model - Keith Bertrand
- b) Multiple Trait Animal Model - Bruce Golden

REPRODUCTION COMMITTEE
Minutes
June 2, 1994
West Des Moines, IA

The meeting was called to order by Chairman Bruce E. Cunningham at 2:15 p.m., June 2, 1994.

Chairman Cunningham gave an introduction and described the purpose of the Reproduction Committee to those in attendance. Also, he went through the list of agenda items.

Chairman Cunningham gave a brief preliminary report from a subcommittee on the genetic evaluation of reproductive traits. This subcommittee was formed last year at the Asheville meeting and included as members, Chairman Cunningham, David Notter, VPI, and Michael MacNeil, USDA-LARRS. This subcommittee report served as an introduction to the topics to be covered by first two speakers regarding the potential genetic evaluation of female reproductive traits.

Michael MacNeil of USDA-LARRS, Miles City, MT presented the results of an analysis of calving date records from the Line 1 Hereford herd located at Miles City. The data included calving date records from 1935 to 1989. Compared to previous studies of calving data, the analysis included the direct effect of the calf and the effect of service sire with year contemporary groups. This full model was more descriptive of the biology of calving date as a trait. The estimated calving date heritabilities were 15% as a trait of the calf and 3% as a trait of the dam. The repeatability of calving date as a trait of the dam was estimated as 7%. If calving date was analyzed as exclusively as a maternal trait, the estimated maternal heritability was inflated. Considering the data from Miles City used a fixed breeding season and single sire breeding pastures, the amount of maternal variation in calving date was small compared to other factors influencing calving date. The results were not encouraging for using calving date as a trait for improving female reproduction.

Bruce Golden of Colorado State University discussed stayability as an indicator trait for female reproduction. Stayability is defined as the probability of surviving to a specific age, given the opportunity to reach that age. The stayability trait was studied on a within herd basis using records from the Colorado State University Beef Improvement Center and the Beckton Stock Farm. For these two herds, stayability was defined using the number of calves born to a cow given she first calved as a two year old cow. Four stayability traits were analyzed within each herd. The heritability estimates ranged from 2% to 21%. Bruce discussed a stayability analysis performed using the Red Angus data base. Stayability was defined for the Red Angus as the probability of a cow calving at six years of age or older, given she had calved at five years of age or earlier. The range in Stayability EPDs among Red Angus sires was -11.8 to 14.2%. The highest ranking Red Angus sire would have about 25% more daughters in production at six years of age compared to the lowest ranking Red Angus sire. The genetic trend for stayability indicated the average EPD for stayability has increased slightly in the Red Angus breed from 1970 to 1992. The preliminary results indicate that a genetic evaluation for female reproduction using stayability is a viable approach.

Robert R. Schalles of Kansas State University presented some background information on a research project that was designed to estimate adjustment factors for yearling scrotal circumference. He introduced Jeremy Geske from Kansas State who made presented the finding of the research project. Scrotal circumference data were collected from 4,218 bulls born in the spring of 1991. The breeds represented in the data were Angus, Red Angus, Brangus, Charolais, Gelbvieh, Hereford, Polled Hereford, Limousin, Salers, and Simmental. These bulls were from on-farm testing programs and central bull test stations. The objectives were to estimate scrotal circumference growth curves, develop age adjustments to 205 and 365 d of age, and develop a 365 d prediction equation using 205 d scrotal circumference measurements. The estimated age adjustments for 365 d scrotal circumference ranged from 0.0305 cm/d for Polled Hereford to 0.0708 cm/d for Brangus. The data indicated that breeds differed in rate of scrotal circumference growth. In order to reach a 32 cm scrotal circumference at a year of age, a bull calf would need a 20 to 23 cm scrotal circumference at weaning based on the breed of the calf.

Following Jeremy's presentation, Chairman Cunningham discussed with the committee that the revision of the BIF guidelines would soon be under way. He told the committee that the age adjustments for scrotal circumference would be presented to the Board of Directors for inclusion in the revised guidelines if there were no objections. Also, he indicated that scrotal adjustments would need to be developed for the other Brahman and Brahman-derivative breeds not represented in the KSU study. Chairman Cunningham indicated that the major revision to the Reproduction section of the guidelines would be the section on the Breeding Soundness Exam along with the section on scrotal circumference. He asked the members of the committee if they had any suggestions for the guidelines to contact him.

After asking the committee if there was any additional business to be discussed by the committee, the Reproduction committee adjourned at 4:15 p.m.

Respectfully submitted by

Bruce E. Cunningham, Ph.D.
Chairman

Genetic Evaluation of Female Reproduction Traits
Preliminary Subcommittee Report

Bruce E. Cunningham, Ph.D.
American Simmental Association
Bozeman, MT

Presently, every breed association with a performance recording program provides Expected Progeny Differences to their members on a routine basis. Expected Progeny Differences are provided by each breed association for birth weight, weaning weight, yearling weight, maternal milk, and maternal weaning weight. Three associations provide calving ease and maternal calving ease evaluations. The reproductive traits evaluated by national cattle evaluation programs are scrotal circumference and gestation length. At this time, there is not any measure of female reproduction in any of the national cattle evaluation program except for Stayability in Red Angus which Dr. Bruce Golden will be discussing today.

What are the potential traits that could be used in a genetic evaluation of female reproduction? Some possible candidates include calving interval, calving date, conception rate, non-return rate, and age at puberty. Conception rate and non-return rate require breeders to do a very good job of recording AI breeding dates and pasture exposure dates. Because of these requirements, their usefulness is limited from a field data perspective. Age of puberty is difficult to measure by ranchers. The industry has adopted scrotal circumference as an indicator trait for age of puberty in males and females. Calving interval is a possibility how ever estimates of the heritability for calving interval have been not been encouraging.

From a field data prospective, calving date has the greatest potential since every calf reported to a breed association has a birth date. As a result, the calf's birth date is its dams' calving date. Of the potential reproductive traits excluding scrotal circumference, it is the most convenient trait to recorded on females. Several studies have indicted that the heritability of first and second calving date is between 10% and 20%. These estimates are very similar to estimates obtained for calving ease in beef cattle field data. We should be able to practice some selection of sires based on their daughters' performance. A question to be asked in these studies is: Have the effects of the service sire been adequately accounted in the analysis for calving date? Dr. Michael MacNeil will discuss this point in his presentation of the analysis of the Line 1 data from Miles City.

In order to improve the quality of reproductive data, breed associations need to encourage their members to practice whole-herd record keeping. By reporting the entire calf crop every year to the breed association, breeders would keep track of their cows' reproductive histories along with maintaining intact contemporary groups for genetic evaluation purposes. To conduct genetic evaluations of female reproductive traits, the associations need to identify herds that have been doing whole-herd record keeping. If herds can be identified, we should be able to develop a genetic evaluation for female reproduction.

Calving Date in Line 1 Hereford Cattle

M. D. MacNeil and S. Newman

USDA - Agricultural Research Service
Fort Keogh Livestock and Range Research Laboratory
Miles City, Montana 59301

INTRODUCTION

Calving date, the numerical day of the year when a cow gives birth to a calf, has been suggested as a selection criterion to improve genetic potential for fertility in beef cattle (Bourdon and Brinks, 1983; Notter, 1988; Meyer et al., 1990). This trait is readily observed in calving cows and routinely reported to breed associations when calves are registered. Phenotypic expression of calving date is a composite trait combining effects of the calf controlling initiation of parturition (Bazer and First, 1983), effects of the dam associated with post-partum interval and fertility (Johnson and Notter, 1987a; Azzam et al., 1990), and effects of the service sire associated with semen quality and libido (Chenowerth, 1981). The purpose of this research was to develop a model for genetic analysis of observed calving date consistent with the underlying biology and to estimate variance components, genetic trend, and fixed effects using records from a 55-year study of Line 1 Hereford cattle at Fort Keogh Livestock and Range Research Laboratory.

METHODS

A 45- to 60-day breeding season began about July 1 from 1934 through 1945 and about June 15 thereafter except for two brief periods. During the years 1974-1977 the breeding season began one week earlier and during 1986-1988 it began one week later. Single-sire mating (199 service sires) was practiced in all years, except when injury or apparent infertility necessitated replacing one bull with another. Parentage information was maintained by identifying cows bred to the second bull through the use of chin-ball markers and in more recent years through blood-typing of questionable progeny. Cow-to-bull ratios ranged from 38:1 to 7:1 with higher ratios generally in earlier years. Lower cow to bull ratios were associated with yearling bulls in the early years of their use, which began in 1969. Day of parturition was routinely recorded.

Beginning in 1965, all novice bulls were subjected to a breeding soundness exam consisting of physical inspection and microscopic evaluation of semen quality. In 1975 and thereafter, the breeding soundness exam was augmented with a short exposure of each bull to an estrual heifer during which copulation was observed. Only two yearling bulls were used as herd sires before 1975.

The following model is proposed for genetic evaluation of calving date:

$$\mathbf{y} = \mathbf{X}\beta + \mathbf{Z}_1\mathbf{u}_1 + \mathbf{Z}_2\mathbf{u}_2 + \mathbf{Z}_3\mathbf{u}_3 + \mathbf{Z}_4\mathbf{u}_4 + \mathbf{e}\text{, where}$$

$\mathbf{y}$ is a vector of observed dates of parturition; X is an incidence matrix relating a vector of fixed effects (β) consisting of linear regressions on inbreeding coefficients of calf and of dam, and discrete effects of sex of calf, age of dam x age at first calving subclasses, year, and previous parity of the cow to $\mathbf{y}$; $\mathbf{Z}_1$, $\mathbf{Z}_2$, $\mathbf{Z}_3$, and $\mathbf{Z}_4$ are incidence matrices relating individual (calf) additive genetic effects ($\mathbf{u}_1$), maternal additive genetic effects (u_2), permanent environment effects of the dam (u_3), and effects of service sire within year contemporary groups (u_4) to **y**; and **e** is a vector of random residual effects. The $E(y) = X\beta$, and variance-covariance structure of the data is:

$$\begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ e \end{bmatrix} = \begin{bmatrix} A\sigma_a^2 & & & \text{symmetric} & \\ A\sigma_{am} & A\sigma_m^2 & & & \\ 0 & 0 & I_c\sigma_c^2 & & \\ 0 & 0 & 0 & I_g\sigma_g^2 & \\ 0 & 0 & 0 & 0 & I_e\sigma_e^2 \end{bmatrix}.$$

In addition to this model, reduced models ignoring individual additive effects and contemporary group effects both individually and simultaneously were examined. Estimates of variance and covariance components were obtained by restricted maximum likelihood using a derivative-free algorithm (Meyer, 1989). Pedigree information started five generations preceding the 1935 calf-crop and included all subsequent animals with records. There were 951 pedigree records that predated 1935, when data collection began and 4692 subsequent recorded calving dates through 1989. Computations were performed with the MTDFREML set of programs (Boldman et al., 1993).

Estimates of genetic and environmental trends were obtained by regression on year. Solutions for the year effects were used to estimate environmental trend. Estimates of u_1 and u_2 were averaged for each birth-year and used to estimate direct and maternal additive genetic trends, respectively.

RESULTS

Bull calves were born 1.58 ± .40 d later than heifer calves, probably due to differences in gestation length. Within age at first calving (2 or 3) cow age effects were small. Comparisons of specific age classes of cows (2,3,4, and 10^+) with cows aged 5 - 10 yr. were within ±2 s.e. of zero. Calves born to cows not weaning a calf the previous year were born 2.81±.81 d earlier than contemporaries that had weaned a calf. The magnitude of this effect is smaller than would be inferred in analyses where calving date was predicted for those cows not calving.

Variance components for calving date were 23.0 for individual additive genetic effects (σ_a^2), 5.8 for maternal additive genetic effects (σ_m^2), 9.2 for maternal permanent environmental effects (σ_c^2), 11.8 for contemporary group effects (σ_g^2), and 161.3 for residual effects (σ_e^2). The direct - maternal covariance (σ_{am}) was -5.7.

The σ_a^2 component reflects individual additive genetic variance remaining among members of sire families, or ¾ of individual additive genetic variance of calving date free of service sire effects associated with libido and/or male fertility. This results because service sire and contemporary group are confounded in single sire natural service breeding herds. Contemporary group effects less ¼ σ_a^2 accounted for 3 % of phenotypic variance. Estimated heritability of calving date (including ¼ σ_a^2 from contemporary group component) as a trait of the calf was 0.15.

Estimates of heritability and repeatability of calving date as a trait of the dam were 0.03 and 0.07, respectively. In the present study, days to calving and calving date would be analogous because within year the breeding season began on a single date. Thus, with year accounted for in the analysis any variation in days to calving arises from variation in calving date. When these data were analyzed as though calving date were a trait of the dam the estimate of maternal additive genetic variance was inflated. In the past, larger estimates of heritability have been used in developing breeding objectives where calving date has been advocated as a selection criterion for fertility (Ponzoni and Newman, 1989). The present finding of small maternal additive genetic variance for calving date confirms the conclusion of Johnson and Notter (1987b) that though calving date is one of the most easily measured and readily available reproductive traits, it does not necessarily exhibit sufficient maternal additive genetic variance to obviate the need for better measures of genetic potential for reproduction.

Choice of date on which to begin the breeding season the year previous to calving contributes to environmental variation in calving date. Aside from managerially imposed changes in the time of the breeding season, there appears to have been a continual environmental trend toward later calving dates (.17 d/yr) throughout the history of the Miles City Line 1 Hereford cattle.

Additive genetic trend associated with the genotype of the calf for earlier calving was.07 d/yr. Estimated maternal genetic trend was essentially zero. Thus, female fertility of this genetic stock exposed for breeding for only 45 to 60 d may be little changed over 55 yr. Alternatively, short duration of the breeding season may not provide sufficient opportunity for expression of differences in genetic potential.

SUMMARY

Variance components, genetic trends and fixed effects for calving date were estimated in the Miles City Line 1 Hereford cattle population. The statistical model included fixed linear continuous effects for inbreeding of calf and inbreeding of dam and discrete effects for year, sex of calf, and age and previous parity of dam. Included in the REML analyses were random sources of variation for individual (calf) additive genetic effects, maternal additive genetic effects, permanent environment effects of the dam, and service sire within year contemporary groups. Thus, this model accounted for additional random sources of variation included in previous analyses. Male calves were born 1.58 ± .40 d later than female calves. Cows failing to wean a calf in the previous year calved 2.81±.81 d earlier than cows that had weaned a calf. Other fixed effects were small. Variance components (d^2) were 23.0 for individual additive genetic effects, 5.8 for maternal additive genetic effects, 9.2 for maternal permanent environmental effects, 11.8 for contemporary group effects, and 161.3 for residual effects. The direct - maternal covariance was -5.7. Environmental trend was +.17 d/yr and individual additive genetic trend was -.07 d/yr. No maternal additive genetic trend was detected.

These results do not encourage the use of calving day as a selection criterion for improving fertility of beef cattle. The maternal additive genetic component of variance for calving date was small relative to other sources of variation. This finding makes maternal calving date more nearly similar to other measures of fertility, like conception rate, than had been suggested. The model used in analysis of the data accounted for additive genetic effects of the calf and contemporary mating group effects that have not been included in previous work. Due to the magnitudes of both contemporary group effects and individual additive effects it is suggested they be accounted for in future work on calving date.

Literature Cited

Azzam, S. M., J. E. Kinder, and M. K. Nielsen. 1990. Modelling reproductive management systems for beef cattle. Agric. Systems 34:103.

Bazer, F. W. and N. L. First. 1983. Pregnancy and parturition. J. Anim. Sci. Suppl. 2 57:425

Boldman, K. G., L. A. Kriese, L. D. VanVleck, and S. D. Kachman. 1993. A manual for use of MTDFREML. A set of programs to obtain estimates of variances and covariances [Draft]. U.S. Dept. Agric. Agric. Res. Serv.

Bourdon, R. M. and J. S. Brinks. 1983. Calving date versus calving interval as a reproductive measure in beef cattle. J. Anim. Sci. 57:1412.

Chenowerth, P. J. 1981. Libido and mating behavior in bulls, boars and rams. A review. Theriogenology 16:155.

Johnson, M. H. and D. R. Notter. 1987a. Simulation of genetic control of reproduction in beef cows. I. Simulation model. J. Anim. Sci. 65:68.

Johnson, M. H. and D. R. Notter. 1987b. Simulation of genetic control of reproduction in beef cows. II. Derived genetic parameters. J. Anim. Sci. 65:76.

Meyer, K. 1989. Restricted maximum likelihood to estimate variance components for animal models with several random effects using a derivative-free algorithm. Genet. Sel. Evol. 23:67.

Meyer K., K. Hammond, P. F. Parnell, M. J. MacKinnon, and S. Sivarajasingam. 1990. Estimates of heritability and repeatability for reproductive traits in Australian beef cattle. Livestock Prod. Sci. 25:15.

Notter, D. R. 1988. Evaluating and reporting reproductive traits. Proc. Beef Improvement Fed. Res. Symp. and Annual Mtg. pp. 21-42. Albuquerque, NM.

Ponzoni, R. W. and S. Newman. 1989. Developing breeding objectives for Australian beef cattle production. Anim. Prod. 49:35.

STAYABILITY AS AN INDICATOR OF REPRODUCTION IN BEEF FEMALES

W. M. Snelling[1] and B. L. Golden[2]

[1]USDA-ARS, Fort Keogh LARRL
Miles City, MT 59301
[2]Colorado State University
Fort Collins, CO 80523

Introduction

The need for measures allowing selection for female fertility is clearly evident. Even with the strong favorable relationship that exists between scrotal circumference (SC) of yearling bulls and age at puberty (AP) of heifers, Notter et al. (1993) indicate selection for SC is not a replacement for direct selection on female reproductive performance. Except for some measures taken early in life, such as AP and day of first and second calving, many measures of reproductive performance are lowly heritable. Some reproductive traits are only observable on females that calve and ignore open females. Also, historical data have little value with selection using measures that require additional data collection.

Defined as the probability of surviving to a specific age, given the opportunity to reach that age (Hudson and Van Vleck, 1981), stayability may overcome some problems associated with other measures of beef cattle reproduction. Historical records are useful to assign observations to both females that calve and those that do not, and the heritability of some stayability traits may be sufficient to allow meaningful selection. Stayability traits may be defined to reflect lifetime reproductive performance of cows, beyond early indications of fertility.

Heritability

Within herd heritability estimates of stayability of dams to four ages (table 1) were obtained using pedigree and birth date information from Colorado State University Beef Improvement Center (BIC) and Beckton Stock Farms (BSF). Data were available from BIC for 1958 through 1992, and from BSF for 1950 through 1989.

The number of calves born to each cow was used to assign binary stayability observations to each female that calved as a two-year-old and was at least the age required. Heritability estimation procedures based on a threshold model (Gianola and Foulley, 1983; Harville and Mee, 1984) were used to obtain animal model estimates for each trait. Marginal maximum likelihood (MML) estimates were obtained with an expectation maximum-like procedure (Hoeschele et al., 1987). Method R (MR) estimates were obtained from regression of low on high accuracy threshold model genetic predictions (Reverter et al., 1993), using random 50% subsamples of observations to obtain low accuracy predictions. Year of birth was included as a fixed effect in these analyses.

Table 1. Stayability traits examined in within-herd analyses.

S(3|2)	probability of a cow having two calves by three years of age, given she first calved as a two-year-old
S(6|2)	probability of a cow having five calves by six years of age, given she first calved as a two-year-old
S(9|2)	probability of a female having eight calves by nine years of age, given she first calved as a two-year-old
S(12|2)	probability of a female having eleven calves by twelve years of age, given she first calved as a two-year-old

The MML procedures yielded heritability estimates on the underlying scale ranging from .02 for S(3|2) in BIC to .20 for S(12|2) in BSF (table 2). Expressed on the binary scale of observation, the estimates are within the .01 to .15 range of heritability estimates for stayability in dairy cows (Schaeffer and Burnside, 1974; Hudson and Van Vleck, 1981; Van Doormall et al., 1985; DeLorenzo and Everett, 1986). Consistent with results from comparison of MML and MR using simulated data (Snelling, 1994), MR estimates were higher than the corresponding MML estimates. In one case, S(12|2) in BSF, MR did not yield an estimate of heritability, perhaps due to the sampling strategy employed.

Table 2. Within herd heritability estimates for stayability of beef cows .

Estimation Procedure	Trait	Herd BSF	Herd BIC
MML	S(3|2)	.09	.02
	S(6|2)	.11	.14
	S(9|2)	.07	.09
	S(12|2)	.20	.07
MR[a]	S(3|2)	.211.04	.031.01
	S(6|2)	.121.03	.221.01
	S(9|2)	.161.02	.191.04
	S(12|2)	NA	.191.02

[a]Mean and standard error of five random 50% subsamples.

Predictions of genetic merit

Threshold model procedures were used to predict genetic merit with single trait animal models. Within herd predictions were made using both MML and MR heritability estimates. In both herds, rank correlations between predictions using the MML heritability estimate and the corresponding MR estimate were .98 or greater. The value of the heritability estimate had greater influence on scale of solutions than on the relative merit of individual animals.

Genetic merit for a stayability trait was also predicted for all animals in the 1994 Red Angus Association of America (RAAA) national cattle evaluation (NCE). The trait considered in this analysis was S(6|5), the probability that a cow would calve at the age of six or later, given she had a calf at age five or earlier. This is similar to S(6|2), without the requirement that cows calve every year to stay in the herd. This requirement was not enforced to allow for incomplete reporting of calves to the association.

Expected progeny differences (EPD) for S(6|5) were obtained from a threshold model analysis that included the fixed effect of contemporary group and the random effect of animal. Contemporary groups were based on birth year and breeder of cow, and breeder of her calves through five years of age. Animal solutions on the underlying scale were transformed to the percent probability scale and EPD expressed as deviations from a 50% probability. Relationships between these EPD and birth weight (BW), direct weaning weight (WW_d), maternal weaning weight (WW_m) and yearling weight (YW) EPD were examined.

The range of S(6|5) EPD among RAAA sires was from -11.8 to 14.2, so the sire with the highest S(6|5) EPD should have almost thirty percent more daughters in production at six years of age than the sire with the lowest EPD. Sires ranking in the top 20% for S(6|5) had similar ranges of BW, WW_d, WW_m and YW EPD as all sires, regardless of S(6|5) EPD (table 3). This suggests stayability EPD may be included in selection criteria without limiting selection for other EPD. Of animals meeting desired criteria for other EPD, those with low stayability EPD may be eliminated from consideration.

Genetic and environmental trends for S(6|5) in the RAAA population indicate a decline in mean contemporary group effects with an increase in mean genetic merit over time (figure 1). While highly variable from year to year, the general decrease in environment indicates increased culling pressure on young cows. From the 1950's until about 1970, year to year change in mean EPD of animals born each year was essentially zero. A gradual increase in genetic trend began about 1970, corresponding to the time practices such as culling open cows and fertility testing bulls became prevalent.

Table 3. Ranges of other EPD among all sires and sires ranking in the highest 20% for S(6|5) EPD.

Trait	Sires	Minimum	Maximum
Birth Weight	All	-10.0	13.7
	Top 20% S(6|5)	-10.0	13.7
Weaning Weight direct	All	-40.1	70.4
	Top 20% S(6|5)	-24.6	70.4
Weainig weight maternal	All	-34.0	31.1
	Top 20% S(6|5)	-27.7	31.1
Yearling Weight	All	-63.6	109.0
	Top 20% S(6|5)	-38.1	109.0

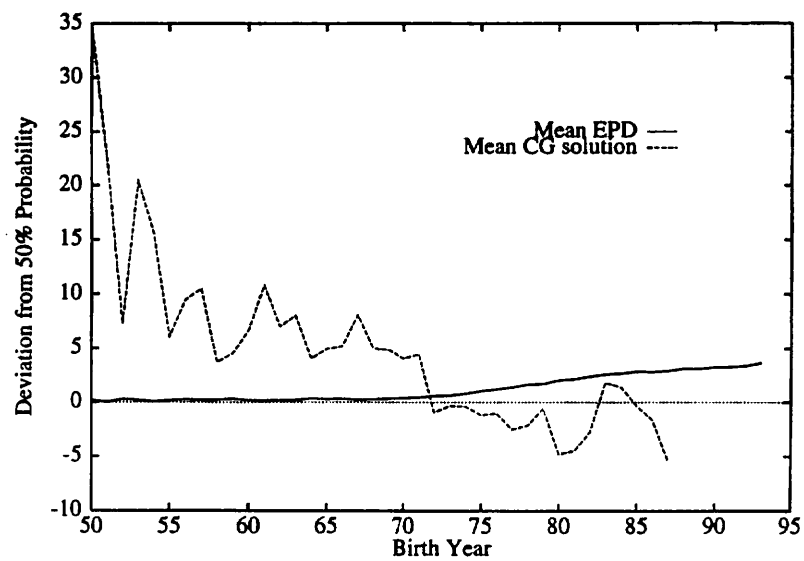


Figure 1. Mean stayability EPD and contemporary group effects by birth year.

Stayability as a measure of reproduction

The stayability traits discussed in this paper provide a measure of fertility by indicating a cow's ability to produce calves for a number or years or after a specific age. The traits considered in within-herd analyses, S(3|2), S6|2), S(9|2) and S(12|2), reflect success or failure to produce a calf every year for the required number of years. The trait considered for the RAAA analysis, S(6|5), does not provide as clear a measure of fertility since cows were not required to have a calf recorded every year to receive a successful observation. As a measure of reproduction, this trait depends on cows being culled for reproductive failure. A cow would be unlikely to be in production at age six without producing several calves, even if some of her calves were not reported to the RAAA. While reproductive failure is the primary reason for culling (Greer et al., 1980; Nunez-Dominguez et al., 1991), the influence of other reasons for culling on stayability evaluations should be studied.

Measures of stayability have economic implications. Except under extremely favorable conditions, a cow cannot pay for her development and maintenance costs with a single calf. Under more typical conditions, five or more calves in consecutive years may be required for a cow to break even (table 4). For a herd to be profitable, enough cows must produce calves past their breakeven age to compensate for those cows that were culled after raising only one or two calves. Stayability to the breakeven age may be useful for genetic prediction of the probability of producing profitable daughters.

There is a trade-off between the age considered and amount of information available for genetic prediction of stayablilty. Earlier ages have the most information available, since more females have had the opportunity to reach that age. Less information is available for later ages with fewer females old enough to receive an observation. While stayability to older ages indicates greater profitability, the loss of available information results in less reliable and possibly less valuable genetic predictions. The most appropriate stayability trait may represent a balance between sustained reproduction to an age near breakeven and the reliability of genetic predictions for stayability to that age.

Table 4. Breakeven ownership period of a cow (years).[a]

Replacement Heifer Value	Salvage Value	Net Return/Cow[b] $50	$100	$150
$500	$400	4	2	1
	450	2	1	1
	500	1	1	1
$600	$400	8	3	2
	450	6	2	2
	500	5	2	1
$700	$400	14	5	3
	450	12	4	3
	500	10	3	2

[a]Dalsted and Gutierrez, 1989.
[b]90% weaning rate and 5% discount rate.

Implications

Stayability may indicate a cow's ability to continue to reproduce for a number of years. Stayability may be measured using pedigree and birth date information, allowing genetic prediction of reproductive ability using historical data. Heritability appears sufficient to allow meaningful selection decisions using genetic predictions for stayability. Animals with high stayability EPD represent a wide range of EPD for other traits, so stayability may be incorporated into existing criteria without restricting selection for other EPD. Areas for further study include quantifying the value of stayability to different ages, determining the most appropriate age(s) for within-herd and national evaluations, and examining the influence of culling for reasons other than reproductive failure.

Literature Cited

Dalsted, N. L. and P. H. Gutierrez. 1989. How long do you keep her? BEEF. Spring 1989. p. 15.

DeLorenzo, M. A. and R. W. Everett. 1986. Prediction of sire effects for probability of survival to fixed ages with a logistic linear model. J. Dairy Sci. 69:501.

Gianola, D. and J. L. Foulley. 1983. Sire evaluation for ordered categorical data with a threshold model. Genet. Sel. Evol. 15:201.

Greer, R. C., R. W. Whitman and R. R. Woodward. 1980. Estimation of probability of beef cows beind culled and calculation of expected herd life. J. Anim. Sci. 51:10.

Harville, D. A. and R. W. Mee. 1984. A mixed-model procedure for analyzing ordered categorical data. Biometrics 40:393.

Hoeschele, I., D. Gianola and J. L. Foulley. 1987. Estimation of variance components with quasi-continuous data using Bayesian methods. J. Anim. Breedg. Genet. 104:334.

Hudson, G. F. S. and L. D. Van Vleck. 1981. Relationship between production and stayability in Holstein cattle. J. Dairy Sci. 64:2246.

Notter, D. R., L. G. McFadden and J. A. G. Bergmann. 1993. Relationship between yearling scrotal circumferance and measures of female reproduction in Angus cattle. Proc. Beef Improvement Fed. Asheville, NC.

Nunez-Dominguez, R., L. V. Cundiff, G. E. Dickerson, K. E. Gregory and R. M. Koch. 1991. Heterosis for survival and dentition in Hereford, Angus, Shorthorn and crossbred cows. J. Anim. Sci. 69:2188.

Reverter, A., B. L. Golden, R. M. Bourdon and J. S. Brinks. 1993. Method-R: Regression algorithm for REML of estimated variance components. J. Anim. Sci. 71(Suppl. 1):96. (Abtsr.).

Schaeffer, L. R. and E. B. Burnside. 1974. Survival rates of tested daughters of sires in artificial insemination. J. Dairy Sci. 57:1394.

Snelling, W. M. 1994. Genetic analyses of binary stayability measures of beef females. Ph.D. Dissertation. Colorado State Univ., Fort Collins.

Van Doormaal, B. J., L. R. Schaeffer and B. W. Kennedy. 1985. Estimation of genetic parameters for stayability in Canadian Holsteins. J. Dairy Sci. 68:1763.

YEARLING SCROTAL CIRCUMFERENCE PREDICTION EQUATION AND AGE ADJUSTMENT FACTORS FOR VARIOUS BREEDS OF BEEF BULLS

J.M. Geske[1], R.R. Schalles[1], K.O. Zoellner[1], and R.M. Bourdon[2]

[1]Dept. Animal Science and Industry, Kansas State University, Manhattan
[2]Dept. Animal Science, Colorado State University, Fort Collins

ABSTRACT

Scrotal circumference (SC) measurements and other data were collected on 4,218 bulls born in the spring of 1991 of breeds Angus (AN), Red Angus (AR), Brangus (BN), Charolais (CH), Gelbvieh (GV), Hereford (HH), Polled Hereford (HP), Limousine (LM), Salers (SA), and Simmental (SM). The bull calves participated in selected on-farm and central bull test stations. The objectives of the study were to determine scrotal circumference growth curves, develop 205 and 365 day age adjustment factors for SC, and derive a 365 day SC prediction equation based on adjusted 205 day SC.

Adjustment factors for 205 day SC are .0856, .0585, .0861, .0767, .0839, .0416, .0969, .0465, .0594, and .0854 cm/d for AN, AR, BN, CH, GV, HH, HP, LM, SA, and SM respectively. Adjustment factors for 365 day SC are .0374, .0324, .0708, .0505, .0537, .0425, .0305, .0590, .0574 and .0543 cm/d for AN, AR, BN, CH, GV, HH, HP, LM, SA, and SM respectively. The 365 day SC prediction equation is: YRSC = adj205SC * B. The B-values for each breed are presented. Using this equation, the 205 day SC necessary to reach 32 cm at yearling was determined. Age of dam adjustment factor for 205 day SC is +.8 cm for 2 and 3 year old dams. For 365 day SC, the age of dam adjustment is +.6 cm for 2 year old dams.

(key words: beef cattle, scrotal circumference, age adjustment)

INTRODUCTION

Previous research has indicated an important relationship between yearling scrotal circumference of beef bulls and some male reproductive traits. Martin et al. (1992), and Brinks (1983) reported SC to be favorably correlated with the semen traits: sperm motility (.25), percent normal sperm (.58), percent primary abnormalities (-.51), percent secondary abnormalities (-.42), semen volume (.29), sperm concentration (.46) and total sperm (.42). Similar results were reported by Gipson et al. (1985). Lundstra (1982) who found SC to be useful in determining age at puberty in males. The Society of Theriogenology recommends a minimum of 30 cm SC for yearling bulls to insure satisfactory reproductive performance. Many cattleman prefer bulls with at least 32 cm SC at yearling.

Scrotal circumference is also favorably correlated with age at puberty and performance of female offspring. Brinks (1983) reported the genetic correlation between SC of yearling bulls and age at puberty of heifers to be -.71. Similar results were found by Smith et al. (1989).

In addition to reproductive traits, SC is also associated with growth and performance. Birth weight, weaning weight, yearling weight, height and gain were all found to be positively associated with SC by Bourdon and Brinks (1986). These results were supported by Kriese et al. (1991). Smith et al. (1989) also found weight traits to be positively correlated with SC.

Scrotal circumference has been reported as moderate to highly heritable (.38 to .69) by Blockey et al. (1978), Bourdon and Brinks (1986), Coulter and Keller (1979), Latimer et al. (1982), Lundstra et al. (1985), Neely et al. (1982), Smith et al. (1989) and Vogt et al. (1987). There is considerable variation in SC, within and among breeds. Baker et al. (1982), Blockey et al. (1978), Coulter and Keller (1979), Latimer et al. (1982) and Vogt et al. (1984) found mean SC in AN and HP to have ranges of 35-37 cm and 33-35 cm respectively. Coulter and Keller (1979), Latimer et al. (1982) and Vogt et al. (1984) found mean SC in SM to range from 37-39 cm.

Because of the high cost of developing bulls from weaning to yearling, it would be desirable to be able to identify individual bulls at weaning that would have a less than desirable SC at yearling. A limited amount of information indicates a high relationship between weaning and yearling SC. In order to determine the minimum weaning SC, the growth rate from weaning to yearling must be determined.

The objectives of this project were to determine a SC growth curve, develop 205 day and 365 day SC age adjustment factors for SC, and derive a 365 day SC prediction equation based on adjusted 205 day SC.

MATERIALS AND METHODS

Scrotal circumference measurements, and other data, were collected on 4,218 bulls born in the spring of 1991. The breeds represented included Angus (AN), Red Angus (AR), Brangus (BN), Charolais (CH), Gelbvieh (GV), Hereford (HH), Polled Hereford (HP), Limiousin (LM), Salers (SA), and Simmental (SM). Bull calves participated in selected on-farm and central bull tests starting in the fall of 1991. Three SC measurements were taken, at the start of the test, midway through, and at the end of the test. At each SC measurement, weight and date were also recorded. The cooperating tests were responsible for obtaining all weights and measurements. The procedure for taking SC measurements as described in the Manual for Breeding Soundness Examination of Bulls (J. of Theriogenology) was followed. Other information collected, when possible, included location of test, pedigree information, age of dam.

The SC growth curves were developed by breed using the non-linear model $SC=B*(1-e^{-C*age})$. Where B is equal to SC at age infinity, C is a function of scrotal growth, e is the base of natural logrithums and age is in days.

The 205 day SC adjustment factors were developed using least squares analysis, by breed, while limiting the age range from 160-250 days. The model included contemporary group as a fixed effect, and age as a regression. The adjustment factor is a result of the linear regression of age on SC. The procedure for the 365 day SC adjustment factor was identical except the age range was 320-410 days.

A 365 day SC prediction equation, based on adj205SC, was developed by the regression of adj365SC on adj205SC. The prediction equation : YRSC = adj205SC * B; where YRSC is the predicted yearling SC, and B is the regression coefficient for each breed.

Least squares procedure was used to determine an age of dam adjustment factor for both 205 and 365 day SC. The age range was again limited, as with the age adjustment factors, to 160-250 for 205 day SC and 320-410 for 365 day SC. The model included contemporary group, breed, age of dam, and age of calf. The age of dam (AOD) was grouped into five category: 2, 3, 4, 5-8, and 9+ year old dams. For 205 day SC, the effects of 2 and 3 yr old dams were not significantly different from each other; nor were the effects of four year old and older dams significantly different from each other. The 2 and 3 yr old dam effects were different from the older dams. The procedure was repeated using only two classes for AOD (2 & 3 yr olds, and 4+ yr olds). For 365 day SC, the effects of three year old and older dams were not significantly different from each other , but were different from two year old effects. The procedure was repeated using two classes for AOD (2 yr old, and 3+ yr olds).

RESULTS AND DISCUSSION

The model , $SC = B*(1-e^{-C*age})$, was used to develop a growth curve for SC for each breed. The values obtained for B and C are as follows: AN = 51.72 and .0031; AR = 55.00 and .0027; BN = 74.43 and .0016; CH = 56.49 and .0026; GV = 52.72 and .0030; HH = 43.35 and .0038; HP = 47.54 and .0034; LM = 57.33 and .0023; SA = 80.63 and .0015; SM = 63.68 and .0023.

TABLE 1. Adjustment factors for 205 and 365 day SC

Breed	205 adj	365 adj
AN	.0856	.0374
AR	.0585	.0324
BN	.0861	.0708
CH	.0767	.0505
GV	.0839	.0537
HH	.0416	.0425
HP	.0969	.0305
LM	.0465	.0590
SA	.0594	.0574
SM	.0854	.0543

Table 1 shows the adjustment factors for each breed that would enable breeders to adjust SC measurements to 205 or 365 days of age. As indicated by the SC growth curves and the linear adjustments in table 1, SC does not grow at the same rate throughout the time period from weaning to yearling. This differs from the results of Evans and Wiltbanks (1989) who reported testicular growth to be approximately equal through 7 to 15 months of age. In that study, they were working only with Santa Gertrudis; in this study, the BN did have more uniform growth throughout than many of the non-zebu breeds.

The 365 day SC adjustments were slightly higher than other studies have indicated. Bourdon and Brinks (1986) reported a yearling SC age adjustment for Hereford bulls as .026 cm/d. Kress et al. (1994) reported age adjustment factors to be from .0308 to .0410 for five composite breeds of beef bulls. Kriese et al. (1991) reported age adjustments of .024 and .041 cm/d for Hereford and Brangus respectively. Lundstra et al. (1988) found an age adjustment of .032 cm/d for yearling bulls, with no differences among breeds.

The results of this study (for 365 day SC age adj) were much higher than those found by Vogt et al. (1984) who reported regression factors for age in days as .0073, .0072 and ..0042 cm/d for AN, HP and SM respectively. Also Gipson et al. (1985) reported age adjustments for yearling SC ranging from .0003 to .0151 for AN, HP and SM. These results were very low, but the bulls used were much older than the bulls used in most other studies. Testicular growth will slow with maturity as will growth in general.

Other studies have found age of dam to have a significant effect on SC. These adjustment factors should not be used in the prediction equations below, but rather as a means of comparing individual bulls for selection purposes. For 205 day SC, bull calves out of 2 and 3 yr old dams should be adjusted by +.8 cm. For 365 day SC, calves out of 2 yr old dams should be adjusted by +.6. These results are slightly less than previous reports. Bourdon and Brinks (1986) reported YRSC AOD adjustments for 2, 3 and 4 yr old HH dams to be .8, .2 and .1 cm respectively. Kress et al. (1994) who studied age and AOD adjustments on composite bulls reported AOD adjustments to be similar to our study. Kriese et al. (1991) found AOD adjustments for HH and BN dams. For 2, 3, 4, 5-7, and 8 yr old HH dams, the adjustments were .7, .3, .2, .2 and .3 cm. For 2, 3, 4-7 and 8+ yr old BN dams, the adjustments were .8, .4, .3 and .2 cm. Lundstra et al. (1988) reported AOD SC adjustment factors for 2, 3 and 4 yr old dams of all breeds to be 1.3, .8 and .4 cm.

The B values from the table 2 were used to estimate adj205SC necessary to average 32 cm at yearling. With the exception of the HH, the breeds were fairly similar. In general, bulls needed about 21 cm at weaning to reach 32 cm at yearling. These results are lower than those reported by Pratt et al. (1991) who suggested that AN, SM and zebu- derivative breeds needed a minimum of 23 cm at weaning; and continental (other than SM) and HP needed 26 cm at weaning to insure 32 cm by yearling.

Table 2. Regression coefficients (B) to predict yearling scrotal circumference and the weaning scrotal circumference needed to expect a yearling scrotal circumference of 32 cm.

Breed	No. of bulls[a]	B[b]	Standard Deviation	Weaning Scrotal[c] Circumference
AN	623	1.54	0.17	20.8
AR	275	1.55	0.14	20.6
BN	108	1.60	0.17	20.0
CH	280	1.54	0.16	20.8
GV	181	1.48	0.13	21.6
HH	90	1.41	0.15	22.7
HP	121	1.53	0.15	20.9
LM	68	1.60	0.19	20.0
SA	88	1.59	0.17	20.1
SM	393	1.59	0.17	20.1

[a]Number of bulls used to estimate the regression coefficients
[b]Regression coefficients. The adjusted 205 day scrotal circumference multiplied by B gives the expected 365 day scrotal circumference.
[c]The 205 day scrotal circumference needed to produce an average yearling scrotal circumference of 32 cm.

CONCLUSIONS AND IMPLICATIONS

Age adjustment factors for 205 and 365 day SC will allow more accurate comparisons between bulls. Selection for SC will become more accurate just as adj 205 day weights have made selection for weaning weight more accurate.

Since many bull buyers prefer at least 32 cm YRSC, seedstock producers could reduce costs by eliminating those bulls at weaning that would likely fail to reach 32 cm SC if they could identify them. The 365 day SC prediction equation and the table of minimum SC should serve as a guideline for producers to identify and cull those individuals.

The AOD adjustments can make comparisons involving calves out of younger dams more accurate.

LITERATURE CITED

Baker,J.H., J.R. Kropp, E.J. Turman and D.S. Buchanan. 1982. A comparison of different breeds for growth rates, performance traits and scrotal circumferences in young beef bulls. Okla. St. Univ. Ag. Exp. Sta. 112:15.

Blockey, M.A. de B., W.M. Straw and L.P. Jones. 1978. Heritability of serving capacity and scrotal circumference in beef bulls. J. Anim. Sci. 47 (suppl. 1):253.

Bourdon, R.M. and J.S. Brinks. 1986. Scrotal circumference in yearling Hereford bulls: Adjustment factors, heritabilities abilities and genetic, environmental and phenotypic relationships with growth traits. J. Anim. Sci. 62:958.

Brinks, J.S. 1983. Genetic aspects of reproduction in beef cattle. Thirty-fourth annual Beef Cattle Improvement Report and Sale data. Colo. St. Univ. Exp. Sta. San Juan Basin Res. Gen. Special Series 25:18.

Coulter, G.H. and D.G. Keller. 1979. Scrotal circumference and its heritability in yearling beef bulls. Seventy-first Ann. Meet. Amer. Soc. Anim. Sci. :288.

Evans, S.G. and J.N. Wiltbanks. 1989. Determination of minimum weaning scrotal circumference in Santa Gertrudis bulls fed a low energy ration. Theriogenology 31:309.

Gipson, T.A., D.W. Vogt, J.W. Massey and M.R. Ellersieck. 1985. Association of scrotal circumference with semen traits in young beef bulls. Theriogenology 24:217.

Kress, D.D., M.W. Tess and K.C. Davis. 1994. Age of dam and age of bull adjustment for scrotal circumference of five beef composites. J. Anim. Sci. (abstract).

Kriese, L.A., J.K. Bertrand and L.L. Benyshek. 1991. Age adjustment factors, heritabilities and genetic correlations-for scrotal circumference and related growth traits in Hereford and Brangus bulls. J. Anim. Sci. 69:478.

Latimer, F.G., L.L. Wilson, M.F. Cain and W.R. Stricklin. 1982. Scrotal measurements in beef bulls: Heritability estimates, breed and test station effects. J. Anim. Sci. 54:473.

Lundstra, D.D. 1982. Testicular development and the onset of puberty in beef bulls. Beef research progress report No. 1, U.S. Meat Anim. Res. Cen. ARS-NC-21:26.

Lundstra, D.D. K.E. Gregory and L.V. Cundiff. 1985. Heritabilities estimates and adjustment factors for yearling testicular size in different breeds of beef bulls. Beef research progress report No.2, U.S. Meat Anim. Res. Cen. ARS-42:41.

Martin, L.C., J.S. Brinks, R.M. Bourdon and L.V. Cundiff. 1992. Genetic effects of beef heifer puberty and subsequent reproduction. J. Anim. Sci. 70:4006.

Neely, J.D., B.H. Johnson, E.U. Dillard and O.W. Robinson. 1982. Genetic parameters for testes size and sperm number in Hereford bulls. J. Anim. Sci. 55:1033.

Ott, R.S. 1986. Breeding soundness examination of bulls. Dm: D.A. Morrow (Ed.) Current Therapy in Theriogenology (2nd Ed.). p. 125. W.B. Saunders Co., Philadelphia, PA.

Pratt, S.L., J.C. Spitzer, H.W. Webster, H.D. Hupp and W.C. Bridges Jr. 1991. Comparison of methods for predicting yearling scrotal circumference and correlations of scrotal circumference to growth traits in beef bulls. J. Anim. Sci. 69:2711.

Smith, B.A., J.S. Brinks and G.V. Richardson. 1989. Relationship of sire scrotal circumference to offspring reproduction and growth. J. Anim. Sci. 67:2881.

Vogt, D.W., J.W. Massey, M.R. Ellersieck and C. Bierschwal Jr. 1984. Scrotal circumference adjustment for differences due to age of beef bulls. JAVMA 184:1125.

Vogt, D.W., T.A. Gipson, M.R. Ellersieck and J.W. Massey. 1987. Genetic and phenotypic parameter estimates for scrotal circumference and semen traits in young beef bulls. UMC Animal Sciences Report. 114:1.

Minutes of the BIF Biotechnology Committee

June 3, 1994
University Park Holiday Inn
West Des Moines, Iowa

Chairman Burke Healey convened the first meeting of the Biotechnology Committee at 2:30 p.m. After a few opening remarks, Chairman Healey introduced Dr. Sue DeNise, Ph.D. from Arizona University to present her perspective of what the newly formed committees priorities and functions should be. Following her presentation, Dr. Daniel Pomp, Ph.D., from Oklahoma State University told the committee the challenges and priorities he saw facing the group in the immediate future. Finally, Dr. Richard Willham, Ph.D. from Iowa State University gave the group his vision for the committee from a historical perspective of the BIF.

Following the three presentations (which are included in these proceedings) a question and answer session ensued. Much of the discussion centered around methods to incorporate the participation of more molecular geneticists in future BIF Biotechnology Committee Meetings. The possibility of soliciting financial support and associate memberships from corporations involved in biotechnology within the beef industry was also discussed at length.

Several felt the Chairman should form a steering committee to help develop programs and priorities for the committee's 1995 annual meeting.

A motion was made and seconded to empower the Chairman to appoint a steering committee for the Biotechnology Committee to assist the Chairman to develop plans for the 1995 committee meeting in Sheridan, Wyoming. The motion passed unanimously.

A motion was made and seconded to urge the Executive Board of Directors of BIF to send resolutions to the Beef Operating Committee, the Cattlemen's Beef Promotion and Research Board, the Beef Industry Council and the National Cattlemen's Association to allocate a percentage of the check off budget to research comparable to what the national Pork Check-off Program allocates. The motion passed unanimously.

There being no further business, Chairman Healey adjourned the meeting at 4:50 p.m.

WHERE CELLS AND COWBOYS MEET:
BIOTECHNOLOGY COMMITTEE - NEW BEGINNINGS AND PARTNERSHIPS

Sue DeNise
University of Arizona

New technologies are going to provide more information about individual animals. These technologies may impact selection decisions, market requirements, and variation in product and food safety. The information may range from genetic defects to genes that contribute to production characteristics; it may guarantee that animals contain a patented gene; or allow a contaminated meat product to be traced to its source.

In my view, the primary challenge of this committee is to encourage communication among users, identify genetic material for research, educate producers on how the information may be used, and offer advice on policy governing the control and ownership of data. There will be the potential for misuse of information or overstating its importance; and perhaps through the efforts of this committee, these problems may be minimized.

Priorities

Marker Assisted Selection - High Priority. We have the tools to identify genetic diseases and genes that contribute to quantitative traits. This information will be available to contribute to cattle management decisions in the near future. We already have examples of genetic diseases that can be identified using molecular biology tools, and we are beginning to see reports of important areas of the genome that contribute to production traits.

There are four research areas that need to be addressed before we can complete technology transfer and producers can apply these tools. Each one of these areas needs several research groups to address these questions.

1. A genetic map must be available to all researchers. This is already a reality through MARC and BOVMAP, and will become more refined as data is added.

2. Search for Quantitative Trait Loci (QTL). Accomplishing this goal requires resource populations where QTL are segregating. Several countries are already developing resource families, and existing families are being used in this way.

3. Learn about the "gene" that affects a quantitative trait: what it is, how it interacts with other genes, how it may affect the entire animal.

4. Incorporate gene effects into genetic prediction models.

Affordable Parentage Identification - High Priority. I have been convinced that this should be a high priority. Parentage identification will be an important tool for the breeder that wants to use multi-sire breeding pastures, but the use of this tool goes far beyond registration concerns.

1. DNA is unique to every animal and almost all tissues contain the identifying material. DNA can become the ultimate method of animal identification that follows an animal from conception to the supermarket, and ties it to all animals that share the same genes.

2. In the absence of other methods of selection, it could be used to identify sires of market animals with undesirable carcass characteristics. Undesirable carcasses could be identified in the plant, a tissue sample taken, DNA extracted, and parentage assigned. It would require that sires' DNA be maintained in a bank (semen sample, ear notch, or other tissue).

3. Because DNA is unique to every animal, it is possible that sources of microbial and other types of contamination of meat products could be identified. A sample of DNA from a contaminated meat product could be used to track its movement through the system: from producer to feedlot to packer and beyond. The source of contamination could be tracked to its origins where perhaps it would be possible to remove the contamination before it comes into contact with food products.

Advise on Social and Legal Issues that the technology will create - High Priority.

1. Patenting will be a major hurdle in the affordability of this technology in the near future. Markers and genes are already being patented, and the effects of these moves are as yet unclear. At a minimum, it reduces communication among researchers; and at worst, it will increase the cost of the technology beyond the reach of the producer.

2. Consumer confidence in the product produced using these tools will also be a concern. It will require education of producers and consumers to overcome fears.

3. Associations of producers must define policy concerning the use of genetic resources. Who owns the DNA? The association? Breeder? Owner? The laboratory running other DNA analyses? Will the data be owned by the association or the owner? Will the information be made generally available?

Transgenic Animals - Low Priority. Are transgenic animals going to be an important part of livestock production? My opinion is that unless the public perception changes toward transgenics, it will not be an important tool in livestock production.

What can this committee do today?

1. Help set priorities on the traits that should be evaluated. The greatest benefit of the technology will be for traits that are lowly heritable and difficult to measure on the live animal. I see little need to design an experiment to study QTL for weaning weights: these weights are moderately heritable and easily measured in the live animal. Traits that should be evaluated: reproduction, milk production, fat deposition, and tenderness.

2. Identify populations of animals for research to locate important genes.

3. Encourage incorporation of information into genetic prediction models.

4. Encourage interest groups to exchange information and reduce proprietary findings. Tom Lyon, CEO of Cooperative Resources International, stated at the annual meeting of the Wisconsin Federation of Cooperatives (November 15, 1993),

> "Let the experience of cattle (dairy) breeding be a lesson to others buying into the idea of our country's economic future being secured through the exportation of technology. The lag

time will be short if the importer has access to large amounts of strategically-placed capital."

By working together for a common cause, we can make more progress than if every research group is competing for patent protection. This is not an easily resolved issue, but is an important aspect of ensuring that the technology flows to the people who can use it.

BIOTECHNOLOGY AND BEEF CATTLE IMPROVEMENT: MYTHS AND REALITIES

Daniel Pomp
Oklahoma State University

When used in the context of animal production, the term "biotechnology" is almost always followed by phrases such as "*revolutionary change*" or "*unimaginable progress*". Gene maps arrive with great fanfare and promises of a new era of enhanced profitability. The use of genetic engineering and embryo cloning promises to provide an unlimited supply of designer made cows. Images of pastures full of identical steers with half-ton weaning weights, lean, tender and flavorful carcasses, no disease and small appetites surely race through the minds of many producers. Unfortunately, the old adage proclaiming that "*its hard to fool mother nature*" has proven to be quite prophetic in relation to bringing many biotechnologies, which appear straightforward and simple in theory, to a practical and successful fruition.

There are several biotechnologies which may play important roles in future beef production practices. One that has been the recent focus of intense interest and research is marker assisted selection. The magnitude and scope of the effect of this and other technologies cannot yet be estimated with any degree of accuracy or confidence. However, with few exceptions, false expectations eventually lead to disappointment and lack of trust. This newly formed Biotechnology Committee of the Beef Improvement Federation must serve a critical function in support of development and application of biotechnology in the beef cattle industry. The Committee should accept the challenge and responsibility of understanding the technologies being developed as well as their potential payoffs and limitations. In other words, knowing what is myth and what is reality, and participating in education of the technology users.

Lessons From the Past

Lessons should be learned from past overreactions to biotechnological developments. When the first giant mice were produced in the early 1980s through the use of transgenesis, it was commonly predicted that within 10 years, the manner in which animal agricultural products would be produced would be completely revolutionized. Nearly 15 years later, the impact of transgenics in animal agriculture is almost non-existent. The combination of a lack of technological efficiency, high expense of research and development, unforeseen complexities in regulation of inserted genes, and public opposition to genetically engineered food products has left this once promising advancement in a state of uncertainty. In contrast, the single biotechnology that has had perhaps the greatest effect on genetic improvement, and one which is unlikely to be paralleled in magnitude in the near future, is the ability to cryopreserve semen and utilize artificial insemination. When the power to greatly increase selection intensity was combined with advancements in statistical and quantitative genetic theory and increased computing power, a true revolution in animal breeding occurred.

It's a Complex System

The main reason why transgenics, and perhaps marker assisted selection for production traits, will prove to be an extremely difficult task is that we are dealing with an exceptionally complex and highly regulated system. There are nearly 3 billion individual pieces of genetic information in every cell of a cow. These 3 billion components are responsible for the production of many thousands of proteins (enzymes and hormones), that act on their own or in concert with each other, under the watchful eye and long arm of the environment. Even if data existed that implicated a particular enzyme or hormone in the control of a trait of interest, that by no means predicts that the gene responsible for producing that enzyme or hormone is a gene that controls that trait. It could just as well be a second or third or fourth or even a fifth gene that is interacting with the primary gene to determine the enzyme or hormone level and hence the phenotypic expression. Traditional selection has been successful because it does not rely on the need to know exactly which genes are responsible and what these genes control. When a superior bull is selected based on performance records it is simply assumed, and correctly so, that the good genes are being selected.

As if this genomic complexity was not enough of a roadblock, we are faced with the fact that most traits of interest in a production setting are quantitative in nature. Current methods of genetic evaluation assume that many genes play a role, but each with a small effect. While there are high hopes that single genes will be found that dramatically affect production traits (i.e. a "marbling gene" or a "tenderness gene"), currently there are little if any data that help support this notion. Unless such genes with large effects are found and characterized, marker assisted selection may not prove as useful as many expect. Furthermore, it can easily be argued that if genes with large, favorable effects on production traits did exist, they would likely have already been fixed in populations through the course of many generations of traditional selective breeding.

Environment Clouds the Situation

One frequently stated myth is that the use of DNA markers in genetic selection will reduce the importance of environment in beef production. The thought behind this statement is based on the truth that environment (i.e. nutrition, housing etc.) does not affect the physical structure of the DNA. Thus, we will be able to tell whether a cow has good or bad forms of genes regardless of effects of environment on expression of its phenotype. Unfortunately, environment will play a critical role in detection of which genes, and which forms of genes, are good or bad, and will always help to determine how much of the genetic advantage actually is expressed in the phenotype.

Traditional animal breeding dogma assumes that selection should be practiced in the same environment in which the selected animals will be expected to perform. This will also be extremely important when considering efforts to identify markers or genes for use in marker assisted selection. A marker that is found to significantly affect tenderness may only be useful for animals that are raised and slaughtered under similar conditions (i.e. sex, age, diet) to those used in the initial study. This complication means that many investigations will be needed to identify significant markers and their affects across several levels of conditions before they can be applied on a wide scale. One uniquely important environmental effect which must be considered, especially in regard to markers for carcass traits, is the means by which traits are measured and the accuracy and consistency of these measurements. Consider, for example, a scenario in which tenderness is measured a certain way and a significant DNA marker is detected that affects this measurement of tenderness. That same marker may not be useful in an operation in which tenderness is measured in a different manner or an inconsistent way. The underlying basis for this is that different genes can be expressed or not be expressed under different environmental conditions, and variation in measurement can easily simulate this effect. Tenderness is a particularly relevant example, considering the huge variation that exists in genetic parameter estimates for this important trait.

Breed Differences: A Blessing and a Problem

Which DNA markers influence a trait and what their relative effects are can also be heavily dependent upon the breed being utilized. This complication is probably even more important than the influence of environment. There is already a growing body of evidence, in both cattle studies and especially in mouse studies, suggesting that the same trait can easily be affected by completely different DNA markers, depending upon the breeds or lines being evaluated. In other words, a DNA marker that significantly affects yearling weight in Herefords may have little or no affect in Angus or other breeds. Even more disturbing is the fact that while a single marker may affect a trait in two different breeds, the form of the gene that is good in one breed may be the bad form in another breed. In addition, some DNA markers may be useful within a breed because the the good form of the marker is at a moderate frequency where it can be increased efficiently, while in another breed the frequency of the good form of the marker may be too low or too high to warrant its use in a selection program. Again, the take-home message here is that marker effects must be evaluated within and across a wide variety of genetic backgrounds, with an emphasis on those breeds that are most heavily used or with the most economic significance. This poses a problem because studies to identify marker effects rely upon the crossing of breeds or lines that are as unrelated or different as possible.

While good forms of genes may be present in one breed and not in a different breed of interest, we may also face a scenario within a population where a useful marker is identified in an individual who is not superior for a composite genotype. In species with shorter generation intervals, it may be possible to move genes from one population (or animal) to another through introgression methods (many generations of backcrossing while monitoring the marker). In cattle this is unlikely to be adopted due to time constraints. Despite a general milieu of negative feelings towards transgenic technology in food animal agriculture, it may be one of the only tools available for efforts to transport forms of genes across populations of cattle. Research geared towards improvement of technological efficiency in this area should be continued, with an emphasis on gene targeting via homologous recombination in embryonic stem cells.

Utilizing the Information

If all of these roadblocks can be overcome and DNA markers are developed that may help identify animals with superior genetic merit, there still would be several serious obstacles preventing efficient use of this new information. At present there is no consensus as to how data on DNA markers will be incorporated into genetic improvement schemes, although a few working models have been developed. It would seem logical to combine new information such as marker genotype with performance records of individuals and relatives into a single value such as an EPD. DNA markers will never have the power to completely replace phenotypic information in selection for production traits. They will simply make EPDs more accurate and thus increase the efficiency of selection and the progress achieved. The mechanisms for accomplishing this still remain to be investigated and determined.

Assuming that DNA marker information will be disseminated through incorporation into EPDs, the result would be that the greatest benefit of DNA markers would be for improvement of seedstock. It would therefore follow that an increase in selection intensity, primarily through increased use of AI, will be necessary in order to reap the additional benefits provided by marker assisted selection. If DNA markers are to be useful in crossbreeding systems, it will also be important to understand how different forms of a gene interact with one another (i.e. dominance relationships).

Needs and Priorities

This discussion of the difficulties and potential pitfalls involved in identifying useful DNA markers is not intended to promote pessimism, but rather realism. There is no doubt that DNA markers will be successfully developed for selection of qualitative traits such as horns, coat color and those diseases or defects that are caused by single or few genes. In addition, DNA markers are already available for accurate identification, or fingerprinting, of individuals. What does remain in doubt, however, is whether DNA markers will be successfully developed for selection of quantitative traits, which incorporate almost every attribute of economic importance in cattle. Personally, I am optimistic that marker assisted selection will become a useful tool in the future beef cattle industry. However, it is important that false expectations do not lead to disappointment and lack of support and enthusiasm for development of the technology.

The recently announced development of preliminary gene maps for cattle was truly a breakthrough, and one that was necessary in order to begin searching for DNA markers linked to production traits. However, these preliminary maps, while perhaps sufficient to potentially identify general regions of chromosomes that contain production trait genes, do not have nearly enough power to identify DNA markers that would be useful in breeding programs. It is important to realize that despite the fanfare, these gene maps are not finished, and much further support is needed to continue to develop the maps and achieve greater saturation with DNA markers. This will be required to facilitate attempts to identify the actual genes that form the underlying basis for variation in quantitative traits.

The greatest need at present is for development and organization of the proper populations of cattle that will be used for testing effects of DNA markers on production traits. It is often assumed that simply having access to cattle and their production records is all that is required to identify markers linked to traits of interest. In reality, two full generations of well designed matings are required to generate a population that is segregating for both phenotype and marker genotype. In addition, very large populations (at least 200 to 1000 cattle) with optimized mating structure are required to identify genes that have even a moderate effect on a trait. As discussed above, several such populations will be required if markers with broadly-based effects are to be found and utilized in the industry.

Not only is there great expense involved in development of such extensively organized and large populations of cattle, the expense of measuring phenotypes and genotypes may be even greater. With few exceptions, individual laboratories and research programs will have little if any chance to develop and evaluate such populations. Because of this, much research effort is currently being placed on marker evaluation within existing populations that are not optimally designed (either in size or structure). Broadly based collaborations will be required, and funding from industry will likely be necessary to supplement federal and state grant support.

There is also a need for industry consensus as to which traits should be targeted for improvement via marker assisted selection. Due to the great expense and difficulties discussed above, it may not be possible to attempt to identify useful DNA markers that for a wide variety of traits. Emphasis should certainly be given to traits that are currently difficult to improve, such as reproduction and health. In addition, emphasis should be placed on traits that, while conducive to improvement via selection, may be difficult or expensive to measure, such as carcass quality and efficiency of lean growth. It is very important to keep in mind that even if DNA markers are developed to assist in selection for these traits, performance records will still be critical informational components in a selection program. Implementation of priorities for marker assisted selection should not come at the expense of development of sire evaluation programs for traits such as carcass quality. This would be akin to forsaking a method that is tried and true for one that has no guarantee of success.

Implementation of technologies such as marker assisted selection faces a combination of problems that are somewhat unique to the beef industry. These include a great number of breeds, many different traits of economic importance, lack of a centralized dissemination structure, use of extensive and often highly variable production practices and environments, variability in phenotypic and product evaluation, and a biological limitation of low reproductive rate and long generation interval. The beef industry will need to learn lessons from competing industries such as swine, where populations designed for developing useful DNA markers are much easier to create and evaluate, and dairy cattle where emphasis can be placed on one or two breeds and traits, and where an extremely organized and developed infrastructure exists for recording and evaluating information and disseminating genetic gain.

BIF Biotechnology Committee

Biotechniques such as cloning, genetic engineering, DNA fingerprinting, marker assisted selection and embryo freezing, sexing and transfer, are among the many that seemingly offer a menu of choices for beef cattle improvement in the future. Unfortunately, information regarding the status and true applications of many technologies is not always complete or accurate. My comments in this paper are an attempt to focus in on one of these techniques, namely marker assisted selection, which is currently the primary focus of biotechnology research as applied to beef cattle and one of unique interest to producers. I have attempted to present a realistic viewpoint as to the potential difficulties that exist in development and utilization of this technology towards the improvement of production traits in cattle.

Organization of this Biotechnology Committee within the Beef Improvement Federation is an important first step towards creating an environment of understanding, coordination and implementation of efforts to utilize new technologies towards the common goal of genetic improvement of beef cattle. The Biotechnology Committee can play an important role in education of producers and consumers on the potential uses, payoffs and limitations of biotechnologies. This education should be based on input from both science and industry and their interaction, and could utilize many formats at differing levels of sophistication, from newsletters to conferences. The Biotechnology Committee can also help facilitate research and development of technologies by identifying and organizing sources of funding, and by coordinating collaborative efforts amongst molecular geneticists, quantitative geneticists, economists and producers.

DREAMS:
Priorities and Functions of the Biotechnology Committee

R. L. Willham
Iowa State University

Dreams were important in 1968 when the Beef Improvement Federation was created out of the dust cloud stirred up at the Denver meeting. That dreams could become realities so quickly defied our imagination. In fact, the technology for EPDs was not yet in place in 1968. But by 1972, national sire evaluation for breeds was a reality and in 1985, national cattle evaluation replaced it. By standards of today, those four years to NSE and the thirteen to NCE are a long time. Once technology adoption begins, it accelerates such that discovery and application almost merge, making the development of appropriate technology difficult. Little time is available to ascertain the social change that always results from the use of new technology. This is where we find ourselves; we are in the midst of a molecular genetic explosion with a somewhat different agenda than was true when quantitative genetics was called on to make genetic predictions in the beef industry. Proprietary rights and the necessity for laboratories are examples. The use of new, appropriate technology from molecular genetics can benefit the beef breeder, who is willing to adapt, but profound social changes in the beef breeding segment of the industry will occur. Today is exciting and need not be without reward!

The PURPOSE of this paper is to examine the priorities and functions of this new standing committee, biotechnology, created by the board of directors of BIF in late 1993. The questions to address concern what this committee can do to participate in the creation of the future for our beef industry.

BASICS

Some basic definitions are in order, not that these cannot be changed because we are the Beef Improvement Federation. BIF is a federation of organizations of the beef industry dedicated to the evaluation of performance and its use in the beef population. It is through these organizations that changes have been made. But, the orderly transition from old technology to new technology utilization has been the singular accomplishment of our BIF in its 26 years of existence. This was achieved through the committee structure of BIF that developed the guidelines and that were published in six editions. Orderly transition became the rule.

Along with the publication of the guidelines, the symposia conducted at the annual meetings of BIF have created a special interface between the researchers and the beef breeding leadership of the industry. These were where ideas and results of research were welded into workable programs with creative dialogue. Often programs were designed and implemented by member organizations in short order. Then program results were shared within the BIF structure such that the best particular program became the industry rule. This sharing among competitive groups has made BIF.

The use of breed loyalties in national sire evaluation programs allowed change to be embraced at a fast rate without destroying some of the social fabric of the beef industry. The introduction of new technology brings about social change, but never has a new technology had the capacity to create such change in industry structure as molecular genetics. To date, BIF has operated as an agent of change and should remain such! This was why it was hard to stop and write the history, when BIF meetings have focused on the future.

PROPOSAL

Now, we are in a position to examine a set of proposed functions for the biotechnology committee and suggest their priorities. The functions of the committee are presented in a priority order of operation not really on the importance of the function to participate in the creation of the future of our beef industry.

1. DESIGN AND DEVELOP A WORKING COMMITTEE: This obviously is the first order of business. As with the genetic prediction committee, this committee must have a contingent of molecular geneticists that are actively engaged in relevant research in the field. This needs to be a solid core of dedicated scientists that are aware of the fact that their expertise will be necessary to help implement their work and that of others for the beef industry. Then there must be a solid group of industry leaders that can dream with the proposers and yet temper the development of sound programs with simplicity and sound judgment. To acquire a good interactive mix of committee members is an essential first step and possibly the most important because from the deliberations will flow the results of the committee activity.

2. DESIGN AND DEVELOP AN INFORMATION GATHERING FUNCTION: Hopefully, the core of molecular geneticists working in the committee will have the breadth of knowledge to suggest where exciting opportunities are being researched and just who are the researchers involved. Even with this, one of the primary functions of the committee should be to keep in touch with the front-line research and development. Industry leadership on the committee should have the insight to see the possible value of an avenue of research for the beef industry. This function could start each meeting of the committee.

3. ORGANIZE AND CONDUCT SYMPOSIA AND WORKSHOPS: To do this function will require some work for designated committee members. Each year of operation should bring new ideas for a symposium at the annual meeting with what is now in biotechnology. To organize a symposium of merit and especially one with focus needs serious attention. This is where the excitement of discovery can be shared with the leadership of BIF. But the

time will come in short order to conduct workshops where in depth study can be given to the development of sound programs that utilize biotechnology. Several general topics for symposia and workshops come to mind immediately. They are as follows:

a. Consideration of a particular biotechnology and its impact on the best interests of the beef industry.
b. Study of the structures of utilization for a particular biotechnology. Is there more than one way to utilize a given technology and if so, which has the best opportunity to move the beef industry in the desired direction?
c. In concert with genetic prediction, facilitate uniform record development so the information can be used for bringing about genetic change. Much coordination and thought needs to go into this area. There is no need to have several record systems when one can be developed to serve the interests of the beef industry.
d. Consideration must be given to the possible social changes coming about by the use of biotechnology. We know change in industry will occur, but how will it affect the various social groups such as breed associations, etc. We can be ready with opportunities rather than ---- I did not think that would happen!

4. SOLICIT NEW ORGANIZATIONS AS BIF MEMBERS: Our BIF has as members many organizations with interest in beef performance rather than actually running a performance program. We need to be ready to include organizations that are involved in biotechnology. In this way, we can better understand the course of events that will transpire. It may be of great use for the groups, as part of a corporation or an entirely new one, to belong to BIF.

5. VALUATE RESEARCH PROGRAMS AND FACILITATE SUPPORT: As the committee develops, evaluation of research programs, especially at universities, can be done with the help of the core experts. BIF at present has no money to support research, but with the leadership of the beef industry being involved in BIF, the opportunity exists to facilitate support. This is a partial incentive to acquire the participation of a core of experts in the committee.

6. COORDINATE WITH GENETIC PREDICTION AND INTEGRATED GENETIC SYSTEMS COMMITTEES: In particular, the development of the best record system requires coordination with other committees. In this way, BIF can serve again in the orderly transition to new technology use. For example, EPDs that haveinformation on QTLs are possible.

7. DEVELOP GUIDELINES: This will become the primary purpose of the committee, but much ground work is necessary. Guidelines present the rationale for doing something in a special defined way. Guidelines promote uniformity within the industry. And these guidelines may

include a write-up on the most useful technologies and their utilization. The purpose is to provide orderly transition.

SUMMARY

This concludes a partial listing of possible functions and their priorities for the Biotechnology committee. The proposed functions in a priority order include the following:

1. Design and develop a working committee.
2. Design and develop an information gathering function.
3. Organize and conduct symposia and workshops.
4. Solicit new organizations as BIF members.
5. Evaluate research programs and facilitate support.
6. Coordinate with relevant committees of BIF.
7. Develop guidelines.

The beginning of the second 25 years of BIF is as full of challenges as the first. By the simple act of initiating this committee by the board of directors indicates that BIF is still involved in creating the future of the beef industry! Thanks.

CENTRAL TEST AND GROWTH COMMITTEE
MINUTES

The meeting was called to order at 2:30 pm, June 3, 1994 by Chairperson Ronnie Silcox. Silcox introduced the first speaker Sally Northcutt, Oklahoma State University who presented a talk on Range Bull Evaluation Versus Central Gain Test. Proceedings are included and there was a lively discussion at the completion of the presentation.

Silcox then introduced the panel to discuss Beef Steer Feedout Programs. This panel included Robert Stewart, University of Georgia, Wayne Shearhart, Oklahoma Cooperative Extension Service, and Randall Grooms, Texas Agricultural Extension Service. Each participant explained the program in their respective states followed by a panel discussion. Each program was different in their implementation, but the central theme was that a sound health program is critical in the success of the program.

Following the panel discussion the floor was opened for business. John Hough with the American Polled Hereford Association moved that a list be comprised of all state sponsored feedout programs and the motion was seconded. The discussion then proceeded as to the need for such a list and it was expressed that the breed associations would be interested in obtaining the information for use in calculating carcass EPDs. Following light discussion the motion was passed and John Hough was appointed to compile the list and if help is needed to organize a committee.

Discussion then followed about possibly standardizing the way data is collected by the states to assist in submitting information to breed associations and for the possibility of a national data base, on state feedout programs. The need for BIF guidelines to assist states getting into feedout programs was also discussed. This was followed by a motion by Darrh Bullock, University of Kentucky, to set up guidelines for conducting and reporting feedout programs, and seconded by Blair McKinley, Mississippi State University. A very active discussion followed as to the need for guidelines. Concern was expressed that states did not need to be told how to conduct programs and others suggested that these were guidelines to assist, not to mandate conformity. Question was called and the motion passed. It was decided the guidelines would be put together over the following year and presented to the committee in 1995. The guidelines will not be included in the next set of BIF Guidelines. A committee of Roger McCraw, North Carolina State University, Robert Stewart, University of Georgia, Keith Bertrand, University of Georgia, John Crouch, American Angus Association, and John Hough, American Polled Hereford Association, was appointed by the chairperson.

Silcox advised the group of the new bi-laws which state that everyone who attends a committee is a member of that committee. Silcox therefore appointed a Subcommittee for Programming. This committee consist of James Bennett, Darrh Bullock, Larry Olson, Keith Zoellner, Sally Northcutt, Larry Nelson, Roger McCraw, Wayne Wagner and Ronnie Silcox.

Old business was then presented by chairperson Silcox. This included a letter from Larry Nelson concerning ribeye area adjustments, which is being handled by the Live Animal and Carcass Evaluation Committee, and scrotal circumference adjustments which is being handled by the Reproduction Committee. A letter by James Bennett was then discussed. This letter was in response to recent criticism of Central Bull Testing and the long-term necessity of testing stations. It was pointed out by Darrh Bullock that Kentucky had replace central testing with EPD based on-farm tested sales and Robert Stewart reported that the University of Georgia was building a new testing station. Although completely different both were supported and promoted at the producer level. This concluded the old business.

Chairperson Silcox reported that he anticipated few changes in the Central Test and Growth section of BIF Guidelines. A committee of Ronnie Silcox, University of Georgia, Sally Northcutt, Oklahoma State University, and Roger McCraw, North Carolina State University are to do the revisions. Anyone interested in making changes should contact one of these individuals.

With no further business the meeting was adjourned at 5:00 pm.

Respectfully submitted,

Darrh Bullock
Secretary

GEORGIA BEEF CHALLENGE

Robert L. Stewart
Extension Animal Scientist
The University of Georgia

The Georgia Beef Challenge (GBC) is co-sponsored by The University of Georgia Extension Animal Science Department and the Georgia Cattlemen's Association. Cooperators include Hitch Feeders II, Inc., in Garden City, Kansas and USDA Market News.

Objectives

(1) Improve the marketability of Georgia-bred cattle by establishing a database of feedlot performance and carcass information.

(2) Provide educational information to Georgia cattlemen regarding the carcass merit of their cattle and establish feasibility of retaining ownership of their cattle.

Eligibility

(1) Members of the Georgia Cattlemen's Association are eligible to consign group(s) of five (5) Georgia-bred steers; priority will be given to groups sired by the same bull with known birth dates although steers from multiple-sire breeding groups are eligible. There is no limit to the number that can be entered.

(2) Steers should be a minimum of 550 lbs. at delivery, preferably heavier. They should be castrated, dehorned and healed prior to delivery. Steers should be dewormed, vaccinated (IBR, PI3, BRSV, BVD, pasteurella, 7-way Clostridium and H. Somnus) and bunk broke prior to delivery; hand feeding five to seven pounds per head daily with free choice hay for about three to four weeks is recommended. A second series of vaccinations is recommended approximately 21 days after the first.

(3) The steers should preferably be sired by a registered purebred bull that has: (A) completed a performance test in Georgia and/or, (B) EPD information available from a breed association.

(4) Beef Challenge steers must be Georgia Pride certified.

Entry

(1) A completed entry form with sire breed, individual identification number, birth date or month and breed of dam accompanied by a copy of the sire(s) regis-

tration certificate and a non-refundable deposit of $35 per animal ($175 per group) will be due August 1 (Group I) and/or October 1 (Group II). Send to Dr. Robert L. Stewart, P. O. Box 1209, Tifton, GA 31793. The deposit will be applied to costs of transportation and other test costs.

(2) Delivery points will be selected to be as convenient as possible to locations of origin. Delivery dates are targeted for the weeks of August 29 and October 24. Exact dates and locations will be announced after entries are in.

(3) Steers remain the property of the owner, who incurs any profits or losses from his(her) steer group.

(4) Feed, veterinary, yardage and any other costs will be deducted from the proceeds of the cattle at slaughter.

(5) Steers in a pen will be sold in one group when the feedlot management determines the group is ready for slaughter; the breeder will be paid the sale price times the weight of the breeder's group less all costs incurred by the group.

(6) Prior to leaving Georgia, each animal will receive an identification number, weight, and visual muscle score; an initial market value will be established by representatives of USDA Market News.

(7) Individual weights will be collected prior to slaughter. In addition, carcass data will include carcass weight, kidney-heart-pelvic fat, carcass quality grade, actual ribeye area, actual backfat, and yield grade.

(8) Final carcass value will be used to determine profitability for the purpose of the contest and will be calculated by using carcass weight, ribeye area, fat cover, quality grade, yield grade and national provisioner "yellow sheet" carcass prices; the final carcass value less costs and initial steer value will determine individual profitability; group profitability will be individual profitability times number of steers in the group; the top four steers will be used in the breeder group calculation and groups must have four steers to compete.

(9) A rotating trophy will be presented based on group profitability.

The calves are shipped from delivery points immediately after processing. Average shipping time is 27 hours (approximately 1200 miles). Upon arrival, the calves are sorted into groups based on estimated days needed on feed. The management of Hitch II determines how calves are sorted.

Consignors are kept informed on the progress of the calves as data becomes available. Intermediate weights are recorded when calves are re-implanted with a growth stimulant. Final weights are taken approximately one week before calves are marketed. Carcass data is collected through the National Cattlemen's Association Carcass Data Collection Service. Final reports are generated as each group is marketed and carcass data is collected.

Each group is marketed when Hitch II management determines the steers are ready for slaughter. Cattle are sold on a live weight basis. Consignors receive proceeds equal to the individual's final weight times pen average price minus average feeding costs for the pen. In the future, the GBC will consider methods of marketing calves and forwarding proceeds on the basis of individual carcass value.

Participation in the GBC has been excellent. Table 1 shows the number of consignors and steers for the first three years. Consignors represent all geographical areas of Georgia. The calves represent 15 breeds of sires and over 50 different combinations of breeds when breed of dam is included.

Observations on the GBC include:

(1) Superior growth genetics excel in the feedlot.
(2) Health has been good (average death loss of 1.3 percent), but could be better.
(3) Consignors have made changes in herd sires based on participation in the GBC.
(4) Frame size is much larger than expected (60-70 percent large-frame).
(5) Quality Grade is less than desired (average approximately 40 percent choice).
(6) Yield Grade is better than expected. (average approximately 55 percent YG 1 & 2).
(7) Consignors are using the data to market cattle.
(8) Lines of communication have been established between the cow-calf producer, feedlots and packers.
(9) Eyes are opened by the data.
(10) The educational value is inestimable -- to the consignors, county Extension agents, Extension specialists, feedlot personnel, etc.

Table 1. Georgia Beef Challenge Participation

	1992	1993	1994
No. Calves	157	462	813
No. Consignors	25	50	57
No. New Consignors	25	35	30

OK STEER FEEDOUT PROGRAM

Wayne Shearhart
Muskogee County Extension Director
Oklahoma Cooperative Extension Service

The OK Steer Feedout is a program for beef producers to find out how well their steers will do in a feedlot situation: both gain and carcass information. Pens of five steers are fed in a 12,000 head feedlot; Oklahoma Feeders Inc. at Coyle, in central Oklahoma. There are two feeding periods; fall calves (born August-December) are started the first week of August and come out by the first week of February. Spring calves (January-May), are started the first week of November and come out by the first week of May. The spring calves are sorted at the start into separate pens based on breed and frame size. Our recent tests have fed for a minimum of 145 days to a maximum of 187 days.

Preconditioning is highly recommended:
1) Weaned and fed 21 days (now recommend 45 days)
2) Vaccination of IBR-PI_3
3) Dewormed
4) Dehorned or tipped

The producers pay a $25 per pen entry fee before the start of the feeding period, and $500 per pen feed and processing at delivery. An additional $625 per pen is required after 60 days on feed -- a total of $1,150 per pen. The feedlot billed the feedout and we pay the feed and medicine bills two times a month. The steers remain the property of the producer.

We receive the cattle and let them stand overnight on hay and water, then we process the cattle the next morning. The feedlot vaccinates with IBR-PI_3-BVD; 7-way Blackleg; Lepto 7 and a pasturella. They are implanted, dewormed, deloused and tagged with our number. The steers are re-vaccinated with a pasturella at 10 days and 80 days. The steers are re-implanted at 80 days.

At processing, we record the breed (or cross); birthday; hip height (frame score), weight; individual steer value and take a slide picture.

We market a pen when we think 3 out of 5 (60%) will grade low choice. They are sold on a grade and yield basis at Canadian Valley Pack at Oklahoma City.

Feed costs are charged to each steer by using the Net Energy System -- which means they are billed based on weight and gain. Other expenses that are deducted are: processing and re-vaccination and re-implanting; medicine used; freight to packer; beef checkoff. These are actual costs and to figure our profit we also charged interest (at the going rate), on one-half the value of the steer and one-half the feed costs.

At the end of the feeding period, we record weight; hip height (frame score); carcass data and take a slide picture.

In our published result book, we provide the following information on each steer and pen: breed, birthday, weight, value, frame, ADG, carcass weight, dressing %, REA, fat cover, KPH, yield grade, quality grade, marbling score, tenderness, cost of gain, feed, vet-med, and profit or loss. This year, for the first time, we will be providing a tenderness score on each steer using the Warner-Bratzler shear test. We use a carcass indexing system to rank the carcasses both individually and by pen. Each steer is given 100 points to start then points are added or subtracted based on five carcass traits and their limits -- carcass weight-600-850 lbs., adjusted fat score - .25"-.39"; internal fat - 2.5%; quality grade - low choice; rib-eye area - based on HCW carcass weight requirements.

From 1983 until now we have recognized the top five steers and top five pens in 1) ADG; 2) carcass index; and 3) profit. We will now recognize pens based on consistency in four performance areas:

1. Minimum ADG of 3.00 lbs
2. Carcass weight of 650-800 lbs.
3. Quality grade of low choice or better
4. Yield grade of 2.9 or better.

We feel this will improve the program.

There are lots of educational opportunities for all beef producers. There have been producers tours to the feedlot while their cattle are on feed and visits to the packing plant have been very informative. We also present the information in the form of slide programs all over the state showing the starting picture, the ending picture, and the rib-eye picture all at the same time. We also publish all the results with names of producers and breeds. With the sponsorship of the feedlot, drug companies and feed companies, we present a program at the feedyard with live cattle evaluation as part of the program, along with current topics of interest and feedout participant participation.

The OK Steer Feedout is a very strong and educational program for us.

THE TEXAS A&M RANCH TO RAIL PROGRAM

J. C. Paschal[1] and R. Grooms[2]

The Texas A&M Ranch to Rail Program is part of the Beef Quality Excellence in Texas Program. Begun in 1991 at Randall County Feedyard near Amarillo, Texas, with 666 head of steers from 74 ranches, it was expanded in 1992 to Ranch to Rail-North (Randall County) and -South, at King Ranch Feedyard near Kingsville. A total of 1,595 steers from 152 ranches participated in that year's program followed by the 1993 program with 3,268 steers from 280 ranches.

The Ranch to Rail program is an information feedback system that was designed to allow commercial and purebred beef cattle producers in Texas (and other states) to familiarize themselves with cattle feeding and to collect feedyard and carcass data on their cattle. A minimum of 5 steers between the weights of 500-700 pounds are nominated in the fall of each year (usually by September 1). Consignors specify if their cattle will go North or South and if they will deliver their own cattle. If not, they will be assigned a delivery point where a cattle truck will pick them up and deliver them to the feedyard. The cost of trucking to the feedyard is included in the feeding costs. Consignors are also requested to fill out a brief description of their cattle (e.g. brands, breed or breed cross, etc.) and their health and management history (birth and weaning dates, etc.).

A $10.00 per head nomination fee was originally charged but it has been raised to $15.00 per head in 1994 to cover the costs of the program. The Ranch to Rail-North steers are delivered to the Texas Agricultural Experiment Station Bushland Center to be weighed, tagged, photographed, priced, processed, (health and implant), and sorted by weight, frame and muscle score. The steers are then shipped to Randall County Feedyard for a feeding period. Steers in Ranch to Rail-South are delivered directly to King Ranch Feedyard for weighing, tagging, photographing, processing, pricing and sorting. Pricing at both North and South is done by a local Federal State livestock market news reporter and prices reflect current market conditions.

All steers are individually tagged on arrival at processing so that medicine charges, death losses, rail out of "realizers" (poor doing cattle), feed costs and processing costs can be appropriately charged. All charges, processing, medicine, feed, transportation, and the Texas Beef Industry Council checkoff ($1.00 per head) and Texas Cattle Feeder Association dues ($.40 per head marketed), are carried by the feedyards at a nominal interest rate. Feedyard performance data collected or

---

[1] Associate Professor and Extension Livestock Specialist, Corpus Christi, Texas
[2] Professor and Extension Livestock Specialist, Overton, Texas

calculated includes average daily gain, feed and total costs of gain, feed efficiency (on a pen basis, dry matter and as fed) and net return. Total cost of gain includes feed cost as well as processing and medicine costs.

The cattle are sold when they reach the weight and condition desired by the industry and current market conditions on the basis of the feedyard manager's experience and the feed consumption patterns. Cattle are sorted and sold individually in truckload lots (40-45 head) rather than as pen lots. The steers are priced on the rail with the appropriate spreads for USDA Quality and Yield Grades with appropriate discounts for heavy and light carcasses, blood splash, Standards and Yield Grade 4s and 5s. The steers are purchased by Iowa Beef Processors (IBP) in Amarillo and Sam Kane's Beef Processors in Corpus Christi. Each steer is individually weighed out of the feedyard and shrunk 4%. Transportation cost to the packer is included in the Ranch to Rail-South but is a separate additional charge in Ranch to Rail-North.

The carcass data is collected in the North by West Texas State University students while the South data is collected by Texas A&M University Meat and Livestock Specialists. Every animal on the kill floor is tagged with a brisket tag. The next day (Ranch to Rail-South) or 48 hours later (Ranch to Rail-North) all of the carcass data is collected: hot carcass weight, fat thickness, ribeye area, estimated % KPH and preliminary yield grade. In Ranch to Rail-South, data is also collected on the USDA marbling score, lean and skeletal maturity, hump size and location, carcass trim and any injection sites on the neck. The carcasses are priced "in the beef" so the marbling scores and subsequent quality grades are not reported, only those assigned by the USDA grader.

The feed charges are allocated on a per head basis in each pen by knowing the total feed consumption and total head days in each pen and the number of days on feed for each steer in the pen. All other charges are already allocated directly to the individual steer. When all of the cattle in either the Ranch to Rail-North or Ranch to Rail-South program are sold, then total feedyard charges are deducted from the carcass income of each steer and the balance (original value of the steer plus any profit or loss from feeding) is remitted to the ranch consigning the steers. In addition, each ranch receives a summary on the feedyard, carcass and financial performance for each individual steer so that the end result of specific management and breeding programs can be identified.

During early May of each year, both Ranch to Rail-North and Ranch to Rail-South host field days for participants and non-participants alike to evaluate the performance of their cattle, with an update on the performance of cattle still on feed, carcasses in the plant for the field day or results from those killed earlier. Everyone in the past has been able to tour and view carcasses on the rail in the cooler at IBP and Sam Kane's. However, this is no longer possible at IBP due to insurance concerns. The participants also get an extended tour of each feedyard to look at the Ranch to Rail and other cattle and to visit with the feedyard management. The Texas Cattle Feeder's Association sponsors a beef steak lunch. In 1993 almost 1,000 people attended the Ranch to Rail-North and -South Field Days.

The Ranch to Rail program is sponsored by Texas A&M University Animal Science Department, the Texas Agricultural Extension Service, Texas Cattle Feeder's Association, Texas Beef Industry Council and the Texas Purebred Cattle Alliance (Texas based beef breed associations). Cooperators include Randall County Feedyard, King Ranch Feedyard, Iowa Beef Processors, Sam Kane's Beef Processors, and West Texas State University.

RANGE BULL EVALUATION VS CENTRAL GAIN TEST

Sally L. Northcutt
Extension Beef Cattle Breeding Specialist
Oklahoma State University

Oklahoma BEEF, Incorporated (OBI), is providing a new program for Hereford bull buyers and seedstock breeders. The program, called "OBI Ideal Hereford Range Bull Evaluation" is designed to allow breeders to develop a set of Hereford bulls which meet various performance parameters. These parameters are centered around a range of EPDs that each bull participating in the program must meet. This evaluation takes a different approach from the traditional OBI testing program. The following report summarizes the features of the new Hereford Evaluation.

Traditional OBI Tests

OBI is a breeder owned and organized central bull testing facility in Stillwater, OK, which resides on land leased from Oklahoma State University. The station was developed in 1973, and has an excellent history of gain testing, as well as all-breed bull sales held the first Monday in April and the third Thursday in October. Traditionally, OBI has been conducting only postweaning gain tests. Bulls are confinement-fed on a 112-d gain period on full feed. Bulls complete the gain test at approximately one year of age, and each are given an index which varies by breed. The index is basically comprised of the traits: average daily gain, weight per day of age, and adjusted yearling weight. The index ranking determines the bulls that are eligible to participate in the OBI sale. Although some breeds have testing dates designed so bulls may remain at the facility between off-test and sale dates, many of the sale bulls return home following the completion of the gain test. The bulls are brought back to the test station for the sale at approximately 15-18 months of age. There are currently 10 breeds participating in the OBI programs.

Participation by the Hereford breed in the OBI testing program has been limited in the last 4 years. Hereford breeders bringing bulls to OBI had practically dropped to zero by the end of 1992. In addition, Hereford breeders had lost interest in gain testing to "win" a contest. They were concerned about emphasis placed on the bull winning the test, solely for gain. Also, feed costs of the traditional program have been criticized. The OBI Hereford members and interested parties realized that there must be a better way to utilize the excellent breeder-owned feeding facility for the benefit of bull buyers and Hereford breeders in the state.

New Hereford Bull Evaluation

The OBI Ideal Hereford Range Bull Evaluation is a new concept for a seedstock bull evaluation program that was developed in cooperation with Oklahoma Hereford Association breeders, OBI personnel, and the OSU Animal Science Department advisors to OBI. Further assistance was received by the American Hereford Association. The program combines the use of EPDs with the use of a central test station to develop a set of bulls under practical conditions. It is not a gain test to find high performers for postweaning gain. Instead, the evaluation is for a set a bulls that have been previously screened by their owners using EPDs as primary criteria for participation. Although some bulls in Oklahoma may not meet the EPD requirements, many breeders will have more than one quality calf that meets the program criteria. The goal is to develop a uniform set of bulls for practical range use that should deliver performance to bull buyers as a tool to maximize profits.

Every Hereford bull delivered to OBI must meet the following performance parameters:

Adjusted birth weight	Under 100 lb (or no recorded BW)
205-d adjusted weaning weight	Under 700 lb
Weaning frame score	5.0 to 6.9

The following EPD parameters must be met upon delivery to OBI:

Trait	EPD Range	Percentiles
Birth weight	0 to +3.9	80% to 10%
Weaning weight	+20 to +42	75% to 5%
Yearling	+32 to +67	75% to 5%
Milk	+2 to +15	80% to 10%

- Bulls that qualify within the limits for just one of the weaning weight or yearling weight EPD ranges are eligible, if they come within 5 pounds (plus or minus) of the other EPD range.
- Bulls without birth weights are eligible to be accepted. However, if birth weights are available, then the birth weight EPD parameters apply.

At the conclusion of the evaluation, the bull must meet the additional criteria:

365-d adjusted yearling weight	Under 1300 lb
Yearling frame score	5.0 to 6.9
365-d adjusted scrotal circumference	Over 33 cm
Satisfactory Breeding Soundness Eval.	30-60 days prior to sale date

Bulls are fed on fence-line bunks in pens that are 75 x 120, with approximately 15 bulls per pen. The feeding program is different from any of the tests at OBI. Bulls are program-fed to gain 3.18 lb ADG on a development ration consisting of a limit-fed pellet (approx. 2% of body weight) (Table 1) and prairie hay (approx. 1% of body weight). Weight, ADG, and WDA are measured for the 112-day period. The goals of the program are innovative in that a "winner" of the test is not determined based on the highest gaining individuals. After the 112-d feed period, bulls remain at the OBI facility until the upcoming sale day. This is particularly convenient to participating breeders.

Table 1. Hereford Pellet

Ingredient	lb. as fed	%. as fed
MIDDS, WHEAT	833.0	41.6%
CORN, GROUND	968.0	48.4%
47.5 SOY MEAL	67.0	3.3%
PELLET PARTNER	100.0	5.0%
CALCIUM CARBONATE	20.0	1.0%
SALT	10.0	.5%
VITAMIN A30	.4	.02%
SELENIUM .02%	1.0	.05%
RUMENSIN 60	.8	.04%
TYLAN 10	.8	.04%

(Prepared by Don Gill, Oklahoma State University)

Bull reports include EPDs for each bull, as well as weights, ADG, WDA and other descriptive information. The bulls are not indexed at the conclusion of the 112-d period. Instead, the bulls are merchandised as a set of individuals with similar EPD values, developed to be sold as yearlings at the OBI sale.

Results of the First Hereford Evaluation

The first set of Hereford bull calves received into the evaluation were January-March 1993 born calves. Thirty-four bulls were delivered to OBI on October 8-9, 1993. Gain data were recorded between October 29, 1993 and February 18, 1994. Bulls were scheduled to sell in the OBI all-breed sale, April 4, 1994.

Average EPDs upon arrival were +2.5 for birth, +30 for weaning, +47 for yearling, and +8 for milk. The average birth weight for bulls with a reported weight was 84.5 lb. Four bulls did not meet the weaning frame score on delivery. The 112-d performance (34 head) for Hereford Evaluation was as follows:

Weaning frame score	5.5
Actual weight (Day 1)	612 lb
ADG (Day 112)	3.79
WDA (Day 112)	2.82
365-d adj. weight	1030 lb
365-d frame score	5.7
Scrotal circumference	34.9 cm

Sale Results

The first offering of the OBI Ideal Hereford Range Bull Evaluation took place on April 4, 1994. Sale order was determined by WDA, a breeder group decision. Seventeen Hereford bulls were represented in the sale. These bulls averaged $1788 ($30,400 gross), which was well above the goal of $1200 hoped for by the Hereford breeders. There were 6 additional Hereford bulls in the sale (avg. $1883) from an OBI traditional test held prior to the start of the new Evaluation. Again, these bulls were from the traditional plan, where bulls were brought back to the sale at 15-18 months of age. Combining both groups of Herefords, the average was $1813 on 23 head. Sale averages for the all-breed sale are given in Table 2. This was quite a comeback for a breed at OBI which had shown little interest in feeding or selling bulls at OBI for years.

Average costs per bull were a total of $348.46, which included an entry fee ($110), any medical costs ($21.08), and feed and hay ($217.38). If the bulls were consigned for the sale, the additional sale cost was $145.52. Thus, total expenses on a sale bull averaged $493.98. Net return per bull averaged $1294.02. Hereford bull buyers had favorable comments about the new approach. Oklahoma Hereford breeders were very pleased with the outcome of the evaluation program.

A new set of delivery dates were scheduled for the future. As with any program, some revisions to the original evaluation have been made. Modifications to the previous set of evaluation standards include:

- Require 205-d weight between 500 to 700 lb.
- Modify Milk EPD range to +2 to +16 lb.
- Modify delivery dates to better suit sale schedule.
- Modify sale order to weight within age group.

Table 2. Spring OBI Sale Results by Breed.

BREED	HEAD	GROSS $	AVG $
POLLED HEREFORD	10	19,710	1,971
ANGUS	131	356,200	2,719
BRANGUS	15	30,250	2,017
HEREFORD	23	41,700	1,813
CHAROLAIS	3	4,675	1,558
LIMOUSIN	12	28,275	2,356
GELBVIEH	13	23,125	1,779
SIMMENTAL	11	17,385	1,580
TOTAL	218	$519,520	$2391

Lessons were learned from the first experiences with this program. Based on the feeding program used, it was advisable for calves to weigh about 500 lb upon arrival. Screening bulls periodically was helpful in keeping breeders informed on their progress. This allowed breeders to remove their bulls from the evaluation, if they had concerns about them meeting final evaluation criteria. In addition, breeders were encouraged to participate in an informal screening of the bulls prior to the sale.

Conclusions

The OBI Ideal Range Bull Evaluation was considered to be a success by Hereford breeders and Hereford bull buyers participating in the first run of the program. Hereford breeders took an active interest in the program, which contributed greatly to its success. As a result, the program is scheduled to continue throughout the next year.

MINUTES
LIVE ANIMAL AND CARCASS EVALUATION COMMITTEE MEETING
JUNE 3, 1994, 2:00 P.M., HOLIDAY INN, DES MOINES, IOWA

The following recommendations were made by the Live Animal and Carcass Evaluation Committee to the BIF Board of Directors for consideration and inclusion into the next revision of the guidelines.

1. The disposition scoring system presented by Dr. Kent Anderson

2. The body conditions scoring system presented by Dr. Sally Northcutt

Chairman Crouch appointed a subcommittee chaired by Drs. Doyle Wilson and Gene Rouse with committee members Dr. Keith Bertrand, Dr. Dave Duello, and Dr. Bruce Cunningham to develop and present recommendations for real-time ultrasound data utilization. These are to include contemporary grouping recommendations and adjustment factors.

Pursuant to industry request, Dr. Robert Schalles recommended to the committee that we adopt the revised frame scoring chart to include bulls and females through 48 months of age.

The committee voted to approve this recommendation, but that frame scores for mature animals (past 21 months of age) be included in a separate chart.

Respectfully submitted,

John Crouch, Chairman

1994 Live Animal and Carcass Evaluation Committee
BIF Ultrasound Certification Program

Gene Rouse, Iowa State University

In the spring of 1993 and 1994, Iowa State University hosted the BIF realtime ultrasound certification for rib eye area and fat cover on live cattle. The 1993 BIF ultrasound certification officials were as follows and all of the individuals listed attended the event.

Keith Bertrand, University of Georgia
John Crouch, American Angus Association
Ronnie Green, Texas Tech University
Mark Thallman, Texas A&M University
John Hough, American Polled Hereford Association
Gene H. Rouse, Iowa State University
Don Schiefelbin, North American Limousin Foundation
Doyle E. Wilson, Iowa State University
Jim Wise, Livestock and Standardization Branch, USDA

In 1994 John Crouch, John Hough, Doyle Wilson, and Gene Rouse conducted the certification program along with assistance from district supervisor Rick Jones, Livestock and Standardization Branch, USDA.

Both years each participant scanned 20 head of cattle (including both steers and bulls.) The cattle were then randomized, renumbered and the scanning process repeated. Upon completion of the scanning, cattle were shipped to Monfort Packing Plant in Des Moines. The following day ribeye area and fat cover were measured on all carcasses by two independent evaluators. Upon completion, measurements were compared and if the ribeye area measurements differed by more than 0.5 sq. inches and fat cover measurements differed by more than 0.05 inches, carcasses were remeasured.

All certification standards had to be met for a technician to pass certification. Certification standards were as follows:

Standard Error of Prediction (SEP)
- Fat Cover: < = 0.10 in
- Rib Eye Area: < = 1.20 in^2

Standard Error of Repeated Measures (SER)
- Fat Cover: < = 0.10 in
- Rib Eye Area: < = 1.20 in^2

Technician Bias
- Fat Cover: < = 0.12 in
- Rib Eye Area: < = 1.20 in^2

Written Examination: 70% or better

Results from the BIF Certification indicated eleven technicians certified each year (11 of 19 in 1993 and 11 of 17 in 1994.)

Several areas need to be considered by this committee with regard to future certification programs.

- Certification to measure percent intramuscular fat
- Certification to measure rump fat
- The possibility of two levels of certification
  - Image collection
  - Image interpretation
- The incorporation of the ultrasound data collected by certified technicians into a breed association data base to calculate carcass EPD's
- Specify the equipment that can be used in certification
- Training and future certification

USE OF REAL-TIME ULTRASOUND IN DETERMINING INTRAMUSCULAR PERCENTAGE FAT (MARBLING) IN LIVE CATTLE

Doyle E. Wilson, Hui Lian Zhang and Gene Rouse
Iowa State University, Ames, IA

The use of real-time ultrasound to measure intramuscular fat (marbling) in live beef cattle has recently been demonstrated by different individuals. This report summarizes the results of using this technology at Iowa State University.

The first attempts at measuring percentage intramuscular fat focused on gray scale levels in images taken at the 12-13th rib position. Images were collected with an Aloka 633 machine with a 12.5 cm transducer. The Aloka generated a pixel gray scale level histogram with a corresponding L-value for each image. The L-value represented the mode of the histogram. Correlations between gray scale L-value and percentage fat were positive in the .25-.35 range. While this was encouraging, the results were not deemed accurate enough to be very useful.

Other image analysis procedures were then investigated that included moment descriptors, Fourier spectrum analysis, and spatial texture analysis. Parameters from these analyses yielded considerable more predictive power than solely looking at gray scale statistics. Prediction models are derived by scanning cattle with 2-3 days prior to slaughter, collecting a 12-13th rib slice for chemical extraction of fat to calculate a percent fat, and then regressing alternative image analysis parameters on the percent fat. All models are developed on a subset of the animals scanned and slaughtered, and then validated on the remaining animals. Current prediction models account for approximately 70 percent of the variation observed with root mean square errors of 1.14 %. It is anticipated that refinements will continue to be made in the prediction models with prediction errors approaching $\pm$.7 %.

Iowa State University has implemented a real-time ultrasound technology transfer program for the seedstock industry in Iowa and other locations. One aspect of the technology transfer program has been scanning bulls that are on test by the Iowa Cattlemen's Association. All bulls are ultrasonically measured for 12-13th rib fat thickness, ribeye area and intramuscular percent fat. Table 1. summarizes the percentage fat predictions by breed for the years of 1993 and 1994. For the breeds with the largest numbers (Angus, Simmental and Limousin), the mean levels are what one would expect based upon the germ plasm evaluation data from USMARC.

From Table 1 it is apparent that mean levels of intramuscular fat in yearling bulls is not high, nor is the range very wide. With the accuracy of the real-time ultrasound prediction models, one can at best only sort bulls into bottom third and top third groups. It is not recommended that producers use the ultrasound predictions to select an individual bull based upon its own measurement. Rather, the ultrasound information should go into national data bases for use in developing EPDs for ultrasound measured traits, using the power of the genetic evaluation methodology to improve the accuracy on the individual animal.

Table 1. Mean values of intramuscular fat (marbling) predictions for bulls on test by the Iowa Cattlemen's Association (1993-4).

	Percent Fat				
Breed	No.	Mean	Std	Low	High
Red Angus	12	2.31	±.30	1.66	2.82
Angus	214	2.25	±.43	.87	3.80
P. Hereford	18	2.10	±.52	.65	2.72
Simmental	170	1.86	±.59	.75	2.53
Gelbvieh	37	1.86	±.71	.64	4.27
Salers	12	1.75	±.59	.75	2.53
Limousin	45	1.75	±.49	.55	3.06
Maine Anjou	19	1.75	±.34	1.15	2.40
Charolais	71	1.72	±.44	.44	2.68

Using ultrasound to measure intramuscular fat in live cattle is new technology. There is still much to be learned in how to best apply this technology. A considerable amount of validation testing needs to be done. In addition, answers to the following and other questions are needed:

1. What is the relationship between ultrasound measures on yearling bulls and their steer progeny?

2. What influence does reaching sexual maturity have on measuring intramuscular fat (marbling) in young bulls?

   a. What is the correct age to ultrasound young bulls?
   b. Is there a breed difference?

3. Do the young bulls need to be on a high plane of nutrition before ultrasound can be used to sort out genetic differences?

4. Would scanning older bulls have any merit? How about mature cows?

Iowa State University has entered into several different research and technology transfer efforts to arrive at answers to these questions. The next two years promise to be exciting as this new tool is implemented by seedstock producers and commercial bull buyers.

STANDARDIZATION OF DISPOSITION SCORING

Kent Andersen, North American Limousin Foundation and
Jim Venner, Iowa State University

INTRODUCTION

Historically, most selection programs have been built around traits that are both easy to measure and have some perceived impact on profit (Newman, 1994). While behaviors and their economic effects are difficult to measure, problems associated with animal-human interactions represent a risk to the safety of handlers, an animal welfare concern, added potential costs for appropriate handling equipment, a potential liability to meat quality, and a threat of reduced performance in related traits (Grandin, 1992).

Just as universal definitions of animal welfare and animal well-being do not exist (Newman, 1994), standardized methods to measure various behaviors do not exist. Specific behaviors of interest might include; the reaction of animals while processed through a squeeze chute, maternal instincts at or around the time of calving, newborn calf vigor, reproductive behaviors including serving capacity, and foraging and/or eating proficiency. Since these are distinctly different behaviors, different strategies are necessary to quantify differences among animals. The purpose here is to discuss evaluation of behavior during the time animals are processed through the chute, and, as a starting point, review scoring systems which are currently used by several breed associations.

DISPOSITION OR DOCILITY?

Thus far, systems used to score cattle as they are processed have been labeled as either disposition or temperament scoring systems. Rather than using these labels, French researchers prefer the word docility, which translates as, the yielding to handling or treatment and submissiveness to training or management (Neindre, 1994). Based on what we are attempting to evaluate, the latter seems to be the label of choice.

EVALUATION SYSTEMS

The first challenge is to develop a docility scoring system and accompanying guidelines for data collection. In this sense, guidelines refer to the conditions of evaluation and the range in age or ages at the time of evaluation.

It stands to reason that all animals should be handled in a quiet and consistent manner during processing in order to minimize stress and the non-genetic effects on docility score. Processing cattle through a squeeze chute provides an opportunity to observe behavior under relatively uniform conditions.

Deciding the age or ages when animals are evaluated is more difficult. While Gonyou (1989) recommends that animals be scored on four separate occasions to judge an animal's behavior, a practical starting point might be to score animals at weaning and/or yearling ages, using the same age guidelines which are in place for collecting weaning and yearling performance information. Because an animal's behavior can be influenced by past experiences, it is advisable that the first scoring be conducted at weaning and/or yearling ages, before behavior is potentially biased by prior handling experiences.

DOCILITY SCORING SYSTEMS

A variety of attempts have been made to quantify docility of cattle by observing their behavior while handled and restrained, then assigning subjective scores based on the observed response. While most attempts have involved dairy cattle, the Limousin, Saler and Gelbvieh breeds currently have scoring systems incorporated into their performance programs.

LIMOUSIN DOCILITY SCORES

Through the use of previously designed scoring systems summarized by Heisler (1979), the North American Limousin Foundation developed a scoring system in 1991 after its Limousin Directions breed improvement symposium. Compared to other systems, an attempt was made to provide a more detailed description of the scores to limit subjectivity. Also, rather than base the scores only on behavior while in the chute, breeders are asked to observe behavior while entering and exiting the chute and while cattle are handled.

Scores 1 through 4 represent behaviors from very docile to progressively more restless, nervous and wild behaviors. Scores 5 and 6 were reserved for animals which exhibit aggressive attitudes, which may or may not be a progression from wild behavior. This is similar to the BIF calving ease scoring system where scores represent an increase in degree of difficulty and the final score is used to identify abnormal presentations. The Limousin scoring system described below is used for weaning age cattle.

DOCILITY SCORE	DESCRIPTION
1 DOCILE	mild disposition, gentle and easily handled, stands and moves slowly during processing, undisturbed, settled, somewhat dull, does not pull on headgate when in chute, exits chute calmly
2 RESTLESS	quieter than average but slightly restless,

may be stubborn during processing, may try to back out of chute, pulls back on headgate, some flicking of tail, exits chute promptly

3 NERVOUS — typical temperament, manageable but nervous and impatient, a moderate amount of struggling, movement and tail flicking, repeated pushing and pulling on headgate, exits chute briskly

4 FLIGHTY (WILD) — jumpy and out of control, quivers and struggles violently, may bellow and froth at mouth, continuous tail flicking, defecates and urinates during processing, frantically runs fenceline and may jump when penned individually, exhibits long flight distance and exits chute wildly

5 AGGRESSIVE — may be similar to score 4 but with added aggressive behavior, fearful, extreme agitation, continuous movement which may include jumping and bellowing while in chute, exits chute frantically and may exhibit attack behavior when handled alone

6 VERY AGGRESSIVE — extremely aggressive temperament, "killers", pronounced attack behavior

To the credit of Limousin breeders, over 19,000 cattle have been evaluated during the first few years of data collection. Researchers at Iowa State University are currently studying these data to determine the usefulness of this system. Objectives of the Iowa State study include evaluating the effects of age, sex, contemporary group and percent Limousin blood on docility score, estimation of the heritability of docility score, and calculation of genetic predictions for docility score. Results of the study are expected by the Fall of 1994. The distribution of reported scores is provided below.

Distribution of Limousin Docility Scores (as of 5-16-94)

Score	Number	Percent
1	7430	38.1
2	6782	34.8
3	4828	24.8
4	397	2.0
5	47	.2
6	18	.1
Total	19502	100.0

SALER TEMPERAMENT SCORES

The American Salers Association has an extensive data base of temperament scores. As part of the Saler performance program, Saler breeders may evaluate temperament while processing cattle at both weaning and yearling ages. A description of the five point scoring system, as well as the number and percentage of reported scores, as of May 94 follows (Doubet, 1994):

Score	Temperament	Number	Percent
1	Excellent	43151	77.9
2	Satisfactory	8843	16.0
3	Fair	2720	4.9
4	Poor	262	.5
5	Completely Unacceptable	408	.7
Total		55384	100.0

GELBVIEH DISPOSITION SCORES

A somewhat different approach to evaluating disposition was taken by the American Gelbvieh Association. While the Limousin and Saler scores have been collected on weaning and/or yearling age cattle, the Gelbvieh system is designed to score cows during calving. As of May 95, a total of 2,177 cows, representing 588 sires were scored. Of the 2,177 cows, 371 were scored two times, once each of the last two years. Thus, the Gelbvieh system is unique, in that it evaluates maternal behavior as a repeated measure, rather than the response of an animal to handling at weaning and/or yearling ages. The distribution of reported Gelbvieh scores is provided below (Marshall, 1994).

Score	Disposition	Number	Percent
1	Very Docile	918	36.0
2		1198	47.0
3		332	13.0
4		89	3.5
5	Very Wild	13	.5
Total		2550	100.0

HERITABILITY ESTIMATES

Unfortunately, docility data collected by the above breeds has not yet been extensively analyzed. Results from other studies of various docility scores suggest heritabilities which range from .08 (Norman and VanVleck, 1972) to .53 (Dickson, 1970). These studies involved Angus, Holstein, Limousin and Bos Indicus cattle.

ALTERNATIVE APPROACHES

Obviously, scoring cattle behavior during processing is only one approach to evaluating docility. French researchers have found that yard tests, where cattle are individually evaluated while sorted, cornered and stroked, provide a more accurate composite picture of docility (Neindre, 1994). These scientists hypothesize that cattle eyesight problems may contribute to differences in docility.

Other researchers have evaluated docility by measuring flight distance (Murphy et al., 1980); time to enter, quiet and exit a scale (Vanderwert et al., 1985) and the order in which cattle tend to pass through the chute (Grandin, 1993). Each of these approaches successfully described differences in docility. Although each of these strategies could be useful, practical application of them may prove challenging, given the constraints of time, cost and personnel.

CONCLUSION

As a starting point for standardization of docility scoring, components of existing systems can likely be incorporated into a standard protocol. Due to the subjective nature of docility scoring, the standard system should include a fairly detailed description of each score. The Saler approach of assigning scores at both weaning and yearling ages (using BIF age guidelines for weaning and yearling traits) allows for repeated observations on each individual. Likewise, although it appears to be a slightly different trait, the Gelbvieh evaluation of docility at time of calving suggests that systems to measure maternal behavior should also be standardized. Depending upon results from current research efforts, alternative methods of measuring docility should also be considered. Eventually, characterization of differences in docility could provide producers with information to help avoid nonconforming genotypes which represent unacceptable behaviors.

REFERENCES

Dickson, D.P., G.R. Barr, L.P. Johnson and D.A. Wieckert, 1970. Social dominance and temperament of Holstein cows. J. Dairy Sci. 53:904.

Doubet, J., 1994. Personal Communication, American Saler Association. Englewood, Colorado.

Gonyou, H., Personal Communication. Dept. of Anim. Sci. University of Illinois at Urbana-Champaign.

Grandin, T., 1993. Behavioral agitation during handling of cattle is persistent over time. Applied Animal Behavior Science, 36:1-9.

Heisler, C.E., 1979. Breed differences and genetic parameters of temperament of beef cattle. M.S. Thesis. Saskatoon, Saskatchewan, CANADA.

Marshall, L.K. 1994. Personal Communication. American Gelbvieh Association. Westminster, Colorado.

Murphy, R.M., F.A.M. Duarte and M.C.T. Penedo. 1980. Approach ability of bovine cattle in pastures: Breed comparisons and a breed X treatment analysis. Behav. Genet. 10:171.

Neindre, P. Le, G. Trillat, J. Sapa, F. Menissier, J.N. Bonnet, J.M. Chupin. Genetic variability of docility in Limousin cattle. Laboratoire Adaption des Herbivores aux JMilieux, INRA Theix, 63122 Saint-Genes Champanelle, FRANCE.

Newman, S., 1994. Quantitative- and molecular-genetic effects on animal well-being: Adaptive mechanisms. J. Anim. Sci. 72:1641-1653.

Norman, H.D. and L.D. VanVleck, 1972b. Type appraisal II. Variation in type traits due to sires, herds and years. J. Dairy Sci. 55:1706.

Vanderwert, W., L.L. Berger, F.K. McKeith, A.M. Baker, H.W. Gonyou and P.J. Bechtel. 1985. Influence of zeranol implants on growth, behavior and carcass traits in Angus and Limousin bulls and steers. J. Anim. Sci. 61:310-319.

STANDARDIZATION OF BODY CONDITION SCORING

Sally L. Northcutt
Extension Beef Cattle Breeding Specialist
Oklahoma State University

Introduction

Body condition has been reported to influence maintenance, growth, reproduction, milking ability, and productive life span (Wiltbank et al., 1962; Klosterman et al., 1968; Dunn et al., 1969; Arnett et al., 1971; Bellows and Short, 1978). The influence of body condition on these economically important traits rapidly brought about the interest in a tool for measuring cow condition. Kress et al. (1969) computed weight to height ratios as a measure of condition. Another popular tool used across the United States to assess condition in beef cows is a subjective scoring system.

Body condition scoring has been used as an indicator of body condition necessary for adequate reproductive ability. A scoring system allows cow-calf operators to evaluate the effectiveness of various feeding programs in the cow herd. Many beef producers are adapting this management tool to their programs, to better assess the nutritional requirements of their cows. Since the influence of body condition on economically important traits in beef cows is well documented, the purpose of the current report is to consider the standardization of a body condition scoring system for beef cows.

Scoring Systems

Body condition scores are numerical values used to suggest the relative fatness or condition of the beef cow. A popularly used description of the 9-point system is given in Table 1 as described by Wagner et al. (1988). This or similar scoring systems have been used during recent years as a simple method to assess body condition. Scores are assessed subjectively ranging from 1=severely emaciated, 6=good condition, 9=very obese; (Whitman, 1975). Richards et al. (1986) used a 9-point scale as an indicator of body condition necessary for adequate reproductive ability.

Another scoring system for cow condition that has been used is based on a 5-point scale. The 5-point body condition scoring system, as reported by Houghton et al. (1990) and Buskirk et al. (1992), is structured as follows: 1=extremely thin, 2=thin, 3=moderate condition, 4=fat, and 5=very fat. This system may be expanded for more accuracy by using a "-", "o", or "+" for each score. Using a 1-5 scale, Buskirk et al. (1990) presented results on net energy requirements of lactating beef cows that vary in condition. Also, the authors gave a conversion to the 1-9 scale.

Table 1. 9-point scoring system for body condition in beef cows (Wagner et al., 1988)

1	*Severely emaciated.* All ribs and bone structure easily visible and physically weak. Animal has difficulty standing or walking. No external fat present by sight or touch.
2	*Emaciated.* Similar to 1 but not weakened.
3	*Very thin.* No palpable or visible fat on ribs or brisket. Individual muscles in the hind quarter are easily visible and spinous processes are very apparent.
4	*Thin.* Ribs and pin bones are easily visible and fat is not apparent by palpation on ribs or pin bones. Individual muscles in the hind quarter are apparent.
5	*Moderate.* Ribs are less apparent than in 4 and have less than .5 cm of fat on them. Last two or three ribs can be felt easily. No fat in the brisket. At least 1 cm of fat can be palpated on pin bones. Individual muscles in hind quarter are not apparent.
6	*Good.* Smooth appearance throughout. Some fat deposition in brisket. Individual ribs are not visible. About 1 cm of fat on the pin bones and on the last two to three ribs.
7	*Very good.* Brisket is full, tailhead and pin bones have protruding deposits of fat on them. Back appears square due to fat. Indentation over spinal cord due to fat on each side. Between 1 and 2 cm of fat on last two to three ribs.
8	*Obese.* Back is very square. Brisket is distended with fat. Large protruding deposits of fat on tailhead and pin bones. Neck is thick. Between 3 and 4 cm of fat on last two to three ribs. Large indentation over spinal cord.
9	*Very obese.* Description of 8 taken to greater extremes.

Visual body condition scoring is generally practiced. Palpation of cow condition would be particular to situations where cows are carrying thick hair coats. Preferences on the areas to evaluate on the cow for scoring may differ slightly among evaluator. However, the general areas of consideration include the last half of the ribs, edge of the loin and the spinous processes, hooks and pins, as well as tail-head, brisket, and shoulder area. Consistency in scoring is the key in utilizing the system as a management tool, along with knowing how the score given to a cow applies to the feed resources necessary for her reproductive performance. For example, a score 5 cow in Nebraska would be scored as a score 5 cow in Florida, also. However, the recommendations for meeting her nutritional needs for efficient reproduction may differ for the two environments.

Importance of Body Condition Scoring

Body condition score at calving has been shown in the literature as a key factor in determining reproductive performance. Numerous studies have indicated that condition at calving is important in determining post-partum interval, and thus re-breeding rate (Richards et al., 1986; Selk et al., 1988; DeRouen et al., 1994). Wagner et al. (1988) reported high correlations between body condition and cow energy reserves. Herd and Sprott (1986) also related body condition score to fat cover. Selk (1988) summarized six trials showing the percentage of cows rebred during normal breeding season after calving in different body condition scores. Results from these data originating in several commercial cow herds and experiment stations paints a clear picture relative to percent of cows rebred. About 60% of the cows scoring 4 or less could be expected to rebreed and calve at approximately the same time next year. In contrast, some 80% of the cows in a condition score 5 would be expected to rebreed on time. The percentage rebred rises over 90% in the case of a cow with condition score 6 or more. In addition, variation in rebreeding rates tended to be larger in the case of body condition score 4 or score 5 cows.

Kunkle et al. (1994) summarized eight trials with over 1000 beef cows represented in Oklahoma and Texas studies. Results indicated that cows with a body condition score of 4 or lower, 5, or 6 or higher at calving had pregnancy rates of 60%, 78%, and 91%, respectively. When comparing pregnancy rates from trial to trial, the rate for each body condition score was variable, reflecting differences in scoring by evaluator as well as other contributors such as weight change after calving. The key result still held that pregnancy rate improved when condition score at calving improved from a score 4 to 5 and from a score 5 to 6. In addition, Florida studies on body condition scores taken at pregnancy testing were summarized with the Texas and Oklahoma trials. Based on a total of 4,000 beef cow records from 12 trials, the improvement in pregnancy rates was dramatic as condition score increased from score 3 to score 6.

Another illustration relating body condition score (at calving) to reproductive performance was reported by Houghton et al. (1990). Longer postpartum intervals were associated with thin cows compared with cows carrying higher levels of condition.

Body condition at calving plays a large role in re-breeding rate, as reported by Bell et al. (1990). If a cow is calved thin, she would be expected to have a lower re-breeding rate, even if she is fed to an acceptable condition between calving and breeding. The practice of flushing has not been conclusively found to provide a large improvement in reproduction, although its impact on milk production and consequently weaning weight is favorable.

Mature size in beef cows is largely influenced by body condition (Klosterman et al., 1968). Body condition scores have been used in a mature size genetic evaluation to account for variation in cow condition (Northcutt et al.; 1992; Wilson, 1994). The effect of body condition score accounted for 16% of the total variation in mature weight in Angus field data.

Available Scoring System Materials

In an effort to assess the availability of body condition scoring educational materials, extension personnel in over 40 states were contacted about their recommended scoring system. Of the universities contacted nationally, all were currently utilizing the 9-point system. It was of interest to note the various materials used for educational purposes. Extension bulletins and fact sheets were popular resources (Corah et al., 1991; Selk and Lusby, 1992; Herd and Sprott, 1986; Hardin, 1990). In particular, the materials from states such as Oklahoma, Georgia, Kansas and Texas were used by more than one state. This listing was not meant to exclude any one source, but rather to point out the sharing of materials on this subject. Also, industry sources provided useful educational materials on body condition in beef cows. Handouts with photographs of cows representing particular condition scores, as well as video tapes were available. The condition scoring table reported by Pruitt and Momont (1988) was used frequently across the country.

Recommendations

Standardization of the body condition scoring system for use by beef cow-calf operators and scientists studying condition effects is well supported by the findings indicating the scoring system as a useful management tool. The importance of body condition on postpartum reproductive performance is well documented in the literature. The 1-9 scoring system has been shown to be effective in the evaluation of condition in beef cows. Standardization of a body condition scoring system would be best served by the 9-point scale commonly used throughout the country.

Educators are providing cow-calf producers with useful materials to better manage their feed resources via implementation of the body condition scoring system. Educational materials are readily in place through universities and extension offices, as well as industry personnel. Also, the use of a standardized system would be beneficial as a tool in beef cattle studies and in uniformly reporting the results.

Recommendations for considering a standard scoring system for cow body condition include the acceptance and use of the 9-point system throughout the beef cattle industry. Description of the accepted system should be supported with photographs and suggestions on key areas of the cow to visually evaluate. Comments should include considerations when using the system, such as in cases of thick hair coat, fill, frame, stage of pregnancy, etc. Use of condition scores as a tool for assessing the nutritional needs of the beef cow requires the consideration of her production environment. Standardization of the condition scoring system does not imply standardization of the recommendations for management of cows fitting various scores.

References

Arnett, D. W., G. L. Holland and R. Totusek. 1971. Some effects of obesity in beef females. J. Anim. Sci. 33:1129.

Bell, D., R. P. Wettemann, K. S. Lusby, D. K. Bishop. 1990. Effects of body condition score at calving and postpartum nutrition on performance of two-year-old heifers. Anim. Sci. Res. Rep., MP-129. Oklahoma State Univ.

Bellows, R. A. and R. E. Short. 1978. Effects of precalving feed level on birth weight, calving difficulty and subsequent fertility. J. Anim. Sci. 46:1522.

Buskirk, D.D., R.P. Lemenager and L.A. Horstman. 1992. Estimation of net energy requirements of lactating beef cows. J. Anim. Sci. 70:3867.

Corah, L. R., P. L. Houghton, R. P. Lemenager, D. A. Blasi. 1991. Feeding your cows by body condition. Kansas Coop. Ext. Ser. C-842.

DeRouen, S.M., D. E. Franke, D. G. Morrison, W. E. Wyatt, D. F. Coombs, T. W. White, P. E. Humes and B. B. Greene. 1994. Prepartum body condition and weight influences on reproductive performance of first-calf beef cows. J. Anim. Sci. 72:1119.

Dunn, T. J., J. E. Ingalls, D. R. Zimmerman and J. N. Wiltbank. 1969. Reproductive performance of 2 year-old Hereford and Angus heifers as influenced by pre- and post-calving energy intake. J. Anim. Sci. 29:719.

Hardin, .R. 1990. Using body condition scoring in beef cattle management. Georgia Coop. Ext. Serv. Circular 817.

Herd, D. B. and L. R. Sprott. 1986. Body condition, nutrition, and reproduction of beef cows. Texas agric. Ext. Ser. Bulletin B-1526.

Houghton, P. L., R. P. Lemenager, L.A. Horstman, K.S. Hendrix and G.E. Moss. 1990. Effects of body composition, pre- and postpartum energy level and early weaning on reproductive performance of beef cows and preweaning calf gain. J. Anim. Sci. 68:1438.

Klosterman, E. W., L. G. Sanford and C. F. Parker. 1968. Effect of cow size and condition and ration protein content upon maintenance requirements of mature beef cows. J. Anim. Sci. 27:242.

Kress, D. D., E. R. Hauser and A. B. Chapman. 1969. Efficiency of production and cow size in beef cattle. J. Anim. Sci. 29:373.

Kunkle, W. E., R. S. Sand and D. O. Rae. 1994. Effect of body condition on productivity in beef cattle. In: Factors affecting calf crop. CRC Press, Inc.

Nelsen, T. C., R. E. Short, W. L. Reynolds and J. J. Urick. 1985. Palpated and visually assigned condition scores compared with weight, height and heart girth in Hereford and crossbred cows. J. Anim. Sci. 60:363.

Northcutt, S. L., D. E. Wilson and R. L. Willham. 1992. Adjusting weight for body condition score in Angus cows. J. Anim. Sci. 70:1342.

Pruitt, D. and P. Momont. 1990. Manage by condition. BEEF magazine, Spring edition.

Richards, M. W., J. C. Spitzer and M. B. Warner. 1986. Effects of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive performance in beef cattle. J. Anim. Sci. 62:300.

Selk, G. E. and K. S. Lusby. 1992. Management of beef cattle for efficient reproduction. Oklahoma Coop. Ext. Serv. Circular E-869.

Selk, G. E., R. P. Wettemann, K. S. Lusby, J. W. Oltjen, S. L. Mobely, R. J. Rasby and J. C. Garmendia. 1988. Relationships among weight change, body condition and reproductive performance of range beef cows. J. Anim. Sci. 66:3153.

Wagner, J. J., K. S. Lusby, J. W. Oltjen, J. Rakestraw, R. P. Wettemann and L. E. Walters. 1988. Carcass composition in mature Hereford cows: Estimation and effect on daily metabolizable energy requirement during winter. J. Anim. Sci. 66:603.

Whitman, R. W. 1975. Weight change, body condition and beef cow reproduction. Ph.D. Dissertation, Colorado State University, Fort Collins.

Wilson, D. E. 1994. American Angus Association sire evaluation report. Spring 1994. St. Joseph, MO.

Wiltbank, J. N., W. W. Rowden, J. E. Ingalls, K. E. Gregory and R. M. Koch. 1962. Effect of energy level on reproductive phenomena of mature Hereford cows. J. Anim. Sci. 21:219.

CORRELATED RESPONSE IN GROWTH, REPRODUCTION, AND MATERNAL TRAITS TO SELECTION FOR CARCASS AND MEAT TRAITS IN BEEF CATTLE

Kelly W. Bruns
Michigan State University
East Lansing, MI 48824-1225

INTRODUCTION

The decade of the 90's is crucial for the beef industry. Beef's market share of total meat consumption has declined 34% since 1976. Along with the decline in consumption, beef has increased 100% in retail price. Simply stated, beef demand has eroded over the past 17 years (Ritchie, 1994). With economic pressures and consumer demands challenging the beef industry, it must develop strategies for generating a consumer acceptable product that is profitable to produce.

According to Adams (1993), "The U.S. beef industry has for too long been focused inwardly. We have been production driven, not consumer driven. We have demonstrated neither the ability nor the inclination to respond adequately to consumer signals in the market place". In addition, Byers (1993) states, "Our total system from conception to consumption must be consumer driven and must focus on the final target product when genetic decisions are made." In contrast, Willham nearly 25 years ago reported an economic relationship ratio for reproduction, growth and carcass cutability of 10:2:1, respectively (Bolze, 1994). In a survey conducted by Ritchie and Banks (1993), a questionnaire was sent to university beef cattle specialists asking them to rank 23 issues facing the U.S. beef industry. With a return rate of 86%, specialists from across the country ranked cost of production and price of the product number one. Consequently, beef cattle producers are faced with the difficult task of directing their programs to meet two sets of needs: remain efficient by reducing production costs, yet please the ever increasing demands of the consumer as we head into the 21st century.

Two genetic tools are available to cattlemen to achieve this task. These tools are selection and crossbreeding. With the introduction of continental European breeds, crossbreeding has become an accepted method for utilizing complementary breed characteristics to better meet market specifications. Cundiff (1970) suggested that if nonadditive and additive genetic variation both are important, then improvement should be maximized by combining systematic crossbreeding with selection. This can be accomplished by exploiting differences both within and among breed types. A large amount of variation exists in live and carcass traits among breeds, because of the great number and diversity of breeds contributing to the available gene pool. No one breed excels in all traits (Cundiff, 1993). Furthermore, producers need to have an understanding of the relationships that exist among bioeconomic traits. When selecting for a given trait, negative effects on other traits may occur. As stated by Bolze (1994), "Dealing with genetic antagonisms is difficult because it involves compromise, and negotiating compromise does not come easy."

REVIEW OF LITERATURE

Overview

In the past five years, industry trends have changed dramatically. The beef industry has become aware that if it wishes to remain a major source of protein for the U. S. population, it must seek ways to better meet the needs of consumers. The 1991 National Beef Quality Audit (Smith and Savell *et al.*, 1992) reported the ten primary concerns of purveyors, restauranteurs, retailers, and packers. Feelings were mixed among all four groups but the number one concern of the industry beyond the packer was excess fat. And rightly so, as it has been estimated by Lambert (1991) that it costs $2.0 billion to produce excess fat and $2.4 billion to ship and remove it, for a total cost of $4.4 billion. Of the $280 that was lost per head in the 1991 National Beef Quality Audit, excess fat accounted for $219 dollars (Smith and Savell *et al.*, 1992). This represents a staggering 78% of the potential revenue that is lost. The concern of excess fat by the industry began with the Consumer Retail Beef Study, conducted in 1986, which revealed that consumers want, and are willing to pay for, closely-trimmed beef (Smith and Savell *et al.*, 1992). As a result, all three major packers are now supplying closely-trimmed, fabricated boxed beef with 1/4 inch or less fat trim. These products include: IBP's "User Friendly" line, Excel's "Smart

Choice" line, and Monfort of Colorado's "Super Lite" line. Within the coming year, closely trimmed lines of boxed beef, which currently make up 12-15% of boxed beef sales, are expected to increase dramatically (Dikeman, 1994). The National Cattlemen's Association Value-Based Marketing Task Force (NCA, 1990) declared a "War on Fat". This battle has and will continue to intensify as we further attempt to meet consumer demand.

Although excess fat is rated as the number one concern, a factor that may be of near-equal importance is eating quality. Recent surveys indicate that consumers rate taste at the top of the list when they make food purchase decisions (FMI, 1993). Beef can be divided into three basic consumer expectations. Highest palatability is required in "white tablecloth" restaurants. There, consumers except only the best in tenderness, flavor, juiciness and visual appeal. This group of consumers is less concerned about price or nutritional value. On the other end of the spectrum, are consumers that are primarily diet and health conscious. They select "lite" or "lean" beef and are willing to sacrifice some taste to get what they perceive as a healthy product. The largest segment of consumers is the "retail" sector. This group is concerned about price, but of equal importance is palatability, nutritional value, and fat. To meet their needs, beef must have sufficient marbling to supply desirable taste and tenderness, but cannot have excess waste in the form of fat (Dikeman, 1994). In simple terms, the "retail" sector wants the most bang for their buck.

With all three of the consumer groups concerned to some degree about tenderness, it is important that the industry keep this trait as a top priority. This is supported by the results of the National Beef Tenderness Survey (Morgan *et al.*, 1991). The survey revealed that approximately 30% of the nation's steaks are rated as less than acceptable in tenderness. This means that one out of every three steaks fail to meet consumer standards for eating satisfaction. Dr. Gary Smith, meat scientist from Colorado State University, stated at the National Cattlemen's Convention that one tough beef carcass can effect 542 consumers (Smith, 1994). This can be attributed to a number of factors, but most notable would be the lack of marbling. Intramuscular fat is the industry's primary determinant of quality grade.

This is because of the positive association that marbling has to the tenderness, juiciness, and flavor of steaks (Ritchie *et al.*, 1993). Sensory panel testing of beef tends to support the relationship between palatability and degree of marbling. Data from the 1991 Beef Quality Audit confirm this relationship by showing that consumers found both choice and select beef acceptable, but preferred choice for its taste. Carcasses with inadequate marbling (less than Slight^{50}) are detrimental to the industry because of the negative relationship with eating satisfaction, which could result in a continuing decline in market share. From 1974 to 1991, marbling decreased 2/3 of a USDA marbling score. In the 1991 Audit, 42% of the carcasses surveyed had quality grades of less than choice. Factors that affect taste account for $29 of the $280, or 10% of potential lost revenue (Smith and Savell *et al.*, 1992). With much of the industry waging a "War on Fat", palatability could conceivably fall victim. The beef industry must guard against this happening, because winning the war against fat does not ensure winning the battle in keeping beef the meat of choice.

<u>Cost of Production</u>

To remain profitable, producers must attempt to reduce the unit cost of production. This can be accomplished by optimizing calf weight weaned per cow exposed, and at the same time minimizing cow maintenance cost. Cattle that excel in post-weaning gain and efficiency, yet produce a maximum yield of retail product per carcass without suffering quality grade or weight discounts, will also help reduce the unit cost of production. A trend among purebred and commercial cattlemen is the increased use of expected progeny differences (EPD's) as a primary selection tool. Weaning weights as well as reproductive traits were changed in a relatively short time according to a report by Rasby (1992). Cattle-Fax (1993) surveyed 317 operations in 36 states. There was a range of $59 to $90/cwt in calf breakeven price between the 25% low-cost and the 25% high-cost producers. This spread of $31/cwt was attributed primarily to two factors: annual production costs of $269 versus $369 and a percent calf crop born of 92.4% versus 84.7% for low- and high-cost producers, respectively. Surprisingly, there were essentially no differences in weaning weight or calf death loss (Table 1). In a similar study, Strohbehn (1993) reported that high profit herds had $121 less cost per cow (Table 2). Furthermore, nearly half of this cost difference was due to additional harvested feed. It may be implied from these results and data from Fox *et al.* (1988) that moderate framed cows that are easy fleshing and have less calving difficulty than extremely large-framed, late-maturing cows will incur less maintenance cost in both feed and labor. Moderation appears to be a key to keeping a low-cost, efficient, profitable cow herd; bigger is not always better.

Heritability and Correlated Response

The relationship between phenotype and breeding value is estimated by heritability. Thus, heritability is an estimate of the genetic transmitability of a trait. Table 3 (Marshall, 1993) is a summary of heritability estimates for carcass traits. In general, carcass traits are moderate to high in heritability. As shown in Table 4 (MacNeil, 1984), heritability estimates for reproductive and maternal traits range from very low to high. Certain genes can affect more than one trait, resulting in genetic correlations between traits. Genetic correlations are useful in determining what can be expected if two traits are affected by common genes. This dual effect is referred to as a correlated response. Producers must be aware of correlated responses if they wish to produce a cost-effective product that meets consumer demands. Table 5 (MacNeil *et al.*, 1984) presents genetic correlations of reproductive and maternal traits with growth and carcass traits. A number of these correlations are antagonistic; that is, a favorable response in one trait is correlated with an unfavorable response in another trait.

Lean Yield Versus Reproduction

As previously outlined in this paper, industry leaders have clearly stated the need to reduce fat and increase lean product yield. It is generally agreed that the ideal carcass is one which yields a maximum amount of muscle and enough fat to meet minimum quality requirements. Reproduction tends to be affected negatively when selecting for certain carcass traits. As indicated in Table 5, females from sires selected for reduced fat trim would be expected to reach puberty later and at a heavier weight, have reduced fertility, experience more calving difficulty, and be slightly larger at maturity. Furthermore, data in Table 5 suggest that selection for increased carcass weight or retail product weight could result in females that are older at puberty, have improved fertility, longer gestation, heavier calves at birth, and larger mature size.

<u>Lean Yield Versus Puberty Versus Marbling</u>

Tables 6 and 7 clearly show that as lean to fat ratio increases, marbling score declines. Also there is a tendency for breeds with more marbling to be higher in milk production. Moreover, breeds with higher milk production tend to reach puberty at a younger age. These relationships have sparked interest in a possible connection between marbling and age at puberty, which would appear to be the case when one considers the data in Tables 6 and 7. Within the Angus breed, Bergfeld *et al.* (1992) reported there was no relationship between marbling EPD's of sires and age at puberty in their daughters. Koch *et al.* (1993) compared the palatability of beef from *Bos taurus* and *Bos indicus* breed types, which differ greatly in age at puberty, as shown in Table 7. In this study, steers from *Bos taurus* steers were more tender than those from *Bos indicus* steers even at the same degree of marbling.

Table 7 shows that breeds with higher than average lean to fat ratios tend to be faster growing and are larger at maturity, although two of the breeds that excel in lean to fat ratio, Piedmontese and Limousin, are only moderate in growth and mature size. Tables 7 and 8 indicate that, with the exception of Longhorn, those breeds having an external fat thickness of less than 9 mm exhibit more growth and mature size than those having more than 10 mm. Those breeds from 9 to 10 mm vary somewhat in growth and size. When Hough *et al.*, (1985) selected Hereford cattle for increased yearling weight and hip height, they noted there was no significant response in fat thickness, but those cattle that grew faster tended to have more lean tissue. Thus, the authors concluded that selection for yearling weight increased lean tissue mass relative to fat. Tatum *et al.*, (1986) found frame size to be positively related to growth rate and to separable muscle at a constant carcass weight; furthermore, as frame size increased, separable carcass fat declined. Byers and Rompala (1979) used regression formulas to predict the rate of protein deposition based on empty body weight and rate of gain. As daily gain increased, protein deposition increased at a decreasing rate until maximum protein deposition had been reached. The authors concluded that average daily gain greater than 2.2 lb would yield little or no increase in protein deposition and that gains greater than this would likely be composed of fat. Koch (1978) found a positive relationship associated with selection for growth rate and muscling score. At a constant weight endpoint, percentage of retail product increased while trimmable fat decreased. It was suggested by the author that dual-trait selection for weaning or yearling weight combined with muscling would lead to a higher proportion of edible product and increased weight at a given age.

Lean Yield Versus Milk Production Versus Efficiency

As noted earlier, when one evaluates data across breeds, marbling appears to be negatively related to lean to fat ratio and positively related to milk production. Furthermore, breeds with extremely high lean to fat ratio are very low in milk production (Table 7). These same breeds exhibit very high cutability as shown in Table 9. Montano-Bermudez and Nielson (1990) reported that the efficiency of cows similar for growth and mature size but different in level of milk production differed from birth to slaughter. Cows in a low milk production group were more efficient biologically than cows in medium or high milk groups. Efficiencies to slaughter were 22.0, 20.6, and 20.3 g carcass weight per Mcal ME for low, medium and high milk groups respectively. In an economic evaluation of these data (Van Oijen *et al.*, 1992), the most economically efficient group when evaluated from birth to slaughter was again the low milk group.

CONCLUSIONS AND IMPLICATIONS

It is evident that a genuine effort is being made by the beef industry to meet the demands of the consumer. All segments of the beef industry have responded by taking steps to reduce fat and increase percent of retail product. However, Bolze (1994) made it clear to cattlemen that reproduction is more economically important than growth or carcass characteristics. With reproduction being such a vital component in determining the efficiency of a cow herd, it must be kept a high priority. In addition to reducing fat and increasing lean while simultaneously holding an acceptable reproductive rate, producers must accomplish this with no undue increase in maintenance cost, or in size and tenderness of retail cuts. Growth has been shown to be correlated with a number of carcass traits. The result of using slow growing, early maturing cattle is carcasses that have excess fat and low cutability. Conversely, extremely fast-growing, late-maturing cattle tend to be lean and have high cutability. A rapid increase in growth can be advantageous in producing more retail product but can have negative effects on intramuscular fat as well as fertility, calving ease, and mature size. Producers must retain early growth as a priority but keep moderate-framed cows that have relatively low maintenance costs, acceptable fertility, and minimal calving difficulty. In a summary to Kansas cattlemen, Ritchie (1994) suggested that finished cattle should fit within a moderate frame score window of 4 to 6 and a weight range of 1000 to 1300 lb., which would better enable them to produce choice carcasses within an industry-acceptable weight range of 625 to 825 lb. Furthermore, cattle of moderate size are more likely to reach puberty earlier and conceive at an younger age.

Research indicates that extremes in muscle/lean can be negatively correlated with calving ease and milking ability. However, extremely high milk production has been shown to be antagonistic to both biological and economic efficiency of beef production.

In the future, it appears that cattle producers will need to direct considerable energy toward matching biological type with consumer needs without jeopardizing early growth, reproduction, or maternal ability. All segments of the industry must come together and unite to share the responsibility for maintaining quality while reducing fat in order to provide closely trimmed, palatable beef at a reasonable cost to consumers and at a reasonable profit to the industry. Staying focused on producing an affordable, quality product efficiently and profitably is the key to the future.

Table 1. Low-cost vs. high-cost cow-calf producers (1992)[a]

Item	Low-cost producers (lowest 25%)	High-cost producers (highest 25%)	Difference, low minus high
Calf breakeven price, $	59/cwt	90/cwt	-31
Annual cow cost, $	269	369	-100
Calves born[b], %	92.4	84.7	+7.7
Calf death loss[b], %	4.1	4.2	-0.1
Calves weaned[b], %	88.3	80.5	+7.8
Spring calf weaning weight, lb	512	503	+9
Fall calf weaning weight, lb	483	493	-10

[a] Cattle-Fax survey of 317 producers throughout the United States.
[b] As a % of cows exposed.

Table 2. Ten year summary of Iowa beef cow business record program (1982-91)[a]

Item	Profitability		Difference
	Top 1/3	Bottom 1/3	Top minus bottom
	Per cow		
Costs and returns			
Feed and pasture costs, $	144	197	-53
Other costs, $	161	229	-68
Total costs, $	305	426	-121
Gross return, $	430	323	107
Net profit, $	125	-103	228
Production factors			
Pounds of beef	614	521	93
% calves weaned	95.8	92.7	3.1
Stored feed/cow, lb	3883	5345	-1462
Stored feed/cwt beef, lb	632	1026	-394
Pasture, acres/cow	2.6	2.5	0.1
Corn stalks, acres/cow	4.5	3.5	1.0

[a] Strohbehn (1993).

Table 3. Heritability estimates for carcass traits (age-constant basis)[a]

Trait	Average heritability estimate
Carcass weight	.45
Rib eye area	.36
Fat thickness	.47
Marbling score	.37
Retail product % (cutability)	.38
Retail product weight	.47
Fat trim %	.57
Fat trim weight	.64
Warner-Bratzler shear force	.37
Taste panel tenderness	.10
Calpastatin activity	.70

[a] Marshall (1993); Summary of ten studies.

Table 4. Heritability estimates for reproductive and maternal traits[a]

Trait	Heritability estimate
Age at puberty	.61
Weight at puberty	.70
Conceptions/service	.03
Gestation length	.30
Calving difficulty	.22
Birth weight	.27
Preweaning daily gain	.09
Mature weight	.54

[a] MacNeil *et al.* (1984).

Table 5. Estimated genetic correlations of reproductive and maternal traits with growth and carcass traits[a,b]

Trait	Growth and carcass traits of steers			
	Daily gain	Carcass weight	Fat trim	Retail product wt
Age at puberty	.16	.17	-.29	.30
Weight at puberty	.07	.07	-.31	.08
Conceptions/service	+[a]	.61	.21	.28
Gestation length	-.10	.30	-.07	.13
Calving difficulty	-.60	-.31	-.36	-.02
Birth weight	.34	.37	-.07	.30
Preweaning daily gain	-[a]	-[a]	-[a]	-.26
Mature weight	.07	.21	-.09	.25

[a] The estimated genetic correlation was either greater than +1.0 or less than -1.0. Only the sign of the estimate has been reported.
[b] MacNeil *et al.* (1984).

Table 6. Sire breed comparisons for marbling score[a,b]

Sire breed	Marbling score[c]
Jersey	602
Shorthorn	550
South Devon	538
MARC Original H X A	535
MARC Current H X A	527
Pinzgauer	518
Brown Swiss	517
Galloway	513
MARC Original Charolais	512
Longhorn	510
Red Poll	509
MARC Current Charolais	507
Braunvieh	502
Devon	501
Tarentaise	500
Salers	499
Piedmontese	496
Holstein	495
Simmental	495
Gelbvieh	491
Maine Anjou	484
Limousin	466
Brahman	464
Chianina	432

[a] Marshall (1993).
[b] Slaughtered at constant age or days-on-feed.
[c] Slight = 400-499; Small = 500-599; Modest = 600-699.

Table 7. Breeds grouped into biological types for four criteria[a,b]

Breed group	Growth rate and mature size	Lean to fat ratio	Age at puberty	Milk production
Jersey	X	X	X	XXXXX
Longhorn	X	XXX	XXX	XX
Hereford-Angus	XXX	XX	XXX	XX
Red Poll	XX	XX	XX	XXX
Devon	XX	XX	XXX	XX
Shorthorn	XXX	XX	XXX	XXX
Galloway	XX	XXX	XXX	XX
South Devon	XXX	XXX	XX	XXX
Tarentaise	XXX	XXX	XX	XXX
Pinzgauer	XXX	XXX	XX	XXX
Brangus	XXX	XX	XXXX	XX
Santa Gertrudis	XXX	XX	XXXX	XX
Sahiwal	XX	XXX	XXXXX	XXX
Brahman	XXXX	XXX	XXXXX	XXX
Nellore	XXXX	XXX	XXXXX	XXX
Braunvieh	XXXX	XXXX	XX	XXXX
Gelbvieh	XXXX	XXXX	XX	XXXX
Holstein	XXXX	XXXX	XX	XXXXX
Simmental	XXXXX	XXXX	XXX	XXXX
Maine Anjou	XXXXX	XXXX	XXX	XXX
Salers	XXXXX	XXXX	XXX	XXX
Piedmontese	XXX	XXXXXX	XX	XX
Limousin	XXX	XXXXX	XXXX	X
Charolais	XXXXX	XXXXX	XXXX	X
Chianina	XXXXX	XXXXX	XXXX	X

[a] Cundiff (1993).
[b] Increasing number of X's indicate relatively higher values

Table 8. Sire breed comparisons for fat thickness[a,b]

Sire breed	Fat thickness, mm
MARC Current H X A	14.9
MARC Original H X A	14.6
Devon	12.4
Brahman	11.9
Red Poll	11.8
South devon	11.6
Shorthorn	11.3
Galloway	11.1
Jersey	10.1
Pinzgauer	9.6
Brown Swiss	9.4
Braunvieh	9.3
Salers	9.3
Tarentaise	9.3
Holstein	9.2
Limousin	8.9
Gelbvieh	8.8
Simmental	8.6
Maine Anjou	8.4
Longhorn	8.3
MARC Original Charolais	8.3
MARC Current Charolais	8.0
Piedmontese	7.6
Chianina	7.0

[a] Marshall (1993); pooled across five studies.
[b] Slaughtered at constant age or day-on-feed.

Table 9. Sire breed comparisons for retail product % (cutability)[a,b]

Sire breed	Retail product, %
Piedmontese	53.1
Chianina	52.6
Limousin	51.9
MARC Original Charolais	51.8
Maine Anjou	51.8
MARC Current Charolais	51.7
Gelbvieh	51.6
Simmental	51.6
Longhorn	51.5
Brown Swiss	51.3
Salers	51.3
Galloway	51.1
Pinzgauer	51.1
Braunvieh	51.0
Tarentaise	50.9
South Devon	50.4
Brahman	50.2
Shorthorn	50.1
Red Poll	50.1
Jersey	50.0
MARC Original H X A	49.9
MARC Current H X A	49.6

[a] Marshall (1993); pooled across four studies.
[b] Slaughtered at constant age or day-on-feed.

Table 10. Breed cross differences in preweaning traits, Cycle IV[a]

Breed group of calves	No. calves Born	Weaned	Calvings unassisted, %	Birth weight
Original H X A	192	185	94.4	77.9
Current H X A	100	94	95.5	83.7
Charolais x	203	184	91.2	89.1
Gelbvieh x	226	211	97.2	87.8
Pinzgauer x	226	213	95.9	88.4
Shorthorn x	181	170	99.9	86.1
Galloway x	173	164	98.0	80.1
Longhorn x	202	187	99.7	69.1
Nellore x	197	184	94.6	89.3
Piedmontese x	202	188	94.7	83.6
Salers x	189	176	97.5	84.3

[a] Cundiff (1993a).

Table 11. Breed cross differences in final weight and carcass traits of steers, Cycle IV[a,b,c]

Breed group of steers	No.	Final weight	Dressing %	Marbling score	Fat thickness, in.	REA	% retail product .0 in trim
Original H X A	80	1116	62.0	531	.65	11.22	62.1
Current H X A	34	1205	62.1	523	.61	11.18	62.5
Charolais x	86	1235	61.8	496	.37	12.18	66.0
Gelbvieh x	105	1182	61.8	498	.36	12.06	66.4
Pinzgauer x	96	1167	61.0	525	.40	11.40	65.1
Shorthorn x	95	1202	61.9	548	.47	11.08	62.5
Galloway x	75	1077	62.2	512	.46	11.28	65.2
Longhorn x	92	1066	61.5	508	.35	10.74	65.1
Nellore x	97	1143	64.2	486	.47	11.35	64.7
Piedmontese x	80	1130	63.6	492	.29	13.19	69.8
Salers x	77	1188	62.3	496	.38	11.94	65.7

[a] Cundiff (1993a).
[b] Means for weight and carcass traits at average slaughter age of 419 days.
[c] Marbling score: Slight = 400-499; Small = 500-599.

BIBLIOGRAPHY

Adams, R., Beef Board, 1993. Beef Industry long range task force release findings and recommendations. Beef promotion and research board meeting, Dec 10, 1993, Phoenix, AZ.

Berfeld, E., R.J. Rasby, J.A. Gosey, M.K. Nielson, and J. Kinder, 1993. Heifers sired by bulls with either high or low EPD's for marbling do not differ in age at puberty. J. Anim. Sci. 71(Suppl. 1):45(Abstr.).

Bolze, R., 1994. Questions and answers about the antagonisms of milk production verses reproduction and maintenance requirements in beef cattle selection programs. 1994 Northwest Kansas Cow/Calf Seminars, Feb. 2-3, 1994.

Byers, F.M. and R.E. Rompala, 1979. Rate of protein deposition in beef cattle as a function of mature size and weight and rate of empty body growth. OARDC Beef Res. Rept. Animal Sci. Series 79-1.

Byers, F.M., 1993. American Feed Industry association nutrition institute. November 8, 1993, St. Louis, MO.

Cattle-Fax, 1993. Cattle-Fax member survey. Cattle-Fax special Edition, February, 1993, Englewood, CO.

Cundiff L.V., F. Szabo, K.E. Gregory, R.M. Koch, M.E. Dikeman, and J.D. Crouse. 1993. Breed comparisons in the germplasm evaluation program at MARC. Proc. Beef Improvement Federation Research Symposium and Annual Meeting, Asheville, NC.

Dikeman, M.E., 1994. Beef carcass quality vs. meat yield. 1994 Northwest Kansas Cow/Calf Seminars, Feb. 2-3, 1994.

FMI, 1993. Trends: Consumer attitudes and the supermarket, 1993. Food Marketing Institute, Washington, D.C.

Fox, D.L., C.J. Sniffen, and J.D. O'Connor, 1988. Adjusting nutrient requirements of beef cattle for animal and environmental variations. J. Anim. Sci. 66:1475.

Hough, J.D., L.L. Benyshek, and J.W. Mabry, 1985. Direct and correlated response to yearling weight selection in Hereford cattle using nationally evaluated sires. J. Anim. Sci. 61:1335.

Koch, R.M. 1978. Selection in beef cattle III. Correlated response of carcass traits to selection for weaning weight, yearling weight and muscling score in cattle. J. Anim. Sci. 47:142.

Koch, R.M., J.D. Crouse, M.E. Dikeman, L.V. Cundiff, and K.E. Gregory, 1993. Effect of marbling on variation and change in beef tenderness in *Bos Taurus* and *Bos indicus* crosses. R.L. Hruska, U.S. Meat Animal Research Center Beef Research Progress Rept. No. 4, ARS-71.

Lambert, C., 1991. Lost opportunities in beef production. International Stockmen's School. February, 1991, Houston, TX.

MacNeil, M.D., L.V. Cundiff, C.A. Dinkel, and R.M. Koch, 1985. Genetic correlations among sex-limited traits in beef cattle. J. Amin. Sci. 58:1171.

Marshall, D.M., 1993. Breed differences and genetic parameters for body composition traits in beef cattle. Anim. Sci. 85th Ann. Mtg., Spokane, WA.

Montano-Bermudez, M. and M.K. Nielsen, 1990. Biological efficiency to weaning and to slaughter of crossbred beef cattle with different genetic potential for milk. J. Anim. Sci. 68:2297.

Morgan, J.B., J.W. Savell D.S. Hale, R.K. Miller, D.B. Griffin, H.R. Cross, and J.D. Shackelford, 1991. National beef tenderness survey. J. Anim. Sci. 69:3274.

NCA, 1990. Report of value-based marketing task force. National Cattlemen's Association, Denver, CO.

Rasby, R.J., 1992. Implementation of successful IRM program and future challenges. Am. Sci. 84th Ann. Mtg., August 11, 1993, Pittsburgh, PA.

Ritchie, H.D., B.D. Banks, 1993. A survey of critical issues in the beef industry. Beef Promotion and Research Board Mtg., August 11, 1993, Pittsburgh, PA.

Ritchie, H.D., S.R. Rust, R.A. Merkel, and W.G. Bergen, 1993. Getting rid of excess fat an easy task. Feedstuffs. 65(11), March 15, 1993. Miller Publishing Co., Minnetonka, MN.

Ritchie, H.D., 1994. Beef industry changes necessary for competitiveness in the 21st century. 1995 Northwest Kansas Cow/Calf Seminars, February 2-3, 1994.

Smith, G.C., J.W. Savell, R.P. Clayton, T.G. Field, D.B. Griffin, D.S. Hale, M.F. Miller, T.H. Montgomery, J.B. Morgan, J.D. Tatum, and J.W. Wise, 1992. Final Report of the National Beef Quality Audit -- 1991. Colorado State University, Texas A & M University, Beef Promotion and Research Board, and National Cattlemen's Association.

Smith, G.C., 1994. Strategic alliances participants outline what they have learned. National Cattleman, March, 1994.

Stohbehn, D.R., 1993. A ten-year summary of the ISU beef cow business record. Iowa State Univ., Beef-Sheep Res. Rept. AS-622:71.

Tatum, J.D., H.G. Dolezal, F.L. Williams, Jr., R.A. Bowling, and R.E. Taylor, 1986. Effects of feeder-cattle frame size muscle thickness on subsequent growth and carcass development. II. Absolute growth and associated changes in carcass composition. J. Amin. Sci. 62:129.

Van Oijen, M., M. Montano-Bermudez, and M.K. Nielsen, 1992. Economic efficiency of beef cattle differing in level of milk production. Univ. Nebraska-Lincoln Beef Cattle Res. Rept. MP 58.

Frank Baker Beef Improvement Essay

LIVE ANIMAL EVALUATION OF CARCASS AND MEAT CHARACTERISTICS IN BEEF CATTLE

Submitted by:
William Herring

Introduction

A major industry concern, as identified by the 1991 National Beef Quality Audit, is the reduction of carcass fat while still maintaining and improving the eating quality of retail beef cuts. In order to consistently satisfy consumer demands for a lean, high quality product, and also, to allow producers to effectively compete in a value based marketing system, genetic values for carcass traits must be developed. However, unless accurate and practical live cattle measures of carcass merit are developed, carcass expected progeny differences will have to be based solely on expensive to collect steer progeny information. Live cattle measures that contribute to carcass merit must be heritable and measured with repeatability to make rapid genetic progress for carcass value in the cattle population.

Review of Literature

Relationships of various carcass traits with carcass merit

Two carcass traits that have been frequently examined for their potential to evaluate cutability are 12-13th rib ribeye area and external fat thickness. Presented in Table 1 are correlations of 12-13th rib fat thickness and ribeye area with cutability from various researchers. A strong negative relationship seems to exist between fat thickness and cutability, whereas a smaller, positive relationship seems to exist between ribeye area and cutability. As a result, the two major components contributing to the USDA Yield Grade equation are 12-13th rib fat thickness and ribeye area (Murphey et al., 1960). Therefore, 12-13th fat thickness and ribeye area seem to be reliable indicators of cutability in the live animal.

Visual assessment has been advocated as a means of determining carcass merit (Boggs and Merkel, 1993). Daley et al. (1983) assessed the efficacy of 12-13th rib visual fat estimates from four skilled evaluators on 140 yearling feeder steers. Correlations between visual and actual carcass fat measurements ranged from .70 to .81 for the four evaluators, whereas a correlation of .81 was found between fat probe estimates and the actual carcass measures. These researchers found that accuracy of estimates decreased as fat thickness increased, and visual assessments were equally as accurate as objective measures.

After evaluating 452 slaughter steers, Crouse et al. (1974) found 12-13th rib fat thickness to be the single most important visual estimate in determining percentage cutability (correlation of -.71 between fat thickness and cutability). However, these researchers found that visual evaluators were not effective in determining carcass quality (correlation of .27 between visual slaughter steer grade and marbling score).

Herring et al. (1994b) found correlations ranging from -.48 to -.57 between visual trimness scores and different measures of cutability on 44 Hereford-sired steers. However, correlations between visual measures of muscling and frame with cutability ranged from only -.08 to -.02. These researchers concluded that visual trimness scores can be reliable measures of carcass composition when appropriate personnel are used. However, a more objective means of carcass merit estimation is needed in the live animal.

Even though visual scores seem to have potential as a means of predicting fat composition with certain personnel, other difficulties remain. As the lack of objectivity increases in the establishment of a phenotypic record, so does the error associated with that record. Finally, visual assessment is a poor predictor of carcass quality for ranking animals.

Ultrasound

Ultrasound use for fat and muscle prediction in beef cattle is certainly not a new technology. Researchers began ultrasound use more than 30 years ago (Temple et al., 1956; Stouffer et al., 1959) to determine live animal composition. A-mode and B-mode technology (Kempster et al., 1981) were used in initial research. However, real-time technology has been used in much of the recent ultrasonic research (Bullock et al., 1991; Brethour, 1992). Cattle producers and beef cattle breed associations have shown enough interest in the use of ultrasound data that the Beef Improvement Federation has held three certification schools to date (BIF, 1989, 1990, 1993).

Carcass composition

As earlier stated, 12-13th rib fat thickness and ribeye area have been indicated to contribute to carcass composition. Therefore, much emphasis has been placed on measuring these two traits as predictors of cutability.

Smith et al. (1992) assessed accuracy of ultrasound fat thickness and ribeye area measurements in two experiments. In both experiments, yearling steers, representing various breed types were measured with an Aloka 210DX real-time ultrasound unit, equipped with a 3-MHz linear array transducer. In the first experiment, correlations of .81 and .43 were found between the ultrasound and carcass measurements for fat thickness and ribeye area, respectively. In the second experiment, the same correlation was found for fat but a correlation of .63 was found between ultrasound and carcass ribeye area. In both experiments, these researchers found there was a tendency to underpredict fat thickness in fatter cattle. Also, ultrasound ribeye area was generally overpredicted for lighter muscled cattle and underpredicted for heavier muscled animals.

Faulkner et al. (1990) conducted three experiments to determine the accuracy of ultrasound for predicting carcass fat and composition. These researchers used a real-time ultrasound machine with a 12.5 cm, 3-MHz transducer, measuring animals at the 12-13th rib. In the first experiment, 371 steers and heifers were measured. When ultrasound fat was regressed on carcass fat measurements, the intercept was not different from 0 nor was the slope different from 1, indicating ultrasound fat measurements were good measures of carcass rib fat. In the second experiment (n=47 mature cows), regression equations predicting percentage carcass fat from ultrasound and carcass measures accounted for similar variation, with R^2 values of .85 and .87, respectively. In experiment 3 (n=36 mature cows), equations from experiment 2 were validated. When actual percentage carcass fat was regressed on predicted percentage carcass fat, the intercept was not different from 0 nor was the slope different from 1. These researchers concluded ultrasound is a valid means of accurately measuring 12-13th rib fat and predicting percentage carcass fat in mature cows.

While ultrasound can be a means of accurately predicting carcass traits in beef cattle, sources of error still exist. Many sources of error may accumulate between the time the actual image is made and the corresponding measurement is made on the carcass. Error is possible by personnel involved with isonification and interpretation, calibration of ultrasound or interpretation equipment, slaughter, and collection of the carcass data. Perkins et al. (1992a) evaluated ultrasound accuracy on 646 feedlot animals using 2 unexperienced technicians measuring ultrasound fat and ribeye area with an Aloka 210DX, equipped with a 12.5 cm, 3-MHz linear array transducer. These researchers found correlations between the ultrasound and carcass measures of .78 and .72 for fat and .54 and .64 for ribeye area for the two technicians, respectively. When analyzed, technician was found to be a significant source of variation for ultrasound fat. These researchers also noted that ultrasound was more precise in measuring fat thickness in leaner cattle, and ultrasound ribeye area measurements were slightly more precise for lighter muscled animals.

Four technicians measured 60 Brangus bulls with Aloka Technicare 210DX and Equisonics LS-300A ultrasound machines in a study performed by Waldner et al. (1992). These researchers evaluated ultrasound accuracy for fat and ribeye area as the absolute difference between the ultrasound and carcass measurement. As with previous experiments, they found ultrasound measurements for fat and ribeye area were underestimated for cattle with greater than 1.0 cm fat thickness and 85 cm^2 ribeye area, respectively. These researchers reported that technicians with little experience using ultrasound could be easily trained to measure fat thickness with equal accuracy of trained technicians, whereas differences in technicians did exist for accuracy of ultrasound ribeye area measurements. Also, differences in ribeye area accuracy did exist due to interpretation of the images. These authors also found no accuracy differences due to machine for either trait. In their study, they were able to account for 84% of the variation in USDA Yield Grade when predicting with variables of live weight, hip height, and ultrasound fat thickness.

Ultrasound measurements must not only be accurate, but repeatable. In Australian training and accreditation schools, accuracy and repeatability of ultrasound fat and ribeye area measurements were evaluated as reported by Robinson et al. (1992). Technicians were required to scan 30 animals twice. Machines used in this study were not able to capture the entire ribeye area in a single scan. Average correlations between ultrasound and carcass measurements were .90 and .87 for fat and ribeye area, respectively. Standard error of predictions for repeatability ranged from .48 to .82 mm and 3.41 to 4.89 cm^2 for ultrasound fat and ribeye area, respectively. These researchers suggested, due to carcass handling, ultrasound may be a better indicator of an animal's 12-13th rib fat than the actual carcass measurement. This was evident since correlations between left and right fat scan measurements were higher than correlations between the left and right carcass measurements. Also, ultrasound fat thickness was measured more repeatabley than were carcass fat measurements. These researchers concluded that ultrasound can be a repeatable and accurate means of measuring 12-13th rib fat thickness and ribeye area in the live animal if qualified personnel are used.

Much of the research thus far has dealt with situations where fat and ribeye area measurements were both sought, and linear array transducers were used in order to accommodate ribeye area capture, even though split-screen imaging was necessary. If only fat thickness measurements are needed, optional transducers may be considered in order to increase image resolution. Brethour (1992) evaluated repeatability and accuracy using an Aloka 210DX equipped with a 5-MHz, 56-mm linear array transducer. A total of 972 cattle were measured in two experiments. A correlation of .975 was found for fat repeatability in the first experiment. For both experiments, correlations of .90 and .92 were found between the ultrasound and carcass measurements. As with other transducers, this researcher found that error in measuring fat ultrasonically increased with carcass fat thickness.

Much of the current ultrasound scanning is being performed with a newer model real-time ultrasound system: an Aloka 500V equipped with a 17.2 cm, 3.5-MHz linear array transducer. This system is being used due to its ability to capture the entire ribeye area in a single scan. Two experienced technicians measured 36 feedlot steers with an Aloka 500V, equipped with a 17.2 cm, 3.5-MHz linear array transducer in a study reported by Perkins et al. (1992b). Both technicians had received similar training and experience, measuring more than 3,200 cattle before this experiment. These researchers found technician not to be a significant source of variation in ultrasound fat or ribeye area accuracy. Pooled across technician, correlations between ultrasound and carcass measures were .86 and .79 for fat and ribeye area, respectively. Average repeatabilities between days for fat and ribeye area were .91 and .81, respectively. These authors found isonification with this ultrasound unit to be an accurate and repeatable method for measuring 12-13th rib fat and ribeye area.

Herring et al. (1994a) assessed technician and interpreter effects for ultrasound fat and ribeye measurements with 44 feedlot steers. In this project, 3 technicians isonified all animals on 2 consecutive days with two ultrasound machines. While all of the technicians had attended a BIF certification school, only two had been certified. However, all technicians were highly experienced. The technicians interpreted their own images in addition to the other technicians images; so effects due to interpretation could be established. Two different model machines were used in the study: an Aloka 210DX, equipped with a 10.7 cm, 3.5-MHz linear array transducer and an Aloka 500V, equipped with a 17.2 cm, 3.5-MHz linear array transducer. Using analysis of variance procedures to examine ribeye area repeatability and accuracy, these researchers found that in all cases the Aloka 500V unit was more repeatable and accurate. However, the non-certified technician was markedly more accurate and repeatable with the Aloka 500V vs the Aloka 210DX unit. Machine seemed to have little influence upon the repeatability or accuracy of fat measures. Even though the differences were small for the two certified technicians, when assessing interpreter, the authors found that across all technicians the images made with the Aloka 500V were interpreted more accurately for ribeye area than those from the Aloka 210DX. They also found that with either machine, fatter or heavier muscled animals were underestimated for fat and ribeye area, respectively. There appeared to be no machine advantage for measuring fat thickness. These researchers concluded that the Aloka 500V, equipped with a 17.2 cm, 3.5-MHz transducer was the machine of choice for measuring both fat and ribeye area, especially if highly skilled technicians were not used.

In another publication involving the same set of animals, Herring et al. (1994b) used ultrasound measurements to predict percentage cutability and trimmable carcass fat. In this study, only the Aloka 500V, equipped with the 17.2 cm, 3.5-MHz transducer was used. These researchers found that live measurement equations including ultrasound fat measures, ranked the animals equally as well for percentage cutability as equations including only carcass measurements. They also found that live animal equations were able to account for 47% of the variation in trimmable carcass fat compared to 67% for equations using only carcass measurements. These researchers concluded that ultrasound is a valid means of predicting carcass composition when qualified personnel are used.

Marbling

Not only are carcasses marketed on USDA Yield, but also on Quality Grade. Marbling or intramuscular is the major determinate of USDA Quality grade. However, until recently, measurements have been restricted to post-mortem estimates. Intramuscular fat has been estimated post-mortem most often by marbling score, which is then used to determine Quality Grade. However, this is only a visual estimate attempting to quantify the amount of actual intramuscular fat present. Therefore, an objective intramuscular fat measurement that can be taken in the live animal might be used for management and selection purposes.

Brethour (1990) evaluated the use of speckle score to predict marbling in 619 steers, heifers, and bulls. The author describes "speckle" as the result of intramuscular fat deposits causing sound waves to scatter. In this study, cattle were isonified with an Aloka 210DX, equipped with a 10.7 cm, 3-MHz linear array transducer. Speckle scores were assigned to the animals after viewing ultrasonic images of the ribeye over the 12th rib. Speckle scores were duplicated with a repeatability of .90. The author was able to correctly classify animals into either Select or Choice grades with 70.4% accuracy. However, he noted the greatest errors in predicting percent Choice were encountered when measuring bulls. This researcher concluded that ultrasound determination of speckle was repeatable but classification accuracy might be increased by incorporation of computer technology.

Hamlin et al. (1992) evaluated the use of pixel histograms for Quality Grade classification based on ultrasound measures. These researchers measured 180 feedlot steers with an Aloka 500V, equipped with a 17.2 cm, 3.5-MHz linear array transducer. Classification was based upon multivariate discriminate analysis due to multicollinearity of pixel statistics. These researchers accurately classified animals into the correct quality grades 68.3% of the time.

For ultrasound to be useful in animal selection for marbling, accurate and reliable marbling predictions of young, non-parent bulls must be established. Wilson et al. (1992) ultrasonically measured 139 bulls and 134 yearling steers with an Aloka 500V, equipped with a 17.2 cm, 3.5-MHz linear array transducer. Images were collected with two orientations: "one with the dorsal point of the transducer located at the 12-13th vertebrae and the ventral point being between the 12-13th ribs; the other with the transducer aligned parallel to the length of the longissimus dorsi across the 11-12-13th ribs at approximately 15 cm from the animal midline." On 98 bulls and 98 steers, gray scale histogram and texture analysis were used to develop prediction equations for percent ether extract based on ultrasound measures. Equations were validated with the remaining animals. These researchers found correlations ranging from .72 to .75 between predicted and actual percent ether extract, whereas the correlation between marbling and ether extract was .80.

Due to the smaller amount of intramuscular fat present in bulls compared to fed steers and heifers, alternative sites that indicate 12-13th rib intramuscular fat may need to be located for measuring young breeding males. Schaefer et al. (1993) ultrasonically measured 30 steers with an Aloka 500V, equipped with a 17.2 cm, 3.5-MHz linear array transducer. Animals were scanned at 6 sites: 9-10th and 12-13th ribs, 3rd and 6th lumbar vertebra, and over the *Infraspinatus* muscle. Histogram analysis and Fast Fourier Transform (FFT) analysis were conducted. The percentage *Spinalis dorsi* intramuscular fat had correlations of .74 and .77 with 12-13th rib marbling score and intramuscular fat, respectively. These researchers found that none of the parameters from the histogram or FFT analysis from the *Longissimus dorsi* were related to 12-13th rib marbling score or percentage intramuscular fat. However, parameters from the *Spinalis dorsi* and *Gluteus medius* were significant in accounting for variation in 12-13th rib marbling score, intramuscular fat, and shear force value. The authors also found that the *Spinalis dorsi* had more variation and a higher percentage of intramuscular fat that did the *Longissimus dorsi*. Finally, they concluded that ultrasound technology demonstrates potential as a means of classifying animals for meat quality characteristics.

Considerations for genetic evaluation

As with any selection scheme, first an understanding of the genetic and environmental variance/covariance structure for the traits involved must be reached. Methods for standardization and editing of the data must be reviewed and understood. Finally, the appropriate models must be chosen and implemented. Some of these topics have already been addressed in the literature. However, many obstacles are yet to be overcome.

Arnold et al. (1991) estimated heritabilities and genetic correlations for yearling ultrasound measurements from 3,482 Hereford bulls and heifers. Ultrasound fat and ribeye area (adjusted to a weight constant) heritability estimates were .26 and .25, respectively, with a genetic correlation estimate between the two of .39. In the same publication, a genetic correlation of -.37 was found between actual 12-13th rib fat thickness and ribeye area on 2,411 Hereford steers.

Genetic parameters for ultrasound measurements were estimated from 1,681 Angus bulls and heifers by Shepard et al. (1992). These researchers found heritability estimates of .56 and .11 for ultrasound fat and ribeye area, respectively. A genetic correlation of -.69 was estimated between ultrasound fat and maternal weaning weight, whereas a correlation of .42 was found between ultrasound ribeye area and weaning weight direct. Using these parameters, these authors projected that ultrasound fat thickness could be affected more than weaning weight or ultrasound ribeye area by selection.

Table 2 represents several literature estimates of genetic correlations of weight traits with cutability and marbling. Obviously, there is a broad range in estimates for each trait. However, some generalizations are apparent. There seems to be either none or a small relationship of birth weight with cutability and marbling. Some of the more current literature suggests that a strong positive genetic relationship exists between weaning weight and marbling, whereas a smaller positive correlation exists with post-weaning gain. If these genetic relationships are applicable, then weaning weight selection may yield a correlated response for marbling. Also, a multiple trait model including weaning weight may need to be considered for genetic evaluation of carcass traits.

Calpastatin

Calpains are naturally occurring enzymes, working post-mortem to break down muscle proteins and alter tenderness. However, calpastatin activity inhibits the calpains. Bishop et al. (1993) has identified RFLP in the calpastatin gene. Other probes have also been developed. However, the relationship between these polymorphisms and tenderness has yet to be established. Once these relationships are identified, marker assisted selection could possibly be used to alter carcass quality. The statistical methodology for marker assisted selection has been explored by Fernando and Grossman (1989).

Conclusions and Implications To Genetic Improvement of Beef Cattle

A genetic evaluation system is currently in place in the United states for many production traits. Obviously this system has been successful due to development of useful statistical methodology and more powerful computing systems. However, its power as a selection tool is due mainly to two reasons: 1) vast amounts of data have been collected allowing for greater flexibility in the system and 2) producers have been able to measure breeding animals. This poses a problem with respect to genetic selection for carcass traits. Currently, the collection of carcass data involves steer progeny tests, which are a timely and expensive means of data collection. Systems that allow for quicker, accurate collection of carcass data are desired. Ultrasound seems to be a reasonable choice from the methods available. Even though it has been established as a reliable technology for collecting carcass data in the live animal, several obstacles must still be overcome. For fat thickness, ribeye area, and marbling, researchers must identify the relationships that exist between breeding animals and their feedlot progeny for each trait. Standardization of data collection procedures and edits will be necessary for uniform beef improvement. Also, as with any technology, validation should always be completed. Finally, the use of only qualified personnel is a must lest producers lose confidence in the technology.

Molecular genetics will become a more important part of genetic evaluation for carcass traits in the future. The statistical methodology is already in place to allow for the use of this technology in selection schemes.

Table 1. Literature estimates of phenotypic correlations of 12-13th rib fat thickness and ribeye area with cutability

Researchers	Fat thickness	Ribeye area
Abraham et al., 1980	-.82	.02
Cross et al., 1973	-.73	.30
Crouse and Dikeman, 1976	-.79	.41
Crouse et al., 1975	-.76	.47
Epley et al., 1970	-.71	-.12

Table 2. Literature estimates of genetic correlations among various weight traits with cutability and marbling

Trait	Cutability	Marbling
Birth weight	.05[2], .14[6]	.02[2], -.18[4], .05[6]
Pre-weaning gain	-.29[2]	.10[2], .81[4]
Weaning weight	1.08[1], -.19[5], -.20[6]	-.40[1], .71[3], -.85[5], .89[4], .16[6]
Post-weaning gain	.50[1], -.15[2]	.15[1], .07[2], .48[3], .19[4]
Yearling weight	.74[1]	.02[1]

[1]Dinkel and Busch, 1973; [2]Koch et al., 1982; [3]Lamb et al., 1990; [4]Veseth et al., 1993; [5]Wilson et al., 1976; [6]Woodward et al., 1992.

Literature Cited

Abraham, H. C., C. E. Murphey, H. R. Cross, G. C. Smith, and W. J. Franks, Jr. 1980. Factors affecting beef carcass cutability: an evaluation of the USDA Yield Grades of Beef. J. Anim. Sci. 50:841.

Arnold, J. W., J. K. Bertrand, L. L. Benyshek, and C. Ludwig. 1991. Estimates of genetic parameters for live animal ultrasound, actual carcass data, and growth traits in beef cattle. J. Anim. Sci. 69:985.

BIF. 1989. Proceedings of the Beef Improvement Federation Research Symposium and Annual Meeting. Nashville, TN.

BIF. 1990. Proceedings of the Beef Improvement Federation Research Symposium and Annual Meeting. Hamilton, Ontario, Canada.

BIF. 1993. Proceedings of the Beef Improvement Federation Research Symposium and Annual Meeting. Asheville, N.C.

Bishop, M. D., M. Koohmaraie, J. Killefer, and S. Kappes. 1993. Rapid communication: restriction fragment length polymorphisms in the bovine *calpastatin* gene. J. Anim. Sci. 71:2277.

Boggs, D. L. and R. A. Merkel. 1993. Live animal carcass evaluation and selection manual (4th Ed.). Kendall/Hunt Publishing Co., Dubuque, Iowa.

Brethour, J. R. 1990. Relationship of ultrasound speckle to marbling score in cattle. J. Anim. Sci. 68:2603.

Brethour, J. R. 1992. The repeatability and accuracy of ultrasound in measuring backfat of cattle. J. Anim. Sci. 70:1039.

Bullock, K. D., J. K. Bertrand, L. L. Benyshek, S. E. Williams,and D. G. Lust. 1991. Comparison of real-time ultrasound and other live measures to carcass measures as predictors of beef cow energy stores. J. Anim. Sci. 69:3908.

Cross, H. R., Z. L. Carpenter, and G. C. Smith. 1973. Equations for estimating boneless retail cut yields from beef carcasses. J. Anim. Sci. 37:1267.

Crouse, J. D. and M. E. Dikeman. 1976. Determinates of retail product of carcass beef. J. Anim. Sci. 42:584.

Crouse, J. D., M. E. Dikeman, and D. M. Allen. 1974. Prediction of beef carcass composition and quality by live-animal traits. J. Anim. Sci. 38:264.

Crouse, J. D., M. E. Dikeman, R. M. Koch, and C. E. Murphey. 1975. Evaluation of traits in the U.S.D.A. Yield Grade equation for predicting beef carcass cutability in breed groups differing in growth and fattening characteristics. J. Anim. Sci. 41:548.

Daley, D. A., J. D. Tatum, and R. E. Taylor. 1983. Accuracy of subjective and objective preslaughter estimates of beef carcass fat thickness. J. Anim. Sci. 56:1.

Dinkel, C. A. and D. A. Busch. 1973. Genetic parameters among production, carcass composition and carcass quality traits of beef cattle. J. Anim. Sci. 36:832.

Epley, R. J., H. B. Hedrick, W. C. Stringer, and D. P. Hutcheson. 1970. Prediction of weight and percent retail cuts of beef using five carcass measurements. J. Anim. Sci. 30:872.

Faulkner, D. B., D. F. Parrett, F. K. McKeith, and L. L. Berger. 1990. Prediction of fat cover and carcass composition from live and carcass measurements. J. Anim. Sci. 68:604.

Fernando, R. D. and M. Grossman. 1989. Marker assisted selection using best linear unbiased prediction. Genet. Sel. Evol. 21:467.

Hamlin, K. E., R. D. Green, T. L. Perkins, R. S. Faught, and L. V. Cundiff. 199?. Relationship between real-time ultrasonic estimates and quality components of carcass merit in diverse biological types of beef cattle. Texas Tech Univ, Agric. Sci. Tech. Rep. No. T-5-317:108.

Herring, W. O., D. C. Miller, J. K. Bertrand, and L. L. Benyshek. 1994a. Evaluation of machine, technician, and interpreter effects on ultrasonic measures of backfat and ribeye area in beef cattle. J. Anim. Sci. (accepted).

Herring, W. O., S. E. Williams, J. K. Bertrand, L. L. Benyshek, and D. C. Miller. 1994b. Comparison of live and carcass equations predicting percentage of cutability, retail product weight, and trimmable fat in beef cattle. J. Anim. Sci. (in press).

Kempster, A. J., A. Cuthbertson, D. W. Jones, and M. G. Owen. 1981. Prediction of body composition of live cattle using two ultrasonic machines of differing complexity: a report of four separate trials. J. Agric. Sci. 96:301.

Koch, R. M., L. V. Cundiff, and K. E. Gregory. 1982. Heritabilities and genetic, environmental and phenotypic correlations of carcass traits in a population of diverse biological types and their implications in selection programs. J. Anim. Sci. 55:1319.

Lamb, M. A., O. W. Robison, and M. W. Tess. 1990. Genetic parameters for carcass traits in Hereford bulls. J. Anim. Sci. 68:64.

Murphey, C. E., D. K. Hallett, W. E. Tyler, and J. C. Pierce, Jr. 1960. Estimating yields of retail cuts from beef carcasses. J. Anim. Sci. 19:1240 (Abstr.).

Perkins, T. L., R. D. Green, and K. E. Hamlin. 1992a. Evaluation of ultrasonic estimates of carcass fat thickness and longissimus muscle area in beef cattle. J. Anim. Sci. 70:1002.

Perkins, T. L., R. D. Green, K. E. Hamlin, H. H. Shepard, and M. R. Miller. 1992b. Ultrasonic prediction of carcass merit in beef cattle: evaluation of technician effects on ultrasonic estimates of carcass fat thickness and longissimus muscle area. J. Anim. Sci. 70:2758.

Robinson, D. L., C. A. McDonald, K. Hammond, and J. W. Turner. 1992. Live animal measurement of carcass traits by ultrasound: assessment of accuracy of sonographers. J. Anim. Sci. 70:1667.

Schaefer, D. L., D. E. Wilson, G. H. Rouse, and D. G. Olson. 1993. The use of real-time ultrasound at several anatomical locations to determine quality attributes of the *Longissimus dorsi* muscle in live beef cattle. Iowa State Univ., 1993 Beef and Sheep Resch. Rep., A. S. Leaflet R1019:35.

Shepard, H. H., R. D. Green, B. L. Golden, C. H. Mallinckrodt, and W. M. Snelling. 1992. Genetic parameter estimates for ultrasonic measures of backfat thickness and longissimus muscle area, and other performance traits, in Angus cattle. Texas Tech Univ. Agric. Sci. Tech. Rep. No. T-5-327:112.

Smith, M. T., J. W. Oltjen, H. G. Dolezal, D. R. Gill, and B. D. Behrens. 1992. Evaluation of ultrasound for prediction of carcass fat thickness and longissimus muscle area in feedlot steers. J. Anim. Sci. 70:29.

Stouffer, J. R., M. V. Wallentine, and G. H. Wellington. 1959. Ultrasonic measurement of fat thickness and loin eye area on live cattle and hogs. J. Anim. Sci. 18:1483.

Temple, R. S., H. H. Stonaker, D. Howry, G. Posakony and J. H. Hazeleus. 1956. Ultrasonic and conductivity methods for estimating fat thickness in live cattle. Proc. West. Sect. Am. Soc. Anim. Prod. 7:477.

Veseth, D. A., W. L. Reynolds, J. J. Urick, T. C. Nelsen, R. E. Short, and D. D. Kress. 1993. Paternal half-sib heritabilities and genetic, environmental, and phenotypic correlation estimates from randomly selected Hereford cattle. J. Anim. Sci. 71:1730.

Waldner, D. N., M. E. Dikeman, R. R. Schalles, W. G. Olson, P. L. Houghton, J. A. Unruh, and L. R. Corah. 1992. Validation of real-time ultrasound technology for predicting fat thickness, longissimus muscle areas, and composition of Brangus bulls from 4 months to 2 years of age. J. Anim. Sci. 70:3044.

Wilson, D. E., H. L. Zhang, G. H. Rouse, D. A. Duello, and M. M. Izquierdo. 1992. Prediction of intramuscular fat in the longissimus dorsi of live beef animals using real-time ultrasound. J. Anim. Sci. 70:224 (Abstr.).

Wilson, L. L., J. R. McCurley, J. H. Ziegler, and J. L. Watkins. 1976. Genetic parameters of live and carcass characters from progeny of Polled Hereford sires and Angus-Holstein cows. J. Anim. Sci. 43:569.

Woodward, B. W., E. J. Pollak, and R. L. Quaas. 1992. Parameter estimation for carcass traits including growth information of Simmental beef cattle using restricted maximum likelihood with a multiple-trait model. J. Anim. Sci. 70:1098.

MINUTES OF BEEF IMPROVEMENT FEDERATION
MIDYEAR BOARD OF DIRECTORS MEETING
Embassy Suites Hotel
Kansas City, Missouri
October 1 & 2, 1993

The BIF Board of Directors held it's Midyear Board Meeting at the KCI-Embassy Suites Hotel in Kansas City, Missouri, on October 1 and 2, 1993.

Board members present for the meeting were Marvin Nichols, President: Ron Bolze, Executive Director; Willie Altenburg, Paul Bennett, Glenn Brinkman, John Crouch, Larry Cundiff, Bruce Cunningham, Jed Dillard, Burke Healey, Doug Hixon, John Hough, Loren Jackson, Gary Johnson, James Leachman, Craig Ludwig, Ronnie Silcox, Norman Vincel and Richard Willham. Board members not in attendance were Don Boggs, Paola de Rose, Dixon Hubbard, Lee Leachman, Steve McGill, Roy McPhee, Gary Weber and Darrell Wilkes.

Also Attending the meeting were Doyle Wilson from Iowa State University.

President Nichols called the meeting to order at approximately 9:05 AM on Friday, October 1, 1993, and the following items of business were transacted.

Executive Director Bolze called roll.

President Nichols cleared the agenda. Three additional items were added to the agenda. These included the Historian Report, the creation of a new Molecular Genetics Committee and an invitation to hold the convention in Alabama in 1996.

Minutes of the Previous Meeting -
Copies of the minutes from the previous Board meeting held May 26-29, 1993 at the Grove Park Inn, Asheville, North Carolina, were distributed by Bolze. Healey moved to approve and wave reading of the minutes. Dillard seconded and the minutes were approved.

Financial Report -
Bolze provided copies of the statement of assets, liabilities and fund balance (cash basis) for July 31, 1993, and September 30, 1993. He also provided copies of the statement of revenues and expenses (cash basis) for the periods of time including: January 1, 1993-July 31, 1993; August 1, 1993-September 30, 1993; and January 1, 1993-September 30, 1993. Checking account had been transferred August 24, 1993 from Georgia to Kansas. Discussion followed. President Nichols requested an audit prior to the next convention.

Historian Report -
Historian Willham presented a report on the archives at Iowa State University including a proposal which requested the Executive Director to maintain the immediate past five years of materials and send the sixth past years' material to be archived annually. The proposal also requested $500 for ISU student labor for initial archive establishment. Leachman moved and Bennett seconded proposal acceptance. Motion passed unanimously.

1994 Program Planning Committee Report - Bennett reported that the 1994 Convention Program Planning Committee consisting of Gary Johnson, Larry Cundiff, Richard Willham, Daryl Strohbehn, Paola de Rose, Doyle Wilson, Marvin Nichols and Ron Bolze had met the previous day. Also, in attendance were Bruce Cunningham and Ronnie Silcox. Doyle Wilson had presented a tentative list of program topics compiled by the Iowa State University Committee including Richard Willham, Daryl Strohbehn, Steve Radakovich, Jim Venner, Warren Bush and Marvin Nichols. Wilson presented the BIF Program Committee's tentative program to the Board. After much discussion mostly involving speaker selection for individual topics, Leachman moved and Crouch seconded program approval. Motion passed unanimously. Wilson then presented a tentative convention budget. Ludwig moved to accept rental tent donation with advertisement on tent if need be along with $90 registration fee. Healey seconded and motion passed. Silcox suggested reduced registration for students. Dillard moved $30 student registration for convention attendance plus proceedings (no meals). Bennett seconded and motion passes.

1994 BIF Budget - Bolze presented the tentative 1994 BIF budget. After discussion on potential additional budgetary items, Brinkman moved and Vincel seconded tabling the budget for later approval.

BIF By-Laws Revision - Healey distributed copies of the By-laws with tentative changes as proposed by the By-laws Revision Committee also including Gibb, Crouch, Bolze, Silcox, Bennett and Vincel. Major discussion included geographic region delineation method of ex-officio Board member appointment, membership organization voting eligibility, By-law amendment methodology and committee action voting eligibility. Crouch moved for By-law approval with revisions and Vincel seconded. Motion passed unanimously. Bolze was instructed to send By-law changes to BIF member organizations at least six months prior to the next annual meeting (convention) for review and approval.

Iowa State University Ultrasound Certification Seminar -
As one of the activities of the Live Animal and Carcass Evaluation Committee, Wilson reported on the Ultrasound Certification Seminar held at Iowa State University on June 2-3, 1993. Eighteen people participated with 11 becoming certified. Tentative plans were being made to hold separate training and certification events in 1994 in the months of March and May, respectively. Wilson requested $2,500 for these events. Crouch seconded. Jackson moved and Hough seconded to table the issue for 1994 Budget discussion. Motion passed.

Frank Baker Memorial Scholarship -
Silcox reported for the committee consisting of McPeake, Silcox, Crouch and Weber and presented a tentative proposal. Silcox reported that BIF was currently classified as an agricultural organization with the IRS and therefore, not eligible to accept tax deductible donations. The process to file and receive an educational organization tax status from the IRS capable of receiving tax deductible donations is time consuming. Suggestions were made to deposit the donations within a Landgrant University foundation classified as an educational organization. Leachman suggested that the process would most appropriately be handled by one of Dr. Bakers personal friends. Bolze suggested that the scholarship be housed at a permanent location because the Executive Directorship rotates periodically. Iowa State seemed logical due to archive presence, Willham's relationship and foundation existence. Crouch pledged Breed Association publicity support. Altenburg suggested BIF Founders Scholarship instead of Baker only. Brinkman moved and Leachman seconded to send back to committee and discuss the following day. Motion carried.

Awards Format and Selection Procedure -
Hixon reported for the committee also including Bennett, Brinkman and Johnson. Hixon presented revised Seedstock and Commercial Producer forms and expressed concern that, in some cases, the nominees had not completed their own forms. Five evaluators have ranked the nominations in the past. Leachman moved and Hough seconded to continue to use five evaluators but remove the low score. Brinkman amended the motion to include seven evaluators and remove the high and low score. The amendment died for lack of a second and the original motion passed. Healey moved to give the Awards Committee the authority to carry over "Nominees at Large" for reconsideration the following year. Brinkman seconded and motion carried. Eligibility for the "Ambassador" award includes both editors and writers. Only one nomination for any one award can come from the same nominating organization.

STANDING COMMITTEE REPORTS

Genetic Prediction Committee -
Chairman Cundiff recapped the Genetic Prediction Committee speaker presentations from the 1993 convention. Willham presented a USDA Regional Research Coordinating Committee proposal that required no Board action. Willham distributed the program for the Genetic Prediction Workshop scheduled for January 21-22, 1993, at the KCI Embassy Suites Hotel in Kansas City, Missouri. Willham requested and moved for $1000 financial support to print the Genetic Prediction Workshop proceedings. Crouch seconded and motion passed. Crouch circulated Angus Guidelines for calculating interim EPD. Silcox cited numerous popular press articles portraying BIF endorsement of Across Breed EPD and questioned BIF's true intent. Cundiff stated that the popular press was responding to breed tables published annually in the proceedings including: 1) A breed table for breeds in which adjustments for genetic trends could be made and 2) a breed table for all 26 breeds in the US - MARC Germ Plasm Evaluation Project that would include all traits available.

Hough questioned the current availability of breed average EPD for Bull Test Station use indicating that tables printed in the proceedings are outdated due to biannual evaluations from some breeds. Birthyear breed average EPD tables generated by both the Genetic Prediction and Central Test and Growth Committees may represent duplications of effort. No further Board action was required.

Systems Committee -
Chairman Hough presented the results of an End Product Targets Survey which had been distributed, to approximately 45 meat and beef specialists across the United States. Twenty-seven of the 45 survey recipients (60%) provided individual opinions on the ideal, minimum and maximum specifications for live weight, hot carcass weight, ribeye area, fat cover, % KPH fat, USDA Yield Grade, marbling score and USDA Quality Grade for both "retail/institutional" and "white tablecloth" targets. Dillard questioned BIF providing direction for end product specification. Healey stated that other beef industry organizations (Beef Industry Council, National Livestock and Meat Board) gather end production information more scientifically. The Systems Committee recommended to the Board that BIF should seek submission of proposals to do a National Beef Industry survey that identifies end product targets and should be done every 2-3 years. Hough moved and Crouch seconded Board approval of the Systems Committee recommendation. Motion was opposed. Crouch moved to authorize Hough to appoint a sub-committee to further monitor end product targets. Jackson seconded and motion carried. No further Board action was required.

Live Animal and Carcass Evaluation Committee -
Crouch distributed and presented guidelines for the use of performance data in the showring including specific recommendations on EPD, frame score, scrotal circumference, weights, judge and spectator exposure to performance data and BIF distribution of fact sheets. Brinkman questioned the merit of weights on older cattle. Crouch moved that a revised form be included in the next Guidelines printing. Altenburg seconded and motion carried. Crouch suggested inclusion in next BIF Update. Crouch discussed the possibility for "recommendations for adjusting carcass data to a common endpoint" as a committee topic for the next convention. No further Board action was required.

Reproduction Committee -
Chairman Cunningham reported that at the convention, a sub-committee consisting of Cunningham, Dave Notter and Mike NcNeill was appointed to survey and report back to the committee on national level breed association current methods and future plans for inventory based cow record systems. Altenburg expressed support for inventory based systems, however, Dillard cited that some breed association fee structures may prevent their adoption. Cunningham reported that the heritability for first calf calving date was .19 - .20 and discussion followed on the best method to report first calf calving date. Cunningham reported that the recently revised society of Theriogenology recommendations for Breeding Soundness Examination (BSE) for beef bulls should be printed in the guidelines. 1994 convention Reproduction Committee topics may include a Kansas State University (Schalles and Zoellner) report on scrotal

circumference age adjustments and some more current work on pelvic area adjustment factors. No Board action was required.

Central Test and Growth Committee
Chairman Silcox cited numerous examples of individual state sponsored steer feedout (retained ownership) programs that have been initiated recently. The need exists for guidelines to result in more uniform reporting measures. Brinkman cited the need for specific age reporting. No Board action was required.

Biotechnology Committee -
Program Committee chairman Bennett reported that the opening session of the 1994 convention in Des Moines, Iowa, would serve as the introduction of a new committee to address molecular genetics. Cundiff expressed that molecular genetics was a rapidly evolving field and a committee is needed to keep us current, informed and involved. Healey's original thought was that the concept fit as a subcommittee of the Genetic Prediction Committee, however, greater status would be gained as a stand alone committee. Leachman cited that a forum is necessary to address legality issues of ownership of genetically altered life forms. Dillard cited that genetic prediction is statistically oriented whereas molecular genetics is biochemically oriented. Jackson moved and Leachman seconded the formation of a new standing committee entitled Biotechnology Committee. Motion passed. Silcox encouraged discussion of Biotechnology Committee function at the Genetic Prediction Workshop. President Nichols appointed Healey as chairman. No further Board action required.

Business Meeting Mechanics
President Nichols briefly outlined his thoughts for the 1994 convention business meeting as outlined in the By-laws. Healey suggested new By-law revision adoption before the caucuses for election of new directors to the Board.

BIF Guideline Revision
Discussion involved revision of BIF "Guidelines for Uniform Beef Improvement Programs". Cundiff expressed the need for genetic prediction revisions including methodologies for across breed EPD, international evaluations, F_1 EPD and Interim EPD. Crouch moved and Bennett seconded to publish the next Guidelines edition in 1995 after the convention. Motion passed.

Beef Industry Long Range Task Force-
Healey, who serves on this task force, discussed the eight leverage points which the committee has identified including profit and sustainability, issues management, public relations, foreign marketing, domestic marketing, quality management, strategic alliance and producer/packer alliances. The task force represents a combined effort of the National Cattlemen's Association, Meat Export Federation, Beef Industry Council and the Cattlemen's Beef Promotion and Research Board. No Board action required.

President Nichols adjourned the meeting at 5:50 PM with plans to reconvene at 8 AM the following morning.

President Nichols reconvened the meeting at approximately 8:05 AM on Saturday, October 2, 1993.

Incorporating Standards -
Healey proposed the establishment of a new standing committee entitled "Profitability and Quality Assessment" to provide standardization to IRM/SPA terminology and methodology for commercial cow/calf, stocker and seedstock applications. Dillard expressed that these needs should be covered by the Systems Committee. Crouch suggested that System Committee activities should be broadened to include these efforts. Cundiff proposed renaming the Systems Committee. Leachman moved to rename the Systems Committee to "Integrated Genetic Systems" committee. Crouch seconded and motion passed.

Nominating Committee -
President Nichols appointed the nominating committee to include Vincel, chairman, Hixon, Cunningham, Ludwig, Hough and Silcox.

Awards Committee -
President Nichols appointed the awards committee to include Brinkman, chairman, Crouch, Leachman, Altenburg, Dillard and Healey.

NCA/BIF Joint Meeting Proposal -
Bolze read a fax message that Nichols had received from Darrell Wilkes inviting BIF to schedule the annual convention such that it could be held in conjunction with the NCA Meeting in Denver. Advantages sighted included increased attendance and participation for both organizations. Discussion also cited advantages including common objectives such as Standardized Performance Analysis (SPA) development and members taking an active role and assuming leadership positions in both organizations. However, disadvantages included BIF losing some identity, a late July-early August schedule providing insufficient time after the BIF Convention and Denver as a permanent location. Leachman moved to respectfully decline the NCA invitation and Jackson seconded. Motion passed. Bolze was instructed to send a letter of decline to Wilkes and NCA officials. The same letter was to include a request for alternative NCA representation at BIF Board meetings when Wilkes' schedule does not permit attendance.

BIF Membership -
Bolze referred to a letter from the Executive Director of the Beef Improvement Association of Australia requesting reciprocal membership in both organizations. After much discussion, Healey moved and Crouch seconded for BIF to invite the BIAA to send an honored quest to all BIF functions including the annual convention, Genetic Prediction Workshop, midyear and annual Board meetings. Motion passed.

Willham initiated a discussion involving an invitation for the Composite Breeds Group to join BIF. Vincel questioned the existence of the Composite Breeds Group structural organization. Dillard moved and Altenburg seconded for BIF to send a letter of invitation to the Composite Breeds Group for associate membership in BIF. Motion passed with a split vote.

Board of Director Travel Reimbursement-
Individual members of the Board have from time to time requested that BIF cover travel expenses for individual Board members. Leachman moved and Dillard seconded to decline requests. Motion passed.

Non-member Voting Eligibility -
Hixon initiated discussion questioning the eligibility of producers voting if from a non dues paying state. The discussion was tabled until later.

Host State Versus BIF Convention Responsibilities -
Chairman Bennett reported for the committee consisting of Vincel, Hough and Roger McCraw. He distributed a convention checklist which outlined the responsibilities of the host state and BIF. Bolze suggested that the convention budget include sufficient funds to cover printing the proceedings, whereas the executive director would actually compile presentation articles, edit and have the proceedings printed. The committee was asked to incorporate financial responsibility options into the checklist as follows:

Option 1:
BIF will underwrite the convention up to $5000 if the host state sends all residual (profits) back to BIF.

Option 2:
Host state assumes all financial responsibility (loss) or benefit (gain)
Brinkman moved and Altenburg seconded acceptance of checklist with revisions and motion passed.

1995 BIF Convention -
Hixon reported tentative plans for the 1995 BIF Convention to be held in Sheridan, Wyoming. Jack and Gini Chase will serve as co-chairs. Hixon introduced Evonne Driggs, Marketing Director, Holiday Inn, Sheridan, Wyoming, who made a brief presentation about hotel accommodations and Sheridan attractions. Hixon proposed the dates of May 31-June 3, 1995. Vincel moved and Ludwig seconded location and date approval and motion passed.

1994 Midyear Board Meeting -
Willham proposed that the BIF Board of Directors hold their 1994 Midyear Board Meeting on October 20-22 at the Barclay Lodge, YMCA of the Rockies, Estes Park, Colorado. After discussion, Willham moved and Bennett seconded to make deposit and reserve this facility on these dates. Motion passed.

1996 BIF Convention Invitation-
Hough reported that Dave Maples from the Alabama Beef Cattle Improvement

Association had extended a tentative invitation to host the 1996 convention in Alabama. The invitation was tabled until the convention Board meeting in Des Moines and Hough was instructed to invite an Alabama representative to make a presentation to the Board.

Tabled Items -
President Nichols then reinitiated discussion on tabled items.

Ultrasound request -
Wilson had requested $2500 BIF support for separate ultrasound training and certification events. Vincel moved and Brinkman seconded for $2000 support. Motion passed with a split vote.

Frank Baker Memorial Scholarship -
Silcox presented four options including:

1)Soliciting donations to be placed in an ISU Foundation account
2)Soliciting donations to be placed in BIF Memorial Fund (requiring different IRS tax status)
3)Budgeting Frank Baker award from BIF treasury (no funds solicited)

Dillard moved for establishment of two Frank Baker Memorial Awards for $250 each for Animal Science Animal Breeding Graduate students (funds taken from BIF treasury). Cunningham seconded. Ludwig amended motion to increase two awards to $500 each to help cover student mandatory attendance at the convention. Brinkman seconded. Amended motion passed. Cunningham moved for establishment of a Frank Baker Award Committee with the committee given the authority to handle details. Hough seconded and motion passed. President Nichols appointed the Committee to include Cundiff, Chairman, Willham, Hubbard and Silcox.

1994 BIF Budget -
Bolze distributed a revised 1994 BIF budget which reflected the 1994 convention income and expenses and additional operating expenses. Brinkman moved for budget approval. Crouch seconded and motion passed.

History Book Distribution and Sales-
Bolze indicated that approximately 500 of the original 2000 printed "Ideas Into Action" were sold and distributed. Bolze indicated that Weber is currently investigating the potential for USDA purchase for distribution to agricultural libraries. Leachman moved and Dillard seconded that BIF negotiate sales with outside firms for resale down to $6/copy (cost of production). Motion carried. President Nichols appointed Brinkman, Crouch and Bolze to History Sales Committee.

Continued By-laws Discussion-
Based on previous discussion on voting eligibility of producers from non dues paying states, Healey suggested a revision in definition of regular membership. Brinkman

moved and Dillard seconded for additional revisions in the previously Board approved By-law revisions. Motion passed.

There being no further business, Cunningham moved and Altenburg seconded adjournment. President Nichols adjourned the Board meeting at 12:08 PM.

BEEF IMPROVEMENT FEDERATION

STATEMENT OF ASSETS, LIABILITIES AND FUND BALANCE
CASH BASIS
December 31, 1993

ASSETS

Cash In Bank	$ 7,808.34
Certificate of Deposit	35,344.06
Total Current Assets	43,152.40
Total Assets	$43,152.40

LIABILITIES & FUND BALANCE

Current Liabilites	$ 0.00
Fund Balance - December 31, 1992	55,631.68
Current Year Deficit	(12,479.28)
Total Fund Balance - December 31, 1993	43,152.40
Total Liabilities and Fund Balance	$43,152.40

See Attached Accountant's Compilation Report

BEEF IMPROVEMENT FEDERATION

STATEMENT OF REVENUES AND EXPENSES
CASH BASIS

For The Year Ending December 31, 1993

REVENUES

Dues	$ 11,027.57	
Proceedings & Guidelines	1,877.04	
Reimbursement Mid-Year Bd Mtg	770.00	
Interest	1,596.14	
Total Revenues		$ 15,270.75

EXPENSES

Wages	$ 757.98	
Payroll Tax	104.33	
Accounting	225.00	
Office Expense	72.22	
Bank Charges	55.66	
Printing	11,223.88	
Miscellaneous	467.45	
Postage & Freight	1,394.57	
Archives	500.00	
Awards & Trophies	2,116.54	
Ultra Sound Certification Workshop	2,000.00	
Pledge - NCA	4,000.00	
History Book Expense	992.28	
Board Meeting Expense	1,058.08	
Telephone	600.00	
Travel - Directors	2,182.04	
Total Expenses		27,750.03
Excess of Expense over Revenue		$(12,479.28)

See Attached Accountant's Compilation Report

ROGER D KOUGH
ACCREDITED IN ACCOUNTANCY & TAXATION
190 WEST 6TH STREET
COLBY, KANSAS 67701
(913) 462-3182

Beef Improvement Federation
Ron Bolze, Executive Director
Colby, Kansas

I have compiled the accompanying statement of assets and liabilities - cash basis - of The Beef Improvement Federation, a not for profit organization, as of December 31, 1993 and the related statement of revenues and expenses - cash basis - for the twelve months then ended. The financial statements have been prepared on the cash basis of accounting, which is a comprehensive basis of accounting other than generally accepted accounting principles.

A compilation is limited to presenting, in the form of financial statements, information that is the representation of the officers of the Federation. I have not audited or reviewed the accompanying financial statements and, accordingly, do not express an opinion or any other form of assurance on them.

Management has elected to omit substantially all of the disclosures required by generally accepted accounting principles. If the omitted disclosures were included in the financial statements, they might influence the user's conclusions about the Federation's financial position, results of operation, and cash flows. Accordingly, these financial statements are not designed for those who are not informed about such matters.

The effects on these financial statements of the above described adjustments, required under generally accepted accounting principles have not been determined by management.

Respectfully Submitted,

Roger D Kough

Roger D. Kough

Agenda
BIF Board of Directors Meeting
Holiday Inn – University Park
Atrium Hotel and Convention Center
West Des Moines, Iowa
Wednesday, June 1, 1994

1) Clear Agenda -- **Marvin Nichols**

2) Minutes -- **Ron Bolze**

3) Treasurer's Report -- **Ron Bolze**

4) Membership Report -- **Ron Bolze**

5) Historian and Archive Report -- **Richard Willham**

6) Report on Iowa Convention -- **Daryl Strohbehn**

7) Iowa Convention Annual Meeting Plans -- **Marvin Nichols**
   a) By-laws Revision Adoption -- **Burke Healey**
   b) Caucuses for Election of Directors -- **Norm Vincel**

8) Plans for 1995 Convention in Wyoming -- **Doug Hixon**

9) NAAB Mini Symposium in Conjunction with 1995 Convention -- **Norm Vincel**

10) Plans for 1996 Convention in Alabama -- **Lisa Kriese, Dave Maples, Karen Walker**

11) Composite Cattle Breeders Alliance -- **Steve Radakovich**

12) Canadian Board Representation -- **Paola de Rose**

13) Standing Committee Reports -- Plans for the Convention
   a) Integrated Genetic Systems -- **John Hough**
   b) Genetic Prediction -- **Larry Cundiff**
   c) Reproduction -- **Bruce Cunningham**
   d) Biotechnology -- **Burke Healey**
   e) Central Test and Growth -- **Ronnie Silcox**
   f) Live Animal and Carcass Evaluation -- **John Crouch**

14) Genetic Prediction Workshop Report -- **Richard Willham**

15) Frank Baker Scholarship Awards -- **Larry Cundiff**

16) Election of New Officers -- **Nominating Committee—Norman Vincel, Chairman**

17) Awards -- **Awards Committee—Glenn Brinkman, Chairman**

18) Hayes Walker Proposal -- **Ron Bolze**

19) BIF Guidelines Revisions and Reprinting 1995 -- **Ron Bolze**

20) National Beef Resource Database -- **Gary Weber/Burke Healey**

21) Midyear Board Meeting -- October 20-22, Estes Park, Colorado -- **Ron Bolze**

22) New Business -- **Marvin Nichols**

23) Adjourn

MINUTES OF BEEF IMPROVEMENT FEDERATION
BOARD OF DIRECTORS MEETING
University Park Holiday Inn
West DesMoines, Iowa
June 1-4, 1994

The Beef Improvement Federation Board of Directors held it's Convention at the University Park Holiday Inn in West DesMoines, Iowa on June 1 through June 4, 1994.

Board members present for the meeting were Marvin Nichols, President; Ron Bolze, Executive Director; Willie Altenburg, Paul Bennett, Don Boggs, Glenn Brinkman, John Crouch, Larry Cundiff, Bruce Cunningham, E. Paola de Rose, Jed Dillard, Burke Healey, John Hough, Loren Jackson, Gary Johnson, Lee Leachman, Craig Ludwig, Roy McPhee, Ronnie Silcox, W. Norman Vincel and Richard Willham.

Board members not in attendance were Doug Hixon, Dixon Hubbard, James Leachman, Steve McGill, Gary Weber and Darrell Wilkes.

Also attending the meeting were Dan Kniffen and John Stowell representing NCA; Linda Martin replacing Steve Radakovich for the Composite Cattle Breeders Alliance; and Dave Maples, Lisa Kriese and Karen Walker representing the 1996 Convention hosts.

President Nichols called the meeting to order at approximately 3:40 p.m. on Wednesday, June 1, 1994, and the following items of business were transacted.

Executive Director Bolze called roll.

President Nichols cleared the agenda. Three additional items were added to the agenda. These included a Fact Sheet Committee report from Don Boggs, 1995 Convention Program Committee appointment and convention hosting state responsibility checklist report from Paul Bennett.

MINUTES OF THE PREVIOUS MEETING - Copies of the minutes from the previous midyear Board meeting held October 1 and 2, 1993, at the Kansas City Airport Embassy Suites Hotel in Kansas City, Missouri were distributed by Bolze. Crouch moved to dispense with reading of the minutes and for approval as written. Dillard seconded and the minutes were approved as written.

TREASURERS REPORT - Bolze provided copies of the statement of assets, liabilities and fund balance (cash basis) for December 31, 1993 and May 31, 1994. Bolze also provided copies of the statement of revenues and expenses (cash basis) for the periods of time including January 1, 1993 - December 31, 1993 and January 1, 1994 - May 31, 1994. Healey moved and Crouch seconded acceptance of the financial report. Motion carried. President Nichols questioned the need for an audit as outlined in previous minutes. Further discussion supported the current method of financial reporting.

MEMBERSHIP REPORT - Bolze distributed copies of the membership report. The report showed that 32 state organizations, 25 breed associations and 16 other firms had paid membership dues as of May 31, 1994. Bolze indicated that dues solicitation notices had been mailed to all previously paid membership organizations the second week of January, 1994. Second notices were sent to all unpaid membership in early May, 1994 along with telephone contact.

HISTORIAN AND ARCHIVE REPORT - Historian Willham distributed the archive report consisting of the "Inventory of the Beef Improvement Federation Records, 1965-1993" (manuscript number MS-270). The records of the Beef Improvement Federation include correspondence of the Executive Directors and others; materials of annual meetings and midyear Board meetings; committee records; financial records; publicity files; and records on awards. In addition, the collection includes a variety of historical records from the prefounding and founding period (1965-68), including a looseleaf notebook of one of the federation's founders, Frank Baker, and materials generated in writing the history of the organization in 1992-93.

PLANS FOR 1994 CONVENTION - President Nichols welcomed Daryl Strohbehn and Doyle Wilson to the Board meeting as Convention hosts. Strohbehn brought the Board up to date on Convention activities and preregistration numbers. The Board expressed thanks to Daryl Strohbehn, Doyle Wilson, Richard Willham and Marvin Nichols for a job well done.

1994 CONVENTION ANNUAL MEETING PLANS - President Nichols outlined plans for the first annual meeting open to all Convention attendees. Healey, chairman of the By-Laws Revisions Committee presented procedures to result in adoption of revised By-Laws.
Healey indicated that a 2/3 approval vote from eligible (dues paid) voters present was necessary for By-Laws revision adoption. Norm Vincel discussed planned procedures for the caucus for election of directors. He indicated that given By-Law revision approval, breed registry organizations needed to elect one director for a three year term to replace Jackson; one director for a three year term to replace Cunningham; and one director for a one year term to fulfill the unexpired term of Steve McGill. In addition, Crouch and Ludwig needed to decide term duration dates of 1995 versus 1996. Bennett's term would be extended for two years and Gary Johnson would be eligible for reelection to a second term representing Central BCIA's. President Nichols appointed Silcox, Boggs, Altenburg and Ludwig to chair the Eastern BCIA, Central BCIA, Western BCIA and Breed Association caucuses, respectively. President Nichols indicated that a call for new business would take place at the end of the annual meeting.

PLANS FOR THE 1995 CONVENTION - In the absence of Hixon, Bolze reported that plans were progressing for the 1995 Convention to be held in Sheridan, Wyoming on

May 31 -June 3, 1995. Jack Chase, Co-Chairman, would provide an official welcome during the Friday luncheon.

NATIONAL ASSOCIATION OF ANIMAL BREEDERS (NAAB) SYMPOSIUM - Vincel proposed that NAAB sponsor a symposium to take place the first evening of the 1995 Convention. Bennett moved and Ludwig seconded for acceptance of the NAAB proposal. Motion carried.

PLANS FOR THE 1996 CONVENTION - A 1996 BIF Convention invitation to Birmingham, Alabama was presented by Dave Maples, Alabama Beef Cattle Improvement Association and Lisa Kriese, Auburn University Beef Extension Specialist. Karen Walker, Birmingham Bureau of Commerce, presented highlights and attractions of Birmingham. Proposed dates were May 15-18, 1996. Hough moved and Jackson seconded invitation acceptance. Motion carried.

COMPOSITE CATTLE BREEDERS ALLIANCE (CCBA) - Linda Martin replaced Steve Radakovich and presented a summary of a recent CCBA organizational meeting. The CCBA recommended BIF Committee formation to address generation of genetic information on mixed breed/composite/hybrid bulls. Cunningham suggested discussion of committee formation be tabled until midyear Board meeting.

CANADIAN BOARD REPRESENTATION - Paola de Rose reported that performance testing and genetic evaluation was shifting from government sponsorship to privatization in Canada. New representation at the midyear Board meeting may be forthcoming.

STANDING COMMITTEE REPORTS - Plans for the Convention

a. Integrated Genetic Systems - John Hough

Hough reported that Lee Leachman would provide an update on the Seedstock Standardized Performance Analysis (SPA) Program, Dan Kniffen would comment on Breed Association Data Processing as it relates to Seedstock SPA and Brent Woodward would report on methods to improve product quality and consistency.

b. Genetic Prediction - Larry Cundiff

Cundiff reported that Doyle Wilson would provide information on International Cattle Evaluation; Ronnie Green on Body Composition EPD and Gene Rouse on Use of Ultrasound for Marbling EPD. In addition, Guidelines for Genetic Prediction speakers and topics included Bruce Cunningham on Interim EPD; Keith Bertrand on National Cattle Evaluation; Robert Schalles on Data Collection and Management; Dale VanVleck on Across Breed EPD; Bruce Golden on Mixed Breed EPD and Bob Scarth on Editing Data.

c. Reproduction - Bruce Cunningham

Cunningham reported that he would provide a sub-committee report on the Genetic Evaluation of Reproductive Traits. Also, Michael MacNeil would report on the Genetic Analysis of Calving Date; Bruce Golden would comment on Stayability Evaluation in Red Angus Cattle and Robert Schulles would present Age Adjustment Factors for Scrotal Circumference Growth.

d. Central Test and Growth - Ronnie Silcox
Silcox reported that Robert Stewart, Wayne Shearhart and Randall Grooms would report on the Steer Feedout Programs from Georgia, Oklahoma and Texas, respectively. In addition, Sally Northcutt would comment on Range Bull Evaluation versus Central Gain Testing. Initial plans would be made for rewriting the Central Test Section of the Guidelines.

e. Biotechnology - Burke Healey
Healey reported that Sue Denise, Daniel Pomp and Richard Willham would lay the groundwork for potential objectives and activities of the Biotechnology Committee. Open discussion would follow concerning committee responsibilities and the need for sub-committees.

f. Live Animal and Carcass Evaluation - John Crouch
Crouch reported that Committee speakers and topic areas would include Gene Rouse on the Ultrasound Certification Process; Doyle Wilson on the use of Ultrasound in Determining Marbling and % Fat in Live Cattle; Kent Anderson on Standardization of Disposition Scoring; Sally Northcutt on Standardization of Cow Body Condition Scoring; and Robert Schalles on Frame Score Formulas for cattle younger than five months and older than twenty-one months of age.

FACT SHEETS - Boggs, Chairman of the Fact Sheet Committee solicited Board input on new fact sheet development. Proposed fact sheets and suggested authors included:

"Obtaining Useable Carcass Data for NCE" - Crouch
"Beef Cow Body Condition Scores" - Northcutt
"Biotechnology Glossary" - Healey
"Use of Composites in Beef Cattle Breeding" - Martin
"On-Farm Testing of Bulls" - Silcox

NATIONAL BEEF RESOURCE DATABASE - Healey discussed the potential merits of the National Beef Resource Database similar to the applications of CDROM currently employed by both the dairy and swine industries. Crouch moved and Dillard seconded to endorse the concept and to write a resolution indicating support. Motion carried.

ELECTION OF NEW OFFICERS - Vincel, Chairman of the Nominating Committee consisting of Cunningham, Hixon, Hough, Ludwig and Silcox, presented the following nominations: Paul Bennett for President and Glenn Brinkman for Vice President. There being no further nominations, Healey moved the nominations cease and the two be elected by acclamation. McPhee seconded and the motion carried.

AWARDS COMMITTEE - Glenn Brinkman
Brinkman, Chairman of the Awards Committee consisting of Altenburg, Crouch, Dillard, Healey and Leachman, presented the following recipients of awards:

Pioneer Award:
Robert de Baca, Tom Chrystal, Roy Wallace

Continuing Service Award:
Bruce Cunningham, Loren Jackson, Marvin Nichols, Steve Radakovich and Doyle Wilson

Ambassador Award:
Hayes Walker, III

Outstanding Seedstock Producer Award:
Richard and Shelly Janssen

Outstanding Commercial Producer Award:
Fran and Beth Dobitz

GENETIC PREDICTION WORKSHOP REPORT - Willham reported on the Genetic Prediction Workshop held at the Kansas City Airport Embassy Suites Hotel on January 21 and 22, 1994. A financial report was distributed indicating that only $520.74 of the original Board approved $1000 was needed to cover the balance of proceedings printing cost. Revenues from future sales of proceedings would be submitted to the BIF account. The Board recognized Willham's efforts in coordinating the Genetic Prediction Workshop.

FRANK BAKER MEMORIAL SCHOLARSHIP AWARDS - Cundiff, Chairman of the committee also including Hubbard, Silcox and Willham reported that two individuals would be recognized as recipients of the Frank Baker Memorial Scholarship Award. Recipients included Kelly Bruns, Michigan State University and William Herring, University of Georgia. The awards consisting of $500 checks plus plaques would be presented at the Friday awards luncheon. Recipients papers would be published in the proceedings. Willham requested that Mel Baker be notified with details of award recipients.

HAYES WALKER PROPOSAL - Bolze distributed a proposal submitted by Hayes Walker requesting that his publication, America's Beef Cattleman (ABC), be designated as the official BIF publication. Silcox state that Walker has printed proceedings papers in the ABC in recent years. Brinkman questioned if editors of other publications would be concerned. Boggs questioned if the ABC would have exclusive rights to BIF material. Altenburg questioned extent of circulation. Healey stated that he currently writes a column for ABC and viewed proposal acceptance favorably. Crouch felt that editors of other publications would not be concerned and thought a one year acceptance on a trial basis would have merit. Leachman moved for proposal acceptance assuming no ABC exclusivity, BIF logo usage and a one year arrangement. Further discussion raised more questions so Jackson moved and Dillard seconded to table until Saturday morning's Board meeting. Motion carried. President Nichols appointed a committee of Leachman, Cunningham and Silcox to visit with Walker for more information.

BIF CONVENTION CHECKLIST - Bennett distributed a checklist which specified various BIF versus host State Convention responsibilities including financial obligations.

Discussion favored policy approved on October 23, 1992, which expects each annual convention to break even, but BIF will underwrite a Convention loss of up to $5,000. BIF and host organization will share equally in profits.

MIDYEAR BOARD MEETING - Bolze reported that reservations had been made with YMCA of the Rockies in Estes Park, Colorado for October 20-23. Deposit was due to hold reservations. Crouch moved and Altenburg seconded to pay deposit. Motion carried.

Cunningham moved and Dillard seconded adjournment until Saturday morning. Motion carried. President Nichols adjourned meeting at 6:55 p.m.

President Paul Bennett reconvened the Board of Directors meeting at 6:15 a.m. Saturday, June 4, 1994. He welcomed three new Directors including Kent Anderson, Roger Hunsley and Doug Husfeld representing breed associations. The Board introduced themselves for Kent Anderson who was present.

PROGRAM COMMITTEE - President Bennett appointed a 1995 Convention Program Com-mittee consisting of Brinkman, Chairman, Hixon, Dillard, Vincel, Altenburg and Anderson. The Program Committee planned to meet a half day early at the Midyear Board Meeting in Estes Park.

STANDING COMMITTEE REPORTS -

a. Integrated Genetic Systems - John Hough

Hough reported that the committee would continue to concentrate it's efforts in the IRM/SPA area. Much committee discussion involved industry quality and consistency challenges. No Board action required.

b. Reproduction - Bruce Cunningham

Cunningham reported that Michael MacNeil's presentation on Genetic Analysis of Calving Date revealed little promise for genetic selection application. A sub-committee had been created to decide the appropriate scrotal growth adjustment factors for inclusion in Guidelines revisions based on Schalles' presentation. No Board action required.

c. Biotechnology - Burke Healey

Healey reported excellent attendance for the first meeting of the Biotechnology Committee. A steering committee had been appointed to plan the program for next year, explore means by which to involve more meats scientists and molecular scientists, and to solicit financial support.

Healey presented a resolution which stressed the need for reallocation of Beef Check-off Funds and increased emphasis on research efforts. Healey moved acceptance of the resolution with copies to be sent to the Beef *Operating* Committee, Beef Industry Council of the National Livestock and

Meat Board, Cattlemens Beef Promotion and Research Board and the National Cattlemens Association. Willham seconded and motion carried.

d. Central Test and Growth - Ronnie Silcox
Silcox reported much interest in the Steer Feedout Program summaries presented by Stewart, Shearhart and Grooms. A subcommittee was established to develop Guidelines for uniform steer feedout data recording. Hough agreed to compile a Directory of feedout programs nationwide. A sub-committee was established to rewrite the Central Test Section for revision of the Guidelines. No Board action required.

e. Live Animal and Carcass Evaluation - John Crouch
Crouch reported that Kent Anderson and Sally Northcutt had made presentations and created much discussion about standardization of Disposition Scoring and Beef Cow Body Condition Scoring, respectively.. Robert Schalles had presented equations to generate frame scores up through 48 months of age. Crouch and Hough would co-chair a subcommittee to explore the application of frame score equations for cattle younger than five and older than 21 months of age. No Board action required.

f. Genetic Prediction - Larry Cundiff
Willham reported that revision of the Genetic Prediction Section of the Guidelines was progressing. No Board action required.

GUIDELINES REVISION - Bolze initiated discussion about a schedule for completion of Guidelines revision. Discussion indicated that an achievable schedule would involve 1)draft by midyear; 2)Board approval by 1995 Convention; and 3)duplicate and distribute fall 1995. Guidelines section authors/editors were allotted as follows:

1)Introduction - Bolze
2)Reproduction - Cunningham
3)Evaluation of Growth Rate and Efficiency of Gain - Silcox
4)Beef Carcass Evaluation - Crouch
5)Live Animal Evaluation - Crouch
6)Guidelines for Performance Programs for Seedstock Producers and Their Organizations - Hough
7)Guidelines for Commercial Performance Programs - Hough
8)Central Test Stations - Silcox/McCraw/Northcutt
9)Genetic Prediction - Willham/Cundiff
10)Embryo Transfer - Cunningham
11)The Systems Concept for Cattle Production and Improvement - Hough

Kniffen suggested committee formation to develop a Guidelines outline. Hough moved and Dillard seconded to appoint a committee to develop an outline for Guidelines revision. President Bennett appointed Willham, Chairman; Silcox, Crouch, Cunningham, Cundiff, Healey and Hough.

Additional topics and authors discussed for potential inclusion in the Guidelines included mature cow size -Anderson; scrotal circumference adjustment equations - Cunningham; Warner Bratsler shear force as a measure of beef tenderness - Healey; sheath and navel scores - Brinkman; udder scoring system - Crouch; and parent verification - Anderson.

HAYES WALKER PROPOSAL - President Bennett reintroduced the Hayes Walker proposal. Committee consisting of Silcox, Leachman and Cunningham reported the following criteria:

*Approximately 2000 circulation
*No editorial license
*No written contract
*BIF arrangement does not transfer with future potential sale of magazine
*No exclusive rights to BIF publications
*No financial transactions
*Freedom to use BIF logo

Vincel moved to raise tabled motion. Healey seconded and motion carried. Vincel moved to amend motion to include criteria. Healey seconded and amendment carried. Amended motion passed unanimously.

CHARGE FOR PROCEEDINGS - Silcox stated that with increased proceedings size and printing cost, BIF was losing money on every copy sold. Altenburg moved and McPhee seconded to increase proceedings price to $10.00. Motion carried.

FRANK BAKER MEMORIAL SCHOLARSHIP AWARD - Cundiff requested retention of same committee consisting of Cundiff, Chairman, Willham, Silcox and Hubbard. Crouch moved and Vincel seconded to retain same committee. Motion carried.

AWARDS PRESENTATION - Healey suggested dividing awards presentations between two luncheons. Program Committee charged with appropriate format.

HISTORIAN REAPPOINTMENT - Healey moved and McPhee seconded to reappoint Willham as official BIF Historian. Motion carried.

There being no further business, President Bennett adjourned the Board Meeting at 7:55, Saturday, June 4, 1994.

Respectively Submitted,

Ron Bolze

Ron Bolze
Executive Director

BEEF IMPROVEMENT FEDERATION

STATEMENT OF ASSETS, LIABILITIES AND FUND BALANCE
CASH BASIS
May 31, 1994

ASSETS

Cash In Bank	$14,816.84
Certificate of Deposit	35,922.45
Total Current Assets	50,739.29
Total Assets	$50,739.29

LIABILITIES & FUND BALANCE

Current Liabilities	$ 0.00
Fund Balance - December 31, 1993	43,152.40
Current Year Excess	7,586.89
Total Fund Balance - May 31, 1994	50,739.29
Total Liabilities and Fund Balance	$50,739.29

See Attached Accountant's Compilation Report

BEEF IMPROVEMENT FEDERATION

STATEMENT OF REVENUES AND EXPENSES
CASH BASIS

For The Five Months Ending May 31, 1994

REVENUES

Dues	$ 9,707.24	
Proceedings & Guidelines	1,914.76	
Interest	691.86	
Total Revenues		$ 12,313.86

EXPENSES

Payroll Tax	$ 6.06	
Bank Charges	10.00	
Accounting	53.50	
Office Expense	90.90	
Printing	945.74	
Miscellaneous	180.00	
Postage & Freight	1,877.27	
Convention Awards, Plaques	1,563.50	
Total Expenses		4,726.97
Excess of Revenue over Expense		$ 7,586.89

See Attached Accountant's Compilation Report

ROGER D KOUGH
ACCREDITED IN ACCOUNTANCY & TAXATION
190 WEST 6TH STREET
COLBY, KANSAS 67701
(913) 462-3182

Beef Improvement Federation
Ron Bolze, Executive Director
Colby, Kansas

I have compiled the accompanying statement of assets and liabilities - cash basis - of The Beef Improvement Federation, a not for profit organization, as of May 31, 1994 and the related statement of revenues and expenses - cash basis - for the five months then ended. The financial statements have been prepared on the cash basis of accounting, which is a comprehensive basis of accounting other than generally accepted accounting principles.

A compilation is limited to presenting, in the form of financial statements, information that is the representation of the officers of the Federation. I have not audited or reviewed the accompanying financial statements and, accordingly, do not express an opinion or any other form of assurance on them.

Management has elected to omit substantially all of the disclosures required by generally accepted accounting principles. If the omitted disclosures were included in the financial statements, they might influence the user's conclusions about the Federation's financial position, results of operation, and cash flows. Accordingly, these financial statements are not designed for those who are not informed about such matters.

The effects on these financial statements of the above described adjustments, required under generally accepted accounting principles have not been determined by management.

Respectfully Submitted,

Roger D Kough

Roger D. Kough

PAID BIF MEMBER ORGANIZATIONS AND AMOUNT OF DUES FOR 1994

as of May 31, 1994

STATE BCIA'S	DUES
Alabama	$100
Buckeye Beef (Ohio)	$100
California	$100
Colorado	$100
Florida	$100
Georgia	$100
Idaho	$100
Illinois	$100
Indiana	$100
Iowa	$100
Kansas	$100
Kentucky	$100
Minnesota	$100
Mississippi	$100
Missouri	$100
New Mexico	$100
New York	$100
North Carolina	$100
North Dakota	$100
Oklahoma	$100
Oregon	$100
Pennsylvania	$100
South Carolina	$100
South Dakota	$100
Tennessee	$100
Texas	$100
Utah	$100
Virginia	$100
Washington	$100
West Virginia	$100
Wisconsin	$100
Wyoming	$100

BREED ASSOCIATIONS

American Angus	$600
American Brahman	$200
American Chianina	$200
American Gelbvieh	$300
American Hereford	$500
American Int. Charolais	$300
American Murray Grey	$100
American Polled Hereford	$300
American Red Poll	$100
American Salers	$300
American Shorthorn	$200
American Simmental	$500
American Tarentaise	$100
Barzona Breeders	$100

(BREED ASSOCIATIONS CONT.)	DUES
Beefbooster Cattle LTD.	$100
Beefmaster Breeders	$300
Canadian Charolais	$200
Canadian Hays Converter	$100
Canadian Hereford	$100
Canadian Simmental	$100
International Brangus Breeders	$300
North American Limousin	$500
North American South Devon	$100
Red Angus	$200
Senepol Cattle Breeders	$100

OTHERS

Agriculture Canada - Red Meat Division	$100
American Breeders Service	$100
Composite Cattle Breeders Alliance	$100
Connors State College	$100
Great Western Beef Expo	$ 50
King Ranch	$ 50
Manitoba Agriculture	$100
National Association of Animal Breeders	$100
National Cattlemen's Association	$100
NOBA	$100
Rancho Arboleda	$ 50
Select Sires	$100
Taylors Black Simmental	$ 50
Tri-State Breeders Crop.	$100
Turner Brothers Farms, Inc.	$ 50
21st Century Genetics	$100

BIF MEMBERS WHO HAVE NOT PAID MEMBERSHIP DUES FOR 1994 (as of May 31, 1994)

STATE BCIA'S

Hawaii	$100
Montana	$100

BREED ASSOCIATIONS

American Beefalo	$100
American Blonde d'Aquitaine	$100
Belted Galloway Society	$100
United Braford Breeders	$200
Salers Association of Canada	$100
Santa Gertrudis Breeders	$200

OTHERS

Beef Improvement Ontario	$100

THE SEEDSTOCK BREEDER 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	1874
Bert Crame	CA	1974
Burwell M. Bates	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chesnut	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
Harold Anderson	SD	1977
William Borror	CA	1977
Robert Brown, Simmental	TX	1977
Glen Burrows, PRI	NM	1977
Henry, Jeanette Chitty	FL	1977
Tom Dashiell, Hereford	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. Benett	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
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 Willson	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 Bryan	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.Cornwell	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	ND	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
Rob Bieber	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 & Families	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
Roy D. McPhee	CA	1986
W.D. Morris & James Pipkin	MO	1986
Clarence Van Dyke	MT	1986
John H. Wood	SC	1986
Evin & Verne Dunn	CAN	1986
Glenn L. Brinkman	KS	1986
Jack & Gini Chase	WY	1986
Henry & Jeanette Chitty	FL	1986
Lawrence H. Graham	KY	1986
A. Lloyd Grau	NM	1986
Mathew Warren Hall	AL	1986
Richard J. Putnam	NC	1986
Robert J. Steward & Patrick C. Morrissey	OR	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	AL	1987
Forrest Byergo	MO	1987
Clayton Canning	CAN	1987
James Bush	SD	1987
Robert J. Steward & Patrick C. Morrissey	OR	1987
Eldon & Richard Wiese	MN	1987
Douglas D. Bennett	TX	1988
Don & Diane Guilford and 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	WS	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 & Ruby Simpson	CAN	1990
T. D. & Roger Steele	VA	1990
Bob Thomas Family	OR	1990
Ann Upchurch	AL	1991
Nicholas Wehrmann & Richard McClung	VA	1991
John Bruner	SD	1991
Ralph Bridges	GA	1991

Dave & Carol Guilford	CAN	1991	Norman Bruce	IL	1993
Richard & Sharon Beitelspacher	SD	1991	Wes & Fran Cook	NC	1993
Tom Sonderup	NE	1991	Clarence, Elaine and Adam Dean	SC	1993
Steve & Bill Florschuetz	IL	1991	Dan Eldridge & Yates Adcock	OK	1993
R.A. Brown	TX	1991	Joseph Freund	CO	1993
Jim Taylor	KS	1991	R.B. Jarrell	TN	1993
R.M. Felts & Son Farm	TN	1991	Rueben, Leroy and Bob Littau	SD	1993
Jack Cowley	CA	1991	J. Newbill Miller	VA	1993
Rob & Gloria Thomas	OR	1991	J. David Nichols	IA	1993
James Burns & Sons	WI	1991	Miles P. "Buck" Pangburn	IA	1993
Jack & Gini Chase	WY	1991	Lynn Pelton	KS	1993
Summitcrest Farms	OH	1991	Ted Seely	WY	1993
Larry Wakefield	MN	1991	Collin Sander	SK	1993
James R. O'Neill	IA	1991	Harrell Watts	AL	1993
Francis & Karol Bormann	IA	1992	Bob Zarn	MB	1993
Glenn Brinkman	KS	1992	Ken & Bonnie Bieber	SD	1994
Bob Buchanan Family	OR	1992	John Blankers	MN	1994
Tom & Ruth Clark	VA	1992	Jere Caldwell	KY	1994
A.W. Compton, Jr.	AL	1992	Mary Howe di Zerega	VA	1994
Harold Dickson	MO	1992	Ron & Wayne Hanson	CAN	1994
Tom Drake	OK	1992	Bobby F. Hayes	AL	1994
Robert Elliott & Sons	TN	1992	Buell Jackson	IA	1994
Dennis, David & Danny Geffert	WI	1992	Richard Janssen	KS	1994
Eugene B. Hook	MN	1992	Bruce Orvis	CA	1994
Dick Montague	CA	1992	John Pfeiffer Family	OK	1994
Bill Rea	PA	1992	Calvin & Gary Sandmeier	SD	1994
Calvin & Gary Sandmeier	SD	1992	Dave Taylor & Gary Parker	WY	1994
Leonard Wulf & Sons	MN	1992			
R.A. Brown	TX	1993			

SEEDSTOCK BREEDER OF THE YEAR

John Crowe	CA	1972	Bill Borror	CA	1983
Mrs. R.W. Jones	GA	1973	Lee Nichols	IA	1984
Carlton Corbin	OK	1974	Ric Hoyt	OR	1985
Leslie J. Holden	MT	1975	Leonard Lodoen	ND	1986
Jack Cooper	MT	1975	Harry Gardiner	KS	1987
Jorgensen Brothers	SD	1976	W.T. "Bill" Bennett	WA	1988
Glenn Burrows	NM	1977	Glynn Debter	AL	1989
James D. Bennett	VA	1978	Doug & Molly Hoff	SD	1990
Jim Wolfe	NE	1979	Summitcrest Farms	OH	1991
Bill Wolfe	OR	1980	Leonard Wulf & Sons	MN	1992
Bob Dickinson	KS	1981	R.A. "Rob" Brown	TX	1993
A.F. "Frankie" Flint	NM	1982	J. David Nichols	IA	1993
			Richard Janssen	KS	1994

BEEF IMPROVEMENT FEDERATION
SEEDSTOCK NOMINEES

Ken & Bonnie Bieber
K & B Herefords
Onida, South Dakota

K & B Herefords was started in 1959 by Ken and Bonnie and today includes sons Brooke and Kirk. Today the ranch consists of 6400 acres of which 5200 acres are grass and 1200 acres are cultivated. Presently, they breed 250 registered Herefords and 150 commercial cows. Bulls and select groups of open heifers are sold at an annual production sale in February. Commercial calves are sold both direct and through local auction markets. The operation is very dependent upon the commercial cattleman and so their breeding program is designed to produce cattle with balanced EPD's, adequate frame and muscle and correct structure. Prospective buyers are provided with useful data including: birth weight, weaning weight, yearling weight, sale day weight, weight per day of age, frame score, scrotal circumference and individual EPD's. Semen from their top bulls is marketed throughout the U.S. and several foreign countries. Utilization of performance records, EPD's, A.I. and embryo transfer have allowed K & B Herefords to realize gains in weaning and yearling weights of 181 and 300 lbs., respectively, over the past 22 years. K & B Herefords has an impressive list of champions at numerous shows. In the 1993 AHA Sire Evaluation, 36 K & B bred bulls were listed. Ken has been recognized with the National Premier Exhibitor Award in 1990-1991, received a conservation award and currently serves as a director for the South Dakota Hereford Association.

Ken & Bonnie Bieber have been nominated by the South Dakota Beef Cattle Improvement Association.

John Blankers
Silver Hills Farm
Holland, Minnesota

Silver Hills Farm, owned and operated by John and Helen Blankers has included cattle production for 42 years. Registered Charolais cattle have been produced for the last 26 years. For 22 years, the herd has been enrolled in the Minnesota Beef Cattle Improvement Association and the American International Charolais Association Performance Programs. Performance information recorded includes: birth, weaning and yearling weight, average calving interval, carcass data, pelvic area and gestation length. Artificial insemination is utilized to maximize the use of individual superior Charolais sires which are selected to lower birthweight, maintain or increase performance and increase milk and total maternal with emphasis on high accuracy, progeny proven sires. Over the last 20 years, heifer weaning and yearling weights have increased 128 and 274 lb., respectively. Likewise, bull weaning and yearling weights have increased 118 and 369 lb., respectively. John is also a believer in cow reproductive function as exemplified by a 90-99% calf crop on average. John has held numerous leadership positions at the local, state and national level including local county cattlemen's board, President of the Minnesota Charolais Association and President of the American International Charolais Association in 1983.

John Blankers has been nominated by the Minnesota Beef Cattle improvement Association.

Jere Caldwell
Jere Caldwell Herefords
Danville, Kentucky

Jere Caldwell, a fulltime farmer, is a lifetime resident of Boyle County in Kentucky. After attending college, he returned to the farm and has been in the cattle business since 1950 and the cow business since 1961.

During his career, he has been active in leadership positions with the beef industry at national, state and county levels. Some of the positions he has held include Kentucky Director for American Cattleman's Association and later for the National Cattlemen's Association. He was appointed as an Executive Committee Member and to the NCA Building Committee. In Kentucky, Jere is a past-president of the Kentucky Feeder Calf Association and Charter President of the Kentucky Beef Cattle Association. On the local level, he has served as a president and director of the Boyle County Livestock Marketing Coop.

Jere's innovative early use of performance records for 32 years, sire evaluation programs, ultrasound evaluations, and his ability to interpret these data, have been the key to his very successful management program and a model for many other producers throughout the county.

Dr. Curtis Absher, Assistant Director of Cooperative Extension Service for Agriculture, of the University of Kentucky College of Agriculture, states, "In his breeding program and his leadership roles, Jere has attempted to keep in mind present and future demands of consumers as well as the opportunities and constraints of the Kentucky farmer. His overriding goals are to unify the industry building bridges of cooperation and understanding among the various segments of the beef industry."

Jere Caldwell has been nominated by the Kentucky Cattlemen's Association.

Mary Howe di Zerega
Oakdale Farm
Upperville, Virginia

Mary Howe di Zerega grew up on the family farm in Fauquier County Virginia and at an early age developed a love of the land and cattle that have been the livelihood of her forbearers since the 1600's. Becoming the owner of Oakdale Farm in 1964, she brought the cattle operation from a 100 cow commercial herd to 250 registered Charolais cows and some 600-700 total head of purebred Charolais.

The primary goal of the Oakdale Farm program is to service the commercial producer with functionally sound, optimum performance level bulls. Oakdale Farm has developed an increasingly popular annual bull sale which has become very successful. Over the years Oakdale has tested bulls in the Virginia BCIA and West Virginia central test stations annually and has received a number of awards.

Mary Howe di Zerega has emerged as a real leader in the Virginia Beef Industry, having served as President and Director of the Virginia Charolais Association, Director of the Virginia Cattlemen's Association, President of the Virginia Beef Expo, member of the American International Charolais Association Breed Improvement Committee, and Beef Advisor Board Member for the Atlantic Rural Exposition. She serves as a member of the Virginia Tech Animal Science Advisory Committee. She has been active locally and currently serves on the Fauquier County Farm Bureau Board of Directors.

She has been recognized as the Conservation Farmer of The Year by the John Marshall Soil and Water Conservation District in 1974 and 1988. She received the Virginia Department of Conservation Clean Water Farm Award in 1988.

Mary Howe di Zerega has been nominated by the Virginia Beef Cattle Improvement Association.

Ron & Wayne Hanson
Hanson's Ranches
Airdrie, Alberta

Hanson Ranches in Airdrie, Alberta is owned and operated by Ron and Wayne Hanson. Now in it's third generation, the ranch was founded by Ron's parents, Gene and Sally Hanson in 1943. The cow business is the lifeblood of this family, and they are known for the sincerity, pride and enjoyment with which they manage Hanson's Ranches.

Today, the Hansons manage a 230 head Hereford and Red Angus seedstock herd. Their breeding philosophy is based upon belief in the value of balanced genetics, a philosophy which has earned them a reputation for cattle which function in both the commercial and purebred industries. Though a purebred operation, they breed primarily for the commercial market. Performance goals originate from the considerable amount of time spent with commercial cattlemen, feeders and packers who identify the needs of the different segments of the industry.

Ron Hanson is a past president of the Alberta Cattle Breeders Association, and has served on the Canadian Hereford Association Board of Directors. In addition to being a past President of the Alberta Hereford Association, Ron was a founding Director of the Alberta Hereford Test Center. Wayne has also been a Director on the Alberta Hereford Association Board of Directors. Ron and Wayne are especially active with the youth of the cattle industry; for 35 consecutive years, Ron was the leader of or adult advisor to 4-H Clubs, and Wayne is presently an adult advisor to the Alberta Junior Hereford Association.

Ron & Wayne Hanson have been nominated by the Canadian Hereford Association.

Bobby F. Hayes
Dixie Cattle Farm
Billingsley, Alabama

Dixie Cattle Farm is a family farm located near Billingsley, Alabama in Central Alabama. The farm consists of 270 owned acres and 80 rented acres. Bobby Hayes, his wife Dora and daughter Kay provide the labor force which manages 60 head of purebred Simmental and 43 head of purebred Limousin cattle. The Hayes' have five other children that were reared on the farm and are now married and are located within thirty miles of the farm.

The Hayes began in the cattle business in the early 1950's with commercial cattle. They began the A.I. process in the mid 1960's and tried many different breeds of cattle. In 1971, they bred their first Simmental and Limousin cattle and have maintained both breeds. Their program is aimed at producing bulls of both breeds for the commercial producers in Central Alabama. Many of their customers have kept performance records on their commercial herds through the Alabama Beef Cattle Improvement Association and have been recognized for their production in statewide awards programs.

Dixie Cattle Farm has produced bulls that have topped all four Central Test Stations in Alabama. The Hayes children have all been active in 4-H and have been successful at local and state shows.

Mr. Hayes has been involved with both state breed associations, serving as board member and officer. Bobby F. Hayes has been nominated by the Alabama Beef Cattle Improvement Association.

Buell Jackson
Jackson Hereford Farms
Mechanicsville, Iowa

Jackson Hereford Farms has been involved in the Hereford seedstock business for 103 years spanning five generations. Today, the herd consists of approximately 135 registered Hereford cows resulting from selection based on 26 years of herd enrollment in the American Hereford Association's Total Performance Records Program. A true believer in performance records, Buell has provided birth, weaning and yearling weight, structural soundness, milking ability and udder soundness information to potential bull and female buyers for 26 years. More recent emphasis areas include carcass data and calving ease scores. Buell has contributed to and utilizes National Sire Evaluation results. Indeed, eight Jackson Hereford Farms bulls currently appear on the American Hereford Sire Summary; three of which are ranked in the top 20 for weaning weight EPD. Buell has placed significant emphasis on female productivity and function as exemplified by a 95% calf crop on average and six cows appearing on the American Hereford Association most efficient cow list. The latest ten year herd performance analysis results show that herd average EPD have increased 4 lb. for birth weight, 27 lb. for weaning weight, 42 lb. for yearling weight, 4 lb. for pure milk and 16 lb. for combined maternal. Buell has served as officer and director of numerous regional, state and national level Hereford and cattle organizations and is heavily involved with local and state church and school activities and responsibilities.

Buell Jackson has been nominated by the Iowa Cattlemen's Association.

Richard Janssen
Green Garden Angus Farm
Ellsworth, Kansas

Richard Janssen owns and operates a 4,000 acre integrated farm that produces wheat, milo, oats, alfalfa and forage crops. His 200 head of registered Angus cows utilize the pasture and crop residues of this farm.

Janssen's goal, for the past 26 years, has been to provide the commercial cattleman with problem-free seedstock that will make him the most profit.

Since 1984, he has been aggressively stacking pedigrees to improve the predictability in his systematic approach to seedstock selection. Systematic selection is simply putting parameters on breeding functions. The first function is calving ease. The breeding process is built around EPD's for birth weight and actual birth weights. The second function is mothering ability. Janssen is interested in puremilk EPD's that are breed average or above. The third function is growth. He does not limit growth as long as the first two functions are maintained. Then those cattle are separated into one of three different systems:

- System 1 - Calving ease: Birth EPD's of -3.0 to +1.0; with actual birth weights of 65 to 80 lbs. and milk EPD's of +0 to +20 lbs.
- System 2 - Combination: Birth EPD's of +1.0 to +4.0; with actual birth weights of 80 to 95 lbs. and milk EPD's of 0 to +15 lbs.
- System 3 - Growth; Birth EPD's of +4.0 to +8.0; with actual birth weights of 95 lbs. and up and milk EPD's of 0 to 15 lbs.

In addition, Janssen is developing a group of carcass cattle by stacking EPD's primarily for the marbling trait as identified by the carcass evaluation program of the American Angus Association.

Janssen feels this selection process gives his customers the opportunity to choose from a wider range of more predictable products that can more accurately target the needs of their cattle operation.

Richard Janssen has been nominated by the Kansas Livestock Association.

Bruce Orvis
Orvis Cattle Company
Farmington, California

Bruce Orvis has dedicated most of his life to improving his ranch and Registered Hereford breeding herd. He has also spent a tremendous amount of time to help pioneer performance testing and the betterment of the beef industry statewide and nationally. He is of the fourth generation on the Orvis ranch and a third generation Hereford breeder. The registered Hereford herd started in 1918 by his father and grandfather represents the oldest continuous herd in California. He believes you must support the basic research being done at the universities and then get that information out to the ranchers in the country.

At 66, he is still actively working and managing the ranch, as well as taking time to be on the Boards of the California-Nevada Hereford Association, the Western States Hereford Committee, and the California Beef Cattle Improvement Association. In the past, he has served as President of the California-Nevada Hereford Association and President of the local Stanislaus-San Joaquin Cattlemen's Association. He was the second President of the California Beef Cattle Improvement Association. He was also named Outstanding Young Farmer of California in 1963.

Although mainly selling registered Hereford breeding bulls off of the ranch to commercial herds in California, Nevada, Oregon and Mexico, his cattle also have won many championships at various bull sales.

Orvis is very committed to working with the Junior Hereford Association and has helped them in their endeavors. After serving in the Navy in 1945 and 1946, he received his BA in Business Economics from the College of Pacific where he was very active in student affairs and athletics.

He has been married to his wife, Roma, for 45 years and has three sons, one daughter, and 12 grandchildren. Bruce Orvis has been nominated by the California Beef Cattle Improvement Association.

The John Pfeiffer Family
Pfeiffer Farms
Orlando, Oklahoma

Pfeiffer Farms, owned and operated by the John H. Pfeiffer Family, Orlando, Oklahoma is the oldest continuously operated Angus herd in Oklahoma. This operation currently involves three generations of family members. They have been in the seedstock business for 64 years and currently run 250 registered cows. Pfeiffer Farms actively participate in the collection of performance data for the Angus Herd Improvement Records program. Approximately 90 bulls are sold each year, with 97% of these going to commercial herds. On-farm testing and central testing of bulls at Oklahoma Beef Incorporated is practiced. Pfeiffer Farms place strong emphasis on EPD performance throughout their seedstock and commercial herds and strive to produce balanced-trait cattle. Great effort is made to buy back calves from customer herds to use in the 1000 head stocker program on wheat pasture. The operation encompasses 6000 acres, including 1800 acres of crop ground, primarily wheat ground that is grazed or harvested for grain, 200 acres milo, and 70 acres of alfalfa. They own 4200 acres of grass that maintains the cow herds. Pfeiffer Farms runs 100 commercial cows developed from the registered herd. Some of their central test bulls are used on their commercial cows, to help determine how well their bulls work for customers. Close watch is kept on cost per cow unit and maternal performance to better fit with their resources. They feel that their operation would not be in the place it is now had they not started keeping performance records when they did.

The John H. Pfeiffer Family has been nominated by the Oklahoma Beef Incorporated and Oklahoma Cooperative Extension Service.

Calvin & Gary Sandmeier
Sandmeier Charolais Ranch
Bowdle, South Dakota

The Sandemier's have been in the cattle business for 24 years. Over the last 18 years they have developed a 450 cow Charolais herd with a performance reputation. Performance records have been an important part of the operation since it's beginning, utilizing the A.I.C.A. program for 16 years. Performance records emphasized include all growth traits, the reproductive traits of calving interval, scrotal circumference and pelvic area, and carcass data. By judicious use of all performance records, weaning weights have increased by 100 pounds and yearling weights by 150 pounds. Approximately 125 bulls are sold through a production sale each year where comprehensive performance records, including all EPD's are provided to buyers. Genetic improvement is made through a careful selection of AI sires. About 40% of the cows are AI'd. Several bulls bred by the Sandemeier's are listed in the Charolais sire summary. Moderate birth weight and high growth describe Sandemeier cattle, with SCR Sir Advantage 9048 being an example, posting a yearling weight EPD of +61.9 and a birth weight EPD of +3.1. Leadership activities include director and president of South Dakota Charolais Association; past president North Central Livestock Association; president South Dakota Beef Breeds Council; and director South Dakota Cattleman's Association. Among the honors awarded Sandemeier Charolais are the 1991 South Dakota Beef Improvement Federation Seedstock Producer of the year; 1994 South Dakota Charolais Seedstock Producer of the year; 1994 American International Purebred Seedstock Producer of the Year.

Calvin and Gary Sandmeier of Bowdle, South Dakota have been nominated by the American International Charolais Association.

Dave Taylor & Gary Parker
Taylor Angus Ranch
Laramie, Wyoming

Taylor Angus started business in 1986 but grew rapidly to presently consist of approximately 600 registered cows and 700 head of commercial purebred Angus. These cattle run on over 35,000 acres of shortgrass range country at over 7300 feet elevation. Manager Gary Parker has built this herd on sound genetic principles and continually strives to fine-tune his genetic program so that the cattle closely fit their very challenging environment. They work at producing functional, problem-free cattle with customer satisfaction as a primary goal. They are currently marketing approximately 190 head of registered bulls annually. Their first female production sale this past fall sold cattle into eleven states and Canada. An annual Customer Appreciation Day attracts large crowds and is highlighted by educational programs, evaluation contests using EPD's as well as the viewing of high quality Angus cattle. Taylor Angus is also strong supporters of 4-H, FFA and Junior Breed Association activities. Their primary goal is to continue to produce functional, predictable Angus cattle that meet with customer satisfaction.

Dave Taylor and Gary Parker have been nominated by the Wyoming Beef Cattle Improvement Association.

FOR IMMEDIATE RELEASE

Richard Janssen named "1994 BIF OUTSTANDING SEEDSTOCK PRODUCER"

Des Moines, Iowa - Richard Janssen, owner and operator of Green Garden Angus Ranch of Ellsworth, Kansas, has been selected as the Beef Improvement Federation's (BIF) 1994 OUTSTANDING SEEDSTOCK PRODUCER at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Richard owns and operates a 4,000 acre integrated central Kansas farm that produces wheat, milo, oats, alfalfa and forage crops. His 200 head of registered Angus cows utilize the native range and crop residues. Richard's goal for the past 26 years, has been to provide the commercial cattleman with problem-free, profitable seedstock.

Since 1984, Richard has been aggressively stacking pedigrees to improve the predictability in his systematic approach to seedstock selection. Systematic selection is simply putting parameters on breeding functions. Richard's first function is calving ease with the breeding process built around EPD's for birthweight and actual birth weights. Richard's second function is mothering ability with pure milk EPD's that excess breed average or above. Richard's third function is growth with no limit as long as the first two functions are maintained. Richard separates the Angus cattle into one of three systematic groups.

System 1 cattle represent a source of genuine calving ease cattle with the genetic ability to maintain moderate mature cow size. System 2 cattle are designed around moderate birthweight with added growth. These cattle provide commercial cattlemen with the opportunity to add more growth to their cowherds without adding excessive birthweight. System 3 cattle are designed to compete with the major growth breeds and are promoted as a terminal cross.

In addition, Richard has developing a group of Angus carcass cattle by stacking EPD's primarily for the marbling trait as identified by the carcass evaluation program of the American Angus Association.

Richard feels that this systematic selection process employed by Green Garden Angus Ranch gives his customers the opportunity to choose from a wider range of more predictable products that can more accurately target the needs of his commercial cattle producing clientele.

Richard is ably assisted in day to day activities by his wife, Shelly. Richard Janssen, Green Garden Angus was nominated by the Kansas Livestock Association.

BIF is pleased to recognize this excellent production system with their 1994 OUTSTANDING SEEDSTOCK PRODUCER AWARD.

THE COMMERCIAL PRODUCER HONOR ROLL OF EXCELLENCE

Chan Cooper	MT	1972	John A. Jameson	IL	1977
Alfred B. Cobb, Jr.	MT	1972	Leo Knoblauch	MN	1977
Lyle Eivens	IA	1972	Jack Pierce	ID	1977
Broadbent Brothers	KY	1972	Mary & Stephen Garst	IA	1977
Jess Kilgore	MT	1972	Odd Osteross	ND	1978
Clifford Ouse	MN	1973	Charles M. Jarecki	MT	1978
Pat Wilson	FL	1973	Jimmy G. McDonnal	NC	1978
John Glaus	SD	1973	Victor Arnaud	MO	1978
Sig Peterson	ND	1973	Ron & Malcolm McGregor	IA	1978
Max Kiner	WA	1973	Otto Uhrig	NE	1978
Donald Schott	MT	1973	Arnold Wyffels	MN	1978
Stephen Garst	IA	1973	Bert Hawkins	OR	1978
J.K. Sexton	CA	1973	Mose Tucker	AL	1978
Elmer Maddox	OK	1973	Dean Haddock	KS	1978
Marshall McGregor	MO	1974	Myron Hoeckle	ND	1979
Lloyd Mygard	MD	1974	Harold & Wesley Arnold	SD	1979
Dave Matti	MT	1974	Ralph Neill	IA	1979
Eldon Wiese	MN	1974	Morris Kuschel	MN	1979
Lloyd DeBruycker	MT	1974	Bert Hawkins	OR	1979
Gene Rambo	CA	1974	Dick Coon	WA	1979
Jim Wolf	NE	1974	Jerry Northcutt	MO	1979
Henry Gardiner	KS	1974	Steve McDonnell	MT	1979
Johnson Brothers	SD	1974	Doug Vandermyde	IL	1979
John Blankers	MN	1975	Norman, Denton & Calvin Thompson	SD	1979
Paul Burdett	MT	1975			
Oscar Burroughs	CA	1975	Jess Kilgore	MT	1980
John R. Dahl	ND	1975	Robert & Lloyd Simon	IL	1980
Eugene Duckworth	MO	1975	Lee Eaton	MT	1980
Gene Gates	KS	1975	Leo & Eddie Grubl	SD	1980
V.A. Hills	KS	1975	Roger Winn, Jr.	VA	1980
Robert D. Keefer	MT	1975	Gordon McLean	ND	1980
Kenneth E. Leistritz	NE	1975	Ed Disterhaupt	MN	1980
Ron Baker	OR	1976	Thad Snow	CAN	1980
Dick Boyle	ID	1976	Oren & Jerry Raburn	OR	1980
James D. Hackworth	MO	1976	Bill Lee	KS	1980
John Hilgendorf	MN	1976	Paul Moyer	MO	1980
Kahau Ranch	HI	1976	G.W. Campbell	IL	1981
Milton Mallery	CA	1976	J.J. Feldmann	IA	1981
Robert Rawson	IA	1976	Henry Gardiner	KS	1981
William A. Stegner	ND	1976	Dan L. Weppler	MT	1981
U.S.Range Exp. Sta	MT	1976	Harvey P. Wehri	ND	1981
John Blankers	MN	1977	Dannie O'Connell	SD	1981
Maynard Crees	KS	1977	Wesley & Harold Arnold	SD	1981
Ray Franz	MT	1977	Jim Russell & Rick Turner	MO	1981
Forrest H. Ireland	SD	1977	Oren & Jerry Raburn	OR	1981

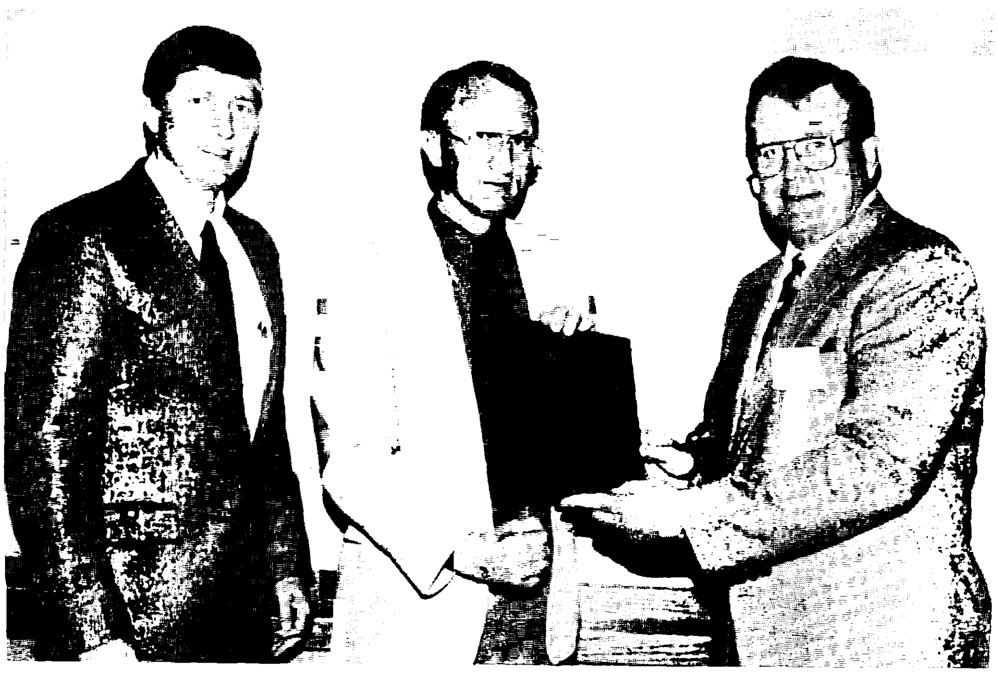
Orin Lamport	SD	1981
Leonard Wulf	MN	1981
Wm. H. Romersberger	IL	1982
Milton Krueger	MO	1982
Carl Odegard	MT	1982
Marvin & Donald Stoker	IA	1982
Sam Hands	KS	1982
Larry Campbell	KY	1982
Lloyd Atchison	CAN	1982
Earl Schmidt	MN	1982
Raymond Josephson	ND	1982
Clarence Reutter	SD	1982
Leonard Bergen	CAN	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
Don Moch	ND	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 Harvey	OR	1985
John Maino	CA	1985
Ernie Reeves	VA	1985
John E. 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 Shuman	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
Raymong R. Peugh	IL	1990
Lewis T. Pratt	VA	1990
Ken & Wendy Sweetland	CAN	1990
Swen R. Swenson Cattle Co.	TX	1990
Rober A. Nixon & Son	VA	1991
Murray A. Greaves	CAN	1991
James Hauff	ND	1991
Pat Hardy	GA	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
W.B. Allen	TN	1992
Mark Barenthsen	ND	1992
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	CA	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 and Steve Kleiboeker	MO	1993
Jim Maier	SD	1993
Bill and 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, V	VA	1994
Clint Reed	WY	1994
Stan Sears	CA	1994

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
Jeff 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

Fran & Beth Dobitz, Cedar Valley Ranch, LTD., receive 1994 Commercial Producer of the Year recognition. (left to right) Ron Bolze, Executive Director; Fran & Beth Dobitz, recipients; Marvin Nichols, President.



Richard Janssen, Green Garden Angus Ranch receives 1994 BIF Seedstock Producer recognition. (left to right) Ron Bolze, Executive Director; Richard Janssen, recipient; Marvin Nichols, President.

BEEF IMPROVEMENT FEDERATION
COMMERCIAL NOMINEES

Fran & Beth Dobitz
Cedar Valley Ranch LTD.
Morristown, South Dakota

Cedar Valley Ranch LTD., Morristown, South Dakota, is a family corporation comprised of Carl and Rosella Dobitz and Carl's son, Fran, and his wife Beth. Carl has been ranching for 43 years and is still actively involved. The ranch today consists of over 11,000 acres of which over 9,000 are in forage production. The excellent cow herd consists of over 500 crossbred cows. These cows are involved in a rotational - terminal crossbreeding system. They also handle up to 750 stocker cattle each year. Carl began keeping performance records on his calves in 1962 when the calves weighed 420 pounds at 205 days. Currently the adjusted 205 day weight is 717 lbs. The 1993 NCA-IRM-SPA production measures are: pregnancy percentage = 93.1%; pregnancy loss percentage = 0.0%; calving percentage = 93.1%; calf death loss = 0.0%; calf crop or weaning percentage = 93.1%; female replacement rate = 17.9%; calf death loss based on number of calves born - 0.0%; calves born during first 21 days = 72%; calves born during first 42 days = 94%; calves born during first 63 days = 100%; calves born after first 63 days = 0.0%; average age at weaning = 164 days; average actual weaning weight = 555 lbs.; and pounds weaned per exposed female = 515 lbs.. Cedar Valley Ranch uses their production statistics to determine future direction and aid in identifying current deficiencies. Cedar Valley Ranch keeps detailed records of the inputs for the cow herd. They are currently concentrating on further reducing these inputs. They have received numerous awards in the past and members of the family are very active in livestock circles and local organizations. The bottom line at Cedar Valley Ranch can be summed up as "Quality is Job One".

Fran and Beth Dobitz were nominated by the North Dakota Beef Cattle Improvement Association.

Bruce Hall
Hall Ranch Trust
Meadow, South Dakota

The Hall Ranch is located in northwestern South Dakota. The ranch was started 60 years ago by Bruce's grandfather, Boyd Hall, and was carried on and expanded to its present state by Bruce's father, Kirk. Today the ranch is run by Bruce, his wife Lynn and their son Chancey. The Hall ranch lies in fairly rough country and consists of many brushy creeks and draws. The 300+ head cow herd consists of mainly Angus and Angus-Hereford cross cows bred for maternal traits, easy fleshing and moderate frame. They have utilized performance records for 30 years to select herd bulls and to cull their cow herd. The cows are bred A.I. during a 6-10 day period with Angus semen and then followed with a clean-up season utilizing Angus and Hereford bulls. The entire breeding season lasts 45 days. In 1993, 96% of the cows calved during the first 38 days of the calving season. Steer calves are sold in the fall with most of the heifer calves kept for breeding stock either for the ranch or sold as bred heifers. Their heifer A.I. program utilizes synchronization with heifers bred one time over a three day period. Average weaning weights of the calves has increased from 502 lbs. in 1986 to 610 lbs. in 1992. The improvement in weaning weights has been accomplished without creep feeding. The Hall Ranch is committed to proper utilization of their natural resources and allow their cows to do as much of the forage harvesting as possible to keep input costs to a minimum.

Bruce Hall was nominated by the South Dakota Beef Cattle Improvement Association.

Lamar Ivey
Ivey & Ivey Farms
Webb, Alabama

Ivey & Ivey Farms is a family owned operation located in Webb, the wiregrass region of Southeast Alabama. Lamar, Kaye, their children and Lamar's parents are the owners of Ivey & Ivey Farms and the Ivey Processing Plant. They have been in business for 46 years with a cow herd now at 140 head.

Mr. Ivey realized early on that to sell a quality product to his customers he would need to produce and monitor each step of the production system. Mr. Ivey has mastered such a system. An exclusive A.I. program is in place with all cows being planned mated to bulls selected by Mr. Ivey. The family owned feedlot is used to finish the steers and 85-90% of the production is sold in the families processing plant. a Total Quality Management Program is maintained by including a superior forage program, an outstanding health program, and a planned breeding program. This type of management has insured the quality product the Ivey family merchandises.

The Ivey cow herd is one of the outstanding herds in the southeast with many of the cows winning awards in Alabama's BICA commercial program.

The Ivey family has also been a leader in the industry for many years, with a true total quality managed cow herd. By controlling each segment of production, they have returned more profit to the farm.

Lamar Ivey was nominated by the Alabama Beef Cattle Improvement Association.

Gordon Mau
Mau Farm, Inc.
New Hampton, Iowa

Gordon Mau of Mau Farm, Inc. has been involved with the commercial cow/calf enterprise for 28 years. Performance records have been utilized to select herd sires and cull the cow herd for this entire time period, with data submitted to the North American South Devon Association and analyzed through the American Polled Hereford Association. The herd of 60 cows has evolved through a rotational cross breeding program to a high percentage South Devon herd today. Artificial insemination is utilized to make corrective matings with sire selection based on EPD's of high accuracy, progeny proven sires. Gordon is a true believer in cow productivity and function as he employs strict criteria to cull females. For more rapid genetic change, he shortens the generation interval with high heifer replacement rates. This is exemplified by 75% of the cows being seven years of age or younger. Gordon retains ownership of all steer and non-replacement heifer progeny through the slaughter phase and collects carcass data. Selection for carcass characteristics has resulted in an increase in Choice, yield grade 2 carcasses over time. Over time, weaning weights have increased by 200 lb., yearling steer weights by 390 lb., yearling heifer weights by 240., and slaughter weights have increased by 200 lb. with 185 less days of age. Gordon has been involved in numerous local, regional and national level cattle and public service activities. He is currently the President of the Iowa South Devon Association and serves on the Performance Committee for the North American South Devon Association.

Gordon Mau was nominated by the Iowa Cattlemen's Association.

Randy Mills
Strait Ranch
Florence, Kansas

Challenge has been the key word for Randy Mills the past 25 years in the cattle business. Being from a non-agriculture background was the first, but certainly not the last challenge he has faced. Challenges have been met while increasing weaning weights over 200 lbs. per head and having averaged 88.67% Choice grade with an average of 51.3% Certified Angus Beef in the past eight years of feeding steers off the cows. In addition, Mills has reduced the breeding season 136 days and nearly tripled the size of the herd. He has gone from virtually no record keeping to compiling a database on calf birth weights, pregnancy rate, bull fertility, EPD information, A.I. information, pasture performance, feeding cost records of the cows and feedlot performance information. The ranch has also doubled in physical size over the past 25 years while maintaining the same number of employees as in 1969.

The use of EPD's when selecting future sires has become a reliable tool for Mills. A.I. is being used for fall calving first calf heifers and an embryo recipient program is in place to raise herd bulls having stacked pedigrees, with a high degree of predictability.

Mills is committed to the beef industry and it's survival and foresees change as inevitable. Accustomed to the challenge of change, Mills is working diligently to prepare his herd for future change. He believes consumer needs and wants will become a priority and if cow-calf producers are going to address these needs, change will occur in many cowherds.

Mills has demonstrated his enthusiasm in every area of the ranching business. He recently received the Excellence in Grazing Management Award from the Kansas Society for Range Management for having demonstrated skill and knowledge by practicing sound grazing management on rangeland. He has been an active member of the Kansas Livestock Association and the National Cattlemen's Association, as well as many other community and business activities.

Randy Mills was nominated by the Kansas Livestock Association's Purebred Council.

W. W. Oliver, V
Eldon Farms
Woodville, Virginia

William W. Oliver V, manager of Eldon Farms at Woodville, Virginia in Rappahanock County is one of the outstanding commercial cattlemen to be found in the state of Virginia. Mr. Oliver has managed Eldon Farm, a large farming and commercial cattle operation owned by Land Industry's since 1979. Mr. Oliver is a native of Princess Ann County, Virginia (Virginia Beach) having grown up on a dairy farm. He received his B.S. degree in Animal Science at Virginia Tech in 1959 and an M.S. degree in Animal Nutrition at Virginia Tech in 1963. Bill Oliver has been a professional farm manager all of his career, having managed a dairy operation prior to management of Eldon Farm.

Eldon Farm runs a cow herd of 850 cows producing outstanding feeder cattle which are marketed largely by teleauction. Typically calves are weaned and preconditioned before being sold in load lots.

The breeding program at Eldon Farm has utilized a number of breeds but currently uses primarily Simmental and Angus. Bulls have been selected primarily from the Virginia BCIA central bull test stations and Bill Oliver is probably Virginia's most discriminating bull buyer, making use of performance data and EPD's. Low birth weight Angus bulls are used exclusively on virgin heifers which has been proven very useful in the Eldon operation. Feeder cattle produced at Eldon Farm today are moderate in frame size but have the ability to gain weight rapidly and produce slaughter cattle in a weight range the market desires.

Bill Oliver has been active in a number of community activities and currently serves on the Board of the Culpeper Hospital as a Vestry Member of Trinity Episcopal Church and as past member of Rappahanock County School Board. He is married to the former Lucy Seldon and they are the parents of three children.

William Oliver was nominated by the Virginia Beef Cattle Improvement Association.

Clint Reed
Thermopolis, Wyoming

Clint Reed started ranching near Thermopolis, Wyoming with his parents upon graduating from high school in 1965.

In 1972, he purchased land from his parents and over the years added more land to where they presently own about 6500 acres in Hot Springs and Fremont counties in Wyoming. They also lease an additional 5000 acres of BLM and state lands.

With his wife, Linda and 3 children, they run 300 head of mother cows and 50 replacement heifers. They put up about 700 tons of hay, some feed oats and enough silage to grow their calves to about 750 pounds.

They became an I.R.M. cooperator in 1983 and have worked closely with their county extension agent, Jerry Langbehn and Wyoming Beef Specialist, Doug Hixon. Their assistance has been most helpful in getting the Reeds started in an A.I. program through which they produce their own replacement heifers. They have also participated in the W.B.C.I.A. Feedlot Test and Carcass Evaluation Program. They have participated in and attended many educational extension programs which they have found to be most informative. Obtaining and utilizing this information has been the key to enhancing their economic position.

Clint Reed was nominated by the Wyoming Beef Cattle Improvement Association.

Stan Sears
Little Shasta Ranch
Montague, California

Stan Sears started in the cattle industry in 1969 with a mortgage on 300 acres and 70 cows. Increasing the net worth has been the long-term goal of Little Shasta Ranch. The ranch now consists of 700 cows, 900 acres of irrigated pasture and 300 acres of alfalfa. Timely livestock management and farming along with judicious use of leveraging through credit by combining production with business has resulted in accomplishment of the long-term goals of Little Shasta Ranch.

The ranch uses a planned crossbreeding program, calving about 600 cows in the fall. This season avoids bad calving weather and produces a calf ready for the finished market at a seasonally good time in March and April. The herd consists of predominately English crossbred cows with a percentage Simmental. Stan strives to maintain a moderate cow size but can handle superior milking due to a majority of irrigated pasture. Sires are selected for balanced EPD's of high accuracy plus structural soundness. Calves are shipped from the ranch in November at about 900 pounds and their ownership is retained through the feedlot. By using the crossbred cow and retained ownership, the benefits of genetic improvements are reaped.

Flexibility and diversification comes from opportunities with rented land and good feed years for purchase of light calves, yearlings and Holstein dairy replacements. A small herd of registered Polled Herefords plus sale of beef heifers in the replacement market provides additional production and marketing opportunities.

Stan Sears was nominated by the University of California Cooperative Extension Service.

FOR IMMEDIATE RELEASE

Fran and Beth Dobitz named "1994 BIF OUTSTANDING COMMERCIAL PRODUCER"

Des Moines, Iowa - Fran and Beth Dobitz, managing partners in Cedar Valley Ranch LTD., Morrison, South Dakota, have been selected as the Beef Improvement Federations (BIF) 1994 OUTSTANDING COMMERCIAL PRODUCER at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Cedar Valley Ranch is a family corporation consisting of Fran, wife Beth, daughters Kelly, Kim and Kari, father Carl, and mother Rosella. Cedar Valley Ranch started from scratch 43 years ago with 13 cows. The operation now consists of more than 500 mature cows on over 11,000 acres of which over 9,000 acres are in forage production. The balance is in the farming entity, which produces feed for the cow/calf operation and 1,000 head capacity feedlot. The Cedar Valley Ranch, headquartered near the Cedar River in southwest North Dakota has had a history of being a winner. They have accomplished this by producing an exceptional herd of commercial cattle. The Dobitz family have transformed their love for the land, their desire to produce the best cow herd possible and their love for each other into one of the best family cattle ranches in North Dakota. Before Fran became an active manager of the operation, Carl and Rosella had put together a well documented operation. Their concern for information and dedication to the task of keeping records made them one of the pioneers in the state. Carl started keeping records on his calves in 1962, the first in Sioux County and one of the first in the North Dakota. Fran attended North Dakota State University earning his degree in Animal Science and then returned to the ranch in 1974, when the partnership was formed. It is a relationship he is please with and one that all are comfortable with. Fran who now handles most of the paper work, notes, "A lot of neighbors kind of wondered when I started to ear number the cows and run more cattle through the chute. Then I went out and bought a scale and they thought I was wasting money, but over the years, many of the neighbors have come over and borrowed the scale from us." Cedar Valley Ranch is currently quite involved in a rotational grazing scheme. The summer cow herd is divided into three groups. Each of these herds is rotated frequently from pasture to pasture. The stocking rate is 25 acres per cow calf unit. This allows for adequate grass left in the pasture for healthy plants, to reduce water erosion and for winter snow catch. The ranch is divided into 35 separate pastures in which there are two dams, 22 dugouts, the Cedar River, numerous creeks, ten wells, three developed springs and three miles of water pipeline feeding numerous tanks. As you can see, the management of Fran and Beth at Cedar Valley Ranch LTD., is quite intense. Here is a place where "Quality is Job One".

Fran and Beth Dobitz and Cedar Valley Ranch LTD., were nominated by the North Dakota Beef Cattle Improvement Association.

BIF is pleased to recognize this excellent production system with their 1994 OUTSTANDING COMMERCIAL PRODUCER AWARD.

FOR IMMEDIATE RELEASE

Hayes Walker, III, receives "1994 BIF AMBASSADOR AWARD"

Des Moines, Iowa - Hays Walker, III, was named the recipient of the 1994 BIF AMBASSADOR AWARD at the BIF Convention held at the University Park Holiday Inn in West Des Moines, Iowa. Walker currently heads an Ottawa, Kansas based livestock publication America's Beef Cattleman which is devoted to keeping producers abreast with the industry's latest in research and performance.

Walker's entire life has been and remains devoted to publications serving the livestock and in particular the beef cattle industry. After graduation from Kansas State University in 1956, with a degree in Ag Journalism, Walker went to work for his father, Hays Walker, Jr., who then owned the American Hereford Journal, founded by Hayes Walker in 1910. In 1956, Hays Walker, Jr. and Hayes Walker, III, purchased the Canadian Hereford Digest. Both the U.S. and Canadian publications were sold in 1961. In 1965 Hayes Walker, III, began the U.S. Charolais Banner followed in 1966 by the Canadian Charolais Banner. The year 1969 saw Walker begin the Maine Anjou Association and purchased Better Beef Business magazine. During 1970, Walker started both the Simmental Shield and the Missouri Beef Cattleman. In 1971, Walker started the Limousin Ledger and in 1984 the Canadian Charolais Connection. In 1985, Walker returned and worked for the American Hereford Journal until 1987 when he founded the America's Beef Cattleman publication.

Besides his other endeavors, Walker printed and distributed a Beef Breeds Poster in 1972, 1987, 1988, and 1989, and wrote the Blue Book of Beef Breeds in 1989. Both posters and the book have been distributed worldwide.

Hayes Walker, III, resides in Ottawa, Kansas, has been and remains a true BIF Ambassador.

BIF is pleased to honor Hayes Walker III, for his many efforts in promoting genetic improvement in the beef cattle industry by presenting him with the 1994 AMBASSADOR AWARD.

AMBASSADOR AWARD

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. de Baca	The Ideal Beef Memo	IA	1990
Dick Crow	Western Livestock Journal	CO	1992
J.T. "Johnny" Jenkins	Livestock Breeder Journal	GA	1993
Hayes Walker, III	America's Beef Cattleman	KS	1994

Hayes Walker, III, receives the 1994 BIF Ambassador Award (left to right) Ron Bolze, Executive Director; Hayes Walker, III, recipient; Marvin Nichols, President.

BIF Pioneers All (left to right) Ron Bolze, Executive Director; Robert de Baca; Tom Chrystal; Roy Wallace; Marvin Nichols, President.

FOR IMMEDIATE RELEASE

Dr. Robert C. deBaca receives a "1994 BIF PIONEER AWARD"

Des Moines, Iowa - The Beef Improvement Federation (BIF) honored a true pioneer in the genetic improvement of beef cattle when they presented a PIONEER AWARD to Dr. Robert C. deBaca at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Dr. Robert C. deBaca has had a long and distinguished career as a professional animal scientist. In the late 1950's he joined the Animal Science Extension faculty of Iowa State University. His pioneering efforts in scientific animal breeding systems culminated with the development of the Iowa Beef Improvement Association, an active organization which continues to serve the beef industry. He was a leader in the application of science to beef improvement systems and with articulate persistence, he implanted that message in the minds of the forward looking beef breeders.

Dr. deBaca demonstrated his concern for people and his ever present willingness to share his scientific expertise in a number of international activities. He was largely responsible for the development of performance testing programs in both beef cattle and swine in Argentina. He also had significant input that benefitted native Americans through his work with the Navajo Indians of the Southwest. After something over 15 years in academia, Bob decided to directly apply his expertise and entered the beef industry, beginning as a geneticist and manager of a major beef breeding program and ultimately developing his own consulting service and beef cattle management enterprise. He served three years as executive secretary of the Beef Improvement Federation and developed a quarterly newspaper published by the organization. He also coordinated the breeding and marketing activities of 13 forward looking Angus breeders who pooled their efforts to breed, advertise and market cattle jointly under the name of Ideal Beef Systems. In addition to coordinating this, he published a newsletter, "Ideal Beef Memo", which provided semi-technical information on beef cattle production to a circulation of 26,000.

Bob deBaca has always been a tireless worker and has willingly and freely shared his expertise in beef cattle production and breeding with all who would listen. He has been particularly sensitive to the needs and interests of foreign visitors and has willingly shared time and ideas with them.

Dr. deBaca undertook to chronicle the historic changes in the beef industry as it developed from an art to a science in a book entitled "Courageous Cattlemen". DeBaca's expertise, his abiding interest in people and his dedicated willingness to share his knowledge have made him a dynamic leader in a rapidly changing business. Currently Dr. deBaca is the principal in the "Managing Partner", a purebred cattle records computer software program and business.

BIF is pleased and honored to be able to recognize the many contributions of Bob deBaca with their 1994 PIONEER AWARD.

FOR IMMEDIATE RELEASE

Tom Chrystal receives a "1994 BIF PIONEER AWARD"

Des Moines, Iowa - The Beef Improvement Federation (BIF) recognized a true pioneer in the genetic improvement of beef cattle when they presented the coveted PIONEER AWARD to Tom Chrystal at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Tom Chrystal pioneered production testing beef cattle in the early 1960's, long before performance oriented cattle became popular. Tom was instrumental in the development of the Iowa Bull Test System and steadfast in the purchasing of superior performance tested bulls for his own herd.

Tom has been a stalwart and early proponent of the Iowa Beef Improvement Association (IBIA) serving as the "Bookkeeper" of the Association as well as Board Member.

Tom pioneered some of the original Integrated Resource Management (IRM) concepts. He was one of the early implementors of pasture development and rotational grazing concepts. Similar to today's Standardized Performance Analysis (SPA), Tom had complete knowledge of cost of production as well as cost analysis of all enterprises.

Tom possesses a unique "wit" combined with a common sense approach to performance as demonstrated by his regular, thought provoking contributions to one of the early performance beef cattle publications, the "Ideal Beef Memo".

Long time BIF supporter, Tom is a regular attendee to the BIF Conventions.

BIF is pleased to recognize the many contributions of Tom Chrystal by presenting him with this 1994 PIONEER AWARD.

FOR IMMEDIATE RELEASE

"1994 BIF PIONEER AWARD" presented to Roy A. Wallace

Des Moines, Iowa - The Beef Improvement Federation (BIF) honored a long-time contributor to the genetic improvement of beef cattle when they presented a PIONEER AWARD to Roy A. Wallace at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Roy A. Wallace started his career in the beef cattle industry upon graduation from Ohio State University in 1967, when he became employed by Central Ohio Breeding Association (COBA). Roy was one of the first persons with a beef background to be employed in a predominantly dairy industry. As a beef representative for COBA, Wallace developed some of the early beef breeding programs that are now standard in the industry.

In August of 1969, he moved to Select Sires, Inc., as a beef sire analyst and remained in that position until he was named Chairman, Beef Programs in 1972. In 1987, he was promoted to Vice-President in charge of Beef Programs.

Under Roy's leadership, Select Sires has grown from an artificial insemination organization with sales of 182,376 units of semen in 1969 to sales of 442,683 units in 1993. Select Sires is now one of the leading authorities of beef genetics in the world. Roy has been responsible for acquiring some of the beef industry's top progeny proven sires for calving ease, growth, milk and carcass merit. Roy has always been a believer in performance testing and National Sire Evaluation programs. In the early years he was instrumental in the development of Sire Evaluation and educating the beef industry in the importance of EPD's, accuracy and using this information to improve beef cattle genetics.

Roy is a member of the technical advisory committee of the American Simmental Association and American Angus Association. Additionally, Roy has served two terms on the Board of Directors of the Beef Improvement Federation (BIF), during which time he chaired the Reproduction and Awards Committees.

Additional professional memberships include board of directors and past president, National Association of Animal Breeders Development Committee, board of directors and past president Ohio Beef Cattle Improvement Association, and member of the Sire Evaluation Committee of the Beef Improvement Federation.

Special awards bestowed on Mr. Wallace include the young professionals award of the Ohio State University Agricultural and Home Economics College, the National Associate of Animal Breeders Quarter Century Award, and the Beef Improvement Federation Continuing Service Award.

BIF is pleased to recognize the many contributions of Roy Wallace by presenting him with this PIONEER AWARD.

PIONEER AWARDS

Jay L. Lush	Iowa State University	Research	1973
John H. Knox	New Mexico State University	Research	1974
Ray Woodward	American Breeders Service	Research	1974
Fred Willson	Montana State University	Research	1974
Charles E. Bell, Jr.	USDA-FES	Education	1974
Reuben Albaugh	University of California	Education	1974
Paul Pattengale	Colorado State University	Education	1974
Glenn Butts	Performance Registry Int'l	Service	1975
Keith Gregory	RLHUSMARC	Research	1975
Bradford Knapp, Jr.	USDA	Research	1975
Forrest Bassford	Western Livestock Journal	Journalism	1976
Doyle Chambers	Louisiana State University	Research	1976
Mrs. Waldo Emerson Forbes	Wyoming Breeder	Breeder	1976
C. Curtis Mast	Virginia BCIA	Education	1976
Dr. H. H. Stonaker	Colorado State University	Research	1977
Ralph Bogart	Oregon State University	Research	1977
Henry Holsman	South Dakota State University	Education	1977
Marvin Koger	University of Florida	Research	1977
John Lasley	University of Florida	Research	1977
W. L. McCormick	Tifton, Georgia Test Station	Research	1977
Paul Orcutt	Montana Beef Performance Assoc.	Education	1977
J. P.. Smith	Performance Registry Int'l	Education	1977
James B. Lingle	Wye Plantation	Breeder	1978
R. Henry Mathiessen	Virginia Breeder	Breeder	1978
Bob Priode	VPI & SU	Research	1978
Robert Koch	RLHUSMARC	Research	1979
Mr. & Mrs. Carl Roubicek	University of Arizona	Research	1979
Joseph J. Urick	US Range Livestock Experiment Station	Research	1979
Byron L. Southwell	Georgia	Research	1980
Richard T. "Scotty" Clark	USDA	Research	1980
F. R. "Ferry" Carpenter	Colorado	Breeder	1981
Clyde Reed	Oklahoma State University		1981
Milton England	Panhandle A & M College		1981
L. A. Moddox	Texas A & M College		1981
Charles Pratt	Oklahoma		1981
Otha Grimes	Oklahoma		1981
Mr. & Mrs. Percy Powers	Texas		1982
Gordon Dickerson	Nebraska		1982
Jim Elings	California		1983
Jim Sanders	Nevada		1983
Ben Kettle	Colorado		1983
Carroll O. Schoonover	University of Wyoming		1983
W. Dean Frischknecht	Oregon State University		1983
Bill Graham	Georgia		1984
Max Hammond	Florida		1984

Thomas J. Marlowe	VPI & SU	1984
Mick Crandell	South Dakota State University	1985
Mel Kirkiede	North Dakota State University	1985
Charles R. Henderson	Cornell University (Retired)	1986
Everett J. Warwick	USDA-ARS (Retired)	1986
Glenn Burrows	New Mexico	1987
Carlton Corbin	Oklahoma	1987
Murray Corbin	Oklahoma	1987
Max Deets	Kansas	1987
George F. & Mattie Ellis	New Mexico	1988
A. F. "Frankie" Flint	New Mexico	1988
Christian A. Dinkel	South Dakota State University (Retired)	1988
Roy Beeby	Oklahoma	1989
Will Butts	Tennessee	1989
John W. Massey	Missouri	1989
Donn & Sylvia Mitchell	Manitoba, Canada	1990
Hoon Song	Agriculture Canada	1990
Jim Wilton	University of Guelph, Canada	1990
Bob Long	Texas Tech	1991
Bill Turner	Texas A & M	1991
Frank Baker	Arkansas	1992
Ron Baker	Oregon	1992
Bill Borror	California	1992
Walter Rowden	Arkansas	1992
James W. "Pete" Patterson	North Carolina State University (Retired)	1993
Hayes Gregory	North Carolina State University (Retired)	1993
James D. Bennett	Virginia	1993
O'Dell G. Daniel	University of Georgia (Retired)	1993
M. K. "Curly" Cook	University of Georgia (Retired)	1993
Dixon Hubbard	USDA-Extension	1993
Richard Willham	Iowa State University	1993
Dr. Robert C. deBaca	Iowa State University	1994
Tom Chrystal	Iowa Bull Test System	1994
Roy A. Wallace	Select Sires, Inc.	1994

Bruce Cunningham receives a
1994 BIF Continuing Service Award
(left to right) Ron Bolze, Executive Director; Bruce Cunningham and Marvin Nichols, President.

Loren Jackson is recognized with a
1994 BIF Continuing Service Award
(left to right) Ron Bolze, Executive Director; Loren Jackson; and Marvin Nichols, President.

FOR IMMEDIATELY RELEASE

Dr. Bruce E. Cunningham receives a "1994 BIF CONTINUING SERVICE AWARD"

Des Moines, Iowa - The Beef Improvement Federation (BIF) honored Dr. Bruce E. Cunningham with a CONTINUING SERVICE AWARD at the Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

A native of Oklahoma, Bruce graduated from high school in Tuttle, Oklahoma, and earned his B.S. in Animal Science from Oklahoma State University in 1983. As an undergraduate, Bruce competed as a member of the Oklahoma State University Meats Judging Team and later served as an assistant coach of the Meats Judging Team at both Oklahoma and Michigan State Universities. Bruce earned his M.S. and Ph.D. degrees in Animal Breeding and Genetics from the Michigan State University Animal Science Department in 1985 and 1989, respectively.

Bruce has served as Director of Education and Research for the American Simmental Association (ASA), since May 1, 1989. Since joining the ASA Staff, Cunningham has had overall responsibility for the association's progressive and innovative cattle program, working in harmony and mutual cooperation with the Animal Breeding Group at Cornell University. He serves as staff liaison to the ASA Improvement Committee.

Bruce has authored numerous educational and positional papers extolling the virtues of Simmental and Simbrah cattle, on behalf of the ASA. In addition, he writes a monthly performance oriented column for the register, the official publication for the Simmental and Simbrah breeds.

Bruce has served as a Beef Improvement Federation Board member since 1989, chairing the Reproduction Committee. Bruce is also an active member of the American Society of Animal Science.

Bruce is a ardent fly fisherman and an enthusiastic downhill skier.

BIF is pleased to be able to recognize Dr. Bruce Cunningham for his many contributions to genetic improvement in the beef cattle industry by presenting him with a 1994 CONTINUING SERVICE AWARD.

FOR IMMEDIATE RELEASE

Loren Jackson receives a "1994 BIF CONTINUING SERVICE AWARD"

Des Moines, Iowa - Loren Jackson, International Brangus Breeders Association (IBBA) Director of Brangus Herd Improvement Records (BHIR) programs, San Antonio, Texas, was honored by the members of the Beef Improvement Federation (BIF) when he was presented the BIF CONTINUING SERVICE AWARD. This award was presented at the 1994 annual BIF meeting held at the University Park Holiday Inn in West Des Moines, Iowa. Jackson completed his second term as a member of the BIF Board of Directors this year.

Jackson is a native of Iowa, where he grew up on a diversified farm near Mechanicsville. As a young cattle raiser, Jackson was a National Hereford Showmanship winner.

He earned a Bachelor of Science degree from Iowa State University, Ames. While in college, he was a member of the livestock judging team; Vice-president of the Block and Bridle Club; and a member of Farmhouse Fraternity.

Jackson joined the American Hereford Association (AHA), Kansas City, Missouri, staff in 1978 as an assistant in the Total Performance Records (TPR) department. In this capacity, Jackson worked to collect carcass and feedlot data. In 1981, Jackson was made the AHA Director of Youth Activities, a position he held until 1989, when he was made Associate Editor of the breed publication.

That same year, Jackson moved from Kansas City to San Antonio to become the IBBA Director of BHIR programs. He implemented an additional Sire Summary edition - IBBA now publishes a spring and fall edition of the Sire Summary. Jackson worked with the Brangus Journal staff this year to publish the 1994 Spring Sire Summary in the April Brangus Journal. During his tenure, Jackson has overseen the development of EPD's on ET calves. He has also developed guidelines and given a start to the IBBA Carcass Evaluation Test Program.

From 1990 to 1993, Jackson had the additional duty of serving as general manager of the America's Brangus Exposition and Futurity (ABEF), the major national summer event for the Brangus breed.

Jackson also works with Brangus breeders on setting up performance data gathering programs; assists the breed publication as a field editor periodically; and is a willing and capable speaker at field days, seminars and educational meetings.

BIF is please to be able to recognize Loren Jackson for his many contributions to genetic improvement in the beef cattle industry by presenting him with a 1994 BIF CONTINUING SERVICE AWARD.

FOR IMMEDIATE RELEASE

Marvin D. Nichols receives a "1994 BIF CONTINUING SERVICE AWARD"

Des Moines, Iowa - Marvin Nichols was honored by the Beef Improvement Federation (BIF) when he received a CONTINUING SERVICE AWARD at the Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Marvin D. Nichols is a native of Iowa and the owner/operator of Nichols Cryo-Genetics of Ankeny, Iowa, a custom semen collection and processing firm. He coordinates a complete health program including work with donor females and embryo transfers with Iowa State University.

Mr. Nichols founded Iowna Farms, Ankeny, Iowa, a purebred Charolais establishment and grain farm in 1956. He is known throughout the United States and the world as a beef cattle authority and has lectured to many foreign groups and university classes, as well as 4-H and FFA groups visiting his operation.

Marvin Nichols was the recipient of the Outstanding Young Farmer Award of Polk County Iowa in 1969. He is a noted beef cattle judge and has served on the board of directors of the American International Charolais Association. He was Iowa Seedstock Producer of the Year in 1982, and has been a member of the Iowa Beef Breeds Council from 1982 to the present.

Mr. Nichols was elected to the board of directors of the Beef Improvement Federation in 1987, served as Vice-president in 1992, and was elected President in 1993.

Marvin and his wife, Janet, have been married 38 years, have five children and five grandchildren.

BIF is pleased and honored to be able to recognize the many contributions of Marvin Nichols with their 1994 CONTINUING SERVICE AWARD.

1994 BIF Continuing Service Award recipient, Marvin Nichols
(left to right)
Ron Bolze, Executive Director;
Marvin Nichols, President

FOR IMMEDIATE RELEASE

Steve Radakovich receives "1994 BIF CONTINUING SERVICE AWARD"

Des Moines, Iowa - The Beef Improvement Federation (BIF) honored Steve Radakovich, former president of BIF, with a CONTINUING SERVICE AWARD at the Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Steve has had an interest in the cattle industry from an early age, beginning with a registered Hereford herd in 1958, at the age of 14. Since that beginning, Steve and his father and partner, George, have expanded their herd in terms of size and genetic base.

An Iowa State University graduate, Steve was active in Block and Bridle, and was a member of the Livestock Judging Team. Steve went on to continue his education at Colorado State University, working towards a Masters degree in Animal Breeding, under Dr. Jim Brinks. However, after meeting his future wife, Penny, Steve and Penny were married in 1968 and returned to Iowa. Radakovich Herefords was then created, which later became Radakovich Cattle Company, with the addition of Angus and a composite consisting of Hereford, Red Angus and Barzona.

Steve has been a strong supporter of objective performance evaluation, and often while judging cattle shows throughout the United States and internationally, Steve has reminded people of the importance of evaluating functional characteristics and EPD's.

Steve was an invited speaker at the 1984 World Hereford Conference in New Zealand, and has returned on several occasions for invited speaking engagements.

In 1982, Steve judged the Centennial Hereford Show, and in September 1994, he will be judging the interbreed competition at the National Show in Zimbabwe.

Steve was on the BIF Board of Directors from 1980 through 1986, serving as President in 1982. He was one of the primary forces in encouraging incorporation of performance data in collegiate livestock judging contests. In addition, during Steve's time on the Board of Directors, he was a major proponent of the optimum approach to seedstock selection.

Steve's other honors include receiving the Iowa Seedstock Producer of the Year Award in 1982, and in 1985 he was inducted into the Iowa State University Animal Science Hall of Fame.

Steve and Penny have four children, Wendy, Tracy, Bobbi, and J.D. Steve's parents George and Gretchen remain actively involved in Radakovich Cattle Company.

BIF is please and honored to recognize the contributions that Steve has made to the performance beef cattle movement by presenting him with a 1994 CONTINUING SERVICE AWARD.

FOR IMMEDIATE RELEASE

Dr. Doyle Wilson receives a "1994 BIF CONTINUING SERVICE AWARD"

Des Moines, Iowa - The Beef Improvement Federation (BIF) honored Dr. Doyle Wilson with a CONTINUING SERVICE AWARD at their Convention held at the University Park Holiday Inn in West Des Moines, Iowa.

Dr. Doyle Wilson is Professor of Animal Science at Iowa State University. While doing his graduate work at Iowa State, he developed software and documentation for the beef feedlot performance monitoring and cost projections programs and the beef feedlot ration analysis program, programs which are still used in Iowa and other states. He received his PHD in animal breeding at Iowa State in 1984. His doctoral research focused on developing a mixed model procedure for the unification of within herd evaluations through National Beef Sire Evaluation.

For the past 10 years, Wilson has continued his research in animal genetics as applied to sire evaluations and extension education. His work helps breeders. cattle feeders and related industry personnel apply this research to their business. Included in his published research are papers on the application of ultrasound in genetic prediction and genetic parameters for carcass traits.

Dr. Wilson is the genetic advisor to the American Angus Association and has assisted them in carcass evaluation programs since 1984. He began his research in the use of real-time ultrasound to measure body composition in the live animal in 1988, and has focused on measuring backfat thickness, ribeye area and marbling using the real-time equipment. The objective of this research is to provide EPD's for beef cattle growth and milk production.

Dr. Wilson's colleagues and the industry have recognized his research and extension contributions with numerous awards. Earlier this year, the College of *Agriculture* at Iowa State University presented him the 1994 Award for Excellence in Applied Research and Extension. He has been invited to present results of his research and extension education to researchers, beef cattle producers, purebred breeders and related industry personnel throughout the United States and in Australia, Argentina, Brazil, Canada, Costa Rica, Mexico, and South Africa.

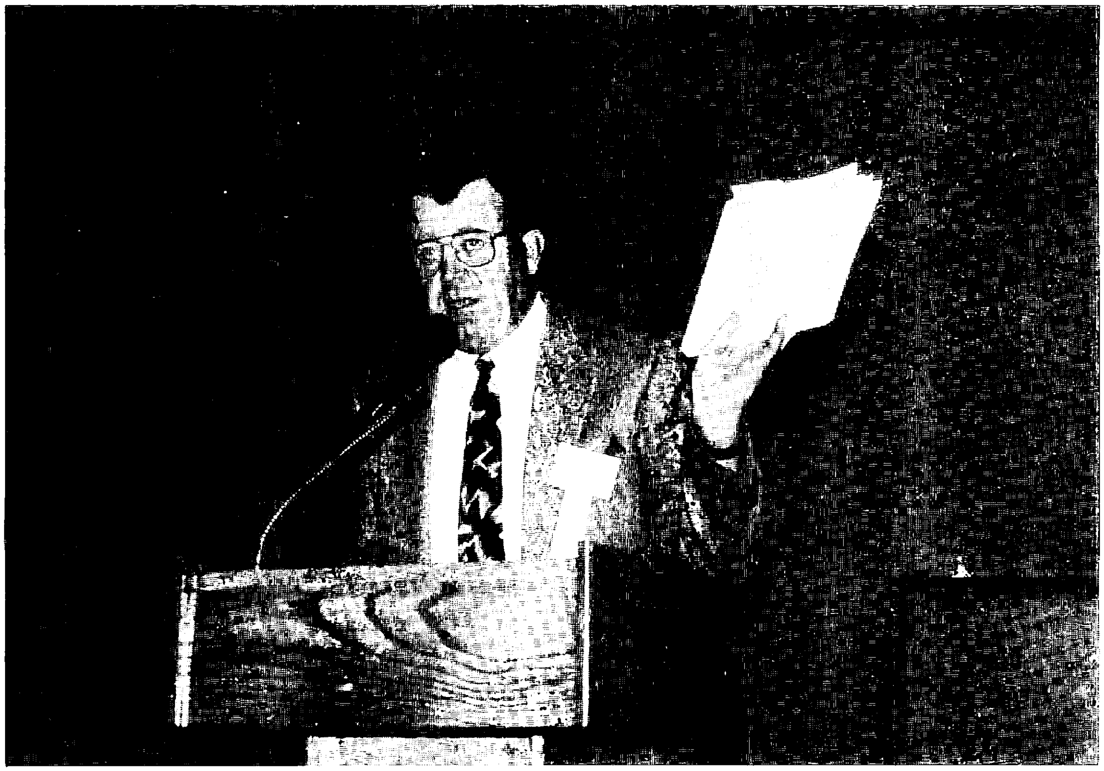
BIF is pleased and honored to be able to recognize the many contributions of Dr. Doyle Wilson with their 1994 CONTINUING SERVICE AWARD.

1994 BIF Continuing Service Award recipient Steve Radakovich
(left to right) Ron Bolze, Executive Director; Steve Radakovich, recipient; Marvin Nichols, President

Doyle Wilson receives 1994 BIF Continuing Service Award
(left to right) Ron Bolze, Executive Director; Doyle Wilson, recipient; Marvin Nichols, President

CONTINUING SERVICE AWARD

Clarence Burch	OK	1972
F. R. Carpenter	CO	1973
E.J. Warwick	DC	1973
Robert De Baca	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
Dr. Bruce E. Cunningham	MT	1994
Loren Jackson	TX	1994
Marvin D. Nichols	IA	1994
Steve Radakovich	IA	1994
Dr. Doyle Wilson	IA	1994



BIF President, Marvin Nichols, presiding over Annual Meeting.

New BIF President, Paul Bennett, expressing appreciation to former President, Marvin Nichols and his wife Janet for contributions to BIF over the past year.

New BIF Vice-president, Glenn Brinkman, addressing BIF Convention attendees.

1994 Frank Baker Memorial Scholarship recipients,
William Herring (left), and Kelly Bruns (right) with Committee Chairman, Larry Cundiff.

BIF Executive Director, Ron Bolze, performing his role as "Chief Paper Shuffler".

1994 BEEF IMPROVEMENT FEDERATION - BOARD OF DIRECTORS
Front Row: Dan Kniffen, Marvin Nichols, Paul Bennett, Glenn Brinkman, Ron Bolze, Bruce Cunningham.
Second Row: Jed Dillard, Kent Anderson, John Hough, Willie Altenburg, John Crouch.
Back Row: Roy McPhee, Burke Healey, Richard Willham, Gary Johnson, Ronnie Silcox, Norman Vincel.
Not pictured: Don Boggs, Larry Cundiff, Paola de Rose, Doug Hixon, Roger Hunsley, Doug Husfeld, Lee Leachman, Craig Ludwig, Gary Weber.

1994 BIF Attendees

Bill Adams
Radakovich Cattle Company
Hwy. 169 N.
Winterset, IA 50273
515-462-3115

C.K. Allen
Northwest Missouri State Univ.
R.R. 3, Box 177
Sovannah, MO 64485
816-662-2655

William Altenburg
American Breeders Service
1604 E. Co. Rd. #76
Wellington, CO 80549
303-568-7808

John & Jackie Andersen
University of Wisconsin
3428 Valley Woods Dr.
Verona, WI 53593
608-833-5960

Kent Andersen
North American Limousin Fd.
8105 S. Poplar Way #A103
Englewood, CO 80112
303-220-1693

Mark Armentrout
Mill Park Feedlot
P.O. Box 2226
Roswell, GA 30077
404-394-5619

Ancel Armstrong
New Breeds Industries
3220 Excel Rd.
Manhattan, KS 66502
913-537-2914

Susan Armstrong
Beef Improvement Ontario, Inc.
R.R. #7
Guelph, Ontario N1H 6J4
519-767-2665

Jerry Arnold
Oregon State University
Withycombe Hall 112
Corvallis, OR 97331
503-737-5043

Terry Atchison
American Chianina Association
P. O. Box 890
Platte City, MO 64079
816-431-2808

David Bailey
Agriculture Canada
Research Station
Lethbridge, Canada
403-327-4561

Edward Ballard
Illinois CES
1209 Wenthe Drive
Effingham, IL 62401-1697
217-347-5126

Barry Bennett
Canadian Simmental Association
#13 4101-19th St. NE
Calgary, Alberta T2E7C4
403-250-7979

Gary Bennett
USDA-ARS
P. O. Box 166
Clay Center, NE 68933-0166
402-762-4254

James D. Bennett
Knoll Crest Farm, Inc.
HCR 1-Box 39
Red House, VA 23963
804-376-3567

Paul Bennett
Knoll Crest Farm, Inc.
HCR 1
Red House, VA 23963
804-376-5675

Larry Benyshek
University of Georgia
L - P Building
Athens, GA 30602
706-542-6259

Henry Bergfeld
Summitcrest Angus
P.O. Box 638
Summitville, OH 43962
216-223-1931

Keith Bertrand
University of Georgia
206 Livestock-Poultry Bldg.
Athens, GA 30602
706-542-1852

James F. Bessler
American Live Stock Ins. Co.
P. O. Box 520
Geneva, IL 60134
708-232-2100

Ed Bible
American Polled Hereford Assn.
11020 NW Ambassador Dr.
Kansas City, MO 64153
816-891-8400

John & Helen Blankers
Silver Hills Farm
R.R. 1, Box 197
Holland, MN 56139
507-347-3105

Phil Blom
Genetic Horizons Group
151 Dripping Springs Rd.
Columbia, MO 65202
314-442-8307

Mark Boggess
University of Idaho
Box 1827
Twin Falls, ID 83303-1827
208-736-3611

Don Boggs
South Dakota State University
Box 2170
Brookings, SD 57007
605-688-5448

Ron & Becky Bolze
Kansas State University
1240 W. 7th
Colby, KS 67701
913-462-7575

Michael Borger
Ohio State University
1328 Dover Rd.
Wooster, OH 44691
216-264-3911

Andy Boston
Purdue University Extension Serv.
645 N. Sandy Hook Rd.
Paoli, IN 47454
812-723-7107

Rick Bourdon
Colorado State University
Dept. of Animal Science
Ft. Collins, CO 80523
303-491-6150

Bill Bowman
American Angus Assn.
3985 Carter Dr.
Smithville, MO 64089
816-532-4174

Garth Boyd
Murphy Farms, Inc.
P. O. Box 759
Rose Hill, NC 28458
910-289-2111

Paul O. Brackelsberg
Iowa State University
119 Kildee Hall
Ames, IA 50011
515-294-7235

Thomas H. Bradbury
Bradbury Land & Cattle Co.
P. O. Box 256
Byers, CO 80103
303-822-5678

Jim Bradford
Brad Z Ranch
R.R. 3, Box 100
Guthrie Center, IA 50115
515-747-2578

Minnie Lou Bradley
Bradley 3 Ranch
Rt. 2, Box 152
Memphis, TX 79245
806-888-1062

Russ Bredahl
Iowa State University Extension
105 W. Adams, Suite B
Creston, IA 50801
515-782-8426

Kenneth Bremer
K & A Farms
R.R. 1, Box 112
Blakesburg, IA 52536
515-938-2163

Robert Briggs
Briggs RX3 Farm
201 E. Wabasha
Winona, MN 55987
507-452-7676

Glenn Brinkman
Camp Cooley Ranch
Rt. 3, Box 745
Franklin, TX 77856
409-828-3968

Joel Brinkmeyer
Iowa Cattlemen's Association
123 Airport Road
Ames, IA 50010-1730
515-233-3270

Donnell Brown
R. A. Brown Ranch
Box 789
Throckmorton, TX 76483
817-849-0611

Gary Brown
Beef Improvement Ontario
R.R. #7
Guelph, Ontario N1H 6J4
519-767-2665

Rob Brown
R. A. Brown Ranch
Box 789
Throckmorton, TX 76483
817-849-0611

Roger Brummett
Iowa State University Extension
312 Main
Bedford, IA 50833
712-523-2137

Kelly Bruns
Michigan State University
113 Anthony Hall
East Lansing, MI 48910
517-336-1389

Dean Bryant
Wye Angus
P. O. Box 169
Queenstown, MD 21658
410-827-6016

Brent Buckley
University of Hawaii
1800 East-West Road
Honolulu, HI 96822
808-956-7090

Darrh Bullock
University of Kentucky
804 W. P. Garrigns Bld.
Lexington, KY 40546-0215
606-257-7514

Jerry Burner
Trio Farms, Inc.
Rt. 5, Box 121
Luray, VA 22835
703-778-2009

Darrell Busby
Iowa State University Extension
R.R. 1, Box 224
Oakland, IA 51560
712-482-6449

Warren L. & Linda Bush
Bush Boys Limousin
Drawer C
Wall Lake, IA 51466
712-664-2892

Dennis Cain
Dee Cee Farms, Ltd.
2332 130th St.
Bagley, IA 50026
515-427-5774

Jay Carlson
Beef Magazine
9800 Metcalf
Overland Park, KS 66217
913-268-5725

Burl Carmichael
ELANCO
13623 Smokey Ridge Pl.
Carmel, IN 46033
317-277-3544

Richard Carpenter
Univ. of Arizona
Dept. of Animal Science
Tucson, AZ 85721
602-621-1972

Jack & Gini Chase
Buffalo Creek Red Angus
Box 186
Leiter, WY 82837
307-736-2422

Chris Christensen
Christensen Bros. Simmentals
Rt. 2, Box 580
Wessington Springs, SD 57382
605-539-9522

Tom & Anjean Chrystal
1887 H Avenue
Scranton, IA 51462
712-652-3759

Don Clanton
C & S Cattle Co.
914 Grande
North Platte, NE 69101
308-532-1971

John Comerford
Penn State University
324 Henning
University Park, PA 16802
814-863-3661

Larry Corah
Kansas State University
Weber Hall
Manhattan, KS 66506-0202
913-532-1249

Tom Corah
ELANCO
6019 Greendale Circle #104
Johnston, IA 50131
515-251-8544

Kim & Pat Cornell
Beef Improvement Ontario
R.R. #2
Devlin, Ontario P0W 1C0
807-486-3477

Clyde Cranwell, Ph.D.
Integrated Genetic Management
P. O. Box 283
Canyon, TX 79015
806-655-9555

John & Judy Crouch
American Angus Association
3201 Frederick Blvd.
St. Joseph, MO 64506
816-233-3101

Larry Cundiff
U. S. Meat Animal Res. Ctr.
P. O. Box 166
Clay Center, NE 68933
402-762-4171

Dr. Bruce E. Cunningham
American Simmental Association
1 Simmental Way
Bozeman, MT 59715
406-587-4531

David & Emma Danciger
Tybar Angus Ranch
1644 Prince Creek Rd.
Carbondale, CO 81623-8911
303-963-1391

Russ Danielson
North Dakota State University
ARS Dept.
Fargo, ND 58105
701-237-7648

Steve Davies
American Simmental Assoc.
P. O. Box 131
Byers, CO 80103
303-822-5837

Robert & Mary de Baca
The Managing Partner
Box 400
Huxley, IA 50124
515-597-2727

E. Paola de Rose
Agriculture Canada
2200 Walkley Rd.
Ottawa, Ontario K1A0C5
613-957-7078

Sid DeHaan
Flying Dutchman Ranch
217 West 1st St.
Pella, IA 50219
515-628-2832

Larry DeMuth
Mississippi Beef Cattle Impr. Assn.
1320 Seven Springs Rd.
Raymond, MS 39154
601-857-2284

Sue DeNise
University of Arizona
243 Shantz
Tucson, AZ 85721
602-621-1972

Dennis DeWitt
Iowa State University Extension
P. O. Box J
Spirit Lake, IA 51360-0609
712-336-3488

Jeff DeYoung
Iowa Farmer Today
P. O. Box 5279
Cedar Rapids, IA 52404
800-475-6655

H. H. Dickenson
American Hereford Association
1501 Wyandotte
Kansas City, MO 64101
816-842-3757

Bob Dickinson
2831 Severin Rd.
Gorham, KS 67640
913-998-4357

Gary DiGiuseppe
KWMT
Box 578
Ft. Dodge, IA 50501
515-576-7333

Jed Dillard
Basic Beefmasters, Inc.
Rt. 2, Box 92
Greenville, FL 32331
904-997-6223

Fran & Beth Dobitz
Cedar Valley Ranch
HC 81, Box 62
Morristown, SD 57645
701-522-3480

Beth Doran
Iowa State University Extension
P. O. Box 511
Rock Rapids, IA 51246
712-472-2576

Jim Doubet
American Salers Association
5600 S. Quebec
Englewood, CO 80111
303-770-9292

Dave Duello
Ankony Angus Corp., Inc.
P. O. Box 307
Minatare, NE 69356
308-783-2121

Rich Dwyer
Kent Feeds, Inc.
1600 Oregon St.
Muscatine, IA 52761
319-265-4518

Lloyd Ebersol
Sire Power, Inc.
R.R. 2, Box 20
Tunkhannock, PA 18657
717-836-3168

Nita Effertz
Beef Today Magazine
S. 2517 Greenferry Road
Coeur D' Alene, ID 83814
208-664-9324

Ben Eggers
Sydenstricker Angus Farms
Rt. 3, Box 106
Mexico, MO 65265
314-581-1225

Arthur L. Eller
Virginia Tech
Dept. of An. Sci.
Blacksburg, VA 24061-0306
703-231-9151

Mauricio Elzo
University of Florida
P. O. Box 110910
Gainesville, FL 32611-0910
904-392-2366

Wayne Eppler
American Brahman Breeders Assn.
1313 LaConcha
Houston, TX 77054
713-795-4444

Russ Euken
Iowa State University Extension
Box 349
Eldora, IA 50627
515-858-5425

S. R. Evans, Jr.
Evans Angus Farm, Mississippi BCIA
1604 Leflore Ave.
Greenwood, MS 38930
601-453-0532

Rick Faber
Virginia Polytechnic Institute
Blacksburg, VA 24060
703-231-4752

Byron Fagg
Purdue University CES
Courthouse Annex
Salem, IN 47167
812-883-4601

Lee Faris
President, Iowa Cattlemen's Assn.
Mount Ayr, IA 50854
515-464-3671

Rod Fee
Successful Farming
1716 Locust
Des Moines, IA 50309
515-284-2689

Robert Felsman
Univ. of Arkansas-Extension
P. O. Box 4007
Pine Bluff, AR 71603
501-543-8530

Frank A. Felton
Felton Ranch
912 South Walnut
Maryville, MO 64468
816-582-2991

Dennis Fennewald
Tri State Breeders
110 1/2 East Crt. #1
Winterset, IA 50273
515-462-1945

Galen Fink
Fink Beef Genetics
7101 Anderson
Manhattan, KS 66502
913-776-9385

Lori Fink
Fink Beef Genetic Systems
7101 Anderson
Manhattan, KS 66502
913-776-9385

Waldo Forbes
Becton Stock Farm
37 Becton Dr.
Sheridan, WY 82801
307-674-6095

Judy A. & Wayne S. Frank
Noller & Frank Farms, Inc.
Sigourney, IA 52591
515-622-2388

Robert Freer
Taurus Technology
P. O. Box 1160
Armidale, Australia
61-67-728831

Cimeron Frost
Illionis Beef Council
993 Clocktower
Springfield, IL 62704
217-787-4280

Henry, Nan & Mark Gardiner
Gardiner Angus Ranch
Rt. 1, Box 290
Ashland, KS 67831
316-635-2932

Joe Garrett
Amer.-International Charolais Assoc.
P. O. Box 20247
Kansas City, MO 64195
816-464-5977

Charles Gaskins
Washington State University
135 Clark Hall
Pullman, WA 99164-6310
509-335-6416

Jeremy Geske
Kansas State University
408 Maple Place
Manhattan, KS 66502
913-539-0896

Tom Ghrist
Radakovich Cattle Company
3558 Lincoln Place Drive
Des Moines, IA 50312
515-279-1439

Jim Gibb
American Gelbvieh Association
10900 Dover St.
Westminster, CO 80021
303-465-2333

Richard P. Gilbert
Red Angus Assoc. of America
4201 N. I-35
Denton, TX 76207-3415
817-387-3502

Ken Gill
Ultra Sight, Inc.
1907 Keokuk
Ackworth, IA 50001
515-942-6693

Neil Gillies
Canadian Charolais Association
2302 41 Avenue, NE
Calgary, Alberta T2E6W8
403-250-9242

J. Benton Glaze, Jr.
Kansas State University
211 Call Hall
Manhattan, KS 66506
913-532-1284

G. Mark & Malissa Goforth
603 Prince Ave.
Goldsboro, NC 27530
919-735-0970

Bruce Golden
Colorado State University
Dept. of Animal Science
Ft. Collins, CO 80523
303-491-7128

Rodney Goodwin
National Pork Producers Council
Box 13083
Des Moines, IA 50306
515-223-2606

James Gosey
University of Nebraska
204 Animal Science
Lincoln, NE 68583
402-472-6417

Hans Graser
University of New England
An. Genetics & Brdg. Unit
Armidale NSW, Australia 2351
61-67-733332

Marcus Greaves
Camp Cooley Ranch
Rt. 3, Box 745
Franklin, TX 77856
409-828-3968

Milt Green
University of Wyoming
Rt. 1, Box 373-G
Torrington, WY 82240
307-532-2436

Ronnie D. Green
Colorado State University
Dept. of An. Sci.
Fort Collins, CO 80523
303-491-2722

Connie Greig
Little Acorn Ranch
3971 182nd St.
Estherville, IA 51334
712-362-3330

Scott Greiner
Iowa State University
119 Kildee Hall
Ames, IA 50011
515-294-5910

Dr. Jerry D. Gresham
University of Tennessee
Dept. of Agric & NR
Martin, IN 38238
901-587-7262

Randall & Henrietta Grooms
Texas Agric. Ext. Serv.
14859 CR 192
Tyler, TX 75703
903-834-6191

Michael Hall
Cal Poly State University
Animal Science
San Luis Obispo, CA 93407
805-756-2685

Arnel Hallauer
Iowa State University
1505 Agronomy Hall
Ames, IA 50011
515-294-7823

Shawn Hamilton
Hamilton Meadows
1015 State Hwy. 6
Chehalis, WA 98532
206-740-9809

Eldon Hans
Iowa Cattlemen's Association
123 Airport Road
Ames, IA 50010
515-233-3270

Russ Hansen
Iowa Beef Breeds Council
820 Liberty Bldg.
Des Moines, IA 50309
515-243-8157

Ken Hartzell
21st Century Genetics
202 Prospect Circle
Shawano, WI 54166
715-526-2141

Norbert Haverkamp
Natur's Hillcrest Blonde's
R.R. #1, Box 114
Horton, KS 66439
913-486-3302

Tony Hayek
Hayek Gelbvieh
2786 R Ave.
Clutier, IA 52217
319-479-2205

Burke Healey
Southern Cross Ranch
P. O. Box 444
Davis, OK 73030-0444
405-369-2711

Dick & Bonnie Helms
Flying H Genetics
Rt. 1, Box 59
Arapahoe, NE 68922
308-493-5411

James & Jean Hemmingsen
Hemmingsen Polled Herefords
21016 Hwy. 7
Newell, IA 50568
712-272-4287

Greg Henderson
Drovers Journal
P. O. Box 2939
Shawnee Mission, KS 66061
913-451-2200

Shauna Hermel
BEEF Magazine
Suite 300, 7900 Int'l Dr.
Minneapolis, MN 55425
612-851-4671

Mark Herring
Herring Beef Cattle
5678 GA Hwy. 111
Whigham, GA 31797
912-872-3316

William Herring
University of Georgia
302 Livestock-Poultry Bldg.
Athens, GA 30602
706-542-1852

Dave Hickman
Merck AgVet
3305 Buchanan Ct.
Ames, IA 50010
515-232-8511

Greg Highfill
Oklahoma State Univ. - Extension
316 E. Oxford
Enid, OK 73701
405-237-7677

Howard Hillman
Bon View Farms
R. 1, Box 31
Canova, SD 57321
605-523-2657

John Hinners
Iowa Cattlemen's Association
123 Airport Road
Ames, IA 50010-1730
515-233-3270

Bill Hodge
University of Georgia
P. O. Box 100
Greenville, GA 30222
706-672-4235

Gordon Hodges
Pineview Farms
Route 1, Box 400
Hamptonville, NC 27020
910-468-6363

Herbert Hoeptner
Hoeptner Herefords
2367 Brownsboro-Meridian Rd.
Eagle Point, OR 97524
503-826-6796

Chad Hoffman
21st Century Genetics
2510 Hwy 63 NE
Stewartville, MN 55976
507-533-4214

David J. Holden
Westwind Angus Ranch
Box 168
Dupuyer, MT 59432
406-472-3243

Jimmy Holliman
Auburn University
105 County Rd. 944
Marion Jct., AL 36759
205-872-7878

John Hough
American Polled Hereford Assn.
11020 NW Ambassador
Kansas City, MO 64153
816-891-8400

Brian House
Select Sires, Inc.
11740 US 42 N.
Plain City, OH 43064
614-873-4683

Arno Huber
Huber-Treasure Chest Gelbvieh
R.R. 1, Box 56
Burbank, OK 74633-9634
405-269-2255

Lance Hughes
West Virginia University
P. O. Box 6108
Morgantown, WV 26506
304-293-2406

Dr. Roger E. Hunsley
American Shorthorn Association
8288 Hascall Str.
Omaha, NE 68124
402-393-7200

Nicholas Hunt
Clan Farms, Inc.
Rt. 2, Box 175A
Atlantic, IA 50022
712-243-5485

Lee Huntrods
Iowa Farm Bureau Federation
5400 University Ave.
West Des Moines, IA 50266
515-225-5435

Doug Husfeld
Amer.-International Charolais Assn.
P. O. Box 20247
Kansas City, MO 64195
816-464-5977

Don Hutzel
NOBA, Inc.
Box 607
Tiffin, OH 44883
419-447-6262

Ron Irvin
Iowa State University Extension
Box 2068
Cedar Rapids, IA 52406
319-398-1272

Lamar & Kay Ivey
Ivey & Ivey Farms, Inc.
3051 Enon Rd.
Webb, AL 36376
205-794-7154

Buell Jackson
Jackson Hereford Farm
64 Indian Avenue
Mechanicsville, IA 52306
319-432-6962

Loren Jackson
International Brangus Breeders Assn.
P. O. Box 696020
San Antonio, TX 78269-6020
210-696-8231

Richard Janssen
Green Garden Angus Farm
Rt. 1, Box 210
Ellsworth, KS 67439
913-472-3752

Jay Jenkins
University of Wyoming
P. O. Box 3099
Cody, WY 82414
307-587-2204

Thomas G. Jenkins
USDA-ARS
P. O. Box 166
Clay Center, NE 68933
402-762-4247

Dan Jennings
University of Illinois
155 N. 3rd St., Suite 200
DeKalb, IL 60115
815-748-5200

Chad Jensen
Oregon State University
Dept. of Animal Sciences
Corvallis, OR 97331
503-737-1901

Dr. Mark Z. Johnson
Oklahoma State University
109 Animal Science
Stillwater, OK 74078
405-744-6065

Gary & Jody Johnson
Johnson Farms
R.R. #1, Box 117
Dwight, KS 66849
913-482-3362

Jim Johnson
Virginia Cattlemen's Association
P. O. Box 176
Daleville, VA 24083
703-992-1009

Greg L. Jorgensen
Jorgensen Farms
HCR 57, Box 91
Ideal, SD 57541
605-842-3439

Tom & Ellen Kasari
Texas A & M University
6349 Smith Rd.
Bryan, TX 77808
409-845-3541

Randy Kernen
Kernen's Cattle
R.R. 2, Box 65
Glidden, IA 51443
712-659-3062

Warren & Lucile Kester
Beef Magazine
6 Wembly Circle
Belle Vista, AR 72714
501-855-2459

Sara Kettle
Nebraska Cattlemen
HC 73, Box 30
Hemingford, NE 69348
308-762-3005

John King
King Feedlot
539 P Ave.
Boone, IA 50036
515-432-4280

Marshall King
King Feedlot
Route 3
Boone, IA 50036
515-432-1181

Brian A. Kitchen
American Simmental Assn.
1 Simmental Way
Bozeman, MT 59715
406-587-4531

Randy Klindt
KPC Systems, Inc.
Rt. 1, Box 158
Bethany, MO 64424
816-425-4660

Karen Klug Frischmeyer
Merck AgVet
P. O. Box 298
Grinnell, IA 50112
515-236-3783

Dan Kniffen
National Cattlemen's Association
P. O. Box 3469
Englewood, CO 80155
303-694-0305

Richard Knipe
University of Illinois
1414 10th St.
Silvis, IL 61282
309-792-2500

Fred Knop
Drovers Journal
8009 Juniper
Prairie Village, KS 66208
913-649-3782

Mohammed Koohmaraie
USDA-ARS
P.O. Box 166 - Spur 18D
Clay Center, NE 68933
402-762-4221

Mick Kreidler
Wallaces Farmer
6200 Aurora, Ste. 609 E.
Des Moines, IA 50322-2838
515-278-7784

Don Kress
Montana State University
Animal Science Dept.
Bozeman, MT 59717
406-994-5576

Lisa Kriese
Auburn University
206 Animal Sciences
Auburn University, AL 36849-5415
205-844-1561

Peter Kuehni
Beef Improvement Ontario, Inc.
R.R. #7
Guelph, Ontario N1H 6J4
519-767-2665

Susan J. Lamont
Iowa State University
201 Kildee Hall
Ames, IA 50011
515-294-4100

Jerry Langbehn
University of Wyoming
328 Arapahoe
Thermopolis, WY 82443
307-864-3421

Don Laughlin
American Angus Association
Rt. 2, Box 28
Guilford, MO 64457
816-652-3500

John Lawrence
Beef Improvement Ontario, Inc.
R.R. #7
Guelph, Ontario N1H 6J4
519-767-2665

Harry Lawson
Ythanbrae Angus
Ythanbrae
Yea Victoria, Australia 3717
057-978-383

Thomas Lawson
Ythanbrae Angus
Ythanbrae
Yea, Victoria, Australia 3717
057-978-583

Leland Leachman
Leachman Cattle Company
P. O. Box 2505
Billings, MT 59103
406-254-2666

Les Ledene
Canadian Charolais Association
2320 41 Avenue, NE
Calgary, Alberta T2E6W8
403-250-9242

Lori Leonard
Iowa Farmer Today
501 2nd Ave. SE
Cedar Rapids, IA 52401
319-398-8471

Byron Leu
Iowa State University Extension
117 W. Alta Vista
Ottumwa, IA 52501
515-472-4166

Shane Lindsey
Dunlap, IA 51529
712-643-2337

Keith & Bonnie Long
KPC Systems
Bethany, MO
307-736-2421

Vernon Long
Long & Sons Limousin
Rt. 3, Box 124
Afton, IA 50830
515-782-7665

Dick Loonan
Loonan Stock Farm
Route 2
Corning, IA 50841
515-322-3921

Bruce Lott
Beefmaster Breeders Universal
6800 Park 10 Blvd #290W
San Antonio, TX 78213
210-732-3132

Dan Loy
Iowa State University
109 Kildee Hall
Ames, IA 50011
515-294-2240

Craig Ludwig
American Hereford
Box 014059
Kansas City, MO 64101
816-842-3747

Dave Lunt
Texas A & M University
773 Ag Farm Rd.
McGregor, TX 76712
817-840-3032

David Lust
West Texas A & M University
Box 998
Canyon, TX 79016
806-656-2551

Mark Lust
Integrated Genetic Management
P. O. Box 283
Canyon, TX 79015
806-655-9555

James Maciulla
University of Arizona
Dept. of Animal Science
Tucson, AZ 85721
602-621-1972

Michael MacNeil
USDA-ARS
Rt. 1, Box 2021
Miles City, MT 59301
406-232-8213

Jack Maddux
Maddux Cattle Co.
Wauneta, NE 69045
308-394-5574

Gordon Malm
Malm Ranch Co.
Box 55
Albin, WY 82050
307-246-3223

Dave Maples
Alabama BCIA
P. O. Box 2499
Montgomery, AL 36102
205-265-1867

Dennis Marple
Iowa State University
101 Kildee Hall
Ames, IA 50011
515-294-2160

Lorna Marshall
American Gelbvieh Association
10900 Dover St.
Westminster, CO 80021
303-465-2333

Linda & J. Vaughn Martin
Kansas State University
129 Weber Hall, Dept. AnSci.
Manhattan, KS 66506
913-532-1236

Steve Marvery
Miller Publishing/Feedstuff
Box 661
Mt. Pleasant, IA 52641
319-385-3670

Gordon & Marie Mau
Iowa South Devon Association
2491 205th St.
New Hampton, IA 50659
515-394-3281

Dennis Maxwell
ISU McNay Research Farm
R.R. 1
Derby, IA 50068
515-766-6465

Jack McCoubrey
Liahn Farms, Ltd.
R.R. #3
London, Ontario, Canada N6A 4B7
519-657-5196

Roger McCraw
North Carolina State Univ.
Box 7621
Raleigh, NC 27695-7621
919-515-7722

Brian McCulloh
Woodhill Farms, Inc.
Rt. 4, Box 192
Viroqua, WI 54665
608-675-3238

John McGrath
Amana Farms
Box 189
Amana, IA 52203
319-622-6148

Robert McGuire
Auburn University
211 ADS Bldg.
Auburn University, AL 36849
205-844-1557

Wayne W. McKee
McKee Family Shorthorns
635 155th Ave.
Indianola, IA 50125
515-961-2073

W. Blair McKinley
Miss.Beef Cattle Impr. Assn.
Box 9815
Mississippi State, MS 39762
601-325-3516

Charles McPeake
University of Georgia
Coliseum - Room 3102A
Athens, GA 30602
706-542-2584

Ed & Diane McPhee
4201 N. 30th
St. Joseph, MO 64506
816-364-0004

Roy & Nellie McPhee
McPhee Red Angus
14298 N. Atkins Rd.
Lodi, CA 95240
209-727-3335

Bill Miller
Beef Today
Rt. 1, Box 51
Council Grove, KS 66846
316-767-7041

Paul Miller
American Breeders Service
6908 River Road
DeForest, WI 53532
608-846-6224

Daniel Moser
University of Georgia
Livestock-Poultry Bldg.
Athens, GA 30605
706-542-0987

Blane & Cindy Nagel
Midwest Sonatech
R.R. 1, Box 9
Springfield, SD 57062
605-369-2628

Carl Neifert
Iowa State University Extension
117 N. 1st
Winterset, IA 50273
515-462-1001

Ralph E. & Joyce Neill
Douglas Center Stock Farm
R. 4, Box 56
Corning, IA 50841-9317
515-322-3481

Larry A. & Mary Nelson
Purdue University
1151 Lilly Hall
West Lafayette, IN 47907-1151
317-494-4831

Dave Nichols
Nichols Farms
R#1, Box 98
Bridgewater, IA 50837
515-369-2829

Dave A. Nichols
Kansas State University
Weber Hall 132
Manhattan, KS 66506
913-532-1239

Marvin & Janet Nichols
Nichols Cryo-Genetics
8827 NE 29
Ankeny, IA 50021
515-965-1551

Mark Nieslanik
Tybar Angus Ranch
1644 Prince Creek Rd.
Carbondale, CO 81623-8911
303-963-1391

David E. Noller
Noller & Frank Farms, Inc.
R.R. 3, Box 51
Sigourney, IA 52591
515-622-3357

Sally Northcutt
Oklahoma State University
201 Animal Science Bldg.
Stillwater, OK 74078
405-744-6060

Bob Nusbaum
University of Wisconsin - Platteville
1 Univ. Plaza
Platteville, WI 53818
608-342-1452

Robert Nutsch
Maquoketa Vet Clinic
615 S. Main St.
Maquoketa, IA 52060
319-652-3171

Frank & Dianne O'Neill
HC77 Box 6569
Terry, MT 59349
406-486-5632

Larry Olson
Clemson University
Edisto REC, P. O. Box 247
Blackville, SC 29817
803-284-3344

Russ Olson
Iowa State University Extension
409 Quimby
Ida Grove, IA 51445
712-364-3003

Tim Olson
University of Florida
P. O. Box 110910
Gainesville, FL 32611-0910
904-392-2366

Dale & Jerolyne Packer
3DJ Charolais
Rt. 4, Box 137
Ames, IA 50014
515-292-3782

Garold Parks
ARA & Mid America Cattle Co.
1046 Gaskill Drive
Ames, IA 50015-7819
515-292-8226

John Parks
Ultra-Tech
708 Meyers Ave.
Milledgeville, IL 61051
815-225-7368

Brent Paulsen
Iowa Agriculturist/Iowa State Univ.
R.R. 1
Wiota, IA 50843
515-296-1089

Lynn & Sue Pelton
Pelton Simmental/Red Angus
HC 2, Box 41
Burdett, KS 67523
316-525-6632

Ken Persyn
Medina Valley Genetics
P. O. Box 535
Castroville, TX 78009
210-538-2233

Charles Peters
North American Limousin Fd.
7383 South Alton Way
Englewood, CO 80112
303-220-1693

John & Alline Pfeiffer
Pfeiffer Farms
Rt. #1, Box 3
Orlando, OK 73073
405-455-2502

Brian Pogue
Ontario Ministry of Agriculture
16 Ferman Dr.
Guelph, Ontario N1H 7E1
519-836-6345

John Pollak
Cornell University
B22 Morrison
Ithaca, NY 14853-4801
607-255-4416

Daniel Pomp
Oklahoma State University
Animal Science
Stillwater, OK 74078
405-744-6070

Duncan Porteous
Canadian Hereford Association
5160 Skyline Way N.E.
Calgary, Alberta T2E6V1
403-275-2662

C. W. Pratt
VA Dept. of Ag & Cons. Serv.
Rt. 1, Box 1205
Atkins, VA 24311
703-783-3038

Dick Pruitt
South Dakota State Univ.
An. Sci. Complex
Brookings, SD 57007
605-688-5458

Connee Quinn
Elanco
HC 66, Box 16
Chadron, NE 69337
605-867-1071

George Radakovich
Radakovich Cattle Company
R.R. 2, Box 90
Earlham, IA 50072
515-834-2352

Steve, Penny & Jason Radakovich
Radakovich Cattle Company
R.R. 2, Box 85
Earlham, IA 50072
515-834-2359

Evan Rayl
Rayl Farms, Inc.
Rt. 1, Box 91
Bridgewater, IA 50837
515-369-4092

Ken Redman
Colorado State University
HC 57, Box 4076
Sidney, MT 59270
406-569-2333

Joe Rickabough
Kansas Livestock Association
6031 SW 37th
Topeka, KS 66614-5128
913-273-5115

Kris Ringwall
North Dakota State Univ.
470 State Ave.
Dickinson, ND 58601
701-227-2348

Harlan Ritchie
Michigan State University
Dept. of An. Sci.
East Lansing, MI 48824
517-355-8401

Rick Robinson
Iowa Farm Bureau Spokesman
5400 University Avenue
West Des Moines, IA 50266
515-225-5412

Douglas Rogers
Rogers Bar HR
P. O. Box 1718
Collins, MS 39428
601-765-8881

Harlan Rogers
Rogers Bar HR
P. O. Box 1718
Collins, MS 39428
601-765-8881

Robert P. & R. Jane Rose
Rose Ranch
HCR 61, Box 250
South Bend, WA 98586
206-875-5765

Randy Rosenboom
Golden Sun Feeds, Inc.
Box 517
Estherville, IA 51334
712-362-3551

Chris Rost
New Breeds Industries
3220 Excel Rd.
Manhattan, KS 66502
913-537-2914

John & Bettie Rotert
Rotert International
577 SW Hwy K.
Montrose, MO 64770
816-693-4844

Max Rothschild
Iowa State University
225 Kildee Hall
Ames, IA 50011
515-294-6202

Gene Rouse
Iowa State University
215 Meat Lab
Ames, IA 50011
515-294-5641

Larry Rowden
American Breeders Service
408 N. 5th Ave.
Broken Bow, NE 68822
308-872-2598

Walt Rowden
NCA - R & E
2 Deerwood
Morrilton, IA 72110
501-354-5651

B.G. Ruffin
Auburn University
215 Animal & Dairy Sci.
Auburn University, AL 36849
205-844-1559

Ivan Rush
University of Nebraska
4502 Ave. I
Scottsbluff, NE 69361
308-632-1230

Bob Sand
Florida Beef Cattle Impr. Assn.
P. O. Box 110910
Gainesville, FL 32611-0910
904-392-7529

Charles Sattler
Nat'l Assoc. of Animal Breeders
P. O. Box 1033
Columbia, MO 65205
314-445-4406

Jim Saunders
Tye Brook Angus
Rt. 1, Box 29B
Piney River, VA 22964
804-277-5455

Tom Saxe
University of Illinois CES
108 Airway Dr.
Marion, IL 62959
618-997-3919

Robert Scarth
P. O. Box 3345
Iowa City, IA 52244
319-339-7829

David Schafer
Colorado State University
18683 Hwy 140
Hesperus, CO 81326
303-385-4574

Robert Schalles
Kansas State University
Dept. of Animal Science
Manhattan, KS 66506
913-532-1217

Dennis Schroeder
Beef Improvement Ontario
R.R. #2
Dachwood, Ontario N0M 5N0
519-237-3708

Denise Schwab
Iowa State University Ext.
Box 308
Toledo, IA 52342
515-484-2703

Ron Sealock
Prima Corporation
1701 48th St. Suite 103
West Des Moines, IA 50266
515-226-8850

Stan Sears
Little Shasta Ranch
4839 Little Shasta Rd.
Montague, CA 96064
916-459-3829

Dave Seibert
University of Illinois
727 Sabrina Drive
E. Peoria, IL 61611
309-694-7501

Joe Sellers
Iowa State University Extension
R.R. 5, Box 91
Chariton, IA 50049
515-774-2016

Wade Shafer
Shafer's Shoestring Ranch
R.R. 2, Box 82
Detroit Lakes, MN 56501
218-847-6818

Wayne Shearhart
Oklahoma Coop. Ext. Serv.
1440 S. Cherokee
Muskogee, OK 74401
918-687-2458

Melford Sheley
Teardrop Brangus
508 Walnut, P. O. Box 92
Guthrie Center, IA 50115-0092
515-747-2597

Laurence Sherriff
Summitcrest Angus
P. O. Box 638
Summitville, OH 43962
216-223-1931

Dave Shue
University of Illinois
3325 Maine
Quincy, IL 62301
217-221-2508

Rich Shuler
Syntex Animal Health
4800 Westown Pkwy. #200
West Des Moines, IA 50266
515-224-2430

Martin Sieber
National Assn. of Animal Breeders
P. O. Box 1033
Columbia, MO 65205
314-445-4406

Mike Siemens
University of Wisconsin
1675 Observatory Dr.
Madison, WI 53706-1284
608-263-4304

Ronnie Silcox
University of Georgia
Coliseum, JGA
Athens, GA 30602
705-542-7023

Danny Simms
Kansas State University
Manhattan, KS 66502
913-532-1254

Dr. Robert Simpson
Simpson-Stimson Ranch
8325 Vineyard Ranch
Paso Robles, CA 93446
805-239-8577

Russell Sjeklocha
Radakovich Cattle Company
R.R. 2, Box 85
Earlham, IA 50072
515-834-2359

Richard L. Spader
American Angus Association
3201 Frederick Blvd.
St. Joseph, MO 64506
816-233-3101

David Spark
Merck
1307 W. 11th St.
Spencer, IA 51307
712-262-2148

Randy Sparks
Radakovich Cattle Company
R.R. 2
Guthrie Center, IA 50115
515-747-2579

James Spawn
American Blonde d'Aquitaine Assn.
1912 Clay St.
N. Kansas City, MO 64116
816-421-1305

Mark Squires
Tri-State Breeders
P. O. Box 50
Westby, WI 54667
800-752-1097

Steve Stanton
Farm Credit Services
4407 64th St.
Urbandale, IA 50322
515-253-0781

Kurt Steinkamp
Iowa State University
425 Jeffrey Lane
Ames, IA 50014
515-292-7432

Robert Stewart
University of Georgia
P. O. Box 1209
Tifton, GA 31793
912-386-3407

John, Avgi & Jennifer Stewart-Smith
Beef Booster Cattle Alberta, Ltd.
1935 32nd Ave., NE, No. 226
Calgary, Alberta T2E 7C8
403-291-9771

Chad Stine
Mississippi State University
Box 9815
Mississippi State, MS 39762
601-325-2802

Julie Stitt
Canadian Hereford Association
5160 Skyline Way, NE
Calgary, Alberta T2E 6V1
403-275-2662

John Stowell
National Cattlemen's Association
P. O. Box 3469
Englewood, CO 80155
303-694-0305

Daryl Strohbehn
Iowa State University
109 Kildee Hall
Ames, IA 50011
515-294-2240

Herbert E. Struss
1006 Abbott
Stillwater, MN 55082
612-439-9767

Zan Stuart
Stuart Land & Cattle Co.
Box 146
Rosedale, VA 24280
703-880-1264

Peter Sullivan
Beef Improvement Ontario
R.R. #7
Guelph, Ontario N1H 6J4
519-767-2665

Harris Swain
Delaware State University
138 Beech Drive
Dover, DE 19901
302-739-5151

William P. Switzer
R.R. 1, Box 173
Cambridge, IA 50046
515-597-2440

James W. Taylor
Taylors Black Simmentals
Box 176
Winona, KS 67764
913-846-7749

Dale Thoreson
Iowa State University Extension
Box 49, 100 1/2 1st NW
Tripoli, IA 50676
319-882-4275

Ann Toner
Omaha World - Herald
World-Herald Square
Omaha, NE 68102
402-444-1000

Don Trimmer
Tri-State Breeders
E10890 Penny Lane
Baraboo, WI 53913
608-356-8357

Jay Truitt
Missouri's Farm Voice
102 N Mason
Carrollton, MO 64633
816-542-0404

Sandra Utter
Matador Cattle Co.
P. O. Box 2256
Wichita, KS 67201
316-832-3861

David Van Heuvelen
Wolf Creek Software
8831 E. St. Charles
Columbia, MO 65202
314-474-9701

Bill & Marilyn Van Tassel
P. O. Box 683
Linden, CA 95236
209-887-3566

Dale Van Vleck
ARS-Univ. of Neb., Lincoln
A218 Animal Sciences
Lincoln, NE 68583-0908
402-472-6010

Keith Vander Velde
ABS
W10276 Hwy CS
Poynette, WI 53955
608-846-3721

Jim Venner
Iowa State University
245 Kildee Hall
Ames, IA 50011
515-294-2569

Norm Vincel
VA-NC Select Sires
P. O. Box 370
Rocky Mount, VA 24151
703-483-5123

Wayne Wagner
West Virginia University
P. O. Box 6108
Morgantown, WV 26506
304-293-3392

Hayes Walker
American Beef Cattleman
Box 190
Ottawa, KS 66067
913-242-9419

Roy A. Wallace
Select Sires, Inc.
11740 US 42 N.
Plain City, OH 43064
614-873-4683

Cunshan Wang
Cornell University
B22 Morrison
Ithaca, NY 14853-4801
607-255-4416

Dr. Barbara Ward
Delaware Valley College
700 E. Butler Ave.
Doylestown, PA 18901
215-345-1500

Duane & Shirley Warden
Wardens Farm
Rt. 4, Box 77B
Council Bluffs, IA 51503
712-323-2387

Leon Warner III
Ellerslie Farm
Rt. 3, Box 6000
Berryville, VA 22611
703-955-2265

Douglas & Rita Washburn
Washburn Family Angus
2813 320th Street
Hornick, IA 51026
712-874-3313

Kim Watson
Drovers Journal
P. O. Box 2939
Shawnee Mission, KS 66061
913-451-2200

Marilou Wegner
Amer.-Int'l Charolais Assn.
P. O. Box 20247
Kansas City, MO 64195
816-464-5977

Milton Weiss
Canadian Charolais Association
2320 41 Avenue, NE
Calgary, Alberta T2E6W8
403-250-9242

Marie Whiteing
Middle America Network
P. O. Box 11
Mapleton, IA 51034
712-279-6286

Gene & Jean Wiese
Wiese and Sons
P. O. Box 305
Manning, IA 51455-0305
712-653-3678

Rex Wilhelm
Stuart Veterinary Clinic
Box 277
Stuart, IA 50250
515-523-1755

Darrell Wilkes
Integrated Beef Technologies
5660 Greenwood Plaza Blvd.
Englewood, CO 80111
303-770-1971

Richard Willham
Iowa State University
239 Kildee Hall
Ames, IA 50011
515-294-3533

Mark Williams
Iowa Cattlemen's Association
123 Airport Road
Ames, IA 50010-1730
515-233-3270

Robert Williams
University of Georgia
302 L-P Building UGA
Athens, GA 30602
706-542-0989

Doyle Wilson
Iowa State University
109 Kildee Hall
Ames, IA 50011
515-294-2240

Brent Woodward
University of Minnesota
101 Haecker Hall
St. Paul, MN 55108
612-624-4995

Doug Wurster
Twin Valley Veterinary Clinic
706 Eaton
Dunlap, IA 51529
712-643-5301

Bruce Young
Matador Cattle Co.
P. O. Box 2256
Wichita, KS 67201
316-832-3861

Doug Zalesky
South Dakota State University
801 San Francisco
Rapid City, SD 57701
605-394-2236

Carl L. & Rosemary Zauche
Zauche Cattle Co.
19900 Zauche Lane
Peosta, IA 52068
319-876-3325

Keith Zoellner
Kansas State University
Call Hall
Manhattan, KS 66506-1600
913-532-1221

SPONSORS FOR 26TH ANNUAL BIF CONVENTION

Brad Z Ranch - Jim Bradford
Bush Boys Limousin - Warren Bush
Community Insurance Agency Co.
Gelbvieh Breeders of Iowa
Guthrie Co. Cattlemen's Assoc.
Heart of America Brangus Assoc.
Jim and Jean Hemmingsen
Iowa Charolais Breeders Assoc.
Iowa Maine Anjou Assoc.
Iowa Red Angus Assoc.
Iowa Salers Association
Iowa Savings Bank
Iowa Shorthorn Breeders Assoc.
Iowa South Devon Assoc.
Little Acorn Ranch - Connie & Wilbur Greig
Nichols Cryo-Genetics, Inc. - Marvin Nichols
Nichols Farms, Ltd. - Dave Nichols
Noller and Frank Charolais
Oak Ridge Farm - Dr. Clark Huinker
Packer Charolais - Dale Packer
Palco, Inc.
Buck Pangburn Simmentals
Sullivan Supply
Summitcrest Angus
Wardens Farm - Duane Warden
Wiese and Sons - Gene Wiese
Zauche Cattle Company - Carl Zauche

SPONSORS FOR COFFEE BREAKS

American Breeders Service
Hawkeye Breeders Service
Integrated Genetic Management
NOBA, Inc.
Select Sires
Sire Power, Inc.
Tri-State Breeders

HOSTS FOR THE CONVENTION

Iowa Beef Breeds Council
Iowa Cattlemen's Association
Iowa State University

Editor: Ron Bolze
Production Assistants: Donna Peters and Sherry Rupp

Additional copies of these proceedings are available
at $10.00 per copy from:

Ron Bolze, Executive Director
Beef Improvement Federation
Department of Animal Science, Kansas State University
Northwest Research-Extension Center
105 Experiment Farm Road
Colby, Kansas 67701