PROCEEDINGS

Beef Improvement Federation
31st Annual Research Symposium
and Annual Meeting

June 16-19, 1999
Hotel Roanoke & Conference Center
Roanoke, Virginia

Hosted By:

Virginia Tech
and
The Virginia Beef Cattle Improvement Association

1999 - 2000 BEEF IMPROVEMENT FEDERATION BOARD OF DIRECTORS

Willie Altenburg
570 E. County Rd 64
Ft. Collins, CO 80524
970-568-7792 (H)
970-568-7881 (O)
970-568-7882 (F)
willie@info2000.net

Kent Anderson
N. Am. Limousin Foundation
P.O. Box 4467
Englewood, CO 80155
303-220-1693 (O)
303-220-1884 (F)
Kent@nalf.org

Darrh Bullock
University of Kentucky
804 WP Garrigus Bldg
Lexington, KY 40546
606-257-7514 (O)
606-323-3412 (F)
dbullock@ca.uky.edu

Gini Chase
Box 186
Leiter, WY 82837
307-736-2422 (H)
307-736-2421 (F)
bufcrk@mcn.net

John Crouch
Am. Angus Association
3201 Frederick Blvd.
St. Joseph, MO 64506
816-383-5100 (O)
816-233-9703 (F)
jcrouch@ccp.com

Larry Cundiff
RLHUSMARC
P.O. Box 166
Clay Center, NE 68933
402-762-3241 (O)
402-762-4173 (F)
cundiff@email.marc.usda.gov

Bruce Cunningham
American Simmental Assn.
1 Simmental Way
Bozeman, MT 59715
406-587-4531 (O)
406-587-9301 (F)
cunningham@simmgene.com

Jed Dillard
P.O. Box 704
Monticello, FL 32345
850-997-4198 (H)
850-599-3546 (O)
850-561-2151 (F)
jhare@mailer.fsu.edu

Sally Dolezal
621 Bent Tree Ct.
Derby, KS 67037
316-250-6168 (H)
dolezalent@aol.com

Sherry Doubet
Am. Salers Assn.
7383 S. Alton Way #103
Englewood, CO 80112
303-770-9292 (O)
303-770-9302 (F)
amsalers@aol.com

S. R. Evans, Jr.
1604 Leflore Ave
Greenwood, MS 38930
601-453-5317 (H)
601-453-0532 (O)
601-453-3079 (F)
wcdoc@netdoor.com

Galen Fink
7101 Anderson Ave.
Manhattan, KS 66503
785-776-9385 (O)
785-776-9385 (F)
finkbull@flinthills.com

Ronnie Green
Dept. of Animal Science
Colorado State University
Ft. Collins, CO 80523
970-491-2722 (O)
970-491-5326 (F)
rdggene@lamar.colostate.edu

Jimmy Holliman
105 County Rd 944
Marion Junction, AL 36759
334-872-8530 (H)
334-872-7878 (O)
334-872-2013 (F)
jhollima@acesag.auburn.edu

Robert Hough
Red Angus Assn. Of America
4201 North I-35
Denton, TX 762073415
940-387-3502 (O)
940-383-4036 (F)
bob@redangusl.org

Don Hutzel
NOBA/CRI
Box 607
Tiffin, OH 44883
419-447-6262 (O)
Voice Mail 118
419-447-6084 (F)

Renee Lloyd
NCBA
5420 S. Quebec St.
Englewood, CO 80155
303-850-3370 (O)
303-770-7109 (F)
rlloyd@beef.org

Richard McClung
Route 1 Box 390
New Market, VA 22844
540-896-5232 (H)
540-896-6049 (F)

Herb McLane
Canadian Beef Breeds Council
6715 8th St. NE Suite 230
Calgary Alberta, Canada T2E7H7
403-730-0350 (O)
403-275-8490 (F)
cbbc@cadvision.com

Terry O'Neill
P.O. Box 30435
Billings, MT 59109
406-373-6016 (O)
406-373-6048 (F)
tomahawk@mcn.net

Connee Quinn
HC 66 Box 16
Chadron, NE 69337
605-867-1071 (H)
605-867-1071 (F)
crq@lilly.com

Ronnie Silcox
Ext. Ani. Sci. Dept. Coliseum
University of Georga
Athens, GA 30602
706-542-9102 (O)
706-542-9316 (F)
rsilcox@arches.uga.edu

James I. Smith
3064 Old 75
Stem, NC 27581
919-528-2403 (O)
919-528-2771 (F)

Bob Weaber
American Gelbvieh Assn.
10900 Dover St.
Westminster, CO 80021
303-465-2333 (O)
303-465-2339 (F)
aga@www.gelbvieh.org

Robert Williams
American-International Charolais Assn.
11700 N.W. Plaza Circle
P.O. Box 20247
Kansas City, MO 64195
816-464-5977 (O)
816-464-5759 (F)
robertw@charolaisusa.com

31^{ST} Annual Convention
" Profiting from Research and Education in the Beef Industry "

The Hotel Roanoke & Conference Center, Roanoke, Virginia
June 16-19, 1999

Wednesday, June 16

2:00 Board of Directors Meeting

3:00 Registration

5:30 Reception

7:00 NAAB Opening Symposium
The Evaluation of Semen: Effect on Fertility and Embryonic Development
Richard Saacke, Virginia Tech
Estrous Synchronization and Induction Systems
Jeff Stevenson, Kansas State University
Recent Developments in Heat Detection Systems and Estrus Management
Tom Geary, USDA-ARS Fort Keogh LARRL

Thursday, June 17

8:00 - Noon **GENERAL SESSION**

Profiting From Efficiency, Moderator: A.L. "Ike" Eller, Virginia Tech

Why is Efficiency So Important to the Future of the Beef Industry?
Harlan Ritchie, Michigan State University
Pork Industry's Approach to Efficiency
Darrell Anderson, CEO of the National Swine Registry
What Can We Do Genetically to Improve Efficiency?
Tom Jenkins, USDA-ARS MARC
What Have We Learned About Efficiency and How Do We Use It?
Bill Brockett, Virginia Beef Corp.; Warren Weibert, Decatur Co. Feedyards

Noon **Luncheon**
Remarks - J. Carlton Courter, III, Commissioner of the Virginia Dept. of Ag and Consumer Sciences. Introduction of nominees for Producers of the Year Awards

2:00 - 5:00 **CONCURRENT SESSIONS**

Producer Technology Application Session, Sally Dolezal, Chair

Crossbreeding: The Lost Art? Managing Heterosis in Small Herds
Darrh Bullock, University of Kentucky
Sourcing Replacement Heifers
Connee Quinn, Quinn Cow Company; Dillon Feuz, Univ. of Nebraska Panhandle Research & Extension Center
Producers Leading the Way: A Horizontal Alliance
Buckingham County Cattlemen's Assn.; Jim Myers, Virginia CES

Whole Herd Analysis Session, John Hough, Chair

An Update o the D.E.C.I. Production Systems Model
Tom Jenkins, USDA-ARS MARC
What Cows Do Breeders Cull?
Kent Anderson, North American Limousin Foundation
Standardized Disposal Codes: Sub-Committee Report
Bob Hough, Red Angus Association of America
Current Research in Measuring Efficiency
Bruce Golden, Colorado State University"
Whole-Herd Reporting: Breeder Expectation and Obligations
Mike MacNeil, USDA-ARS, Fort Keogh LARRL
Panel Discussion - Whole Herd Reporting: What is the Impact?
Paul Bennett, Red House, VA; Gini Chase, Leiter, WY; Frank Felton, Maryville, MO; Judy Frank, Sigourney, IA; Loren Jackson, IBBA, San Antonio, TX

Genetic Prediction Session, Larry Cundiff, Chair

Panel: How Can Genetic Evaluation Programs Be Improved?
Paul Bennett, Knoll Crest Farms; Keith Bertrand, University of Georgia; Mark Gardiner, Gardiner Angus Ranch; Kent Anderson, North American Limousin Foundation
Review of Research Topics
L.D. VanVleck, ARS, USDA, Lincoln, NE, Grandmaternal or Sire-Year Interaction Effects, Reproduction and Carcass Trait Genetic Correlation, Across Breed EPD Update
National Cattle Evaluation Research Proposal
John Pollak, Cornell University

6:30 **Virginia Reception**

Friday, June 18

8:00 - Noon **GENERAL SESSION**

Profiting From Increased Demand Moderator: Harlan Ritchie, MSU

Connecting the Cow Herd to the Carcass
Harlan Ritchie, Michigan State University
Opportunities to Re-Capture Demand for Beef
Andrew Gottschalk, LFG, Inc. Colorado
Stimulating Demand Through New Products
Bernie Hansen, Concept Foods, KS
Connecting Processors to Producers to Increase Demand
Marcine Moldenhauer, Excel Corporation
New Tools for Predicting Consumer Acceptability
Duane Wulf, South Dakota State University
Can Producers Have Their Cake and Eat it Too?
Ronnie Green, Colorado State University

11:30 Director Elections and Annual Meeting

1:30 - 4:30 **CONCURRENT SESSIONS**

Multiple Trait Selection Session, Kent Anderson, Chair

Sire Selection for Profit: The Circle A Sire Alliance
W. O. Herring, University of Missouri
Profiting Through Response to MTS: Making Sense Out of Using All the Available EPDs
Panel Discussion:
- Profiting through response to MTS: Understanding "Indicator Traits" vs. the "Actual Trait" and Understanding "Threshold Traits.
- Birth weight, calving Ease and Survivability
- Puberty, Pregnancy and Longevity
- Marling and Palatability
- Dressing Percent, Ribeye Area, Fat and Red Meat Yield
- Growth, Mature Size, Milk and Maintenance Requirements

Today's Electronic Sire Selection Tools:
Sire Selection Software Demonstrations

Emerging Technology Session , Ronnie Green, Chair

Overview of Services Available From Perkin Elmer Ag Gen
Tom Holm and Bridget Feuz

What is the Benefit of Sire Identification in Multiple Sire Breeding Systems?

Update on Marker-Assisted Selection Applications from the Carcass Gene Mapping Project
Jerry Taylor, Texas A&M University

Update on the National Genetics of Carcass Merit Project
John Pollak, Cornell University; and Ronnie Green, Colorado State University

Overview and Update on the USDA-ARS Search for Genes Affecting Reproductive Performance
Steve Kappes, USMARC

Panel: Can the Full Brother Concept be Used to Increase Consistency?
Galen Fink, Fink Genetics Systems; Randy Mills, Florence, KS; Gary Johnson, Manhattan, KS; William Herring, University of Missouri; Tom Field, Colorado State University

Live Animal Evaluation Session, Bruce Cunningham, Chair

Genetic Evaluation of Ultrasound Measurements
Doyle Wilson, Iowa State University - Angus; John Hough and William Herring, University of Missouri- Hereford; Loren Jackson, International Brangus Breeders Association, Brangus

Ultrasound Recording Among Breed Associations
Robert Williams, American International Charolais Association

Standardization of Ultrasound Reporting
Bruce Cunningham, American Simmental Association

Determining Value with The Boxed Beef Calculator
Glen Dolezal, Oklahoma State University

5:30 Awards Banquet and Social

Saturday, June 19

6:30 Optional Program Tour: "Meat Lovers" Tour

9:00 Optional Program Tour: "Valley" Tour

TABLE OF CONTENTS

Opening Symposium

Sponsored by

The National Association
of Animal Breeders

IMPROVING REPRODUCTIVE PERFORMANCE

The Evaluation of Semen: Effect of Semen Quality on Fertility and Embryonic Development

R. G. Saacke
Virginia Polytechnic Institute and State University

Relationship of semen quantity and quality. The nature of subfertility due to the male is proving as complex as that of the female. We often consider that the bull or his semen in the AI dose succeeds or fails based upon whether or not the egg was fertilized. We now know that success or failure of a mating due to the male or inseminate can reside in whether or not the egg was fertilized (fertilization rate) **or** whether or not the embryo developed normally and hatched in time to signal pregnancy to the dam (very early embryonic death). Both scenarios are embraced by semen quality and quantity and they must be considered together to address problems associated with low pregnancy rate to artificial insemination or natural service. Salisbury and VanDemark (1961) were the first to suggest the nature of the relationship between sperm quality and quantity. They proposed that fertility to AI increases with increasing numbers of sperm delivered up to a threshold, after which limiting factors in the female population (herd) become important and further increased in sperm inseminated are without effect on fertility. From a semen quality standpoint, Pace et al. (1981) found this relationship to hold true for the semen quality traits of progressive sperm motility, and integrity of the sperm membranes (acrosomal and cell membrane). Both motility and membrane integrity are measures of sperm life (viability) and it is clear from much data on the fate of sperm in the female reproductive tract that only live sperm are capable of participating in fertilization in the oviduct following insemination. Therefore, it is the number of live (viable) spermatozoa delivered to the female that must be at or above threshold to optimize fertilization rate. Sullivan and Elliott (1968) showed that the threshold (minimum number of motile sperm required to achieve maximum fertility) differed among bulls and that bulls differed further in the maximum fertility achieved. They further reported that lower fertility bulls required more sperm than higher fertility bulls to reach their respective maximum fertility. They theorized that the requirement of more sperm by the lower fertility bulls was due to higher levels of abnormal sperm in their semen ant that many of the abnormal sperm simply could not proceed through the female tract from the site of deposition to the site of fertilization in the oviducts. This concept has since been confirmed in cattle (Saacke et al., 1998). den Daas et al. (1992), reported that minimum numbers of sperm required to reach maximum fertilization rate for a given bull (threshold number of sperm per dose) was quite variable, as shown by Sullivan and Elliott; however, she also found that this trait was independent of the maximum fertility achievable by that same bull. Collectively, and important to semen evaluation, these findings lead us to the concept that within bulls there are adverse semen traits which can be considered **compensable** and others which should be considered **uncompensable**. Furthermore, they indicate that a given bull may have these two traits in any possible combination. Semen traits which are detrimental to fertility, but can be overcome by increasing numbers of sperm inseminated would represent the compensable components of semen, while those semen traits that adversely affect fertility at any sperm dosage would be the uncompensable traits. Clearly, in the meaningful laboratory evaluation of semen, we must realize that there will be no single test which would embrace both compensable and uncompensable traits. In addition, we should also expect that a given bull could possess both traits and in any possible combination.

Compensable semen traits. The compensable traits would represent those deficiencies precluding sperm access to the egg in the cow's tract and would be considered important when calculating the dilution rate of semen to be used in artificial insemination where such deficiencies could be offset by a higher number of sperm per dose. Compensable traits are thought to include: immotile sperm or sperm with tail defects, sperm with protoplasmic droplets (immature sperm) or sperm with distinctly misshapened heads, all of which would affect the motile pattern of the sperm reducing its ability to traverse barriers in the cow and access the site of fertilization in the oviduct (for review, Saacke et al., 1998). There are also bulls whose sperm have a high or low accessibility to the egg in the cow that cannot be explained by motility pattern or the above traits (den Daas et al. 1997 and Nadir et al., 1993). Thus, recognition of all compensable traits is not yet possible and more research in this area is necessary. As long as there are sufficient numbers of sperm in the inseminate that can access the egg, no harm is done by compensable deficiencies and fertilization would still be optimized. However, a problem in pregnancy rate might be expected when the inseminate contains below threshold numbers of sperm for the compensable deficiencies present in the semen or when semen handling and/or AI technique is inadequate resulting in below threshold delivery of viable sperm to the cow.

Uncompensable semen traits. In the evaluation of semen, the uncompensable traits should be discriminated against heavily in both AI bulls and natural service bulls selected for use in the herd. In both cases, bulls or inseminates with uncompensable deficiencies would result in pregnancy rates below that achievable by the female population (herd) regardless of sperm numbers delivered to the cow. In this case, there is good evidence that such bulls provide sperm capable of reaching the egg and initiating fertilization, but not competent in sustaining the fertilization process or the resulting young embryo. Uncompensable sperm traverse the cow's reproductive tract and compete for fertilization at the surface of the egg with fully competent sperm and would therefore represent a pregnancy wastage at a level reflected by the frequency at which they appear in the inseminate. Observations in a variety of species, including cattle, have shown that factors associated with lowered sperm quality, measured by sperm viability and morphology, result in low embryo quality or very early embryonic failure, prior to maternal recognition of pregnancy (Courot and Colas, 1986; Barth, 1992; DeJarnette et al., 1992). Differences among bulls in embryonic development have been reported at the time of routine recovery for embryo transfer (Miller et al., 1982) and after observation of embryo survival in recipients (Coleman et al., 1987). Bulls were also shown to differ in the development of their embryos following in vitro fertilization (Eyestone and First, 1989; Parrish, 1994).

Unfortunately, uncompensable sperm that can cause embryonic failure have not been identified using current laboratory semen tests available. However, sperm with subtly misshapened heads was well as those with nuclear vacuoles (craters, diadem or nuclear pouches, defined by Coulter et al., 1978) on otherwise normally shaped heads are known to access the eggs following insemination (as determined by accessory sperm, Saacke et al., 1998). In addition, semen with sperm having these traits has been shown to yield higher frequencies of low quality embryos and lowered fertilization rates than controls where such traits are missing or minimized in the semen (Miller et al., 1982; DeJarnette, et al., 1992; Saacke, et al., 1994).

Morphologically abnormal sperm in semen of bulls has been associated with subfertility and sterility for many years (Williams and Savage, 1925 and 1927; Lagerlof, 1934). We now recognize that the classically misshapened sperm recognized by these workers with their more simple microscopes, do not traverse the female reproductive tract or participate in fertilization. On this basis, they would be considered compensable traits. However, males having disturbances in spermatogenesis resulting in ejaculation of abnormal sperm usually provide a broad spectrum in severity of the morphological forms. It is now believed that recognition of abnormal sperm in semen may represent only the "tip of the iceberg". Disturbances in spermatogenesis in the bull testes represented by abnormal sperm undoubtedly extend to otherwise normal or near-normal appearing sperm in the same ejaculates that can access the egg following insemination (Saacke et al., 1998). These subtle misshapened sperm (particularly slightly misshapened heads) and normal appearing sperm in abnormal ejaculates, are probably the most likely candidates for the "uncompensable" traits causing pregnancy wastage through very early embryonic death. Current research designed to identify these uncompensable sperm is directed toward the health of the DNA carried in the sperm head. <u>At present, the semen tests most indicative of the existence of uncompensable traits in semen would be the level of morphologically abnormal sperm in the semen sample with abnormal heads being of highest significance.</u>

Much of our current research at Virginia Tech deals with development of semen evaluation tests as well as identification of management factors affecting the outcome of an artificial insemination. In this task we have been asking the cow what she does with the sperm that we inseminate. Through the use of accessory sperm in the egg and embryo as well as the fertilization status of the egg and quality of the resulting embryo, she has been giving us answers to some of our questions. The answers have been important to our understanding of the male contribution to subfertility. In the remaining portion of this presentation I will try to cover some of the practical answers that the cow has given us relative to semen quality and reproductive management.

The accessory sperm approach to understanding fertility of bull semen.

Accessory sperm are those sperm that become entrapped in the outer coverings of the cow's egg (called the zona pellucida) following breeding. Although there is only one sperm that enters the egg proper (the fertilizing sperm), the accessory sperm represent in number and quality the sperm in the inseminated dosage that were available for fertilization when the egg was receptive. These sperm passed all the barriers posed by the female and underwent several physiological processes of preparation for fertilization including egg recognition and partial penetration. Thus, they represent the sperm competing for fertilization. The reason they were entrapped in the zona pellucida is because the fertilizing sperm activates the egg to block further progression of the accessory sperm. This is an important function because more than one fertilizing sperm would result in embryonic death.

Our accessory sperm evaluations are conducted 6 days following insemination. At this time the embryo or egg is flushed non-surgically from the cow's uterus, as it would have been in an embryo recovery destined for transfer. The embryo (expected to be in the pre-hatching stage called a morula) is graded as excellent, good, fair, poor, or degenerate, or, if fertilization did not occur, as a UFO (unfertilized ovum/egg). The significance of this to pregnancy rates in cattle is simply that embryos classified excellent to good result in twice as many pregnancies as those classified as fair to poor (Lindner and Wright, 1983). Degenerate embryos and, of course, UFOs would not result in pregnancy. Following evaluation of fertilization status/embryo quality we digest the zona pellucida rendering the accessory sperm available for count and morphological evaluation under the microscope. Thus, the bull's or inseminate's contribution to this spectrum of fertilization status/embryo quality, along with sperm quantity and quality available, are what collectively impact the economic factor we call "pregnancy rate". Essentially, our research approach utilizes the 6-day-old egg/embryo as a biomonitor of the male or semen quality as well as provides insight to other factors affecting success to AI (see time of insemination later in this paper).

What have we learned from accessory sperm and the eggs/embryo from which they come? Through several years of experimentation in our lab we have now recovered, non-surgically, 6-day-old single-ovulated eggs and/or embryos from nearly 1,000 cows bred artificially to more than 25 bulls providing acceptable semen. Figure 1 shows that the distribution of accessory sperm found in the zonae of these embryos and eggs to be highly skewed having an average, median and mode of 12.0, 2.4, and 0 sperm per egg or embryo, respectively. Of reproductive importance is the association of accessory sperm number per egg or embryo to the fertilization status and embryo quality, best described by the median (50 percentile of eggs/embryos recovered) number of accessory sperm per egg/embryo Table 1. Clearly from these data, unfertilized eggs are simply sperm hungry, having a median accessory sperm number of 0. Also evident from Table 1 is that embryo quality is positively related to median accessory sperm number. This has been interpreted to suggest that the larger accessory sperm numbers are most likely associated with higher embryo quality because they represent increasing competition among potential fertilizing sperm at the time of fertilization and that this competition favors a more competent sperm (see Saacke et al., 1998 for review of this concept). Basically, the old adage is that it takes only one sperm. This is true, but to maximize pregnancy rate, we want more than one sperm competing for the egg because the covering of the egg is the final and perhaps the most formidable barrier in the female toward sperm selection. Given a choice, our data says that the female can pick the better sperm. Unfortunately, this data also indicates that the bovine female often does not have a choice of sperm. From Figure 1, it may be seen that approximately 60% of the cows range between 0 and 3 sperm/embryo or egg. On this basis, it should be clear that a bull with uncompensable semen traits can do considerable reproductive damage in the herd.

Based upon the positive relationship of accessory sperm number and both fertilization and embryo quality, we have examined several factors which we deemed potentially important to sperm accessing the egg following artificial insemination. The findings are summarized in Table 2 and have been reported previously (Saacke et al., 1994). Presently, the positive influences over which we have control are: Choice of the bull, site of semen deposition, and time of insemination. Bulls are quite different in the number of sperm per egg and can vary 5-fold in this trait based upon accessory sperm. This trait is also observed in the minimum number of sperm per dose of semen required for maximum fertility (den Daas et al., 1998). Unfortunately, this trait cannot be predicted from current semen evaluation procedures and is therefore only available from AI non-return data where there are sufficient services on a given bull at or below threshold numbers of sperm/dose. The Ai association providing semen on a bull can be of best help in selecting such bulls. The site of insemination can enhance sperm delivery to the egg; however, a very deep insemination using special insemination equipment is necessary. Even with the specially designed insemination rod, only modest increases in sperm per egg were achieved. Thus, this technique will be most advantageous when used with sexed semen or when below threshold numbers of sperm per dose are dictated. Timing of insemination appears to be the most important to both sperm delivery to the egg as well as to embryo quality.

In determining the effect of time of artificial insemination on numbers of accessory sperm and the fertilization status/embryo quality achieved, the HeatWatch® system was employed. In this heat detection system, an electronic device is placed on the rump of the cow and a signal is transmitted via antennas to a computer when the device is activated for two seconds by the pressure of a mounting cow. On this basis, first mount, duration of mounting and number of mounts were permanently recorded along with the identification of the standing cow. In our herd, ovulation occurs 27.6 ± 5.4 hours following the first mount (Walker et al. 1996). Our experimental artificial insemination time was either 0 hour (heat onset indicated by first mount), 12 hours or 24 hours following first mount. However, due to logistics associated with monitoring the computer every three hours followed by retrieval of the cow for insemination, actual times of insemination were: 2.0 ± 0.9 hours, 12.1 ± 0.6 hours, and 24.2 ± 0.7 hours following the first mount, respectively. Artificial insemination was to one of three bulls, used randomly and balanced across all embryos/eggs for each insemination time (this is done to be sure the large bull influence is removed). Six days following insemination, the embryo was recovered non-surgically and examined for fertilization status/embryo quality and accessory sperm as described previously. Table 3 presents the accessory sperm data obtained from the insemination times. It is clear that accessory sperm number is favored by breeding later rather than earlier in heat. Figure 2 shows the fertilization status and embryo quality achieved by time of insemination. This chart indicates that pregnancy rate to AI is a "compromise". Fertilization rate follows the accessory sperm number as expected, being greatest by inseminations late in heat. However, embryo quality did not follow this trend. Rather, embryo quality was best at heat onset inseminations and poorest at late inseminations (24 hours). From these data, it appears that pregnancy rate would be optimized by breeding nearer to the middle of heat where we would expect a compromise between fertilization failure (early insemination) and embryo failure (late insemination). Based upon the Lindner and Wright (1983) embryo classification and success scheme, we would predict pregnancy rates to follow the curve shown in Figure 3. This curve is quite close to that reported from field pregnancy rates following artificial insemination times after first mount dictated by "HeatWatch® systems (Dransfield et al. 1998). Both field and embryo recovery data suggest that optimum artificial insemination time is between 6 – 12 hours following first mount or approximately 16 – 22 hours before ovulation, recognizing that first mount is our best estimate for time of ovulation.

The basis for pregnancy rate failure by breeding late (24 hours post onset of heat) could reside in the fact that we would often have an aging egg waiting for sperm if we assume that ovulation occurs 27.6 ± 5.4 hours post heat onset. Entry of sufficient potential fertilizing sperm into the oviduct (site of fertilization) in from the site of semen deposition requires approximately six hours in the cow (Hunter and Wilmut, 1984). Also, the high embryo quality associated with early insemination (Figure 2) suggests that duration of sperm residence in the female tract may result in exertion of additional selection pressure favoring fertilization by a more competent sperm, particularly where there are uncompensable sperm present in the inseminate.

Clearly, more research on the nature of reduced pregnancy rates to both artificial insemination and natural service is necessary before we have a full grasp of the tests we should apply to semen as well as the management strategies that will be most effective.

Conclusions and Summary: We have learned from laboratory evaluation of semen as well as accessory sperm and the embryos/eggs from which they come that there will not be a single test of semen quality that will predict fertility. On the contrary, pregnancy rates are dependent upon both the quantity and quality of semen delivered to the female. In addition, deficiencies in semen resulting in subfertile performance can vary from those which are **compensable** (can be overcome by increase semen dosage to the cow) to those which are **uncompensable** where lower fertility results regardless of sperm dosage. In addition, both deficiencies may exist within a given male and in any quantitative combination.

1. Sperm motility (viability) and factors affecting normal sperm motion (including misshapened sperm) are the most likely known candidates for compensable factors in semen. Normal sperm motion and morphological factors affecting this motion would impair sperm from gaining access to the egg at the site of

fertilization in the oviduct. Sperm factors (most likely at the molecular level) affecting sperm-egg recognition, binding and egg penetration are yet to be identified before a full appreciation of compensable components in semen will be in hand. In semen evaluation, it is still important that normal sperm motility be a recognizable component of semen evaluation.

2. Deviations in spermatozoal morphology is undoubtedly our best evidence for the existence of the uncompensable component in semen. Although classically recognized misshapened spermatozoa have been shown to be excluded from participation in fertilization following natural or artificial insemination, their presence in the ejaculate of the bull is indicative of the existence of a deeper problem extending to more normal appearing sperm in the same semen. The more normal appearing sperm in such samples appear to be incapable of sustaining the fertilization process or embryonic development once initiated, thus causing pregnancy failure at the level they exist in the sample. These uncompensable sperm cannot be recognized using contemporary semen tests, however, research efforts revealing differences in the stability of the sperm head DNA appear promising.

Finally, choice of the bull and time of artificial insemination in respect to onset of heat affect both fertilization rate (accessory sperm number per embryo/egg) and quality of the embryo. Collectively, these effects provide the basis for the economically important outcome, pregnancy rate. Comparing artificial insemination at heat onset vs. 12 and 24 hours later indicates optimum pregnancy rate would be expected at approximately 12 hours post onset. Loss of pregnancy rate to early inseminations is due to fertilization failure (but embryo quality is high), whereas, loss to late insemination is due to embryonic failure (but fertilization rate is high), thus, optimum insemination time appears to be a compromise.

Table 1. Relationship of accessory sperm per embryo/ovum to fertilization status and embryo quality. (n = 927)

Fertilization Status/Embryo Quality	N	Mean ± SD	Median
Excellent/good	449	24.5 ± 44.1	7
Fair/poor	213	17.2 ± 32.2	5
Degenerate	80	13.5 ± 38.1	1
Deg/UFO	12	2.7 ± 5.7	0.5
Unfertilized	173	1.6 ± 16.5	0

Table 2. Efforts to raise accessory sperm number.

Effort	Outcome	Reference
Block sperm loss	*no effect*	DeJarnette' et al. 1992
Frozen vs. fresh semen	*no effect*	Nadir, et al. 1993
Extender (milk/EY)	*no effect*	Dalton, et al. 1994
Microencapsulation	*neg*	Munkittrick et al. 1992
Select male	*pos*	Nadir, et al. 1993
Semen dosage	*pos*	Nadir, et al. 1993
Site of insemination	*pos*	Dalton, et al. 1999
Seminal plasma	*no effect*	Nadir, et al. 1996
AI timing	*pos*	Dalton, et al. 1998

Table 3.
Effect of artificial insemination time on accessory sperm per embryo or egg.
(breeding time post onset of estrus based on HeatWatch System®)
(Dalton et al., 1998)

Treatment[a]	N	Mean ± SD	Median	Range
0 hour AI	39	9.5 ± 23.1	1	0 – 120
12 hour AI	39	21.2 ± 46.2	2	0 – 198
24 hour AI	39	33.0 ± 52.7	4	0 – 209

[a] Actual times of insemination were: 2.0 ± 0.9, 12.1 ± 0.6 and 24.2 ± 0.7 hours post heat onset for 0, 12 and 24 hour treatments, respectively.

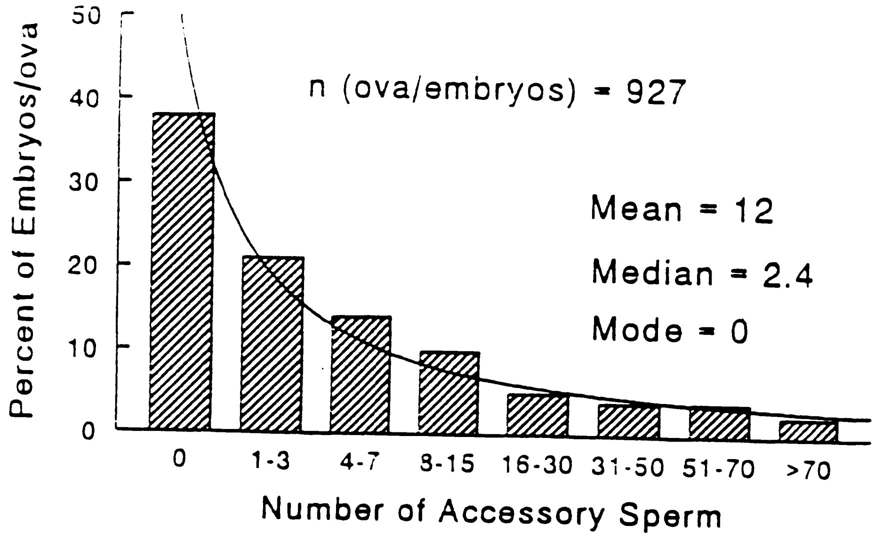


Figure 1. Frequency distribution of accessory sperm per embryo or egg in artificially inseminated single-ovulating cows. Quality and quantity of semen used varied, but was within acceptable standards for commercial artificial insemination.

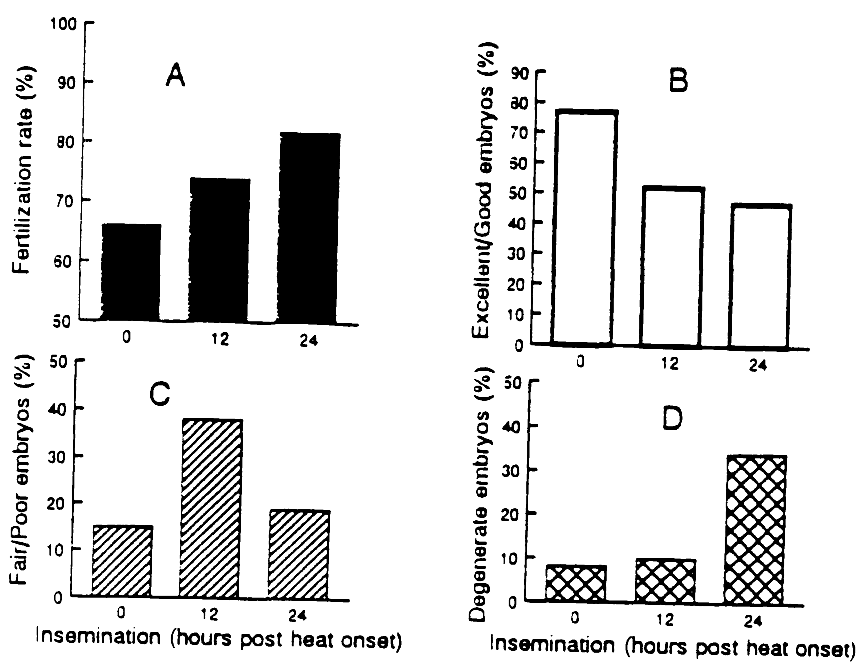


Figure 2. Effect of time of artificial insemination following onset of standing heat (Heat Watch System) on fertilization status and embryo quality judged 6 days following artificial insemination (n=117).

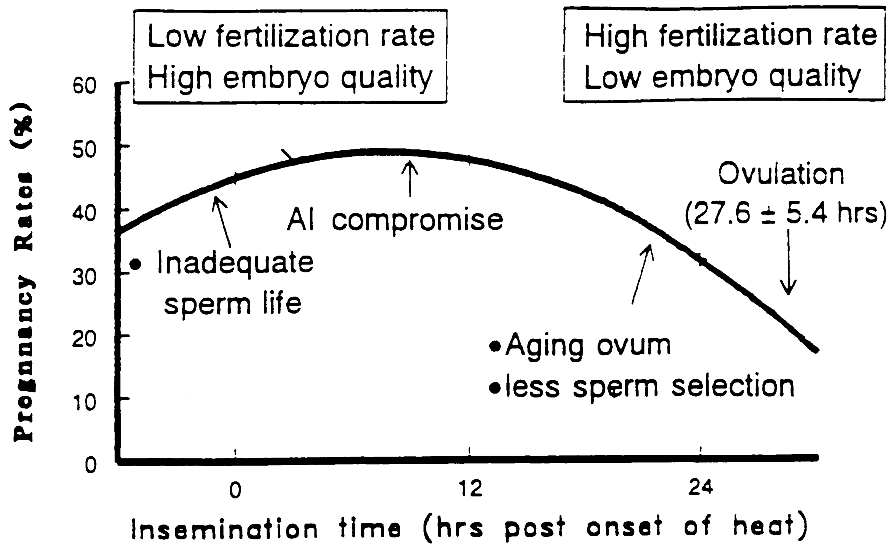


Figure 3. Calculated pregnancy rate from data presented in figure 2 and based upon the ability of embryos classified excellent to degenerate to constitute a pregnancy (according to Lindner and Wright, 1983). AI as a compromise is based upon early inseminations being inadequate due to high levels of unfertilized eggs, and late inseminations characterized by poor embryo quality.

References:

Barth, A.D. The relationship between sperm abnormalities and fertility. Proc. 14th Nat'l Assoc. Admin. Breeders Technical Conf. On Artif. Insemin. And Reprod., Columbia, MO. 1992; 47-63.

Coleman, D. A., R. E. Dailey, R. E. Leffel, R.D. Baker. Estrous synchronization and establishment of pregnancy in bovine embryo transfer recipients. J. Dairy Sci; 70:858-866. 1987.

Coulter, G. H., R. J. Oko, J. W. Costerton. Ultrastructure of "crater" defect of bovine spermatozoa. Theriogenology 9:165-168. 1978.

Courot, M., G. Colas. the role of the male in embryonic mortality (cattle and sheep). In: J.M. Greenan, J. M. Diskin, MG (ed), Embryonic Mortality in Farm Animals. Dordrecht, Martinus Nijhoff, 195-203; 1986.

Dalton, J., S. Nadir, S. Degelos, J. Bame, R. G. Saacke. Effect of cream added to the inseminate on accessory sperm number in cattle. J. Anim. Sci. 72:172 (Suppl. 1); 1994.

Dalton, J., S. Nadir, J. Bame, M. Nofsinger, R. L. Nebel, R. G. Saacke. Effect of artificial insemination time and natural service on accessory sperm number, fertilization status and embryo quality in cattle. J. Anim. Sci. 76:239. (Suppl. 1). 1998.

Dalton, J., S. Nadir, J. H. Bame, and R. G. Saacke. Effect of deep uterine insemination on spermatozoal accessibility to the ovum in cattle: a competitive insemination study. Theriogenology 51:883-890. 1999.

DeJarnette, J. M., R. G. Saacke, J. Bame, C. J. Vogler. Accessory sperm: their importance to fertility and embryo quality, and attempts to alter their numbers in artificially inseminated cattle. J. Anim. Sci. 70:484-491. 1992.

den Daas, J.H.G., G. DeJong, L. Lansbergen, A.M. Van Wagtendonk-De Leeuw. The relationship between the number of spermatozoa inseminated and the reproductive efficiency of individual dairy bulls. J. Dairy Sci. 81:1714-1723.

Dransfield, M.G.B., R. L. Nebel, R. E. Pearson, and L. D. Warnick. Timing of insemination in dairy cows identified in estrus by a radiotelemetric estrus detection system. J. Dairy Sci., 81:1874-1882. 1998.

Evenson, D. P., Z. Darznikiewicz, M. R. Melamed. Relation of mammalian sperm chromatin heterogeneity of fertility. Science 240:1131-1134. 1980.

Eyestone, W. H., N. L. First. Variation in bovine embryo development in vitro due to bulls. Theriogenology 31:191. 1989.

Hunter, R. H. F., I. Wilmut. Sperm transport in the cow: periovulatory redistribution of viable cells within the oviduct. Reprod. Nutr. Develop 24:597-603. 1984.

Lagerlof, N. Morphological studies on the changes in the sperm structure and in the testes of bulls with decreased or abolished fertility. Acta Path Mivrobiol. Scand. 19:254-267. 1934.

Lindner, G. M., R. O. Wright, Jr. Bovine embryos morphology and evaluation. Theriogenology 20:407-411. 1983.

Miller, D., M. Hrudka, W.F. Cates, Mapletoft. Infertility in a bull with a nuclear sperm defect: a case report. Theriogenology 17:611-621. 1982.

Munkittrick, T. W., R. L. Nebel, R. G. Saacke. Effect of microencapsulation on accessory sperm in the zona pellucida. J. Dairy Sci. 75:725-731. 1992.
Nadir, S., J. Dalton, J. Bame, S. Pandolfi, R. G. Saacke. Seminal plasma: How does it aid sperm function in cattle? Proc. 16th Tech. Conf. Artif. Insem. and Reprod., NAAB Columbia, MO. Pp 65-70. 1996.
Nadir, S., R. G. Saacke, J. Bame, J. Mulins, S. Degelos. Effect of freezing semen and dosage of sperm on number of accessory sperm, fertility and embryo quality in artificially inseminated cattle. J. Anim. Sci. 71:199-204. 1993.
Pace, M.M., J. J. Sullivan, F. I. Elliott, E. F. Graham, G. H. Coulter. Effects of thawing temperature, number of spermatozoa and spermatozoal quality on fertility of bovine spermatozoa packaged in 0.5-ml French straws. J. Anim. Sci. 53:693-701. 1981.
Parrish, J. J., L. Eid. In vitro fertilization and its relationship to bull fertility. Proc. 15th Tech. Conf. Artif. Insem. and Reprod. NAAB, Columbia, MO. Pp. 68-73. 1994.
Saacke, R.G., J. M. DeJarnette, J. Bame, D. S. Karabinus and S. S. Whitman. Can spermatozoa with abnormal heads gain access to the ovum in artificially inseminated super- and single-ovulating cattle? Theriogenology 50:117-128. 1998.
Saacke, R. G. J. Dalton, S. Nadir, J. Bame, R. L. Nebel. Spermatozoal characteristics important to sperm transport, fertilization and early embryonic development. In Gametes: Development and Function ed. A. Lauria, F. Gandolfi, G. Enne and L. Gianaroli., Serono Symposia, Milano. Pp 320-335. ISBN:88-85974-37-6. 1998.
Salisbury, G. W., N. L. Vandemark. Physiology of reproduction and artificial insemination of cattle. San Francisco, Freeman. 1961; 361.
Sullivan, J. J. F. I. Elliott. Bull fertility as affected by an interaction between motile spermatozoa concentration and fertility level in artificial insemination. VI Int'l Cong. Anim. Reprod. Artif. Insem. 2:1307. 1968.
Walker, W. L., R. L. Nebel, M. L. McGilliard. Time of ovulation relative to mounting activity in dairy cattle. J. Dairy Sci. 79:1555-1561. 1996.
Williams, W. W., A. Savage. Observations on the seminal micropathology of bulls. Cornell Vet 15:353-375. 1925.
Williams, W. W. A. Savage. Methods of determining the reproductive health and fertility of bulls. A review with additional notes. Cornell Vet. 17:374-376. 1927.

Estrus Synchronization and Induction Protocols in Beef Cattle

Jeffrey S. Stevenson
Kansas State University, Manhattan

Summary
Several new treatments have been developed to induce fertile heats and(or) ovulations in noncycling, suckled, beef cows and also synchronize estrus in cycling beef cows at the beginning of the breeding season. Use of GnRH (Cystorelin®, Factrel®, or Fetagyl®) before prostaglandin $F_{2\alpha}$ (Lutalyse® or Estrumate®) induces ovulation of a follicle in more than 80% of the cycling and noncycling cows. The resulting luteal structure is regressed by a prostaglandin injection that follows in 7 days. Increased success (greater pregnancy rates) is achieved with the addition of a progestin (Syncro-Mate-B® implant or the CIDR-B® insert) during the 7-day period between injections of GnRH and prostaglandin. These AI programs have been successful using timed insemination as well as inseminations after detected estrus. Pregnancy rates (percentage of all cows treated that become pregnant to the first AI) have met or exceeded 50 in most studies. In those herds where pregnancy rates did not exceed 50%, the new treatments always produced greater pregnancy rates than the control (a two-injection prostaglandin system). These treatments should make AI more successful for purebred and commercial cattle producers.

Introduction
Traditional estrus-synchronization programs were designed to improve reproductive efficiency by facilitating the grouping of cows and heifers so artificial insemination (AI) could be used more easily (Stevenson et al., 1997). They were not designed to induce estrus in noncycling, suckled beef cows. Treatments involving single or multiple injections of gonadotropin-releasing hormone (GnRH) given 10 to 12 days apart and(or) implants of norgestomet have been used to 'jump start' (induce estrus) in noncycling cows. Injections of GnRH induce secretions of LH and FSH and can induce ovulation of mature follicles in both cycling and noncycling cows. Norgestomet primes the hypothalamic-pituitary axis to release of endogenous GnRH, LH, and FSH that are necessary for follicle growth. In prepubertal heifers and anestrous suckled cows, the norgestomet implant also prevents the short luteal phase or short estrous cycle that normally follows first pubertal or postpartum ovulations. This first, short, estrous cycle prevents the continuation of pregnancy, even when fertilization occurs. Therefore, the objective of research in this area has been to test the effects of several novel treatments consisting of $PGF_{2\alpha}$, GnRH, and(or) norgestomet for their ability to induce estrus and increase pregnancy rates in noncycling suckled cows, as well to synchronize estrus in cycling females before heat detection or one fixed-time insemination at the onset of the breeding season.

Cycling Activity on Kansas Ranches
Most research over many years ahs indicated that cows should have body condition scores (1 = thin and 9 = fat) of at least 5 at calving time to prevent prolonged periods of

anestrus in suckled cows (Short et al., 1990). These investigations have shown that body condition at calving time is most critical to cycling activity after calving, although some increase in body condition can occur if postcalving feed intake is improved. Most of these nutrients are directed toward increased milk production and only slightly improve body condition. Since 1994, we have monitored the incidence of cycling activity in 2,041 beef cows before the breeding season and determined that about 50% of the cows are cycling when the breeding season begins. Greater body condition scores at the onset of the breeding season are associated with greater rates of cycling activity (Figure 1). A greater percentage of cows in the 5 to 6 body score range will be cycling at the onset of the breeding season. Even though replacement heifers are bred to calve up to 3 weeks earlier than cows, as 2-year-olds, their cycling rate is still less than that of older cows (Figure 2). The percentage of cows cycling at the onset of the breeding season obviously increases when cows have calved earlier in the calving season (Figure 3). We have found that cycling activity reaches a peak by approximately 70 days after calving (Figure 3).

Measures of Fertility

Success of an AI program usually is measured by the number of pregnant cows after one insemination. Definitions of rates of heat detection, conception, and pregnancy are illustrated in Figure 4. Conception rate is the measure of pregnancies achieved in all cows that are inseminated but does not reflect the real success of the breeding program, because it does not account for non-inseminated cows as does pregnancy rate. When all cows are inseminated at a predetermined time (timed AI), conception rate and pregnancy rate are synonymous by definition and the heat detection really becomes an AI submission rate. The product of conception rate times heat detection rate is pregnancy rate (Figure 4).

Ovsynch

The evolution of the newest breeding programs began with the Ovsynch protocol in dairy cows (Figure 5). This protocol uses the initial GnRH injection (100μg or 2 cc) to induce ovulation of a dominant follicle (largest follicle in either ovary) that develops into a second corpus luteum in the cycling dairy cow. In cycling dairy cows, about 60 to 80% of the cows given the initial GnRH injection ovulate a follicle in response to the LH released by the GnRH injection, depending on the stage of their estrus cycle. Following this induced ovulation, a new wave of follicles emerges from both ovaries within 48 hr, from which a new dominant follicle develops. Seven days after the initial GnRH injection, a prostaglandin product is injected to lyse or kill the original corpus luteum (if one was present at the time of the initial GnRH injection) and the corpus luteum induced by GnRH. During the next 48 hr, the new dominant follicle rapidly matures; and at 48 hr after prostaglandin, a second GnRH injection (100 μg) is administered, and the cow is inseminated in the next 24 to 32 hr. A time-response study was conducted in which dairy cows were inseminated at the same time as the second GnRH injection (0 hr) or at 8, 16, 24, or 32 hr later; the best pregnancy rates occurred when the times AI occurred at 16 hr (Pursley et al., 1998). In practice, on dairy farms, cows are inseminated anytime they detected in heat during this protocol, and further hormonal injections are discontinued. For dairy cows, a half dose (50 µg or 1 cc) of the Cystorelin product has been used successfully in the Ovsynch protocol at both GnRH injection times. No research has been conducted with the half dose in beef cows, so we do not know if it is effective.

The first application of the Ovsynch protocol in beef cattle was done by Tom Geary (Geary et al, 1998a). In those early studies, the Ovsynch protocol as compared to a standard Syncro-Mate-B® (SMB) protocol with 48-hr calf removal (Figure 6). Overall, the Ovsynch protocol produced greater pregnancy rates (54 vs. 42%) than SMB, particularly among the cycling cows (59 vs. 38%).

Select Synch

We initiated studies using a modified Ovsynch protocol that is now known as Select Synch. The logic for this protocol is analogous to that for Ovsynch, except cows are inseminated according to observed signs of estrus after prostaglandin (Figure 7). A similar protocol that we call Select Synch + NORG includes the SMB ear implant left in place for 7 days (removed when prostaglandin is injected) to provide a pre-estrus exposure to a progestin (Figure 8). The progestin is included to provide an additional stimulus to jump-start the noncycling cow. We used these two protocols in on-ranch studies in 1996. We compared them to a standard two-injection prostaglandin (PGF) protocol in which cows were injected with Lutalyse® 14 days apart, with the second injection occurring at the same time when the single prostaglandin injection was given to cows in the Select Synch and Select Synch + NORG groups. Results of this experiment in 890 beef cows are shown in Figure 9. Pregnancy rates were not different among treatment protocols for cows that were cycling at the beginning of the breeding season. In contrast, both Select Synch and Select Synch + NORG increased pregnancy rates in noncycling cows that were induced to show heat in the first 6 days of the breeding season (Forbes et al., 1997).

The distributions of heats in those cows detected in estrus during 144 hr after prostaglandin based on their cycling status at the onset of the breeding season are illustrated in Figures 10 and 11. The distributions of heats were similar in cycling cows treated with the two Select Synch protocols, but those in the PGF group were more variable. In contrast, in noncycling cows, the NORG implant prevented early heats and produced a peak in estrus activity between 36 and 48 hr after prostaglandin. The noncycling Select Synch cows came into heat very early, but the PGF cows were very spread out across the 6-day period. Because of this response in noncycling cows treated with Select Synch, we recommend that heat detection begin 2 day before prostaglandin is administered (Figure 7). When cows are observed in heat before prostaglandin, they should be inseminated based on signs of estrus and then not given the prostaglandin injection. Other studies have indicated that about 8% of the cows may show heat before the prostaglandin injection.

During our combined studies spanning the last 5 years (n = 1,467 suckled beef cows), we have seen greater percentages of cows in heat after the Select Synch + NORG treatment than after Select Synch or a PGF protocol (Figure 12). It is clear that the addition of the progestin (NORG or the CIDR-B insert) assists in jump-starting the noncycling cows. The cows at risk for failure to cycle at the beginning of the breeding season are those with body condition scores <5, the 2-year-olds, and those that are less than 60 days postpartum. The addition of a progestin consistently improves chances for conception to the AI at the beginning of the breeding season.

Cosynch

Based on distribution of heats after the Select Synch protocol and the early success with Ovsynch in beef cows, the Cosynch protocol was developed (Figure 13) and tested. The logic behind this protocol was to reduce the number of trips through the working facility to three. Comparisons of Cosynch to Ovsynch were made (Figure 14), and pregnancy rates in the first study were not different (Geary and Whittier, 1997). A further study with these two protocols that also incorporated 48-hr calf removal (between the injections of prostaglandin and the second GnRH injection) was tested (Geary et al., 1998b) after both the Ovsynch and Cosynch protocols. Calf removal produced pregnancy rates that were 9 percentage points greater than rates after those same protocols without calf removal (Figure 15).

We conducted a similar study in Kansas on three ranches in which we treated all cows with either Select synch or Cosynch or inseminated a third group of cows according to estrus up until 54 hr after prostaglandin, when the remaining cows were time inseminated and given a second GnRH injection at AI (Figure 16). Pregnancy rates among noncycling cows were very similar, but among cycling cows, those inseminated at estrus after the Select Synch protocol had greater pregnancy rates than those in the other protocols (Thompson et al., 1998).

Mechanisms of Estrus Induction

How is a fertile estrus produced in the cycling and noncycling cows so successful inseminations can be made according to estrus after GnRH + PGF? How does a fertile ovulation occur in cycling and noncycling cows after the Ovsynch or Cosynch protocols in which cows are inseminated by appointment? We studied 40 suckled beef cows during 1996 and 1997 that were about 34 days postpartum at the onset of three treatments (Thompson et al., 1999). Figure 17 illustrates the experimental procedure for three treatments: 1) GnRH injection plus an SMB implant for 7 days (Select Synch+ NORG); 2) GnRH injection (Select Synch); and 3) saline injection plus an SMB implant for 7 days (NORG). Cows then were given prostaglandin, the implants were removed, GnRH was injected 48 hr later, and insemination occurred 16 hr after GnRH. Daily blood collection and examination of both ovaries using transrectal ultrasonography were used to determine what happens to ovarian structures during the treatment protocols prior to AI as well as to monitor concentrations of estradiol (from the follicle) and progesterone (from the corpus luteum; Figure 18).

More than 75% of the noncycling cows treated with GnRH ovulated a follicle compared to only 20% of the noncycling cows given saline (Figure 19). The percentage of noncycling cows with a corpus luteum 7 days after GnRH exceeded 80% (Figure 20), and nearly all the corpora lutea regressed in response to PGF (Figure 21). The percentage of cows ovulating after the second GnRH injection exceeded 80%. Pregnancy rates in the three groups of cows were very different. The Select Synch + NORG protocol produced a 71% pregnancy rate, which was greater than that achieved after the Select Synch and NORG protocols with timed inseminations (Figure 22).

Implications

Treatment of suckled cows with GnRH 7 d before an injection of prostaglandin partially resolves the problem of anestrus before the beginning of the breeding season. This is not possible with prostaglandin-dependent systems, because more cows are detected in estrus with normal fertility. Addition of a progestin at the time of GnRH injection further improves the response. Fixed-time inseminations that follow a second GnRH injection after prostaglandin may reduce fertility unless the treatment also includes a progestin. Further refinement and success of these treatments should increase the appeal of AI to beef producers.

Acknowledgments

We thank the Kansas Agricultural Experiment Station, Manhattan, for major support and the following for contributions of funds and products that were used to support this research: Select Sires, Plain City, OH; Merial, Iselin, NJ; Pharmacia & Upjohn, Kalamazoo, MI; fort dodge Laboratories, Fort Dodge, IA; Intervet, Millsboro, DE; and InterAg, Hamilton, NZ.

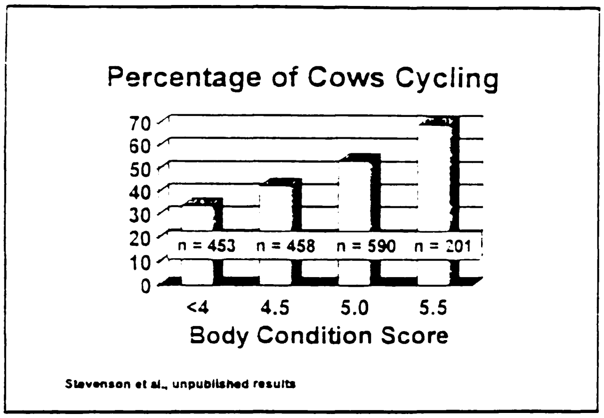


Figure 1. Cycling activity: Body condition.

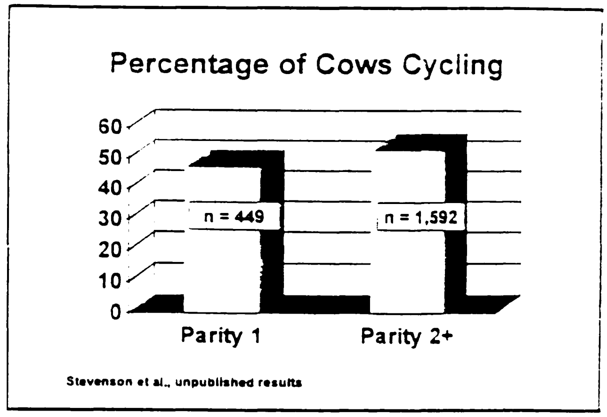


Figure 2. Cycling activity: Parity.

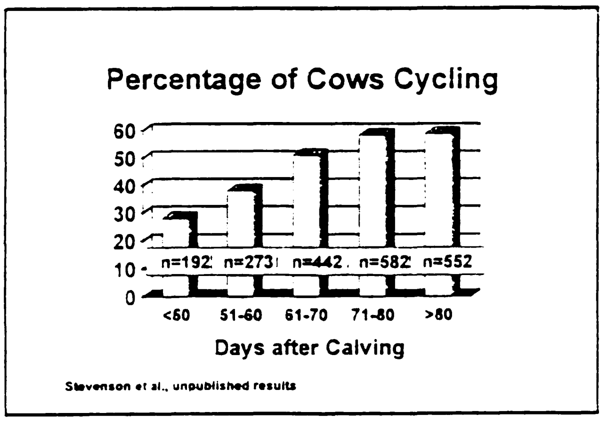


Figure 3. Cycling activity: Days after calving.

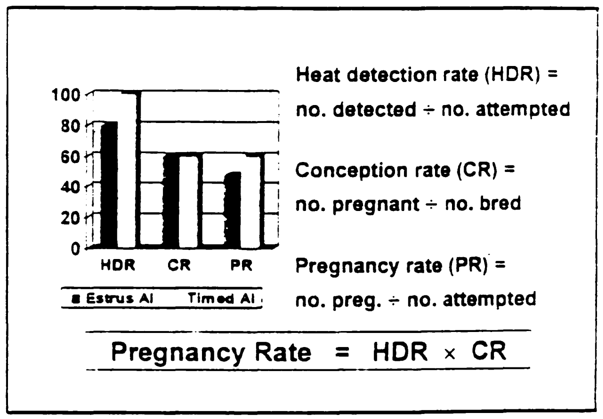


Figure 4. Definitions of reproductive rates.

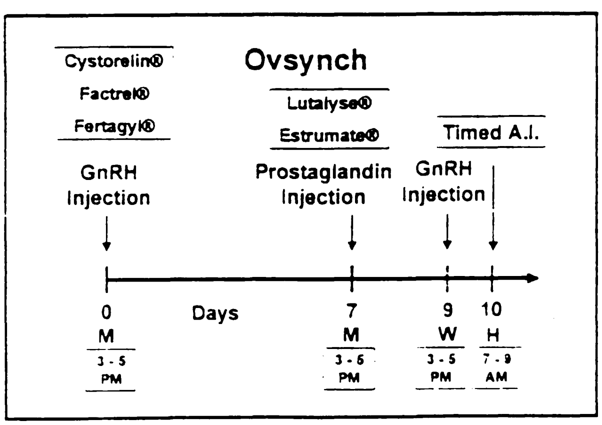


Figure 5. Ovsynch protocol.

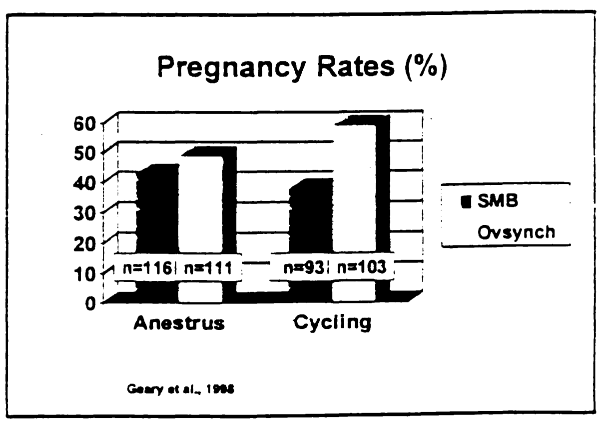


Figure 6. Pregnancy rates: Syncro-Mate-B (SMB) vs. Ovsynch.

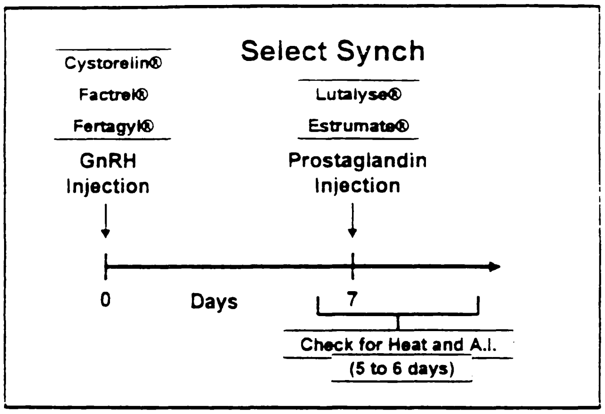


Figure 7. Select Synch protocol.

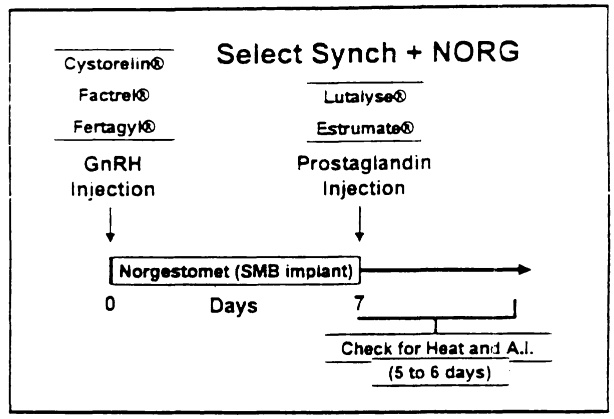


Figure 8. Select Synch + norgestomet (NORG).

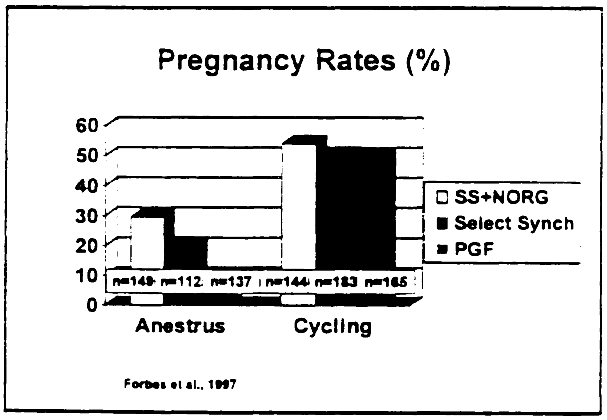


Figure 9. Pregnancy rates: Select Synch + NORG, Select Synch, vs. $PGF_{2\alpha}$.

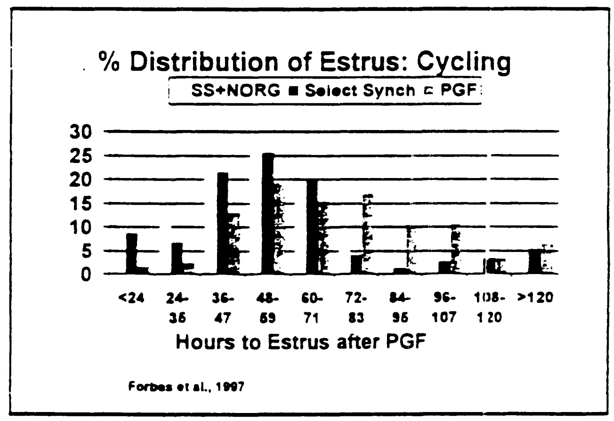


Figure 10. Distribution of estrus in cycling cows.

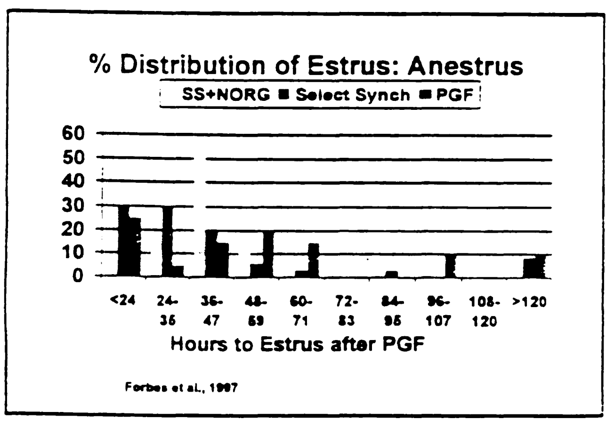


Figure 11. Distribution of estrus in anestrous (noncycling) cows.

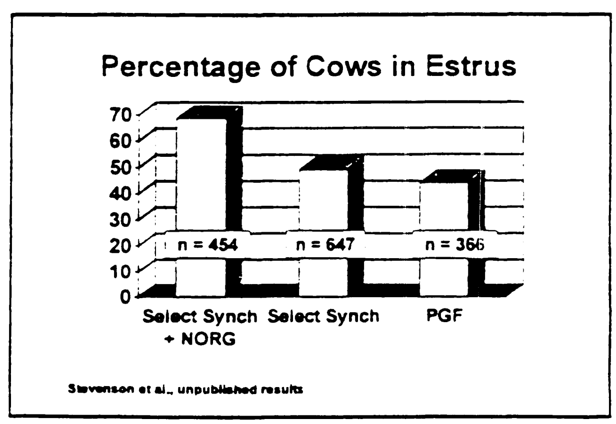


Figure 12. Percentage of cows in estrus.

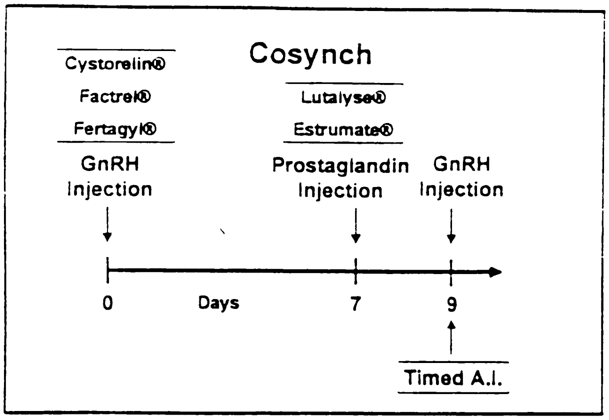


Figure 13. Cosynch protocol.

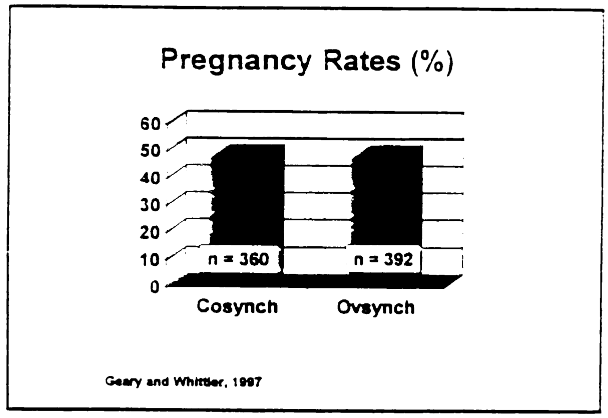


Figure 14. Pregnancy rates: Cosynch vs. Ovsynch.

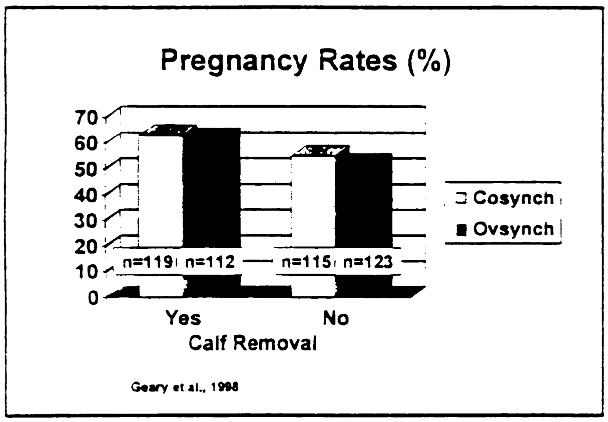


Figure 15. Pregnancy rates after 48-hr calf removal: Cosynch vs. Ovsynch.

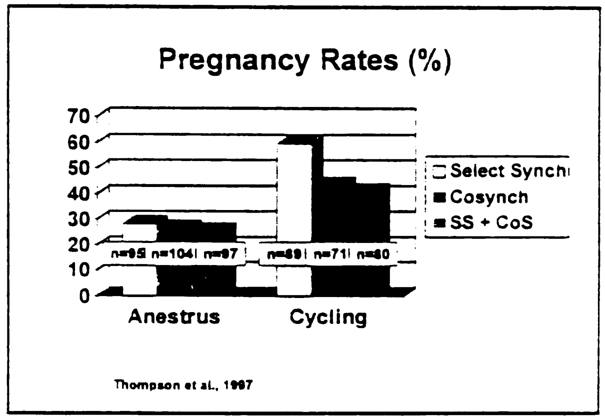


Figure 16. Pregnancy rates: Select Synch. Cosynch, Select Synch + Cosynch.

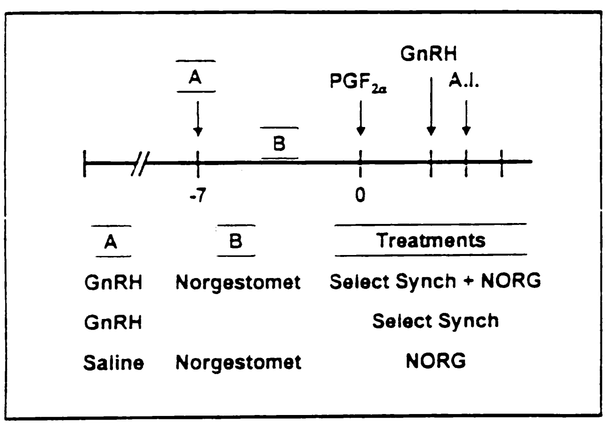


Figure 17. Treatment protocol-1.

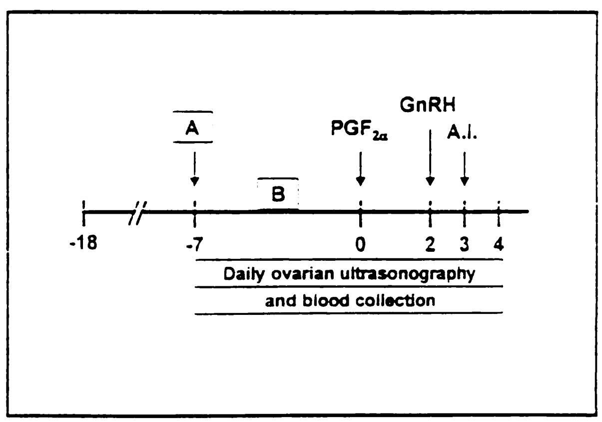


Figure 18. Treatment protocol-2.

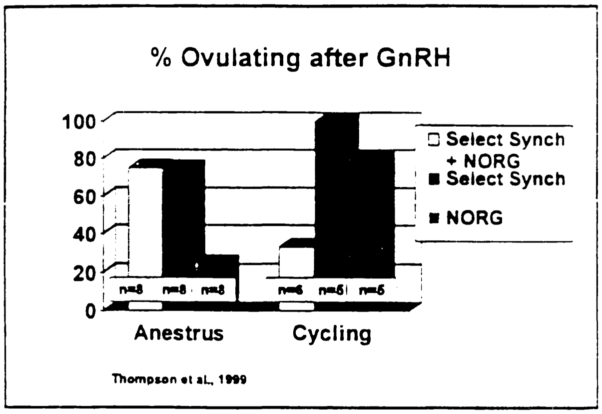


Figure 19. Percentage ovulation after Select Synch, Select Synch + NORG, and NORG.

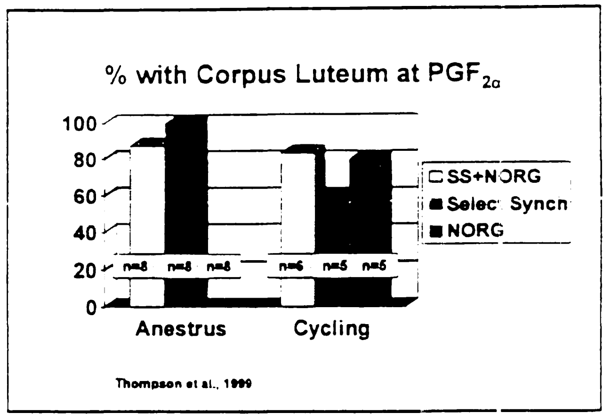


Figure 20. Percentage of cows with a corpus luteum (CL) at the time of $PGF_{2\alpha}$.

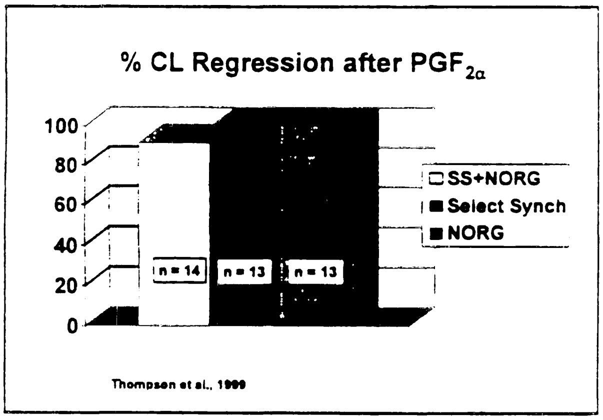


Figure 21. Percentage regression of CL after $PGF_{2\alpha}$.

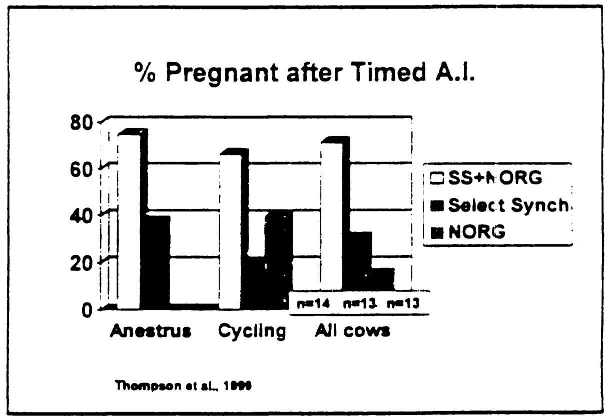


Figure 22. Percentage pregnant after timed AI.

Selected References

Forbes, W. L., L. R. Corah, D. m. Grieger, and J. S. Stevenson. 1997. Synchronized follicular growth and luteal regression before insemination of suckled beef cows. J. Anim. Sci. 75(Suppl. 1):90 (Abstr. #241).

Geary, T. M., and J. C. Whittier. 1997. Modifications of the Ovsynch estrous synchronization protocol for use in beef cows. J. Anim. Sci. 75(Suppl. 1):236 (Abstr.).

Geary, T. M., J. C. Whittier, E. R. Downing, D. G. LeFever, R. W. Silcox, M. D. Holland, T. M. Nett, and G. D. Niswender. 1998a. Pregnancy rates of postpartum beef cows that were synchronized using Syncro-Mate-B® or the Ovsynch protocol. J. Anim. Sci. 76:1523-1527.

Geary, T. M., J. C. Whittier, and D. G. LeFever. 1998b. Effect of calf removal on pregnancy rates of cows with the Ovsynch or Co-Synch protocol. J. Anim. Sci. 76(Suppl. 1):278(Abstr.)

Pursley, J. R., R. W. Silcox, and M. C. Wiltbank. 1998. Effect of time of artificial insemination on pregnancy rates, calving rates, pregnancy loss, and gender ratio after synchronization of ovulation in lactating dairy cows. J. Dairy Sci. 81:2139-2144.

Short, R. E., R. A. Bellows, R. B. Staigmiller, J. G. Berardinelli, and E. E. Custer. 1990. Physiological mechanisms controlling anestrus and infertility in postpartum beef cattle. J. Anim. Sci. 68:799-816.

Stevenson, J. S., D. P. Hoffman, D. A. Nichols, R. M. McKee, and C. L. Krehbiel. 1997. Fertility in estrus-cycling and noncycling virgin heifers and suckled beef cows after induced ovulation. J. Anim. Sci. 75:1343-1350.

Thompson, K. E., J. S. Stevenson, G. C. Lamb, D. M. Grieger, and C. A. Lőest. 1999. Follicular, hormonal, and pregnancy responses of early postpartum suckled beef cows to GnRH, norgestomet, and $PGF_{2\alpha}$. J. Anim. Sci. In press.

Heat Detection Systems and Estrus Management

Tom Geary
USDA-ARS Fort Keogh, Miles City, MT

Accurate detection of estrus among cows and heifers is critical to the success of any AI program. It is the most important of four variables that determine the pregnancy rate of an AI program. The other three variables include inseminator efficiency, fertility level of the herd, and semen fertility. Without accurate heat detection, females may be inseminated at the incorrect time, decreasing female fertility. Also, the most fertile semen in the world and the best inseminator in the world cannot overcome the problems of inseminating cows at the wrong time. Estrus is generally defined as standing to be mounted by herdmates or by a bull. The focus of this article is to identify tools to improve heat detection in beef herds and identify critical management strategies to maximize pregnancy rates to AI.

To begin, let's evaluate the task at hand to determine if there is a problem. Is heat detection difficult? No, but it is time consuming, and often we don't spend enough time with this task or give this task to people who are less qualified. Let's face it, heat detection can be boring, and the weather does not always make it an enjoyable experience. Why are we willing to spend upwards of $15 -20 to buy the best semen, and sometimes $3 - 10 on the best synchronization system, but as little as possible for heat detection? The answer is that we think we are saving money. But, are we really saving money, or are we compromising our success? We need to consider two different scenarios (with or without estrous synchronization) when we seek to evaluate our success at heat detection.

Effects of Estrous Synchronization on Heat Detection Efficiency and Accuracy
Hormonal events determine the maximum duration of estrus, but environmental and social factors have major roles in the expression of estrous behaviors. The HeatWatch system is an "around the clock" electronic heat detection system that has beer used in research projects to evaluate the efficiency and accuracy of visual heat detection in beef herds (Stevenson et al., 1996, Whittier et al., 1996). Based on ovarian structures or hormonal profiles, the HeatWatch system efficiently identifies 89 to 100% of heats in beef cows and heifers (Borger et al., 1996; Stevenson et al., 1996). The accuracy of the HeatWatch system in correctly identifying estrus is 88 to 100% in beef herds. Visual detection of estrus (30-60 minutes each morning and evening) was just as accurate as the HeatWatch system, but much less efficient. Visual detection of estrus missed 22 to 31% of heats detected by HeatWatch in herds when synchronization of estrus was used and up to 80% of heats detected by HeatWatch when estrous synchronization was not used (Stevenson et al., 1996; Borger et al., 1996; Whittier et al., 1996). The take home message from this is that we miss a lot more heats than we are willing to admit.

There are several reasons why we miss heats with visual detection alone, however the main reason is that we just don't spend enough time observing cows for signs of estrus. When estrous synchronization is used, most cows will exhibit estrus within a 120-hr (5-day) window. However, without estrous synchronization, cows exhibit estrus over a 504-hr (21-day) window. Obviously, when we choose not to use estrous synchronization, we must spend more hours observing cows, and the task becomes labor intensive. However, observing cows for additional days is not the only reason we miss heats. The duration of estrus is longer and the number of mounts is greater among cows that are synchronized compared to cows that are not synchronized (Table 1). The increased duration of estrus and number of mounts is related to the number of cows that are in estrus simultaneously (Hurnik et al., 1975). Simply put, when only one or two cows are in estrus simultaneously, they have difficulty finding others that will mount them. Because of these variables, we have about a 10% greater chance of detecting each cow in heat if we use estrous synchronization.

Table 1. Duration and intensity of estrous synchronized or naturally occurring heats.

Parameter Measured	Synchronized Heat	Natural Heat
No. Mounts/Cow	48 mounts	22 mounts
(Range)	(2 – 211)	(2 – 68)
Duration of Heat	12 hours	8 hours
(Range)	(.1 – 27)	(.02 – 22)

We also may miss more naturally occurring heats than synchronized heats because of when we spend time observing cows and when cows exhibit estrus. Table 2 contains the time of day, on average, that cows and heifers come into heat. The majority of cows exhibit estrus during daylight hours. However, without estrous synchronization, a large percentage of beef cows may exhibit estrus only during darkness, when estrous detection is almost impossible. The reason that more heifers tend to initiate estrus between midnight and 5 a.m. is likely due to the predominant use of the MGA/PGF (melangestrol acetate/prostaglandin) system for synchronizing estrus, and a high percentage of heifers receiving their PGF injection during the morning. The old standard for heat detection was that 30 minutes of observation each morning and evening was sufficient. If every cow or heifer would read the literature and remain in heat for 8 – 12 hours during which time they would actively engage in mounting activity, then perhaps this limited amount of heat detection would be sufficient. However, scientists are now learning that cows don't read (whether they can read is another question). Table 2 also suggests that a higher percentage of cows and heifers may be detected in estrus by adding another period of observation between noon and 6 p.m. This additional period of estrous detection might also lead to a more appropriate timing of insemination that results in a higher pregnancy rate. After all, when we don't spend much time observing cows, we don't know if we are identifying cows early or late in their heat period.

There are several estrous synchronization protocols available for beef females (Geary, 1997; 1999; Stenquest and Geary, 1998). These protocols include the MGA/PGF protocol, the Syncro-Mate-B protocol, one or two-injection PGF protocols, and the Select Synch protocol. The Ovsynch and CO-Synch protocols are generally considered ovulation synchronization protocols. Each of these protocols has advantages and disadvantages. Choosing the best one depends on the females you are trying to synchronize, your goals, facilities, and resources. Some of these protocols are able to induce estrous cycles in heifers and cows, however, none of them are replacements for poor management.

Table 2. Percentages of beef cows and heifers that first displayed standing estrus by time of day.

Time of Day	Synchronized Heat (heifers)[a]	Synchronized Heat (cows)[b]	Natural Heat (cows)[c]
Midnight to 6 a.m.	35%	16%	14%
6 a.m. to Noon	13%	35%	35%
Noon to 6 p.m.	28%	27%	24%
6 p.m. to Midnight	25%	22%	28%
Displayed Heat During Darkness only	**???**	**3%**	**28%**

[a]Stevenson et al., 1996.
[b]Pooled data from Whittier et al., 1996; Greene and Borger, 1996; Borger and Breene, 1997.
[c]Whittier et al., 1996.

Heat Detection Aids

There are numerous heat detection aids available that can increase our efficiency of visual detection of estrus. However, we must remember that these aids are only to be used to supplement visual observation. Heat detection aids can be broken down into visual aids, electronic aids, and the use of teaser animals with or without visual aids.

A. Visual Aids

Kamar Detector – This 4 ½ x 2-inch detector is applied with adhesive over the sacrum of the cow between the hip bone and the tail head. It remains white until it is triggered from the weight of a mounting cow, at which time it turns a bright red indicating that the cow is in standing heat. Cost of the Kamar is approximately $1 - 2 per cow.

Bovine Beacon – The Bovine Beacon is similar to the Kamar device and is glued to the tail head of the cow. It contains a fluorescent dye that glows in the dark when a cow in heat is mounted by another cow. Cost of the Bovine Beacon is approximately $1-2 per cow.

Painted/Chalked Tail Heads – The simplest and perhaps most economical aid for detecting estrus is to smear liberal amounts of chalk or paint on the tail head of cows.

Livestock paint sticks work well and will last several days. Other paints may be suitable. This procedure is especially helpful for synchronized herds, since most paints or chalk will not be visible after a couple of weeks.

Chin-Ball Marker – This marker device fits under the chin of the teaser (gomer) bull or androgenized cow. As the animal wearing the device mounts and slides off the cow in heat, an ink mark is left on the back and hip of the cow that has been mounted. Cost is about $150 plus ink.

B. Electronic Aids

HeatWatch – This article has already made reference to the HeatWatch electronic estrous detection aid. This system consists of gluing a patch over the sacrum of the cow that contains an electronic transmitter. On the top of the transmitter is a pressure sensitive button that, when pressed, emits a radio signal to a receiver that is connected to a computer. The computer contains software that stores information about the cow that was mounted including the time of the first mount, the duration of each mount, and the number of mounts. Initial cost of the HeatWatch system for 100 cows would be about $95 per cow. Once the system and transmitters are purchased, the annual cost drops to about $5 per cow.

C. Teaser Animals

Penile Blocked Bulls – Gomer bulls that have been equipped with a penile block device are proven companions to the chin-ball marker. The penile block does not deter normal bull mounting but does prevent extension of the penis and insemination. Installation is not difficult, but it must be properly installed. The services of a qualified veterinarian are recommended for this procedure. This procedure may be effective for only one year since some bulls so equipped tend to lose sex drive rather quickly. This method prevents copulation and helps prevent the spread of venereal diseases.

Vasectomized Bulls – Vasectomy is a surgical procedure in which the vas deferens (tubes which carry sperm from the testes to the penis) are severed, resulting in sterility. Since the blood and nerve supply to the testes are not interrupted, the bull remains normal in all other respects. Thus, vasectomized bulls have normal libido and are helpful for identifying females in estrus. Chin-ball markers work well on vasectomized bulls also. Vasectomized bulls can spread venereal diseases, but there is new data that suggests breeding stimuli by sterile bulls increase the conception rate to AI (Rodriquez and Rivera, 1999).

Prepuce/Penis Deviated Bulls – Redirection of the prepuce and penis is another method of altering bulls so they can be used for estrous detection. The purpose of this procedure is to move the opening of the prepuce to one side so that the penis fails to line up with the vulva of the female, thus preventing breeding. Males with a redirected prepuce are more advantageous for detecting estrous females than either vasectomized males or males with a Penile Block. The problem of disease spread and loss of sex drive is eliminated, resulting in a bull that would be useful for a much longer period of time.

Caudal Epididymectomized Bulls – Caudal epididymectomy has been used extensively for years in Australia and New Zealand and to a limited extent in the U.S. during the past decade. To perform a caudal epididymectomy, an incision just long enough to allow the epididymis to pop out , is made in the bottom of the scrotum. The protruding tail of the epididymis is then removed with scissors and cauterized. This procedure is relatively simple to perform and has served as an easy and economical method of preparing a teaser bull. This procedure prevents sperm from reaching the penis, but does not prevent copulation or the possible spread of venereal disease.

Androgenized Females – Some livestock managers prefer to use cull heifers or cows that have been treated with androgens (mainly testosterone) as teasers. Androgenized females can be used for long periods of time, are safer than bulls, and the injection of androgens is usually cheaper than surgically altering a bull. Older cows (6 to 8 years old) appear to work better than younger cows. Androgenized females can be fitted with chin-ball marking devices to help identify cattle that are in estrus. One androgenized cow should be sufficient for each 30 synchronized cows or 50 non-synchronized cows.

Testosterone propionate is the hormone of choice for producing androgenized females and can be purchased through your local veterinarian. This hormone is injected at the dose of 200 mg every other day for 20 days prior to the breeding season. At this time the cow can be used as a teaser animal. Booster shots of 200 mg must be given every 10 days during the breeding season. The cow used as an androgenized cow can be one that has lost her calf, thus eliminating the need for maintaining extra animals throughout the winter just for teaser animals.

Synovex H, a hormone implant for increasing growth efficiency in feedlot heifers, which contains estradiol valerate and testosterone propionate, can be used for androgenizing a teaser cow. Place five implants subcutaneously in the ear of the teaser cow. The testosterone propionate in these implants will keep the cow active for several months. The implants must be removed before sending these cows to slaughter.

Secondary Signs of Estrus

There are secondary signs of estrus that an observer should look for. The cow in heat may attempt to ride several different females; she may follow them, stand beside them, and put her head on their back or rump. Many cows bawl or bellow considerably during their heat period. Others will exhibit restlessness and walking in search of a bull, pace along a fence, or try to go through it. Sometimes clear mucus may be seen flowing from the vulva indicating that the cow is close to estrous. Oftentimes this mucus can be observed on the buttocks or as strings on the tail. This is also a strong indicator of estrus. Keep in mind, however, that the only definitive sign of estrus is standing to be mounted.

Estrus Management
Each operation should have a customized heat detection program in place because blanket recommendations often fail when applied to many operations. However, cows should be observed for signs of estrus at least twice daily for a minimum of 60 minutes each time. Perhaps a better rule of thumb would be that cows should be observed for at least 30 minutes after removing cows that are in heat to see if more submissive cows will stand to be mounted. As mentioned earlier in this article, an additional observation period between noon and 6 p.m. may increase our heat detection efficiency. In addition, if cows are lying down when you arrive to observe them, get them up.

We used to believe that leaving cows in heat with others cows would help us identify other cows in heat. When estrus synchronization is not used, then perhaps this is beneficial. However, when there are several cows in heat, the more submissive cows often go unnoticed. In addition, when several cows are mounting at the same time it is difficult to record every cow in heat. Removing cows that are in heat and placing them into a "hot" pen will allow us to focus better on cows that are more submissive, and avoid missing heats. If the "hot" pen is adjacent to the pasture that we heat check in, then oftentimes cows coming into heat will be attracted to that pen and be easier to identify.

Data obtained by using the HeatWatch system in dairy cows and once a day insemination shows that 4-14 hours following the first displayed estrus is the best time to inseminate cows (Dransfield et al., 1998). This time interval is not likely to be different among beef cows because ovulation occurs 26-32 hours following the onset of estrus in both beef and dairy cows. When we don't know the exact time that cows first displayed standing heat, we must rely on the averages. The averages still suggest that cows should be inseminated roughly 12 hours after our observation of estrus.

The factor that decreases our efficiency of heat detection the most is failure to spend time observing our cows. The HeatWatch system is a powerful tool because it gives us 24 hour heat detection. However, it is also more expensive than most producers can afford. An example that demonstrates that the time with cows, rather than the HeatWatch system is the most important component to efficient heat detection is illustrated in Figures 1 and 2. Figure 1 shows the heat detection efficiency of cows within one herd that were observed approximately 2 hours each morning and evening plus 1 hour around noon versus 30 minutes each morning and evening. In addition, the cows observed for 4 hours daily had HeatWatch transmitters. All cows received the same Select Synch estrous synchronization system and cows were bred by the am/pm rule (cows in heat in the morning were bred the following evening and cows in heat in the evening were bred the following morning). The HeatWatch and intense visual observation were equally efficient in detecting heat among these cows.

When we conducted the study illustrated in Figure 1, we did not know that a percentage of cows receiving the Select Synch protocol would display estrus earlier than the PGF injection. Thus, the 9% that were observed in heat early were not inseminated and are not represented in Figure 2. More accurate identification of the initiation of estrus obtained by intense visual observation may result in higher conception and pregnancy rates. In our study, we obtained twice as many AI pregnancies with intense observation of estrus.

One other question that producers often have regarding AI is the effects of stress on pregnancy. Stress around the time of AI does not have any effect on pregnancy rates (Yavas, 1996). This makes sense because when a cow is in heat and being mounted by several other cows, her stress level is probably already maximized. There is data that suggests the best time to transport cattle following AI is within the first 4 days after AI (Harrington et al., 1995). When heifers were transported to pasture between day 8-12 or day 29-33 following AI, pregnancy rates to AI were 12% and 9% lower than when transportation occurred during day 1-4 following AI.

Literature Cited

Borger, M. L., W. A. Greene and D. L. Grooms. 1996. Electronic pressure sensing system as an alternative to visual observation of estrus in beef cows with or without Syncro-Mate-B treatment. J. Anim. Sci. 74(Suppl. 1):244.

Borger, M. L. and W. A. Greene. 1997. Characteristics and costs associated with estrus detection methods for beef cows. J. Anim. Sci. 75(Suppl. 1):236.

Geary, T. W. 1997. Synchronization programs update. Proceedings, The Range Beef Cow Symposium 15:121. Rapid City, South Dakota.

Geary, T. W. 1999. Six ways to synchronize. Farmer Stockman. April Issue. Pp. WB10-11.

Greene, W. A. and M. L. Borger. 1996. Comparison of two estrus detection methods and estrus characteristics for beef cows. J. Anim. Sci. 74(Suppl. 1):246.

Harrington, T. E., M. E. King, H. E. Mihura, D. G. LeFever, R. Hill, and K. G. Odde. 1995. Effect of transportation time on pregnancy rates of synchronized beef heifers. Colorado State University Beef Program Report. Pp. 81-86.

Hurnik, J. F., G. J. King, and H. A. Robertson. 1975. Estrous and related behavior in postpartum Holstein cows. Appl. Anim. Ethol. 2:55.

Rodriguez, R. O. L. and M. J. Rivera. 1999. Fertility of beef cattle females with mating stimuli around insemination. Anim. Reprod. Sci. 54:221-226.

Stenquist, N. J. and T. W. Geary. 1998. Synchronizing estrus in beef cattle. Cooperative Extension Bulletin CL405. In: Cow-Calf Management Guide and Cattle Producer's Library. Cooperative Extension System. University of Idaho Ag Publications Distribution, Moscow, Idaho.

Stevenson, J. S., M. W. Smith, J. R. Jaeger, L. R. Corah, and D. G. LeFever. 1996. Detection of estrus by visual observation and radio telemetry in peripubertal, estrus-synchronized beef heifers. J. Anim. Sci. 74:729-735.

Whittier, J. C., B. L. Weech, D. Schutz, D. LeFever, and T. Patterson. 1996. Use of an electronic estrous detection system to describe behavioral estrus in beef cows. Colorado State University Beef Program Report. Pp 79-84.

Yavas, Y., D. M. deAvila, and J. J. Reeves. 1996. Stress does not lower conception in heifers. Theriogenology 45:623-632.

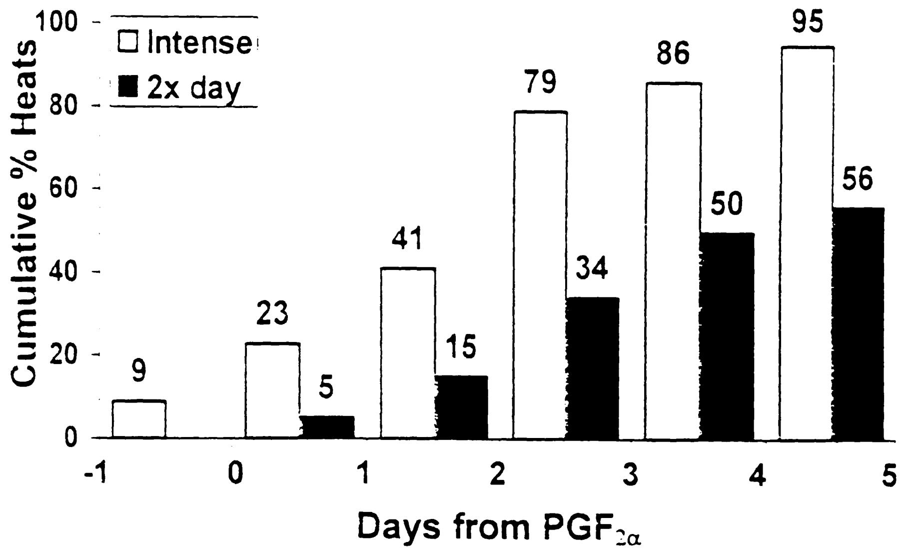


Figure 1. Percentage of heats observed with intense heat detection (2 hours each morning and evening plus 1 hour around noon) or 2x daily (morning and evening) heat detection for 30 minutes following synchronization of estrus using the Select Synch protocol.

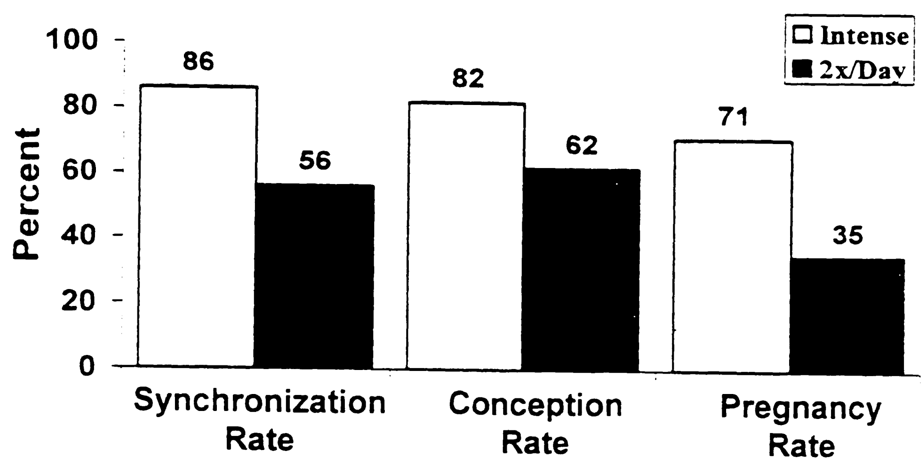


Figure 2. Pregnancy rates of cows inseminated by the am/pm rule following intense heat detection or 2x daily heat detection.

General Session 1

Profiting From Efficiency

WHY IS EFFICIENCY SO IMPORTANT TO THE BEEF INDUSTRY?

Harlan D. Ritchie
Distinguished Professor of Animal Science
Michigan State University

Introduction

An up-front answer to the question posed in the title of this paper would be the following: "Efficiency impacts unit cost of production, thereby having the potential to increase beef's competitiveness in both the domestic and global marketplace, to improve industry profitability, and to enhance long-term sustainability of the beef industry."

Demand for beef has slipped considerably in the Western economies; the main reasons have been poultry and pork's improved efficiency in the conversion of the right genetics into customer required products at reasonable cost (Ball, 1998). In the United States, beef demand has declined by about 50% since 1979 (Purcell, 1998). It seems logical that improved efficiency is an important step in preventing further erosion in beef demand.

Biological Efficiency

As shown in Table 1, it is unreasonable to expect that beef production can ever attain the biological efficiency level of the monogastric species. Dickerson's estimates show that an average of only 5% of the total life cycle dietary energy expended in beef production is used for protein deposition in market progeny. Pork and broiler chicken production is considerably more efficient at 14% and 22%, respectively. Similar levels of efficiency among species have been reported by Baldwin et al. (1992) and Webster (1994). However, it should be noted that a large proportion (over 80 %) of the total life cycle dietary energy used to produce beef in the U.S. consists of high-fiber forages which cannot be utilized by monogastric species. Nevertheless, it remains clear that beef production is not a highly efficient process from the standpoint of total energy expenditure.

Maintenance

One explanation for the high energetic cost of beef production is the cost of maintenance. Johnson (1984) reported that 71% of the total dietary energy expenditure in beef production is used for maintenance and that 70% of the maintenance energy is required for the cow herd. Therefore, 50% (71% x .70 = 50%) of the total energy expended in producing beef is used for maintenance of the cow. Research has indicated that the genetic variation for maintenance energy requirement of cattle is moderate to high, which suggests there may be opportunities to select for more biologically efficient cows (DiConstanzo et al., 1990; Hotovy et al., 1991). Unfortunately, there is currently no simple or inexpensive method for evaluating the maintenance requirements of individual cattle. If a technological breakthrough were to provide such a measure, it could conceivably pave the way for development of an EPD for maintenance.

Table 1. % of total life cycle dietary energy expended in protein deposition[a]

Species	% of total dietary energy to protein deposition in market progeny
Broiler chicken	22
Turkey	18
Rabbit	24
Pork	14
Lamb	5
Beef	5

[a]Adapted from Dickerson (1984).

U.S. MARC workers (Ferrell and Jenkins, 1984) reported that biological types differ significantly in their maintenance requirements. They found that heavier-milking breedtypes exhibit greater maintenance needs not only during lactation, but during the dry period as well. In a subsequent review of literature (Ferrell and Jenkins, 1985), they made the following important statement: "Research results indicate a positive relationship between maintenance requirements and genetic potential for measures of production (e.g., rate of growth, milk production, etc.). Available data also suggest, possibly as a consequence of increased maintenance requirements, that animals having genetic potential for high productivity may be at a disadvantage in a more restrictive environment."

Genotype X Environment Interactions

A classic example of an interaction between genotype and production environment and the effect on cow efficiency was shown in an extensive 5-year study by Jenkins and Ferrell (1994) in which they compared biological efficiencies of nine pure breeds of mature cows fed year-round on one of four different levels of dry matter. The cows were mated to have purebred calves. Biological efficiency was expressed as grams (g) of calf weaned per kilogram (kg) of dry matter intake per cow exposed. Table 2 shows that if dry matter intake increased from 3,500 to 7,000 kg per cow per year, there was a dramatic change in the efficiency of the breeds. For example, at 3,500 kg, Red Poll and Angus were the most efficient breeds, but at 7,000 kg, they ranked considerably lower. Conversely, efficiency of Charolais, Simmental, Gelbvieh, Braunvieh, and Limousin improved markedly when their intake went from 3,500 to 7,000 kg. Although not shown here, when Jenkins and Ferrell calculated the dry matter intake required to maximize efficiency for each of the nine breeds, there was a wide range in intake (3,790 to 8,000 kg), but a much narrower range in efficiency (35.1 to 47.1 grams) among breeds.

Table 2. Predicted biological efficiency at varying dry matter intakes for nine breeds of cattle[a]

Breed	Dry matter intake, kg/cow/yr	
	3,500	7,000
	g calf weaned/kg DM/cow exposed	
Angus	39	17
Braunvieh	33	42
Charolais	27	45
Gelbvieh	29	36
Hereford	30	13
Limousin	33	42
Pinzgauer	38	44
Red Poll	47	24
Simmental	26	42

[a] Adapted from Jenkins and Ferrell. 1994. JAS. 72:2787.

Market End Point

Gregory et al. (1994) evaluated the efficiency of post-weaning gain of the steer progeny of the nine pure breeds of cows in Table 2 when fed to different market end points (Table 3). Biological efficiency was expressed as grams of live weight gain per megacalorie (Mcal) of dietary metabolizable energy (ME) consumed. In general, the following trends were observed: when fed to a constant time end point, there was no consistent trend, but smaller breeds having less weight to maintain tended to be more efficient; when fed to a constant carcass weight end point, breeds with the highest rate of gain tended to be more efficient; when fed to a constant retail product weight end point, the leaner Continental breeds were more efficient than the British breeds; when fed to a constant marbling score, the British breeds were most efficient. The take-home message is that when evaluating energetic efficiency of post-weaning feedlot gain, it is important to clearly define the market end point.

Table 3. Postweaning efficiency at various market endpoints [a]

Breed group	Market endpoint			
	Time, 207 d	Carcass wt., 734 lb	Retail product, 463 lb	Marbling score, Small°
	Grams live wt. gain/Mcal of ME			
Red Poll	49	48	47	51
Hereford	54	51	46	57
Angus	50	49	46	54
Limousin	54	54	57	47
Braunvieh	50	51	51	49
Pinzgauer	50	50	50	51
Gelbvieh	48	49	50	45
Simmental	51	52	54	49
Charolais	52	53	55	49
Diff. ($P < .05$)[b]	1.9	2.0	2.4	1.9

[a] Adapted from Gregory et al. 1994. JAS. 72:1138.

[b] Difference ($P < .05$) is the approximate difference between means of breeds required for statistical significance.

Economic Efficiency

Research in recent years has shown that biological efficiency, while important, is not necessarily related to economic efficiency (profitability). As Taylor (1994) noted, maximum profitability is nearly always achieved before maximum productivity. This point is illustrated in Table 4, a Nebraska study (Van Oijen et al. 1993) on economic efficiency of three biological types of cows that differed in milk production, but were very similar in body size. All three groups were fed in a manner that allowed them to express their milk production potential. Measure of economic efficiency was the ratio of value of output per $100 of total input costs. If calves were sold at weaning time, the spread between milk groups was relatively narrow, but favored the low and medium groups over the high group. If progeny were sold as finished cattle, rank of the groups remained the same, but the spread among them was greater than at weaning time. It should be noted that the "low" cows were actually relatively good milkers by industry standards. Average production of the low cows over a 205-day lactation was nearly 14 lb per day. In general, a level of 12 lb milk per day could be considered adequate to raise a thrifty calf having an acceptable weaning weight (Notter, 1984).

Table 4. Economic efficiency of beef production from three milk groups[a]

Cow Milk Group	205-d milk prod., lb[b]	Sale Time: Weaning	Sale Time: Slaughter
		$ Output / $100 Input	
Low	2833	90.3	99.5
Medium	3599	89.2	96.5
High	4143	88.1	95.3

[a]Van Oijen et al. 1993. JAS. 71:44

[b]Cows four years and older

Montana workers (Davis et al.,1994) reported the results of a well-designed simulation experiment which was based upon data from a 10-yr study involving five biological types of cows in north central Montana, a region that is typical of a northern U.S. semi-arid range environment. In an earlier paper, Kress et al. (1990) reported that biological efficiency (calf weaning wt/cow exposed/unit cow wt) of these five cow types tended to favor ½-Simmental cows over the other breedtypes, followed by ¼-Simmental, ¾-Simmental, straightbred Hereford, and Angus X Hereford. However, as shown in Table 5, when economic efficiency, expressed as annual net profit per cow exposed was determined, there was a shift in the rank of the groups. Net profit was highest for the two F_1 groups, Angus X Hereford and Simmental X Hereford, followed by the ¼-Simmental, ½-Simmental, and straightbred Herefords, respectively. Although not shown here, maternal heterosis effects on net profit were large and highly significant. In contrast, maternal breed effects were much smaller than maternal heterosis effects and generally were not significant. Furthermore, percentage increase in dollar output from maternal heterosis was only half negated by increased feed costs (25 vs. 12%).

Table 5. Economic performance of five biological types of cows[a].

Dam breed group	Total cost per cow exp.,$/yr	Net profit per cow exp., $/yr
Angus X Hereford	412[d]	55[b]
Hereford X Hereford	475[b]	-23[e]
¼ Simmental, ¾ Hereford	425[c,d]	34[c,d]
½ Simmental, ½ Hereford	437[c]	46[b,c]
¾ Simmental, ¼ Hereford	482[b]	19[d]

[a] Davis et al. 1994. JAS. 72:3591.
[b,c,d,e] Means within columns differ (P < .05).

This paper would not be complete without recognizing the significant increase in efficiency that can be achieved by taking advantage of the maternal heterosis of the *Bos indicus* X *Bos taurus* crossbred female in tropical and sub-tropical environments. Although biological efficiency is well-documented in the literature, there is little research on economic efficiency of the *Bos indicus* crossbred female. Nevertheless, data adapted from Marshall et al. (1982) indicated that second-generation two-breed rotational Brahman X European crosses returned an average of 26 % more income above feed costs than the average of the parent breeds (Brahman/Angus, Brahman/Charolais and Brahman/Hereford).

Upon reviewing a large body of literature, it becomes clear that the crossbred cow offers so much maternal heterosis that she becomes an important ingredient for maximizing profit in most commercial cow herds. The challenge then becomes the choice of breeds that go into the makeup of the crossbred cow. We now have enough data characterizing breeds (e.g., the Germ Plasm Evaluation program at U.S. MARC, as well as other research studies) to do a reasonably accurate job of matching cow genotype to the production environment. The BIF Systems Committee has already performed an important task of developing guidelines for optimal levels for a number of traits in varying production environments (BIF, 1996). Based on these guidelines, Table 6 presents four (by no means all) examples of matching genotypes to different production environments.

Table 6. Examples of matching genotype to production environment[a]

- Restricted feed resources, arid climate:
  British X British
- Medium feed resources, semi-arid climate:
  British X Smaller Continental
- Abundant feed resources, adequate precipitation:
  British X Larger Continental
- Sub-tropical environment:
  Bos taurus X Bos indicus

[a] Based on guidelines of BIF Systems Committee (BIF, 1996).

Economic Efficiency (Profitability) Within Industry Sectors

A question that is often raised in beef cattle circles is, "What are the critical factors (aside from cyclical cattle prices) that affect profitability within industry sectors?" With the data collection and analysis technologies that have emerged in recent years, we have a somewhat clearer idea of those factors than we did in the past.

Cow-Calf Sector

Table 7 is a recent summary of the national Standardized Performance (SPA) database which is managed by Cattle-Fax, Englewood, Colorado (Weaber, 1999). It contains financial as well as animal performance data on several hundred herds throughout the U.S. over an 8-year time period.

Table 7. Cow-calf performance measures by net income quartiles[a]

	Net income quartile			
Measure	High 25%	2nd 25%	3rd 25%	Low 25%
Net income/cow	$194	$76	$4	-$172
Weaning wt., lb	541	504	517	502
Calves weaned/cow exp.	.87	.85	.83	.82
Lb weaned/cow exp.	474	430	429	411
Feed cost/cow	$95	$97	$114	$147
Total cost/cow	$300	$314	$238	$454

[a] David Weaber, Cattle Fax (SPA summary, June 9, 1999).

Average net income per cow ranged from $194 to -$172 for the high and low quartiles, respectively. Weaning weight and calves weaned per cow exposed did not range as widely as one might expect. But when they are multiplied to compute pounds of calf weaned per cow exposed, the range widens. The greater differences, however, were on the cost side, both feed and total cost per cow.

Table 8 is a recent summary of Northern Plains beef cow herds that participate in the North Dakota Integrated Resource Management (IRM) Program managed by Dr. Harlan Hughes, North Dakota State University. In this summary, the herds are broken down by cost category: low, middle, and high. It is interesting to note that the range in gross income is a relatively narrow $72 ($422 vs. $350). As in the SPA data, the major differences are on the cost side, especially feed costs. The bottom-line result is a range of $228 in net income per cow ($113 vs. -$115), and a doubling in unit cost of production ($58 vs. $117 per hundred pounds of calf weaned). Hughes reported that 35% of the $228 difference in net return was due to production efficiency and 65 % was due to economic efficiency.

Table 8. Northern Plains IRM herds, 1997[a]

	Cost category		
Item	Low cost 1/3	Middle cost 1/3	High cost 1/3
% calf crop	88%	86%	89%
Wean. wt., lb	547	571	536
Lb calf/cow exposed	470	488	441
Gross income	$420	$422	$350
Feed costs (summer & winter)	$196	$256	$288
Other costs	$111	$121	$177
Total costs	$307	$377	$465
$ cost/hundredweight calf	$58	$79	$117
Net return to labor, mgt., & equity capital	$113	$45	-$115

[a] Harlan Hughes, North Dakota State Univ. Market Advisor (Jan. 21, 1999).

In his newsletters of May 27 and June 10, 1999, Hughes summarized the important lessons learned in a decade of the IRM program:

1. The critical success factors for running a high profit herd are low overall costs, low feed costs, calf weaning weight per cow exposed, and high gross income.
2. These four critical success factors collectively determine unit cost of production (cost of producing a hundredweight of calf), which is the single most powerful measure of economic efficiency in a beef cow herd.
3. The belief that profits are highly correlated with high weaning weights and/or gross income is not necessarily true. High production efficiency is a necessary condition, but not the only condition, for high net income.
4. Low-cost producers are frequently the high profit herds.
5. Beef cows will not support a lot of debt – probably less than 40 % of the capital invested in the beef cow herd profit center.
6. Cost of farm raised feeds is generally lower than purchased feeds, except when large amounts of money are borrowed on the feed-producing land and the harvesting machinery.

Retained Ownership/Backgrounding Sector

Retained ownership of calves beyond weaning time has increased in recent years. The idea is to capture greater return by adding value to the product. As we know, this did not work in 1998, as those producers who retained ownership watched the cattle market turn bad and the value of their calf crop decline rather than increase. Nevertheless, as shown in Table 9, over the past 18-19 years, many of the alternatives for retained ownership have been more profitable than selling spring-born calves at weaning time in the fall. However, cash-flow considerations preclude many cow-calf producers from retaining ownership.

Table 9. Profitability of various marketing alternatives for spring-born calves over a 19-yr. (1980-98) or 18-yr. period (1981-98)[a]

Program	Years profitable	Avg. profit ($/hd)
Calves sold at weaning (475#)	10 of 19	$22
Winter drylot (175 d @ 1.0#/d = 650#)	7 of 19	-$17
Full season grass after winter drylot (160 d @ 1.5#/d = 890#)	12 of 18	$58
Feedlot after winter drylot & full season grass (120 d @ 3.2#/d = 1275#)	15 of 18	$103
Preconditioning/wheat pasture (145 d @ 1.8#/d = 740#)	14 of 19	$53
Short season grass after wheat pasture (129 d @ 1.35#/d = 915#)	14 of 18	$78
Feedlot after wheat pasture & short season grass (112d @ 3.2#/d = 1275#)	16 of 18	$124
Feedlot after wheat pasture (140 d @ 3.1#/d = 1175#)	12 of 18	$72
Background yard (144 d @ 2.25#/d = 800#)	14 of 19	$54
Feedlot after background yard (133 d @ 3.0#/d = 1200#)	13 of 18	$60

[a] Cattle-Fax Retained Ownership Analysis (April, 1999).

Feedlot Sector

Dallas Horton, owner and operator of a commercial feedyard near Greeley, CO, recently noted, "The cattle that invariably make the most money in our feedyard are those that gain the most weight, in the shortest period of time, on the least amount of feed. So far, carcass characteristics have not had as much influence because there has not been as much variation in carcass value as there is in gain and feed conversion." In an analysis of close-outs, he found that a 20% change in feed conversion, average daily gain and quality grade affected profit per head by $62, $10, and $7, respectively (Horton, 1998).

The costs associated with sickness can have a significant effect on profit, especially among calf-feds. In a 6-year analysis (Gardner et al., 1996) of factors affecting profitability of calves in the Oklahoma Steer Feedout, medical cost ranked first. The 1998-99 Texas Ranch to Rail Program (McNeill, 1999), showed a difference of $80.12 in net return per head between calves that stayed healthy and those that were treated for sickness.

Current grid pricing systems now offer significant premiums for carcasses that have quality grades above Low Choice and/or yield grades of 2.9 or better. Table 10 is a summary of a project on grid marketing by the Iowa Beef Center (Lawrence et al., 1998). The high quartile group received an average premium of $29.20. U.S. Premium Beef, Ltd. (USPB, 1999) recently reported that the top 25% of USPB cattle have averaged $34.77 per head above the cash market in 1999. These are substantial premiums, but one must keep them in perspective relative to the impact of other profit-driving factors. As shown in Table 11, a 10 % improvement in feed efficiency can result in a savings of $22.50 to $36.00 per head, depending upon ration cost. Reducing death loss and using available ionophore and implant strategies likewise offer significant returns (Table 12).

Table 10. Difference in premiums by quartile group of 2,654 cattle sold on a high quality grid[a]

	Quartile group			
Item	High 25%	Hi Med 25%	Lo Med 25%	Low 25%
% grading Choice or Prime	92.9	80.5	67.6	56.3
% yield grades 1 & 2	61.8	59.5	62.1	61.1
% yield grades 4 & 5	4.3	2.8	3.9	8.4
Premium/head, $	$29.20	$17.29	$3.75	-$13.50

[a] Iowa Beef Center Bulletin: 1998-01.

Table 11. Impact of feed efficiency on cost per head

	% improvement in feed efficiency[a]		
Ration cost, DM basis	10	15	20
	Dollars saved on 600-lb gain		
$160/T	$36.00	$54.00	$72.00
$140/T	$31.50	$47.25	$63.00
$120/T	$27.00	$40.50	$54.00
$100/T	$22.50	$33.75	$45.00

[a] % improvement relative to a base of 7.5 feed conversion.

Table 12. Impact of various management practices on return/head[a]

	Price of corn	
Item	$2 corn	$3 corn
	Added return/head	
Reduce death loss 1%	$8	$8
Using an ionophore	$12	$16
"Middle-of-the-road" implant strategy	$17	$21
Aggressive implant strategy	$31	$39

[a] Iowa Beef Center Bulletin: 1998-01.

Range in Profitability Within Sectors

In a revealing analysis of Cattle-Fax data, Brink and Schiefelbein (1998) sorted each of three production sectors into the highest 25% and lowest 25% in profitability. Results of their analysis (Table 13) showed that the range in profitability was $173, $84, and $40 for cow-calf, feedlot, and carcass, respectively. This suggests that the greatest opportunity for improving industry efficiency currently resides within the cow-calf sector, the least within the carcass sector, and the feedlot sector intermediate.

Table 13. Difference in profit between highest 25% and lowest 25% in profitability within beef sectors

Beef Sector	Difference ($/head)
Cow-calf	$173
Feedlot	$84
Carcass	$40

SOURCE: Brink and Schiefelbein, (1998).

Potential Opportunities for Improving Efficiency

The following sections discuss current and future opportunities for improving beef production efficiency. These opportunities range from sophisticated biotechnological advances to relatively routine management changes. Other opportunities undoubtedly exist, but it is beyond the scope of this paper to cover all of them.

Identification of Tender Beef

The ability to identify tender lines of cattle could potentially reduce time on feed and cost of gain in the feedlot. U.S. cattle are currently fed to a degree of fatness that will ensure a greater probability of achieving a Small degree of marbling (Low Choice quality grade). However, there are lines of cattle within all breeds that can reach an acceptable level of tenderness without grading Choice. Lambert (1991) made the first estimate of the cost of excess fat in the industry. His calculations indicated the annual cost to feed it on totaled $1.99 billion and the cost to ship and remove it came to $2.42 billion, for a staggering total of $4.41 billion. In the most recent National Beef Quality Audit (Smith et al., 1995), the cost of producing excess fat (> 16.5% trimmable fat) was estimated at $27.42 per head. Applying this estimate to 1999's projected fed cattle slaughter of 29.4 million head, the annual cost of excess fat production would come to $806 million, still a substantial cost.

Based upon recent research, the ability to differentiate among tenderness levels could add value to the industry. As shown in Table 14, a consumer study conducted by Texas Tech University indicated that shoppers would be willing to pay $0.27, $0.49, and $0.56/lb more for guaranteed tender than for intermediate, tough, and very tough steaks, respectively. When applied to an estimated 136 lb of saleable steaks from a 750-lb carcass, the added value ranged from $36.72 to $76.16 per carcass. National Cattlemen's Beef Association (Reagan, 1999) recently reported that consumers in the Denver area would be willing to pay approximately $0.50/lb more for guaranteed tender steaks (slice shear value under 33 lb) than for average to marginally tender steaks (slice shear value over 50 lb). All steaks in this study were of Select quality grade.

Table 14. Value differences between tenderness classification in strip loin steaks[a]

	Value difference	
Comparison	$/lb	$/carcass[b]
Guaranteed tender vs. intermediate	$0.27	$36.72
Guaranteed tender vs. tough	$0.49	$66.64
Guaranteed tender vs. very tough	$0.56	$76.16

[a] Miller et al. 1998. Proc. Reciprocal Meat Conf. 51:4.
[b] Based on 136 saleable steaks from 750-lb carcass.

The National Carcass Merit Project (NCBA, 1998), a cooperative effort between NCBA, several universities and 16 breed associations, holds promise for identifying tender lines of cattle. Included among the project's objectives is the development of EPDs for tenderness.

Sexed Semen

After decades of anticipated breakthroughs, it appears that sexed semen may be commercially available within the foreseeable future (Seidel, 1998; Deutscher, 1999). Current technology can sort sperm into male and female cells with 85 to 90% accuracy. Fresh sexed semen has conception rates nearly comparable to that of industry frozen semen. The sperm sorting process is still too slow and expensive to make it an industry-wide commercially viable enterprise. Eventually, these challenges will be overcome, but the timeline is uncertain. There are several applications for sexed semen that potentially could enhance beef industry efficiency: 1) sexed semen would enable production of the sex that is more valuable under a given situation; 2) specialized heifer producing herds could generate F_I females for sale to terminal sire herds; 3) virgin heifers could be inseminated with female sperm to reduce dystocia; 4) single sex systems of production could become feasible, in which each female could reproduce herself and be harvested by 30 months of age.

Twinning

In spite of the problems involved in twin births (greater dystocia and lower calf survival), twinning technology may have potential for improving beef production efficiency under very intensive production systems. A selection project was initiated at U.S. MARC in 1981 for the purpose of increasing twinning rate in cattle (Gregory et al., 1996, 1997; Guerra-Martinez, 1990). By 1995, twinning rate had increased from 4% to 31%. Compared to single births, cows having twins weaned 65% more calves, calf weight weaned per cow calving was 58% greater, and average daily gain to slaughter was only 5% lower. Dystocia was twice as high in twin births, and calf survival to weaning was 15% lower. Assuming increased labor and veterinary costs of 40%, the estimated increase in economic efficiency from producing twins is about 24%. The economic threshold for adoption of twinning technology appears to be a twinning rate of approximately 40%. Currently, twinning rate in the U.S. MARC herd is up to nearly 50%.

U.S. MARC researchers (Kappes et al., 1999) reported that because ovulation rate in puberal heifers is a moderately heritable (.35) trait, it would be an effective indirect selection criterion for twinning rate. By collecting such data in heifers, progeny testing of a sire for twinning rate could be accomplished in 3.5 years.

Cloning

Bourdon and Golden (1999) recently commented on the future of cloning technology. Its future in farm animal species is somewhat clouded for various reasons, including financial as well as legal considerations. Superior bulls likely will be the first candidate for cloning. Next may be cloned F_I replacement females having optimum combinations of traits matched to specific environments and market targets; they could be purchased as embryos and put into a producer's own cows. Looking into the future, many seedstock herds (and intensively managed commercial herds) conceivably could become multiplier populations or herds of recipient cows for embryos bred elsewhere.

Conventional breeding programs carried out in elite herds would still be needed to contribute the genetic variation required to produce future generations of clones.

In reviewing the implications of cloning for breed improvement, VanVleck (1998) cautioned that today's "perfect" animal might not be ideal over time as market demands change. Furthermore, use of cloning to increase uniformity of phenotype could be only partially successful because phenotype is determined by genetics and environment. Cloning would eliminate genetic variation but not environmental variation. For example, if the genetic variation of a trait were 25%, the phenotypic standard deviation among clones would only be reduced to 87.5% that of uncloned animals. Therefore, clones are not identical copies of one another when it comes to quantitative traits influenced by many genes. In addition, cloning an animal that has an ideal combination of a few highly desirable traits, such as low fat combined with high marbling, does not screen out undesirable antagonistic genes that may accompany the desirable genes. On the positive side, cloning is a natural for achieving full expression of a qualitative trait controlled by only one or two pairs of genes, such as color or horns. Van Vleck concluded by noting that cloning is another tool for animal improvement but its use will need to be managed to be cost-effective for improvement of quantitative traits.

Summer Calving

Spring is the traditional calving season for a high percentage of North American beef cow herds. But a recent 3-year study (Lardy et al., 1998) at University of Nebraska's Sandhills laboratory suggests that summer calving may offer an opportunity for improved profitability in some situations. In this study, spring calves were born beginning March 18, and summer calves beginning June 8. Calves were weaned at a comparable age, October 10 for spring-born and January 10 for summer-born. Summer calves weighed 35 lb less at weaning, but gross income was similar because of the historical rise in feeder calf prices from October to January. Summer calving reduced the amount of hay needed by 3,150 lb per cow per year. The cost savings due to reduced hay feeding made the summer-born system more profitable at weaning time. In the feedlot, there were no significant differences between groups in daily gain, feed efficiency or carcass characteristics. Under the condition of the study, summer calving offered significant feed and labor savings and more profit potential for producers selling calves at weaning time. Obviously, summer calving is not for everyone, but in some production environments it may be worth considering. However, a summer-calving month other than June may be more feasible, depending upon individual situations.

Early Weaning

Traditional weaning age for most calves in North America ranges from approximately 200 to 240 days. Previous research has shown that early weaning may be beneficial for spring-born calves under one or more of the following conditions: limited summer forage availability, drought, poor milking cows, late calving cows, and first-calf heifers. Under such conditions, early weaning has been shown to increase body condition and reduce weight loss in cows, allowing them to go into winter in improved condition. Early weaning has also been shown to shorten the postpartum interval to first estrus and increase conception rates. Recently, there has been renewed interest in early weaning because more producers are retaining ownership through the feedlot phase. In this case, there is less incentive to maximize weaning weight by keeping calves on dams to the traditional weaning and sale age. From a nutritional standpoint, feeding the weaned calf is more efficient than feeding its dam to maintain milk production during late lactation. With early weaning, it may also be possible to finish calves when the fed cattle market reaches its normal seasonal high during winter/early spring.

Research in several Midwestern states (Illinois, Iowa, Michigan, Nebraska, Ohio) was initiated recently to explore the possibility of improving efficiency by early weaning at ages ranging from 90 to 168 days versus weaning at traditional ages ranging from 200 to 270 days. Table 15 summarizes a recent Illinois study (Meyers et al., 1999) in which Simmental X British steer calves were weaned at three different ages, placed on a high-concentrate finishing diet and harvested at a constant backfat endpoint (.32 in.). As weaning age decreased, days on feed increased but age at harvest decreased and overall weight per day of age increased. There were no significant differences in feedlot daily gain or harvest weight. There was a linear improvement in feed conversion as weaning age decreased, but total feedlot dry matter intake tended to be greater because of increased time on feed. Carcass traits were not significantly different, but 90-day steers tended to have higher marbling scores and a greater percentage grading Mid-Choice or higher. Cow body condition improved as weaning age decreased and pregnancy rate was improved 12 percentage units for cows on the 90-day treatment.

Table 15. Weaning ½ Sim. X ½ Brit. Steer calves at 90, 152, and 215 days of age [a].

	Weaning age, days		
Item	90	152	215
Harvest target, BF, in.	.32	.32	.32
Morbidity @ weaning, %	32	6	29
Mortality @ weaning, %	2	4	6
Days on feed	335	280	242
Harvest age, d	419	429	463
Harvest wt., lb	1050	1014	1019
Feedlot ADG, lb/d	2.56	2.54	2.53
Final wt./day of age, lb	2.51	2.36	2.20
DM/gain, lb/lb	5.13	5.62	6.25
Total DM intake, T/hd	2.19	2.01	1.94
Yield grade	2.45	2.33	2.39
≥ Choice, %	98	96	92
≥ Mid-Choice, %	65	53	56
Prime, %	11	9	6
Dams' BCS @ 215 d	4.9	4.5	4.2
Dams' pregnancy rate, %	79	67	67

[a] Myers et al. 1999. JAS. 77:323.

One of the more interesting aspects that has been noted in nearly all of the recent Midwestern trials is the potential for improving quality grade with early weaning, especially if the producer's target is the upscale restaurant and/or export market. In a Nebraska study (Story et al., 1999), percent grading Choice was 78, 84, and 94% for calves weaned at 270, 210, and 150 days, respectively. Weaning calves at 100 days versus 205 days increased average quality grade from Low Choice to Mid-Choice in an Ohio trial (Fluharty et al., 1996). In a preliminary 2-year summary of a Michigan study (Barker et al., 1999), weaning Angus calves at 100 days versus 200 days increased percent grading Mid-Choice or higher from 83 to 94%.

Two potential problems have been noted in early-weaned calves: 1) an increased risk of morbidity at weaning time; and 2) a tendency for smaller-framed, earlier-maturing genotypes to produce under-weight carcasses if harvested at an acceptable degree of finish or over-fat carcasses if harvested at an acceptable carcass weight. Ohio researchers (Schoonmaker et al., 1999) recently reported that placing early-weaned calves on an aggressive implant regimen may be a viable management option for alleviating the second problem.

Substituting Grain for Hay in the Beef Cow Diet

Recent research at Ohio State University and the University of Illinois has demonstrated that corn or other grains can economically replace a substantial amount of hay in the beef cow diet when roughage is scarce and/or expensive. To reduce the risk of digestive problems and irregular intake, it is generally recommended that a minimum of 0.5 % of bodyweight of hay dry matter be fed in addition to grain (e.g., 1200 lb cow x .005 = 6 lb hay DM/day). A protein supplement may be necessary depending upon crude protein content of the hay and corn. Because corn is extremely low in calcium, a limestone-based mineral supplement may be needed.

Table 16 (Buskirk, 1998) illustrates the potential cost savings by replacing hay with corn over a range of hay and corn prices. Based on the assumptions in Table 16, substituting corn for hay can become economically feasible when hay price is over $40/ton and corn is under $3.00/bu.

Table 16. Percent cost savings for a limit-fed corn-based diet vs. a free-choice hay diet[a]

	Hay price, $/T			
Item	40	60	80	100
Free-choice hay cost, $/cow/day[b]	$.61	$.96	$1.23	$1.54
Corn price, $/bu:	% cost savings by replacing hay with corn[c]			
1.80	28	44	53	57
2.20	18	38	48	54
2.60	8	32	43	50
3.00	0	26	39	46

[a] Buskirk. 1998. Mich. State Univ. *Cattle Call* newsletter, Vol. 3, No. 3.
[b] Preg. cow (1200 lb) consuming 2.25% of BW/day (no wastage).
[c] Reducing hay DM to 0.5% of BW daily & replacing with corn + soy supp. ($190/T).

Hay Feeder Design

Occasionally, simple, often-overlooked adjustments in management can result in considerable cost savings, contributing to improved efficiency. This was demonstrated in a Michigan State University trial where the objective was to determine if hay wastage is related to feeder design. As shown in Table 17, cows fed hay in cylindrical feeders (ring and cone) wasted significantly less hay than those fed with rectangular rack-type feeders (cradle and trailer). Assuming a hay cost of $70/ton and a winter feeding period ranging from 120 to 180 days, cost savings would range from $10 to $26 per cow.

Table 17. Effect of feeder type on wastage of round baled hay fed to cows[a]

Item	Type of round bale feeder			
	Ring	Cone	Cradle	Trailer
No. of cows	40	40	40	40
Hay disappearance, lb/cow/day	30.9	29.6	35.5	37.1
Waste, lb/cow/day	1.8	1.0	5.1	4.1
Waste, %	5.9[b]	3.3[b]	14.2[d]	11.1[c]

[a] Buskirk et al. 1999. MSU Report to NCR-87.
[b,c,d] Values in rows with different superscripts differ significantly (P < .05).

Current and Future Efficiency Research

Multi-Trait Selection Indexes

Over 50 years ago, Lanoy Hazel, Iowa State University (Hazel, 1943), presented compelling evidence that genetic improvement could be most efficiently achieved by combining traits of greatest importance into a single index (selection index). Each trait in the index would be weighted according to its economic value, heritability, genetic correlation with other important traits, and standard deviation (variation). Charles Smith, University of Guelph, reinforced Hazel's pioneering research when he stated, "There is a need for combining the various EPDs into a single overall figure, summarizing the net economic value of the animal."

Since the late 1980's, a number of research teams have worked on methodology to establish economic values for important beef cattle traits that could be used to construct selection indexes. Considerable progress has been made recently, especially in Canada and Australia. University of Guelph researchers (Koots and Gibson, 1998 a,b) have developed a bioeconomic model to derive economic values for profit maximization of an Eastern Canadian intensive, integrated beef enterprise under various production and marketing scenarios. In either a purebreeding or rotational crossing system, they found that of the 16 traits in the model, those traits having the greatest economic value in dollars per genetic standard deviation per cow were calf survival, $17.53; cow fertility, $14.72; dressing percentage, $13.58; growing cattle feed intake, -$13.21; and mature cattle feed intake, -$12.41. These traits also ranked highly in specialized dam and sire lines in a terminal crossbreeding system (with the exception of cow fertility in sire lines). Under a marketing system similar to the U.S. in which penalties were assessed to carcasses not grading Choice, marbling had a relative economic value of .34 compared to calf survival (set at 1.00). Under a marketing system in which payment was based only on saleable lean product in the carcass, lean meat yield became the most important trait with a relative economic value of 1.38.

Australian scientists at the University of New England recently developed a software program called BREEDOBJECT to assist in the design of customized breeding objectives for beef producers in different environments targeting different markets. The program calculates selection indexes in dollar values which provide an overall ranking of animals on the balance of their estimated breeding values (EBVs) to fit a particular breeding objective. The program first computes relative economic values for traits that have EBVs available. The relative economic values are based on a producer's production costs, performance levels and market targets; then a set of index weighting factors are developed to apply to each EBV. Weighting factors account for the relative economic value and heritability of each trait and its genetic correlation with other traits having EBVs. The individual EBVs are then multiplied by these weighting factors and summed to produce an overall dollar index for each animal. Examples of weighting factors to be applied to EBVs in the construction of two greatly different Australian markets are presented in Table 18 (Parnell and Barwick, 1999). In Market 1, the target is the high marbled Japanese export market. In Market 2, the target is grass finished production for the domestic supermarket trade with no marbling requirement. In Market 1, EBVs for marbling, 600-day weight and retail beef yield receive the most positive emphasis, and EBVs for mature cow weight and days to calving receive the greatest negative emphasis. In Market 2, 600-day weight receives the most emphasis followed by retail yield, calving ease direct, calving ease maternal, and mature cow weight.

Table 18. Weighting factors applied to trait EBVs to construct selection indexes[a,b,c]

Trait	Market 1	Market 2
600-day wt.	+22%	+34%
Retail beef yield, %	+14%	+13%
Rib fat	+2%	+7%
Marbling	+25%	0%
Days to calving	-11%	-7%
Milk	+1%	+4%
Mature cow wt.	-14%	-11%
Calving ease (direct), %	+5%	+13%
Calving ease (maternal), %	+5%	+11%
	100%	100%

[a] Parnell and Barwick (1999).
[b] Weighting factors account for relative economic value, heritability, and the genetic correlations between traits.
[c] Selection Index = Sum of Weighting Factors x EBVs.

Research on multi-trait selection will continue into the future, and will provide the industry with even more precise tools to fine-tune efficiency of beef production.

Net Feed Efficiency

In Australia, scientists at the Trangie Research Centre are conducting an interesting project on selection for net feed efficiency (NFE), which is measured as the difference between an animal's actual feed intake during a 120-day test and its expected feed intake, based on its body weight and growth rate. Because NFE is the feed intake of the animal net of its requirements for production, it is sometimes called net feed intake. In contrast to feed conversion ratio, NFE appears to be independent of body weight or growth rate. High NFE animals will consume less than expected (negative NFE value) while low NFE animals will consume more than expected (positive NFE value). Results to date have shown there is genetic variation in net feed intake with a heritability estimate of approximately 0.4. In the Trangie project, high NFE bulls are mated to high NFE heifers, while low NFE bulls are mated to low NFE heifers. Table 19 is a summary of the results of one generation of selection for high or low NFE (Maynard, 1998). Progeny of high NFE parents were significantly lower than progeny of low NFE parents in actual feed intake, net feed intake, feed conversion ratio, and fat depth. There was no difference in average daily gain or 365-day weight. The difference in fat depth warrants further investigation due to its potential genetic antagonisms with other traits such as marbling and reproductive efficiency.

Table 19. Performance of progeny of high NFE and low NFE bulls and heifers[a]

Trait	High NFE progeny	Low NFE progeny
365 day liveweight (kg)	405	398
Average daily gain (kg)	1.25	1.22
Actual feed intake (kg)	1243[b]	1299[c]
Net feed intake (kg)	-20[b]	59[c]
Feed conversion ratio	8.4[b]	9.2[c]
Fat depth (mm)	7.5[b]	8.3[c]

[a] Maynard (1998). Proc. BIF Res. Symp. & Annual Mtg., Calgary, AB.
[b,c] Statistically significant difference.

Literature Cited (Partial List)

Baldwin, R.L., K.C. Donovan, and J.L. Beckett. 1992. Returns of human edible input in agriculture updated. Feedstuffs, Aug. 17, 1992.

Barker, J.M., D.D. Buskirk, and S.R. Rust. 1999. Early weaning: feedlot performance and carcass characteristics of steers. Michigan State Univ. Annual Rep. to NCR-87.

Bourdon, R.M., and B.L. Golden. 1999. Beef cattle breeding in the new millennium. American Red Angus, Feb., 1999.

Buskirk, D.D. 1998. How to feed your cows 75% less hay. Michigan State Univ. Cattle Call newsletter. Vol. 3, No. 3.

Buskirk, D.D., M. Kaercher, T. Harrigan, A.Z. Zanella, D.R. Hawkins, G. Lindquist, J. Cowley, and J. VanLente. 1999. Evaluation of forage loss from large round bale feeders. Michigan State Univ. Rep. to NCR-87.

Davis, K.C., D.D. Kress, D.E. Doornbos, and D.C. Anderson. 1994. Life cycle evaluation of five biological types of beef cattle in a cow-calf production system: II. Biological and economic importance. J. Anim. Sci. 72:2591.

Dickerson, G.E. 1984. Measuring efficiency of beef production. In: Proc. Breeding Beef Cattle in a Range Environment. P. 115. Fort Keogh Research Symp., Miles City, MT.

DiConstanzo, A., J.C. Meiske, S.D. Plegge, T.M. Peters, and R.D. Goodrich. 1990. Within-herd variation in energy utilization for maintenance and gain in beef cows. J. Anim Sci. 68:2156.

Ferrell, C.L. and T.G. Jenkins. 1984. Energy utilization by mature, nonpregnant, nonlactating cows of different types. J. Anim. Sci. 58:234.

Ferrell, C.L., and T.G. Jenkins. 1985. Cow type and the nutritional environment. J. Anim. Sci. 61:725.

Fluharty, F.L., T.B. Turner, S.J. Moeller, and G.D. Lowe. 1996. Effects of age at weaning and diet on growth of calves. Ohio State Univ. Research and Reviews. OARDC Circ. No. 156.

Gardner, B.A., S.L. Northcutt, H.G. Dolezal, D.R. Gill, F.K. Ray, J.B. Morgan, and C.W. Swearhart. 1996. Factors influencing profitability of feedlot steers. Oklahoma State Univ. Animal Science Research Rep. P-951.

Gregory, K.E., G.L. Bennett, L.D. Van Vleck, S.E. Echternkamp, and L.V. Cundiff. 1997. Genetic and environmental parameters for ovulation rate, twinning rate, and weight traits in a cattle population selected for twinning. J. Anim. Sci. 75:1213.

Gregory, K.E., L.V. Cundiff, and R.M. Koch. 1994. Breed effects, dietary energy density effects, and retained heterosis on different measures of gain efficiency in beef cattle. J. Anim. Sci. 72:1138.

Gregory, K.E., S.E. Echternkamp, and L.V. Cundiff. 1996. Effects of twinning on dystocia, calf survival, calf growth, carcass traits, and cow productivity. J. Anim. Sci. 74:1223.

Guerra-Martinez, P., G.E. Dickerson, G.B. Anderson, and R.D. Green. 1990. Embryo-transfer, twinning and performance in beef production. J. Anim. Sci. 68:4039.

Hotovy, S.K., K.A. Johnson, D.E. Johnson, G.E. Carstens, R.M. Bourdon and G.E. Seidel, Jr. 1991. Variations among twin beef cattle in maintenance energy requirements. J. Anim. Sci. 69:640.

Jenkins, T.G., and C.L. Ferrell. 1994. Productivity through weaning of nine breeds of cattle under varying feed availabilities. 1. Initial evaluation. J. Anim. Sci. 72:2787.

Johnson, D.E. 1984. Maintenance requirements for beef cattle: Importance and physiological causes of variation. In: Proc. Beef Cow Efficiency Forum. p. 6. Michigan State Univ., East Lansing, MI, and Colorado State Univ., Fort Collins, CO.

Koots, K.R., and J.P. Gibson. 1998a. Economic values for beef production traits from a herd level bioeconomic model. Can. J. Anim. Sci. 78:29.

Koots, K.R., and J.P. Gibson. 1998b. Effects of production and marketing circumstances on economic values for beef production traits. Can. J. Anim. Sci. 78:47.

Kress, D.D., D.E. Doornbos, and D.C. Anderson. 1990. Performance of crosses among Hereford, Angus and Simmental cattle with different levels of Simmental breeding. V. Calf production, milk production and reproduction of three-to eight-year-old dams. J. Anim. Sci. 68:1910.

Lambert, C. 1991. Lost opportunities in beef production. Proc. International Stockmen's School, Feb. 14, 199, Houston, TX.

Lardy, G., D. Adams, D. Clark, T. Klopfenstein, J. Johnson, and A. Applegate. 1998. Spring versus summer calving for the Nebraska Sandhills: Production characteristics. Univ. of Nebraska Beef Cattle Rep. MP 69-A.

Lusk, J., J. Fox, T. Schroeder, J. Mintert, and M. Koohmaraie. 1999. Will consumers pay for tender steak? Research Bull. 3-99, Research Inst. on Livestock, Pricing, Agricultural and Applied Economics, Virginia Tech, Blacksburg.

Maynard, G. 1998. Net feed efficiency in beef cattle. Beef Improvement Federation Research Symp. And Annual Meeting, June 30-July 2, 1999, Calgary, Alberta.

McNeill, J.W. 1999. Texas A&M Ranch to Rail – North/South 1998-99 Summary Report. Texas A&M Univ., College Station.

Meyers, S.E., D.B. Faulkner, F.A. Ireland, and D.F. Parrett. 1999. Comparison of three weaning ages on cow-calf performance and steer carcass traits. J. Anim. Sci. 77:323.

Miller, M.F., C.B. Ramsey, L.C. Hoover, M.A. Carr, and K.L. Crockett. 1998. Consumer thresholds for establishing the value of tenderness. Proc. Reciprocal Meat Conf. 51:4.

Parnell, P., and S. Barwick. 1999. Using a selection index to assist in sire selection. Angus GROUP BREEDPLAN Rep., Autumn, 1999.

Purcell, W.D. 1998. A primer on beef demand. Research Bull., Research Inst. on Livestock Pricing, Agricultural and Applied Economics, Virginia Tech, Blacksburg.

Schoonmaker, J.P., F.L. Fluharty, T.B. Turner, D.M. Wulf, S.J. Moeller, and S.C. Loerch. 1999. Effect of weaning age and implant regimen. II. Carcass Characteristics of steers. Ohio State Univ. Research and Reviews. OARCC Special Circ. 162.

Seidel, G.C. 1998. Potential applications of sexed semen in cattle. J. Anim. Sci. 76 (Suppl. 1): 219 (Abstr.).

Smith et al. 1995. The National Beef Quality Audit. Colorado State Univ., Oklahoma State Univ. and Texas A&M Univ., Dec., 1995.

Story, C., R. Rasby, T. Milton, and M. Dragastin. 1999. Effects of time of weaning on cow and calf performance. Univ. of Nebraska Beef Cattle Rep. MP 71A.

Taylor, R.E. 1994. Beef Production and Management Decisions (2nd ed.). Macmillan Publ. Co., New York, N.Y.

USPB. 1999. USPB News. Vol. 1, Issue 2, July, 1999. U.S. Premium Beef, Ltd., Kansas City, MO.

Van Oijen, M., M. Montano-Bermudez, and M.K. Nielsen. 1993. Economical and biological efficiencies of beef cattle differing in milk production. J. Anim. Sci 71:44.

Van Vleck, L.D. 1998. Implications of cloning for breed improvement strategies: Are traditional methods of animal improvement obsolete? J. Anim. Sci. 76 (Suppl. 1): 56 (Abstr.).

Webster, A.J.F. 1994. The role of meat in the human diet. Proc. Nutr. Soc. 53(2):263.

The Pork Industry's Approach to Efficiency

Jim Venner
National Swine Registry

Introduction

Today's animal agriculture is an entirely different beast than what many of today's producers grew up with. In this rapidly changing, consumer driven environment, livestock producers are faced with ever increasing demands to provide a more desirable end product at an economical cost. This is a challenge that even the most efficient producers struggle with, and we as the producers of red meat, need to take advantage of every opportunity to fine tune our operations. Every sector that uses animals to produce edible protein needs to take a look at itself in an effort to fine tune their bottom line through efficient use of their inputs. Today I am going to address a few of the techniques the swine industry utilizes to improve production efficiency in this area of animal agriculture.

Where We've Been

The United States is the second leading exporter of pork worldwide, producing 10% of the world's total supply of pork. In 1998, the swine industry produced the greatest amount of pork in history, 101 million slaughter animals resulting in over 19 billion pounds of product. This was accomplished with 6.7 million sows, the fewest number of producing females since 1986. Efficiency gains resulted from changes in management, consolidation of smaller production units into more efficient large scale hog farms and a greater understanding and utilization of available genetics. Table 1 illustrates the increased production the last 35 years, a greater than two fold boost in female efficiency.

Table 1. Annual Production per Breeding Female

Year	Pigs / Sow / Year	Pork Produced / Sow
1965	9.64	1315
1970	10.16	1442
1975	9.61	1531
1980	10.54	1704
1985	12.40	2120
1990	13.02	2230
1995	14.11	2523
2000*	15.45*	2700*

* projected
Source: 1998 / 1999 Pork Facts, National Pork Producers Council

Where Are We Going?

The internal structure of the industry is rapidly changing. In this same 35 year time period, the number of swine producing farms has gone from over a million units nationwide to less than 100,000. In the last 10 years alone, the number of pigs marketed by "small" producers, those with under 1,000 head annually, has dropped from 1 in every 3 animals to less than 1 in 20. On the other end of the spectrum, in 1988 19 % of market hogs were produced on farms with over 10,000 head compared to over half in 1997, with nearly 1 in 4 animals harvested coming from "mega-producers" marketing over 500,000 annually. The traditional "mortgage lifter" has disappeared from many rural settings and has become a profit generating center for big business.

Another issue to contend with is the buying patterns of the American consumer. Per capita consumption of beef and pork has decreased 22 % and 15 % respectively since 1970 while fish consumption is up 25 % and poultry sales have doubled during this period, none of which bodes well for red meat producers. So what is today's hog producer doing to survive? We'll look at a few of the tactics in place from the genetic side of the equation.

"Successful pork production depends first upon the selection of proper breeding stock." E. L. Quaife, 1944

This comment from E. L. Quaife, an Iowa State University Extension Swine Specialist, is just as true today as it was then. The majority of the efficiency advances in pork production during the last decade are the result of genetic selection and proper use of specifically designed breeding schemes.

A study completed in 1995 by the Purdue Cooperative Extension Service ranking technologies by financial returns and ease of implementation, suggested that proper use of genetics, from both the production and marketing sides, has potentially the greatest impact on profit (Table 2.). We can also see that utilizing superior genetics through selection and artificial insemination, is one of the easier technologies to implement, and therefore a provides a logical place to start when fine-tuning your pork production unit.

Table 2. Ranking of Technologies by Return and Ease of Implementation

Rank	Technology	Financial Impact	Ease
1	Genetics (Selection and AI)	13.76	3
2	Segregated Early Weaning	11.59	6
3	Intensive Farrowing	7.57	7
4	Split Sex / Phase Feeding	4.39	1
5	All In / All Out	1.83	2
6	Network Selling	1.79	4
7	Network Buying	1.72	5

Source: Positioning Your Pork Operation for the 21st Century

So how can we use genetics to improve production efficiency? We can genetically improve economically important traits at the rate of 2-3% per year. Economically important traits (EIT) in swine are those that contribute to productive efficiency and desirability of the end product, and include reproductive performance, growth and feed efficiency and end product merit. This potential annual improvement is dictated by two major issues. One factor is proper selection of animals to be used as parents within a particular population. This can be enhanced through the use of Expected Progeny Differences (EPD's). Since I'm addressing a group that is certainly the leader in utilizing this technology, I'll not dwell on this matter other than to mention that we generate EPD's for Number Born Alive (NBA), 21 Day Litter Weight (LWT), Days to 250 Pounds (Days) and Backfat (BF). A Pounds of Lean EPD (Lbs) is created using backfat and loin eye measurements indicating pounds of lean in a 185 pound carcass (or approximately a 250 pound animal), and three bio-economic indexes are generated. These indexes include a Sow Productivity Index (SPI), taking into account number born alive, number weaned and 21 day litter weight; a Terminal Sire Index (TSI) weighting growth (days to 250 pounds), backfat and loin eye area; and a general all-purpose index denoted as Maternal Line Index (MLI) which factors in all the above information. Pertinent economic factors are considered and weighted, and the indexes are reported in a manner equivalent to one dollar per index point.

The second important factor is the choice of a genetic system that can utilize the optimum amount of heterosis. Table 3, shows the advantages heterosis can provide, often for very little added expense. A properly designed swine crossbreeding program provides results similar to its beef counterpart, improving maternal efficiency by up to 27% and feedlot performance by up to 7%. Maximum success would also necessitate utilizing the appropriate populations, which would typically consist of pure breeds selected for specific strengths such as maternal ability, growth or leanness.

Table 3. The Advantage of Heterosis in Swine Production

Trait	Heritability	F1 Program with purebred parents, % Heterosis	Terminal Program with F1 Females and PB Males, % Heterosis
Number Born Alive	.10	0.5	8.0
Conception Rate	.12	.0.	8.0
Number Weaned	.06	9.0	23.0
21 Day litter Wt.	.15	10.0	27.0
Days to 250 Pounds	.30	7.5	7.0
Feed Efficiency	.30	2.0	1.0
Backfat	.40	-2.0	-2.0
Loin Eye Area	.48	1.0	2.0

Source: Pork Industry Handbook

Genetic Systems Utilized Within the Swine Industry

Let's take a look at several typical swine genetic systems used in the industry today. First we'll consider a rotational program. In the 1960's, producers first recognized that crossbreeding had inherent advantages over a straight-bred breeding plan, and the rotational breeding scheme became the system of choice. Figures 1 and 2 depict typical three and four breed rotational genetic schemes. Advantages of this system include ease in implementation and management. A different breed of sire is purchased each generation in a systematic rotational fashion, and used on females sired by the previous breed of sire. Replacement females can therefore be kept out of the top producing females each generation, however total production will be compromised over time since half of the market animals will be sired by maternal breed boars and half the females retained will be sired by terminal breed sires. Maternal production, growth and end product merit will all be less than optimum, with heterosis levels ranging from 86 – 93 % depending upon the number of breeds involved. While all progeny at a given time period will be uniform from a breed composition standpoint, this will change with each generation and could affect reimbursement from packers since producer history and consistency of product are factors in determining market price.

Figure 1.

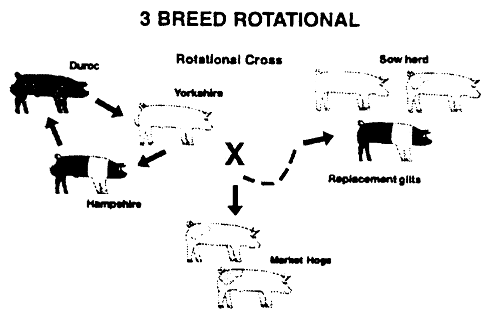
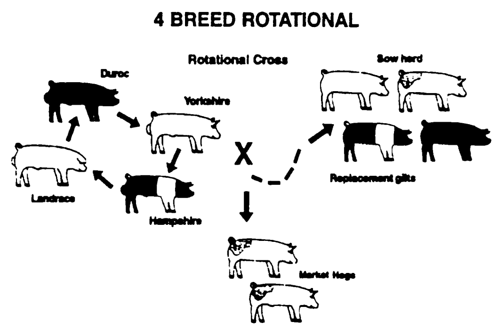


Figure 2.



The next program to consider is a terminal program with F1 females and purebred terminal sires (Figure 3). This provides 100 % heterosis throughout the system, allows for use of breed complementarity, and results in uniformity of both breeding and market animals. If females are purchased, this is a very easy system to manage as the only females on hand are genetically the same, and only terminal boars are kept, therefore there will be no mis-matings resulting in a loss of heterosis. If gilts are retained, approximately 15 % of the herd should be grandparent stock (GP), and in this case would be a pure line. Thus, heterosis will be lost on the maternal side in 15 % of the litters born, and about 10 % of the market animals will be sired by a maternal line boar, sacrificing both performance and end product merit. With the use or artificial insemination, maternal sires may not have to be present, or if the firm collects on site, at least a minimal number is necessary. On occasion, depending upon the size of the operation, pure line females will need to be introduced into the herd.

For within herd multiplication, a genetic scheme using three-way cross females will help optimize heterosis as all grandparent females will be F1's (Figure 4). This terminal-breeding program has the same advantages of using F1 parent stock regarding complementarity and uniformity of market animals, with the added benefit of lower cost production of parent females. Three percent of the sows will be pure line great-grandparents (GGP) which are bred to maternal line sires to produce the F1 grandparent stock. These are in turn mated to another maternal line sire, producing the three-way cross parent gilt. While extremely cost effective on a large scale, smaller operations will be challenged to maintain the quality necessary in the great-grandparent herd to maintain total herd performance. Artificial insemination is nearly a must in this scenario, and GGP females should be purchased unless the firm is very large. Options to this program include purchasing all parents gilts or purchasing the grandparent F1 females, which is the most popular choice in the industry today. In this case, approximately 15 % of the total number of sows will be F1's, similar to the first terminal program outlined.

Figure 3.

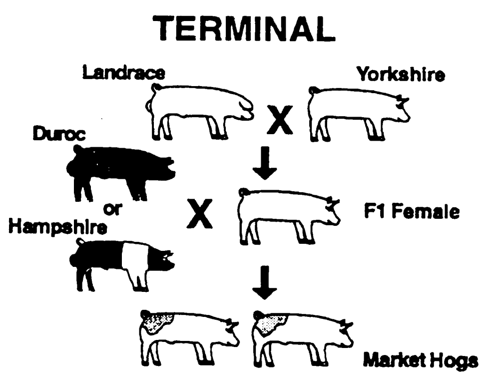
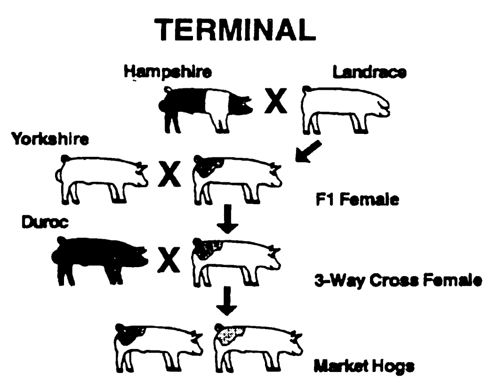
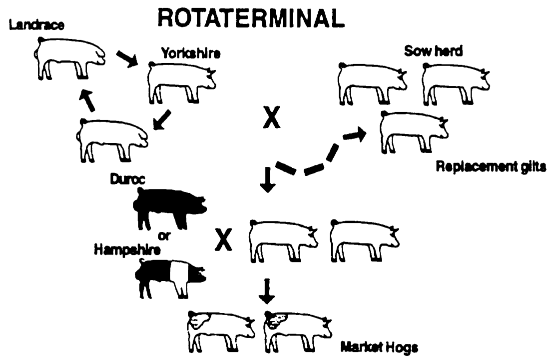


Figure 4.



The final genetic scheme I will discuss is the rotaterminal program, which is a hybrid of those above. As shown in Figure 5, two, three or four sires are rotated on 15 % of the female base for maternal replacements and parent gilts are retained from this sector. Superior management skills are necessary in order to keep the maternal rotation correct in order not to compromise maximum use of heterosis. Advantages include use of 100 % heterosis and complementarity in the market animals, and the ability to raise your own replacements. Artificial insemination is almost a necessity here and if all semen is brought in, no animal ever need to be introduced into the herd, helping to maintain bio-security within the operation.

Figure 5.



Summary

Pork production is a rapidly changing industry, as is all of animal agriculture, and only the most efficient operations will survive. Competition for the consumer dollar is fierce, and the firms who can't or won't produce what the their end product user desires, shall fall by the wayside. The swine industry does have several trump cards in its hand, not the least of which is access to one of the most diverse genetic pools of any animal species. Producers who desire strong maternal traits, superior feedlot performance, or premium carcass quantity or quality, have breeds and individuals within those breeds that can provide these tools. The choice of the appropriate genetic system and selection of the animals that will make that system work is vital for the independent producer.

The efficiencies that are needed for survival in this industry can be obtained by informed decision making and proper management. I have outlined several of the strategies that are available regarding genetic pyramidal breeding schemes to help ensure maximum use of one of the only free things left in animal agriculture, heterosis.

Literature Cited

Boehlje, M., K. Clark, T.R. Cline, K. Foster, J. Hale, C. Hurt, D. Jones, S. Nichols, A. Schinckel and W. Singleton. 1995. Positioning Your Pork Operation for the 21st Century

Boehlje, M. 1998. Staying competitive in today's pork business.

National Pork Producers Council. 1998/1999. Pork Facts. NPPC. Clive, Iowa.

National Pork Producers Council. Crossbreeding systems for commercial pork producers. NPPC. Clive, Iowa

WHAT CAN WE DO GENETICALLY TO IMPROVE EFFICIENCY?

Thomas G. Jenkins
USDA, ARS, U. S. Meat Animal Research Center

During the Twentieth Century, genetic improvement in beef cattle has evolved from an art form driven by a desire to have the "best" animal for bragging rights to application of scientific tools. These tools are used to modify animal resources for consideration in the decision making process by management of an agribusiness concern motivated by the desire for profit. We have evolved from ranking animals for genetic merit based on visual evaluations to applications of technologies that rank animals for merit based on genetic principles. Competition among food industries in the market for the consumer dollars has driven this evolution through demands transmitted by the various segments of the beef industry. This competition created the need for the beef industry to become a more effective user of production resources. What challenges will be addressed in the next millennia and what will be the role of those enterprises and associations involved in genetic improvement in meeting these challenges?

Efficiency is the measure of the effectiveness of resource use in the production of a product. The beef industry will continue to face increasing competition for consumers' dollars. It must recognize that the competition includes any industry that seeks to satiate the desire for consumption of edible product. To retain or expand market share at the industry level, the ability to convert resources such as energy, capital, nutrients, etc., to meat product needs to be continually improved. This term, efficiency, is used both in popular and academic press when addressing the economic health of the industry. Three points need to be considered when the issue of efficiency is raised (Harris, 1970).

1) Efficiency of animal industries relative to other food industries.
2) Efficiency of animal industries relative to other animal industries.
3) Efficiency of one producer relative to others in the same industry.

The first two points are concerned with market share and competition among these groups to gain an advantage relative to other competitors. The first point forces us to realize that the industry competes with any industry producing a product that consumers eat. Satiation of appetite or fulfilling daily nutrient requirements through consumption of any non-meat products reduces the willingness of today's consumer to spend income on meat products. Attempts by food industry companies to garner a greater position in the market place create urgency for the beef industry to become more competitive. The most effective tool available to the industry is attractive pricing. To increase efficiency, i.e., the effective conversion of raw resources to a marketable product, the industry must place a product before the consumer that is equal to or superior in desirability to the competitors' product at a cost that is acceptable to the consumer. Becoming more efficient creates a greater market share for the product resulting in greater demand that trails back through the system as increased product demand.

Over the last 35 years, the beef industry has responded to the challenge to retain a competitive position in the food industry by adopting new knowledge to keep costs at attractive levels for consumers by increasing supply. The increase in supply, manifesting itself in competitive consumer prices for retail beef products, reflects the evolution of management and production strategies for all segments of the beef industry since the 1960's. In the production sector, pounds of beef produced per cow in the national beef brood cowherd has increased sharply. This increase in beef supply mirrors the introduction of continental cattle breeds, selection for performance traits, and adoption of mating systems by the commercial industry. Combining genetic improvement with better management has resulted in greater production of products at lower cost to consumers.

Competition within the meat industries is dynamic; the poultry and swine industry's transition to vertically integrated systems places greater pressure on the beef industry to improve efficiency. Improving the industry's efficiency of production has led to increased production per unit input, lower consumer cost and increased demand but has not, in general, resulted in greater profits for individual producers within the industry. Rather, a spiral appears to have been created, as competition drives the food industries to achieve better efficiencies, those commercial producers that do not reduce cost per unit of production do not remain viable. The competition has moved from the industry level to the individual producer within the same industry level, the third point of consideration presented by Harris, 1970.

The remainder of the presentation will address efficiency at the producer level.

For the purpose of the talk, let producer be defined as an enterprise involved in the use of resources to produce and sell animals directly into market channels to meet consumer demands for beef products. Within the context of this definition, a seedstock enterprise would not be considered a producer. At the producer level, what is the appropriate definition for efficiency? Is efficiency a single trait such as feed efficiency or lean growth efficiency? To remain in the context of industry efficiency, the following discussion will consider efficiency on the enterprise basis. Is an index of energy or protein harvested relative to units of energy of protein invested input into the production process (commonly referred to as production or biological efficiency) the appropriate measure? Jenkins and Ferrell (1994) evaluated production efficiency, measured by grams of calf weaned per cow exposed per unit of dry matter intake by the cow during an annual production cycle. Breeds evaluated were Angus, Braunvieh, Charolais, Hereford, Gelbvieh, Limousin, Pinzgauer, Red Poll, and Simmental breeds of cattle. Individual cow daily dry matter intakes and production data such as milk production, measures of reproduction, and calf weights were recorded for five years for cows representing the nine breeds. The objective of the study was to determine if breed rankings for annual production efficiency varied with feed availability. Ranking for breed mean efficiencies changed dependent on level of feed intake. At lower feed availability, breeds more moderate in genetic potential for growth and milk production (Angus, Red Poll, and Pinzgauer) were more efficient because of higher conception rates. Breeds with higher genetic potentials for growth and milk production were less efficient because the cows did not cycle or conceive during the breeding season if they were nursing a calf on the lower levels of intake. However, at the highest levels of feed intake, breeds with the highest genetic potentials for growth and milk production were the most efficient because feed availability was sufficient for the genetic potentials to be expressed. Cows of breeds with more moderate potential effect for milk or growth simply became fatter at the highest feed availability. While informative, this expression of production efficiency may not be the best to use as a management tool. In other words maximizing efficiency may not be the appropriate goal for an enterprise.

Jenkins and Ferrell (1999) reported the relationship between energy consumed by cows during lactation and weight of calf weaned at 170 days of age. All cows in this study weaned a calf so the effect of nutrition on reproduction is not considered a factor. If the breeding objective of a cow/calf enterprise was to maximize an index of production efficiency (pounds of calf weaned per Mcal of metabolizable energy consumed by the cow) as the enterprises goal, cows would be provided a minimum lowest energy intake (2550 Mcal ME) but the mean weaning weight available for marketing of each breed would be low. Figure 1 summarizes the study. At maximum production efficiency weaning weights at 170 days for calves of cows sired by Angus or Hereford (AH), Shorthorn (SH), Galloway (GL), Longhorn (LH), Nellore (NL), and Salers (SL) were 215, 239, 188, 219, 262, and 234 pounds, respectively. Increasing energy availability during the lactation period from 2550 Mcal ME by 70% to 4400 Mcal ME would increase the mean weaning weights of the calves by 40%, 36%, 47%, 40%, 33% and 37% for AH, SH, GL, LH, NL, and SL respectively. The primary source of income for cow/calf producers is revenue generated by selling calf weight at weaning; therefore it would seem advisable not to maximize production efficiency.

Typically a producer has a set of financial goals; e.g., homes, college education for the children, a standard of living, etc. These goals require the enterprise to generate a profit. Therefore, an appropriate measure of efficiency to manage by should be an expression represented in monetary terms. Goals could then be to:

- Maximize profit where profit is defined as the difference between revenue and expense for the enterprise.
- Maximize the return on investment, which is expressed as a ratio of revenue to expense.
- Minimize the cost per unit of production expressed as the ratio of expenses relative to units of product adjusted for value of product.

Therefore, for a producer to genetically improve efficiency requires that the genetic merit of a trait must be defined in monetary terms within the producer□s production environment.

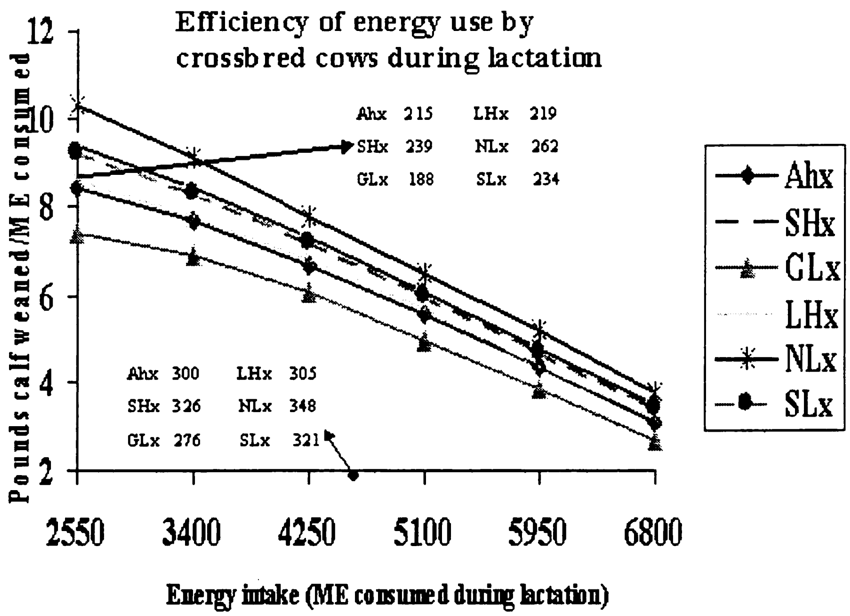


Figure 1 -- Production efficiencies of six breed crosses during the lactation period.

The process to provide predictive evaluation of the effect of genetic improvement on efficiency at the producer level is referred to as systems analysis. This approach employs biologically accurate simulation models to describe the system over time. These simulation models are composed of mathematical equations describing biological functions and relationships among these functions describing the components of a production enterprise. Databases of genetic parameters, environment (e.g., weather, topography, soils, markets, etc.) and economic information (e.g., interest rates, price cycles) facilitate evaluations of genetic merit at the enterprise level. Benefits derived from application of systems analyses include:

(1) Breeders allowed to specifically identify objective functions in the intended environment and mating system.
(2) Use this information to establish selection criteria.
(3) Define genetic merit in terms of production and mating systems.
(4) Designing selection and breeding systems that accommodate nonlinear relationships among economic values for defined traits.
(5) Provide a process to account for genotype by environment interactions (Cartwright, 1979).

The most effective means for a producer to genetically improve economic efficiency is through use of mating systems. Mating systems allow producers to utilize both additive and non-additive genetic variation to enhance revenue generation with marginal increases in production cost. For mating systems to be effective, a diversity of breeds, each with above average merit for traits of value should be available to producers. To create this asset of a diverse breed resource, the breeding industry will be challenged to move from measures of performance to assessment of economic value of a unit change in the genetic merit of a trait, much as it responded to the challenge of evolving from the concept of the ideal animal based on visual appraisal to measuring performance.

A first step in achieving this goal is to identify those traits contributing to profit. A partial list might include:

(1) Fertility - including component traits such as age at puberty, post-partum interval, conception, and gestation length.
(2) Survival - including component traits such as calf survival, soundness, adaptation, and longevity.
(3) Growth - including the component traits such as weight measures at different chronological ages, rates of maturing, and tenderness(?).
(4) Nutrients - including the component traits such as appetite, foraging ability, energy partitioning and use, composition, and tenderness(?).
(5) Milk - including peak lactation, yield at time of peak lactation and total yield.

To achieve enhanced efficiency through genetic improvement requires that a breeding objective be defined at the producer level identifying the amount profit would change per unit of change in the trait. Characterization of the objective function in Figure 2 illustrates the need to define the breeding objective at the producer level. The general classifications of traits listed above are presented in the figure. The expression of these traits at the enterprise level are influenced by management decisions that commit limited resources such as land, labor and capital to the production process. Because these resources, are limited there is an expense associated with each unit committed to the process. Also influencing the economic value of a unit change in one of the traits on the profit of the enterprise is the profit center identified as the primary source of revenue for the enterprise. The pathways indicate possible genetic relationships among the traits and interactions with the production environment.

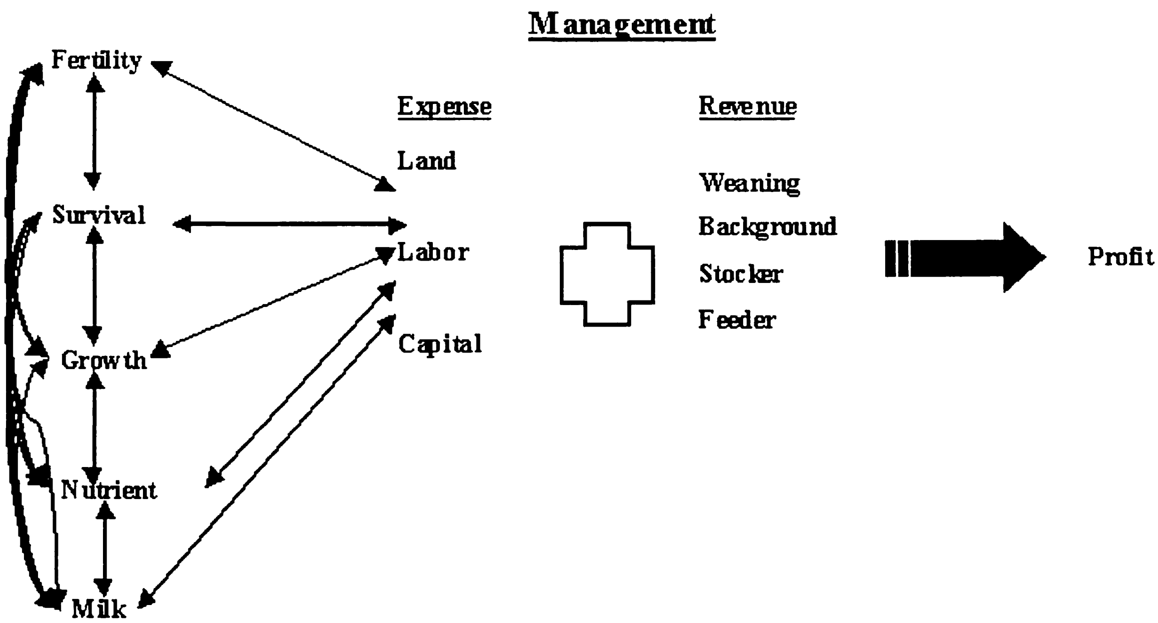


Figure 2 -- Illustration of interactions among general classifications of components of the breeding objective at the producer level.

To achieve success in the goal of improving profits of producers through use of genetics requires those involved in the seedstock sector to assume certain responsibilities. For the individual seedstock breeder, a dynamic relationship must be developed with the producer customer. Before enhanced profits can be realized through genetic improvement, the breeder should assist the producer in identifying costly management practices within the current production system and offer recommendations to remove these inefficiencies. Working together, the producer and breeder should identify those traits and production costs contributing to profit; i.e., identify an appropriate breeding objective. From this exercise, those traits having the greatest influence on profit can be identified. Breeds and sires within breeds can then be identified to be used by the producer. In the next millennium, the seedstock breeder must become information central.

If the seedstock breeder is information central for the producer then the breed association's role is to be an information provider to the breeder. Trait or traits of "excellence" for breed should be identified in the context of the beef industry and improved upon. The breed association should provide more accurate genetic predictions and expand the number of traits being recorded. Networking with other breed associations should be promoted. This element is critical, as breeders become full service for producer customers, as description of the genetic merit of an individual(s) animal from a breed has to be portable to allow comparisons with animals from other breeds.

BIF primary responsibility is to provide effective leadership. The organization must be visionary and dynamic. Resilience to change should not be considered a virtue, rather could be considered a vice. The proactive position members of this organization have taken in the evolution of visual appraisal of individuals to evaluation by performance must be continued as we move to adoption of breeding objective and multiple trait selection. Recommendations based on dialogue between animal scientists and BIF membership should encourage the adoption of breeding objectives. The responsibility for development of a precise terminology in the area of breeding objectives should be assumed.

As BIF provided leadership for implementing genetic predictions to improve efficiency in the current millennium, the organization should assume leadership in the marketing and support for the application of the concept of systems analyses for the production component of the beef industry. In the next millennium, this approach will provide the beef industry the tool for improving efficiency.

References

Cartwright, T.C. 1979. The use of production systems analysis in Animal Science with emphasis on Animal Breeding. J. Anim. Sci. 49:817-825.

Harris, D.L. 1970. Breeding for efficiency in livestock production: Defining the breeding objective. J. Anim. Sci. 30:860-867.

Jenkins, T. G., and C. L. Ferrell. 1994. Productivity through weaning of nine breeds of cattle under varying feed availability's. I. Initial evaluations. J. Anim. Sci. 75:95-104.

Jenkins, T. G., and C. L. Ferrell. 1999. Lactation traits and calf weight traits of mature crossbred cows fed varying daily levels of dry matter. J. Anim. Sci. (accepted).

WHAT HAVE WE LEARNED ABOUT EFFICIENCY AND HOW DO WE USE IT?

William Brockett
Virginia Beef Corporation

The answer to this question, "What have we learned about efficiency?", is very simple. Efficiency, many times, is the difference between profit and loss. The pork and poultry industries have proven that. They can sell their products at a much lower price profitably, than we in the beef industry can. One of the main reasons is because of better efficiency.

If you ever attend a pork or poultry meeting such as we are having here, the table conversations dwell on two subjects, creating demand and increasing efficiency. We in the beef industry dwell on the selling price. I don't mean that pork and poultry don't talk about price, they just know that they need to be competitive in the meat market. We don't just have a beef market, it is a meat market, and price is a factor that affects the consumers' choice.

There are three (3) major efficiency areas that can be directly related to genetics:

1. Reproductive
2. Cow Maintenance
3. Feedlot Conversion

In the past there have been a number of articles and talks regarding reproductive and cow maintenance efficiency. Today I would like to discuss feedlot conversion efficiency as it relates to the cow herd, because it is the area that I think the least amount of genetic work has been done to date. Most calf producers and seedstock producers do not own their calves through to the packer even though there has been a big push nationwide for retained ownership. If more seedstock and calf producers did retain ownership through the feedlot, they would see how conversion is a huge factor in making a profit. (See Table 1.)

For the past fourteen (14) years, I have bought or raised bulls to breed to our cows that I thought would increase efficiency. The main barometers I have used to increase efficiency have been YW EPD and frame size! There is not an EPD for efficiency, nor is there one breed that excels in efficiency. I hope that someday soon the major breeds will develop an EPD for efficiency. Extreme frame size, too large or too small, affects efficiency or marketability. During that fourteen (14) year period, we have decreased our dry matter conversion more than one (1) pound. The first ten (10) years we made the biggest changes. During the last four (4) years, the increase in efficiency is getting harder because the seedstock breeders aren't focusing on this trait. If someone doesn't soon recognize this as being the most important trait that needs identifying and improving, we could end up like the lamb industry. There are lines in several of the major breeds that excel and if we had the tools to select for efficiency, I know it could be improved. The differences in lines can be shown in Dallas Horton's tests.(See Table 2.)

Year one (1) shows the best of both worlds. The pen with the highest percent Choice and the best conversion is the best, however, please note that the pen with only twenty-one (21%) percent choice and a 5.57 conversion has a much higher profit than a pen with twice as much Choice grade.

Year two (2) shows the other extreme, the worst conversion and the worst percent Choice. Once again, please notice the difference in profit in the pen that converts at 6.82 versus 7.58 with the Choice grade being near even.

Year three (3) might be the most interesting of all. This was a terrible year for prices, but it still shows how efficiency affects profit more than grade. The pen with eighty-nine (89%) percent Choice lost more than the pen with thirty-three (33%) percent Choice because of the difference in conversion, 5.07 versus 5.4. The 5.4 is still a good conversion. Today we would not complain if all cattle converted at 5.4. Also, please note that the pen with seventy-eight (78%) percent Choice but only 6.4 conversion was the least profitable, or in this test, had the highest loss.

If an animal has six hundred (600) pounds of gain in the feedlot and you reduce the conversion by one (1) pound (6.5 to 5.5) you would save six hundred (600) pounds of feed. Today's feed costs approximately $140/ton, so your bottom line is increased by $42, and there is no offsetting cost against it. (See Table 3.)

I hope that the trend that we have had in the beef industry over the last decade toward more Choice-grading cattle would be duplicated in making cattle more efficient. I am not saying to decrease the percent of Choice cattle, as this is not necessary to increase efficiency.

Efficiency/conversion is the least talked about trait among most seedstock producers and the most talked about among cattle feeders. Sometimes seedstock producers forget that, ultimately, the reason for raising beef cattle in the United States is for meat production. Presently, the cattle feeder buys weight condition to increase efficiency, and once in a while a cattle feeder will find a commercial breeding program that does have genetics to increase efficiency.

The real change toward better efficiency has to come from the seedstock producers. The breed and breeders that get onto this trait will succeed and become, if they already are not, the industry leaders.

The beef industry has a habit of taking traits to extremes, such as size, color, milk, etc. I have never agreed with extremes before, but possibly trying for extreme efficiency is the best thing the beef industry can do.

Table 1. Feedlot Closeout Comparison

	Pen One	Pen Two
Total Head	131	127
Purchase Weight (Virginia)	567	551
Shrink	8.37	9.01
Purchase Price	65.10	65.27
Sex	Heifer	Heifer
Avg. Sale Weight (Kansas)	1,077	1,149
Avg. Daily Gain	2.47	3.17
Death Loss	0	.76
Conversion (Dry)	6.93	5.77
Cost of Gain	57.84	46.99
Profit/Head	25.96	84.25
Date Out	4/22/99	4/22/99
Selling Price	.65	.65

Pen Two = 7 days less feed; 1.16 pounds less feed per pound of gain; .1085 cents less cost per pound of gain; (because of less feed, less yardage, less interest)

LESS IS MORE!! This is just one illustration, but I can honestly say that every week when I receive my closeouts from the different feedlots, that the cattle with the best efficiency show the highest profit, or in the case of 1998, the lowest amount of loss.

Table 2. Horton Progeny Test Summary Data

	ADG	Feed Conversion	% Choice	Feedlot Profit
Year 1				
C1	3.27	6.54	44	51.00
C2	3.45	4.80	67	184.00
L1	3.10	5.57	21	99.00
Year 2				
C1	2.95	6.82	57	84.00
S1	2.75	8.26	20	-1.00
L1	2.58	7.58	52	7.00
Year 3				
C1	3.25	5.07	33	-18.00
S1	2.83	6.40	78	-71.00
A1	3.13	5.40	89	-22.00

In each year there is the most profitable and the least profitable pen of steers plus one sires pen that showed how Choice grade has less affect than efficiency.

Table 3. Conversion Comparison

	Steer A	Steer B
Conversion Rate (DMB)	5.5:1	6.5:1
Ration Cost (DMB)	$140/ton	$140/ton
Starting Weight	550 lbs	550 lbs
Ending Weight	1150 lbs	1150 lbs
Total lbs consumed (DMB)	3,300 lbs	3,900 lbs
Total Cost of Feed	$231.00	$273.00
Savings	$42.00	

WHAT HAVE WE LEARNED ABOUT EFFICIENCY AND HOW DO WE USE IT?

Warren Weibert, Owner/General Manager
Decatur County Feed Yard, Inc. – Oberlin, Kansas

Decatur County Feed Yard is a 38,000 head commercial feed yard located in northwest Kansas. I have been co-owner and General Manager since 1977. For most of those years, we have been specializing in retained ownership of ranch calves, many of which are preconditioned but unweaned. We have specialized in retained ownership cattle because it seemed to us to be a much more efficient marketing system with fewer profit centers and had the potential to help improve the channels of communication from consumer to producer. This career path has been both challenging and rewarding.

I am here today to describe what we call the Decatur Beef Alliance. We are about to complete our fifth year of this alliance and this year we will run about 35,000 cattle through the program. Several Virginians sitting in this room today are active participants in our program.

My talk today is "Efficiencies of Production—What Have We Learned?" There are various kinds of efficiencies we could discuss today—after the calf leaves the producer's ranch.

How efficient is the marketing channel, as we know it, when we trade cattle? Who pays for transportation costs, shrinkage, commissions, redundancy of vaccinations, implants, wormers, growing cattle too large, overfinishing? There are a lot of ways to waste money with traditional management and marketing programs.

There is a management theorem that states, "You cannot manage what you cannot measure." The Decatur Beef Alliance attempts to maximize the net return on each animal placed into the program. So we weigh and measure each animal several times throughout the feeding program and harvest the animal when he most efficiently hits the grid price target negotiated with a packer. Then, after all the animals in the rancher's lot are sorted and shipped, the cattle owner gets a detailed individual animal closeout listed in order of poorest to best performer on an adjusted net return per animal basis.

We can dissect the information in various ways. For example, one group of 378 Virginia bred and raised heifers was recently closed out and the data was broken down by adjusted net return. On a market-adjusted basis, the pen averaged $91.30 per head profit. But the top 25% netted $164.83 per head, while the bottom 25% made just $15.27. The top 25% gained 4.63 pounds of feed to pound of gain and graded 96% choice. The bottom 25% had a respectable 3.32 ADG but a feed conversion of 6.64:1 and graded just 36% choice. We believe this is valuable information that you can use to dramatically improve your productivity and income. Imagine what you can do for your bottom line if you have the data to actually cull the bottom 20-25% of your herd each year.

In early 1993, we became aware of the Allflex electronic ear tag, and in early 1994, we were introduced to the Micro Chemical Accu-Trac Electronic Cattle Management system. We installed Phase III in the fall of 1994 and recently completed installing Phase IV in our new processing and sorting facility. Accu-Trac gives us the ability to manage the diversity in any group of cattle by measuring, sorting and collecting carcass data. If properly sorted and managed, nearly all calf fed cattle fall into a 120 day marketing window. The window is determined by receiving weight, target finish weight, fat deposition rate, average daily gain, muscling, and animal health. From the day the cattle first arrive at the feed yard, our goal is to maximize their genetic potential at the feed yard and their carcass value at the packing plant.

As the cattle are processed upon arrival at the feedlot, they are individually frame scored with the use of video cameras, weighed, ultra-sounded for backfat, electronically identified and cross referenced to your ranch ID and sent to their home pen. The rancher receives an arrival report with this data. At regular re-implant time, about 65 days later, we will re-measure the cattle and sort them into at least two feeding groups, based upon whether they will finish early or late. The cattle might be co-mingled with other owner's cattle with similar marketing dates. The rancher receives an interim report. As we review the individual data, we determine when we will have the early finishers ready for harvest. When that date approaches, the early finishing group of cattle is run through the chute for the third and last time and sorted into three or four marketing groups 15 days apart and co-mingled with similar cattle. The marketing groups are then scheduled with a packer. When the late finishing group has reached their optimum genetic potential for net return, the process is repeated.

With this sophisticated system of measurements and sorts, all cattle have the same opportunity to compete, they are fed the same rations, are fed for the same carcass targets, are harvested at the same plant, on the same day of the week, graded by the same graders, so the data is as consistent as possible. When all cattle in your lot are harvested, you get an individual animal closeout listing your animals from worst net return to best. The diversity between cattle from the same ranch is startling, and it is nearly absurd that we manage and sell cattle today, as a feeding industry, as large pens, unsorted, and wonder why consumers think we have a beef product that is unpredictable. Think of all the money that is spent on bulls for all kinds of reasons, including marbling. Then the calves are fed in a feedlot and sold as a group without sorting so that some are over fed by 60 days and some under fed 60 days. Then the rancher wants either group or individual carcass data back to see how the new bull has improved his carcasses. Who knows? The cattle were mismanaged.

So, what have we learned about efficiency? We have learned that animals must be treated as individuals, and they must be sorted several times in the feedlot.

The difference in adjusted net return from best to worst animal owned by any rancher is routinely \$300-\$350 per head. The potential for profit improvement by utilizing our individual animal closeout information to make genetic improvement in your herd is incredible. The technology to manage animals as individuals is available today. We have been using it for five years! For all of us to truly make meaningful improvements in our herds and give the consumer a consistent, quality beef value, we must, I believe, begin to manage cattle as individuals—not groups—and measure the results. The ranchers who make the most rapid changes will be rewarded for their efforts through retained ownership and some sort of alliance. They have a real opportunity to survive and prosper in the rapidly changing arena of value-based marketing.

Decatur Beef Alliance

Lot 8215

	378 HD	Top 25%	Bot 25%	Spread	*283 HD**
NR/HD	*49.99*	120.54	-20.95	141.49	*73.80*
TCOG	*43.56*	39.44	48.62	9.18	*41.86*
PR	*5.20*	5.20	5.20	0.00	*5.20*
OTH	*8.79*	8.78	8.80	0.02	*8.79*
TREAT	*0.12*	0.00	0.45	0.45	*0.01*
COST	*526*	539	520	19	*528*
FM	*6.14*	6.48	5.96	0.52	*6.21*
WTR	*799*	834	780	54	*803*
CLWT	*1186*	1273	1114	159	*120*
DOFF	*98*	96	100	4	*98*
OEDM		40%BF	67%BF		
ADG	*3.95*	4.63	3.32	1.31	*4.16*
FE	*5.99*	5.45	6.64	1.19	*5.75*
QG	*71%ch+*	96%ch+	36%ch+	60%ch+	83%ch+
YG	*3.05*	2.90	3.03	0.13	*3.05*
REA	*12.90*	13.88	12.18	1.70	*13.14*
HCW	*740*	807	682	125	*76*
C/CWT	*100.06*	103.04	96.79	6.25	*101.16*
L/CWT	*62.69*	65.36	59.39	5.97	*63.79*
ACV	*19.93*	42.06	-3.19	45.25	*27.71*
ADJ	*91.30*	164.83	15.27	145.56	*116.77*

****Notes Feeding only the Top 75%***

General Session 2

Profiting From Increased Demand

RECAPTURING CONSUMER BEEF DEMAND FOR THE NEW MILLENNIUM

Andrew Gottschalk, LFG, Inc. Colorado

Beef demand in the US peaked during 1979-1980 and a precipitous decline began that has continued for the past two decades. Record high retail beef prices relative to pork (1.7:1) and broilers (3.5:1) resulted from the record beef prices in 1979. Additionally, during this period increased consumer health concerns evolved simultaneously with changing population demographics. Grading changes in the mid-eighties that essentially devalued the quality of beef product occurred too. These factors served to undermine longstanding domestic beef demand trends.

Beef's share of meat production has declined approximately one percent per year since 1975. If this trend is allowed to persist, beef's share of red meat and poultry production will suffer a fifty percent decline over the three decade time span ending in 2005. Domestic per capita consumption of beef has declined the equivalent of losing seventy-nine million consumers since 1975. While declining per capita consumption and declining market share are not a measurement of demand, they are a symptom of a declining beef demand structure. *Beef demand is a price-quantity function.* As such, changes in per capita beef consumption versus deflated retail beef price can measure beef demand and/or its changing structure. If beef demand had only maintained the level of the 1980's, fed cattle prices during 1998 would have averaged approximately fourteen dollars per hundred-weight higher ($76.00/cwt versus $62.00/cwt.). Demand is not the same for all beef product. Demand for high quality middle meats continues to advance, while demand for the end items (chucks and rounds) continues to weaken. The latter two products comprise fifty-one percent of the carcass by weight. During the price advance this June, the tenderloin and strip posted new all time high prices, while the chuck and round remained thirty-eight and thirty-two percent below the previous record highs. Within this condition lays tremendous opportunity to add value and capture increasing consumer dollars. *Each dollar gain in annual domestic per capita beef spending is worth approximately $270 million dollars to the beef industry.*

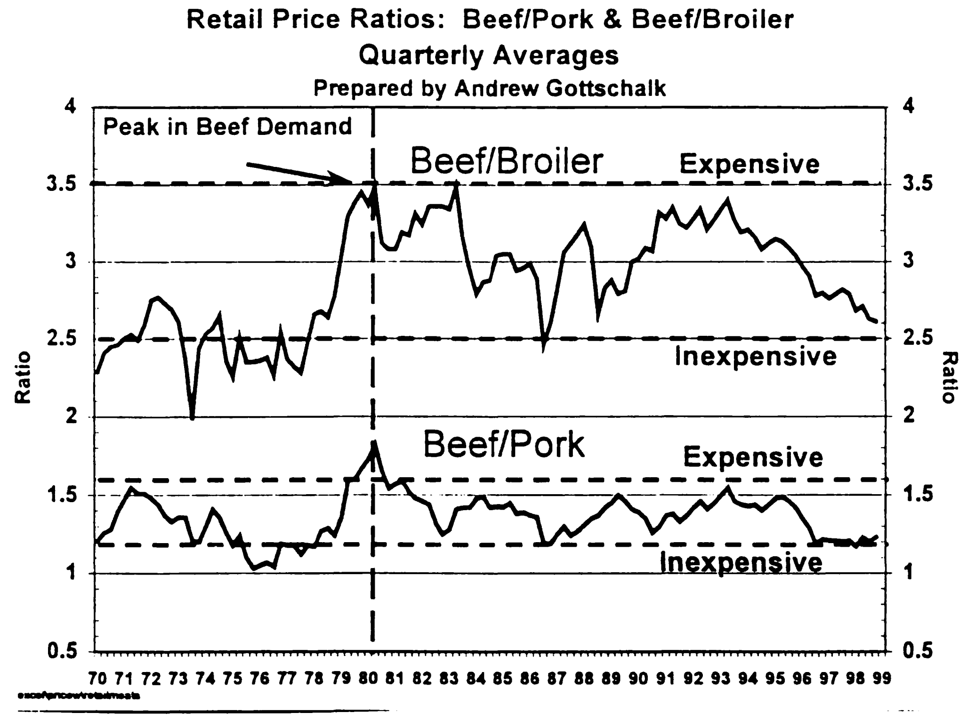
The impact of declining domestic beef demand is masked to some degree by growing exports of beef. This condition led to complacency within the US beef industry, further delaying the necessary actions to stem the erosion in domestic beef demand. Beef exports comprise approximately nine percent of US beef production. The American consumer is our largest market, consuming ninety-one percent of domestic beef production.

This industry is presently in a debate over "price discovery," while the domestic and foreign consumer is concerned with "value discovery". "Value" is a price-quality function and differs dramatically from price discovery issues. Providing the consumer with the product they want at a competitive price, as opposed to giving them what we may desire to produce, is the means to stem the ongoing erosion in beef demand. The modern day consumer has neither the time nor the desire to learn the old-fashioned ways of beef preparation. Increasingly, convenience and simplicity in meal preparation are part of the "value" equation. By determining those factors that add "value" in the consumers' minds and addressing these issues, this industry can begin to grow after nearly twenty-five years of stagnation and retreat. Vertical cooperation and coordination among all segments of the beef industry is essential in the battle to restore consumer beef demand. This industry is on the threshold of major change. The opportunities are numerous for those who have taken the opportunity to understand those factors that contributed to declining beef and are prepared to resolve these issues.

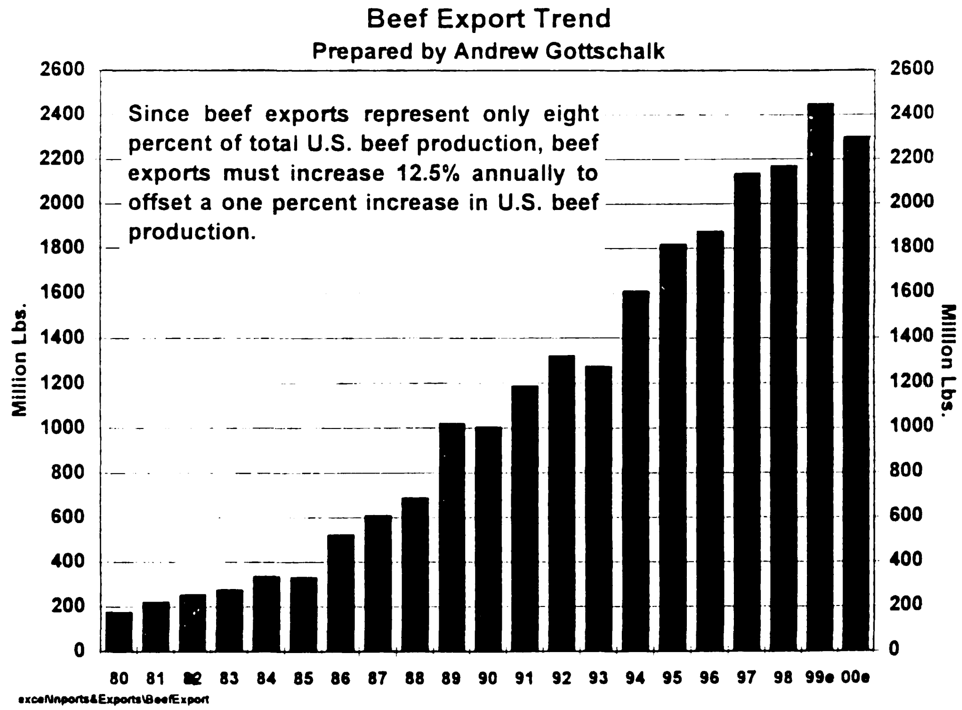
THE BEEF INDUSTRY'S GREATEST CHALLENGE IS TO REVERSE THE TREND IN DECLINING BEEF DEMAND

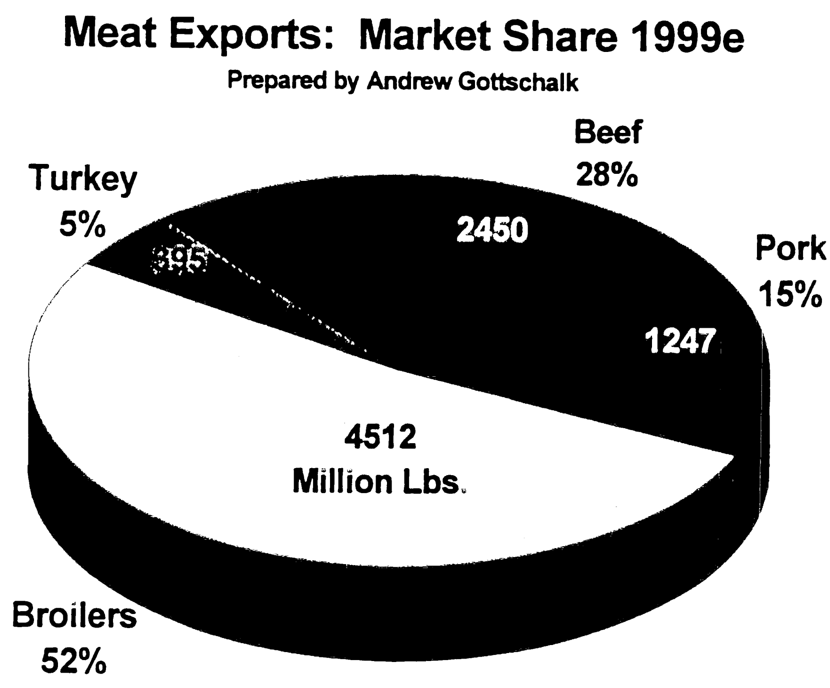
THEREFORE, THE BEEF INDUSTRY'S TOP PRIORITIES MUST BE:

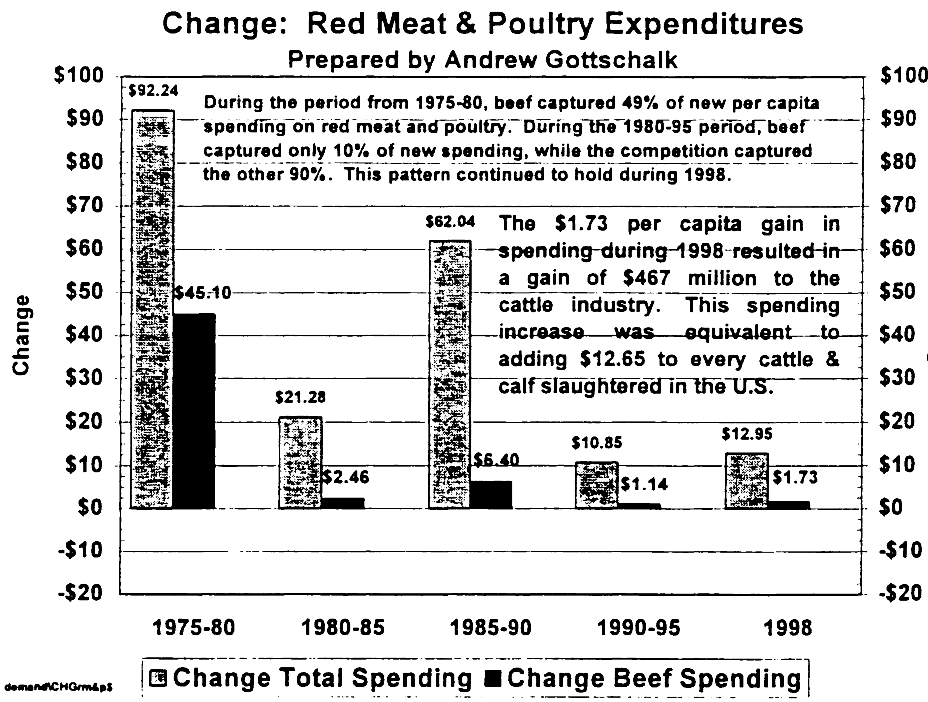
–LOWERING COSTS
–IMPROVING QUALITY
–GREATER CONVENIENCE
–IMPROVING CONSISTENCY
–FOOD SAFETY

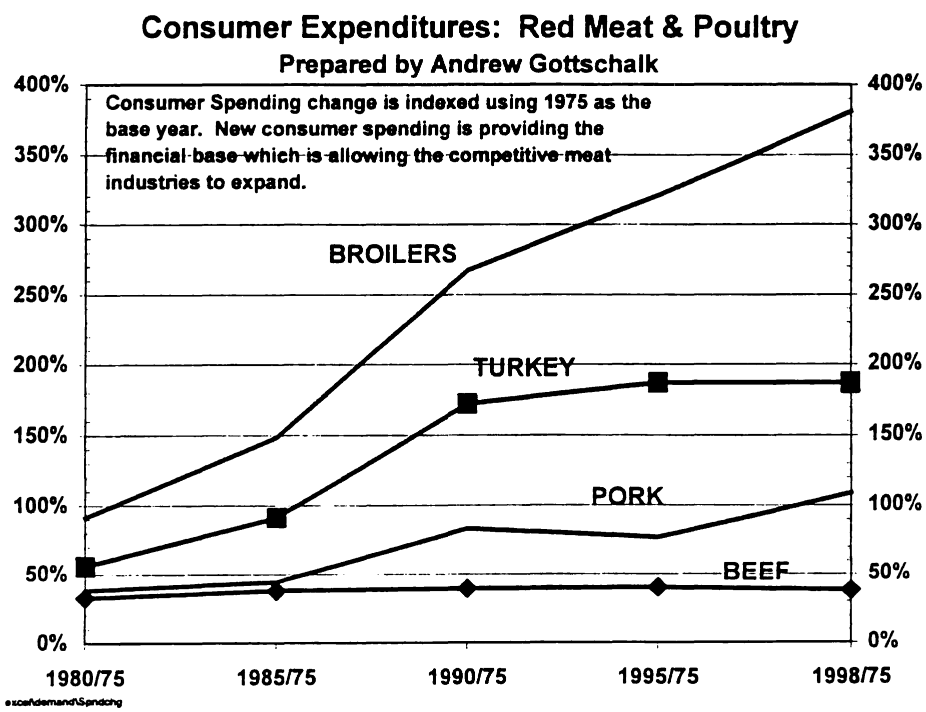


BEEF PRICES ARE INCREASINGLY IN-FLUENCED BY THE PRODUCTION & PRICE OF THE COM-PETING MEATS

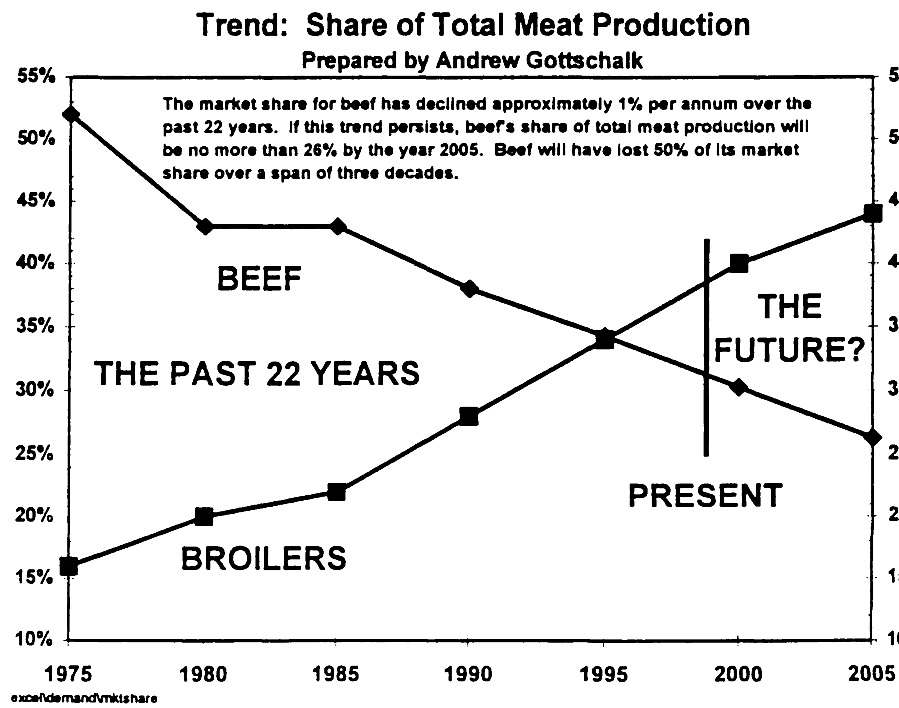

Beef Export Trend
Prepared by Andrew Gottschalk
Since beef exports represent only eight percent of total U.S. beef production, beef exports must increase 12.5% annually to offset a one percent increase in U.S. beef production.
Million Lbs.
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99e 00e


Meat Exports: Market Share 1999e
Prepared by Andrew Gottschalk
Beef
28%
2450
Pork
15%
1247
Turkey
5%
4512
Million Lbs.
Broilers
52%

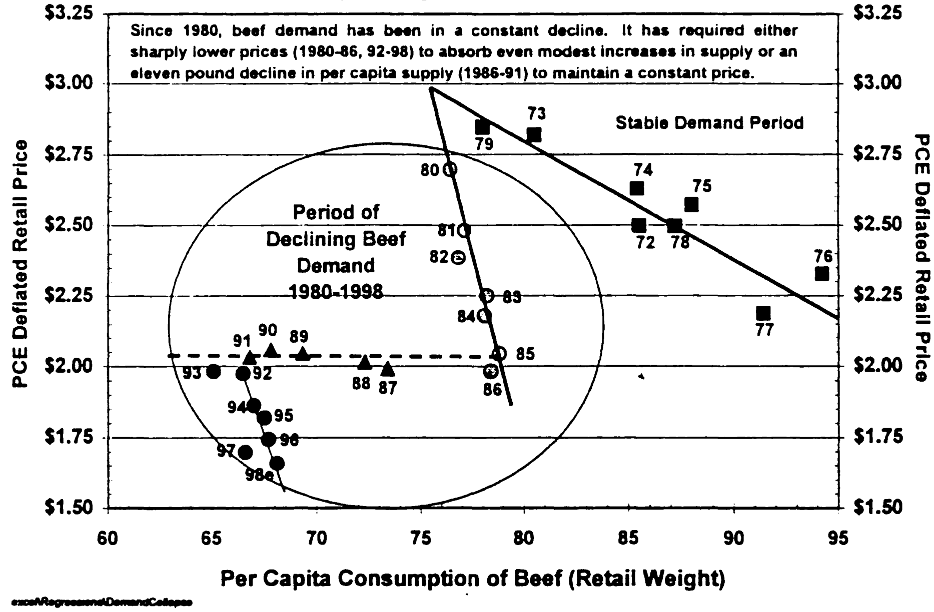

Change: Red Meat & Poultry Expenditures
Prepared by Andrew Gottschalk
During the period from 1975-80, beef captured 49% of new per capita spending on red meat and poultry. During the 1980-95 period, beef captured only 10% of new spending, while the competition captured the other 90%. This pattern continued to hold during 1998.
The $1.73 per capita gain in spending during 1998 resulted in a gain of $467 million to the cattle industry. This spending increase was equivalent to adding $12.65 to every cattle & calf slaughtered in the U.S.
$92.24
$45.10
$21.28
$2.46
$62.04
$6.40
$10.85
$1.14
$12.95
$1.73
$100
$90
$80
$70
$60
$50
$40
$30
$20
$10
$0
-$10
-$20
Change
1975-80
1980-85
1985-90
1990-95
1998
Change Total Spending
Change Beef Spending
demand\CHGrm&p$


Consumer Expenditures: Red Meat & Poultry
Prepared by Andrew Gottschalk
Consumer Spending change is indexed using 1975 as the base year. New consumer spending is providing the financial base which is allowing the competitive meat industries to expand.
BROILERS
TURKEY
PORK
BEEF
400%
350%
300%
250%
200%
150%
100%
50%
0%
1980/75
1985/75
1990/75
1995/75
1998/75
excel\demand\Spndchg

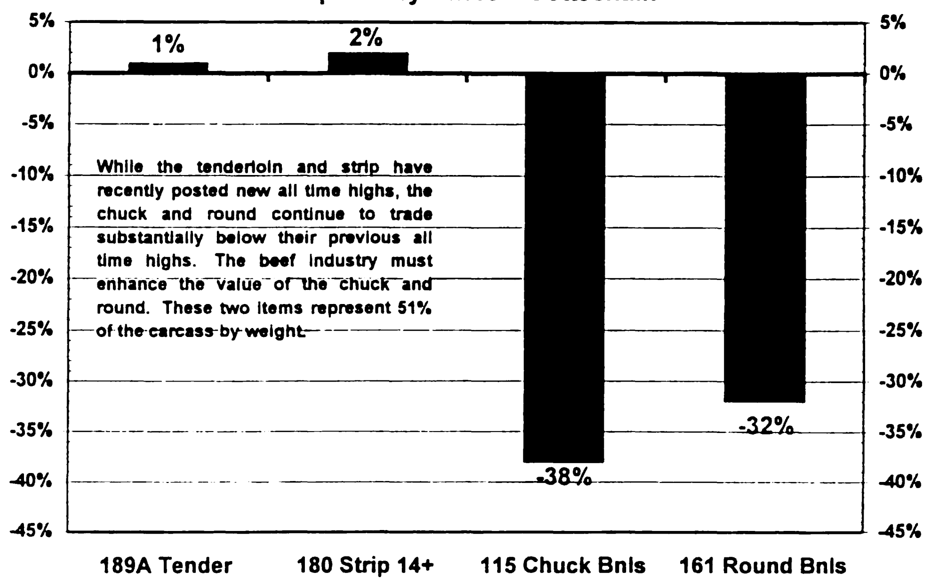
FOR EVERY ONE DOLLAR INCREASE IN DOMESTIC PER CAPITA BEEF SPENDING, THE BEEF INDUSTRY GAINS $270 MILLION DOLLARS.

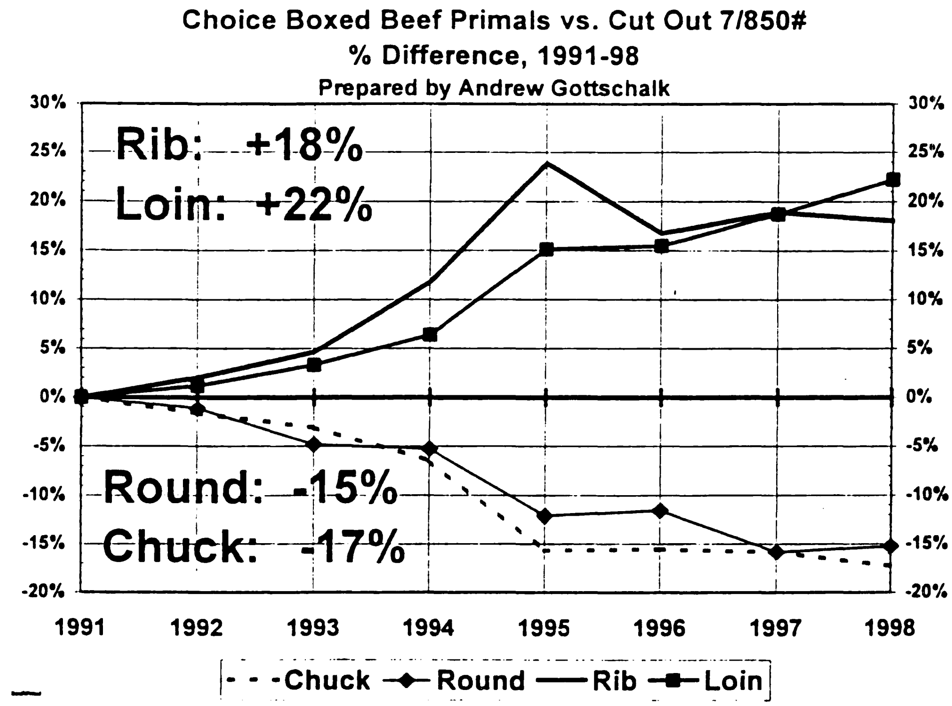


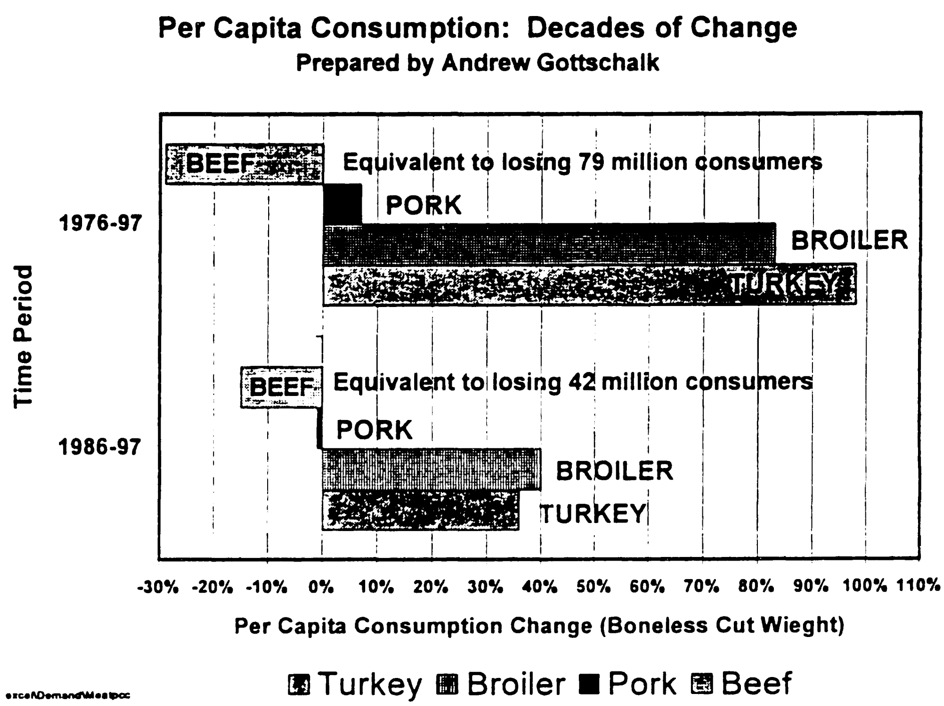
Beef Demand: 1972 - Present
Beef Consumption vs Retail Prices
Prepared by Andrew Gottschalk



Tender, Strip, Chuck & Round: Current Price (Week Ending June 11) vs Previous All-Time High
Prepared by Andrew Gottschalk

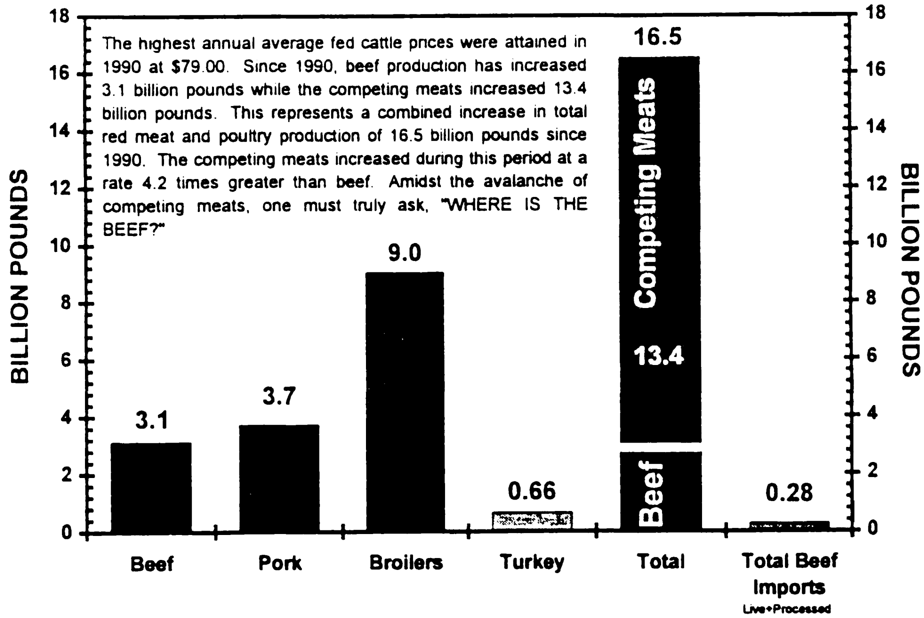



Choice Boxed Beef Primals vs. Cut Out 7/850#
% Difference, 1991-98
Prepared by Andrew Gottschalk
Rib: +18%
Loin: +22%
Round: -15%
Chuck: -17%
30%
25%
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
1991
1992
1993
1994
1995
1996
1997
1998
Chuck
Round
Rib
Loin


Per Capita Consumption: Decades of Change
Prepared by Andrew Gottschalk
BEEF
Equivalent to losing 79 million consumers
PORK
BROILER
TURKEY
1976-97
Time Period
BEEF
Equivalent to losing 42 million consumers
PORK
BROILER
TURKEY
1986-97
-30% -20% -10% 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 110%
Per Capita Consumption Change (Boneless Cut Wieght)
Turkey
Broiler
Pork
Beef

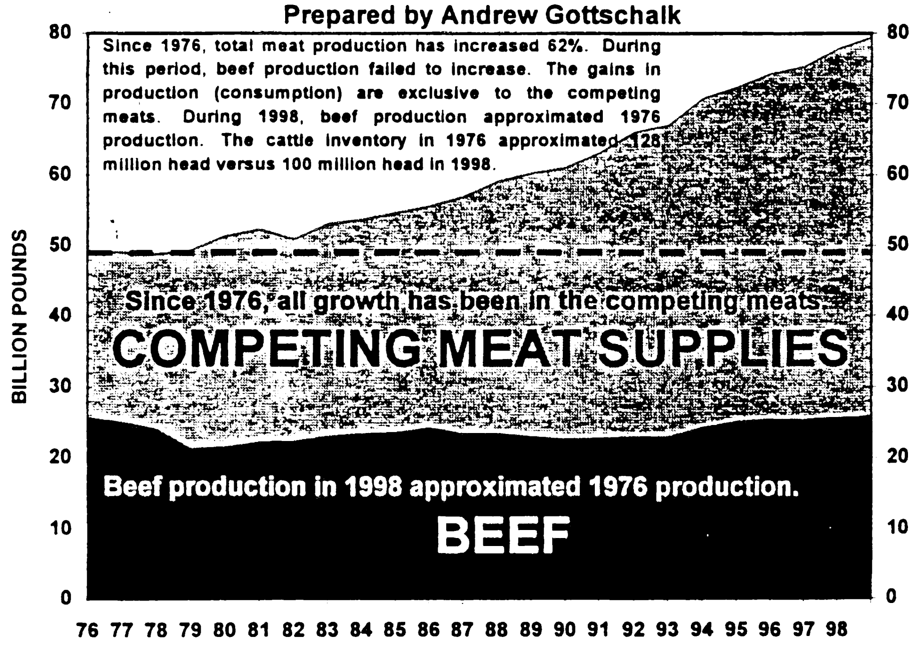
Meat Production Changes: 1998e vs 1990

Prepared by Andrew Gottschalk LFG, L.L.C. (800) 756-0063



TREND: Total Meat Production

Prepared by Andrew Gottschalk



CONNECTING PROCESSORS TO PRODUCER TO INCREASE DEMAND
"Building Relationships"

Marcine Moldenhauer, Excel Corporation

The Beef Industry has been at a crossroads for several years now and change is taking place. In many instances, the changes are being quietly implemented, and the rewards being repeated by more than a significant few.

A few years ago I would have called these changes in the Beef Industry revolutionary. Today, I firmly believe that does not accurately describe the true depth and meaning of what the Beef Industry is yet to experience.

A Revolution is a radical change, to change completely. This has occurred, however, the changes will not stop there.

This transformation is not a revolution, it is a Metamorphosis. The change of form and structure has begun in many industries, Agriculture, and Beef more specifically is in an early stage of the process. Producers working closely with Excel Corporation are leading this transformation.

The biggest challenge for the Beef Industry as this transformation takes place, is for Seedstock and Cow/Calf producers to decide where and how they fit, and how they want to participate long term. The decisions and answers to these questions are the basis for behavioral changes in any successful relationship. In my presentation, I will cover many of the behaviors, expectations, and questions that producers must understand, and how these choices will change your operations.

I. Finding Common Ground
   a. Individual Business Disciplines
      i. Does your philosophy, goals, and objectives match or compliment your business partners? An example would be: If you, as a cow/calf producer, don't believe in the Individual Identification concept and the Feedlot and Processor strongly believe that individual identification is an important avenue to improve genetics and management, odds are, neither will be satisfied with the relationship.

II. Risk vs. Reward
   a. What risk can you afford to take to reap the reward? You must find a partner who is willing to take the risk so you can learn what your cattle's capabilities are. However, don't expect to reap 100% of the reward.
      i. Do you need to change genetics?
      ii. What can you afford and how big of a reward do you expect?
      iii. Are your genetics acceptable, but management strategies needed changing?

III. Quality vs. commodity
   a. A Quality concept is to take a focused, approach to adding value through all segments to meet or exceed the consumer/consumers expectation. The Quality concept allows for these expectations to be produced repeatedly in volume. A Quality producer will have more opportunities available, have more information to negotiate a better deal, and become a "Price Maker".
   b. Commodity concept is to produce an average product cheaply with no added value. The commodity producer will, over time, be a "Price Taker", and will have little or no information to learn from. This producer doesn't see the value of information, and it does not serve his operation long term.

IV. Values and Beliefs
   a. The partners must believe in the same values and beliefs when doing business. As a producer, you may be more challenged than a feedlot or processor when it comes to understanding their businesses. However, if you select the correct partner (similar or complementing goals) they will understand the importance of you having a basis understanding of their business.
   b. Your Values and Beliefs will be tested, and are of vital importance when challenges, problems, and issues arise. The true test of two business complimenting each other is how they are able to work through the tough times. Those who truly understand, and put forth an effort to turn a tough situation into a win-win will not only survive, but also prosper.

I have tried to lay the foundation and basis for building a relationship as viewed by Excel Corporation. The balance of the presentation will be more general in kind, but just as important. These are several other areas which become critically important when building the a relationship between each segment

I. Individual business disciplines and goals

II. Willingness and ability to challenge traditional view, actions, and processes,

III. The desire to service the customer
   a. Service is universally defined in the Quality Concept as: Listening to not only what the customer says, but also what they mean.
   b. What are the customers' expectations and can you deliver?
   c. Does the customer believe you honestly care about them, their operation, profitability, etc.
   d. Do you answer the question for them, "What's in it for me, the customer?"
   e. What value are you adding to my business? Can I receive this value anywhere else?

IV. Service a need and profits will follow.

V. "What you do speaks so loudly, I can't hear what you're saying." Each partner will over time judge the other by how and what he or she contributes to the overall partnership.

VI. Reward structure for partnerships
   a. Alliances (formal or informal)
   b. Joint ventures to align the value chain and share in the value created.
   c. Partnerships/networking (formal or informal)

VII. Achieving long lasting relationships
   a. Openness and good communication/listening skills
   b. Understanding each other's problems, challenges, goals, and needs
   c. The want-to attitude to help each other
   d. Patience
   e. Sincerity
   f. Ethics and integrity
   g. Information sharing/training
   h. Trust

All of these attributes must be present, and the willingness to accept each partner's differences, views, challenges, and yet build on these differences to strengthen the whole. The ability to TRUST each other, and build confidence and consensus is the most difficult to achieve, yet a very powerful when harnessed.

Excel Corporation wishes you and your operation the best in your business venture.

NEW TOOLS FOR PREDICTING CONSUMER ACCEPTABILITY

Duane M. Wulf, Ph.D.
South Dakota State University

INTRODUCTION

The value of any product is determined by a customer's willingness to pay for that product, which is determined by that customer's wants and needs. The value of beef is therefore ultimately determined according to beef customers' desires. There are three basic beef carcass characteristics that affect value. These are shown in Table 1.

Table 1. Beef carcass characteristics affecting carcass value and the ease at which they are assessed.

Beef carcass characteristic	Ease of assessment
1. Product size	Easy to assess
2. Product cutability	⇕
3. Product quality (appearance and eating quality)	Difficult to assess

PRODUCT QUALITY (Appearance and Eating Quality)

Beef is offered for sale to the consumer at generally higher prices than other protein sources. The relatively higher retail price of beef is mainly a result of inherent disadvantages in cattle production efficiency, such as longer gestation periods, lower prolificacy, and reduced feed conversion as compared to pigs and poultry. Although beef producers should strive to reduce production costs and retail beef prices, the industry must rely on superior quality to increase demand for its product because beef will, inevitably, always be priced higher than pork and poultry. According to the Beef Customer Satisfaction Study, consumers perceive beef to be better tasting than either chicken or pork (NLSMB, 1995). However, several studies have documented wide variation in the quality of beef currently produced in the United States (Morgan et al., 1991; Savell et al., 1991).

The United States Department of Agriculture (USDA) Grading Service attempts to sort through this diversity in the cattle population and assign carcasses into grades of expected eating quality. These USDA quality grades are based primarily on evaluations of carcass maturity and the amount of intramuscular fat (marbling) present in the longissimus muscle (USDA, 1989). Both of these factors, maturity and marbling, have been shown by numerous researchers to significantly impact beef palatability. Increased maturity has been associated with decreased palatability (Romans et al., 1965; Breidenstein et al., 1968; Prost et al., 1975; Smith et al., 1982; Smith et al., 1988). The largest study of maturity effects on palatability was conducted by Smith et al. (1982) and utilized beef from 1,005 carcasses of all maturity groups (A through E). Substantial decreases in palatability and tenderness were found with increased maturity. However, the vast majority of carcasses within the fed steer and heifer population are classified into the "A-maturity" group (Lorenzen et al., 1993), and Smith et al. (1982) found little association between maturity and palatability within the "A-maturity" group (r^2 = 0 for longissimus muscle, r^2 = .18 for semimembranosus). Furthermore, USDA grades are assigned independent of differences in carcass maturity within the "A-maturity" group (USDA, 1989). Therefore, we can assume that, for most of the fed steer and heifer population, maturity is a constant and marbling is the sole determinant of USDA quality grade.

The impact of marbling level on beef palatability has also been extensively examined (Blumer, 1963; Romans et al., 1965; McBee and Wiles, 1967; Smith et al., 1984; Savell et al., 1987). Similar to the research on beef maturity, the effects of marbling on palatability have been studied across the extreme range of marbling scores. Smith et al. (1984) utilized 1,005 carcasses with marbling scores from "practically devoid" to "moderately abundant" and found a moderate relationship between marbling and palatability (r^2 = .34 for longissimus muscle, r^2 = .07 for semimembranosus) within the "A-maturity" group. However, The National Beef Quality Audit (Smith et al., 1995) reported that 84% of all carcasses from the fed steer and heifer population had marbling scores of "small" or "slight". Smith et al. (1984) reported no significant differences between means for "small" and "slight" for all 14 palatability attributes examined. With the majority of the fed steer and heifer slaughter being in a narrow maturity range (A-maturity) and in a narrow marbling range (slight and small), the USDA quality grades do not effectively segregate these carcasses into uniform palatability groups. However, substantial palatability differences do exist within this narrow maturity:marbling window. Therefore, the beef industry must seek other methods of distinguishing carcasses with palatable beef from carcasses with unpalatable beef, and continue to strive towards improving palatability.

Two ready-to-use on-line methods of assessing the palatability of beef carcasses appear promising. For the purpose of this paper, these two methods will be referred to as: 1) the Tenderness Classification System and 2) the Colorimeter System.

The Tenderness Classification System was developed by USDA researchers at the U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska (Shackelford et al., 1999). The shear force of cooked meat has long been used by researchers in the laboratory to assess meat tenderness. The Tenderness Classification System uses this shear force technology, but in an accelerated manner which therefore makes it adaptable to on-line use in a packing plant. In this system, a one-inch-thick rib steak is removed from each carcass and trimmed of all fat and bone. This steak is then cooked on a belt grill, which cooks both sides simultaneously, for a period of 7 minutes. Following cooking, a 0.4 inch by 2.0 inch slice is removed from the steak and the force required to shear this slice is measured on an electronic testing machine. The entire process, from cutting the steak to shearing the steak can be accomplished in 10 minutes. This system could be utilized at chain speeds of 400 head per hour (Goering, 1999). The Tenderness Classification System has been shown to explain 46 to 56% of the variation in aged beef tenderness (Shackelford et al., 1997).

The Colorimeter System was first tested at Colorado State University (Wulf et al., 1997), later at The Ohio State University (Wulf et al., 1998), and currently at South Dakota State University. Research to integrate color measurements to predict tenderness along with cutability prediction in a single VIA instrument known as the "BeefCam" is currently ongoing at Colorado State University (Goering, 1999). The Colorimeter System, as defined by the Ohio State research uses three factors to predict eating quality: marbling, hump height, and colorimeter readings. Hump height is a measure of the neck hump on beef carcasses and can be used to sort out those tenderness problems associated with *Bos indicus* genetics. If those carcasses with humps of greater than 3.5 inches are excluded, eating quality can be improved. Colorimeter readings are very simple to measure. It requires only 3 seconds to obtain a colorimeter reading on the surface of the rib eye muscle. The one critical factor that must be taken into account is bloom time, because bloom time will dramatically affect muscle color. Carcasses with a darker shade of muscle color (not necessarily dark cutters) have been shown to have less tender beef than carcasses with a brighter muscle color. In the Ohio State research, marbling explained 12% of the variation in eating quality, hump height explained 8% of the variation in eating quality, and colorimeter readings explained 24% of the variation in eating quality. Putting these three factors together in a single grading system explained 39% of the variation in eating quality (Wulf et al., 1998).

Table 4 shows a comparison of systems at predicting eating quality. The Tenderness Classification System is the most accurate system and will probably always be the most accurate system because it is a direct measure of tenderness, whereas the other systems are indirect measures of tenderness and/or eating quality. However, the Tenderness Classification System is an evasive system (it uses one steak from each carcass) and is also quite expensive to operate in its present form. Other systems are not evasive and are relatively simple to operate. Therefore, one must weigh accuracy versus expense when deciding which system to use.

Table 4. Accuracy of various methods at predicting eating quality within the young beef (fed steers and heifers) population.

Method	r^2 for prediction of eating quality
USDA quality grades	.05 to .15
Tenderness Classification (Shackelford et al., 1997b, 1999)	.46 to .61
Colorimeter System (Wulf et al, 1998)	.36 to .42

As the beef industry moves towards a more consumer-oriented approach to decision making, beef producers must increase product quality and consistency. Currently, however, it is very difficult for beef producers to improve product eating quality because a rapid, accurate method of measuring palatability is not being used. How can we improve quality when we can't measure it? The beef industry cannot hit a target that it can't see. These new systems reviewed here may or may not be implemented into the USDA grading system. However, at a minimum, they hold much potential for a branded beef program to differentiate its products. And if used, these systems would allow a more true value assessment of beef.

LITERATURE CITED

Blumer, T. N. 1963. Relationship of marbling to the palatability of beef. J. Anim. Sci. 22:771.

Breidenstein, B. B., C. C. Cooper, R. G. Cassens, G. Evans, and R. W. Bray. 1968. Influence of marbling and maturity on the palatability of beef muscle. 1. Chemical and organoleptic considerations. J. Anim. Sci. 27:1532.

Goering, K. 1999. Instrument grading: A different sort of measurement. National Cattlemen, vol. 14, num. 1, pp. 54-56.

Lorenzen, C. L., D. S. Hale, D. B. Griffin, J. W. Savell, K. E. Belk, T. L. Frederick, M. F. Miller, T. H. Montgomery, and G. C. Smith. 1993. National beef quality audit: Survey of producer-related defects and carcass quality and quantity attributes. J. Anim. Sci. 71:1495.

NLSMB. 1995. Beef Customer Satisfaction: Report to the industry: A comprehensive in-home product test among frequent beef consumers. National Live Stock and Meat Board, Chicago, IL.

McBee, J. L., and J. A. Wiles. 1967. Influence of marbling and carcass grade on the physical and chemical characteristics of beef. J. Anim. Sci. 26:701.

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.

Prost, E., E. Pelczynska, and A. W. Kotula. 1975. Quality characteristics of bovine meat. II. Beef tenderness in relation to individual muscles, age and sex of animals and carcass quality grade. J. Anim. Sci. 41:541.

Romans, J. R., H. J. Tuma, and W. L. Tucker. 1965. Influence of carcass maturity and marbling on the physical and chemical characteristics of beef. 1. Palatability, fiber diameter and proximate analysis. J. Anim. Sci. 24:681.

Savell, J. W., R. E. Branson, H. R. Cross, D. M. Stiffler, 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.

Shackelford, S. D., T. L. Wheeler, and M. Koohmaraie. 1997. Tenderness classification of beef: I. Evaluation of beef longissimus shear force at 1 or 2 days postmortem as a predictor of aged beef tenderness. J. Anim. Sci. 75:2417.

Shackelford, S.D., T. L. Wheeler, and M. Koohmaraie. 1999. Tenderness classification of beef: II. Design and analysis of a system to measure beef longissimus shear force under commercial processing conditions. J. Anim. Sci. 77:1474.

Smith, G. C., B. W. Berry, J. W. Savell, and H. R. Cross. 1988. USDA maturity indices and palatability of beef rib steaks. J. Food Qual. 11:1.

Smith, G. C., Z. L. Carpenter, H. R. Cross, C. E. Murphey, H. C. Abraham, J. W. Savell, G. W. Davis, B. W. Berry, and F. C. Parrish, Jr. 1984. Relationship of USDA marbling groups to palatability of cooked beef. J. Food Qual. 7:289.

Smith, G. C., H. R. Cross, Z. L. Carpenter, C. E. Murphey, J. W. Savell, H. C. Abraham, and G. W. Davis. 1982. Relationship of USDA maturity groups to palatability of cooked beef. J. Food Sci. 47:1100.

Smith, G. C., J. W. Savell, H. G. Dolezal, T. G. Field, D. R. Gill, D. B. Griffin, D. S. Hale, J. B. Morgan, S. L. Northcutt, and J. D. Tatum. 1995. The Final Report of the Second Blueprint for Total Quality Management in the Fed-Beef (Slaughter Steer/Heifer) Industry: National Beef Quality Audit - 1995. National Cattlemen's Association, Englewood, CO.

USDA. 1989. Official United States standards for grades of carcass beef. Agric. Marketing Serv., USDA, Washington, DC.

Wulf, D. M., S. F. O'Connor, J. D. Tatum, and G. C. Smith. 1997. Using objective measures of muscle color to predict beef longissimus tenderness. J. Anim. Sci. 75:684.

Wulf, D.M., J. K. Page, T.R. Schwotzer, and G.R. Dunlap. 1998. Final report to National Cattlemen's Beef Association: Using measurements of muscle color/pH/water-holding capacity to augment the current USDA beef carcass quality grading standards and improve the accuracy and precision of sorting carcasses into palatability groups. The Ohio State University, Columbus, Ohio.

CAN BEEF PRODUCERS HAVE THEIR CAKE AND EAT IT, TOO?

R. D. Green, T. G. Field, N. S. Hammett, B. M. Ripley, and S. P. Doyle
Colorado State University

The Beef Industry is Lost in Its Own Fog?

Over the past couple of decades, the beef cattle industry has become a confusing place to exist. Messages have been conveyed to producers at a fast and furious pace. This would not be a problem if these messages were consistent and if they were compatible with each other, yet this is far from the real situation. Our good friend Daryl Tatum, has been known to occasionally coin the term to describe confusion as "someone being lost in his / her own fog". Unfortunately, this verbage very accurately describes the beef cattle production environment of the 1990s. One could compose a lengthy list of dichotomies in the current beef cattle industry. A partial list might include:

1. A forage-based production system (low input) versus a concentrate-based feedlot system (high input).
2. Fierce pride in producer individuality and independence versus strategic alliances and cooperative relationships.
3. Segmentation and resulting inefficiencies versus vertical coordination and / or integration.
4. Traditional purebred cattle-focused seedstock production versus commercially-oriented specification seedstock production.
5. "Show cattle" versus "performance cattle".
6. Commodity-based marketing versus value-based marketing.
7. Totally "vested" beef cattle producers versus "less-vested" small land-owners.
8. Public lands versus private land use for beef production.
9. "Artificially selected" cattle versus "naturally selected" cattle.
10. "Animal welfare" versus "animal rights".
11. Systematic crossbreeding versus mongrelization.
12. Purebred breeding versus composite breeding.
13. Increased quality and consistency versus increased genetic variation.
14. High tech production versus low cost production.
15. Matching the cow to the production environment versus matching the calf to the marketing environment (i.e. **cow adaptability versus carcass acceptability**).

The collective concerns and issues listed above, along with a number of others we could further list, have contributed to "the fog" for beef cattle producers. Given how spontaneously and explosively these issues can appear (or increase in importance), what is a cow-calf producer to do? The objectives of this presentation are to: 1) Provide an overview of how to match a producer and production system to a specific industry target; 2) Discuss current and future tools needed for proper genetic decision-making, and 3) Provide some perspective on how the beef cattle industry can go about increasing "quality and consistency" while maintaining balances in cow herd efficiency and profitability.

What About Lowering Costs of Production?

All changes in a commercial cow-calf operation must be evaluated in terms of their effect on profitability of the whole enterprise. Given the problem that profitability is often, in the short-term, very affected by external market conditions, Dickerson (1984) advocated that these changes be evaluated on the basis of economic efficiency measured as the ratio of input costs per unit of output product value. When one operates under this philosophy, cost of production becomes very important relative to desired increases in product value. Furthermore, it is imperative to remember that many of these desired ends are often antagonistically related, meaning that we must be careful to keep the "big picture" in perspective.

For example, traditionally we have thought that in relative economic terms, reproductive efficiency is roughly twice as important as growth performance which is approximately five times as important as carcass merit (Melton et al., 1979). A few years ago, a reanalysis of the importance of these three types of traits under a more current, value-based type of marketing system was completed. Under this more current marketing system, the former 10 reproduction: 5 growth: 1 product ratio was now closer to 2 reproduction: 1 growth: 1 product (Melton, 1995). A more recent evaluation of these economic weights has been presented from the American Gelbvieh Association's Gelbvieh Alliance marketing program (Figure 1). After some 110,000 feedlot cattle had gone through their program, the estimated relative importance of these three trait categories was approximately 4:2:1 (Schiefelbein, 1998). There are several things about these relative economic values that are very important. First, under the general assumptions used in their derivation, these results indicate that while we have paid a lot of attention to growth of calves in the past, that will not suffice in the future. In most cases, the problems are in the other two categories: reproductive efficiency because it has been so difficult to genetically change, and carcass merit because we simply have not paid much attention to this area.

Secondly, one should not fall prone to the common error of assuming that these economic weights are universally true. They are applicable to one particular system and environment but may be quite different if the system is changed. One of the universal strengths that makes the beef industry unique is that it uses God-given resources from the land which cannot be more efficiently utilized by other production systems. Cattle harvest energy from sunlight, soil, and water that is then converted to a higher quality form of protein. They do this from a set of natural resources that cannot be "farmed" any other way. The problem is that those resources exist under such a wide array of ecosystems that we are challenged to come up with one management system that will work for all environments (Hohenboken, 1988). Herein also lies our genetic dilemma when we try to build the best beast to harvest and harness that energy from the environment.

Thirdly, we also often tend to over-generalize in the beef industry when talking about "*THE* TARGET". As Dell Allen of Excel, Inc. has stated, there a several different target markets in our industry (Allen, 1987). The first question that a commercial producer must ask before addressing anything else genetically, is "Which target am I going to aim my production resources toward?". As marketing of cattle in alliance and grid programs has escalated over the past 24 months, it has become clear that there are major targets in "lean beef", "high-quality beef", and "export beef" trade. There are certainly other smaller specialty markets as well. The market may change over time in relation to premiums and discounts for "leanness" versus "quality". However, a given producer must decide **before the genetic decisions are made** on a well-defined target that is comfortable. Given the current plethora of alliance marketing programs, one must become educated on where he/she fits and then set their target based on that marketing program. **Only then can one truly go about determining the relative importance of these traits.**

What Should be in a Commercial Producer's Want Ad?

In 1987, the beef cattle symposium program at the annual meeting of the American Society of Animal Science was entitled "Bovine Nirvana". In that program, Rick Bourdon and Bill Hohenboken discussed different perspectives on how one might describe the "ideal" cow (Bourdon, 1988; Hohenboken, 1988). As they both stated in their remarks, this beast does not really exist, primarily due to the reasons already described earlier in this paper. However, we do know that it is possible to provide some general guidelines for the specifications we would look for in performance criteria in the beef cattle production system.

Bob Taylor, our recently deceased colleague and friend, had great foresight in realizing the need to look at "balanced" performance of cattle long before it was popular. A number of years ago, he developed a simple analogy to illustrate the importance of this philosophy to his beef production students. He said that what commercial producers should do is develop a "want ad" for the type of bulls and females they use in their system. This want ad should then be what is used by the seedstock industry to develop "specification seedstock" to address the needs of the commercial production sector of the industry. While this is a very simple approach, in concept, one is left to wonder just how often it has been applied. Taylor's generalized want ad, shown in table 1, provides an excellent overview of the challenge a breeder has to mount in order to "hit the overall" target.

Is It Possible to Genetically Improve Cow Adaptability and Carcass Acceptability?

Within Population Selection. Fortunately, collective research results over the past 50 years have clearly shown that genetic variation exists both between and within breeds for many of the important measures of performance in beef cattle production. Table 2 provides a summary of the average levels of heritability for a variety of reproductive, growth and carcass traits as provided in an exhaustive analysis of the research literature by Koots et al. (1994a). In general, selection within breed populations is quite effective for carcass traits, moderately effective for growth related traits, and much slower for reproductive efficiency related traits.

Until recently, we have believed that there was limited opportunity to genetically improve fertility via direct selection within breeds. While indicator traits of fertility and age at puberty, such as scrotal circumference, have proven to be quite useful and heritable, they have not been shown to be highly genetically correlated to fertility measured as pregnancy success. Because fertility measures are binary traits (i.e. they are observed as either pregnant or not pregnant), it is quite difficult to use phenotypic information to determine genetic differences (e.g. two females may both get pregnant but may differ widely in their true genetic potential for fertility). This results in traditional analytical methods not being adequate to separate these genetic differences and thus, we have always stated that the heritability of these traits is quite low (see table 2). More appropriate statistical methodology called "threshold modeling" allows appropriate analysis of these types of traits on an underlying continuous probability scale. One of the first applications this approach was to define a new trait called "stayability" that has been adopted by the Red Angus Association of America and is now in the process of being implemented by several other breeds (Snelling et al., 1995). This estimated breeding value is a genetic prediction of the probability of females still being in the herd at a breakeven age of six years given that they were selected as replacements. This measure combines performance differences in fertility, growth, and survivability/adaptability of these females.

In the direct fertility area, an analysis of heifer pregnancy records from the Hereford herd at the Bell Ranch in New Mexico has recently been completed (Evans et al., 1996). In that study, the researchers determined that heifer pregnancy was indeed more heritable than previously thought (14%). Furthermore, when the relationship of heifer pregnancy with yearling bull scrotal circumference was estimated, a non-linear relationship was revealed. A second study conducted a similar analysis using historical data from the Colorado State University Beef Improvement Center Angus population at Saratoga, WY (Doyle et al., 1996). These researchers reported a heritability level for heifer pregnancy of 19%, corroborating the result of Evans et al. (1996). These two studies indicate that it is feasible to produce genetic predictions to enable direct genetic improvement in reproductive rate. The only obstacle is getting breed association national cattle evaluation performance databases to adopt a "whole-herd reporting" format that is necessary to allow computation of these types of EPD (Golden et al., 1996). While this is only a start on the whole reproductive efficiency complex, it is a 200% improvement over current genetic capabilities in this important area.

Between Population Selection. Larry Cundiff and co-workers at the U.S. Meat Animal Research Center have conducted the most extensive genetic evaluation of breeds in the world over the past 30 years in the Germ Plasm Evaluation (GPE) program at the U. S. Meat Animal Research Center. The design for this project has allowed for the evaluation of a widely diverse set of breeds (Cundiff and Gregory, 1999). From the collective results of this effort, they have reported that the magnitude of genetic variability between breeds is roughly equivalent to that within breeds (table 3) for most performance traits. While this infers that genetic improvement is possible through proper breed selection implemented in designed crossbreeding programs (i.e. breed complementarity), it also points out that no one breed excels in all characteristics simultaneously, along with a great degree of overlap between various breeds.

The GPE program, along with other studies, has also shown that many genetic antagonisms exist in beef production systems. Koots et al. (1994b) summarized published estimates of genetic and phenotypic correlations between a number of traits of interest (table 4). These estimates clearly reveal general genetic antagonisms between growth rate and calving ease, growth rate and mature cow size, maternal characteristics and cutability, and carcass quality and cutability. Additionally, the review of these authors pointed out how many genetic relationships between traits of economic importance are poorly understood. A prime example of the sparseness of information is the lack of any understanding of the relationship between measures of tenderness and other performance criteria.

The most troubling genetic antagonism we must consider when attempting to genetically improve product quality and consistency concerns the relationship between carcass attributes and measures of reproductive efficiency. There is generally a lack of this type of information in the research literature. The best existing data relating actual carcass measures to reproductive traits comes from a study by MacNeil et al. (1984) at the U. S. Meat Animal Research Center. Table 5 provides a summary of that information and indicates antagonistic relationships between selection to increase retail product weight and age at puberty, services required to settle a cow and mature size. When one considers these estimates in concert with the experiences of the swine industry with pale, soft, and exudative pork (PSE), a definite red flag is raised.

Unfortunately, even though there have been numerous attempts to make one believe otherwise, these antagonisms leave **no doubt that no one breed allows breeders to have their cake and eat it, too!** Bourdon (1994) used the analogy of "sensible beef stew" to describe the effectiveness of utilizing designed mating systems to "mix and match" strengths and weaknesses of breeds to meet specifications for balanced performance. This fact has been further supported in the analysis of the American Gelbvieh Alliance results where a ratio of 50% British to 50% Continental European breeding appears optimal to hit market targets (Schiefelbein, 1998). Cundiff et al. (1994) additionally pointed out the need for alteration of breed inputs in sub-tropical environments to include either some Bos indicus or heat tolerant Bos taurus germ plasm.

Heterosis......The Final Piece of the Puzzle

Fortunately, nature has provided a significant amount of heterosis observed in the reproductive efficiency and maternal trait complex to allow breeders to overcome the obstacles of direct selection for fertility and cow adaptability mentioned earlier. Heterosis levels of 20 to 25% are achievable in pounds of calf weaned per cow exposed to breeding using systems which exploit a terminal sire breed mated to crossbred females of unrelated breeds (table 6, Cundiff and Gregory, 1999). This amount varies according to the breeds used in the crossing system because heterosis is directly proportional to the difference in gene frequencies affecting the traits between the breeds used in the cross. This is the basis for the success of the Bos indicus x Bos taurus crosses in the sub-tropical zones where these females express phenomenal heterosis in maternal and reproductive performance.

Unfortunately, in the chase to utilize this "free-lunch" heterosis gift, as has too often been the case in animal breeding, there has been too much emphasis on "maximize" and not enough emphasis on "optimize". When we recall what was mentioned before about evaluating the effects of change on cost per unit of output product value, there is an optimum amount of everything we do, even reproductive performance. Beyond that optimum it costs more to achieve than benefits received in return. This is an important concept to keep in check.

So, How Do We Genetically Manage to Simultaneously Improve End-Product Performance and Lower Cost of Production?

Given that there are literally hundreds (thousands may be even more appropriate) of feed resource and climatic environments used in cattle production, yet end-product performance must fit within specification targets, what do we do? Animal breeders have unanimously stated over the past several generations of cattle production that we must achieve this balance by using breed complementarity and heterosis in very carefully designed crossbreeding programs. This must be a several step process to work successfully. First, the proper breeds must be chosen to for matching maternal performance of the cow herd to a given production environment. Secondly, the proper lines from within those breeds must be selected to properly hit those environmental targets while also meeting minimum acceptable performance in end-product characteristics. Then a terminal sire breed must be selected to bring necessary performance for growth and end-product performance to the system. Furthermore, the sires selected from within the terminal breed (or breeds) chosen, must have documented performance for growth and carcass traits (i.e. EPD) in addition to the sires selected for maternal replacements having documented EPD for reproductive and functional soundness.

There are several different types of crossbreeding programs available to producers. These have been discussed in detail in the past (Bourdon, 1994; Kress, 1994; Cundiff and Gregory, 1999). There are certainly advantages and disadvantages to each of them. Unfortunately, a number of the product inconsistency problems our industry is experiencing today are from misuse and abuse of these systems. It has not usually been the choice of the particular crossbreeding program that has gotten breeders into trouble as much as the inability to properly design, implement and then stay the course in a crossbreeding program. Many programs have been doomed from the start because they were not properly thought out, while yet others have failed because a new breed has come along that tempts the curiosity too much. Furthermore, there are still many breed and tradition loyalties which run rampant which often get in the way of breeding program objectivity. These facts, coupled with the wild chase for extra growth and extra heterosis have resulted in what some have called the "mongrelization" of the U.S. beef cow herd.

Is There Any Way to Reduce Crossbreeding Variation?

Cundiff and Gregory (1999) presented an excellent summary of the effectiveness of various crossbreeding systems in terms of heterosis utilization, use of breed complementarity, and consistency of production in 1994. In that presentation, the most effective system at doing all three things simultaneously, along with being the easiest to manage effectively, was composite breeding. The theory behind composites has been amply proven by the Germ Plasm Utilization Project at the U.S. Meat Animal Research Center under the leadership and guidance of Keith Gregory. The published summary (Gregory et al., 1995) of that work proves that composite breeding offers a usable solution to many of the problems we are discussing here. Heterosis utilization is high, breed percentages are fixed and do not vary between generations, and breed differences can be utilized to match breed strengths and weaknesses to the production and marketing environment. The ability to overcome genetic antagonisms and still retain high levels heterosis in maternal performance is unmatched by any of the other designed systems. Furthermore, once the composite is formed, the breeding system is much simpler to manage than any of the others.

Detractors of the composite approach have argued that composite mating systems will increase rather than decrease variability of production due to increased levels of heterozygosity. USDA-ARS work has shown that there is not a significant increase in the variability observed in the composite lines as compared to the purebreds (table 7). Furthermore, compared to other mating systems such as rotational crosses and rota-terminal systems, the inter-generational variation is eliminated (figure 2). These same detractors of composites have argued that we cannot afford to give up the consistency that purebreeds have worked so hard to develop through their history. They do forget, however, that those purebreeds with their consistency have to be the foundation for the composite lines. Just like there is no one breed that offers everything, the beef cattle industry will not be able to develop only one maternal line composite. While that may work better for the poultry and swine industries, it will not work for the beef industry. Therefore, the challenge is for the purebred breeds to find where they will fit into various composite lines as they develop.

There are, however, also a few negatives to the composite approach. One is that in order to develop a composite line, it needs to be done from a relatively large base to avoid inbreeding. The typically used number is to have 400 to 500 females in the breeding population. Then there has to be intentional avoidance of inbreeding practiced to maintain the heterosis level in the composite line. A second negative is that genetic evaluation is much more difficult, i.e. EPD are not readily available, nor as accurate, for most composites as compared to purebreeds. We are just beginning to see some movement in the U.S. to address this problem through such efforts as the American Simmental Association's multi-breed EPD program (Pollak and Quaas, 1998). Another negative is that composite breeding still cannot overcome poor breeding decisions. A composite made from the wrong breeds and the wrong lines within those breeds still is a bad product. It has to be carefully and meticulously done.

How Are We Coming With Carcass EPD?

So, even if many problems can be remedied with designed breeding programs, breeders still must be able to accurately select the best animals. If we do not have the information for end product breeding value, then how do we select the right terminal sire? For example, there is little doubt that the Brahman crossbred female is hard to outperform in the Gulf Coast region of the U.S.. However, we also know that we need to find a way to make sure that the Brahman sire lines used in that cross do not present the wrong type of end-product specs (particularly for tenderness; Sherbeck et al., 1995a,b; Crouse et al., 1989). If we do not have genetic predictions available for these carcass traits, we are doing no better than shooting in the dark.

If there is such a need for carcass EPD and the genetic bases of these traits is relatively high, why are they not widely available? Even though there have been several factors which have contributed to this problem, fortunately we are finally in the midst of seeing them resolved. The largest hindrance to collecting carcass information has been that until recently 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 accurate individual identification of carcasses. The combination of these factors has resulted in somewhat limited amounts of progeny data being placed into breed performance databases in the past. In the U.S., the American Angus Association has had the most concerted effort in designed progeny testing of sires. Approximately 50% of their currently published sires have carcass information (2,772 of 5,527 with published EPD (Angus, 1998)). While this proves the difficulty of obtaining progeny data for carcass traits, it also emphasizes that useful carcass information can be obtained for a meaningful percentage of the breed. Several other breed programs are attempting to build databases (table 8).

The second hindrance has been the lack of ability to determine true carcass value differences on live, yearling seedstock cattle to circumvent the need for progeny data. Real-time ultrasound imaging technology has been pursued over the past ten years as the primary means to obtain these live animal measures and now appears to be entering the adoption mode. A national consortium of U.S. universities worked together during the early 1990s in a project which had as one of its three objectives "to determine the efficacy of using real-time ultrasound imaging to measure body composition and carcass merit traits in beef cattle" (Bertrand et al., 1994; Green et al., 1994; Wilson et al., 1994). The conclusions drawn from a compilation of this and other research indicate: 1) assessment of retail yield amount or percentage on the basis of 12th rib fat thickness (FT) and 12th rib ribeye area (REA) is slightly less effective using ultrasonic measures on the live slaughter animal as compared to direct measures on the carcass postmortem (Hamlin et al., 1995; Herring et al., 1994; Perkins et al., 1992b); 2) FT is a better predictor of cutability than is REA in the current cattle population (Hamlin et al., 1995; Herring et al., 1994), although not so of retail product weight, 3) ultrasonic measures of these retail yield indicators appear to be under a moderate degree of genetic control (weighted average h^2 of .37 for FT and .26 for REA (Hassen et al., 1999; Shepard et al., 1996; Evans et al., 1995; Robinson et al., 1993; Johnson et al., 1993; Duello et al., 1993; Arnold et al., 1991; Turner et al., 1990; Lamb et al., 1990; deRose et al., 1988), 4) genetic correlation estimates between ultrasonic predictors of carcass merit and other economically important traits are sparse but indicate some antagonism between REA and mature size (Shepard et al., 1996; Johnson et al., 1993), 5) prediction of intramuscular fatness and palatability traits is more difficult using ultrasound, although high and acceptable levels of accuracy have been achieved in the past few years (Brethour, 1998; Crouch, personal communication; Wilson et al., 1995), and 6) data to estimate relationships between ultrasonic measures in yearling bulls and slaughter steer carcass retail yield and palatability have been more limiting (Crouch, personal communication; Kriese 1996; Diles et al., 1996a,b; Wilson et al., 1995; Evans et al., 1995; Steinkamp, 1995; Schalles et al., 1992).

This last issue has been the hardest one to resolve in recommending the adoption of ultrasound-generated carcass data for breed improvement programs. As data addressing this issue have been accumulated over the past five years, the conclusions of various researchers have not all agreed. However, as more data have been analyzed in some larger breed databases, the conclusions have become more clearly in favor of the use of real-time ultrasound. Data from the Brangus (Kriese, 1996) and Angus (Crouch, personal communication) breeds have indicated high correlations between ultrasound and actual progeny carcass data for sires where both types of information have been collected. These conclusions have lead to the recent adoption of policy to accept ultrasound data by several breed associations, including Angus, Hereford, Simmental, Brangus, and Gelbvieh (table 10), with more associations to follow suit in the next few years. Coupled with actual carcass progeny data, use of real-time ultrasound data should allow great acceleration to occur in the percentage of active sires with carcass EPD for most breeds. For example, the American Angus Association amassed enough ultrasound data in the first 9 months after adoption to increase the size of its carcass record database by almost 50% (Crouch, personal communication).

Do We Have All of the Necessary Information to Genetically Address Carcass Acceptability?

The only area that may be a little tough (no pun intended) is genetic evaluation of overall meat quality, particularly tenderness. The reason that this is a major issue for the beef industry to confront is that we have estimates that one in five of the steaks produced in the current industry are tougher than desired (Morgan et al., 1991). No industry can afford this kind of defect rate!

There have been numerous debates in the U.S. over the last few years regarding how marbling can, or cannot, be used to address the meat quality and tenderness issue. This same discussion has also been occurring in Australia as they have begun to implement eating quality assurance grading standards (Polkinghorne, 1999). The collective U.S. experience indicates that while it would be nice to rely on marbling and USDA Quality Grade to be the "insurance policy" for palatability, it is simply not good enough. While the probability of getting an unpalatable steak does significantly reduce when going from Standard up through Choice and Prime grades, there is so much overlap in palatability amongst the grades that today it is possible to have steaks from carcasses of Prime and Standard grades that will be equally palatable (Smith et al., 1987).

Increasing emphasis is being placed on marbling in breeding programs at the current time, largely due to the marketing success of the Certified Angus Beef program (Marston et al., 1999). Increasing selection intensity for marbling appears to be short-sighted, however, for several reasons: 1) marbling is, at best, an insurance policy for eating satisfaction of beef; 2) marbling only explains 10 to 15% of the variation in overall palatability of cooked beef product; and 3) just as in any other trait, there are genetic antagonisms with marbling which must be carefully managed (recall the discussion of cutability and marbling earlier in this paper). However, without a more direct, accurate system for assessing true palatability differences, breeders are responding to increased consumer demand for quality and consistency using marbling as their selection criterion since it is the only tool available to them. As long as this selection occurs in a balanced trait configuration it should net small, yet positive, gains over time (Marston et al., 1999).

What About Tenderness?

It seems like there has been more discussion about beef tenderness in the past five years than in all of the previous century. As reviewed by Tatum (1999), beef is perceived to currently have a toughness problem, particularly in relation to cattle of Bos indicus descent (O'Connor et al., 1998; Sherbeck et al., 1995). There are two ways to handle this problem; tenderize the product post-mortem and/or genetically fix it. We know that postmortem aging, electrical stimulation, and calcium chloride injection post-mortem can be used to reduce toughness problems (Tatum et al. 1997). We also know that tenderness, assessed as Warner-Bratzler shear force of loin or rib steaks at a 14 d aging endpoint is heritable ($h^2 = .38$) and variable (Wulf et al., 1996). Although calpastatin, a primary inhibitor of muscle proteolysis post-mortem, appeared to offer a useful selection criterion in early research targeting genetic improvement in tenderness (Wulf et al., 1996; Koohmaraie et al., 1995), genetic polymorphisms in the calpastatin gene have not proved practically usable (Lonergan et al., 1995; Green et al., 1996a,b; Green et al., 1994). However, as pointed out in the previous presentation in this symposium, application of best management practices post-mortem results in a toughness rate that is still unacceptable, leaving the only remedy long-term through genetic selection (Tatum, 1999). Collectively, this means that breeders must position themselves on the tenderness issue by collecting objective progeny tenderness data (measured as Warner-Bratzler shear force).

This challenge has been taken seriously by commodity group leaders in the U.S. and abroad. In 1998, an extensive genetic evaluation project for carcass merit was approved for funding by a consortium of 16 beef cattle breed associations and the beef checkoff (Green et al., 1998). The 42-month study, referred to as the National Carcass Merit Project, was initiated in June of 1998 and will collect complete carcass data (including ribeye shear force) from 11,000 progeny of sires from these breeds. Each breed is testing a minimum of ten of their most widely used sires with a minimum of 50 progeny each. Additional sires will be tested with fewer progeny in a majority of the breeds. The objectives of the project include estimation of EPD for shear force and sensory panel assessments of tenderness (as well as all other carcass traits) and an economic analysis of the costs and benefits associated with this type of information. As the planning for this project developed, a particular focal point of the effort became an evaluation of a set of previously identified and promising 11 DNA marker tests for carcass merit.

A number of developments over the past ten years have led to some DNA testing beginning to be made available to industry. Since we have been discussing tenderness and carcass merit traits at length, it might be helpful to show what is happening in this area as an example. As pointed out previously, the beef cattle industry in the United States has been attempting to improve consumer demand for beef products by improving carcass merit of the cattle population. In particular, the need has been identified to increase the marbling potential of domestic grain-fed U.S. beef. In response to these needs, a beef checkoff funded project was initiated at the Angleton research station of Texas A&M University to identify genes, referred to as "quantitative trait loci" (QTLs), affecting variation in marbling ability (Taylor et al., 1996). The project was started in 1990 and required the development of resource families that would be expected to be highly heterozygous for gene loci affecting this trait as well as other measures of carcass merit. Based upon previous research, the scientists chose a design that utilized Brahman X Angus crosses to develop these families due to their divergent performance relative to marbling (Angus high, Brahman low). They first produced reciprocal F_1 crosses between these two breeds. These first crosses were then used to produce full sib families of backcrosses to either Angus or Brahman through multiple ovulation and embryo transfer. A total of 42 full sib families were produced representing 16 sires and 19 dams. Life history data on 613 head of progeny were collected in this project (Taylor et al., 1997).

In analyses conducted in this project, the research team identified a number of possible QTL for several traits including five genes which appear to affect marbling, and an additional seven genes that influence either tenderness as assessed by Warner-Bratzler shear force or sensory taste panel. Additionally, the project has allowed identification of five QTL effects on ribeye area and 5 QTL for dressing percentage. One QTL effect that was detected in the project seemed to influence postweaning growth independent of birth weight variation, a very favorable gene effect. This QTL maps to the same chromosome (bovine chromosome 2) that had been identified to contain the gene causing double-muscling, the so-called myostatin gene (Grobet et al., 1997).

Several things are evident from the experience and results of this project. First, it is clear that these resource families take a great deal of time to develop and collect information from. It is a slow, expensive, and laborious process. Secondly, the reverse genetics approach (i.e. designing the families to allow detection of differences after the fact), is fairly powerful for detecting these effects, but will likely only yield linked markers in chromosomal regions containing large QTL effects. The researchers still must positionally clone and sequence these gene loci before they can determine the genetic cause of these differences and have more direct genotype tests. This positional cloning requires much finer mapping in order to elucidate the gene of interest. Thirdly, because of patenting/licensing of any DNA tests that develop from this type of research, much vagueness is observed in reporting of research results. Instead of knowing the map locations of the QTL effects presented above, the research group can only say that have identified effects rather than elucidating where those are located and in what linkage groups. Unfortunately this slows down overall progress in the field but is a fact of life in any form of current day biotechnology. Fourthly, because the reverse genetics approach hopes to identify markers to be used in a marker-assisted selection approach, the linkage relationships identified from a particular set of families may not hold up in other populations due to the phase of the linkage relationship. In other words, the markers linked to QTL effects identified in this particular project may not be useful in other families or breed populations. For example, perhaps the effects being found are breed-specific alleles that we already see in measuring differences between breeds, yet are not segregating within those other breeds (i.e. they are fixed). This last issue can possibly result in the direct application of QTL detected through this approach being difficult to apply beyond the resource population of study.

This research provides an excellent example of the process the animal industries will face to make usable technology from this approach. Given that it is unknown how useful the markers identified in that project will be across other families and breeds, a second step must be taken. This is where the National Carcass Merit Project mentioned earlier will play a major role. The project has several objectives, one being to validate the DNA markers identified by the Texas A&M project across the major U.S. beef breeds. The project is designed to collect complete carcass data, including Warner-Bratzler shear force, on 50 progeny from each of 10 widely used reference sires in each of the 16 breeds. Additionally, sensory panel evaluation will be performed on steaks from approximately 3,000 of these progeny. By going through this effort, the question will quickly be answered about whether these markers will be useful in a wide array of germ plasm. Additionally, it is hoped that the researchers will at the same time be able to move closer to positionally cloning the actual QTLs being "marked". The breeds and numbers of progeny participating in the project are shown in table 9.

What Other QTL Have Been Found ??

There are a number of QTL effects that have now been identified through research work at several locations. In addition to the work described above, associations have been reported for myostatin (Georges et al., 1998); growth traits (Beever et al., 1992); and carcass attributes, including tenderness (Keele et al., 1999; Stone et al., 1999; Green et al., 1996a,b). Additionally, associations have been reported with the ryanodine receptor gene with the pale, soft and exudative meat quality problem (Milan et al., 1996), markers associated with growth and fatness traits (Andersson et al., 1994; Archibald et al., 1994), and the estrogen receptor gene with litter size (Rothschild et al., 1998) in swine; the callipyge gene with double-muscling in sheep (Cockett et al., 1994, 1997; Freking et al., 1999); the bovine leukocyte adhesion deficiency condition in Holstein dairy cattle and other markers related to milk production traits (Dentine, 1995; Georges et al., 1995); and the hyper-parakalemic periodic paralysis condition in American Quarter Horses (Spier et al., 1993). It is not a coincidence that many of these associations are with single-gene, simply inherited traits. We are likely to see much of the benefit of DNA marker, or direct gene, testing on these types of qualitative traits.

More recently, mapping efforts have been initiated using complex study populations to identify large QTL effects for traits previously untouchable in genetic improvement programs. The two most exciting of these are both located in Nebraska. The first is a project being led by Daniel Pomp and Merlyn Nielsen at the University of Nebraska where they are using lines of mice which have been selected divergently for heat production. Heat loss can be used to estimate maintenance energy requirements of an animal through direct calorimetry. The Nebraska project was initiated in the early 1980s to determine if genetic variation existed for maintenance requirements using this approach. They have been successful in changing the heat production between high and low lines by 50% of the average. Earlier this year, this group reported that in a QTL search of an F_2 intercross of lines of these mice, they were able to identify two major QTL affecting heat production, with another two putative QTL (Moody et al, 1998). This is exciting in that it indicates that it may be possible through marker-assisted selection approaches to identify animals with improved feed efficiency, perhaps our most difficult economic trait to measure.

A second major QTL effort is underway at the USDA-ARS Meat Animal Research Center. In one aspect of that effort, researchers are attempting to utilize the twinning population where selection has been applied over several generations for twinning rate, to detect QTL for ovulation rate and embryo survival. Initial results in that project have been very promising, with at least one major QTL already identified in the early part of the project (Kappes and Cundiff, personal communication).

Where Will Marker-Assisted Selection Be of Greatest Benefit?

The resulting QTL that are identified through the ongoing searches of the developing bovine gene map are likely to be most beneficial for those traits that are difficult and expensive to measure, as detailed above. We can expect the following categories of traits to benefit the most from marker-assisted selection (in order of greatest to least degree of benefit): disease resistance and immunocompetence, carcass quality and palatability attributes, fertility and reproductive efficiency, maintenance requirements (i.e. energetic efficiency), carcass quantity and yield, milk production and maternal ability, and growth performance. This ranking is due to a combination of considerations including: 1) the relative difficulty in collecting performance data, 2) the relative magnitude of the heritability and phenotypic variation observed in the traits, 3) the current existing amount of performance information available, and 4) when performance data becomes available in the life-cycle of the cow herd, (collected at birth, weaning, yearling, maturity?). Most of the rankings above then become self-explanatory.

To be realistic, however, we must realize that QTL will not serve as magic, silver bullets. As long as we are relying on markers, rather than the QTL themselves, we are still only crudely defining the genotypes across the larger beef cattle population. Once QTL are finely mapped and direct tests are available, then the accuracy of selection will be markedly improved. Until then, however, the marginal gains that MAS will give us over selection on polygenic breeding values is not as high as one might think. Charles Smith predicted in the late 1970s that gene level information would only provide substantial gains for traits where information is lacking for genetic evaluation. Thus, for traits that are currently widely evaluated in national cattle evaluation programs (eg. growth rate) MAS will not help a great deal. His prediction was quite accurate given that results from a number of simulation studies now show quite clearly that he was correct (Haley and Visscher, 1998). The overall conclusion is that markers combined with EPD information will enhance the accuracy of genetic evaluation. The marginal gain, however, is very dependent on the particular trait, the number of markers available for whole genome scans, the availability of performance information, and the availability of marker information from large numbers of animals.

Lastly, in the current day climate of the beef cattle industry, where everyone is looking for a quick and magical solution to all that ails us, it is imperative that breeders not overestimate this technology. It is not uncommon to hear statements such as "all we have to do is find the marbling gene and then we will have the problem solved". This is absolutely not going to happen. We must remember that economically important quantitative traits are controlled by many genes, i.e. they are polygenic. While it is also likely true that there are some of those genes that play a bigger role than others, there still are many genes in the picture. Put simply, to put a measure of performance in front of the word gene and then say that is all we need is much too simplistic.

While marker-assisted selection is a popular new phrase in academic animal breeding circles, what we are more likely to see needed is what could be called **"marker-assisted <u>optimum</u> selection".** What this means is that markers identifying QTL of large effect can be used to add to EPD for the same trait. This will result in optimal use of information from both the molecular and phenotypic performance levels. In other words, marker-assisted selection or EPD singularly are not great, but together they markedly increase the accuracy of genetic evaluation. It is important for the breeder to put these last two paragraphs firmly into perspective.

How Does One Practice Balanced Trait Selection With So Many Important Traits?

One of the areas being currently debated by some of the thought leaders in the academic beef cattle breeding community would really help producers in this regard.

The ideas being batted around relate to how to best combine information on several traits into "selection indexes" for specified breeding objectives. These ideas have been around a long time (since Jay Lush and Lanoy Hazel at Iowa State first proposed them in 1943), but have really become applicable and important as we have developed genetic information on more and more traits in the past ten years. For example, suppose one is looking for a maternal-line bull to produce females for a given production and marketing environment, then these indexes of traits weighted according to their relative amounts of heritable variation, relationships with other traits, and relative economic importance could be very valuable tools.

The dairy and swine industries have already produced indexes for use in their national genetic evaluation programs and the beef industry will hopefully see rapid development of the same in the next few years. In our case, however, the indexes will need to be somewhat "customized" for a given type of production scenario, similar to the discussion earlier in this paper about the importance of defining and sticking to a particular market target for a producer before deciding what to do genetically. Fortunately, we are seeing tools developed to help in this area such as the recently released Decision Evaluator for the Cattle Industry (DECI) model developed by USDA scientists at the U.S. Meat Animal Research Center (Bourdon, 1998; Jenkins and Williams, 1999). This simulation model is an attempt to provide a tool that will allow a producer to provide a base-line picture of his/her production system so that lots of "what if" questions can be asked. This is a critical area where a great deal of research and development is needed.

Implications

The following are unavoidable conclusions from experiences over the past 30 years:

1) Beef is losing market share relative to poultry and pork.

2) A large portion of the reason for lost market share is due to higher costs of production. Reproductive efficiency and other aspects of maternal performance in the environment cannot be sacrificed.

3) We can genetically alter cattle for end-product performance.

4) The most feasible way to approach the end-product non-conformance problem genetically is to use properly designed and implemented crossing systems which match maternal production to environmental feed resources with sire selection based on growth and carcass performance.

5) The benefits of heterosis on overall performance of a cow herd (upwards of 25% improvement in weight of calf weaned per cow exposed) cannot be ignored.

6) Proper terminal sire selection for growth and carcass performance is unachievable in the absence of end-product EPD and proper maternal sire selection for reproductive and maternal performance is unachievable in the absence of appropriate EPD.

7) Single-trait selection has never been and will never be a wise breeding philosophy.

Given these conclusions, we have several possible approaches to be successful in **achieving both cow adaptability and carcass acceptability** . Each of these has merit, and therefore, should be attempted. In priority order, they are:

1) Immediately demand that end-product performance data be gathered and utilized in national cattle evaluation programs. This must be done by amassing the necessary progeny data (either carcass or ultrasound) for lean yield and objectively measured meat quality attributes. Additionally, we must implement whole-herd reporting formats for breed performance data collection to enable calculation of EPD for fertility and longevity-related traits.

2) Educational plans should be developed, by geo-climatic region, for matching of breed resources to environments.

3) Breeders must more willingly evaluate the alternative of using "composite" breeding programs where they are applicable. Breeds need to be working today to determine where their germ plasm fits into the composite puzzle which is inevitably going to become a reality.

4) We must develop a high-integrity system of identification on **every** animal produced in the beef production system. We must then be willing to use this system to provide information feedback and true value discovery / pricing.

5) We must use all available resources to identify new DNA-based technologies to assist in making genetic improvement in problematic traits (e.g. Maintenance energy cost, disease resistance).

6) Seedstock suppliers must adopt the philosophy of being a FULL SERVICE GENETIC PROVIDER to their clientele.

Several of these items are much more politically difficult to achieve than others which are physically more challenging. The political may, or may not, ever happen. This entirely depends on whether groups and people within the industry are committed to the good of the whole industry or the good of their portion of the industry. The physical challenges, however, are ones over which breeders and scientists have direct control. We can make those happen with the right resources directed in the right directions (eg. carcass EPD, individual animal ID and feedback, and whole-herd reporting). What happens if every commercial bull-buyer starts demanding reproductive / fertility and end-product EPD specifications before he/she will buy a bull? What happens if a feedlotter requires an electronic ID (or better yet a DNA bar code) on every incoming feeder or yearling before they will purchase and/or feed them? What happens if, on the basis of that identification, the industry provides direct pricing (with information feedback) on every animal? What happens if seedstock suppliers develop systems to analyze the needs of their customers followed by production of specification seedstock rather than producing first and then trying to find customers? What happens if animal breeding scientists take a more active role in education and technology adoption? The beef industry would universally benefit in the long term.

Literature Cited

Allen, D. L., L. Corah, and H. Gardiner. 1987. Evaluating Genetic Influences on Carcass Traits. Proceedings of Annual Mtg. of Beef Improvement Federation, Wichita, KS, pp 55-63.

American Angus Association. 1998. Spring Sire Evaluation Report, April 1998.

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 the pig. Science 263:1771.

Bourdon, R. M. 1994. Breed roles in hitting a new target. Proceedings of Annual Mtg. of Beef Improvement Federation, Des Moines, IA, pp 115-122.

Bourdon, R. M. 1998. Shortcomings of current genetic evaluation systems. J. Anim. Sci. 76:2308.

Bourdon, R. M. 1988. Bovine nirvana-from the perspective of a modeler and purebred breeder. J. Anim. Sci. 66:1892.

Brethour J. 1998. Ultrasound backfat and marbling projections using serial ultrasound measures to generate models of marbling and backfat thickness changes in feedlot cattle. J. Anim. Sci. (in review).

Cockett, N. E., S. P. Jackson, T. L. 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. National Academy of Science 91:3019.

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

Cundiff, L. V. and K. E. Gregory. 1999. What is systematic crossbreeding? Proceedings of Cattlemens College, National Cattlemens Beef Association, Charlotte, NC. February 1999.

Cundiff, L. V., K. E. Gregory, and R. M. Koch. 1994. Breeding cattle for improved product consistency. In: Proceedings of National Cattlemen's Association Cattlemen's College., Reno, NV, January 1994.

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.

Dickerson, G. E. 1970. Efficiency of animal production – molding the biological components. J. Anim. Sci. 30:849.

Diles J. J. B., R. D. Green, H. H. Shepard, L. J. Hughes, and G. L. Mathiews. 1996a. Variation within and between groups of genetically identical nuclear transfer Brangus bulls and steers for growth measures over time. Prof. Anim. Scientist 12:250.

Diles, J. J. B., R. D. Green, H. H. Shepard, L. J. Hughes, G. L. Mathiews, and M. F. Miller. 1996b. Relationships between body measurements obtained on yearling Brangus bulls and measures of carcass merit obtained from their steer, clone-mates. Prof. Anim. Scientist 12:244.

Doyle, S. P., R. D. Green, B. L. Golden, G. L. Mathiews, C. R. Comstock, and D. G. LeFever. 1996. Genetic parameter estimates for heifer pregnancy and subsequent rebreeding rate in Angus cattle. J. Anim. Sci. 74 (Suppl. 1):117.

Evans, J. L., B. L. Golden, C. R. Comstock, K. L. Long, R. M. Bourdon, C. H. Mallinckrodt, and R. D. Green. 1996. Genetic parameter estimates for heifer pregnancy rate in Hereford cattle. J. Anim. Sci. 74 (Suppl. 1) : 117.

Evans, J. L., B. L. Golden, D. R. C. Bailey, R. P. Gilbert, and R. D. Green. 1995. Genetic parameter estimates of ultrasound measures of backfat thickness, loineye muscle area, and gray shading score in Red Angus cattle. Proc. Western Sect. Amer. Soc. Anim. Sci. 46:202.

Freking, B. A., J. W. Keele, S. D. Shackelford, T. L. Wheeler, M. Koohmaraie, M. K. Nielsen, and K. A. Leymaster. 1999. Evaluation of the ovine callipyge locus: III. Genotypic effects on meat quality. J. Anim. Sci. (in press).

Georges, M., L. Grobet, D. Poncelet, L. J. Royo, D. Pirottin, and B. Brouwers. 1998. Positional candidate cloning of the bovine mh locus identifies an allelic series of mutations disrupting the myostatin function and causing double-muscling in cattle. Proceedings of 6th World Congr. Applied to Livestock Prodn. 26:195.

Golden, B. L., W. M. Snelling, J. L. Evans, and C. R. Comstock. 1996. Reproduction: The Next Era of Evaluation. Proceedings of Annual Mtg. of Beef Improvement Federation, Birmingham, AL, pp 48-56.

Green, R. D. 1999. DNA + EPDs = Marker-Assisted Optimum Selection. Proceedings of Cattlemens College, National Cattlemens Beef Association, Charlotte, NC. February 1999.

Green, R. D. 1999. Breeding to satisfy customer requirements in the 21st century. Proceedings of Association for the Advancement of Animal Breeding and Genetics, Mandurah, Western Australia. 13:17.

Green, R. D. 1999. Utilising new genetic improvement technologies to improve beef profitability and palatability. Proceedings of Association for the Advancement of Animal Breeding and Genetics. 13 (Suppl. 1):40.

Green, R. D., M. E. Dikeman, J. Pollak, S. Koontz, J. F. Taylor, S. K. Davis, and J. O. Reagan. 1998. Overview of the National Tenderness EPD and DNA Marker Validation Project. Proceedings of Ann. Mtg. of Beef Improvement Federation, Calgary, ALB., July 1998.

Green, R. D., N. E. Cockett, J. D. Tatum, D. M. Wulf, D. L. Hancock, and G. C. Smith. 1996a. Association of a TaqI calpastatin polymorphism with postmortem measures of beef tenderness in Charolais- and Limousin-sired steers and heifers. J. Anim. Sci. 74 (Suppl. 1):113.

Green, R. D., N. E. Cockett, J. D. Tatum, S. F. O'Connor, D. L. Hancock, and G. C. Smith. 1996b. Association of a TaqI calpastatin polymorphism with postmortem measures of beef tenderness in Bos taurus and Bos taurus-Bos indicus steers and heifers. J. Anim. Sci. 74 (Suppl. 1):111.

Green, R. D. 1995. Why do carcass EPD not already exist? Proceedings of 5th Beef Improvement Federation Genetic Prediction Workshop, Kansas City, MO, December 1995. pp 69-75.

Green, R. D., N. E. Cockett, M. F. Miller, D. L. Hancock, C. Bidwell, L. S. Barrett, J. B. Morgan, and J. D. Tatum. 1994. Characterization of TaqI polymorphisms in the bovine calpastatin gene. Proceedings 5th World Congress on Genetics as Applied to Livestock Production 19:450.

Gregory, K. E., L. V. Cundiff, and R. M. Koch. 1995. Genotypic and phenotypic (co)variances for growth and carcass traits of purebred and composite populations of beef cattle. J. Anim. Sci. 73:1920.

Haley, C. S. and P. M. Visscher. 1998. Strategies to utilize marker-quantitative trait loci associations. J. Dairy Sci. 81:85.

Hamlin, K. E., R. D. Green, L. V. Cundiff, T. L. Wheeler, and M. E. Dikeman. 1995. 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. 73:1725.

Hassen, A., D. E. Wilson, and G. H. Rouse. 1999. Evaluation of carcass, live, and real-time ultrasound measures in feedlot cattle. I. Assessment of sex and breed effects. J. Anim. Sci. 77:273.

Hohenboken, W. D. 1988. Bovine nirvana-from the perspective of an experimentalist. J. Anim. Sci. 66:1885.

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.

Jenkins, T. G., and C. B. Williams. 1999. An overview of the Decision Evaluator for the Cattle Industry model. Proceedings of Cattlemens College, National Cattlemens Beef Association, Charlotte, NC. February 1999.

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.

Kappes, S. M., J. W. Keele, R. T. Stone, R. McGraw, T. S. Sonstegard, T. P. L. Smith, N. Lopez-Corrales. 1997. A second generation linkage map of the bovine genome. Genome Res. 7:235.

Keele, J. W., S. D. Shackelford, S. M. Kappes, M. Koohmaraie, and R. T. Stone. 1999. A region on bovine chromosome 15 influences beef longissimus tenderness in steers. J. Anim. Sci. 77:1364.

Koohmaraie, M., J. Killefer, M. D. Bishop, S. D. Shackelford, T. L. Wheeler, and J. R. Arbona. 1995. Calpastatin based methods for predicting meat tenderness. In: A. Ouli, D. Demeyer, and F. Smulders (Ed.). "Expression, Regulation and Role of Proteinases in Muscle Development and Meat Quality". pp 395-412. ECCEAMST (European Consortium for Continuing Education in Advanced Meat Science and Technology), Utrecht, The Netherlands.

Koots, K. P., J. P. Gibson, C. Smith, and J. W. Wilton. 1994a. Analyses of published genetic parameter estimates for beef production traits. 1. Heritability. Anim. Breeding Abstr. 62:309.

Koots, K. P., J. P. Gibson, C. Smith, and J. W. Wilton. 1994b. Analyses of published genetic parameter estimates for beef production traits. 2. Phenotypic and genetic correlations. Anim. Breeding Abstr. 62:825.

Kress, D. D. 1994. Crossbreeding with a New Target. Proceedings of Annual Mtg. of Beef Improvement Federation, Des Moines, IA, pp 83-92.

Kriese, L. A. 1996. Ultrasound: Past pitfalls and present promise? Proceedings of Annual Mtg. of Beef Improvement Federation, Birmingham, AL, pp 73-87.

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

Lonergan, S. M., C. W. Ernst, M. D. Bishop, C. R. Calkins, and M. Koohmaraie. 1995. Relationship of restriction fragment length polymorphisms (RFLP) at the bovine calpastatin locus to calpastatin activity and meat tenderness. J. Anim. Sci. 73:3608.

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.

Marshall, D. 1994. Breed differences and genetic parameters for body composition traits in beef cattle. J. Anim. Sci. 72:2745.

Marston, T. T., J. P. Gleghorn, and L. E. Wankel. 1999. The impact of selecting for marbling on beef cow herds. Certified Angus Beef, American Angus Association, St. Joseph, MO.

Melton, B. E. 1995. Conception to consumption: The economics of genetic improvement. Proceedings of Annual Mtg. Beef Improvement Federation, Sheridan, WY. pp 40-87.

Melton, B. E., E. O. Heady, and R. L. Willham. 1979. Estimation of economic values for selection indices. An. Prod. 28:279.

Moody, D. E., D. Pomp, and M. K. Nielsen. 1998. Isolation of quantitative trait loci (QTL) controlling energy balance in mice. Proc. of 6th World Congr. on Genetics Applied to Livestock Prodn. 26:300.

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.

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

O'Connor, S. F., J. D. Tatum, R. D. Green, D. M. Wulf, and G. C. Smith. 1997. Genetic influences on beef palatability in Bos indicus composite and Bos taurus cattle. J. Anim. Sci. 75:1822.

Polinghorne, R. 1999. Cuts based marketing and Meat Standards Australia. Proceedings, Australian Beef Improvement Association Bi-Annual Conference, Armidale, AU, pp 23-24.

Pollak, E. J. and R. L. Quaas. 1998. Multi-breed genetic evaluations of cattle. Proc. of 6th World Congr. on Genet. Applied to Livestock Production. 23:81.

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.

Rothschild, M. F. 1998. Identification of quantitative trait loci and interesting candidate genes in the pig: Progress and prospects. Proceedings of 6th World Congr. on Genetics Applied to Livestock Prodn. 26:403.

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.

Schiefelbein, D. 1998. Back to the Basics – A Real World Strategy for Improving the Quality and Consistency of Beef. Proceedings of the Annual Mtg. of Beef Improvement Federation, Calgary, AB, pp 74-89.

Shepard, H. H., R. D. Green, B. L. Golden, K. E. Hamlin, T. L. Perkins, and J. B. Diles. 1996. Genetic parameter estimates for live animal ultrasonic measures of carcass merit in Angus cattle. J. Anim. Sci. 74:761.

Sherbeck, J. A., J. D. Tatum, T. G. Field, J. B. Morgan, and G. C. Smith. 1995a. Feedlot performance and palatability traits of Hereford and Hereford X Brahman steers. J. Anim. Sci. 73:3613.

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.

Snelling, W. M., B. L. Golden, and R. M. Bourdon, 1995. Within-herd genetic analyses of stayability of beef females. J. Anim. Sci. 73:993.

Steinkamp, K. 1995. Validation of real-time ultrasound measurements in live Angus cattle to predict body composition. Proceedings of Annual Mtg. of Beef Improvement Federation, Sheridan, WY. pp 263-265.

Stone, R. T., J. W. Keele, S. D. Shackelford, S. M. Kappes, and M. Koohmaraie. 1999. A primary screen of the bovine genome for quantitative trait loci affecting carcass and growth traits. J. Anim. Sci. 77:1379.

Tatum, J. D. 1999. New approaches for improvement in beef tenderness, quality, and consistency. J. Anim. Sci. (in press).

Tatum, J. D., M. H. George, K. E. Belk, and G. C. Smith. 1997. Final Report: Development of a Palatability Assurance "Critical Control Points" (PACCP) Model to Reduce the Incidence of Beef Palatability Problems. NCBA, March 1997.

Taylor, J. F. And S. K. Davis. 1997. Beef Cattle Genomics: Past, Present, and Future. Conference Proceeedings, Texas A&M University, October 15-17, 1997.

Taylor, J. L., S. K. Davis, J. O. Sanders, J. W. Turner, J. W. Savell, R. K. Miller, S. B. Smith, N. E. Cockett, A. Eggen, M. D. Bishop, and S. M. Kappes. The Angleton project: 1996 update. 1996. Proceedings of the Annual Mtg. of the U. S. Beef Improvement Federation, Birmingham, Alabama, pp 28-37.

Taylor, R. E. And T. G. Field. 1999. Beef production and Management Decisions. 3rd Ed. Prentice Hall, Upper Saddle River, NJ.

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. 1995. Carcass and live animal evaluation. Proceeding of 5th BIF Genetic Prediction Workshop, Kansas City, MO, December 1995. pp 25-34.

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

Wulf, D. M., J. D. Tatum, R. D. Green, J. B. Morgan, B. L. Golden, and G. C. Smith. 1996. Genetic influences on beef palatability in Charolais- and Limousin-sired steers and heifers. J.Anim. Sci. 74:2394.

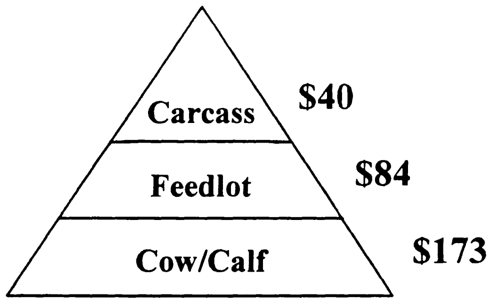


Figure 1. Relative Importance of Trait Categories (Schiefelbein, 1998)

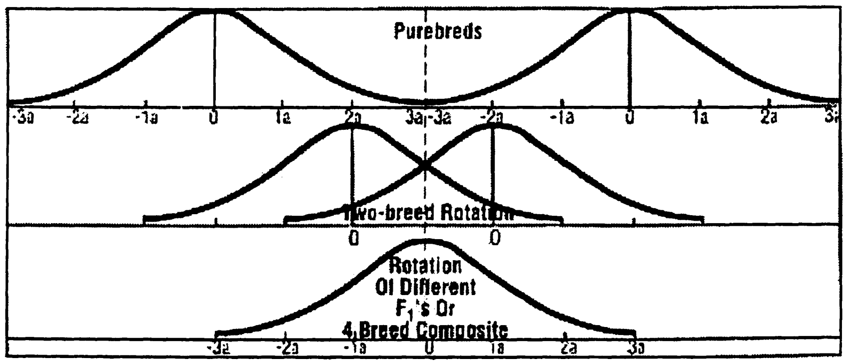


Figure 2. Variation Resulting From Various Mating Systems (Cundiff and Gregory. 1994)

Table 1. Production and Marketing Specifications for Beef Cattle

Trait	Optimum Range[a]	Industry Target[b]
Age at Puberty (mos)	12-16	14
Scrotal Circumference (cm)	32-40	36
Weight at Puberty (kg)		
Heifers	270-360	320
Bulls	400-500	450
Age at First Calving (mos)	23-25	24
Birth Weight		
Calves from Cows (kg)	35-45	39
Calves from Heifers (kg)	27-36	32
Body Condition Score (BCS, 1-9)	4-6	5
Postpartum Interval (d)	55-95	75
Calving Interval (d)	365-390	365
Calf Crop Weaned (% cowsexposed)	80-95	85
Cow Longevity (yr of age)	9-15	12
Mature Cow Weight (kg at BCS 5)	400-600	500
Weaning Wt (kg; steer @ 7 mos)	200-275	240
Yearling Wt (kg; steer @ 365 d)		
Grazed and / or backgrounded	275-365	320
Weaning to Feedlot	400-500	450
Feedlot Gain (kg / d)	1.1-1.6	1.4
Feedlot Feed Efficiency (steer)	5-7[c]	6[c]
Days on feed (high energy ration)	60-120	90
Carcass Weight (kg)	275-365	320
Quality Grade	Select$^+$ to Choice$^+$	Choice$^-$
USDA Yield Grade	1.5-3.5	2.5
Fat Thickness (mm)	2.5-15.2	7.5
Ribeye Area (cm^2)	71-97	84
Palatability (% fat in retail cuts)	3-7	5
Warner-Bratzler Shear Force (kg)	Below 3.65	Below 3.65
Frame Score		
Cows	4-6	5
Bulls – Maternal	4-6	5
Terminal	5-7	6

(Adapted from Taylor and Field, 1999).

[a]Range will include most commercial beef operations where an optimum combination of productivity and profitability is desired.

[b]Target gives central focus applicable to many commercial beef operations. Deviation from this target and optimum range is dependent on market, economic, and environmental conditions in specific commercial beef operations.

[c]High-energy ration, kg feed per kg gain.

Table 2. Levels of Heritability (h^2) of Beef Cattle Performance Traits

Trait	Number of Studies[a]	Weighted Mean h^2 [b]
Age at First Calving (Direct)	7	6
Age at First Calving (Maternal)	1	19
Calving Date	7	8
Calving Interval (Cows)	3	1
Calving Interval (Heifers)	7	6
Calving Ease (Direct)	19	10
Calving Ease (Maternal)	11	9
Calving Rate	9	17
Scrotal Circumference	25	48
Heifer Conception Rate (Direct)	9	5
Heifer Conception Rate (Maternal)	1	2
Cow Conception Rate (Direct)	21	17
Cow Conception Rate (Maternal)	1	2
Birth Weight (Direct)	167	31
Birth Weight (Maternal)	34	14
Weaning Weight (Direct)	234	24
Weaning Weight (Maternal)	38	13
Yearling Weight (Direct)	147	33
Yearling Weight (Maternal)	6	6
Mature Cow Weight	24	50
Feed Efficiency	25	32
Feed Intake	21	34
Backfat Thickness	26	44
Ribeye Area	16	42
Carcass Weight	19	23
Dressing Percentage	13	39
Cutability	12	47
Lean:Bone Ratio	4	63
Marbling Score[c]	12	38
Warner-Bratzler Shear Force	12	29
Sensory Panel Tenderness	3	13
Yearling Frame Score	27	61

(Adapted from Koots et al., 1994a and Green, 1999).
[a]Number of research studies represented.
[b]Average heritability of trait, weighted by number of observations in studies. Expressed as a percentage.
[c]Recent review of Marston et al. (1999) reported average of 43% heritability for marbling.
[d]All traits are expressed on an age constant basis where applicable.

Table 3.
Relativity of Variation Within and Between Breeds for Various Performance Criteria

Trait	No. of Additive Genetic Standard Deviations
Age at Puberty (d)	8.5
Slaughter Weight (450 d)	8.0
Retail Product Weight (450 d)	8.2
Retail Product % (450 d)	6.6
Marbling Score (450 d)	6.1
Warner-Bratzler Shear Force (kg)	5.1

Adapted from Cundiff and Gregory (1999).
[a]Assumption is made here that within a breed approximately six genetic standard deviations of variation exist in any trait.

Table 4. Weighted Mean Literature Estimates of Genetic Correlations Between Various Performance Traits[a]

Traits[b]	Phenotypic Correlation	Genetic Correlation
Calving Ease / Birth Weight	-0.28	-0.74
Birth Wt / Feed Efficiency	-0.12	-0.46
Yearling Wt / Feed Efficiency	-0.46	-0.60
Feed Intake / Feed Efficiency	---	0.71
Wean Maternal / Feed Intake	---	0.80
Scrotal Circumference / Feed Efficiency	0.12	0.61
Birth Wt / Weaning Wt	0.46	0.50
Birth Wt / Yearling Wt	0.38	0.55
Weaning Wt / Yearling Wt	0.71	0.81
Weaning Wt / Mature Wt	0.45	0.57
Weaning Wt / Slaughter Wt	0.65	0.79
Yearling Wt / Slaughter Wt	0.65	0.56
Yearling Wt / Scrotal Circumference	0.36	0.39
Backfat / Feed Intake	0.29	0.44
Backfat / Scrotal Circumference	0.27	0.78
Carcass Wt / Birth Wt	0.41	0.60
Carcass Wt / Yearling Wt	0.85	0.91
Cutability / Yearling Wt	0.85	0.87
Marbling / Yearling Wt	0.14	-0.33
Marbling / Feed Intake	0.24	0.90
Marbling / Cutability	-0.25	-0.35
Ribeye Area / Weaning Wt	0.23	0.49
Ribeye Area / Yearling Wt	0.35	0.51
Ribeye Area / Slaughter Weight	0.33	0.43
Ribeye Area / Cutability	0.33	0.45
Ribeye Area / Marbling	0.06	-0.21
Tenderness / Marbling	????	????
Tenderness / Cutability	????	????

[a]Estimates shown are taken from Koots et al. (1994b) and represent the weighted mean of available literature estimates.
[b]Traits represented are expressed on an age constant basis where appropriate and represent direct genetic effects.

Table 5. Genetic Correlations Between Measures of Carcass Merit and Reproductive Efficiency (MacNeil et al., 1984)

Female Trait	Postweaning Gain (kg)	Carcass Weight (kg)	Fat Trim (kg)	Retail Product (kg)
Age at Puberty (d)	.16	.17	-.29	.30
Wt at Puberty (kg)	.07	.07	-.31	.08
Serv./conception	1.33	.61	.21	.28
Gest. Length (d)	-.10	.03	-.07	.13
Calving Difficulty	-.60	-.31	-.31	-.02
Birth Weight (kg)	.34	.37	-.07	.30
Mature Weight (kg)	.07	.21	-.09	.25

Table 6. Heterosis Effects in Crosses of Bos Taurus x Bos Taurus Breeds and in Crosses of Bos Indicus x Bos Taurus Breeds From Diallel Crossing Experiments[a]

	Bos taurus x Bos taurus			Bos indicus x Bos taurus		
	N	Units	%	N	Units	%
Trait	**Crossbred calves (individual heterosis)**					
Calving rate, %	11	3.2	4.4			
Survival to weaning, %	16	1.4	1.9			
Birth weight, kg	16	0.8	2.4	4	3.3	11.1
Weaning weight, kg	16	7.4	3.9	10	21.7	12.6
Postweaning ADG, kg/d	19	.034	2.6	6	.116	16.2
Yearling weight, kg	27	13.2	3.8			
Cutability, %	24	-.3	-.6			
Quality grade, 1/3 grade	24	.12	---	6	.3	---
	Crossbred cows (maternal heterosis)					
Calving rate, %	13	3.5	3.7	7	9.9	13.4
Survival to weaning	13	.8	1.5	7	4.7	5.1
Birth weight, kg	13	0.7	1.8	6	1.9	5.8
Weaning weight, kg	13	8.2	3.9	12	31.1	16.0
Longevity, yrs	3	1.36	16.2			
Lifetime production						
No. Calves	3	.97	17.0			
Cumulative weaning wt	3	272	25.3			

[a]Estimates are from experiments contributing to North Central Regional Project NC-1 (Iowa, Indiana, Missouri, Ohio, USDA-ARS and Nebraska), Southern Regional Project S-10 (Virginia, Florida, Louisiana, Texas, USDA-ARS and Louisiana, USDA-ARS and Florida) as reported by Cundiff and Gregory (1999).

Table 7. Genetic Standard Deviations (sg) and Phenotypic Coefficients of Variation (CV) for Purebreds and Composites (Castrate Males)

	Purebreds		Composites	
Trait	s_g	I. CV	s_g	CV
200-d weight, kg	13.3	.10	14.2	.11
Slaughter weight, kg	21.7	.08	28.7	.08
Carcass weight, kg	12.4	.08	17.9	.09
12^{th} rib fat, mm	1.3	.48	2.0	.44
Retail product, %	2.2	.04	2.3	.06
Carcass lean weight, kg	8.1	.08	10.7	.09
Carcass fat weight, kg	8.6	.18	6.3	.19
Carcass bone weight, kg	2.8	.08	2.1	.10
Longissimus muscle fat, %	.6	.27	1.0	.29
Shear force, kg	.18	.22	0.59	.21

(Cundiff and Gregory, 1999 and Gregory et al., 1995)

Table 8. Current U.S. National Cattle Evaluation Programs -- Carcass Merit (as of 1 Jan 99)

Breed	Total Sires	Total Published Sires	Sires with Carcass Data	Sires with Carcass EDP	Traits Evaluated	
Angus	95,995	5,527	1,944	2,772	1,2,3,4,5	Yes
Beefmaster	10,756	401	180	Not Released	2,3,4	Yes
Brangus	8,999	982	150	Not Released	2,3,4	Yes
Charolais	21,453	1,650	27	0	2,3,4,5	Yes
Gelbvieh	5,173	1,800	363	219	1,2,3,4	Evaluating
Hereford	94,221	4,261	4,986	1,010	2,3,4	Yes
Maine-Anjou	1,240	348	55	0	1,2,3,4	Evaluating
Red Angus	16,910	1,145	829	293	2,3,4	No
Salers	10,827	657	N/a	85	1,2,3,4	No
Shorthorn	11,788	862	565	115	1,2,3,4	No
Simmental	80,804	2,804		372	1,4,5	Yes

[a]Traits: 1=Carcass Weight, 2=Ribeye Area, 3=Fat Thickness, 4=Marbling, 5=% Retail Cuts.

Table 9. Distribution of Progeny Across Breeds in the National Carcass Genetic Merit Project (Green et al., 1998)

Breed	# DNA Sires @ 50 hd each	# Addl. EPD Sires @ 25 hd each	Total # Sires
Beefmaster	10	5	15
Brahman	10	5	15
Brangus	10	0	10
Braunvieh	10	0	10
Charolais	10	9	19
Gelbvieh	10	7	17
Hereford	10	23	33
Limousin	10	15	25
Maine-Anjou	10	5	15
Red Angus	10	10	20
Salers	10	0	10
Shorthorn	10	5	15
Simmental	10	15	25
Simbrah	10	5	15
South Devon	10	0	10
	160	**124**	**284**
Total # Progeny	**8,000**	**3,100**	**11,100**

*EPD sires are to calculate EPD only (no DNA analyses will be performed).

Producer Technology Application Session

Minutes

Producer Technology Applications Committee Meeting
June 17, 1999, Roanoke, VA

The meeting was called to order by Sally Dolezal, Oklahoma State University, at 2:00 p.m., on June 17, 1999, at The Hotel Roanoke & Convention Center, Roanoke, VA. Dolezal welcomed participants and described the format of the BIF special interest session. She encouraged all those present to be active in the discussion and to provide input for future meetings.

Dolezal served as moderator for the program outlined below:

Crossbreeding: "The Lost Art"
Managing Heterosis in Small Herds
Darrh Bullock, Extension Beef Specialist, University of Kentucky

The Replacement Heifer: Do I Raise or Buy Her? What does She Cost?
Connee Quinn, Quinn Cow Company, Chadron, NE

Producers Leading the Way: A Horizontal Alliance
Buckingham County Cattlemen's Association representatives Mike Barton, Tom Hill, Clyde Brown, and Jim Myers, Extension Agent, Animal Science, Virginia Cooperative Extension

Each speaker presentation was followed by a discussion session. Proceedings papers were submitted by Darrh Bullock and the Buckingham group. After a question and answer period, Dolezal adjourned the committee meeting at 5:00 p.m.

Respectfully submitted,

Sally L. Dolezal, Chair

CROSSBREEDING: THE LOST ART? MANAGING HETEROSIS IN SMALL HERDS

Darrh Bullock, University of Kentucky

The major thrust of many in the beef industry in recent years has been to improve the quality of the end product. This should be the overall objective of the beef industry, but for most commercial producers this probably should not be their primary goal. Producers that are implementing breeding plans that will allow them to capture some rewards for improved carcass characteristics may be hurting their overall bottom line. There are many breeding practices that may fit under this scenario, but this paper will focus on an industry trend toward straightbred cattle.

Breed popularity tends to be a cyclical event with breeds coming into and falling out of favor with commercial producers. We are currently seeing great popularity in the Angus breed because of many beneficial traits possessed by Angus cattle, including carcass quality. Angus cattle have a lot to offer our industry, but over emphasizing one breed in an individual's breeding program can lead to reduced heterosis, which results in diminished production. Using the same breed of herd bull year after year in a system that keeps replacement heifers, results in straightbred females in a relatively short period of time.

Crossbreeding is certainly not a new concept and there have not been many new developments in recent years on improved techniques. However, it may be time to review why we crossbreed and discuss systems that can work in small herds.

Much of the information presented in this paper is from Crossbreeding Beef Cattle for Western Range Environments 1988, University of Nevada-Reno and USDA (TB-88-1).

Why Crossbreed? To take advantage of heterosis and breed complementarity.

Heterosis (hybrid vigor). Heterosis, which is the average advantage of crossbred calves over the average of the breeds contributing to the cross, is realized when a bull of one breed is bred to cows of another breed or breed crosses. . There are two types of heterosis, individual and maternal. Individual heterosis is the increased performance a crossbred calf exhibits, such as growth to weaning or yearling weight. Maternal heterosis is expressed in a crossbred female's progeny, such as the increased weaning weight of crossbred females' calves due to increased milk production of their crossbred dams. We realize heterosis for most beef production traits, but the affect tends to be highest for reproduction traits, lowest for carcass traits and the growth traits tend to be intermediate. Overall production is greatly affected by heterosis. Calf weaning weight per cow exposed is a trait that includes the herd's reproductive performance, calf survival, milk production and weaning growth. When a complete crossbreeding program is implemented we see an increase in production of approximately 18% over straightbred cattle. Cow longevity, which indicates how long a cow stays productive in the herd, has a heterosis measurement of 38%. Thus, it is easy to see that moving towards a straightbred herd and giving up some of these economically important benefits of crossbreeding will be detrimental to a producer's bottom line.

Breed Complementarity. Breed complementarity is the matching of breeds based on their advantages and weaknesses for specific production environments and marketing strategies. Breed complementarity has been used extensively in the swine industry with the white breeds being used for maternal purposes and the colored breeds being crossed on those breeds to increase growth and carcass characteristics. The beef industry has breeds that fit into certain environments, also. Table 1, which categorizes breeds into different production types, is based on work conducted at the Meat Animal Research Center. This information can help producers choose the breeds that best fit their production system. If feed resources are often limited, then moderate sized, moderate milk producing breeds should be considered for the base cow herd and, depending on the crossbreeding system utilized, a high growth, lean breed of bull can be used to produce feeder calves. If feed resources are consistently abundant, larger, higher production breeds may be considered as maternal breeds. It is important to remember that these are general characterizations and individuals within any breed can be found to serve most purposes.

Crossbreeding Systems

Two Breed Rotation. Simple system of choosing two breeds and always breeding cows to the breed of bull that she has the lowest percentage of. This requires a minimum of two breeding pastures and adequate records to know which breed of bull a cow should be mated. This system realizes about 67% of maximum heterosis. The sire breeds chosen should be of the same biological type, which reduces the ability to use complementarity.

Three Breed Rotation. Same as above, but three breeds are utilized. This system is more complicated to keep up with which breed of bull a cow should be bred to and requires a minimum of three breeding pastures. There is an increase in realized heterosis to 86%. The sire breeds chosen should be of the same biological type, which reduces the ability to use complementarity. This system is not practical for most beef producers.

Rotate Sire Breed. This is a very simple system that requires only one breeding pasture. With this system, you can choose certain breeds or change bull breed when you like. In this system change the breed of bull every 4 years and change the bull within breed every two years. Unless you change bull breed each time, you will not maximize heterosis, but even with a two breed sire rotation you can have good results. Once again, breed complementarity is fully utilized. If you have a one bull herd then it is critical to change the bull every two years to avoid inbreeding. This system lends nicely to bull leasing programs or two cooperating producers swapping bulls after the two year period. These practices will increase the useful production life of the bull.

Terminal Cross. This system is also very simple with all females being purchased, bred to high growth, lean bulls and all calves sold. The previous rotation systems have not benefited from breed complementarity, but this system maximizes both heterosis and breed complementarity. The purchased females should be of the type to fit your production environment, which tends to be the limiting factor in this system because those females are often unavailable for purchase.

Rotaterminal Cross. This is a combination of rotating breed of sire, to generate replacement females, and the terminal cross systems. This system is slightly complicated and requires at least two breeding pastures, but can be very productive. With this system you must determine what your replacement rate will be and breed all first calf heifers and enough of the youngest cows to an easy calving, maternal bull to generate replacement females. All older cows would then be bred to a high growth, lean bull and all calves from this mating are to be sold.

Composites. Composites are a means of combining several breeds into a line and then maintaining that line by interbreeding within. The concept is that you retain half of the maximum heterosis, based on the percentage of each breed in the cross. In this system a composite breeder typically supplies you with your replacement animals, males and females. Replacement heifers can be generated, but it is critical to avoid inbreeding. When choosing a composite it is imperative that the breeder started from a very large base to develop the line or inbreeding can be a problem. It is also extremely important that the composite breeder's goals match your goals because the majority of selection decisions are made by the breeder.

What can be done to improve crossbreeding in small herds?

Artificial Insemination. Artificial insemination has been available, but minimally utilized in the beef industry for years. With new advances in estrous synchronization, it is becoming more practical for small producers to take advantage of this practice. Few producers have the time or labor resources to observe heat and breed cows over the course of the breeding season, but synchronizing cows and heifers then breeding them all on a timed basis results in an AI rate of approximately 50%. With this knowledge a producer can use AI within the rotaterminal crossbreeding system with good results. All first calf heifers and enough young cows, realizing the reduced conception with a timed breeding system, necessary to generate replacement females would be bred AI to a maternal calving ease bull. After the one time AI mating, the cows would go in with a cleanup bull that had high growth and leanness. First calf heifers would only be exposed to the AI mating; if they do not conceive at this mating, they are culled.

Terminal Cross. This system fits very well into small herds because it requires only one pasture, heterosis is maximized and breed complementarity is utilized. As previously mentioned the limitation to this program is the availability of replacement females. Ideally, the replacements would be open, young cows that fit into your breeding season and do not require a calving ease bull. Another option is first calf heifers that have been bred to a calving ease bull and will calve to fit your calving season. When purchasing replacement females, be certain they are of the genetics you desire, are crossbred (maternal heterosis) and have received a sound health program. There are beginning to be sources for quality replacements and to optimize efficiency in our industry the need is going to become greater.

Conclusions

In order for beef producers to be competitive, they must produce beef as efficiently as possible while providing a desirable product to the consumer. Because of the relationship between heritability and heterosis, the best way to accomplish this task is to improve reproduction and production through sound crossbreeding programs and improve production and product through selection. It is important that we utilize the technologies available to accomplish these tasks. Technologies such as estrous synchronization and AI, once thought to be too expensive for commercial producers, should be given additional consideration, even in small herds. Communicate with your AI stud representative and see what programs are available. Cooperation among producers will benefit everyone. There is an opportunity for producers to specialize in certain areas, such as producing replacements, and others to utilize those heifers in a terminal cross system. Communication and cooperation are the keys to making this work.

Many beef breeds are available to produce the type of cattle that will fit our diverse environments and provide a product that consumers demand. Each of these breeds bring benefits, and often drawbacks, to the mix. It is important to keep the economically important traits in perspective and not pursue one trait at the expense of others. This is no more evident than in the current trend towards straightbreeding with the purpose of improving carcass acceptability, at the expense of reducing overall performance.

Table 1. Some Breed Crosses Grouped into Production Types

Breed group[1]	Growth rate and mature size	Lean-to-fat ratio	Age at puberty	Milk production
Jersey-X	+[2]	+	+	+++++
Hereford-Angus-X	++	++	+++	++
Red Poll-X	++	++	++	+++
South Devon-X	+++	+++	++	+++
Tarentaise-X	+++	+++	++	+++
Pinzguaer-X	+++	+++	++	+++
Sahiwal-X	++	+++	+++++	+++
Brahman-X	++++	+++	+++++	+++
Brown Swiss-X	++++	++++	++	++++
Gelbvieh-X	++++	++++	++	++++
Simmental-X	+++++	++++	+++	++++
Maine Anjou-X	+++++	++++	+++	+++
Limousin-X	+++	+++++	++++	+
Charolais-X	+++++	+++++	++++	+
Chianina-X	+++++	+++++	++++	+

[1] X = Hereford-Angus on dam side, sire breed is listed first.
[2] + = low, +++++ = high
Source: Crossbreeding Beef Cattle for Western Range Environments. 1988. University of Nevada-Reno and USDA. TB-88-1.

THE BUCKINGHAM CATTLEMEN'S ASSOCIATION PROGRAM

Jim Myers, Virginia Cooperative Extension

Farmers, including beef cattle producers are an independent bunch. It's always how I can one up my neighbor. A group of producers in Buckingham County have stopped and taken a long look at the beef industry and were they were headed and decided to work as a group rather than independently of one another. The Association has stressed that this program provides for educational programs that they can use in the day to day management of their beef herds. They have participated in a beef cattle nutrition short course), a beef reproduction short course, a herd health course, and a beef genetics course.

This Program is not a program that started yesterday. These producers have been willing to go after the best bulls they could afford for the past twenty years. They marketed through the local feeder cattle association sales, mostly the Lynchburg Growth Sale. This sale had a rigid set of health requirements. The numbers in the co-mingled sales started to decline and the prices begin to drop. Direct marketing resulted in getting paid on the average rather than getting paid for a superior calf with a known genetic package and herd health program.

The Association decided to adopt the Virginia Quality Assured Program because it closely mirrored the program they were following. It includes two components, a health and a genetic component:

The Health Component:
IBR, PI3, BRSV, BVD and 7-Way Clostridial + Somnus first vaccination given at turn out in the spring **(after calf is 4 months old or 120 days**). If a **killed vaccine** is used the second vaccination is to be given not more than 50 days and not less than 14 days prior to the sale the same vaccine(brand name) must be used for the 2nd shot . If you use a **modified live** vaccine the second vaccination is not required.
Pasteurella (must contain a leukotoxoid) may require two vaccinations depending upon what you buy. It can be purchased that will require only one. Again if you use the one shot or give the booster, it must be administered in the 50-14 day window.

The Genetic Component:
- Breed of sire identified
- Sire must meet minimum yearling weight EPD'S
    - British Breeds must be at least breed average (year born)
    - Continental sires (Charolais, Gelbvieh) must be at least 70% of the breed average

The General Requirements:
- Must be certified by a third party such as a veterinarian, extension agent or anyone who has been trained as a certifier.

- Producers must attend a Beef Quality Assurance Program
- All vaccinations given in the neck area.
- Processing map to accompany cattle.
- Minimum weight of 400 pounds.
- Heifers guaranteed open.
- A guarantee against stags.

The rewards of the marketing efforts of the Association are seen in the table below.

Buckingham VQA Feeder Cattle Sales
vs
Graded Special Sales (LMI)
$/cwt. Price Advantage

	Steers		
	1997	1998	2 yr Average
5-wt.	+$8.40	+$8.18	+$8.29
6-wt.	+$7.10	+$5.14	+$6.12
7-wt	+$5.59	+$4.56	+$5.08
	Heifers		
5-wt.	+$1.80	+$2.79	+$2.30
6-wt.	+$4.88	+$0.46	+$2.67

Genetic Improvement

It is the intention of this group to tighten the genetic pool in their calves and produce a uniform predictable product. As mentioned earlier this group has purchased the top performing bulls offered for sale. Most were purchased from the Virginia Beef Cattle Improvement Association sponsored sales. Several members of the association decided to look into artificial insemination as a way to make further improvements in the genetic packaging. The Association wrote letters to several Artificial Insemination Companies requesting bids on a turn key program to breed heifers based on 100 heifers. The bid price was to include; synchronization material and help in administrating, help in heat detection, a technician to inseminate, and semen on a proven bull with high accuracy's. The first year there were 250 heifers; last year there were 759 mostly heifers and this past January there were 880 females in the program. There are 20 producers that are using sons of the AI Sire as clean up bulls and this allows those not interested in using AI to be in the program. These sons must meet the requirements set by the group.

Competition in some areas is a good thing and to tell you that there is none within this group would be a total untruth. The fact that it remains in the group and they continue to work together is what makes this program unique. When you hear two producers discussing weaning weights and they have it down to the one thirds of a pound, it's tight.

Whole Herd Analysis Session

BIF Whole Herd Analysis Committee
Thursday June 17, 1999, 2:00 to 5:15 p.m.
Roanoke, Virginia

The meeting was called to order by Chairman John Hough of EPD International, Statham, Georgia at 2:15 p.m. A brief introduction was made as to the focus of the committee.

Tom Jenkins of the USDA-ARS Meat Animal Research Center in Clay Center, Nebraska started the committee presentations by giving an update on the D.E.C.I. Production Systems Model. A considerable amount of effort has been spent on this model with many aspects coming to fruition. Next, Bob Hough of the Red Angus Association of American, Denton, Texas gave a sub-committee report on Standardized Disposal (Activity) Codes. These proposed codes are listed in the following section. The committee recommended that these codes be presented to the BIF board for adoption and be incorporated into the next printing of the *BIF Guidelines*. Bruce Golden from Colorado State University, Ft. Collins, Colorado gave the next presentation. Bruce outlined his current research in Measuring Efficiency. Much of this work was conducted with Red Angus cattle. There is immense potential for exciting genetic evaluation for several traits if appropriate raw data can be collected. These traits will almost certainly need to be utilized in a formal multiple-trait selection system. "What Cows do Breeders Cull?" was the next topic covered by Kent Anderson, North American Limousin Foundation, Englewood, Colorado. These results were quite informative and interesting. After a short "7th inning stretch", Mike MacNeil of USDA-ARS, Fort Keogh Lab, Miles City, Montana gave a presentation on "Whole-Herd Reporting: Breeder Expectations and Obligations." Beneficial results from whole-herd reporting are quite evident, but not without effort by both breeders and breed associations. Written papers follow in these proceedings.

The final topic of the day was a panel discussion entitled "Whole-Herd Reporting: What is the Impact?" Panelists included Paul Bennett, Red House, Virginia; Bob Hough, RAAA, Denton, Texas; Frank Felton, Maryville, Missouri; Judy Frank, Sigourney, Iowa and Loren Jackson, IBBA, San Antonio, Texas. Each member made some short introductory comments pertaining to the status, acceptance and usefulness of whole-herd reporting in their breed. Much discussion prevailed pertaining to this subject. Following each presentation, further discussion pursued. After considerable interaction, the committee adjourned at 5:15 p.m.

Respectfully submitted,

John Hough, Chairman

LOOKING AT BREEDER OBLIGATIONS AND EXPECTATIONS IN PERFORMANCE TESTING

Michael D. MacNeil
Fort Keogh Livestock and Range Research Laboratory, Miles City, Montana

Introduction: Confusion as to their obligations may result in breeders not participating in national cattle evaluation. Likewise, failure of national cattle evaluation to meet their expectations may result in breeders becoming disenchanted with centralized genetic improvement programs and thus not participating in them either. With the increasing popularity of whole-herd reporting, this seems a particularly appropriate time to review breeder obligations and expectations in performance testing. Much of the commentary is futuristic reflecting a personal view of what can be rather than analyzing these systems as they exist today.

Obligations: The first obligation of a seedstock breeder is to participate in performance testing. Today, that means taking part in the breed's national cattle evaluation. There are at least three reasons why participation is important. It lowers the cost of performance testing and genetic evaluation for all breeders. By taking part in a genetic evaluation program, breeders are demonstrating both their personal concern for quality assurance and collectively the breed's progressive vision. Finally, participation in genetic evaluation is the mechanism by which breeders can provide essential information to their customers.

A substantial fraction of the total cost of genetic evaluation is fixed. Therefore, increasing the number of calves reported and number of breeders participating lowers the per unit cost of genetic evaluation for all participants. Also, maximum participation makes it most likely that procedures used in genetic evaluation systems can continue to keep pace with new scientific developments.

In marketing, *perception is reality*. Participation in programs that add value to the products being marketed reflects the breeder's concern for quality of the seedstock being produced. On a breed-wide basis, breeder participation in programs that add value to the seedstock reflect the breed's commitment to excellence. If only a small fraction of breeders participate, it creates the image that the breed as a whole is not committed to producing a quality product.

Seedstock is bought and sold for the genes that can be transmitted to subsequent progeny. All producers need to understand that genetic predictions from national cattle evaluation are a more accurate basis for selection decisions than are phenotypic records (Cunningham and Klei, 1995). Thus, participation in national cattle evaluation is the means by which seedstock breeders can most accurately describe the animals they produce to potential purchasers. Likewise, purchasers of seedstock can most readily and accurately appraise animals described by genetic predictions (i.e. EPD) with the highest possible accuracy.

All modern systems of genetic evaluation rely on identification of parentage. Thus, the second obligation of breeders participating in a genetic evaluation system is to make a diligent effort to assure accurate parentage. It has been estimated that, even with single sire mating and conscientious observation at calving time, one pedigree in twenty may be erroneous (MacNeil, 1998). The consequences of inaccurate pedigree information are reduced apparent heritability and less accurate genetic evaluation (Mallinckrodt et al., 1992).

Contemporary groups are made up of animals that have had a similar opportunity to perform. It is an obligation of the breeder to determine when this opportunity to perform is fair and equal for all members of a group. The BIF (1996) Guidelines provide insight into the process of forming contemporary groups and breeders need to understand the concept of forming contemporary groups. Then they can identify those situations when, although it may outwardly appear that all members of a group of calves are contemporaries, not all calves can be fairly compared with each other. Inaccurate specification of contemporary groups leads to losses of reliability in EPD (Mallinckrodt et al., 1992). Within the constraints imposed for making fair comparisons among all individuals, there are statistical advantages in having more than one sire and a large number of calves in each contemporary group. Breeders should consider management practices that facilitate having a few large contemporary groups rather than more smaller groups.

It would seem to go without saying that accurate measurement of phenotypes is an important responsibility of breeders who participate in performance testing programs. Reporting inaccurate phenotypes, like inaccurate pedigrees, reduces apparent heritability and results in less accurate genetic evaluation. In addition, reporting inaccurate phenotypes may complicate the genetic evaluation process by introducing heterogeneous variance conditions where they would not otherwise exist. Attempts to alter results of national cattle evaluation through manipulation of phenotypes are both unethical and if successful at all will have only transient effects. In some instances, inaccurate phenotypes may contribute to large changes of EPD in subsequent analyses. At present, most complete national cattle evaluations are done once or twice each year. Failure to report data in a timely manner results in a temporary loss of information with a resulting loss in accuracy of genetic predictions. Thus, under current conditions, it is prudent for breeders to collect and report data giving attention to deadlines associated with the most timely analysis.

The final obligation of breeders participating in performance testing and national cattle evaluation is for complete reporting of all phenotypes from all animals. Selective reporting of phenotypes may bias estimates of genetic parameters obtained from the data and result in less reliable prediction of genetic merit (Mallinckrodt et al, 1995).

Expectations: While breeders have several implied obligations associated with performance testing, they also expect to derive benefits from their participation.

Perhaps the most obvious benefits are derived from genetic evaluations for traits affecting profitability (both costs and returns). Currently, national cattle evaluation tends to focus on growth traits and place secondary emphasis to carcass traits. However, from an economic perspective reproduction is several times more important than either growth or carcass traits. Development of replacement females represents a sizeable cost for commercial producers and genetic evaluations for herd-life-span provide an opportunity to reduce those costs. Feed represents another major cost of production. Without genetic evaluation for it, breeders are afforded little opportunity to reduce cost of production or improve efficiency. Finally, each breed has the opportunity to address breed-specific genetic weaknesses through prediction of EPD for "convenience" traits.

As more and more genetic evaluations become available for economically important traits, the number of evaluations reported for indicator traits should also be reduced. For example, if a genetic evaluation for caving ease (an economically important trait) is conducted using a multiple trait model that also includes birth weight (an indicator trait) then the genetic evaluation for birth weight is of relatively little value. To make a selection decision based on calving ease, one could consider the genetic evaluations for both birth weight and calving ease. However, their joint consideration actually introduces additional error in the selection decision relative to considering only the genetic evaluation for calving ease. Other indicator traits (associated economically important trait) for which genetic evaluation may become less important include scrotal circumference (age at puberty) and mature size (cow's feed requirement).

Note was made of the need for timely reporting in discussing breeder obligations. However, timely analyses of the reported data may be equally, if not more, important. With the revolution in computing technology, it seems reasonable that a breeder would expect reporting of their genetic evaluation results shortly (two weeks) after they submit the data. If full genetic analyses were conducted weekly, breeders would always have nearly the most current and accurate results available to them.

As breeders are confronted with an increased number of genetic predictions for each animal, they should anticipate simultaneous development of tools for systematic identification of individuals with genetic potential for increasing profit in a given commercial production system. Currently, the swine industry has such tools available for general use through the selection indexes presented in their national genetic evaluation system (Stewart et al., 1990). Progressive beef cattle breeders have similarly begun to adopt this technology (e. g., MacNeil and Newman, 1994; Herring et al., 2000).

A common complaint of breeders about national cattle evaluation is that the genetic evaluations change dramatically with new analyses or additional data. Some of these problems may be created by the breeders themselves (see obligations, above) or result from substantial increases in the amount of information. However, others may result from restructuring the analyses used in predicting the EPD. Systems for reporting results of genetic evaluation that are independent of structural characteristics of the analysis merit investigation. It is also reasonable for breeders to expect timely and precise explanations for those dramatic changes that occur.

Finally breeders should expect that the organizations performing genetic evaluations will consistently use state-of-the-art technology. This represents a substantial obligation of these service entities to their customers as the evolution of statistical procedures proceeds at a rapid pace.

Summary: Costs and benefits of seedstock producer participation in national cattle evaluation are more easily assessed if their obligations are readily apparent and their expectations fulfilled. This article attempts to examine obligations from the perspective of an analytical agent and expectations for the perspective of a progressive seedstock breeder. It is apparent that a stronger partnership of breeders and analytical agents, in which each participant is fully cognizant of the others needs, can result in more rapid genetic improvement of beef cattle than has occurred to date.

Literature Cited

BIF. 1996. Guidelines for Uniform Beef Improvement Programs, 7th Edition. Curtiss Bailey, editor. Writing & Business Support. Reno, NV.

Cunningham, B. E. and L. Klei. 1995. Performance and genetic trends in purebred Simmental for regions of the United States. J. Anim. Sci. 73:2540-2547.

Herring, W. O., V. L. Pierce, M. D. MacNeil, C. J. Kaiser, and L. L. Benyshek 2000. An overview of the 1997 Angus sire alliance. Proc. Beef Improvement Federation. (this volume).

MacNeil, Michael. 1998. Benefits of multiple sire mating for purebred breeders. Western Beef Producer, October, WB48.

MacNeil, M. D. and S. Newman. 1994. Selection indices for Canadian beef production using specialized sire and dam lines. Can. J. Anim. Sci. 74:419-424.

Mallinckrodt, C. H., B. L. Golden, and R. M. Bourdon. 1995. The impact of data problems on the reliability of expected progeny differences. Proc. Western Section Amer. Soc. Anim. Sci. 43:135-138.

Mallinckrodt, C. H., B. L. Golden, and R. M. Bourdon. 1995. The effect of selective reporting on estimates of weaning weight parameters in beef cattle. J. Anim. Sci. 73: 1264-1270.

Stewart, T. S., D. H. Bache, D. L. Harris, M. E. Einstein, D. L. Lofgren, and A. P. Schinckel. 1990. A bioeconomic profit function for swine production: application to developing multitrait selection indexes. J. Anim. Breed. Genet. 107:340-350.

INTERNATIONAL BRANGUS BREEDERS ASSOCIATION WHOLE HERD REPORTING PROGRAM

Loren Jackson, International Brangus Breeders Association

The International Brangus Breeders Association initiated discussion to move to a Whole Herd Reporting program in the Fall of 1997. The vast majority of the IBBA membership embraced the WHR concept because of the opportunity to obtain future measures of fertility and stayability. However, considerable resistance was expressed in changing to an inventory based fee structure.

IBBA set out to design an affective means of developing a WHR program that would accomplish the program objectives, but maintain the existing association based fee structure. A policy was implemented by the association requiring members to report the activity or status of every female in the member's herd on a yearly basis. This is accomplished in one of two ways, by either submitting calf information or reporting a status code on the female.

The fees and procedures for submitting data, registering and transferring cattle have not changed in the Brangus WHR program.

IBBA members were sent a listing of their herd inventory in the Summer of 1998. Brangus breeders were asked to delete inactive animals and return the updated inventory to IBBA prior to processing any registration work in 1999. No registration work will be processed by IBBA until an updated herd inventory is received from the breeder. Brangus breeders may obtain a preprinted inventory registration application from IBBA upon request.

The submission of calving data or a status code is required on each female in the herd by year-end to maintain the animal on inventory. In December, a listing of females that have not had any activity reported will be sent to the member. Brangus breeders will have until February to submit calving information or an updated status code. If no information is received on the female, the animal will become inactive. Once a female is removed from the inventory, a $25 administration fee is assessed to place the animal back on the WHR inventory.

Producers purchasing registered cattle that have not previously been involved in the WHR program will be added to the buyers inventory automatically at the time of transfer. No administration fee will be assessed on these cattle.

The IBBA WHR system accomplishes the objectives of obtaining valuable herd fertility and disposal information as well as maintaining current active inventories. The program is easily implemented without changing the accounting system and fee structure and has been widely accepted by the membership with very little resentment.

Genetic Prediction Session

Genetic Prediction Committee Minutes
June 17, 1999
Roanoke, Virginia

Submitted by: Keith Bertrand, Recording Secretary

Chairman Larry Cundiff called the meeting to order at 2:30 p.m. First order of business was a panel discussion on "How Can Genetic Evaluation Be Improved?" The panelists were Paul Bennet, Keith Bertrand, Mark Gardiner and Kent Anderson. Each panelist briefly presented their opinions on the topic. After the presentations, the panel fielded from others in attendance in the Committee Session.

Dr. Hans Schild Chairman of the Beef Working Group of the International Committee (ICAR) for Animal Recording made a presentation on the objectives of ICAR and the work to date of the Beef Working Group.

Dale Van Vleck made a presentation on the updated across breed EPD adjustments to the 1997 base. Dr. Van Vleck also presented some research information on the genetic relationships between steer carcass traits and heifer productivity.

John Pollak the presented some information on the "National Cattle Evaluation Research Proposal". The proposal is to fund a virtual National Evaluation Center composed of Colorado State University, Cornell University, Iowa State University and the University of Georgia in order to consolidate efforts among the four land-grant institutions to conduct research to better meet the priorities of the beef industry in the area of beef genetic evaluation and to streamline the process between the development and adoption of new methodologies by the industry. A straw vote of the Committee resulted in a favorable endorsement of the proposal.

Chairman Cundiff adjourned the meeting a 5:00 p.m.

Improving Genetic Evaluation of Beef Cattle in North America

J. Keith Bertrand
Animal and Dairy Science Dept., University of Georgia

To be effective, a genetic evaluation program must have both sound technical and educational components. Beef genetic evaluation in North America can be improved by the development of EPDs for new economically important traits, by the development and implementation of model improvements, by providing decision-making tools and educational information to assist producers effectively use EPDs and by improving the infrastructure for genetic evaluation. The purpose of this paper is to briefly list and discuss some items that would improve genetic evaluation.

Development of EPDs for New Traits.

1. Genetic values for growth traits are now common place. Some breed associations have sire carcass EPDs that were predicted from slaughter steer and heifer progeny data. A few have carcass EPDs that were predicted from yearling seed-stock live animal ultrasound measures. More breeds need to develop carcass EPDs.

2. Having a herd of reproductively sound cows is economically important to producers, yet genetic values for female reproductive traits are available for only a few breeds. The prediction of EPDs traits such as longevity or length of productive life, cumulative survival, days to calving and stayability should become more feasible as breeds move towards whole herd reporting. Mature cow size EPDs should be computed for breeds because of the importance of mature size with respect to management of resources.

3. Traits such as feed efficiency and tenderness, though difficult to measure, need to be developed because of their large impact on profitability in the beef industry.

Model Improvements.

Improvements in the evaluation procedures for currently evaluated traits will provide for an increase in accuracy. The following is a list of some of these improvements.

1. Development and refinement of multi-breed models for the analysis of association data bases that contain several breed combinations. The application of multi-breed models for the evaluation of growth traits will be in place for several breed association within the next 12-18 months. Refining the procedures includes research to determine effective methods to account for heterogeneous variances among breeds and to expand multi-breed evaluation to carcass and reproductive traits. Ultimately research in this area could lead to improvements in the prediction of across breed EPDs.

2. Across Country Evaluation. Providing across country genetic evaluation enhances marketing opportunities for North American breeders and should enhance the accuracy

of evaluation. Determining the importance of genotype by country interactions, heterogeneous variances across countries and impact of differences in across country connectedness must be done before across country evaluation can be effectively implemented.

3. Some improvements that may enhance the accuracy of evaluation include accounting for important heterogeneous variances, when they exist, application of joint linear and threshold animal model methodology for the evaluation of birth weight and calving ease, inclusion of sire by year or sire by contemporary group effects into weaning weight evaluation models, development of models to incorporate both steer carcass and seed-stock live animal ultrasound carcass measures into carcass evaluation procedures, inclusion of dominance effects to better evaluate full-sib families and development of random regression models or multi-trait models to provide more accurate mature weight EPDs.

4. The incorporation of individual animal DNA information into genetic evaluation models will most certainly become important in the future. The use of this information could lead to substantial increases in evaluation accuracy, especially for traits that are difficult to measure.

Use of Genetic Values Provided From Evaluation Programs

1. The development of decision-making software that incorporates many inputs, including genetic differences within and across breeds, and merges these inputs production and financial information would provide a great tool to assist producers as they strive to make sound management decisions. More must be done to provide information to breeders and commercial producers so that they can effectively use EPDs in their programs.

2. Since EPDs are used as a marketing tool, breeders have placed an undue amount of weight on the magnitude of EPDs, especially the milk EPD, as they are buying and selling seedstock. Many breeders are erroneously using the average magnitude of EPDs computed from different breed association data banks to compare breeds. As a result, most breed associations are now adjusting their EPDs to a base chosen to provide their breeders the best marketing advantages when competing with breeders that have other breeds. While there is nothing wrong in doing this, it is important that breeders and producers are educated to not equate the magnitude of breed average EPDs to differences between breeds. More must be done to provide educational programs to both the seedstock and commercial industry on the proper use of EPDs.

Improvements in the Infrastructure For Genetic Evaluation

1. All breeds should move to whole herd reporting with emphasis placed on collecting information, such as accurate disposal codes, yearly weights and condition scores, on cows to assist in the prediction of reproductive and mature size EPDs. More emphasis

needs to be put on collecting measures throughout the productive lives of females in order to provide more information to compute mature size genetic values.

2. More emphasis needs to be placed by the purebred breed associations into improving the quality and amount of information collected. A significant amount of information, ranging from 10% to 57%, is eliminated from the data provided by breed associations prior to the prediction of EPDs. It may be time for some breeds to combine some of their resources and staff to ensure the effective management of data sets and to adequately serve their constituents in other areas, such as education.

3. The computation of across breed EPDs for as many breeds as possible may best be accomplished by the combining of the data from all the breed associations into one multi-breed evaluation using a combination of data and literature estimates. If the beef industry truly wants across breed EPDs, then associations will need to allow their data to be combined for research purposes, and maybe eventually, for genetic evaluation.

4. More resources need to be directed towards research and development. The costs of conducting National Cattle Evaluation programs are climbing, while the resources available to the institutions conducting these programs have been decreasing. May be time for industry to find funds for key research institutions to form virtual centers to work together to solve large genetic evaluation problems.

SIRE SUMMARIES OF THE FUTURE

Mark Gardiner
Gardiner Angus Ranch, Ashland, Kansas

Sire summaries of the future will be crucial for the success of the beef industry. Since the advent of the first field data reports for most of the major breed associations in 1980, sire summaries have made steady improvement. As a seedstock producer, I need as much performance data and as many genetic predictions as possible to make mating decisions, however our commercial customers remind me that for them, sometimes **less is more.** Some commercial producers are more educated on using EPDs than most seedstock producers. Other producers are like me trying to use the computer; they get so overwhelmed with the information, that they quit out of frustration, without understanding the information. Most sire summaries may well offer more traits than some producers want, but I believe that sire summaries should offer a smorgasbord of EPDs which will allow producers to choose the traits that are most important to their operations.

Simply stated, our commercial bull-buying customers want a few understandable breeding values that allow them to choose problem-free genetics that work in their respective environments. These genetics usually entail producing as many pounds as possible in the correct package. This "genetic package" must reproduce easily, be born with little or no assistance, grow rapidly to the desired end point and repeat the process year after year. For the most part, identifying cattle with these genetics is attainable using information from today's sire summaries. For example, I remember in the Angus breed it used to be said, "you can't have low birth weight, high growth cattle in a moderate frame package". Now Angus breeders have identified "spread" bulls and created an ever-growing population of low-birth, high-growth genetics. In fact, today we can use calving ease bulls that have more yearling growth, yet less frame than the yearling weight trait leaders of just a few years ago.

In my mind, the next objective is to consistently identify genetics that will produce pounds in the correct package and heave desirable carcass traits. In our own breeding program, we have always charted matings that resulted in offspring with genetic estimations that were more desirable than breed average for marbling, back fat thickness and ribeye area. In the past, it was difficult to select for superior carcass sires because too much would be sacrificed on the production side. Using the largest database in the industry, Angus breeders now have created an ever-increasing population of cattle who are superior in their production traits, and superior for carcass merit. Today, we can select for superior carcass traits without sacrificing production traits.

EPDs are economic reality. I am sometimes accused of being an "EPD nut". I would agree with that assessment. In my opinion, the best-kept secret in the beef industry is that EPDs are **MONEY.** The economic reality of these numbers can allow cattlemen to be **PROFITABLE.** I firmly believe that selection pressure made using reliable sire summaries will allow cattle breeders to achieve any goal they may choose for production traits.

Keeping EPDs relevant to both the purebred breeder whom wants "more" and the commercial customer who wants "simple" may be the greatest challenge to those "gurus" who produce the sire summaries, but there are other challenges as well. The following is an overview of my opinion on several areas that I believe are most critical for enhancing sire summaries of the future:

➢ **KISS** – "Keep it simple stupid". We need to concentrate on the major traits of economic importance. As a genetics supplier, I always want to see more information with which to make breeding decisions. However, some of our customers at times< are overwhelmed with information and want only the information that affects their bottom line. Other commercial customers of ours want all of the information they can possibly get. We need to satisfy all of our customers.

In some cases we may need to have fewer EPDs. For example, in the Angus breed we have five EPDs related to carcass merit (carcass weight, marbling, ribeye area, back fat thickness and percent retail product). I personally enjoy and need to look at all of these EPDs, but the reality is that the only carcass EPDs that really matter at this time are marbling and percent retail product. Commercial producers would benefit from reducing the number of carcass EPDs and making their decision less confusing. With print media and interment capabilities it seems logical to assume that we could publish a "readers Digest version" of the sire summary for commercial cattlemen and an expanded version for anal retentive purebred breeders (like me).

➢ **Magnitude and economic importance of traits** – Make sure a trait truly has significant economic value before an ED for it shows up in the sire summary. The value of purebred bulls or cows can be greatly influenced by ED values. If these values are of little economic importance or if the effects are of a very small magnitude, animals with "good genetics" for traits that are of major economic improtance can be discarded or rarely used. An example of this scenario is the use of the scrotal EPD in the Angus breed. A bull's scrotal circumference is the most accurate estimate of his daily sperm production. Scrotal circumference is (and should be) one of the major components of a bull breeding soundness exam. Unfortunately, the scrotal EPD has been misunderstood as a **fertility** EPD, which of course it is not. We have been asked in our own program "if I use a negative scrotal EPD bull or female will these cattle be **sterile?** To illustrate that scrotal circumference does not necessarily have a positive correlation with conception, I did a conception comparison of three bulls used extensively in our own program. These bulls were bred to the same contemporary groups by the same inseminators. Precision (-.85 scrotal) settled 221/307 for 72% , Travler 1489 (+.51 scrotal) settled 438/799 for 55%, and Prime time (+1.53 scrotal) settled 186/284 for 66%.

Fortunately, there is also a positive correlated response between a sire's yearling scrotal circumference and the age at puberty of his daughters. However, the magnitude of this effect is small and the relationship between scrotal circumference and daughters' age at puberty is **not** an indicator of the daughters' potential "fertility." Each centimeter of scrotal is worth only .8 days towards daughter puberty. In other words, seven centimeters of scrotal circumference only changes the first estrus by five and one-half days. This is important, but there are many things such as nutrition that will have a larger effect on age at puberty. This was grossly **misunderstood** when the scrotal circumference EPD was added to sire summaries. My point is that in addition to publishing EPDs judiciously, we have to educate potential users about EPDs or we do them a disservice.

➢ **Fertility EPDs** – Can we accurately measure and successfully select for a lowly heritable trait? According to Dr. Richard Saacke, semen evaluations can only account for 50% of the variation of fertility between bulls. On the female side, the environmental differences between neighbors have more affect on cow herd fertility than differences in their genetics. Like any producer, I want an EPD for reproduction that will allow me to effectively select bulls or cows with higher fertility, but I also think we should realize that we are dealing with very low heritabilities on fertility traits. Heterosis will have more affect on reproductive traits than genetic selection during two of my lifetimes. Therefore, while I am excited about the possible inception of whole-herd reporting of performance data and the research on developing a fertility EPD, I think that direct selection for fertility would have a minimal effect because of the low heritability of reproductive traits.

➢ **Regional Environmental Adjustment Factors** – Many breeders (including me), are of the opinion that national cattle evaluations need to account for regional differences due to the variation in the environments across the country. Publishing a sire summary for each region of the US is not the answer. Such a move would decrease the database for each region, thereby reducing the accuracies and make the sire summary less valuable. However, environmental effects on reproduction traits should be characterized and performance data entered in the database for EPD calculations should be adjusted for regional environmental effects.

➢ **Ultrasound technology** – Using ultrasound measurements as a database for calculation of carcass EPDs will rapidly accelerate our ability to select for carcass traits and improve our end product. The American Angus Association has nearly 42,000 carcasses measured on 2,163 sires, in the 1999 Sire Summary, but this data took several years to collect. In a research project supported by AAA, Iowa State researchers recently measured carcass traits on 35,000 live animals with ultrasound in a 60-day period. This means that with ultrasound technology we can literally measure more animals in a day than we might get through kill data in a year. Ultrasound data will create a huge database and allow us to make better decisions on which young sires to progeny test. I'm excited that the American Angus Association has announced that it will publish their first "ultrasound sire summary" in the fall of 1999.

➢ **Develop a tenderness EPD** – The carcass EPDs available today are helpful in improving the genetics that control beef product quality, but the key element that we do not have is a "genetic handle" on tenderness. We need to investigate the notion of a tenderness EPD. Unlike, reproductive traits, the estimated heritability of tenderness is high to moderately high, therefore, if an estimated breeding value for tenderness were available, the industry could make rapid genetic change.

Developing a tenderness EPD requires that we first develop the technology for online measurement of tenderness in packing plants. Accurately determining carcass tenderness could accomplish two valuable goals. First, tenderness measurements could be used in the national sire evaluation to develop a tenderness EPD. Second, any carcass that failed to meet a minimum level of tenderness, could be segregated and either upgraded by physical or chemical means that improve tenderness or processed into ground beef or processed meats. Understanding the genetic control of tenderness and devising technology to accurately measure tenderness appear to be the two major barriers to developing a tenderness EPD.

➢ **Develop total product value EPDs** – We need total value information on a carcass basis. The value of the carcass may vary between different marketing grids, but each grid would represent a different contemporary group. One of the ways to do this is on a carcass basis is with video imaging technology. This technology would help accurately measure each carcass for its exact value, instead of our current estimation with a USDA grader. With precise value information this would also facilitate more accurate price discovery for cattle, and this would send clearer signals to producers as to which cattle are the most valuable on a carcass basis.

➢ **Develop EPDs for the commercial cowherd** – EPDs are the most powerful information that the beef industry has, commercial cattlemen need this information on the maternal side also, not just the sire side. I often deal with commercial cattlemen who believe they may be sacrificing too many pounds with their predominantly British cowherd. I certainly would agree that these cowherds might have growth EPDs that are substantially below the breed average of the British parent breeds. I also deal with commercial cattlemen who believe that their continental cross cattle may be too large for their environment. These cattlemen might have selected continental cross cattle that are excessive for yearling hip height, and mature daughter weight and height. Commercial cattlemen cannot establish what they need if they do not know where they are. It is much too simplistic to automatically assume that British cattle do not have enough growth, or that Continental cross cattle are automatically too large.
In conclusion, I believe that sire summaries of the future will look a lot like the sire summaries of today. The most important job of a sire summary is to present reliable information on the economically important traits. The **KISS**, (keep it simple stupid) philosophy needs to rule. These summaries must present relevant informaiton without frustrating some producers with too much information. All producers must realize that EPDs are **Money.** This information can allow producers to be profitable, if disciplined selections are made to fit each individuals environment. I believe that there are too frew

producers who actually understand how to use this information. Therefore, the education of how to interpret and apply this information is critical for the survival of the beef industry. EPDs are the only way to win the protein war that we are waging with pork and poultry. We must remove our industry from the commodity mode it has operated in for hundreds of years. If we do not change our beef products, and recapture market share, we will not be a relevant industry. The opportunity of our industry has never been greater. World urbanization and population growth will cause the world's food demand to double by the year 2020. We will make more progress in our industry in the next ten years than we have in the past 300 years. Sire summaries are the tools that will allow us to succeed.

GENETIC CORRELATIONS BETWEEN CARCASS TRAITS AND HEIFER PRODUCTIVITY TRAITS

L. D. Van Vleck*, R. K. Splan† and L. V. Cundiff‡
Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, *Lincoln and ‡Clay Center, NE 68933 and †University of Nebraska, Lincoln

Summary

Selection for one trait or group of traits has the potential to lead to unfavorable genetic change in other traits. The amount of change will depend partly on genetic correlations among the traits and heritabilities of the traits. Measurements of carcass traits which affect productivity of beef and acceptability to the consumer are difficult to obtain. A question that might be asked is whether selection for carcass traits would be expected to change other traits. This report summarizes estimates of heritabilities for carcass traits and genetic correlations with weaning weight and heifer productivity traits obtained from analyses of records from the Germ Plasm Evaluation project at the U.S. Meat Animal Research Center. The number of weaning weight records was 22,572. Measurements were also available on about 4,000 steer carcasses. Measurements were also made on age at puberty, calving rate as a heifer (1,0) and calving difficulty as a heifer on about 3,000 heifers. Heritability estimates for carcass traits were generally moderate to high (.25 to .65) which indicates selection could be effective if such measurements were readily available and selection goals were known. Estimates of genetic correlations between carcass traits and both direct and maternal genetic value for weaning weight revealed no important antagonisms. Similarly, estimates of genetic correlations between carcass traits and heifer productivity traits did not indicate any important antagonisms.

Introduction

Any action should consider the law of unintended consequences. With genetic selection for any set of traits, the unintended consequences will be correlated genetic response in other traits. For example, suppose selection is for increased yearling weight. If selection is effective, calves that result from selection of sires and dams for larger yearling weight will have genetic potential for larger size at a year of age. The unintended (but perhaps obvious) consequences are likely to be cows with larger mature weight and calves with larger birth weight. The economic impact of the intended and unintended consequences may be complicated but the example shows the importance of having some idea of the "unintended consequences". The statistics needed to calculate the expected consequences are genetic correlations between traits and heritabilities of the traits.

This article will summarize some recent work and some research in progress on estimating genetic correlations between carcass traits and direct and maternal components of early growth (weaning weight, WWT) and between carcass traits and heifer productivity measured by age at puberty (AGEPUB), calving rate (RATE, defined as 1 if calved after first breeding season, and as 0 if not), and calving difficulty of first calf (DIFF, defined as 1 if caesarian or aided by calf jack, and as 0 if none or hand assistance only is required). This paper will report results from recent studies (Splan et al., 1998, 2000) of data collected at the U.S. Meat Animal Research Center (USMARC) from Cycles I-IV of the Germ Plasm Evaluation (GPE) project with records collected from 1970 through 1994. The second part of the paper will summarize recent results from Canada (Crews and Kemp, 1999) as well as the review by Marshall (1994).

Description of Data, Traits, and Models

Figure 1 describes the breeding design for Cycles I - IV and which animals were recorded for carcass traits, heifer productivity traits, weaning weights and maternal weaning weights. Heifer productivity traits were measured on paternal half sisters of steers for which carcass traits were measured. Weaning weights were from both heifer and steer calves related as paternal sibs and also from calves of the heifers. The relationship ties through common sires of heifers and steers allow for estimation of the genetic correlations between the carcass and heifer productivity traits. The weaning weights of calves of the heifers (the calves which initiated the measurements of calving rate and calving difficulty for the heifers) allowed estimation of the genetic correlations between maternal effects for weaning weight and direct effects for carcass traits.

The number of records and average records for the various traits are shown in Table 1. The number of steers with carcass measurements ranged from about 3,700 to 4,100. The number of heifers with productivity measurements ranged from about 2,900 to 3,200. The total number of weaning weights was about 22,000. The number of sires represented was about 600 for all traits. More detailed description of the records and definitions of the traits can be found in Splan et al. (1998).

All analyses considered relevant fixed factors such as breed composition, age of dam, birth year and covariates as appropriate for calendar day of birth, slaughter age and age at weaning.

Because heifers measured for productivity and steers measured for carcass traits could have dams in common, a dam effect was added to the model to avoid confounding of maternal and direct effects. The extra generation of weaning weights allowed weaning weight to be modeled with direct and maternal genetic effects as well as maternal permanent environmental (dam of calf) effects which also allowed two-trait analyses to estimate the genetic correlation between maternal effects for weaning weight and direct effects for carcass traits.

Estimates of Parameters

The estimates of direct and maternal heritability for weaning weight were .25 and .21 with a negative genetic correlation of -.35 between direct and maternal genetic effects. These estimates are similar to many other estimates (Koots et al., 1994a).

The estimate of maternal heritability shows that the mating design allows estimation of maternal effects for weaning weight and, therefore, allows estimation of the genetic correlation between maternal effects for weaning weight and direct effects for carcass traits.

Table 2 presents estimates of heritability for the carcass traits and estimates of genetic correlations between carcass traits and direct as well as maternal effects for weaning weight. The heritability estimates are large for most carcass traits and agree with estimates summarized by Koots et al. (1994a).

The direct correlations with weaning weight are generally reassuring. Only two are above .20, which is kind of a guideline for potential importance of correlated response. The large correlation with hot carcass weight is expected (.68) as weaning weight is a component of slaughter weight. Hot carcass weight is a trait under management control so is usually not considered as part of carcass quality. The correlation with REA is small to moderate (.26) and also is expected as heavier calves would tend to be larger with a larger rib eye area. The correlation with marbling score of .19 may indicate some need for monitoring changes in weaning weight, if selection becomes more effective for marbling score. The other correlations are near zero. Although this experiment included more measurements than any previous study, the estimated correlations probably have relatively high sampling variances (that is, may not agree with estimates if hundreds of thousands of measurements on carcass traits could be analyzed).

Only one estimate of genetic correlation between maternal effects for weaning weight and direct effects for carcass traits was greater than .16. The estimate of .44 between bone percent and maternal weaning weight is a bit puzzling although Koch et al. (1976, 1979) had reported breed group means indicating that at a constant carcass weight, percent bone was greater in breeds with a history of selection for milk production than in breeds that had not been selected for milk production. This correlation may be due to chance or may be real. The implications of a real correlation of this size are that further study may be needed and that, if selection should involve bone percentage, the effects on maternal genetic value for weaning weight should be monitored. The other correlations are so small that, if real, they are of little to no concern.

Table 3 lists the estimated genetic correlations between carcass traits of steers and the heifer productivity traits. Estimates of heritability for the heifer traits were similar to other reports; .47 for age at puberty, .09 for heifer calving rate, and .11 for calving difficulty. That these estimates are in the usual range of such estimates add creditability to estimates of genetic correlations between those traits and carcass traits.

The correlations with heifer productivity traits are based on much less information than correlations with direct and maternal weaning weight but are among the first such estimates to be reported. Only one carcass trait had a correlation with age at puberty that exceeded an absolute value of .12. That trait was taste panel tenderness score (-.32). The estimate, however, with Warner-Bratzler shear force, an objective measure of tenderness, was near zero. The negative correlation (-.32) is actually favorable as the expected response is such that if tenderness improved, age at puberty would decrease. Only one of the genetic correlations between calving rate and carcass traits exceeded an absolute value of .20: the correlation of -.33 with bone percentage. If real, the implications are not clear. The negative sign suggests that selection for greater bone percentage would reduce calving rate. A few of the genetic correlations with calving difficulty were greater in absolute value than .20 but only one was greater than .30. The negative signs of the correlations with fat trim percentage and kidney-pelvic-heart fat percentage suggest that as fat percentages decrease, calving difficulty would increase somewhat, i.e., is an unfavorable correlation. The size of those correlations do not seem large enough to be of much concern, although they do suggest a need for continued study.

The largest correlation with calving difficulty is with taste panel tenderness (-.42). A biological reason is not clear. The smaller correlation (.19) for calving difficulty with Warner-Bratzler shear force is in partial agreement as high shear force is associated with less tenderness. These correlations may or may not be real but, if real, the correlation is favorable, that is, increased tenderness would lead to easier calving.
Other Studies

Crews and Kemp (1999) analyzed four carcass traits of 1972 progeny of 36 Limousin sires mated to 775 F_1 and backcross dams of Angus, Charolais, Hereford, Shorthorn and Simmental crosses. The carcass traits were hot carcass weight, fat depth, rib-eye area and lean yield percentage. The heritability estimates were intermediate (.30, .45, .39, and .38, respectively) and somewhat less than those from the MARC analyses. In general, the estimates were similar to those reviewed by Koots et al. (1994b) which averaged .23, .44, .42, and .55, respectively. Some evidence was found for maternal effects for three traits. Maternal heritabilities were .00, .09, .06, and .08, respectively.

Estimates of genetic correlations between direct genetic effects for the carcass traits and direct and maternal genetic effects for BWT and WWT are in Table 4. Estimates with direct genetic value for BWT were moderately high, about .50 for hot carcass weight, rib-eye area, and lean yield percentage and -.44 for fat depth. These estimates with BWT, surprisingly, were larger in magnitude than with direct WWT. The correlations for direct genetic value for carcass traits with maternal genetic values were generally low except for .44 and .64 for carcass weight with maternal BWT and WWT which are surprisingly large.

Marshall (1994) in a review for NC-196 and a symposium at the ASAS annual meeting, reported average heritability estimates shown in Table 5. These average estimates are generally smaller than those from the current MARC study and would have contained estimates from earlier reports based on some of the same data from the MARC study. Marshall (1994) also reported ranges in estimates of the genetic correlation between carcass traits and weaning weight and post weaning gain. The wide ranges for the estimates reflects the relatively small amount of carcass information available from any one study and possibly reflects differences in breeds and conditions where measurements were made. The most consistent estimates were the large (and expected) correlations with carcass weight. The correlations of WWT and postweaning gain (PWG) with fat trim percentage summarized by Marshall (1994) are moderately large and positive compared to the near zero correlation of fat trim percentage with WWT in the MARC study reported earlier. The wide ranges in estimates of genetic correlations for the other carcass traits with WWT and PWG indicate the need for collection of more data to increase the certainty of the estimates.

Conclusions

Heritability estimates for carcass traits from MARC data and other studies are large enough that selection to change those traits could be effective. The basic limitation is that few measurements are available for genetic evaluation for carcass traits due to costs of obtaining carcass data. An obvious difficulty for selection is that animals which provide carcass measurements are not available for breeding. Ultrasound measurements may alleviate that problem for some traits but different management of animals slaughtered and those kept for breeding after measurement by ultra-sound procedures may be a problem. Standardization of measurements from one study to another will also be a concern. If enough measurements become available, the various carcass traits still must be assigned economic values consistent with their contribution to income of the beef producer. Those economic values also need to be coordinated with economic values for weight and reproductive traits. Selection for all three types of traits – carcass, weight, reproductive – would become more difficult if many of the genetic relationships are antagonistic. The estimates of genetic correlations between carcass traits and weaning weight (direct and maternal) found with the MARC data do not indicate any serious antagonisms. Similarly, estimates of genetic correlations between carcass traits and traits associated with heifer productivity, also do not appear to represent any important antagonisms.

Literature Cited

Crews, D. H., Jr., and R. A. Kemp. 1999. Contributions of preweaning growth information and maternal effects for prediction of carcass trait breeding values among crossbred beef cattle. Canada. J. Anim. Sci., 79:17-25.

Koch, R. M., M. E. Dikeman, D. M. Allen, M. May, J. D. Crouse, and D. R. Campion. 1976. Characterization of Biological types of cattle. III. Carcass composition, quality and palatability. J. Anim. Sci. 43:48-62.

Koch, R. M., M. E. Dikeman, R. Jerry Lipsey, D. M. Allen, and J. D. Crouse. 1979. Characterization of biological types of cattle – cycle II. III. Carcass composition, quality and palatability. J. Anim. Sci. 49:448-460.

Koots, K. R., J. P. Gibson, C. Smith, and J. W. Wilton. 1994a. Analyses of published genetic parameter estimates for beef production traits. 1. Heritability. Anim. Br. Abstr. 62:309-338.

Koots, K. R., J. P. Gibson, and J. W. Wilton. 1994b. Analyses of published genetic parameter estimates for beef production traits. 2. Phenotypic and genetic correlations. Anim. Br. Abstr. 62:825-853.

Marshall, D. M. 1994. Breed differences and genetic parameters for body composition traits in beef cattle. J. Anim. Sci. 72:2745-2755.

Splan, R. K., L. V. Cundiff, and L. D. Van Vleck. 1998. Genetic parameters for sex-specific traits in beef cattle. J. Anim. Sci. 76:2272-2278.

Splan, R. K., L. V. Cundiff, and L V. Cundiff. 2000. Estimates of parameters between direct and maternal genetic effects for weaning weight and genetic effects for carcass traits in beef cattle. (In peer review for J. Anim. Sci.).

Table 1. Number of records (n) and averages for weaning weight, carcass traits and heifer productivity traits

Trait	n	Average	Standard deviation
Wean wt (kg)	22572	182.2	30.6
Hot carcass wt (kg)	4086	301.5	41.2
Retail product (%)	3707	68.7	4.10
Fat trim (%)	3707	18.4	4.72
Bone (%)	3708	12.9	1.08
KPH fat (%)	3712	5.3	1.05
Rib-eye area (cm^2)	4094	11.4	1.41
Fat thickness (cm)	4094	0.5	.19
Marbling (score)	3708	4.0	1.14
W-B shear force (kg)	3719	4.2	1.52
Age at puberty (d)	2864	355	.33
Calving rate (0,1)	3183	.95	.36
Calving difficulty (0,1)	3017	.35	.42

Table 2. Estimates of heritabilities for carcass traits and genetic correlations with weaning weight (WWT)

Carcass trait	Heritability	Correlation (WWT)	
		Direct	Maternal
Hot carcass wt (kg)	.53	.68	.16
Retail product (%)	.65	-.10	-.06
Fat trim (%)	.57	.09	.02
Bone (%)	.50	.03	.44
KPH fat (%)	.37	-.08	-.02
Rib-eye area (cm^2)	.59	.26	.07
Fat thickness (cm)	.54	.10	-.02
Marbling (score)	.61	.19	.02
W-B shear force	.25	.00	.00

Table 3. Estimates of genetic correlations between carcass traits and heifer productivity traits[a]

Steers	Age PUBerty	CalveRATE	CalveDIFF
Hot carcass wt (kg)	.06	.05	-.17
Retail product (%)	-.01	-.13	.18
Fat trim (%)	-.01	.18	-.23
Bone (%)	.01	-.33	.27
KPH fat (%)	-.12	-.12	-.29
Rib-eye area (cm^2)	.04	.15	-.04
Fat thickness (cm)	-.01	.19	-.14
Marbling (score)	-.04	-.05	-.09
W-B shear force	.01	.11	.19
Tenderness (panel)	-.32	.07	-.42

[a]Age PUBerty = age at puberty in days; CalveRATE = 0 if the heifer has no calf at 2 yr of age, and = 1 if a calf is born; CalveDIFF = 1 with calving difficulty and 0 with none.

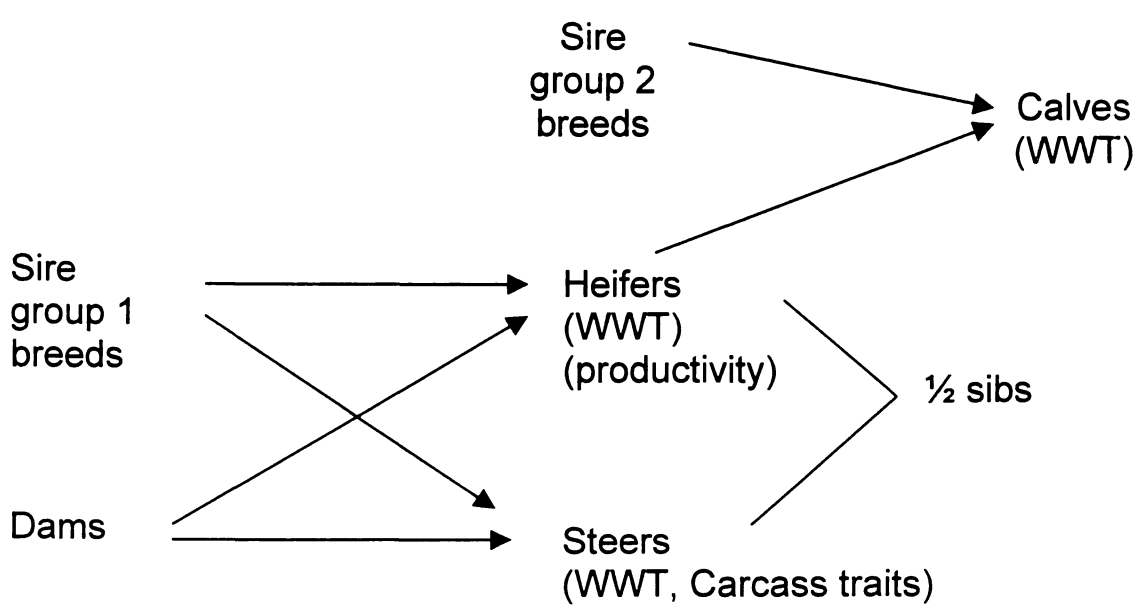
Table 4. Estimates of genetic correlations from paper of Crews and Kemp (1999)

	Birth weight		Weaning weight	
Trait	Direct	Maternal	Direct	Maternal
Hot carcass wt (kg)	.52	.44	.28	.64
Fat depth	-.44	-.09	-.25	.04
Rib-eye area (cm^2)	.54	-.23	.34	.18
Lean yield (%)	.51	.01	.15	.03

Table 5. Estimates of heritability and genetic correlations from review by Marshall (1994)

Trait	Heritability	Range of genetic correlations	
		Wean weight	Post wean gain
Hot carcass wt (kg)	.41	.48 ↔ .94	.78 ↔ .94
Retail product (%)	.36	-.03 ↔ .20	-.13
Fat trim (%)	.57	.32 ↔ .40	.40 ↔ .64
Bone (%)	.53	-	-
Rib-eye area (cm^2)	.37	.16 ↔ .72	-.07 ↔ .82
Fat thickness (cm)	.44	.04 ↔ .59	-.20 ↔ .62
Marbling (score)	.35	-.02 ↔ .81	-.62 ↔ .48
W-B shear force	.37	-.05	-.48 ↔ .06

Figure 1. Breeding design for estimation of genetic correlations between carcass and heifer productivity traits.



ACROSS-BREED EPD TABLES FOR 1999 ADJUSTED TO A 1997 BASE

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

INTRODUCTION

This report is the 1999 update of estimates of sire breed means from data of the Germplasm Evaluation project at the U.S. Meat Animal Research Center (MARC) adjusted to a 1997 base using EPDs from the most recent national cattle evaluations.

Changes from the 1998 update (Van Vleck and Cundiff, 1997) are as follows:

1) Included were 153 progeny of 15 South Devon bulls. The average BIF accuracy values were about .38 and the regression coefficients of progeny performance on sire EPD were negative for weaning and yearling weight and for maternal weaning weight.
2) Changes in bases for the national Gelbvieh and Angus genetic evaluations are reflected in this report.
3) Weaning weights were available for 82 more Hereford, 75 more Angus, 151 more Brahman and 9 more Charolais calves. These included progeny of 1 Hereford, 1 Charolais and 12 Brahman bulls with EPD reported for the first time this year.
4) For the maternal analyses, new records included weaning weights of 347 grand progeny of 14 South Devon bulls, 110 grandprogeny of Hereford bulls, 78 grandprogeny of Angus bulls, 295 grandprogeny of Brahman bulls, and 16 grandprogeny of the newly reported Charolais bull.

METHODS

The calculations are as outlined in the 1996 BIF Guidelines. The basic steps were given by Notter and Cundiff (1991) with refinements by Núñez-Dominguez et al. (1993), Cundiff (1993, 1994), Barkhouse et al. (1994, 1995), and Van Vleck and Cundiff (1997, 1998). All calculations were done with programs written in Fortran language with estimates of variance components, regression coefficients, and breed effects obtained with the MTDFREML package (Boldman et al., 1995). All breed solutions are reported as differences from Angus. The table values to add to within-breed EPDs are relative to Angus.

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

Models for Analysis of MARC Records

Fixed effects in the models for birth weight, weaning weight (205-d) and yearling weight (365-d) were: breed of sire (13), dam line (Hereford, Angus, MARC III Composite) by sex (female, male) by age of dam (2, 3, 4, 5-9, ≥10 yr) combination (26), year of birth (70-76, 86-90, 92-94 and 97-98) and a separate covariate for day of year at birth of calf for each of the three breeds of dam. Dam of calf was included as a random effect to account for correlated maternal effects for cows with more than one calf (3347 dams for BWT, 3099 for WWT, 2974 for YWT). For estimation of variance components and to estimate breed of sire effects, sire of calf was also used as a random effect (441).

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

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

The fixed effects for the analyses of maternal effects included breed of maternal grandsire (13), maternal grand dam line (Hereford, Angus, MARC III), breed of natural service mating sire (15), sex of calf (2), birth year-GPU cycle-age of dam subclass (63), and mating sire breed by GPU cycle by age of dam subclass (34) with covariate for day of year of birth. The subclasses are used to account for confounding of years, mating sire breeds, and ages of dams. Ages of dams were (2, 3, 4, 5-9, ≥10 yr). For estimation of variance components and estimation of breed of maternal grandsire effects, random effects were maternal grandsire (395) and dam (1952 daughters of maternal grandsires). For estimation of regression coefficients of grand progeny weaning weight on maternal grandsire EPD for weaning weight and milk, random effects of both maternal grandsire and dam (daughter of MGS) were dropped from the model.

Adjustment of MARC Solutions

The calculations of across-breed adjustment factors rely on solutions for breed of sire or maternal grandsire from records at MARC and on within-breed EPDs. The records from MARC are not included in within-breed EPD calculations.

The basic calculations for BWT, WWT, and YWT are as follows:

MARC breed of sire solution adjusted for genetic trend:

$$M_i = MARC(i) + b[EPD(i)_{1997} - EPD(i)_{MARC}]$$

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

$$A_i = (M_i - M_x) - (EPD(i)_{1997} - EPD(x)_{1997})$$

where,

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

$EPD(i)_{1997}$ is the average within-breed EPD for breed i for animals born in the past year (1997), $EPD(i)_{MARC}$ is the weighted (by number of progeny at MARC) average of EPD of bulls of breed i having progeny with records at MARC,

b is the pooled coefficient of regression of progeny performance at MARC on EPD of sire (for 1999: 1.14, .86, and 1.17 for BWT, WWT, YWT),

i denotes breed i, and

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

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

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

$$MWWT(i) = MARC(i)_{MGS} + b_{wwt}[EPD(i)_{97WWT} - EPD(i)_{MARCWWT}] + b_{MLK}[EPD(i)_{97MLK} - EPD(i)_{MARCMLK}]$$

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

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

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

$$A_i = [MILK(i) - MILK(x)] - [EPD(i)_{97MLK} - EPD(i)_{MARCMLK}]$$

where,

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

$EPD(i)_{97WWT}$ is the average within-breed EPD for WWT for breed i for animals born in 1997,

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

$EPD(i)_{97MLK}$ is the average within-breed EPD for MILK for breed i for animals born in 1997,

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

b_{WWT}, b_{MLK} are the coefficients of regression of performance of MARC grand progeny on MGS EPD for WWT and MILK (for 1999: .51 and 1.16),

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

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

RESULTS

Tables 1, 2, and 3 (for BWT, WWT and YWT) summarize the data from, and results of, MARC analyses to estimate breed of sire differences and the adjustments to the breed of sire effects to a 1997 base. The last column of each table corresponds to the "breed table" factor for that trait. The number of MARC progeny with records was the same for 1999 as for 1998 except for an increase of 82 Hereford, 75 Angus, 151 Brahman and 9 Charolais calves of 1, 0, 12 and 1 additional bulls, respectively, for the four breeds for weaning weight. New in 1999 were 134 weaning weights of calves of 15 South Devon bulls. Changes from 1998 are not great except for Gelbvieh which in the last year made changes in the base for their genetic evaluations. Except for Gelbvieh, changes in the table adjustments from 1998 are generally within .3 lb for BWT and 2 to 3 lb for WWT (Simmental, -6.6 lb). Changes from 1998 are greater for YWT. The changes seem to be due to the weighted average EPD of Angus bulls at MARC being less different from the average Angus nonparent EPD (35.4 - 53.3 lb) in the 1999 analysis than in the 1998 analysis (27.3 - 50.9 lb). Most changes in the table factors (except for Gelbvieh and Brahman) for YWT are 2 to 10 lb with little change in Hereford and a larger change in Salers. The trend to larger table factors for YWT relative to Angus continue a pattern seen from 1997 to 1998 and may be due to the change in Angus base.

Table 4 summarizes the calculations for the table adjustment for MILK EPDs. Because daughters of the MGS are still producing calves and some bulls were reported for the first time, some new grand progeny had records; 110 more Hereford, 78 more Angus, 295 more Brahman, and 16 Charolais grand progeny of the newly reported sire and 347 grand progeny from 69 daughters of the 14 South Devon bulls. Changes in 1999 compared to 1998 were less than 4 lb with most from 0 to 2 lb except for Gelbvieh which had a major change in the base.

Table 5 summarizes the average BIF accuracy for bulls with progeny at MARC weighted appropriately by number of progeny or grand progeny. South Devon bulls had relatively small accuracy for all traits as did Brahman and Maine-Anjou bulls. Table 6 reports the estimates of variance components from the records that were used in the mixed model equations to obtain breed of sire and breed of MGS solutions. Neither Table 5 nor Table 6 changed much from 1998.

Table 7 updates the coefficients of regression of records of MARC progeny on sire EPD for BWT, WWT and YWT which have theoretical expected values of 1.00. The standard errors of the specific breed regression coefficients are large relative to the regression coefficients. Large differences from the theoretical regressions, however, may indicate problems with genetic evaluations, identification, or sampling.

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

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

Prediction Error Variances of Across-Breed EPD

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

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

$$(32.9 + 15.0) - (1.6 + 30.0) = 47.9 - 31.6 = 16.3.$$

The prediction error variance for this difference is (use the 21.6 in the upper part of Table 10 at intersection of row for HE and column for SA):

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

$$21.6 + 75 + 50 = 146.6$$

with

standard error of prediction $\sqrt{146.6} = 12.1$.

If the difference between the Salers and Hereford breeds in 1997 could be estimated perfectly, the variance of the estimate of the breed difference would be 0 and the standard error of prediction between the two bulls would be:

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

REFERENCES

Barkhouse, K. L., L. D. Van Vleck, and L. V. Cundiff. 1994. Breed comparisons for growth and maternal traits adjusted to a 1992 base. Proc. BIF Research Symposium, Des Moines, IA, May, 1994. pp 197-209.

Barkhouse, K. L., L. D. Van Vleck, and L. V. Cundiff. 1995. Mixed model methods to estimate breed comparisons for growth and maternal traits adjusted to a 1993 base. Proc. BIF Research Symposium, Sheridan, WY. May 31-June 3, 1995. pp 218-239.

Cundiff, L. V. 1993. Breed comparisons adjusted to a 1991 basis using current EPD's. Proc. BIF Research Symposium, Asheville, NC, May, 1993.

Cundiff, L. V. 1994. Procedures for across breed EPD's. 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. 69:4763-4776.

Núñez-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. 71:1419-1428.

Van Vleck, L. D., and L. V. Cundiff. 1994. Prediction error variances for inter-breed genetic evaluations. J. Anim. Sci. 71:1971-1977.

Van Vleck, L. D., and L. V. Cundiff. 1995. Assignment of risk to across-breed EPDs with tables of variances of estimates of breed differences. Proc. BIF Research Symposium, Sheridan, WY. May 31-June 3, 1995. pp 240-245.

Van Vleck, L. D., and L. V. Cundiff. 1997. The across-breed EPD tables adjusted to a 1995 base. Proc. BIF Research Symposium, Dickinson, ND. May 14-17, 1997. pp 102-117.

Van Vleck, L. D., and L. V. Cundiff. 1997. Differences in breed of sire differences for weights of male and female calves. Proc. BIF Research Symposium, Dickinson, ND. May 14-17, 1997. pp 131-137.

Van Vleck, L. D., and L. V. Cundiff. 1998. Across-breed EPD tables for 1998 adjusted to a 1996 base. Proc. Beef Improvement Federation Research Symposium and Annual Meeting. Calgary, Alberta, Canada. July 2, 1998. pp 196-212.

Van Vleck, L. D. 1994. Prediction error variances for inter-breed EPD's. Proc. Fourth Genetic Predication Workshop, Beef Improvement Federation, Kansas City, MO, Jan. 1994

Van Vleck, L. D., and L. V. Cundiff. Influence of breed of dam on across-breed adjustment factors. 1998. Midwestern Section ASAS and Midwest Branch ADSA 1998 Meeting, Des Moines, IA. Abstract # 10. p 31

Table 1. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1997 base and factors to adjust within breed EPDs to Angus equivalent - BIRTH WEIGHT (lb)

Breed	Number Sires	Number Progeny	Raw MARC Mean (1)	Ave. Base EPD Breed 1997 (2)	Ave. Base EPD MARC Bulls (3)	Breed Soln at MARC + Ang (4)	Breed Soln at MARC vs Ang (5)	Adjust to 1997 Base + Ang (6)	Adjust to 1997 Base vs Ang (7)	Factor to adjust EPD to Angus (8)
Hereford	79	1085	86	3.7	2.7	91	4.6	92	5.4	4.3
Angus	79	888	86	2.6	2.2	86	.0	86	.0	.0
Shorthorn	25	181	87	1.9	.9	93	7.2	94	7.9	8.6
South Devon	15	153	80	.2	-.1	92	5.7	92	5.7	8.1
Brahman	40	589	98	1.5	.7	99	12.9	100	13.3	14.4
Simmental	28	422	85	4.0	3.8	95	8.7	95	8.5	7.1
Limousin	20	387	80	1.1	-1.3	91	4.6	93	6.9	8.4
Charolais	64	594	88	1.7	.7	96	9.9	97	10.6	11.5
Maine-Anjou	15	174	94	-.2	1.0	98	11.6	96	9.8	12.6
Gelbvieh	25	386	89	2.0	1.0	93	6.6	94	7.4	8.0
Pinzgauer	16	435	84	-.1	-.4	93	6.6	93	6.5	9.2
Tarentaise	7	199	80	2.4	1.8	91	5.0	92	5.2	5.4
Salers	27	189	85	1.0	1.4	92	5.7	91	4.8	6.4

Calculations: (4) = (5) + (1, Angus)
(6) = (4) + b[(2) - (3)] with b = 1.14
(7) = (6) - (6, Angus)
(8) = (7) - (7, Angus) - [(2) - (2, Angus)]

Table 2. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1997 base and factors to adjust within breed EPDs to Angus equivalent - WEANING WEIGHT (lb)

Breed	Number Sires	Number Progeny	Raw MARC Mean (1)	Ave. Base EPD Breed 1997 (2)	Ave. Base EPD MARC Bulls (3)	Breed Soln at MARC + Ang (4)	Breed Soln at MARC vs Ang (5)	Adjust to 1997 Base + Ang (6)	Adjust to 1997 Base vs Ang (7)	Factor to adjust EPD to Angus (8)
Hereford	79	1007	511	31.6	18.5	492	1.6	503	4.1	1.6
Angus	79	797	490	29.1	18.9	490	.0	499	.0	.0
Shorthorn	25	170	521	11.6	7.0	508	18.3	512	13.4	30.9
South Devon	15	134	443	7.5	.3	491	1.5	498	-1.1	20.5
Brahman	40	509	532	11.2	4.9	512	21.5	517	18.2	36.1
Simmental	27	368	470	37.3	20.2	510	20.1	525	26.0	17.8
Limousin	20	338	445	9.0	-9.8	496	5.8	512	13.2	33.3
Charolais	63	515	491	12.7	1.5	515	25.4	525	26.2	42.6
Maine-Anjou	15	155	460	2.3	1.5	511	21.4	512	13.3	40.1
Gelbvieh	25	355	484	33.0	24.3	515	25.1	523	23.8	19.9
Pinzgauer	16	415	478	.6	-4.1	496	5.8	500	1.0	29.5
Tarentaise	7	191	476	11.3	-4.8	498	8.3	512	13.3	31.1
Salers	27	176	525	6.7	6.9	510	19.5	509	10.5	32.9

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

Table 3. Breed of sire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1997 base and factors to adjust within breed EPDs to Angus equivalent - YEARLING WEIGHT (lb)

Breed	Number Sires	Number Progeny	Raw MARC Mean (1)	Mean EPD Breed 1997 (2)	Mean EPD MARC Bulls (3)	Breed Soln at MARC + Ang (4)	Breed Soln at MARC vs Ang (5)	Adjust to 1997 Base + Ang (6)	Adjust to 1997 Base vs Ang (7)	Factor to adjust EPD to Angus (8)
Hereford	79	930	857	54.5	31.5	846	-8.8	873	-2.8	-4.0
Angus	79	742	855	53.3	35.4	855	.0	876	.0	.0
Shorthorn	25	168	918	18.0	13.9	884	29.2	889	13.0	48.3
South Devon	15	134	744	10.4	.1	858	2.7	870	-6.2	36.7
Brahman	14	438	838	18.9	8.6	827	-28.3	839	-37.2	-2.8
Simmental	27	332	795	51.9	10.7	876	21.3	924	48.5	49.9
Limousin	20	334	740	17.0	-14.9	839	-16.3	876	.0	36.3
Charolais	63	477	847	22.4	3.0	892	37.0	915	38.8	69.7
Maine-Anjou	15	154	791	3.7	2.8	885	29.6	886	9.7	59.3
Gelbvieh	25	353	819	58.0	42.3	872	17.4	891	14.9	10.2
Pinzgauer	16	347	838	.7	-8.0	847	-8.3	857	-19.1	33.5
Tarentaise	7	189	807	20.7	-4.1	837	-18.2	866	-10.2	22.4
Salers	27	173	898	10.9	11.3	879	24.1	879	2.7	45.1

Calculations: (4) = (5) + (1, Angus)
(6) = (4) + b[(2) - (3)] with b = 1.17
(7) = (6) - (6, Angus)
(8) = (7) - (7, Angus) - [(2) - (2, Angus)]

Table 4. Breed of maternal grandsire solutions from MARC, mean breed and MARC EPDs used to adjust for genetic trend to 1997 base and factors to adjust within-breed EPDs to Angus equivalent - MILK (lb)

	Number			Raw MARC Mean	Mean EPD				Breed Soln at MARC		Adjust to 1997 Base			Factor to adjust MILK EPD to Angus
					Breed		MARC		MWWT		MWWT		MILK	
					WWT	MILK	WWT	MILK	+ Ang	vs Ang	+ Ang	vs Ang		
Breed	Sr	Gpr	Daughters	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Hereford	64	1435	350	475	31.6	10.2	12.9	.1	476	-13.7	498	-9.2	-13.8	-8.7
Angus	65	950	243	490	29.1	12.8	12.6	5.4	490	.0	507	.0	-2.6	.0
Shorthorn	22	251	69	527	11.6	2.4	6.9	7.3	518	27.9	515	7.7	-1.6	11.3
South Devon	14	347	69	488	7.5	-.1	.3	.6	499	9.5	502	-4.7	-6.7	8.8
Brahman	40	777	216	521	11.2	5.4	4.9	2.5	530	40.1	537	29.6	18.0	27.9
Simmental	27	796	152	513	37.3	7.4	20.2	6.8	523	33.2	533	25.6	10.1	18.0
Limousin	20	764	150	477	9.0	3.0	-9.9	.2	485	-4.7	498	-8.8	-18.0	-5.6
Charolais	57	917	199	501	12.7	7.0	.8	2.0	504	14.4	516	9.3	-6.3	2.0
Maine-Anjou	14	355	63	536	2.3	-.4	1.3	-2.3	523	33.5	526	19.2	10.0	25.8
Gelbvieh	25	653	143	537	33.0	18.0	24.2	15.6	528	37.9	535	28.2	13.7	11.1
Pinzgauer	15	545	133	504	.6	-1.0	-1.7	6.4	509	18.5	501	-5.9	-9.0	7.4
Tarentaise	6	341	78	513	11.3	2.0	-6.0	4.8	516	25.8	521	14.4	5.2	18.6
Salers	25	351	87	534	6.7	7.2	5.6	9.3	518	27.8	516	8.9	1.1	9.2

Calculations: (6) = (7) + (1, Angus)
(8) = (6) + b_{WWT} [(2) - (4)] + b_{MLK} [(3) - (5)] with b_{WWT} = .51 and b_{MLK} = 1.16
(9) = (8) - (8, Angus)
(10) = [(9) - Average (9)] - .5[(7, Table 2) - Average (7, Table 2)]
(11) = (10) - (10, Angus) - [(3) - (3, Angus)]

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

Breed	BWT	WWT	YWT	MWWT	MILK
Hereford	.66	.65	.54	.63	.51
Angus	.79	.77	.74	.70	.68
Shorthorn	.81	.79	.66	.80	.77
South Devon	.37	.38	.37	.41	.42
Brahman	.49	.53	.34	.53	.39
Simmental	.97	.97	.97	.97	.97
Limousin	.96	.95	.93	.95	.92
Charolais	.62	.60	.51	.59	.52
Maine-Anjou	.46	.49	.30	.51	.49
Gelbvieh	.67	.59	.55	.68	.63
Pinzgauer	.85	.68	.62	.70	.64
Tarentaise	.95	.95	.94	.95	.95
Salers	.85	.83	.74	.82	.80

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

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

	Direct			Maternal
Analysis[a]	BWT	WWT	YWT	MWWT
Direct				
Sires (441) within breed (13)	12.4	151	697	
Dams (3099) within breed (3)	29.3	1020	1452	
Residual	68.0	1541	4154	
Maternal				
MGS (395) within MGS breed 13)				204
Daughters within MGS (1952)				895
Residual				1245

[a](Numbers) for weaning weight.

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

	BWT	WWT	YWT
Pooled	1.14 ±? .06	.86 ?± .07	1.17 ?± .06
Sire breed			
Hereford	1.17 ±? .10	.81 ?± .10	1.11 ±? .09
Angus	.93 ±? .14	.61 ±? .13	1.14 ±? .11
Shorthorn	.81 ±? .45	.74 ?± .42	1.06 ?± .34
South Devon	1.04 ?± .55	-.19 ±? .38	-.17 ±? .44
Brahman	1.80 ?± .27	1.20 ±? .28	.80 ±? .26
Simmental	1.37 ?± .30	1.09 ±? .29	1.14 ±? .27
Limousin	1.17 ?± .39	1.36 ±? .47	1.93 ?± .50
Charolais	1.11 ?± .18	.93 ±? .21	1.25 ?± .19
Maine-Anjou	1.14 ?± .60	.71 ±? .65	.58 ±? .73
Gelbvieh	.82 ?± .24	.87 ±? .42	.90 ?± .32
Pinzgauer	1.25 ?± .17	1.48 ±? .21	1.65 ±? .17
Tarentaise	.83 ?± .90	.69 ±? .53	1.30 ±? .60
Salers	1.26 ?± .38	.81 ±? .48	.97 ±? .48
Dam breed			
Hereford	1.14 ?± .10	.80 ? .10	1.11 ±? .09
Angus	1.22 ?± .08	.88 ±? .08	1.16 ±? .08
MARC III	.97 ?± .13	.90 ±? .15	1.32 ±? .14
Sex of calf			
Female	1.18 ±? .08	1.00 ±? .08	1.02 ±? .08
Male	1.10 ?± .08	.71 ±? .08	1.32 ?±. 07

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

Type of regression	MWWT	MILK
Pooled	.51 ±? .05	1.16 ±? .08
Breed of maternal grandsire		
Hereford	.57 ±? .08	.89 ±? .13
Angus	.67 ±? .11	.97 ±? .19
Shorthorn	.28 ±? .35	.56 ±? .42
South Devon	.15 ?± .27	-1.38 ±? .94
Brahman	.61 ±? .22	1.06 ±? .43
Simmental	.69 ±? .26	1.29 ±? .62
Limousin	.81 ±? .36	2.51 ±? .35
Charolais	.09 ±? .17	1.75 ±? .26
Maine-Anjou	-.67 ±? .44	.45 ±? .51
Gelbvieh	.50 ±? .30	1.28 ±? .37
Pinzgauer	.68 ±? .19	.40 ±? .58
Tarentaise	.20 ±? .58	.80 ±? .75
Salers	1.12 ±? .32	2.71 ±? .40
Breed of maternal grandam		
Hereford	.42 ±? .08	1.35 ±? .13
Angus	.59 ±? .07	1.14 ±? .10
MARC III	.39 ±? .13	.81 ±? .19
Sex of calf		
Female	.51 ±? .06	1.20 ±? .10
Male	.51 ±? .06	1.13 ±? .10

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

Breed	HE	AN	SH	SD	BR	SI	LI	CH	MA	GE	PI	TA	SA
HE	.0	.4	1.0	1.7	.6	1.1	1.1	.7	1.7	.9	.9	2.8	.9
AN	26.9	.0	1.0	1.8	.6	1.1	1.1	.7	1.7	1.0	1.0	2.8	1.0
SH	65.7	67.7	.0	2.3	1.3	1.6	1.7	1.1	2.2	1.3	1.4	3.4	1.1
SD	108.0	110.3	145.2	.0	2.1	1.5	1.6	1.5	2.9	2.2	2.2	4.1	2.2
BR	41.9	43.1	91.7	134.8	.0	1.4	1.5	1.0	1.9	1.2	1.0	2.8	1.3
SI	68.4	71.1	106.1	95.0	94.6	.0	.9	.9	2.3	1.6	1.6	3.4	1.6
LI	70.4	73.4	109.2	97.5	96.8	58.0	.0	.9	2.3	1.6	1.6	3.5	1.7
CH	43.6	46.2	70.9	96.1	69.2	55.7	58.6	.0	1.9	1.1	1.1	3.0	1.0
MA	111.8	114.0	146.5	191.2	133.8	150.8	153.1	125.8	.0	1.5	2.1	3.9	2.1
GE	61.1	63.4	87.5	141.0	83.2	99.7	101.1	69.2	106.5	.0	1.3	3.2	1.3
PI	61.7	64.8	94.4	144.2	73.0	103.3	105.9	75.5	139.3	86.6	.0	2.8	1.4
TA	168.6	172.6	209.1	251.8	174.5	211.7	214.8	187.2	245.9	199.0	171.5	.0	3.3
SA	61.6	64.4	75.7	141.5	87.8	102.7	105.8	76.6	142.8	84.6	91.8	205.3	.0

[a]For example, a Hereford bull has within breed PEV of 300 for YWT and that for a Shorthorn bull is 200. Then the PEV for the difference in EPDs for the two bulls is 65.7 + 300 + 200 = 565.7 with SEP = 23.8.

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

Breed	HE	AN	SH	SD	BR	SI	LI	CH	MA	GE	PI	TA	SA
HE	.0	8.9	22.7	35.1	12.0	21.3	22.3	13.8	34.2	18.9	17.1	43.3	21.6
AN	23.5	.0	23.8	36.2	13.2	22.8	23.7	15.2	35.3	20.1	18.6	45.2	23.0
SH	54.2	55.9	.0	49.0	30.4	35.5	36.8	24.7	47.8	29.6	30.4	59.0	27.4
SD	69.0	71.1	101.5	.0	42.9	30.4	31.6	30.6	61.5	45.7	45.2	71.8	48.0
BR	27.7	29.0	66.5	82.5	.0	29.0	29.9	21.3	40.6	25.2	19.2	44.0	29.2
SI	50.2	52.3	82.7	65.5	63.6	.0	17.8	16.5	47.6	31.5	30.9	58.0	34.6
LI	54.2	56.6	86.9	69.7	67.7	50.8	0	17.7	48.5	32.1	32.1	59.3	35.9
CH	30.9	32.7	58.0	60.5	43.7	41.5	45.8	.0	39.7	22.0	22.6	50.5	23.8
MA	71.6	74.1	103.8	120.8	83.5	101.9	106.1	81.6	.0	31.2	41.8	68.6	46.8
GE	42.2	44.0	68.2	90.2	53.9	71.2	75.3	48.6	62.5	.0	25.7	54.1	28.8
PI	52.2	55.2	82.7	102.7	56.8	83.7	87.9	62.2	102.3	71.4	.0	42.7	29.8
TA	125.4	129.0	160.8	177.3	126.9	158.5	162.7	138.4	175.9	147.5	139.0	.0	58.0
SA	45.6	48.0	65.9	93.4	58.2	74.6	78.8	50.0	95.6	60.3	74.9	152.5	.0

1997 AVERAGE EPDs FOR EACH BREED

For selection of breeding stock, it is important to know how expected progeny differences (EPDs) for an individual animal compare to the current breed average. Mean non-parent EPDs are useful for making comparisons within breeds. They cannot be used to compare different breeds because EPDs are estimated from separate analyses for each breed. The means are for all calves born in 1997 from the most recent (1998-1999) genetic evaluations. The 1997 birth year was chosen because limited data were available on calves born in 1998 for yearling weight and other traits.

1997 ALL ANIMAL NON-PARENT AVERAGE EPDs FROM 1999 OR MOST RECENT GENETIC EVALUATIONS

Breed	Birth Wt lb	Wean. Wt , lb	Yrlg. Wt, lb	Milk lb	Total mat., lb	Scrot. circ., cm	Calv. ease dir., %	Calv. ease mat., %	Ultra-sound REA	Carc. REA	Fat thick.	Marb-ling	Stay-ability	Docility	Gest. length
Angus	+2.6	+29.1	+53.3	+12.8	+.5	+.06				+.14[a]	+.00[a]	+.10[a]			
Beefmaster	+.27	+4.6	+8.6	+2.2											
Brahman	+1.6	+11.3	+19.6	+5.4	+11.1										
Brangus	+1.2	+14.2	+25.4	+0.7	+13.3				+.2		-.001	-.01[b]			
Brayford	+1.1	+7.8	+9.7	+1.3	+5.2										
Charolais	+1.7	+12.7	+22.4	+7.0	+13.3										
Gelbvieh	+2.0	+33	+58	+18	+35	+0.1	+102	+103		+.01	+0.0	-.01			
Hereford	+3.7	+31.6	+54.5	10.7	26.5	+.4									
Limousin	+1.1	+9	+17	+3	+7	+.1				-.02	0.0	+.01	+.8	+4	-0.4
Maine Anj.	-0.2	+2.3	+3.7	-0.4	+0.7										
Pinzgauer	-0.1	+0.6	+0.7	-1.0	-0.7										
Red Angus	+.5	+23.2	+38.1	+9.6	+21.2								+5.4		
Salers	+1.0	+6.7	+10.9	+7.2	+10.5	0.0				+.01	0.0	0.0		+.8	
Santa Gert.	+.58	+4.2	+5.0	+1.4	+3.6										
Shorthorn	+1.9	+11.6	+18.0	+2.4	+8.2										
Simmental/ Simbrah	+4.0	+37.3	+51.9	+7.4	+26.1										
S. Devon	+0.2	+7.5	+10.4	-0.1	+3.7										
Tarentaise	+2.4	+11.3	+20.7	+2.0	+7.6										

[a]Average EPDs for ribeye area, fat thickness, and marbling are for Angus born in 1995.
[b]Percent intramuscular fat estimated from ultrasound evaluation.

NATIONAL BEEF CATTLE EVALUATION CENTER

E. John Pollak
Cornell University, Ithaca, NY

The mission of this National Beef Cattle Evaluation Center will be to develop and implement methodology and technologies for genetic evaluation of beef cattle for the purpose of maximizing the impact genetic programs have on the economic viability, international competitiveness and sustainability of U.S. beef cattle producers and to provide consumers with affordable and healthy beef products.

Center Objectives:

ESTABLISH AND COORDINATE priorities for genetic evaluation of U.S. beef cattle with the goal of positioning the U.S. as a leader in this area thereby increasing the global competitiveness of the U.S. beef industry.

CONSOLIDATE efforts among the four land-grant institutions to conduct research to meet these priorities with the goals of reducing duplication of effort and maximizing the return of useable information to the beef industry.

STREAMLINE the process between the development and adoption of new methodologies by the industry with the goal of ensuring the economic viability and sustainability of producers in the U.S. beef industry.

IDENTIFY new traits and technologies for inclusion in genetic programs with the goals of reducing the costs of beef production and providing consumers with a high value, healthy, affordable protein source.

CREATE decision-making tools that incorporate the increasing number of traits being evaluated and the increasing amount of information from DNA biotechnology into genetic improvement programs with the goal of optimizing the overall efficiency, product quality/safety, and health of the national cattle herd resource.

Rationale for Creating an NCE Center

For selective breeding, Expected Progeny Differences (EPDs) have been the most important tool available to seedstock and commercial producers of beef cattle. Analysis of beef records for EPDs for the vast majority of seedstock cattle in the United States occurs at four universities: Colorado State University, Cornell University, University of Georgia, and Iowa State University. These institutions have long histories in genetic evaluation (tracing back to the late 1970s and early 1980s) and are unique in their faculty expertise and ability to implement these programs. The success of genetic evaluation has also been greatly influenced by the existence of an established delivery system for making EPDs readily available to all producers.

This delivery system includes breed associations through their sire summaries reporting EPDs, AI organizations and seedstock producers through their dissemination of superior genetics based on EPDs. Evidence for successful use of EPDs is the marked genetic trends for economically important traits. The ability to influence the genetics of U.S beef cattle has enhanced our competitiveness of beef production both domestically and globally.

As important as national cattle evaluations (NCE) have become to the beef industry and consumers of beef products, it can be argued that the infrastructure of the current system has duplication of effort and is fragile because of the few scientists actually doing most of the work. It does not provide an efficient platform to accomplish the research necessary to meet the changing and increasing demands of the industry. A remedy is to create an infrastructure that encourages the sharing of resources and expertise among the four institutions. This can be accomplished by establishing a center devoted to research, development, and implementation of genetic evaluation methodology. The prime objective of such a center is to provide for systematic and coordinated efforts in research and implementation of new methodology for evaluations. Sharing resources and consolidation of research efforts will reduce the inefficiencies that currently exist due to redundancy and alleviate concerns regarding the fragile nature of the current infrastructure.

Development of a center approach is essential to meet the increased demand for methodology to accommodate the products of biotechnology and to convert the explosion of data being experienced in the industry into information. Research efforts will focus such areas as:

- Managing databases, creating mining strategies for handling the increased data being generated (informatics) and preserving these database resources.
- Including DNA information in genetic evaluation programs
- Expanding multibreed applications for genetic improvement programs.
- Creating selection decision tools to improve production efficiency, product quality/safety and herd health.
- Developing new traits such as reproductive efficiency, carcass composition, and quality along with decision-making tools for the incorporation into breeding programs.
- Developing new methodologies to enhance the accuracy, reliability, and productiveness of the systems.

ACTIVITIES OF THE ICAR BEEF GROUP

Hans J. Schild

1. Introduction

First of all I want to thank you for your kind invitation to this Congress. I feel very honored and I am happy to attend your meeting as a representative of ICAR, the International Committee for Animal Recording.

I will briefly introduce myself. My name is Hans Jürgen Schild and I am working at the Bavarian animal recording organization, which is located in Munich. As many of you perhaps know, the most important cattle breed of Southern Germany is Simmental, which is kept here as a dual purpose breed. In Bavaria there are more than one million cows under milk control. Besides milk recording advanced methods for beef recording and evaluation have been developed in the recent 15 years. In this connection a very cheap field test was established, which is based on slaughter house records and actually provides nearly 500,000 animals a year (with about 50% young finishing bulls, which actually are used for genetic evaluation).

For genetic evaluation of beef traits we use a multi trait animal model which is based on data from any applied recording schemes. The objective traits are BVs for net gain, meat percentage and carcass conformation score. From these we compute an overall beef index, which by definition has an average of 100 and a genetic standard deviation of 12 pts.

As my company deals with milk recording for more than 50 years, there has been a traditional contact with ICAR. Before moving on the ICAR Beef Group, I think, I should briefly say some words about ICAR for those who are not familiar with this organization.

2. ICAR International Committee for Animal Recording

ICAR is an international non profit and non governmental organization. It was founded in 1951 in the Netherlands as the "European Committee on Milk-Butterfat Recording". In 1990 an expansion to further species of ruminants and to non milk traits took place. For this reason the organization changed its name to "International Committee for Animal Recording".

One membership is possible per country. The national members are mainly umbrella organizations which deal with animal recording. Actually there are 44 member countries. However for historical reasons there is mainly a membership of national milk recording associations. So for example, the American membership is held by the National Dairy Herd Improvement Association DHIA.

Table 1: Member Countries of ICAR

• Argentina	• Finland	• Jersey	• Romania
• Australia	• France	• Korea	• Russia
• Austria	• Germany	• Latvia	• Scotland
• Belgium	• Greece	• Lithuania	• Slovenia
• Bulgaria	• Holland	• Luxemburg	• South Africa
• Canada	• Hungary	• Mexico	• Spain
• Croatia	• India	• New Zealand	• Sweden
• Czech Republic	• Ireland	• North Ireland	• Switzerland
• Denmark	• Israel	• Norway	• Tunesia
• England	• Italy	• Poland	• USA
• Estonia	• Japan	• Portugal	• Zimbabwe

Besides the board and the secretariat there are 3 permanent sub committees and one task force for developing countries:

- SC INTERBULL
- SC Meters and Jars
- SC Animal Identification
- TF Development Fund

Furthermore there are 13 working groups, which work in co-operation in case of overlapping problems:

- WG Milk Testing Laboratories
- WG Animal Information Details
- WG Computer Developments
- WG AI and Relevant Technologies
- WG Lactation Calculation Methods
- WG Milk Recording of Goats
- WG Milk Recording of Goats
- WG Milk Recording of Sheep
- WG Milk Recording of Buffaloes
- WG Conformation Recording
- WG Health and Fertility Recording
- WG Efficiency Recording
- WG Sheep and Goat Meat Recording
- WG Beef Recording

3. ICAR Beef Recording Working Group

The beef working group consists of 13 personal members, who are involved in national beef recording schemes and genetic evaluation of beef traits. Apart from Australian and South African memberships, there has been a slight dominance of European countries until now.

Table 2: Group composition of the ICAR Beef Group

• Australia	• H. U. Graser	• Ireland	• A. I. Grogan
• Austria	• B. Fürst	• Italy	• A. Rosati
• Belgium	• Ch. Michaux	• Poland	• N. N.
• Denmark	• M. Hansen	• South Africa	• J.v.d. Westhuizen
• France	• L. Journaux	• Spain	• Cl. Diaz
• Germany	• H. J. Schild	• UK	• D. Pullar
• Hungary	• S. Sebestien	• (USA	• K. Bertrand)

The objectives of the ICAR Beef Group are:

- Development of recommendations and guidelines for the international harmonization and standardization of beef performance control
- Support for international communication and information exchange
- Safeguarding of consistency and agreement with guidelines of other ICAR working groups
- International surveying of beef performance recording

Until now a general guideline which refers to the following beef testing schemes was developed.

- Suckler Herds
- Individual station test
- Abattoirs
- Finishing herds
- Official sales

Other guidelines like "Comparable genetic evaluation for beef traits" or "Linear scoring of muscle shape" are actually in preparation.

In view of the big diversity of world wide applied beef recording schemes, the present recommendation is a first rough frame, setting up some minimum standards and requirements. However, we are planning an investigation, which is titled "Comparative Analysis and Synthesis of Different National Recommendations/ Regulations for Beef Performance Control". Based on the results of this investigation we will try to create detailed and complete international standards for beef recording. In this connection the present BIF Guidelines will be an important source of information.

The ICAR Beef Group does not deal with international genetic evaluation of beef traits directly. In this connection it should be stressed, that a quick and comprehensive solution will not be likely to be achieved in the near future. Although there exist well developed national procedures, it seems not reasonable to use MACE-procedures at the moment in view of the large diversity of applied methods. Even conversion formulas are difficult to apply, as - compared to dairy breeds - there are quite small breeding populations and only little genetic exchange occurs between various countries. According to our opinion the easiest way for a joint international genetic evaluation would be performed by common sets of raw data. However, for doing this, a common language, i.e., a uniform definition of beef recording items would be essential.

An international standardization and harmonization will be supported by appropriate standards for electronic data exchange. For this reason, we will set up an international data dictionary on the base of the appropriate ICAR recommendations and the appropriate ISO standards. By this means the mutual intra- and international electronic data exchange will be facilitated and common data evaluation would speed up considerably.

Emerging Technology Session

Emerging Technology Committee
Minutes of Meeting
June 18, 1999, Roanoke, Virginia

Chairman: Ronnie D. Green, Colorado State University

The BIF Emerging Technology Committee met from 1:30-5:30 pm on Friday, June 18, 1999. The focus of the first portion of the committee agenda was DNA diagnostics. Excellent and informative invited presentations were made by Tom Holm and Bridger Feuz on services offered by PE AgGen (Perkin Elmer BioSystems), Sue DeNise on parentage identification using DNA fingerprinting (University of Arizona), Jerry Taylor on marker-assisted selection for carcass traits (Texas A&M University), and Steve Kappes on marker-assisted selection for reproductive efficiency traits (U.S. Meat Animal Research Center, Clay Center, NE). An open discussion followed these presentations with a number of questions from the audience.

The National Carcass Merit Project, funded by the beef checkoff, 15 breed associations, and Perkin Elmer AgGen, was then discussed by Ronnie Green (Colorado State University) and John Pollak (Cornell University). Approximately 2,000 of the 11,000 head in the project have been harvested with Simmental and Angus breeds having several sires nearly complete. The first analyses of data from this project will be compiled by the research team during the fall and will be reviewed at a meeting with breed association personnel during the upcoming BIF Genetic Prediction Workshop in Kansas City on December 2-4, 1999.

The final portion of the committee agenda consisted of a panel discussion on the use of full sib brothers as a method to increase consistency. Panelists included Galen Fink (Manhattan, KS), Gary Johnson (Manhattan, KS), Randy Mills (Florence, KS), Tom Field (Colorado State University), and William Herring (University of Missouri). Panelists indicated that while there is little reason from a population genetics perspective to expect increased consistency from this approach, there may be an advantage when considering functionality and disposition traits that are not evaluated in national cattle genetic evaluation programs.

For the first time in its five year history, the meeting was very well attended (approximately 200 people). Considerable interest was expressed by producers in attendance that BIF sponsor a workshop on the "jargon" of DNA selection. This request was forwarded to the BIF board of directors for consideration in formulating the program of the 2000 annual meeting in Wichita.

The meeting was adjourned at 5:30 pm.

EMERGING TECHNOLOGIES COMMITTEE
OVERVIEW OF SERVICES AVAILABLE FROM PERKIN ELMER AGGEN

Tom Holm and Bridger Feuz

The Perkin Elmer Corporation has a successful history in developing and supplying cutting edge instrumentation and technology to the research community. In recent years PE has expanded the utilization of their technologies into new markets where substantial benefits can be derived from the application of these novel technologies. Two years ago this expansion resulted in the formation of a DNA service organization, named PE AgGen, that is focused exclusively on the application of DNA technologies for agricultural applications.

By utilizing the latest technologies available from Perkin Elmer, PE AgGen has been able to offer a broad range of services focused entirely on plant and animal breeding and production. PE AgGen products range from routine services (such as parent verification and trait testing), to contract research (such as test development), and finally to genomics (such as broad based research programs to identify and understand genes that are responsible for important economic traits). PE AgGen's goal is to accelerate the pace of discovery for research involving agricultural applications of DNA and protein technologies and to provide commercialization channels for these discoveries. As the rate of discovery increases and more applications are developed there will be a greater need to deliver the benefits of these technologies to the animal breeding and production segments.

PE AgGen has been active in the development of DNA-based technologies and testing services to the beef industry. We were one of the first groups to use DNA technology as a powerful and routine method for individual animal identification and parent verification. Today, AgGen not only offers parentage verification to a large proportion of the purebred industry, but has also identified new benefits and applications for the use of DNA technologies in multi-sire breeding programs. AgGen has demonstrated the power of DNA technology by offering single sire identification of progeny that are produced in multi-sire breeding programs. These testing programs provide a number of important benefits to the purebred breeder such as fewer open cows, more efficient pasture management, and shortened calving season. In general, this type of testing program allows the purebred breeder to manage his cattle in a commercial management setting without sacrificing data collection and analysis of genetic traits for calculation of EPDs. Multi-sire testing also allows our purebred customers to determine the serving capacity of their bulls when they are used in a multi-sire environment.

AgGen is currently working with several groups to expand the use of our multi-sire testing programs into commercial settings. We have discovered that a breeder or producer that has the capability to obtain carcass data can make genetic progress by utilizing our multi-sire parent verification program. In these instances we have found that a producer can make substantial genetic and economic progress by knowing which bulls are producing carcasses that are receiving discounts versus those carcasses for which he is receiving premiums. By utilizing this information in selection decisions a producer can rapidly recover his initial investment in the program and in fact, can quickly turn his investment into substantial returns.

AgGen is also focusing their efforts on the development and commercialization of DNA technologies that can be utilized for specific traits. Research organizations such as Texas A&M University have discovered a large number of DNA markers that are tightly associated with quantitative trait loci (QTL) that effect growth and carcass merit. AgGen is currently participating in the National Genetics of Carcass Merit Project to validate the use of these DNA markers across seventeen US beef breeds. Once the validations are complete AgGen expects to offer a commercial DNA testing service based on the use of these markers. Researchers have discovered that the utilization of marker assisted selection (MAS) technology can result in faster and more efficient incorporation of desirable genes into their seedstock. MAS is currently being used successfully in both the crop and swine breeding industries to make rapid genetic progress for a variety of traits.

Industry experts believe that MAS will have an especially large impact on the improvement of traits that are difficult to measure such as tenderness or overall palatability. Since tenderness and product consistency have been identified as leading research priorities by the beef industry we are confident that the utilization of DNA marker technology will have a positive impact on these challenges. It should be noted, however, that MAS is not a silver bullet, but is simply another tool that is available to the breeding and production segments. MAS will not replace the current systems for analyzing animal performance, but it does have the potential to greatly enhance these systems (i.e. MAS will not be a substitute for EPDs, but will allow for improved accuracy of EPDs). In addition, MAS will allow for other benefits such as selection of desirable genes across breeds and for improved selection response.

One of the challenges that exists for the successful launch of an MAS breeding program is to determine how it can best be implemented across a diverse and non-integrated beef industry. AgGen has developed models and systems that will allow for easy use and access to this technology by the US beef industry. In our model DNA-based sire verification of progeny is performed on a percentage of animals produced at the commercial level. An analysis of these tests will allow the producers (both seedstock and commercial) to determine which sires are producing predominantly high value carcasses and from those that are producing an abundance of discounted carcasses. This data will also allow producers to determine the serving capacity for each sire. Selection decisions could be made directly at this point using the sire verification data coupled with standard bull ranking systems. In our system, however, we take the analysis one step further. Instead of using randomly distributed DNA markers in the parent verification step we use markers that are associated with important economic traits. Therefore, the producers not only get information on overall bull performance, but they also get information on which markers are associated with particular traits. In the ideal situation (such as a strategic alliance) the information on individual DNA markers is shared between the commercial and purebred producers. Sharing of this information will allow the breeder to make selection decisions based on both standard methodologies and on MAS. You will notice our system has the important benefit that only sires producing the largest proportion of progeny are available for MAS since sampling is only done on a percentage of the progeny. Therefore, DNA testing costs will be minimized and only high fertility bulls will be selected.

Our belief is that the system outlined above will allow for the fastest use and integration of DNA marker technology in the US beef industry. We are aware that the system will require some effort and cooperation to implement since in many instances the industry structure is not setup to handle routine sharing of information. However, the industry is moving rapidly toward the establishment of better communication channels and information feedback loops between the seedstock and commercial segments. The successful formation and growth of strategic alliances that incorporate both breeders and producers will greatly enhance the adoption and utilization of this powerful new technology.

USING PARENTAGE ANALYSIS IN COMMERCIAL BEEF OPERATIONS

Sue DeNise, Ph.D.
University of Arizona, Tucson

Introduction. Parentage verification is the most common use of molecular biology technology currently available. Blood-type markers have been traditionally used for parentage verification and are reliable for most parentage disputes. However, with only 12 blood-group systems available to determine the genetic profile of an individual animal, this method is limited in parentage disputes involving closely related individuals or in large mating groups. DNA markers provide a virtually unlimited number of genetic determinants that can be used to identify specific chromosomal segments in progeny that link to its parents. There are currently over 2600 markers available in cattle and over 2200 of the markers are useful in parentage analysis. (http://locus.jouy.inra.fr)

Parentage verification can be an important genetic tool when reliable information concerning pedigree structure is not available. For example, commercial herds that rely on multiple-sire breeding pastures are unable to determine the value of the progeny produced from a given sire unless they have used a phenotypic marker (like coat color or Brahman influence) or DNA typing. There are a limited number of phenotypic markers available; thus, the evaluation from visual markers compares breed performance instead of the genetic potential of individual sires. DNA typing can be used as a progeny-testing tool by assigning calves to their individual sires based on inheritance of markers. For traits easily measured in the bull (like weaning and yearling weights and growth rate), this additional information usually adds little to the estimate of genetic merit of a sire. However, for those traits that cannot be measured directly in the bull (for example, carcass traits) parentage verification may provide additional information to improve the genetic potential of the progeny for traits that are economically important.

Parentage analysis has not been widely adopted because the benefits of DNA testing all calves has not been justified given the current costs of testing. This paper presents scenarios where DNA parentage analysis may be economically feasible. As the technology continues to improve and the cost of testing decreases, these scenarios are likely to be implemented in the cattle industry.

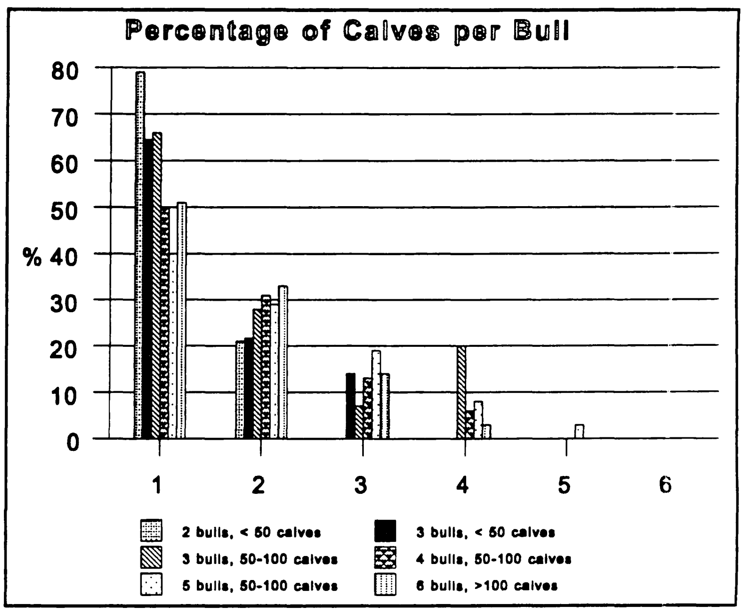
Parentage Exclusion. At a single genetic marker, parents can have only two copies of the gene: one from their sire and one from their dam. There can be many different forms of the gene at each marker, but each parent and each progeny can only have two copies. One of those two copies must be passed on to their progeny. Parentage analysis is determined by excluding potential parents until only one parent of each sex remains that has a genotype consistent with the calf's genotype. Thus, in order to successfully match calves with their sire, DNA samples from all bulls that possibly could have mated cows must be included in the analysis. For example, if three bulls were used in a given pasture and they had the genotypes at one marker as follows:

	Bull A	Bull B	Bull C
genotypes	11	23	34

A calf with the genotype □11" must have been sired by Bull A, assuming all potential bulls have been identified. Bull B and Bull C could not be the sire- they are excluded as parents. A calf with the genotype □33" is more problematic. Bull A is excluded as the parent, but more markers must be tested before either Bull B and Bull C can be excluded.

Differences in siring rate. In herds that use multiple sires in their breeding pastures, it is generally assumed that each bull will contribute equally to the genetic merit of the progeny produced. However, this is not the typical outcome. In data presented here and generated in Australia (Holroyd et al., 1998), DNA testing in multiple-sire breeding pastures has shown a wide divergence in the number of calves sired per bull. In data collected from a single ranch that has used DNA typing to match sires to calves, twenty-three breeding groups representing 42 bulls and 1615 progeny were used to evaluate differences in percentage of calves sired per bull. Two to six bulls per pasture were used in a three year period with an average bull to calf ratio of 1:18. Bull breeds used were Brangus, Simbrah, Braford and Angus; each breed was represented by a minimum of two pastures. Bulls remained with cows for a 90 day breeding season. Blood samples were collected at weaning for DNA analysis.

Bulls within a pasture did not sire an equal number of progeny. Figure 1 depicts the distribution of percentage of calves sired per bull, ranked by decreasing number of progeny. The trend was a single dominant bull in every breeding pasture, with other bulls siring an exponentially diminishing number of calves. Generalizing across groups, 50% of the bulls produced an average of 77% of the calves, regardless of the size of the groups. There were no differences among breed of bull.



Could this dominance effect be related to age of the bull, illness or just a bad year for a bull? Or do bulls with few calves the first year continue to have poor representation in future calf crops? To evaluate the long term prospects for a bull, we evaluated repeat breeders. Sixty-four percent of the bulls were used for either two or three years. Bulls were usually grouped together in subsequent years, only a few bulls were moved to other groups. Table 1 and 2 present a summary of fertility data grouped by a bull's first year fertility. Table 1 shows the data as a deviation from equal fertility among all bulls in the pasture. Table 2 shows actual percentages of fertility, not adjusted for different sized groups. Both tables show that bulls that have poor first year fertility will continue to have below average fertility. Bulls that sired 10% or fewer calves averaged less than 10% fertility in subsequent matings and represented 37% of the bulls evaluated: a substantial proportion of the total bull numbers. In fact, in all categories, a bull's first year fertility performance was related to subsequent fertility: the repeatability of fertility was 53.9%.

Table 1.
Average fertility based on a bull's first year fertility as a deviation from equal fertility.

	Deviation from equal fertility				
	20% less than average	10-20% less than average	10% below and 10% above average	10-20% above average	greater than 20% above average
Percentage of bulls in category	15%	37%	22%	15%	4%
Average fertility over all matings	-20.8%	-9.7%	2.0%	8.6%	16.6%
Average fertility over subsequent matings	-10.3%	-5.0%	5.7%	10.8%	15.4%

Table 2. Average fertility based on a bull's first year fertility.

	First year fertility			
	<10%	10-30%	30-50%	>50%
Percentage of bulls in category	37%	26%	26%	11%
Average fertility over all matings	6.2%	25.2%	35.5%	52.8%
Average fertility over subsequent matings	9.6%	30.6%	26.7%	45.3%

Holroyd et al., 1998, evaluated number of progeny produced in multiple-sire breeding pastures in northern Australia using DNA parentage analysis. They evaluated 9 herds and 37 multiple-sire mating groups. When bulls were mated in groups of seven or less, there was a greater variation in number of calves per bull than in pastures with 8 to 24. Seven percent of the bulls did not sire any calves. The repeatability of number of calves ranged from 12 to 67% on bulls used in two consecutive breeding seasons. Several measures were recorded on subsets of the bulls: dominance (measured as number of win/losses of bulls in small pen setting), scrotal circumference, semen quality, and serving capacity. Of these, dominance was significant in 2 out of the 3 sites tested, scrotal circumference was significant in 1 out of the 6 sites tested, percent normal sperm was significant in 4 out of the 6 sites tested, mounts+services (but not individual scores) were significant in 1 out of 2 sites tested. The amount of variation accounted for by all measurable factors ranged from 18% to 97% in the 6 sites.

DNA analysis for genetic evaluations. DNA analysis can be used in multiple-sire systems to link sires with the phenotypes of their progeny, thus, supplying data for a genetic evaluation program. The genetic evaluation program could be used within the commercial herd or could be utilized by a bull supplier. Unfortunately, the cost of DNA testing all calves has been prohibitive for commercial operations. The cost of an individual test is likely to be reduced due to improvements in efficiency and technology in the future. To utilize the technology today; however, an innovative strategy to reduce the actual number of DNA tests performed needs to be developed.

Phenotypic values for economically important traits usually follow a normal distribution, that is most individuals have values near the mean and fewer animals have values in the tail of the distribution. The majority of the information is contained in the tails; thus, we should be able to sample animals with extreme values for the traits and feed that information back into the genetic evaluation system. The distribution of siring rate adds an additional component of complexity to the problem, since all bulls are not expected to have an equal number of calves in a multiple sire setting.

A deterministic model that estimates genetic improvement and economic benefits when utilizing new technologies has been written by Gerard Davis from Genetic Solutions as described in Davis and DeNise, 1998. The model estimates the net genetic gain expected by sampling animals at both ends of the distribution, and accounts for the multi-sire effects of unequal progeny per sire. The marginal genetic improvement is estimated when additional information from DNA testing is available. The program allows for sampling the calves from any percentage of the total calf crop (equal proportions in each tail) and estimates the selection intensity based on selected data (Burrows, 1972 and Saxton, 1988). The marginal increase in genetic values due to implementing the technology is used in an economic model. The economic model estimates the economic benefit of the marginal value over a specified time horizon.

In the examples presented, a 500 cow herd was modeled with a bull to cow ratio of 1:25. Bulls were used for 3 years and the average age of the cows was 7 years; 80% of the calves survived to the testing stage. Using the data from the multi-sire breeding pasture analysis, it was assumed that 50% of the bulls produced 80% of the calves. Every calf has a permanent identification that links it to performance data (birth weights, weaning weights, carcass information, i.e. all traits in the breeding objective). Different DNA sampling strategies were compared: testing 40% (20% of the best and 20% of the worst), 80% (40% of the best and 40% of the worst) or 100% (all) of the calves. Using this information, the net genetic gain was estimated from the additional information generated from DNA analysis. This information was used to select bulls as future sires.

The economic model predicts the benefit of the technology over a time horizon. The technology can be applied for a given period, but the benefit will continue to pay back to the operation from improved genes contained in replacement animals. The economic return was estimated from net present value that accounts for the discount rate (5% in this example), the lag time between implementation of the technology and when the benefit is realized (2 years before improved bulls have calves going to slaughter), the value of the gain, the amount of gain per year, the rate of adoption, and the dilution effect of removing selection pressure after the technology is no longer applied (see Davis and DeNise, 1998, for additional details). Annual costs of implementing the technology and the returned value based on the marginal genetic improvement were estimated for a 10 year horizon, after the test had been used for 5 years. The benefit was defined as the return minus the cost. The cost of the test was set at $25 per animal.

The first example modeled a herd that was selecting for an index of marbling score and percent retail yield. The value of 1% increase in the index was estimated at $4.59 based on Melton, 1995, and the heritability of the index was .45. Table 3 shows the maximum annual cost of the technology, the accumulated benefit over the 10 year horizon, and the benefit: cost ratio when sampling 40%, 80% or 100% of the steer calves.

Table 3. Maximum annual cost of DNA testing steer progeny, accumulated benefit over a 10 year horizon, and benefit: cost ratio under different sampling strategies when selecting for an index of marbling and percent retail yield.

	Sampling Strategy		
	40%	80%	100%
Maximum Annual Cost ($)	2,167	4,167	5,167
Accumulated Benefit (10 yrs, $)	75,927	71,518	67,548
Benefit:Cost	6.29	3.08	2.35

In this scenario, the marginal improvement in genetic gain based on DNA analysis is beneficial because the traits cannot be measured in the parents and it is assumed that bulls do not have EPDs for carcass merit. Without DNA analysis, there could be no genetic improvement; and, because all emphasis was placed on consumptive traits, the benefit of using DNA technology is apparent. The surprising outcome of this analysis is that substantial improvement can be made from sampling a limited number of calves.

In a multi-sire operation without DNA testing the only opportunity for genetically improving consumptive traits is to select replacement bulls with EPDs for carcass merit, but these EPDs will have low accuracies. DNA analysis of a limited number of calves not only helps a producer identify bulls with inferior carcass merit genes, but can also benefit the bull supplier. Bull suppliers could use this information to more accurately predict genetic merit among related individuals still in their herd.

The most important contribution of this strategy is that only a fraction of the calves must be DNA tested to see genetic improvement. In this scenario, the greatest benefit occurs when sampling only 40% of the steer calves and the benefit of sampling only a fraction of the calves increases the value of the test in a non-linear fashion. With this sort of selection program, a producer could use the test to make long-term gains in consumptive traits with short-term selection pressure.

The second example modeled a herd that was selecting for postweaning gain. In this scenario, individual bull weights were recorded postweaning, thus each bull already had an EPD for gain. Both steer and heifer calves were included in the analysis. Table 4 shows the maximum annual cost of the technology and the accumulated benefit over the 10 year horizon when sampling 40%, 80% or 100% of all calves.

Table 4. Maximum annual cost of DNA testing, accumulated benefit over a 10 year horizon, and benefit: cost ratio under different sampling strategies when selecting for post-weaning gain.

	Sampling Strategy		
	40%	80%	100%
Maximum Annual Cost ($)	4,167	8,167	10,167
Accumulated Benefit (10 yrs, $)	(29,773)	(51,610)	(62,775)

DNA analysis under these conditions is never profitable because bulls have a highly accurate estimate of genetic value from their own records. Understanding when DNA analysis may be useful in a commercial operation is the key for using the technology effectively and profitably.

Conclusion. Producers will be faced with a number of new technologies that have the potential to influence the profitability of their operation. DNA parentage analysis is one of the technologies that is readily available, but the cost of implementing the program has been prohibitive for most commercial operations. Two different examples were presented to show how the technology could be utilized in our current production systems.

Bulls do not sire calves equally in multi-sire breeding pastures. The reasons for this outcome are not well understood but the results influence the genetic makeup of the calf crop and affect the value and maintenance costs of bulls. In multi-sire settings, the only way to determine the contribution of bulls is a parentage verification analysis.

Commercial producers rely on bull suppliers to provide them with animals that have the genetic merit required for a particular operation. Melton (1995) reported that the economic emphasis among reproduction, production and consumptive traits shifts depending on whether you are a cow-calf producer or you contribute to an integrated production system like a strategic alliance. He summarizes that a cow-calf producer should have a relative economic emphasis of 47% on reproduction, 24% on production and 30% on consumption, while an integrated producer should have a relative economic emphasis of 31% on reproduction, 29% on production and 40% on consumptive traits. As the emphasis shifts to the consumptive traits, the need to have timely, accurate information concerning the genetic merit of parents becomes even more critical. Progeny testing is the most accurate method to determine the genetic worth of a bull for carcass merit traits. DNA testing a limited number of calves allows a producer to identify bulls not meeting their targets for consumptive traits, and allows them to control the costs of the testing.

As for the future, markers linked to traits influencing carcass merit are currently being tested in a number of breeds. These markers could be used for two purposes: identifying calves with high value for carcass traits and allowing for parentage verification. These markers may be able to provide feedback for selection programs and help producers decide how to market specific animals. DNA technologies will become more integrated and less costly in the future, and will provide new management tools that will help producers position themselves for their specific goals.

Literature Cited.

Burrows, P.M. 1972. Expected selection differentials for directional selection. Biometrics 28:1091.

Davis, G.P. and S.K. DeNise. 1998. The impact of genetic markers on selection. J. Anim. Sci. 76:2331.

Holroyd, R.G. V.J. Doogan, J. DeFaveri, G. Fordyce, M.R. McGowan, J.D. Bertram, D.M. Vankan, L.A. Fitzpatrick, G.A. Jayawardhana and R.G. Miller. 1998. Bull selection and use in northern Australia: Calf output and predictors of fertility of bulls in multiple-sire herds. Proc. XX World Assoc. for Buiatrics Cong., Sydney, Australia, July. p. 417.

Melton, B. 1995. Economic differences between commercial and seedstock genetic decisions. Proc. Composite Cattle Breeders International Assoc. North Platte, NE, August.

Saxton, A.M. 1988. Further approximations for selection intensity. Theor. Appl. Genet. 76:465.

IDENTIFICATION OF GENES INFLUENCING REPRODUCTION IN CATTLE

Steven M. Kappes, Gary L. Bennett, and R. Mark Thallman
USDA, ARS, U. S. Meat Animal Research Center

Reproductive performance is a major determinant of profitability for cattle producers. Melton (1995) found reproductive traits to be more than twice as economically important as production traits for commercial cow-calf producers. Selection for reproductive performance has had limited success because of long generation interval for progeny testing, low estimates of heritability, and it is a sex-limited trait. If loci or genes affecting reproductive performance traits can be identified then DNA markers can be used to select genetically superior animals and improve the selection response.

Numerous gene mapping studies are being used to identify genes influencing production traits in cattle and other livestock species. Our ability to identify these genes is dependent upon several factors. One critical factor is the percentage of the total variation for a trait that is controlled by genetics. Genes influencing highly heritable traits (i.e., growth and carcass traits) should be easier to identify than genes for lowly heritable traits (i.e., reproduction and disease resistance). Many traits, including reproduction, are measured in a manner that actually measures several components. The percentage of cows that wean a calf is a common measurement of reproductive performance and it includes conception, embryo/fetal survival, calving, and postnatal survival. Conception rate, another measurement of reproduction, is actually a multi-component trait itself and it includes postpartum interval or age of puberty, ovulation, fertilization and embryo/fetal survival until time of pregnancy detection. The low heritability estimates of reproductive traits are not only due to genetic and non-genetic factors (nutrition, environment, animal health, etc.) of the cow but also interactions between the cow and bull (genetic and non-genetic). In addition, most females have only a few parities and therefore it is quite difficult to estimate genetic differences in reproduction. This does not necessarily indicate that genetics has a very small effect on components of reproduction but the manner that we are measuring reproduction efficiency does not allow us to detect genetic differences very well when they do exist.

A strategy to increase the likelihood of identifying genetic variation in a multi-component trait is to dissect the trait into separate components and measure them independently. We were fortunate to have a cattle population at the U. S. Meat Animal Research Center (MARC) that has been evaluated for components of reproduction. The MARC twinning population (Gregory et al., 1990; 1997) has been selected for increased twinning rate since 1981. A total of 2,510 cows have produced 7,626 calving records. The heritability estimates in this population for a single observation of ovulation rate and twinning rate were .10 and .09, respectively. The low heritability estimates indicate that genetic response would be limited when selection uses only a single observation of ovulation rate or twinning rate. Multiple records of ovulation rate in heifers were used to obtain a better estimate of genetic potential for ovulation rate and twinning rate at a very young age. This also allowed new sires to be progeny tested by the time that they were

4 years of age. Ovulation rate data has been collected for 3,556 heifers by ovarian palpation for 6-8 estrous cycles per female. The estimate of heritability for the mean ovulation rate from six estrous cycles was .35 (Gregory et al., 1997) and the genetic correlation between ovulation rate and twinning rate was .75. Ovulation rate and twinning rate data are used in a multiple-trait animal model for calculating predicted breeding values, which are used as a selection tool (Van Vleck et al., 1991; Van Vleck and Gregory, 1996). The current rate of multiple ovulation is approximately 25% in 12 to 18-month-old heifers and the current twinning rate exceeds 35% (Echternkamp and Gregory, 1999).

The MARC twinning population was used to initiate a quantitative trait loci (QTL) project designed to identify ovulation rate and twinning rate loci. Research on ovulation rate and twinning rate loci should identify critical components of reproduction. Genes that influence ovulation rate are likely to be involved in follicular recruitment and development, or the ovulation process. Genes that influence twinning rate and not ovulation rate are likely to be involved in fertilization, embryo survival, implantation or other components of conception.

DNA markers were genotyped on 181 sires of the twinning population to scan the entire genome and select chromosomal regions for genotyping in female progeny. The 181 sires represented essentially all of the sires that had been progeny tested since the inception of the project and had semen available for DNA extraction. A statistical analysis was performed on 10 sire families. Forty-one chromosomal regions were selected to evaluate in female progeny. A chromosomal region was defined as a region of a chromosome that passed a statistical threshold for each sire. Strong statistical evidence indicates that loci affecting ovulation rate have been identified on chromosomes 5, 9, 10, and 22. A previous report (Blattman et al., 1996) had identified a locus on chromosome 7 that affects ovulation rate in the MARC twinning population. Loci on chromosome 4 and chromosome 28 appear to influence twinning rate and not ovulation rate.

The MARC twinning population is the result of a selection experiment and it represents a multi-generation, complex pedigree with many relationships between animals within and across generations. Consequently, its structure is not optimized for the analysis of quantitative trait loci (QTL) and standard methods of analysis used in populations designed for QTL detection are not applicable. Current analysis programs require ignoring many of the relationships before the analysis can be performed and therefore, a large amount of mapping information is lost from complex pedigrees. A statistical analysis program has been developed (Thallman et al., 1999; submitted) that is capable of analyzing genetic marker data in complex pedigrees using a founding alleles model.

A very small part of the twinning population has been used to identify these loci. The remainder of twinning animals with available DNA will be used to add statistical support for these loci, resolve the location of each locus to a smaller chromosomal region, characterize a larger number of founding alleles for each locus, and obtain more accurate estimates of effects for the different founding alleles. Development of the founding allele analysis has enabled us to utilize more of the mapping information that is available in the twinning population. It also provides the information that will be needed to implement a marker-assisted selection program that augments the current predicted breeding value (PBV) selection program. The genotyping process and analysis program are well suited for using industry populations that have been selected for different production traits for a number of generations. The genotyping process for the twinning population involved genotyping markers that cover all of the chromosomes only in sires that had semen available. Selected progeny were only genotyped for markers in specific chromosomal regions based upon the analysis with the sires' genotypic data. The founding allele analysis uses genotypic information of related animals to predict the genotypes of ungenotyped animals. Therefore, the founding allele analysis uses mapping information from ungenotyped animals in the analysis. In many cases, including industry cattle populations, phenotypic data has been collected for a number of generations but DNA is not available except from the current generation. Provided that semen is available from some of the older generation sires, these populations can be used to map loci that affect production traits if that data has been collected.

Some industry populations are quite similar to long-term selection experiments because they represent multi-generation, complex pedigrees that contain considerable mapping information. Industry populations can be an integral part of evaluating mapping information because the effects of the different segregating alleles will need to be characterized in different populations. New loci can also be identified in the industry populations with simultaneous use of marker-assisted selection for previously identified and characterized loci.

Identification of loci influencing a production trait is only the first step in identifying the genes that cause variation in the trait. The genes do not need to be identified before the loci can be used in a selection program but identification of the genes and the particular sequence differences that are causing phenotypic variation will make it easier to utilize the locus in different cattle populations. Identification of the genes and characterization of the different alleles will also enhance our understanding of the biochemical and physiological processes involved in determining the phenotype of the trait.

Mapping efforts in humans and mice will help identify genes for livestock QTL because these maps contain many more genes than the livestock maps and because regions of the maps are conserved across species. If a locus has been identified by a cattle QTL mapping study then genes in the region of the locus are used to identify a similar region on the human map. Different genes are selected from the human map that appear to be located at the most likely position of the locus on the cattle map and these genes are mapped in cattle. Genes that map in the same location on the cattle map as the QTL are sequenced to determine if sequence differences can be associated with different effects on the phenotype. A limitation of this process is that very few cattle genes have been mapped. Several research groups have initiated an effort to map a large number of genes in cattle and other livestock species by sequencing short segments of genes to determine, by sequence similarity, the homologous gene in humans and then map the gene on the livestock map. This effort will indicate which cattle and human chromosomal regions contain the same genes. These comparative maps between cattle, other livestock species and humans will rapidly increase the rate that genes can be identified for the different QTL. Genes identified by mapping studies of different species for the same traits can also be evaluated across species. Genes affecting reproduction traits in sheep and pigs (or other mammalian species) may or may not cause variation in reproduction in cattle. However, it is very likely that the genes will have a similar function in cattle.

Mapping genes that influence components of reproduction not only identifies genes that cause variation in reproductive traits but these genes can also be used to identify other genes in the biochemical and physiological pathways that are essential for reproduction. Gene expression studies can be performed that will identify genes that interact with the genes identified in the QTL studies. Recent technological advancements, primarily from the human gene mapping field, have provided new tools to perform expression studies on a very large number of genes at a considerable savings of time and money. Identification of genes that are involved in the biochemical and physiological pathways that are required for reproduction will enhance our understanding of reproduction and may lead to pharmaceutical agents that can be used to increase reproductive efficiency.

References

Blattman, A. N., B. W. Kirkpatrick, and K. E. Gregory. 1996. A search for quantitative trait loci for ovulation rate in cattle. Anim. Genet. 27:157-162.

Echternkamp, S. E., and K. E. Gregory. 1999. Effects of twinning on gestation length, retained placenta, and dystocia. J. Anim. Sci. 77:39-47.

Gregory , K. E., G. L. Bennett, L. D. Van Vleck, S. E. Echternkamp, and L. V. Cundiff. 1997. Genetic and environmental parameters for ovulation rate, twinning rate, and weight traits in a cattle population selected for twinning. J. Anim. Sci. 75:1213-1222.

Gregory, K. E., S. E. Echternkamp, G. E. Dickerson, L. V. Cundiff, R. M. Koch, and L. D. Van Vleck. 1990. Twinning in cattle: Foundation animals and genetic and environmental effects on twinning rate. J. Anim. Sci. 68:1867-1876.

Melton, B. E. 1995. Conception to consumption: The economics of genetic improvement. Annual Beef Improvement Federation Meeting. pp. 40-69.

Van Vleck, L. D., and K. E. Gregory. 1996. Genetic trend and environmental effects in a population of cattle selected for twinning. J. Anim. Sci. 74:522-528.

Van Vleck, L. D., K. E. Gregory, and S. E. Echternkamp. 1991. Prediction of breeding values for twinning rate and ovulation rate with a multiple trait, repeated records animal model. J. Anim. Sci. 69:3959-3966.

Live Animal and Carcass Evaluation Session

Minutes

Live Animal and Carcass Evaluation Committee
Roanoke, Virginia
June 18, 1999

The meeting was called to order by Chairman Cunningham at 2:00 pm on June 18, 1999.

Chairman Cunningham gave an introduction and described the purpose of the Committee. Also, he went through the list of agenda items.

The first half of the committee meeting was devoted to the use of ultrasound for genetic prediction of carcass traits. Dr. Doyle Wilson gave a report of some preliminary research using centrally processed ultrasound records conducted by Iowa State University and the American Angus Association. Dr. John Hough, EPD International Inc., provided an update of the carcass evaluation program using ultrasound data developed by the American Hereford Association. Loren Jackson, International Brangus Breeders Association, provided an update of the Brangus ultrasound genetic evaluation, which is the longest running evaluation using ultrasound data.

Dr. Robert Williams, American-International Charolais Association, provided a report of the status of ultrasound in the performance programs of a number of breed associations

Dr. Bruce Cunningham, American Simmental Association, gave a report on the standardization of reporting ultrasound information from technicians to breeders to their respective breed associations.

Dr. Sally Dolezal, Oklahoma State University, presented a report on the Boxed Beef Calculator software developed at Oklahoma State University and its use for ranking sires based on boxed beef cut out value.

After asking if there were any additional business to be discussed by the committee, Chairman Cunningham closed the meeting at 4:30 p.m.

Respectfully submitted,

Bruce E. Cunningham, Ph.D.
Chairman

GENETIC EVALUATION OF ULTRASOUND MEASURES: ANGUS

D. Wilson, G. Rouse, C. Hays, and A. Hassen
Iowa State University, Ames, IA

Iowa State University (ISU) has a two year research project with the American Angus Association (AAA) to develop ultrasound-based expected progeny differences (EPD) for carcass traits. The project was initiated January 1, 1998 and will end December 30, 1999. The two major elements of this project are to develop a centralized ultrasound processing capability and to develop the genetic prediction methodology. The purpose of this report is to provide an update on the genetic prediction methodology.

The majority of the scans that breeders have collected are from yearling bulls, however, there is a sizeable number of replacement heifers. The centralized processing status as of June 6, 2999 is given in Table 1 for the different classes of animals that are being scanned.

The genetic analysis to date has only been on the yearling bull data. Analysis of the heifer data will occur after the analysis of the bull data is complete. Table 2 summarizes the combined 1998 and 1999 ultrasound data that is available. This data has been edited to remove data outside the age range of 320-440 days. Animal records with missing observations have also been deleted. Ultrasound measures include % muscular fat (marbling), ribeye area, 12-13th rib fat thickness, and rump fat thickness. The yearling bull records are represented by 1,630 sires. All weight and ultrasound records were age adjusted to a 365-day end point. Ribeye area, 12-13th rib fat thickness, and rump fat thickness are additionally adjusted for an animal's weight at scanning time as deviated from its 365-day weight. These bulls are significantly younger than steers going into the carcass database and much easier to evaluate genetically because their individual measures do not require major end point adjustments.

Of major importance to breeders are the genetic relationships between ultrasound-measured traits in yearling bulls and similar traits measured in steer carcasses. The first results of this research for the Angus breed are presented in Table 3. There were 19,095 ultrasound records and 42,353 carcass records included in the analysis. Heritabilities of the traits are listed on the diagonal. The genetic correlations are presented below the diagonal. Variance component estimates were developed using an Average Information-Restricted Maximum Likelihood algorithm. The analysis was conducted both pair-wise and multiple-trait (four traits), with consistent variance component estimates from both methods. Results of significance are: (1) heritability estimates in this joint analysis are consistent and almost identical to previously developed estimates using the ultrasound data alone and using the carcass data alone, (2) genetic correlation estimates within ultrasound traits and within carcass traits are almost identical to estimates previously determined, and (3) genetic correlations between the three basic traits of marbling (or % Fat), ribeye area, and external fat thickness as measured in either yearling bulls or in steer carcasses are all higher than .70. Genetic correlations of this magnitude would strongly suggest that the traits are identical, and that breeders can use ultrasound EPDs to make the same genetic progress in these three traits as compared to using carcass EPDs.

It is anticipated that long term and expensive progeny carcass testing programs within the Angus breed will soon receive much less emphasis than ultrasound scanning. Genetic progress will in fact be much faster with ultrasound because of the shortened generation interval achieved by measuring yearling bulls and heifers. Additionally, an animal model will be used that allows for accounting for the female side as well as the male side of an animals pedigree.

Table 1. Centralized ultrasound processing status for Angus cattle as of June 6, 1999

Class	1998	1999
Yearling bulls	6,224	20,816
Replacement heifers	1,194	5,586
Steers	542	579
Feedlot heifers	42	76
Commercial bulls	718	4,126
Commercial heifers	118	965
Serial scan project cattle	537	780

Table 2. Yearling Angus bull ultrasound measures

Trait	Mean	Std. Dev.
Age, days	365	23.6
Weight, lb	1079	120
% Fat, %	3.51	.84
Ribeye area, sq. in.	11.84	1.47
12-13th rib fat, in.	.25	.09
Rump fat, in.	.29	.10

Table 3. Heritability and genetic correlation estimates for yearling Angus bull ultrasound- measured traits and carcass traits measured in steer carcasses.

	Bulls			Steers		
Trait	U % Fat	U REA	U Fat	C Marb.	C REA	C Fat
U % Fat	.30*					
U REA	-.18**	.37				
U Fat	.11	.24	.33			
C Marb.	.77	-.14	-.02	.37		
C REA	-.15	.71	.01	-.07	.28	
C Fat	.04	.00	.75	.01	-.18	.24

*Heritability estimates on the diagonal

** Genetic correlations in the off-diagonals.

GENETIC EVALUATION OF ULTRASOUND MEASUREMENTS

FOR HEREFORD CATTLE

John Hough, EPD International, Statham, Georgia and
William Herring, University of Missouri, Columbia, Missouri

Ultrasound technology has been gaining considerable attention in the past several years. Even though ultrasound measurements of ribeye area and fat thickness have been available for many years, estimation of intramuscular fat in live cattle has stimulated the most interest. The American Hereford Association (AHA) commissioned the University of Missouri to analyze its ultrasound data to test the appropriateness of the information to be utilized in a genetic analysis. After this original research was completed, the University of Georgia conducted the actual genetic analysis for carcass traits.

Considerable debate has existed whether actual carcass measurements of steers in the cooler are more beneficial than ultrasound measurements of live breeding cattle for predicting carcass merit. There are certainly trade-offs when evaluating either methodology to measure carcass traits. The advantages of actual steer carcass measurements include the fact that most producers have the perception that actual carcass measurements are more accurate than ultrasound measurements. In addition, actual steer carcasses are indeed the actual end product that is produced, not yearling breeding cattle. The industry standard is actual carcass data.

Nonetheless, ultrasound measurements have several advantages over actual carcass measurements. The timeline to grow cattle and collect ultrasound data is considerably shorter. Typically, one can have accurate carcass evaluations based on ultrasound two to four years prior to having the same evaluation based on actual steer carcass measurements. Seedstock breeders produce breeding cattle, not necessarily steers, thus collecting ultrasound measurements on their own breeding cattle is considerably easier for seedstock breeders compared to feeding and collecting packing plant carcass data from steers produced by their breeding cattle. When measuring breeding cattle, collecting data from complete contemporary groups is considerably more realistic than with feedlot steers. Seldom is every sire produced mated to commercial cows to produce steers for carcass data collection. Additionally, when measuring yearling breeding cattle, it is very simple to collect ultrasound measurements on each and every animal within the contemporary group. Because of these combined reasons, collecting ultrasound data on many more cattle compared to actual carcass measurements is quite realistic. The overall costs associated with collection ultrasound data are typically less than those associated with actual steer carcass measurements.

The real bottom line though is to address the question: Would sire EPDs rank the same if based on yearling ultrasound breeding cattle progeny compared to steer progeny carcass traits. Some research, considerable experience and the above points prompted the American Hereford Association to answer "Yes".

The Hereford ultrasound database consisted of over 10,000 records collected by Animal Ultrasound Practitioners (AUP) certified technicians. Technicians were certified in single traits, not necessarily all traits. If a technician was not certified in a specific trait, that measurement was not utilized in the analysis. All ultrasound measurements were adjusted to 365 days of age with acceptable ages between 330 and 430 days of age. Normal yearling weight contemporary grouping definitions were included in the analysis. Weaning weights were included in a multiple-trait analysis to account for selective data reporting as well as to account for an animal's weight while calculating carcass EPDs. Sire as well as Paternal and Maternal grandsire connectivity was required in the genetic analysis. Restricted maximum likelihood procedures were utilized to estimate genetic and environmental variances and covariances.

For the (co)variance component estimation, the raw records were edited very stringently. Final numbers of weaning weights numbered 5,214 with a mean of 603 lb. There were 1,351 ultrasound intramuscular fat measurements with a mean of 3.56%. There were 4,634 ultrasound fat thickness measurements with a mean of .19 in. There were 4,636 ultrasound ribeye measurements with a mean of 11.56 sq. in.

Table 1 shows the heritabilities of each of the traits in the analysis. Generally, these values are quit similar to those found in prior research studies. Carcass traits certainly are ample to facilitate genetic response to selection. As in many other studies, the genetic correlation between fat and ribeye was very large, while the other carcass correlations were nearly zero. Tables 2 through 4 show the descriptions of each of the carcass EPD traits.

The initial release and printing of ultrasound carcass EPDs was July 1998. Overall accuracy of this analysis was considerably less than the normal growth trait analysis simply because of the number of records being analyzed. To put the two analyses into perspective, there are approximately 0.5% as many ultrasound records in the AHA database compared to weaning weight. An increasing number of ultrasound records are currently being collected, particularly since carcass EPDs have been released. The overall accuracy of the analysis will certainly increase with more records. As the ultrasound database size increases, the statistical models and (co)variance estimation will need to be refined.

Another factor to note is the carcass EPDs currently published are not on a "steer carcass" basis, but are on a yearling breeding animal basis. Since very little Hereford cross-reference information between bulls and steers is available, the steer-basis adjustment was not an option. As carcass EPDs were first released, a considerable effort was spent on education against single-trait selection based on these or any trait. Because of adverse relationships to other economically import traits, one should not select for only carcass traits.

The first AHA Carcass Sire Summary was released in June, 1998. There were 177 total bulls published in the listing that met two criteria: 1) At least one carcass trait must have had at least a .60 accuracy and 2) At least 5 ultrasound measured progeny must have been utilized in the analysis. There has not been another genetic analysis for any traits since that time. The following three graphs show the distributions for published sires for each of the carcass traits. These graphs show the range in sire EPDs as well as the actual EPD increments.

Plans at the American Hereford Association are to continue and expand the ultrasound measurement of bulls and heifers. Additionally a designed progeny carcass evaluation program has been initiated. Actual carcass data will be gathered as well as ultrasound on some groups. The BIF Guidelines are being followed in this designed progeny test. Approximately 10 to 15 commercial herds are utilizing 25 to 30 sires on 2,000 to 2,500 females. Contemporary groups are being maintained through marketing with the initial data ready for analysis the summer of 2000. This information will also be utilized in the NCBA National Carcass Tenderness Project. The ultimate goal is to utilize both ultrasound and actual steer carcass data in the same genetic analysis.

Research indicates ultrasound measurements in yearling bulls can be used to calculate carcass EPDs. Based on this information AHA has calculated and released the initial ultrasound carcass EPDs. Acceptance has been very favorable to this point. Additionally, a designed actual carcass program is under way with the ultimate goal of ultrasound and carcass measurements jointly being used for future AHA genetic evaluation programs.

Table 1. Heritabilities and Genetic Correlations[a]

	WnWt[b] direct	WnWt maternal	UIMF	Ufat	UREA
WnWt[b] direct	.44				
WnWt maternal	-.55	.15			
UIMF	-.01	.01	.39		
Ufat	.54	.04	-.02	.26	
UREA	.68	.00	-.01	.59	.31

[a] Heritabilities on the diagonal and genetic correlations below the diagonal.
[b] WnWt= Weaning weight, UIMF=Ultrasound intramuscular fat percentage, Ufat=Ultrasound 12th rib fat thickness, UREA=Ultrasound ribeye area.

Table 2. Description of Fat Thickness EPDs

Variable	N	Mean	Minimum	Maximum
Phenotype, in.	9,493	.19	.01	.62
EPD, in.	35,326	.00	-.03	.05
Accuracy	35,326	.24	.07	.84
Progeny	26,106	.73	0	93

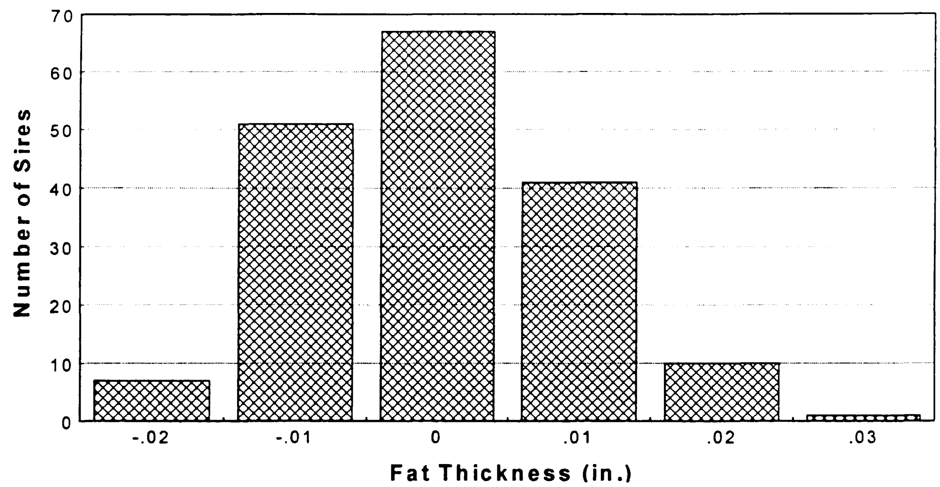
Table 3. Description of Ribeye Area EPDs

Variable	N	Mean	Minimum	Maximum
Phenotype, in^2.	9,239	10.9	5.4	16.7
EPD, in^2.	35,497	.02	-0.5	0.9
Accuracy	35,497	.24	. 08	.84
Progeny	26,106	.71	0	93

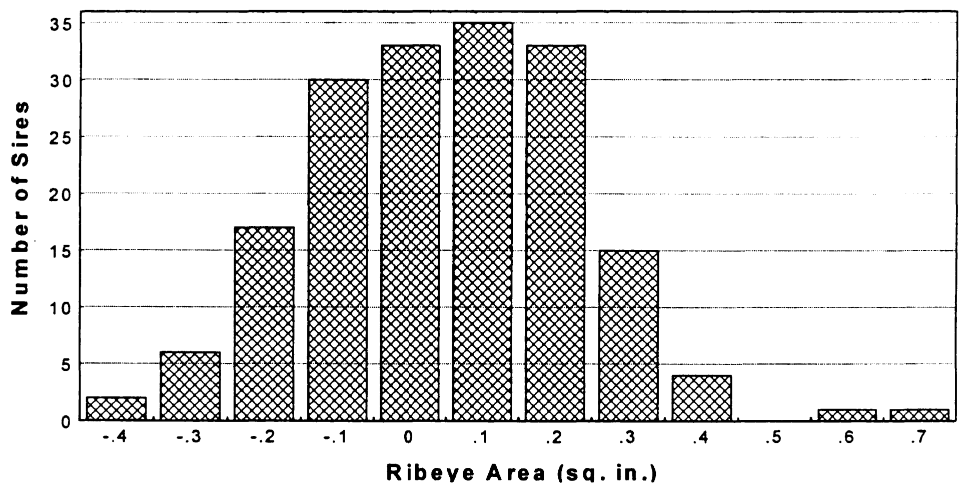
Table 4. Description of Intramuscular Fat Percentage EPDs

Variable	N	Mean	Minimum	Maximum
Phenotype, %	3,759	3.3	.45	7.8
EPD, %	15,403	0.0	-.5	.6
Accuracy	15,403	.24	.09	.81
Progeny	26,106	.73	0	67

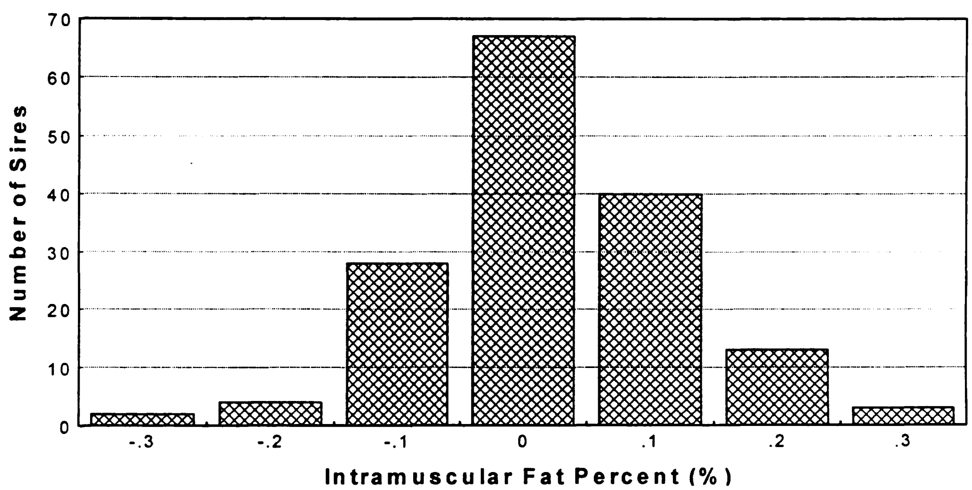
Graph 1. Distribution of Sire EPDs for Fat Thickness



Graph 2. Distribution of Sire EPDs for Ribeye Area



Graph 3. Distribution of Sire EPDs for Intramuscular Fat Percent



BRANGUS ULTRASOUND GENETIC EVALUATION PROGRAM

Loren Jackson, International Brangus Breeders Association

Genetic evaluation of Brangus cattle through the use of real-time ultrasound was first initiated in 1986.

IBBA believed the advancement of the technology would ultimately have a favorable impact on beef cattle selection in the future. For this reason, IBBA actively participated in research development.

The IBBA database currently has information from over 100 producers. Total field data records include in excess of 20,000 measurements for rib eye area and fat thickness and over 9,000 records for percent intramuscular fat.

Brangus implemented the first rib eye area EPD from real-time ultrasound technology in the Fall of 1995. Additional EPDs for carcass traits from ultrasound were added in 1998 for fat thickness and percent intramuscular fat.

IBBA requires that all data be collected by certified technicians of the association of Animal Ultrasound Practitioners (AUP).

The carcass trait genetic evaluation utilized by IBBA and developed by The University of Georgia is a multiple trait analysis with weaning and yearling weight. The genetic correlation between traits is included to provide better estimates of prediction.

Both ultrasound and carcass data measurements are included in the analysis and EPDs are generated on an ultrasound EPD basis. The decision was made to calculate the EPDs on an ultrasound basis rather than a carcass basis, since the number of ultrasound measurements significantly overshadows the number of carcass measurements in the analysis. It is estimated that this trend will certainly continue and will most likely be weighted more heavily toward ultrasound information in the future.

In the process of analyzing the Brangus ultrasound and carcass data, IBBA and The University of Georgia decided to eliminate measurements scanned prior to 1994. Removing this information significantly improved the genetic correlation between the ultrasound and carcass data. There were several reasons for removing the early data, including technology advancements in hardware and software available for reading and interpreting the information. Also, the implementation of the technician certification process significantly advanced the quality of the data included in the evaluation.

IBBA feels confident that the Brangus heritiability estimates and genetic relationships that exist between ultrasound and carcass data are significant and merit the inclusion of the data into the genetic evaluation program. Also, research indicates that genetic progress can be made in carcass traits through selection of cattle based on ultrasound genetic evaluation.

Table 1. Summary of Brangus Cattle with Ultrasound Carcass EPDs

Trait	# Animals	Avg. EPD	EPD Range	Std. Dev.
REA	15,254	0.07	-0.59 to 0.91	± 0.19
FT	12,937	-0.002	-0.021 to 0.019	± 0.005
% IMF	6,950	-0.004	-0.22 to 0.27	± 0.06

Table 2. Ultrasound Carcass Trait Genetic Trend Since 1985

Birth Year	REA EPD	%IMF EPD	F. T. EPD
1985	-0.04	-.01	0.000
1986	-0.07	-.01	-0.001
1987	-0.06	.00	-0.002
1988	-0.04	.00	-0.003
1989	-0.03	-.01	-0.003
1990	0.00	.00	-0.002
1991	0.04	.00	-0.003
1992	0.06	.00	-0.002
1993	0.08	.00	-0.002
1994	0.11	.00	-0.002
1995	0.16	.00	-0.001
1996	0.17	-.01	-0.002
1997	0.20	-.01	-0.001

Table 3. Heritability Estimates from Brangus Ultrasound Carcass Analysis

	Ultrasound	Carcass
Rib Eye Area	.24	.33
Fat Thickness	.25	.29
% Intramuscular Fat/Marbling	.18	.33

Table 4. Genetic Correlation of Yearling Seedstock Ultrasound Measurements with steer carcass measurements

Trait	Entire Ultrasound Data Set	Elimination of Ultrasound Prior to 1994
U FAT – C FAT	.69	.71
U REA – C REA	.71	.90
U IMF% - C MARB	.42	.70

ULTRASOUND RECORDING AMONG BREED ASSOCIATIONS

Robert Williams, Director of Breed Improvement
American-International Charolais Association
Canadian Charolais Association

Breed associations and its members are well aware of the cost and other problems associated with collecting carcass data on fed progeny for sire evaluation programs. Recent research and the success of a few breeds utilizing ultrasound data for the computation of EPDs has shown that such data can be used to compute Carcass EPD that will result in a meaningful genetic description of seedstock and their fed progeny. It appears that ultrasound can be a cost-effective way to expand the breeds database for carcass merit without jeopardizing the integrity of the data. However, there has been some confusion among ultrasound technicians concerning training and qualifications for the acceptance of ultrasound data by different breed associations, especially those technicians that are new to the business. Furthermore, breed associations are not unified on policy regarding the collection, technician requirements and submission of data for inclusion in the breed database. To address some of these concerns among breed associations a meeting was held during the National Western Stock Show in Denver, Colorado on January 17, 1999.

Six beef breeds were represented at the meeting while several others expressed an interest but were unable to attend due to scheduling conflicts. Those breeds that were able to attend the meeting were the American Maine Anjou Association, American Simmental Association, International Brangus Breeders Association, American Hereford Association, American Gelbvieh Association and the American-International Charolais Association. Each breed in attendance expressed that interest among breeders for the collection of ultrasound data for Carcass Merit EPD was high. Currently the American Hereford Association and the International Brangus Breeders Association both publish EPD for carcass merit based on ultrasound measurements.

All breeds in attendance that have association policy require certification of ultrasound technician's either through the Animal Ultrasound Practitioners Association or the American Angus Associations Centralized Ultrasound Processing Center. Several in attendance expressed support for an independent and unbiased certification process. For a more complete list regarding current association policy see Table 1. Some additional information is made available for U.S. beef breed associations outside the United States. Many breeds are now adopting policy regarding the collection and interpretation of ultrasound images. The Animal Ultrasound Practitioners Association certification guidelines were discussed. Discussion centered on the training and cost of certifying technicians. The continued training and certification of technicians was a major concern to those in attendance. Furthermore, the participants agreed that the responsibility of reporting data rested with the breeder. Ultrasound technicians can help tremendously by knowing what data to report and in what format. In an effort to standardize data reporting across breeds it was agreed to review the forms for several breeds and to design a standard form for ultrasound technicians to use.

Other discussion was concerned with the current cost of collecting ultrasound data and continuing research needs. There was concern expressed about inadequate values for lower marbling cattle, this is a particular concern when measuring yearling bulls that have been developed on grass. Also more research needs to be done in Continental breeds to confirm the utility of utilizing ultrasound data on different breed types.

It was a general consensus that the use of ultrasound for the live animal evaluation of carcass merit in beef cattle has moved forward in the last 5 to 10 years. There is little reason not to expect similar improvements in ultrasound in the next 5 to 10 years given that interest and competition can remain high. Cooperation among breeds and improved communication between the breed associations and technicians will be an asset to continued improvements in the technology and subsequent use of the information generated.

Table 1. Current Policy Status of Breed Associations

Breed	AUP	AAACUP	Policy In Place
United States			
Angus		Yes	Yes
Beefmaster	Yes		Yes
Brangus	Yes		Yes
Charolais	Yes		Yes
Chianina	Yes	Yes	Yes
Gelbvieh	Yes	Yes	Proposed Policy
Hereford	Yes		Yes
Limousin	Non-Exclusive		Yes -- Encourages AAACUP Data
Maine Anjou			Evaluating Policy
Red Angus			Evaluating Policy
Salers			Evaluating Policy
Simmental	Yes	Yes	Yes -- Encourages AAACUP Data
Canadian			
Angus	Yes		Yes
Charolais	Yes		Yes
Hereford	Yes		Yes
Limousin	Yes		Yes
Simmental			Currently Adopting Policy
Australia			
Technicians are certified by the Performance Beef Breeds Association			

CHARACTERIZATION OF BOXED BEEF VALUE IN ANGUS FIELD DATA[1]

B. R. Schutte[2], S. L. Dolezal[3], H. G. Dolezal[4], and D. S. Buchanan[4]

Summary

The OSU Boxed Beef Calculator was used to generate closely-trimmed boxed beef value on 33,350 progeny produced by 1,087 sires. Wholesale prices reflected a three-year average (1995, 1996, 1997) for 19 boxed beef items and five quality grade categories. Nonconforming carcasses (i.e., YG 4.0 or >) were priced separately. Quarterly differences were significant (P<.05) indicating that boxed beef prices reflect a significant Choice/Select spread seasonal pattern. The current study indicated that sire rankings based on carcass price ($/cwt) are not expected to change between the low and average pricing periods or the average and high pricing periods. Sires in the top 10% had a higher carcass price ($/cwt) because progeny from those sires had more desirable quality by yield grade combinations than the bottom 10%. Moreover, sires in the top 10% had higher carcass values expressed in $/hd for all three quality grade spreads because of heavier carcass weights and higher carcass prices ($/cwt). The percentage of sires meeting carcass price ($/cwt) and carcass value ($/hd) benchmarks were acceptable; however, percentages could be improved with the elimination of progeny that do not conform to boxed beef fabrication specifications (U.S. Standard, yield grade 4's and 5's, and carcass weights less than 550 lb or greater than 949 lb). Absolute differences in boxed beef value represent a more industry applicable picture of profit potential for sire groups and reinforce the importance of a multiple-trait systems approach.

(Key Words: Beef Cattle, Carcass, Value.)

Introduction

Increased interest in breed strengths and application of expected progeny differences (EPD) require a fast-paced seedstock industry. Seedstock producers are planning aggressive breeding programs to meet future bull buyer needs. The American Angus Association National Sire Evaluation Report (1998) includes EPDs for percent retail product. The use of a cutability equation to predict percentage retail product allows for simultaneous consideration of relative fatness and muscling instead of independent assessment of the latter two traits. These EPDs are valuable for comparing the expected difference in average cutability of future progeny from bulls.

One of the more difficult areas to make genetic improvements based on Audit findings is in the area of enhancing taste and tenderness. Genetic tools for enhancing product quality and palatability are limited. Identification of genetic combinations to produce offspring in the upper 2/3 U.S. Choice or better categories (i.e., Certified Angus Beef™) are hindered by limited bull selection tools for quality and tenderness. Marbling EPDs are based on progeny data available in the particular breed association and are used to

[1] Oklahoma State University, Department of Animal Science 1998

[2]Graduate Assistant [3]Associate Professor [4]Professor

predict differences in average marbling score of future offspring. A challenge to seedstock and commercial cow-calf operators is to balance quality and red meat yield. Results from the American Angus Association database show a genetic correlation of nearly zero, indicating that selection for marbling does not hinder improvement in percent retail product. However, the ability to identify sires whose progeny excel in both quality grade and red meat yield remains challenging. Too often, sizeable improvements in progeny marbling deposition are accompanied with excess external and seam fat, small ribeyes, or both.

The purpose of the study was to examine the impact of average, low and high Choice/Select quality grade price spreads on Angus sire progeny mean boxed beef values as well as examines year, contemporary group, and sire effects on boxed beef value. Another objective was to determine sire close trim boxed beef value rankings based on progeny data and evaluate whether or not sire rankings differ significantly due to seasonal Choice/Select quality grade price spreads. In addition, progeny carcass performance was compared with benchmark values.

Materials and Methods

The potential exists to generate a genetic value by combining quality grade and red meat yield attributes into one selection tool. The Oklahoma State University Boxed Beef Calculator (Gardner et al., 1996) may be used to generate closely-trimmed boxed beef values for every individual carcass record on progeny of bulls. The Calculator is designed to utilize individual carcass weight, quality grade (5 levels: Prime, Premium Choice, Choice, Select, or No Roll), yield grade (nearest 0.1 yield grade; 1.0 to 5.0), and dressing percentage (individual or lot) to generate closely trimmed boxed beef values in dollars per hundred pounds of carcass weight. Through the use of a 1995-97 price database (average of the top three packers) for wholesale subprimals (19 boxed beef items), premiums and discounts are derived relative to a base value or industry par for carcass merit. Seasonality of prices exists; however, the extensive price database allows average quality grade and yield grade spreads to be generated. In the future, more detailed prices can be provided if cattle marketing endpoints and seasonal time frames are known.

Wholesale prices reflected a 3-yr average (1995 to 1997) for the 19 boxed beef items. Nonconforming carcasses were priced separately (carcasses with YG 4.0 were discounted $15/cwt from the base; YG 5.0 $20.00; <550 and >999 lb carcasses $25.00; 950-1,000 lb carcasses $10.00). The average closely trimmed premiums/discounts ($/cwt) relative to the base price for quality grades and additional yield grades were: Prime = +$5.00, Premium Choice = +$2.00, Select = -$7.79, No-Roll = -$15.58, YG 1 = +$16.27 and YG 2 = +$7.24.

Progeny data (n=37,848), adjusted for age at harvest (480 d), were received from the American Angus Association, St. Joseph, MO, and in cooperation with Iowa State University, Ames, IA. Data included herd code, harvest date, sire registration number, steer or heifer tag number, fat thickness (in, 12th/13th rib interface), ribeye area (in^2), carcass weight (lb), percentage kidney, pelvic and heart fat, percentage retail product and marbling score for progeny harvested between spring 1975 and fall 1997. Edited data for the current study (n=33,350) represented 1,087 sires with 10 or more offspring per sire. A similar approach in evaluating beef sires is reported by Dolezal and Dolezal (1998). Also, the database included 328 herds and 218 harvest dates (defined as month/year).

Progeny records were processed through the Boxed Beef Calculator using Low, Average, and High Choice/Select quality grade spreads (Low=$4.03, Average=$7.79, and High=$12.54). Thus, every progeny record was priced in each of three pricing scenarios so that three databases (Low spread, Average spread, and High spread) were available for further analyses.

Carcass traits were analyzed using a mathematical model accounting for harvest date, gender, sire and residual error term. Correlations among carcass traits were computed after accounting for these known sources of variation. Sire progeny means were computed under each Choice/Select spread scenario and sire rank correlations were examined.

Results and Discussion

Table 1 presents the characteristics of the adjusted data as well as the boxed beef data calculated using the OSU Boxed Beef Calculator. Steers comprised 93.5% of the progeny records (n=31,181), while 6.5% were heifers (n=2,169). Of the 33,350 records, 28,210 (84.6%) progeny were considered to conform to boxed beef fabrication specifications (U.S. Prime through U.S. Select, U.S. yield grades 1.00 to 3.99 and carcass weights within the range of 550 to 949 lb).

Correlations for all progeny (Table 2) indicated that percentage boxed beef yield, boxed beef yield without lean trim, boxed major cuts yield, and percentage retail product had a strong relationship with yield grade (r_p=-.94, -.99, -.99, and -.99, respectively). Correlations between retail product and other traits of interest were: carcass weight (-.26), marbling score (-.18), ribeye area (.54) and fat thickness (-.80). Boxed beef cut-out variables followed the same phenotypic relationship with percentage retail product for all carcass characteristics and carcass values. Boxed beef subprimal yields computed without lean trim were more closely associated with retail product yield estimates.

Sire differences, after accounting for harvest date, and gender variation (*P*<.01), were highly significant (*P*<.01). Considering all progeny data, Figure 1 illustrates the percentage of progeny above and below the benchmark price for a low Choice, yield grade 3.99 weighing 750 lb (low Ch/Se=$102.39/cwt, average Ch/Se=$102.67/cwt, and high Ch/Se=$105.18/cwt). This benchmark was determined for a 3.99 because the BBC allows for further segmentation of whole numerical yield grades (i.e., 3.99 vs. 3). The low Choice/Select spread resulted in the highest percentage of progeny (78.8%) to exceed the carcass price benchmark. The percentage above the benchmark declined to 72.1 and 68.6% during the average and high Choice/Select spreads because as mentioned earlier, yield grade premiums were less important while quality grade requirements had a greater impact on carcass price as the quality grade spread increased.

If the benchmark had been tightened to a 3.0 rather than 3.99, then the benchmarks would have been $107.56, 107.85, and 110.50 cwt, for low, average and high spreads, respectively. Corresponding percentage of progeny above these benchmarks would be 42.8, 42.3, and 40.0%. Even in a breed that demonstrates excellent carcass merit, it is important to set future, progressive benchmarks as this 3.0 yield grade target demonstrates.

Figure 2 carcass value benchmarks of $767.93, $770.03, and $788.85/hd were used for the low, average, and high pricing periods to determine the percentage of progeny that exceeded or fell short in carcass value ($/hd). Because carcass value ($/hd) was influenced by carcass weight (750 base), the percentages above and below the low, average, and high Choice/Select benchmarks were lower than percentages for carcass price ($/cwt). Nevertheless, Figure 2 indicates over half of all progeny were above all three carcass value benchmarks.

There is concern that when sires are ranked on carcass price using the average Choice/Select spread, rankings may change during the low and high quality grade spread seasons of the year. However, Spearman Rank correlations showed that the relationships between sire rankings for the average and low Choice/Select spreads, as well as the average and the high Choice/Select spreads were both strong (.99; $P<.0001$). This indicates that when sires are ranked by the average Choice/Select spread, significant rank order change is not expected if progeny are harvested during the low or high quality grade seasonal spreads. The correlation between the low Choice/Select spread and the high spread drops to .95 ($P<.0001$), which suggests that some re-ranking of sires can be expected. Therefore, the average Choice/Select spread should be used to evaluate sire value based on boxed beef prices.

Of the 1,087 sires, the top and bottom 10% based on carcass value ($/cwt) were evaluated and are presented for the average quality grade spread in Table 3. The top 10% showed an improvement of $16.04/cwt in carcass price in comparison with the bottom 10% during the average Choice/Select spreads. Similar patterns occurred in the low and high Choice/Select spreads. This improvement in carcass price ($/cwt) resulted in a carcass value advantage for all three pricing periods of greater than $200.00/hd. Progeny from the top 10% sires had significantly ($P<.001$) higher quality carcasses with less fat, larger ribeye areas, heavier carcass weights, and more desirable yield grades when compared with the bottom 10%. The improved value of the top 10% over the bottom 10% was also a direct effect of the minimal occurrence of progeny not conforming to boxed beef fabrication specifications for one or more of the qualifying characteristics.

Implications

It is important to recognize that, as with other carcass traits, the values are assuming performance at various production stages has been optimized. As with percentage retail product, extreme differences in carcass weight, for example, would influence the overall profitability difference between sire progeny groups. Breeds with interest in carcass merit should consider the development of genetic values to assess profitability using a progressive carcass value determination system.

Acknowledgements

This report represents a portion of the completed analyses of boxed beef value in Angus cattle. Authors wish to acknowledge Doyle E. Wilson, Iowa State University, Ames, IA, for providing adjusted carcass data, as well as the American Angus Association for funding this research.

Literature Cited

American Angus Association Sire Evaluation Report (Fall 1998). 1998. American Angus Association. St. Joseph, MO.

Dolezal, S. L., and H.G. Dolezal. 1998. Characterization of boxed beef value in Angus sires. Okla. Agr. Exp. Sta. Res. Rep. P-965.

Gardner, T.L. et al. 1996. Estimation of beef value based on boxed beef yields. Okla. Agr. Exp. Sta. Res. Rep. P-951:31.

Table 1. Carcass trait means for complete progeny data and progeny data conforming and not conforming to boxed beef fabrication specifications.

Traits	Complete	SD	Conforming	SD	Non-Conforming	SD
Number of progeny	33,350		28,210		5,140	
Marbling score[a]	5.77	1.02	5.81	.96	5.56	1.28
Quality grade[b]	2.85	.85	2.80	.78	3.10	1.14
Prime, %	3.1	-	3.0	-	3.4	-
Premium Choice, %	32.8	-	33.0	-	32.2	-
Choice, %	42.8	-	44.5	-	33.1	-
Select, %	18.6	-	19.5	-	13.8	-
Standard, %	2.7	-	-	-	17.6	-
Fat thickness, in	0.54	.16	0.51	.14	0.68	.23
Ribeye area, in^2	12.37	1.37	12.53	1.30	11.50	1.38
Carcass weight, lb	745.0	88.41	745.34	78.48	743.08	130.06
< 550 lb	2.3	-	-	-	14.6	-
550 to 949 lb	97.1	-	100.0	-	81.2	-
950 to 999 lb	.6	-	-	-	3.7	-
1000 lb >	.1	-	-	-	.4	-
KPH, %[c]	2.33	.62	2.28	.59	2.62	.69
Yield grade	3.18	.67	3.06	.54	3.87	.87
1.0 to 1.99	3.4	-	3.4	-	3.3	-
2.0 to 2.99	35.8	-	39.3	-	16.9	-
3.0 to 3.99	50.1	-	57.3	-	10.8	-
4.0 to 4.99	9.9	-	-	-	64.3	-
5.0 to 5.99	.7	-	-	-	4.7	-
Box yield, %	67.22	2.19	67.43	1.78	66.08	3.50
Box yield w/o lean trim, %	52.09	1.98	52.38	1.62	50.47	2.84
Box major cuts yield, %	40.29	1.64	40.53	1.32	38.95	2.40
Retail product, %	62.66	2.67	63.18	2.15	59.82	3.37
Low spread, $/cwt.	104.83	7.80	107.73	3.71	88.91	4.41
Average spread $/cwt.	104.59	8.30	107.49	4.75	88.73	5.10
High spread $/cwt.	106.23	9.06	109.05	6.20	90.75	6.19
Low spread $/hd	781.84	112.07	803.36	92.59	663.73	133.95
Average spread $/hd	780.24	114.72	801.68	96.07	662.60	135.52
High spread $/hd	792.56	119.72	813.49	102.46	677.72	140.68

[a] 5.00 to 5.99 = Small; 4.00 to 4.99 = Slight.
[b] 2.0 to 2.99 = premium Choice; 3.00 to 3.99 = Choice.
[c] Kidney, pelvic, and heart fat.

TABLE 2. RESIDUAL CORRELATIONS[A] AMONG CARCASS TRAITS FOR ALL PROGENY DATA (N=33,350).

Traits		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.	Quality grade[b]		-.88	-.26	-.39	-.47	-.07	.02^{ns}	-.17	-.13	-.17	.19	.19	.19	.17
2.	Marbling score[c]			.20	.30	.36	.07	-.02^{ns}	.17	.13	.18	-.19	-.19	-.19	-.18
3.	Low $/cwt.				.98	.91	-.16	.46	-.52	-.03	-.66	.51	.60	.60	.66
4.	Average $/cwt.					.98	-.14	.44	-.47	-.01^{ns}	-.60	.46	.54	.54	.60
5.	High $/cwt.						-.12	.40	-.41	.01^{ns}	-.52	.40	.47	.47	.52
6.	KPH, %[d]							-.01^{ns}	.15	.04	.26	-.26	-.26	-.26	-.35
7.	Ribeye area, in^2								-.09	.40	-.55	.47	.50	.49	.54
8.	Fat thickness, in									.25	.80	-.74	-.79	-.79	-.80
9.	Carcass weight, lb										.30	-.37	-.36	-.38	-.26
10.	Yield grade											-.94	-.99	-.99	-.99
11.	Box yield, %												.98	.98	.94
12.	Box yield w/o lean trim, %													1.0	.98
13.	Box major cuts yield, %														.98
14.	Retail product, %														

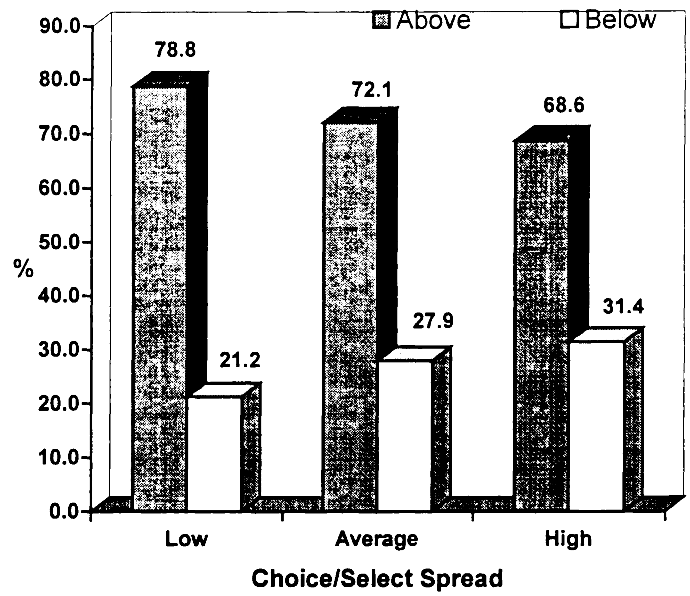
[a] ^{ns} (P>.05); * (P<.05); all other correlations (P<.0001).
[b] 1.00 to 1.99 = Prime; 5.00 to 5.99 = Standard.
[c] 10.00 to 10.99=Abundant; 9.00 to 9.99=Moderately abundant; 8.00 to 8.99=Slightly abundant; 7.00 to 7.99=Moderate; 6.00 to 6.99=Modest; 5.00 to 5.99=Small; 4.00 to 4.99=Slight; 3.00 to 3.99=Traces; 2.00 to 2.99=Practically devoid.
[d] Kidney, pelvic and heart fat.

Table 3. Progeny carcass trait means for sires in the top and bottom 10% for the average choice/select spread.

	Average Choice/Select spread				
	Top 10%		Bottom 10%		
Traits	Mean	SD	Mean	SD	Diff**
Number of sires	109	--	110	--	
Number of progeny	2728	--	1751	--	
Marbling score[a]	6.29	1.06	5.05	1.04	1.24**
Quality grade[b]	2.44	.73	3.53	.96	-1.09**
Prime, %	7.7	--	.7	--	7.0
Prem. Choice, %	47.4	--	14.7	--	32.7
Choice, %	38.5	--	32.7	--	5.8
Select, %	6.1	--	35.0	--	-28.9
Standard, %	.2	--	16.9	--	-16.7
Fat thickness, in	.48	.13	.55	.21	-.07**
Ribeye area, in^2	12.92	1.33	11.31	1.27	1.61**
Carcass weight, lb	748.58	75.59	645.71	107.11	102.87**
< 550 lb, %	.3	--	20.2	--	-19.9
550 to 949 lb, %	99.4	--	79.4	--	20.0
950 to 999 lb, %	.4	--	.5	--	-.1
1000 lb >, %	0	--	0	--	0
KPH, %[c]	2.22	.57	2.96	.58	-.74**
Yield grade	2.85	.56	3.29	.79	-.44**
1.0 to 1.99, %	6.2	--	3.9	--	2.3
2.0 to 2.99, %	53.8	--	34.3	--	19.5
3.0 to 3.99, %	38.5	--	41.3	--	-2.8
4.0 to 4.99, %	1.4	--	18.2	--	-16.8
5.0 to 5.99, %	0	--	2.3	--	-2.3
Box yield, %	68.03	1.86	68.26	3.26	-.23**
Box yield w/o lean trim, %	52.97	1.69	52.38	2.58	.59**
Box major cuts yield, %	41.01	1.37	40.58	2.17	.43**
Retail product, %	64.03	2.23	61.78	3.11	2.25**
Carcass price, ($/cwt.)	110.19	1.04	94.15	2.72	16.04**
Carcass value, ($/hd)	822.27	90.94	616.36	130.97	205.91**

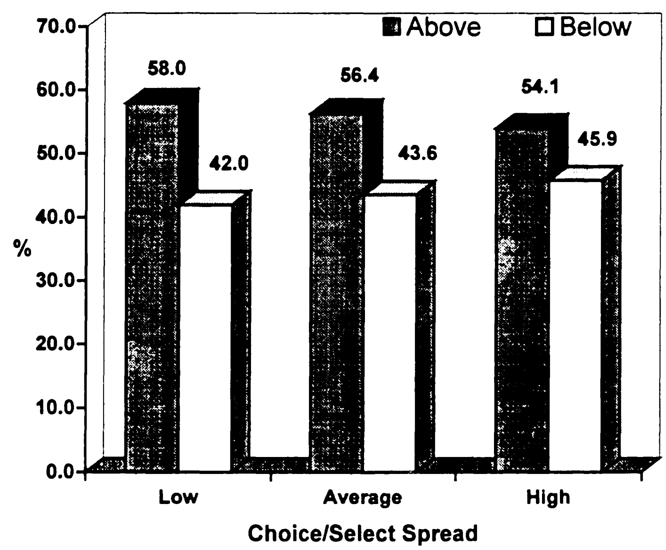
[a] 6.00 to 6.99-Modest; 5.00 to 5.99=Small.
[b] 2.00 to 2.99 = premium Choice; 3.00 to 3.99 = Choice.
[c] KIDNEY, PELVIC AND HEART FAT.
** (P<.01).

Figure 1. Percent of all progeny (n=33,350) above and below the carcass price ($/cwt) benchmark for the low, average, and high quality grade spreads[a].



[a] U.S. Choice, yield grade 3.99, 750 lb carcass weight: Low spread = $102.39/cwt; Average spread = $102.67/cwt; High spread = $105.18/cwt.

Figure 2. Percent of all progeny (n=33,350) above and below the carcass value ($/hd) benchmark for the low, average, and high quality grade spreads[a].



[a] Low, average and high quality grade spread benchmark prices X 750 lb carcass weight: Low spread=$767.93/hd; Average spread =$770.03/hd; High spread = $788.85/hd.

Student Essays and Abstracts

GENETIC EVALUATION FOR MATURE WEIGHT IN BEEF CATTLE

Janice M. Rumph
The University of Nebraska-Lincoln

Introduction

Expected Progeny Differences (EPDs) are effective selection tools for cow-calf producers. Most breeds have developed EPDs for use in selection of their purebred animals. Some of the EPDs that are currently available include those for production traits such as weaning and yearling weights; carcass traits such as ribeye size, carcass weight, and marbling; and maternal traits such as birth weight and milk production. Today's EPDs seemingly cover almost every trait that could be important to a cow-calf operation, but mature cow weight is often ignored.

To date, the only breed association that has included mature weight EPDs in its genetic evaluations is the American Angus Association while three other breeds had research in progress in 1995 to include the information: the American Polled Hereford Association (now part of the American Hereford Association), the American Gelbvieh Association, and the North American Limousin Foundation (Andersen, 1995). Although research was initiated, at present, these breeds have yet to include mature weight EPDs in their evaluations.

If there is one type of cow that can be considered the "optimum cow," she has not yet been found. The beef cattle industry is constantly changing in an attempt to find her, but has yet to succeed in doing so. In the 1950's, it was thought that the optimum beef animal was one whose back didn't get any higher than the producer's belt buckle. It was determined that this was not the perfect animal, so beef cattle were then bred with the idea of "the bigger the better." The relatively long generation interval of cattle makes it difficult for the industry to make such an extreme change in a short amount of time, so it wasn't until the 1980's that this other extreme was reached. The industry has now realized that the optimum cow is not one that the producer can walk under either, so the industry is currently trying to breed smaller cattle to moderate cow size. Moderation seems to be the current trend when it comes to cow size.

The beef cattle industry is trying to find the ideal animal that will fit into every breed and every production scenario and when one type doesn't work, we go on to the next (Klosterman 1972). Producers need to realize that there is no way that we will ever find the perfect animal for every situation. Different breeds and different lines of cattle are best suited for different situations. The beef cattle industry is not like the poultry, dairy, or swine industries where the production environment is unchanged from state to state, region to region, and even country to country. In those industries, genetics can be identified that can be used to produce the most desirable and economical product and those breeds and/or lines are best suited for every system because there is little to no environmental change between operations. The beef cattle industry does not have that luxury. It is the diversity of environments that beef cattle are raised in that requires a diversity of genetics to continue efficient production (Notter, 1999). Certain breeds and lines are best suited for certain environmental situations. Specific traits are necessary for survival and productivity in some environments and those same traits are detrimental in others. This is not a new concept, but it is one that should be considered when discussing mature weight of cows. Mature weight is important because in some situations, smaller cattle are better suited and in other, larger cattle are better suited.

Review Of Literature

Maintenance Requirements

Mature weight is an important trait that should be considered when making breeding decisions. Of the total amount of feed energy required for beef production, approximately one half of all that is required for the entire herd is needed for cow maintenance (Ferrell and Jenkins, 1984). Additionally, based on unpublished work by Baker and Barker that was quoted by Baker, et al. (1973), 48-67% of the feed required in a cow-calf herd is consumed by the dam when calves are retained and sold as fat cattle, while 85-93% is consumed by the dam when calves are sold at weaning.

Maintenance requirements are thought to be primarily determined by cow weight and level of milk production (McMorris and Wilton, 1986; Montaño-Bermudez et al., 1990). This means that selection for lighter mature weights and/or lower milk production has the potential to decrease the maintenance requirements of the cow herd and ultimately, decrease feed costs. Producers are able to effectively select for or against milk production through the use of milk EPDs which are provided by almost every breed association, but, except in the Angus breed, are unable to do the same with regard to mature weight.

Profitability of the cow herd is contingent on three main factors which are related to mature cow size: the amount of food required for maintenance, rate of growth, and amount of product produced per animal (Baker, et al., 1973). If the amount of product produced per animal remains constant while the amount of food required for maintenance increases and/or the rate of growth decreases, then the herd can be expected to decline in its profitability.

The amount of energy required for maintenance is commonly accepted to be a function of metabolic body size, which, for ruminants, is considered to be body weight taken to a power of .75. Therefore, as the mature size of the cow herd increases, so does the metabolic body size which, in turn, means that the amount of energy required for maintenance will also increase. If the growth rate of the individual does not increase at the same time, then this also means that feed conversion efficiency would decrease. Additionally, if that cow does not produce more product (pounds of weaned calf), this added feed expense is wasted because it will bring no added income. It is thought that there is little variation in biological efficiency with varying mature weights but, the requirements of the animal will change as will the amount of product produced by the animal as mature weight changes (Morris, 1976).

Although it adds to the equation, the mature size of the sire generally does not greatly affect the overall energy requirement of the herd because the sire to dam ratio is so small (Baker, et al., 1973). In contrast, dam mature weight is important because, provided there is no change in the amount of product produced across varying cow sizes, a smaller mature cow size will result in a lower proportion of food required by the dam per unit of output (pounds of calf weaned).

Heritability

In order to develop mature weight EPDs, the genetic parameters associated with mature weight must first be determined. The heritabilities found in literature suggest that effective genetic progress can be made through selection for mature weight. Table 1 summarizes these heritabilites which have been calculated in various analyses. Northcutt and Wilson (1993) found heritabilities for mature weight in Angus cattle to be between .45 and .51 in several different two-trait analyses. Similarly, Bullock et al. (1993) found that mature weight had a heritability of .52 when averaged over seven different two-trait analyses in Polled Herefords.

Brown et al. (1972) also studied mature weights for Angus and Hereford cattle and found heritabilities to be somewhat lower than those found above, but the high standard errors, due to a relatively small sample size, indicates that these estimates are not necessarily different from those above. The mature weight heritability in Herefords was higher ($h^2 = .34 \pm .25$) than it was in Angus ($h^2 = .21 \pm .21$), indicating that selection for mature weight in Hereford cattle could be expected to make a greater genetic change than selection in Angus.

Those estimates of heritability were less than those reported by Fitzhugh et al. (1965) in which heritability for cow weight was extremely high with estimates of .96 and .74 at calving and weaning, respectively. Similarly, Brinks et al. (1962) analyzed weights on Hereford cows taken both in the spring and fall on spring calving females and found extremely high estimates of heritability. Their study found that mature weight had a heritability of .75 and .73 in the spring and fall, respectively, when weights were averaged on the females in order to reduce the proportion of variation due to environment. When records were considered individually, heritabilites on the same females were found to be .57 and .62 for spring and fall weights, respectively. These heritability estimates are considerably larger than those found by Brinks in a later study conducted at the same research station, but with a smaller number of animals (Brinks 1964). The estimates that were calculated in this later study were $.52 \pm .11$ and $.57 \pm .11$ for spring and fall, respectively where spring weights in this study were taken prior to cows being turned out to the breeding pasture and fall weights being taken at weaning of the calves.

Correlation with Calf Traits

Concern for mature weight in females is only valid if there is a definite advantage to cows of a particular size, whether that be small, medium, or large. As shown previously, maintenance costs are directly proportional to mature cow size. However, increasing feed costs are not the only reason why producers should be concerned about the size of the cow herd. Stewart and Martin (1981) reported that cows with heavier mature weights would produce calves that are heavier at weaning ($P < .01$), but that these same cows would also produce fewer calves over the course of their lifetime ($P < .05$). In their data, this equated to an overall decrease in production of pounds at weaning over the lifetime of the cow, although the differences were not statistically significant. This result, if true, indicates the cow that is costing the producer more money due to increased maintenance costs, also, in the long run, is actually producing less product, and therefore, less income for the producer.

These results agree with those of Lopez de Torre et al. (1992) with Retinta beef cows in Spain who showed that for each 100 kg increase in mature weight, cows produced .5 less calves ($P < .05$) and weaning weight per cow exposed per year decreased by 17 kg, although this was not statistically significant.

Similarly, Hawkins et al. (1965) found that cows with the heaviest precalving and early pasture weights had fewer calves born per cow exposed, fewer calves weaned per cow exposed, and lower weaning weights. It was also found that cows that weighed less at weaning of their calves actually weaned more calves and more total pounds of calf.

Additionally, it has been shown that larger cows also tend to suffer from decreased fertility, delayed puberty, and increased calving difficulty compared with their smaller contemporaries (Notter, 1977).

Brinks et al. (1962) have shown that birth weight and weaning weight had correlations with dam's mature weight of .21 and .05 for fall dam weights and .29 and .16 for spring dam weights, as shown in Table 2. The higher correlations with the dam weights taken in the spring are thought to be due to the fact that the cows were close to full term and therefore included the weight of the calf, whereas the fall weights were taken early during gestation when calf weight is negligible.

Correlation with Other Cow Traits

Utilization of mature weights on females is difficult for several reasons. First, the length of time a cow requires to reach mature weight makes progress through selection decrease because she will have already been in production and passed along genes to her progeny. It is unrealistic and unprofitable for a producer to keep a female out of production until she has reached her mature weight before deciding if she should be culled or not. This will increase the already long generation interval that cattle have relative to other livestock species and will slow genetic progress.

Secondly, the time at which mature weight is reached is difficult to know exactly because fluctuations in weight during the normal course of a year due to pregnancy and lactation make it difficult to determine what the exact mature weight of a cow is. Finally, and perhaps most importantly, measurements of mature weight for cows may not be available because mature weight is not necessarily considered a "profitable" trait as is weaning and yearling weight, so it is not a measurement that producers routinely take. This is shown in the analysis done by Bullock, et al. (1993) where the APHA provided more than 500,000 weaning weight records, but less than 7,000 records were able to provide mature weight information.

One way of resolving these conflicts is through the use of correlated traits. Mature weight can be estimated based on earlier weight measurements taken on the individual. Northcutt and Wilson (1993) have shown the genetic correlations for mature weight to birth weight, weaning weight, and yearling weight to be .57, .62, and .45 and the phenotypic correlations to be .19, .37, and .41 respectively. Bullock et al. (1993) found slightly higher estimates with genetic correlations of birth weight, weaning weight, and yearling weight of .64, .80, and .89 and phenotypic correlations of .33, .32, and .46. The results from Brown et al. (1972) also agree with other studies for the Hereford data, but are surprisingly low for the Angus data. The genetic correlations for mature weight to yearling weight were found to be .63 for Hereford and .05 for Angus. Phenotypic correlations were found to be .12 for Hereford and .21 for Angus.

In the second study of Brinks, et al. (1964), mature weight was also found to be highly correlated with premature weights. Genetic correlations with birth weight, weaning weight, and yearling weight were .61, .59, and .66 for spring weights and .68, .51, and .62 for fall weights. Environmental correlations were .23, .41, and .51 for spring weights and .19, .47, and .55 for fall weights and phenotypic correlations were found to be .35, .45, and .57 for both spring and fall weights. Additionally, the correlations between the spring and fall weights were found to be .93 (genetic), .80 (environmental), and .87 (phenotypic).

The correlation of mature weight to premature weight measurements means that mature weight can be estimated early in life, but also that selection for faster growing steer calves could potentially increase the mature size of the cow herd. A common goal of cow-calf producers is to select for calves that will be heavier at weaning, which therefore means that they will be fast growing. On average, only half of the cow herd will produce steers, so if the other half, or a portion of, are retained as replacement heifers, the females going back into the herd will have had the same selection pressure for more growth. Thus, it is possible that the increased profits from the heavier weight steer and cull heifer calves may be diminished, or even completely voided, by the eventual increase in maintenance costs for the cow herd due to increased mature weight. These correlations are shown in Table 3.

Conclusions and Implications

Although mature weight is a trait that is often overlooked by producers, mature weight is important to consider when making breeding decisions. Selection for heavier weaning steer calves would indirectly cause the mature size of the cow herd to increase if replacement heifers are retained in the herd. Not only would increasing mature cow weight cause the cost to maintain the cow herd to increase, but would also cause overall productivity of the cow herd to decrease, which, in turn, would result in decreased or possibly even nonexistent profits.

National cattle genetic evaluations need to consider mature weight and its correlation with other traits and incorporate this information into the evaluations so that producers can use mature weight as another selection tool when choosing a bull to breed to their cows. Admittedly, based on the above stated correlations with premature weights, selection for only smaller cows could result in smaller calves and consequently less dollars, but if used in conjunction with the premature weight EPDs, a mature weight EPD could be a valuable tool to select for moderate cow size while also selecting for increased growth in calves. An ideal situation would be to develop an index that takes mature weight as well as premature weights into consideration so that producers can select for increased growth, but not to the extreme point where it affects the mature size of the cow herd considerably.

It also must be realized that a smaller cow may not be the most ideal animal for every situation. Some environments may require a larger cow size in order to survive. Mature weight EPDs can also help in selection for those sires that will produce heavier weight daughters. Mature Weight EPDs are, as with all EPDs, a tool for producers to select for the type of cattle that they believe would be of the greatest benefit to their specific situation.

Table 1. Estimates of heritability (h^2) for Mature Cow Weight

Source	Breed	Conditions[a]	h^2
Brinks et al. (1962)	Hereford	Fall	.62-.73
	Hereford	Spring	.57-.75
Brown et al. (1972)	Angus		.21 ± .21
	Hereford		.34 ± .25
Bullock et al. (1993)	Polled Hereford		.52
Fitzhugh et al. (1965)		Calving	.96
		Weaning	.74
Northcutt and Wilson (1993)	Angus		.45 -.51

[a] Conditions, apart from breed, which gave varying heritabilites within a study

Table 2. Genetic Correlations of Dam's Mature Weight with Calf Traits

			Correlations	
Source	Breed	Conditions[a]	BW	WW
Brinks et al. (1962)	Hereford	Fall	.21	.05
	Hereford	Spring	.29	.16

[a] Conditions, apart from breed, which gave varying heritabilites within a study

Table 3. Correlations of Mature Weight with Premature Traits of the Individual

		Type of	Correlations with		
Source	Breed	Correlation[a]	BW	WW	YW
Brinks et al. (1964)		G	.61-.68	.51-.59	.62-.66
		E	.19-.23	.41-.47	.51-.55
		P	.35	.45	.57
Brown et al. (1972)	Hereford	G			.63
	Hereford	P			.12
	Angus	G			.05
	Angus	P			.21
Bullock et al. (1993)		G	.64	.80	.89
		P	.33	.32	.46
Northcutt and Wilson (1993)		G	.57	.62	.45
		P	.19	.37	.41

[a] G = Genetic, E = Environmental, P = Phenotypic

Literature Cited

Andersen, Kent. 1995. Opportunities to Reduce Costs Through the Use of EPDs. Proc. Beef Improvement Federation 27th Research Symposium & Annual Meeting.

Baker, R.D., R.V. Large, and C.R.W. Spedding. 1973. Size of Animal in Relation to Productivity with Special Reference to the Ruminant – Economic Aspects. Proc. Br. Soc. Anim. Prod. (New Series). 2:35-42.

Brinks, J.S., R.T. Clark, N.M. Kieffer, and J.R. Quesenberry. 1962. Mature Weight in Hereford Range Cows - Heritability, Repeatability, and Relationship to Calf Performance. J. Anim. Sci. 21:501-4.

Brinks, J.S., R.T. Clark, N.M Kieffer, and J.J. Urick. 1964. Estimates of Genetic, Environmental, and Phenotypic Parameters in Range Hereford Females. J. Anim. Sci. 23:711-716.

Brown, J.E., C.J. Brown, and W.T. Butts. 1972. A Discussion of the Genetic Aspects of Weight, Mature Weight and Rate of Maturing in Hereford and Angus Cattle. J. Anim. Sci. 34:525.

Bullock, K.D., J.K. Bertrand, and L.L. Benyshek. 1993. Genetic and Environmental Parameters for Mature Weight and Other Growth Measure in Polled Hereford Cattle. J. Anim. Sci. 71:1737-41.

Ferrell, C.L. and T.G. Jenkins. 1984. Energy Utilization by Mature, Nonpregnant, Nonlactating Cows of Different Types. J. Anim. Sci. 58:234-243.

Fitzhugh, H.A., Jr., T.C. Cartwright, and R.S. Temple. 1965. Effects Associated with Beef Cow Weight. J. Anim. Sci. 24:848. (Abstr.).

Hawkins, D.R., C.F. Parker, E.W. Klosterman, and W.R. Harvey. 1965. Body Weight as a Measure of Productivity of Hereford Cows. J. Anim. Sci. 24:848. (Abstr.).

Klosterman, E.W. 1972. Beef Cattle Size for Maximum Efficiency. J. Anim. Sci. 34:875-880.

Lopez de Torre, G., J.J. Candotti, A. Reverter, M.M Bellido, P. Vasco, L.J. Garcia, and J.S. Brinks. 1992. Effects of Growth Curve Parameters on Cow Efficiency. J. Anim. Sci. 70:2668-2672.

McMorris, M.R. and J.W. Wilton. 1986. Breeding System, Cow Weight, and Milk yield Effects on Various Biological Variable in Beef Production. J. Anim. Sci. 63:1361-1372.

Montaño-Bermudez, M., M.K. Nielsen, and G.H. Deutscher. 1990. Energy Requirements for Maintenance of Crossbred Beef Cattle with Different Genetic Potential for Milk. J. Anim. Sci. 68:2279-2288.

Morris, C.A. and J.W. Wilton. 1976. Influence of Body Size on the Biological Efficiency of Cows: A Review. Can. J. Anim. Sci. 56:613-647.

Northcutt, S.L. and D.E. Wilson. 1993. Genetic Parameter Estimates and Expected Progeny Differences for Mature Size in Angus Cattle. J. Anim. Sci. 71:1148-53.

Notter, David R. 1977. Simulated Efficiency of Beef Production for a Cow-Calf-Feedlot Management System. PhD Dissertation, University of Nebraska.

Notter, David R. 1999. The Importance of Genetic Diversity in Livestock Populations of the Future. J. Anim. Sci. 77:61-69.

Stewart, T.S. and T.G. Martin. 1981. Mature Weight, Maturation Rate, Maternal Performance and Their Interrelationships in Purebred and Crossbred Cows of Angus and Milking Shorthorn Parentage. J. Anim. Sci. 52:51.

THE EFFECTS OF SLAUGHTER END-POINTS ON CARCASS TRAIT PARAMETER ESTIMATES AND SUBSEQUENT EPD

Bruce C. Shanks
Animal & Range Sciences Department
Montana State University - Bozeman

INTRODUCTION

Marketing systems within the cattle industry are experiencing rapid change. Areas include retained ownership, grids, alliances, formulas, forward pricing, new product development, and branded products. In response to changing marketing systems, there is an increased emphasis on traits which determine carcass merit. This has prompted further development of carcass Expected Progeny Differences (EPD) for use as selection tools.

Expected Progeny Differences are considered the most technical method of reporting genetic differences. However, do carcass EPD rank and separate sires the way producers want? Currently, carcass EPD are reported at a common age end-point, which may not match slaughter criteria used in today's production systems. An additional issue is EPD are dependent upon genetic parameter estimates. If genetic parameters are sensitive to slaughter end-point, carcass EPD may rank sires differently based on the end-point.

We know large differences exist in the carcass traits of beef cattle in North America. Importation of many new breeds and use of crossbreeding by producers are responsible for some of the diversity found in today's slaughter cattle population (Dolezal et al., 1993). Amer et al. (1994a,b) state that in order to compensate for different genetic types of cattle and to fully exploit the value of carcass traits, cattle should be managed to an optimum slaughter end-point. Differences in growth and maturation of cattle associated with mature size and fattening characteristics are largely responsible for the various optimum slaughter end-points present between breeds (Amer et al., 1994a).

Beef producers face the challenge of utilizing diverse resources to produce cattle that are profitable to all segments of the industry and to produce meat products that target consumer demand (Marshall, 1994). To accomplish these goals, breeders need genetic information from a broad spectrum of marketing end-points to implement effective breeding and management plans. Reviews by Koots et al. (1994a,b) and Marshall (1994) provide excellent summaries of genetic parameter estimates for carcass traits. However, these reviews do not focus on the effects of slaughter end-points on parameter estimates. The purpose of this paper is to 1) present information on genetic parameter estimates of carcass traits to assess the effect of slaughter end-point, 2) examine the usefulness of current methods of reporting carcass EPD, and 3) suggest potential research needs and possible considerations for reporting carcass EPD in the future.

REVIEW OF LITERATURE

Studies containing genetic parameter estimates reflect a range of slaughter end-points. This complicates summarizing estimates from several sources because end-points can alter the expression of genetic and environmental differences (Koch et al., 1995). For this reason, it is necessary to sort information into common slaughter end-point groups. Genetic parameter estimates are separated into age or time-on-feed, slaughter weight, fat thickness (FT), and choice grade constant end-points. An age or time-on-feed end-point refers to when animals are slaughtered after they reach a particular age or after they have spent a certain amount of time in a feedlot. A predetermined live weight during the feeding period is utilized as criteria for a slaughter weight end-point. A FT end-point refers to when animals are slaughtered after they have been identified as having a designated amount of FT. Fat thickness on live animals can be identified visually or may be estimated by using an ultrasound machine. Ultrasound can also be utilized to predict when animals have reached a choice grade end-point.

Heritabilities

Table 1 contains sources of carcass trait heritability estimates found in the literature. Portions of these sources were adapted from previous reviews by Koots et al. (1994a,b) and Marshall (1994). Heritability estimates are presented in Tables 2, 3, 4, and 5. The tables contain estimates for yield grade (YG) factors, quality grade (QG) factors, and consumer acceptance factors. The estimates are divided into tables according to end-point. Ranges and simple (unweighted) averages are given for each trait. Estimates that fell outside normal heritability bounds (0 to 1.0) were set to zero or one for calculation of ranges and averages.

Average heritability estimates for YG and QG factors were generally moderate to high at an age- or time-on-feed-, slaughter weight-, FT-, and choice grade-constant basis (Tables 2 and 3). Only three estimates of YG and five estimates of kidney, pelvic, and heart fat (KPH) were found in the literature. No estimates for QG were found. Yield grade and KPH heritabilities were not similar in the studies that reported estimates. Carcass weight (CW) heritabilities ranged from .18 to .48 across all end-points. The highest average was at a choice grade end-point, and the lowest average was found at a FT end-point. Average rib-eye area (REA) heritabilities remained essentially the same across all end-points. However, individual heritability estimates ranged from .01 to .73. The small REA heritability estimates reported by Dunn et al. (1970) and Reynolds et al. (1991) at an age or time-on-feed end-point could be explained by the low number of records contained in the studies. Average FT heritabilities were considerably smaller at a FT end-point, but remained larger and similar across all other end-points. Fat thickness heritability estimates varied considerably at an age- or time-on-feed-constant basis. Marbling had the greatest number of heritability estimates. Estimates ranged from -.15 to .93. The negative heritability estimate reported by Dunn et al. (1970) could once again be due to the small number of records contained in the study. The average marbling heritability was surprisingly larger at a choice grade end-point. At an age- or time-on-feed-constant basis the average marbling heritability was larger than for a slaughter weight- or FT-constant basis. Generally, the choice grade end-point contained the highest heritability averages for all traits, and all traits were extremely consistent from study to study at a slaughter weight end-point. Values were generally more variable at an age- or time-on-feed-constant basis, but this could be explained by the large number of studies conducted at this end-point.

Average heritability estimates for consumer acceptance factors were low to moderate at an age- or time-on-feed-, slaughter weight-, and FT-constant basis (Tables 4 and 5). Fewer estimates were found for consumer acceptance factors than YG and QG factors, and estimates tended to be from recent literature. The only heritability estimate found for consumer acceptance factors at a choice grade end-point was marbling. Also, there were no heritability estimates for intermuscular fat (seam fat) found in the literature. Marbling was included as a consumer acceptance factor in order that comparisons could be made between it and other traits. Average tenderness heritability estimates remained similar across all end-points. However, there was variation across end-points for Warner-Bratzler shear force (WBS) average heritabilities. The lowest average WBS was reported at a slaughter weight end-point, and the largest average was found at a FT end-point. Also, WBS heritabilities were extremely consistent at a FT end-point. Three estimates for calpastatin activity were found in the literature. The average calpastatin activity at a FT end-point was lower than that reported at an age or time-on-feed end-point. Juiciness and flavor were both lowly heritable at an age or time-on-feed end-point. The single estimates reported for juiciness and flavor at a slaughter weight end-point were similar to those reported at an age- or time-on-feed constant basis.

Overall YG and QG factors tended to be more heritable than consumer acceptance factors. Lowest average heritability estimates for REA, tenderness, and juiciness were at an age- or time-on-feed-constant basis. Highest average heritability estimates for marbling, KPH, FT, and CW were at a choice grade end-point. A slaughter weight end-point resulted in the least amount of variation between studies for all traits and estimates at a choice grade end-point were more consistent than age or time-on-feed or FT end-points.

Genetic and phenotypic correlations
Table 1 contains sources of genetic and phenotypic correlations found in the literature. A portion of these sources were adapted from previous reviews by Koots et al. (1994a,b), and Marshall (1994). Genetic and phenotypic correlations are presented in Tables 6, 7, 8, 9, 10a, 10b, 11a, and 11b. The tables contain correlations among and between YG factors, QG factors, and consumer acceptance factors. The estimates are divided into tables according to end-point.

Genetic and phenotypic correlations among YG and QG factors at an age- or time-on-feed, slaughter weight-, FT-, or choice grade-constant basis are shown in Tables 6 and 7. There were few correlations which contained YG or KPH. Correlations including QG were not found in the literature. Genetic and phenotypic correlation averages were moderately positive between CW and REA and between CW and FT at an age- or time-on-feed-constant basis. The same end-point resulted in a lower average correlation between CW and marbling. Genetic correlations between CW and REA and between CW and FT were extremely variable at a slaughter weight-, FT-, or choice grade-constant basis. Genetic and phenotypic correlations across all end-points between REA and FT, and between REA and marbling suggests that selection for increased REA would result in decreased FT and marbling. Generally, positive genetic and phenotypic correlations were found for FT and marbling across all end-points. This indicates a possible selection antagonism between increased marbling and decreased FT. Interestingly, Gilbert et al. (1993) reported a -.83 genetic and -.20 phenotypic correlation between FT and marbling, and Wilson et al. (1993) reported a genetic correlation of -.13 between FT and marbling. Correlations at an age or time-on-feed end-point were generally more consistent from study to study than correlations found at a slaughter weight, FT, or choice grade end-point.

Genetic and phenotypic correlations among consumer acceptance factors at an age- or time-on-feed-, slaughter weight-, or FT-constant basis are presented in Tables 8 and 9. There were few values available for calpastatin activity in the literature. Few correlations involving juiciness and flavor were found at a slaughter weight or FT end-point. It is interesting to compare values of marbling with tenderness, WBS, and calpastatin activity. The average genetic correlations were .46 for marbling and tenderness, -.69 for marbling and WBS, and -.34 for marbling and calpastatin activity at an age- or time-on-feed-constant basis. Average phenotypic correlations were .23 between marbling and tenderness, -.20 between marbling and WBS, and -.07 between marbling and calpastatin activity at a slaughter weight- or FT-constant basis. This provides evidence that marbling is associated with improved tenderness. Marbling also seems to be associated with improved flavor and juiciness. The average genetic correlation between marbling and juiciness was .37, and the average genetic correlation between marbling and flavor was .44 at an age or time-on-feed end-point. As expected, genetic and phenotypic correlations between tenderness and WBS were highly negative across all end-points. Genetic correlations between tenderness and juiciness, and tenderness and flavor were highly positive. In addition, highly positive genetic correlations were found between juiciness and flavor. Correlations at an age or time-on-feed end-point were generally more consistent from study to study than correlations found at a slaughter weight or FT end-point.

Genetic and phenotypic correlations among YG/QG factors and consumer acceptance factors at an age- or time-on-feed-, slaughter weight-, or FT-constant basis are presented in Tables 10a, 10b, 11a, and 11b. The number of correlations for slaughter weight and FT end-points were small, so inferences from these data are limited. Carcass weight was either negatively associated or not associated with all consumer acceptance factors, except marbling and juiciness across all end-points. There was a favorable genetic relationship between REA and tenderness and a negative association between REA and WBS across all end-points. This indicates potential in selecting for increased REA without decreasing tenderness. Positive genetic and phenotypic correlations were found between FT and tenderness and negative correlations were found between FT and WBS across all end-points. Generally, phenotypic correlations tended to be closer to zero than genetic correlations.

Overall, there tended to be considerable variation in correlations found in the literature. Generally, an age or time-on-feed end-point resulted in the least amount of variation between studies for most correlations. Perhaps, slaughter weight, FT, and choice grade end-points resulted in more variability because of the small number of correlations for these end-points found in the literature. The positive relationship found between marbling and traits which measure and determine tenderness generally supports USDA quality grade standards. The potential to select for REA without decreasing tenderness is also promising. However, effectiveness of simultaneous selection for some trait combinations are slowed by antagonistic relationships.

CONCLUSIONS AND IMPLICATIONS TO GENETIC IMPROVEMENT OF BEEF CATTLE

This paper establishes that heritabilities and genetic and phenotypic correlations of carcass traits are affected by slaughter end-point selection. There is evidence that the degree of heritability and the amount and direction of the relationships between some carcass trait combinations are altered by slaughter end-points. Consequently, EPD calculated from age constant parameter estimates may be ineffective when used in diverse production systems. Indeed, carcass EPD may not rank and separate sires the way producers want.

A majority of the parameter estimates contained in this paper have been estimated at an age- or time-on-feed-constant basis. This parallels current methods of reporting carcass EPD, but does not correspond to slaughter criteria used in today's production systems. Management issues, marketing conditions, and economic signals for desirable yield and quality grades usually necessitate slaughtering cattle when they have reached a predetermined amount of FT or marbling. A slaughter weight end-point is rarely used in the industry. In addition, market conditions may motivate owners to sell cattle at lighter weights or hold them to heavier weights than their biological optimums.

Future research should be aimed at determining the extent that slaughter end-points affect parameter estimates and to identify which end-points allow a favorable balance of carcass traits for given breed and environmental differences. In addition, research should be focused on evaluating how sires rank at different slaughter end-points. As new information is gathered, I suggest that B.I.F. study this issue and make recommendations to breed associations. As the U.S. beef industry shifts toward a more value based marketing system, and producers can realize added profits from superior carcasses, some consideration may need to be given to slaughter end-point prior to designing breeding and management plans.

Table 1.Sources of published genetic parameter estimates for carcass and associated growth traits

Source	No. of records	No. of sires	Sex[a]	Sire breed[b]	Dam breed[b]	Mating system[c]
1. Shelby et al., 1963	616	87	S	H	H	S
2. Cundiff et al., 1964	265	47	S	H, A	H, A	S
3. Dunn et al., 1970	191	49	H, S	H, A, Sh	H, A, Sh	R
4. Dunn et al., 1970	184	49	H, S	H, A, Sh	H, A, Sh	S
5. Brackelsberg et al., 1971	257	46	S	H, A	H, A	S
6. Cundiff et al., 1971	503	75	S	H, A, Sh	H, A, Sh	F, BC, S
7. Dinkel and Busch, 1973	679	70	S	H	H	S
8. Wilson et al., 1976	646	46	H, S	H	A x Ho	F
9. Koch, 1978	377	64	H	H	H	S
10. Benyshek, 1981	8,474	1,524	H, S	H	H	S
11. Koch et al.,1982	2,453	370	S	16[d]	H, A	F, S
12. MacNeil et al., 1984	1,683	187	H, S	7[e]	H, A	F, S
13. O'Ferrall et al., 1989	218	37	S	F	F	S
14. Lamb et al., 1990	824	95	B	H	H	S
15. Arnold et al., 1991	2,411	137	S	H	H	S
16. MacNeil et al., 1991	527	124	B, S	6[f]	H, A	F, S
17. Reynolds et al., 1991	169	30	B	H	H	S
18. Van Vleck et al., 1992	682	111	S	5[g]	H, A	BC, F
19. Woodward et al., 1992	8,265	420	B, H, S	S	S	S
20. Gilbert et al., 1993	318	59	B, H	H, A	H, A	S
21. Veseth et al., 1993	401	75	B	H	H	S
22. Wilson et al., 1993	10,733	699	S, H	A	A	S
23. Gregory et al., 1994	1,461	307	S	12[h]	12[h]	C, S
24. Shackelford et al., 1994	555	235	S	18[i]	18[i]	C, F, S
25. Gregory et al., 1995	1,594	306	S	12[h]	12[h]	C, S
26. Barkhouse et al., 1996	1,669	147	B, H, S	5[g]	H, A	F
27. Wheeler et al., 1996	888	258	S	11[j]	H, A	F
28. Wulf et al., 1996	392	18	H, S	C, L	X	F
29. O'Conner et al., 1997	575	83	H, S	9[k]	9[k]	C, F, BC, S

[a] B=bull; H=heifer; S=steer.

[b] Breeds and composites are as follows: A=Angus; B=Brahman; Bf=Beefmaster; Bv=Braunvieh; BS=Brown Swiss; C=Charolais; Ch=Chianina; J=Jersey; F=Friesian; Ga=Galloway; G=Gelbvieh; H=Hereford; Ho=Holstein; J=Jersey; L=Limousin; Lo=Longhorn; MA=Maine Anjou; N=Nellore; Pd=Piedmontese; P=Pinzgauer; R=Red Angus; RB=Red Brangus; RP=Red Poll; Sw=Sahiwal; Sa=Salers; Se=Senepol; Sh=Shorthorn; Si=Simbrah; S=Simmental; SD=South Devon; T=Tarentaise; MARC I=1/4 Bv, 1/4 C, 1/4 L, 1/8 H, 1/8 A; MARC II= 1/4 G, 1/4 S, 1/4 H, 1/4 A; MARC III=1/4 RP, 1/4 P, 1/4 H, 1/4 A; x=cross.

[c] BC=back crosses; C=composites; F=F_1 crosses out of unrelated breeds; R=rotational crosses; S=straightbreds.

[d] Sire breeds include A, H, J, SD, S, L, C, RP, BS, G, MA, Ch, Sw, B, P, T.

Table 1. Sources of published genetic parameter estimates for carcass and associated growth traits (continued)

[e] Sire breeds include H, A, J, SD, L, C, S.
[f] Sire breeds include A, H, P, RP, S, T.
[g] Sire and dam breeds include H, A, B, P, Sw.
[h] Sire and dam breeds include RP, H, A, L, Bv, P, G, S, C, MARC I, MARC II, MARC III.
[i] Sire and dam breeds include A, Bv, C; G, H, L, P, RP, S, MARC I, MARC II, MARC III, Ga, Lo, N, Pd, Sa, Sh.
[j] Sire and dam breeds include H, A, C, G, P, Sh, Ga, Lo, N, Pd, Sa.
[k] Sire and dam breeds include composite, percentage, or straightbred breeds of A, Bf, H, RB, R, Se, Si, S, T.

Table 2. Heritability estimates for yield grade and quality grade factors (age- or time-on-feed-constant basis)

	Trait					
Source	Yield grade	Carcass weight	Rib-eye Area	Fat thickness	KPH[a]	Marbling
1	--	.57	.26	--	--	--
2	--	--	.73	.43	--	--
3	--	--	.02	.94	--	-.15
4	--	--	.60	.39	--	.42
6	--	.56	.41	.50	--	.31
7	--	--	.25	.57	--	.31
9	--	.68	.28	.68	--	.34
11	--	--	.56	.41	.83[c]	.40
12	--	.44	--	--	--	--
13	--	.32	--	--	--	--
14	.24	.31	.28	.24	--	.33
16	--	--	--	.52	--	--
17	--	.33	.01	--	--	--
18	--	--	.60	--	--	.45
19	--	--	--	--	--	.23
21	--	.38	.51	--	.37	.31
22	--	.31	.32	.26	--	.26
23	--	--	--	.30	--	.52
24	--	--	--	--	--	.93
25	--	.23	.22	.25	--	.48
26	--	--	--	--	--	.30
27	.76	.15	.65	.56	.32	.73
Range	.24 - .76	.15 - .68	.01 - .73	.24 - .94	.32 - .83	.00 - .93
Average[b]	.50	.39	.38	.47	.51	.40

[a] Kidney, pelvic, and heart fat.
[b] Simple (unweighted) average.
[c] Kidney fat only.

Table 3. Heritability estimates for yield grade and quality grade factors (slaughter weight-, fat thickness-, or choice grade-constant basis)

Source	Yield grade	Carcass weight	Rib-eye area	Fat thickness	KPH[a]	Marbling
			Slaughter weight			
6	--	--	.32	.53	--	.33
8	--	--	.42	.41	.00[c]	.33
15	--	.24	.46	.49	--	.35
Range	--	--	.32 - .46	.41 - .53	--	.33 - .35
Average[b]	--	.24	.40	.48	.00	.34
			Fat thickness			
20	--	.26	.48	.14	--	.28
28	.76	.10	.52	--	--	.16
29	--	--	--	--	--	.52
Range	--	.10 - .26	.48 - .52	--	--	.16 - .52
Average[b]	.76	.18	.50	.14	--	.32
			Choice grade			
5	--	--	.40	.43	.72[c]	.73
10	--	.48	.40	.52	--	.47
Range	--	--	--	.43 - .52	--	.47 - .73
Average[b]	--	.48	.40	.48	.72	.60

[a] Kidney, pelvic, and heart fat.
[b] Simple (unweighted) average.
[c] Kidney fat only.

Table 4. Heritability estimates for consumer acceptance factors (age- or time-on-feed-constant basis)

	Trait					
Source	Marbling	Tenderness	WBS[a]	Calpastatin activity	Juiciness	Flavor
3	-.15	--	--	--	--	--
4	.42	--	--	--	--	--
6	.31	--	--	--	--	--
7	.31	--	--	--	--	--
9	.34	--	--	--	--	--
11	.40	--	.31	--	--	--
13	--	.09	--	--	.06	.01
14	.33	--	--	--	--	--
18	.45	.10	.09	--	.14	.03
19	.23	--	--	--	--	--
21	.31	--	--	--	--	--
22	.26	--	--	--	--	--
23	.52	--	--	--	--	--
24	.93	--	.53	.65	--	--
25	.48	.22	.12	--	.25	.07
26	.30	.05	.15	--	--	--
27	.73	.50	.37	--	--	.19
Range	.00 - .93	.05 - .50	.09 - .53	--	.06 - .25	.01 - .19
Average[b]	.40	.19	.26	.65	.15	.08

[a] Warner-Bratzler shear.
[b] Simple (unweighted) average.

Table 5. Heritability estimates for consumer acceptance factors
(slaughter weight-, fat thickness-, or choice grade-constant basis)

	Trait					
Source	Marbling	Tenderness	WBS[b]	Calpastatin activity	Juiciness	Flavor
			Slaughter weight			
6	.33	--	--	--	--	--
8	.33	.23	.17	--	.26	-.06
15	.35	--	--	--	--	--
Range	.33 - .35	--	--	--	--	--
Average[b]	.34	.23	.17	--	.26	.00
			Fat thickness			
20	.28	--	--	--	--	--
28	.16	.08	.31	.52	--	--
29	.52	.31	.28	.15	--	--
Range	.16 - .52	.08 - .31	.28 - .31	.15 - .52	--	--
Average[b]	.32	.20	.30	.34	--	--
			Choice grade			
5	.73	--	--	--	--	--
10	.47	--	--	--	--	--
Range	.47 - .73	--	--	--	--	--
Average[b]	.60	--	--	--	--	--

[a] Warner-Bratzler shear.
[b] Simple (unweighted) average.

Table 6. Genetic (below diagonal) and phenotypic (above diagonal) correlations among yield grade and quality grade factors (age- or time-in-feedlot-constant basis)[a]

	1	2	3	4	5	6
1. Yield grade		.38 (27)	-.47 (27)	.83 (27)		.20 (14) .18 (27)
2. Carcass weight	.18 (27)		.46 (1) .52 (6) .37 (9) .58 (14) .58 (21) .43 (22) .40 (25) .39 (27)	.38 (6) .42 (9) .38 (14) .24 (22) .28 (25) .33 (27)	.31 (21)	.17 (6) .18 (9) .28 (14) .28 (21) .08 (22) .13 (25) .09 (27)
3. Rib-eye area	-.79 (27)	.15 (1) .66 (6) .02 (9) .68 (14) .80 (21) .47 (22) .66 (25) .25 (27)		-.07 (2) -.05 (4) -.28 (7) -.08 (9) -.15 (11) .04 (14) -.08 (22) -.06 (25) -.07 (27)	-.04 (11)[b] .19 (21)	-.06 (4) -.01 (7) -.03 (9) .03 (11) .19 (14) .00 (18) .16 (21) -.01 (22) -.05 (25) -.06 (27)
4. Fat thickness	.86 (27)	.34 (6) .95 (9) .14 (14) .38 (22) .13 (25) .24 (27)	.08 (2) -.27 (4) -.59 (7) .03 (9) -.44 (11) -.04 (14) -.06 (22) -.06 (25) -.43 (27)		.18 (11)[b]	.32 (4) .09 (7) .25 (9) .24 (11) .38 (14) .12 (22) .24 (23) .25 (25) .14 (27)
5. Kidney, pelvic, and heart fat		.21 (21)	.01 (11)[b] .36 (21)	.10 (11)[b]		.18 (11)[b] .31 (21)
6. Marbling	.32 (14) .19 (27)	.23 (6) -.33 (9) .64 (14) .38 (21) -.06 (22) .31 (25) -.03 (27)	-.38 (4) -.17 (7) -1.34 (9) -.14 (11) .57 (14) -.40 (18) .51 (21) -.04 (22) -.02 (25) -.37 (27)	1.00 (4) .38 (7) .73 (9) .16 (11) .73 (14) -.13 (22) .32 (23) .44 (25) .01 (27)	.29 (11)[b] .59 (21)	

[a] Number in parenthesis indicates source of estimate.
[b] Kidney fat only.

Table 7. Genetic (below diagonal) and phenotypic (above diagonal) correlations among yield grade and quality grade factors (slaughter weight-[a], fat thickness-[b], or choice grade-[c]constant basis)[d]

	1	2	3	4	5	6
1. Yield grade						.13 (28)
2. Carcass weight			.17 (15) .64 (20)	.02 (15) .05 (20)		.05 (15) .08 (20) -.02 (28)
3. Rib-eye area		.09 (15) 1.19 (20)		-.25 (5) -.30 (8) -.14 (15) -.13 (20)	-.22 (5)[f]	-.07 (5) -.15 (8) -.07 (15) .12 (20) -.14 (28)
4. Fat thickness		.36 (15) -1.42 (20)	-.09 (5) -.47 (8) -.37 (15) -1.14 (20)		.54 (5)[f]	.42 (5) .17 (8) .14 (15) -.20 (20)
5. KPH[e]			-.35 (5)[f]	.87 (5)[f]		.46 (5)[f]
6. Marbling	.04 (28)	.33 (15) .55 (20) .67 (28)	-.12 (5) -.38 (8) -.01 (15) .63 (20) .13 (28)	.62 (5) .37 (8) .19 (15) -.83 (20)	.63 (5)[f]	

[a] Slaughter weight-constant basis for sources 8, 15.
[b] Fat thickness-constant basis for sources 20, 28.
[c] Choice grade-constant basis for source 5.
[d] Number in parenthesis indicates source of estimate.
[e] Kidney, pelvic, and heart fat.
[f] Kidney fat only.

Table 8. Genetic (below diagonal) and phenotypic (above diagonal) correlations among consumer acceptance factors (age- or time-in-feedlot-constant basis)[a]

	1	2	3	4	5	6
1. Marbling		.19 (18) .19 (23) .20 (25) .22 (26) .12 (27)	-.12 (11) -.18 (18) -.23 (23) -.27 (24) -.24 (25) -.19 (26) -.11 (29)	-.19 (24)	.18 (18) .20 (23) .21 (25)	.12 (18) .12 (23) .12 (25) .09 (27)
2. Tenderness	.74 (18) .34 (23) .32 (25) .58 (26) .33 (27)		-.70 (18) -.57 (23) -.57 (25) -.67 (26) .71 (27)		.39 (13) .50 (18) .60 (23) .60 (25)	.49 (13) .34 (18) .16 (23) .17 (25) .40 (27)
3. WBS[b]	-.25 (11) -.53 (18) -1.00 (23) -.57 (24) -1.00 (25) -.90 (26) -.55 (27)	-.96 (18) -.98 (23) -1.00 (25) -.87 (26) -1.00 (27)		.27 (24)	-.26 (18) -.19 (23) -.19 (25)	-.26 (18) -.23 (23) -.23 (25) -.37 (27)
4. C. activity[c]	-.34 (24)		.50 (24)			
5. Juiciness	.60 (18) .28 (23) .23 (25)	1.55 (13) .95 (18) .91 (23) .88 (25)	-.95 (18) -.96 (23) -.96 (25)			.16 (18)
6. Flavor	.79 (18) .34 (23) .33 (25) .28 (27)	2.80 (13) .89 (18) .81 (23) .63 (25) .99 (27)	-.82 (18) -1.00 (23) -1.00 (25) -1.00 (27)[d]		3.00 (13) .78 (18) 1.00 (23) .79 (25)	

[a] Number in parenthesis indicates source of estimate.
[b] Warner-Bratzler shear.
[c] Calpastatin activity.
[d] Value exceeded -1.00 and, thus, was set at -1.00.

Table 9. Genetic (below diagonal) and phenotypic (above diagonal) correlations among consumer acceptance factors (slaughter weight-[a] or fat thickness[b]-constant basis)[c]

	1	2	3	4	5	6
1. Marbling		.27 (8) .19 (28) .14 (29)	-.27 (8) -.18 (28) -.16 (29)	-.03 (28) .00 (29)	.21 (8)	.05 (8)
2. Tenderness	-.20 (8) .90 (28) .00 (29)		-.43 (8) -.56 (28) -.51 (29)	-.14 (28) .27 (29)	.77 (8)	.79 (8)
3. WBS[d]	-.36 (8) -.53 (28) .28 (29)	-.54 (8) -.64 (28) -.92 (29)		.28 (28) .27 (29)	-.32 (8)	-.27 (8)
4. Calpastatin activity	-.75 (28) .61 (29)	-1.14 (28) .00 (29)	1.14 (28) .35 (29)			
5. Juiciness	-.81 (8)	1.00 (8)	-.30 (8)			.74 (8)
6. Flavor						

[a] Slaughter weight-constant basis for source 8.
[b] Fat thickness-constant basis for sources 28, 29.
[c] Number in parenthesis indicates source of estimate.
[d] Warner-Bratzler shear.

Table 10a. Genetic correlations among yield/quality grade factors and consumer acceptance factors (age- or time-in-feedlot-constant basis)[a]

	Tenderness	WBS[b]	Calpastatin activity	Juiciness	Flavor
Yield grade	.16 (27)	-.04 (27)			-.16 (27)
Carcass weight	-.63 (13) .15 (25) .32 (27)	-.10 (25) -.47 (27)		.95 (13) .03 (25)	-1.68 (13) -.12 (25) .13 (27)
Rib-eye area	-.04 (18) .56 (25) -.25 (27)	-.28 (11) -.14 (18) -.48 (25) .14 (27)		-.01 (18) .24 (25)	.16 (18) .22 (25) -.25 (27)
Fat thickness	.30 (23) .14 (25) -.14 (27)	.26 (11) -.35 (23) -.23 (25) .33 (27)		.45 (23) .34 (25)	.31 (23) .10 (25) -.62 (27)
KPH[c]		.04 (11)[d]			
Marbling	.74 (18) .34 (23) .32 (25) .66 (26) .33 (27)	-.25 (11) -.53 (18) -1.00 (23) -.57 (24) -1.00 (25) -.90 (26) -.55 (60)	-.34 (24)	.60 (18) .28 (23) .23 (25)	.79 (18) .34 (23) .33 (25) .28 (27)

[a] Number in parenthesis indicates source of estimate.
[b] Warner-Bratzler shear force.
[c] Kidney, pelvic, and heart fat.
[d] Kidney fat only.

Table 10b. Phenotypic correlations among yield/quality grade factors and consumer acceptance factors (age- or time-in-feedlot-constant basis)[a]

	Tenderness	WBS[b]	Calpastatin activity	Juiciness	Flavor
Yield grade	.02 (27)	.02 (27)			.00 (27)
Carcass weight	-.04 (13) .02 (25) .05 (27)	-.07 (25) -.09 (27)		-.04 (13) .01 (25)	-.05 (13) .09 (25) .07 (27)
Rib-eye area	.00 (18) -.02 (25) .01 (27)	-.02 (11) -.05 (18) .02 (25) -.07 (27)		.07 (18) -.04 (25)	.05 (18) .03 (25) .04 (27)
Fat thickness	.05 (23) .05 (25) -.01 (27)	-.01 (11) -.06 (23) -.06 (25) .03 (27)		.10 (23) .09 (25)	.10 (23) .09 (25) -.01 (27)
KPH[c]		.00 (11)[d]			
Marbling	.19 (18) .19 (23) .20 (25) .22 (26) .12 (27)	-.12 (11) -.18 (18) -.23 (23) -.27 (24) -.24 (25) -.19 (26) -.11 (27)	-.19 (24)	.18 (18) .20 (23) .21 (25)	.12 (18) .12 (23) .12 (25) .09 (27)

[a] Number in parenthesis indicates source of estimate.
[b] Warner-Bratzler shear force.
[c] Kidney, pelvic, and heart fat.
[d] Kidney fat only.

Table 11a. Genetic correlations among yield/quality grade factors and consumer acceptance factors (slaughter weight-[a] or fat thickness-[b]constant basis)[c]

	Tenderness	WBS[d]	Calpastatin activity	Juiciness
Yield grade		.19 (28)	.25 (28)	
Carcass weight		-.06 (28)	-.24 (28)	
Rib-eye area	.30 (8)	-.09 (8) -.21 (28)	-.30 (28)	.04 (8)
Fat thickness	.32 (8)	-.29 (8)		.01 (8)
Marbling	-.20 (8) .90 (28) .00 (29)	-.36 (8) -.53 (28) .28 (29)	-.75 (28) .61 (29)	-.81 (8)

[a] Slaughter weight-constant basis for source 28.
[b] Fat thickness-constant basis for sources 28, 29.
[c] Number in parenthesis indicates source of estimate.
[d] Warner-Bratzler shear force.

Table 11b. Phenotypic correlations among yield/quality grade factors and consumer acceptance factors (slaughter weight-[a] or fat thickness-[b]constant basis)[c]

	Tenderness	WBS[d]	Calpastatin activity	Juiciness	Flavor
Yield grade		-.08 (28)	.05 (28)		
Carcass weight		-.02 (28)	-.00 (28)		
Rib-eye area	-.03 (8)	-.06 (8) .06 (28)	-.05 (28)	.05 (8)	.02 (8)
Fat thickness	.12 (8)	-.19 (8)		.11 (8)	.08 (8)
Marbling	.27 (8) .19 (28) .14 (29)	-.27 (8) -.18 (28) -.16 (29)	-.03 (28) .00 (29)	.21 (8)	.05 (8)

[a] Slaughter weight-constant basis for source 8.
[b] Fat thickness-constant basis for sources 28, 29.
[c] Number in parenthesis indicates source of estimate.
[d] Warner-Bratzler shear force.

BIBLIOGRAPHY

Amer, P. R., R. A. Kemp, J. G. Buchanan-Smith, G. C. Fox, and C. Smith. 1994a. A bioeconomic model for comparing beef cattle genotypes at their optimal economic slaughter end-point. J. Anim. Sci. 72:38-50.

Amer, P. R., R. A. Kemp, G. C. Fox, and C. Smith. 1994b. An economic comparison of beef cattle genotypes for feedlot traits at their optimal slaughter end-point. Can. J. Anim. Sci. 74:7-14.

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. 69:985-992.

Barkhouse, K. L., L. D. Van Vleck, L. V. Cundiff, M. Koohmaraie, D. D. Lunstra, and J. D. Crouse. 1996. Prediction of breeding values for tenderness of market animals from measurements on bulls. J. Anim. Sci. 74:2612-2621.

Benyshek, L. L. 1981. Heritabilities for growth and carcass traits estimated from data on Herefords under commercial conditions. J. Anim. Sci. 53:49-56.

Brackelsberg, P. O., E. A. Kline, R. L. Willham, and L. N. Hazel. 1971. Genetic parameters for selected beef-carcass traits. J. Anim. Sci. 33:13-17.

Cundiff, L. V., D. Chambers, D. F. Stephens, and R. L. Willham. 1964. Genetic analysis of some growth and carcass traits in beef cattle. J. Anim. Sci. 23:1133-1138.

Cundiff, L. V., K. E. Gregory, R. M. Koch, and G. E. Dickerson. 1971. Genetic relationships among growth and carcass traits of beef cattle. J. Anim. Sci. 33:550-555.

Dinkel, C. A., and D. A. Busch. 1973. Genetic parameters among production, carcass composition and carcass quality traits of beef cattle. J. Anim. Sci. 36:832-846.

Dolezal, H. G., J. D. Tatum, and F. L. Williams, Jr. 1993. Effects of feeder cattle frame size, muscle thickness, and age class on days fed, weight, and carcass composition. J. Anim. Sci. 71:2975-2985.

Dunn, R. J., W. T., Magee, K. E. Gregory, L. V. Cundiff, and R. M. Koch. 1970. Genetic parameters in straightbred and crossbred beef cattle. J. Anim. Sci. 31:656-663.

Gilbert, R. P., D. R. C. Bailey, and N. H. Shannon. 1993. Body dimensions and carcass measurements of cattle selected for postweaning gain fed two different diets. J. Anim. Sci. 71:1688-1698.

Gregory, K. E., L. V. Cundiff, and R. M. Koch. 1995. Genetic and phenotypic (co)variances for growth and carcass traits of purebred and composite populations of beef cattle. J. Anim. Sci. 73:1920-1926.

Gregory, K. E., L. V. Cundiff, R. M. Koch, M. E. Dikeman, and M. Koohmararaie. 1994. Breed effects, retained heterosis, and estimates of genetic and phenotypic parameters for carcass and meat traits of beef cattle. J. Anim. Sci. 72:1174-1183.

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. 47:142-150.

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. 55:1319-1329.

Koch, R. M., K. E. Gregory, and L. V. Cundiff. 1995. Genetic aspects of beef carcass growth and development. In: Proc. Fifth Genetic Prediction Workshop, December 8 and 9, 1995. p 9. Kansas City, Missouri.

Koots, K. R., J. P. Gibson, C. Smith, and J. W. Wilton. 1994a. Analysis of published genetic parameter estimates for beef production traits. 1. Heritability. Anim. Breed. Abstr. 62(5):309.

Koots, K. R., J. P. Gibson, C. Smith, and J. W. Wilton. 1994b. Analysis of published genetic parameter estimates for beef production traits. 2. Phenotypic and genetic correlations. Anim. Breed. Abstr. 62(11):825.

Lamb, M. A., O. W. Robinson, and M. W. Tess. 1990. Genetic parameters for carcass traits in Hereford bulls. J. Anim. Sci. 68:64-69.

MacNeil, M. D., D. R. C. Bailey, J. J. Urick, R. P. Gilbert, and W. L. Reynolds. 1991. Heritabilities and genetic correlations for postweaning growth and feed intake of beef bulls and steers. J. Anim. Sci. 69:3183-3189.

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. 58:1171-1180.

Marshall, D. M. 1994. Breed differences and genetic parameters for body composition traits in beef cattle. J. Anim. Sci. 72:2745-2755.

O'Connor S. F., J. D. Tatum, D. M. Wulf, R. D. Green, and G. C. Smith. 1997. Genetic effects on beef tenderness in *Bos indicus* composite and *Bos taurus* cattle. J. Anim. Sci. 75:1822-1830.

O'Ferrall, G. J. M., R. L. Joseph, P. V. Tarrant, and P. McGloughlin. 1989. Phenotypic and genetic parameters of carcass and meat-quality traits in cattle. Lives. Prod. Sci. 21:35-47.

Reynolds, W. L., J. J. Urick, D. A. Veseth, D. D. Kress, T. C. Nelsen, and R. E. Short. 1991. Genetic parameters by son-sire covariances for growth and carcass traits of Hereford bulls in a nonselected herd. J. Anim. Sci. 69:1000-1007.

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. 72:857-863.

Shelby, C. E., W. R. Harvey, R. T. Clark, J. R. Quesenberry, and R. R. Woodward. 1963. Estimates of phenotypic and genetic parameters in ten years of Miles City R.O.P. steer data. J. Anim. Sci. 22:346-353.

Van Vleck, L. D., A. F. Hakim, L. V. Cundiff, R. M. Koch, J. D. Crouse, and K. G. Boldman. 1992. Estimated breeding values for meat characteristics of crossbred cattle with an animal model. J. Anim. Sci. 70:363-371.

Veseth, D. A., W. L. Reynolds, J. J. Urick, T. C. Nelesen, 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. 71:1730-1736.

Wheeler, T. L., L. V. Cundiff, R. M. Koch, and J. D. Crouse. 1996. Characterization of biological types of cattle (Cycle IV): Carcass traits and longissimus palatability. J. Anim. Sci. 74:1023-1035.

Wilson, D. E., R. L. Willham, S. L. Northcutt, and G. H. Rouse. 1993. Genetic parameters for carcass traits estimated from Angus field records. J. Anim. Sci. 71:2365-2370.

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. 43:569-576.

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. 70:1098-1109.

Wulf, D. M., J. D. Tatum, R. D. Green, J. B. Morgan, B. L. Golden, and G. C. Smith. 1996. Genetic influences on beef longissimus palatability in Charolais- and Limousin-sired steers and heifers. J. Anim. Sci. 74:2394-2405.

STRENGTHS AND WEAKNESSES OF WHOLE HERD ENROLLMENT

Jill Beck, University of Saskatchewan, Saskatoon, Saskatchewan

In the past, many breed organizations kept track of animals on a calf-based system. This allowed producers to register only the calves that met their standards. This system was at odds with increasing the productivity and efficiency of a cowherd by not evaluating each female's performance in the herd.

Whole Herd Enrollment (WHE) has gained a tremendous amount of attention in the last few years and is widely being researched and implemented in breed associations in Australia, United States and now Canada. WHE is a mandatory records system in which the breeding status of each cow is tracked. The reason for developing a whole herd record system is to improve the quality of information to help breeders make decisions based on more complete information. All cows will be recorded which would allow an accurate inventory and the incentive to cull non-productive females, in turn building a stronger herd.

A Delphi approach was used to get the views of seven experts. Respondents or participants were identified by a nominating process as having some expertise in WHE. Participants were from Canada, United States and Australia. The participants were asked to respond to questions in three different categories. The three categories consist of basic information about WHE, whether their Association has a WHE system in place or if they plan to implement such a program in the near future. The second category consisted of the experts' assessment of the strengths and weaknesses of their Association's WHE system. The participants were asked to rate each strength and weakness on a 1 to 5 scale and to optionally comment on each statement. The third category consisted of additional information, such as how they see WHE evolving in the future.

Of the seven breeds, four have a cow based record system in place. Two other breeds are planning to implement WHE within the next two years. The final breed has no immediate plans to implement WHE.

Many conclusions were made based on the experts views;

1. There is a competitive advantage for associations with WHE compared to associations who operate on a calf based system. WHE members will have access to better information that will enhance producer's decisions and in turn increase the quality of their herd.

2. WHE will allow improved information for making breeding decisions. By enrolling all breeding females in the herd, members are able to track production of each animal by disposal and breeding codes. This will help to see where non-productive females are and allow breeders to evaluate each cow based on productivity.

3. WHE will increase the accuracy of EPDs recorded. Some experts felt that it would have no affect unless performance information was made mandatory, others believed that by having it mandatory faulty numbers may be entered. The argument to have performance information voluntary appeared to carry more weight. Producers and buyers will have more accurate data and accuracy will be improved for those producers. This will give members the option to track performance or not, there is no in between. If a producer has fifty calves and wants to keep performance records on them, he must record all calves or else give a reason why they were not recorded. By giving the producers the option, the ones who track performance will gain by having improved accuracy of EPDs from tracking more progeny. By allowing breeders the choice of tracking performance, the chance of having producers who are against it submit estimated or faulty numbers will be reduced.

Based on this survey of experts, it is strongly recommended that all breed associations adopt WHE in the near future. All people want the most information that can be made available to come to the correct conclusion. This is also true in the cattle industry. If breeders have information on the fertility, breeding and calf performance from each cow each year this will make it easier to evaluate a herd and build a herd made of productive females. By having the herd consist of highly productive females, the number and performance of the offspring will be maximized, which in turn will maximize profits.

ASSIGNING BULL PARENTAGE BY DNA TYPING IN A COMMERCIAL RED ANGUS BEEF CATTLE BREEDING HERD COMPRISED OF 30 CANDIDATE SIRES PASTURED WITH 477 COWS

M.D. Brown[1], G.R. Rupp[1], L.L. Hungerford[1], B.M. Feuz[2], T.R. Holm[2], G.B. Sherman[1].
Department of Veterinary and Biomedical Sciences, Great Plains Veterinary Educational Center, University of Nebraska, Clay Center, NE[1].; PE AgGen, Davis, CA[2].

Statistical theory predicts that the greater the number of bulls included in a single breeding group of beef cows, the more difficult it becomes to establish paternity by DNA typing. This study was performed to test the ability of semiautomatic fluorescence-based genotyping using 11 DNA microsatellite markers to determine paternity in a large multi-sire breeding herd of Red Angus beef cattle. DNA was isolated from blood samples obtained from the 30 sires and 477 calves. Polymerase chain reaction (PCR) was performed to amplify and fluorescently label alleles representing 11 bovine microsatellite loci (StockMarks IIÔ, PE BioSystems). Genotypic analysis was performed using an ABI-373s sequencing instrument and GenotyperÔ analysis software (PE BioSystems). Genotypes of the calves were compared to each of the 30 potential sires and genetic candidate sires were identified. Out of the 477 calves, a single sire was identified for 339 calves (84%). Two genetic candidate sires were identified for 68 calves (14%), and three genetic candidate sires were identified for 6 calves. One calf was determined to have 4 genetic candidate sires. For an additional 63 calves, no natural service sires were identified, however, records indicate that 62 calves were the result of artificial insemination using germ plasm material not available at the time of this study. We conclude that even with a very large battery of potential sires, genotypic analysis at 11 loci was sufficiently robust to identify sire parentage in a significant percentage of a breeding herd. Furthermore, it is anticipated that inclusion of dam genotype information and/or an additional set of microsatellite markers in this analysis would have resolved unique sire parentage for a significant number of the 75 calves determined to have two or more genetic candidate sires.

HEIFERS BORN HEAVIER AND ACHIEVING SUPERIOR PRE- AND POST-WEANING AVERAGE DAILY WEIGHT GAINS SHOW POTENTIAL FOR ABOVE AVERAGE FIRST AND LIFETIME PREGNANCY RATES.

P. B. Mwansa, R. A. Kemp, D. H. Crews Jr., and J. P. Kastelic
Lethbridge Research Centre
Agriculture and Agri-Food Canada. Lethbridge, Alberta, T1J 4B1

Genetic and phenotypic correlations between heifer (n = 1883) traits and lifetime pregnancy rate (LPR) in multibreed (.25 Charolais, .25 Simmental, .44 Hereford/Angus, .06 Limousin) beef cattle populations from Brandon (Manitoba) and Manyberries (Alberta) were estimated using a multi-trait animal model. The heifers were born from 1987 to 1994. Fixed effects of location, breed-cross type, location-year, direct and maternal heterosis, and age of dam were accounted for in the models for all traits studied. An additional fixed effect of service sire was included in models used to describe heifer pregnancy rate (HPR) and LPR. For HPR, the trait was considered binomial (0/1) with an underlying normal distribution. To estimate genetic potential for lifetime reproductive efficiency, breeding and pregnancy status records until disposal were used. LPR was then estimated as number of pregnancies divided by number of mating years to disposal. Data on age at puberty (AGEPH), estimated weight at first estrus (ESTWT), birth (BWT), weaning (WWT) and yearling weight (YWT), pre-weaning (ADG1) and post-weaning (ADG2) daily gain were also available. Heifer average BWT, WWT and YWT were 37±5 kg, 225±28 kg and 341±33 kg, respectively and their ADG1 and ADG2 were 0.95±0.13 and 0.68±0.15 kg, respectively. On average, heifers reached puberty at 297±47 d weighing 293±42 kg. Direct heritabilities were 0.66, 0.43, 0.36 and 0.78 for BWT, WWT, ESTWT and YWT, respectively, and 0.37, 0.39, 0.27, 0.21 and 0.17 for ADG1, ADG2, AGEPH, HPR and LPR, respectively. While moderate to high genetic correlations (0.20-0.98) were found among pre- and post-weaning growth-related heifer traits, only ESTWT was significantly ($P<.05$) related to AGEPH, with $r_g = 0.72$. Except for ESTWT, all pre- and post-weaning traits had positive and favorable genetic relationships (rg=0.20-0.62) with HPR. AGEPH had a low but favorable genetic relationship with LPR (r_g=-0.21). BWT (r_g=0.58), WWT (r_g=0.57) and ADG1 (r_g=0.47) had favorable and moderate genetic relationships with LPR. A high genetic correlation (rg=0.97) between HPR and LPR was found. Heifers with higher birth weights, above average pre-and post-weaning growth rate, higher weaning and yearling weights, reached puberty earlier, had higher first-time pregnancy rates and above average lifetime pregnancy rates.

MARKER-ASSISTED SELECTION FOR MEAT QUALITY IN OUTBRED CATTLE POPULATIONS.

Susan M. Tanksley, Sara L.F. Davis, Scott K. Davis and Jeremy F. Taylor
Department of Animal Science, Texas A&M University, College Station TX 77843.

The U.S. produces about 25 billion pounds of beef annually from a total inventory of 100 million head of cattle. This includes at least 80 breeds of beef cattle and each population is reproductively isolated at the level of the seedstock sector. The effective population size for each breed is large and for most polygenic phenotypes, there is as much variation within a breed as between breeds. The seedstock sector is responsible for the development of the elite germ-plasm (primarily bulls used in natural service) that is utilized by commercial beef producers. Within this sector, most breeding programs are based on the application of expected progeny differences (EPDs) produced by best linear unbiased prediction from performance and pedigree data. However, while carcass composition (e.g., fat deposition sites and lean tissue yield) and quality (e.g., muscle tenderness and palatability) are critical to the determination of carcass value and consumer satisfaction, these characteristics cannot be measured in live animals, and are thus difficult to improve through selection programs based on EPDs.

We have performed a whole genome-scan for QTLs influencing variation in carcass composition and quality in a double reciprocal backcross and F_2 population produced by multiple ovulation and embryo transfer from Angus (*Bos taurus*) and Brahman (*Bos indicus*). This study has putatively identified up to 7 genes influencing beef tenderness, 5 genes influencing intramuscular fat and 7 genes influencing lean yield differences between the subspecies. These QTLs are presently being validated for their effects in a series of 10 paternal halfsib families of 50 siblings per family for each of the 16 most numerically important breeds of cattle in the U.S. In each family, a series of microsatellites, regardless of within-breed polymorphism, will be genotyped in the region of each QTL and the alternate paternal haplotypes will be contrasted for their effect on the appropriate phenotype. Once a QTL has been validated as segregating within a breed by this approach, marker-assisted selection for carcass composition and quality will be applied within families for breeds identified to be segregating for specific QTLs. Marker information specific to each breed will be used to improve the accuracy of EPDs for carcass quality and tenderness traits.

BRUCE SHANKS
Frank Baker Memorial
Scholarship Essay Award

JANICE RUMPH
Frank Baker Memorial
Scholarship Essay Award

MIKE BROWN
BIF Poster
Competition Winner

1999 BIF
AWARDS PRESENTATIONS

SEEDSTOCK PRODUCER HONOR ROLL OF EXCELLENCE

John Crowe	CA	1972
Dale H. Davis	MT	1972
Elliot Humphrey	AZ	1972
Jerry Moore	OH	1972
James D. Bennett	VA	1972
Harold A. Demorest	OH	1972
Marshall A. Mohler	IN	1972
Billy L. Easley	KY	1972
Messersmith Herefords	NE	1973
Robert Miller	MN	1973
James D. Hemmingsen	IA	1973
Clyde Barks	ND	1973
C. Scott Holden	MT	1973
William F. Borror	CA	1973
Raymond Meyer	SD	1973
Heathman Herefords	WA	1973
Albert West III	TX	1973
Mrs. R. W. Jones, Jr.	GA	1973
Carlton Corbin	OK	1973
Wilfred Dugan	MO	1974
Bert Sackman	ND	1974
Dover Sindelar	MT	1974
Jorgensen Brothers	SD	1974
J. David Nichols	IA	1974
Bobby Lawrence	GA	1974
Marvin Bohmont	NE	1974
Charles Descheemacker	MT	1974
Bert Crame	CA	1974
Burwell M. Bates	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chestnut	WA	1975
George Chiga	OK	1975
Howard Collins	MO	1975
Jack Cooper	MT	1975
Joseph P. Dittmer	IA	1975
Dale Engler	KS	1975
Leslie J. Holden	MT	1975
Robert D. Keefer	MT	1975
Frank Kubik, Jr.	ND	1975
Licking Angus Ranch	NE	1975
Walter S. Markham	CA	1975
Gerhard Mittnes	KS	1976
Ancel Armstrong	VA	1976
Jackie Davis	CA	1976
Sam Friend	MO	1976
Healey Brothers	OK	1976
Stan Lund	MT	1976
Jay Pearson	ID	1976
L. Dale Porter	IA	1976
Robert Sallstrom	MN	1976
M.D. Shepherd	ND	1976
Lowellyn Tewksbury	ND	1976
Harold Anderson	SD	1977
William Borror	CA	1977

Robert Brown	TX	1977
Glen Burrows	NM	1977
Henry, Jeanette Chitty	NM	1977
Tom Dashiell	WA	1977
Lloyd DeBruycker	MT	1977
Wayne Eshelman	WA	1977
Hubert R. Freise	ND	1977
Floyd Hawkins	MO	1977
Marshall A. Mohler	IN	1977
Clair Percel	KS	1977
Frank Ramackers, Jr.	NE	1977
Loren Schlipf	IL	1977
Tom & Mary Shaw	ID	1977
Bob Sitz	MT	1977
Bill Wolfe	OR	1977
James Volz	MN	1977
A. L. Frau		1978
George Becker	ND	1978
Jack Delaney	MN	1978
L. C. Chestnut	WA	1978
James D. Bennett	VA	1978
Healey Brothers	OK	1978
Frank Harpster	MO	1978
Bill Womack, Jr.	AL	1978
Larry Berg	IA	1978
Buddy Cobb	MT	1978
Bill Wolfe	OR	1978
Roy Hunt	PA	1978
Del Krumwied	ND	1979
Jim Wolf	NE	1979
Rex & Joann James	IA	1979
Leo Schuster Family	MN	1979
Bill Wolfe	OR	1979
Jack Ragsdale	KY	1979
Floyd Mette	MO	1979
Glenn & David Gibb	IL	1979
Peg Allen	MT	1979
Frank & Jim Wilson	SD	1979
Donald Barton	UT	1980
Frank Felton	MO	1980
Frank Hay	CAN	1980
Mark Keffeler	SD	1980
Bob Laflin	KS	1980
Paul Mydland	MT	1980
Richard Tokach	ND	1980
Roy & Don Udelhoven	WI	1980
Bill Wolfe	OR	1980
John Masters	KY	1980
Floyd Dominy	VA	1980
James Bryany	MN	1980
Charlie Richards	IA	1980
Blythe Gardner	UT	1980
Richard McLaughlin	IL	1980
Bob Dickinson	KS	1981
Clarence Burch	OK	1981
Lynn Frey	ND	1981
Harold Thompson	WA	1981
James Leachman	MT	1981
J. Morgan Donelson	MO	1981
Clayton Canning	CAN	1981

Russ Denowh	MT	1981
Dwight Houff	VA	1981
G. W. Cronwell	IA	1981
Bob & Gloria Thomas	OR	1981
Roy Beeby	OK	1981
Herman Schaefer	IL	1981
Myron Aultfathr	MN	1981
Jack Ragsdale	KY	1981
W. B. Williams	IL	1982
Garold Parks	IA	1982
David A. Breiner	KS	1982
Joseph S. Bray	KY	1982
Clare Geddes	CAN	1982
Howard Krog	MN	1982
Harlin Hecht	MN	1982
William Kottwitz	MO	1982
Larry Leonhardt	MT	1982
Frankie Flint	NM	1982
Gary & Gerald Carlson	NS	1982
Bob Thomas	OR	1982
Orville Stangl	SD	1982
C. Ancel Armstrong	KS	1983
Bill Borror	CA	1983
Charles E. Boyd	KY	1983
John Bruner	SD	1983
Leness Hall	WA	1983
Ric Hoyt	OR	1983
E. A. Keithley	MO	1983
J. Earl Kindig	MO	1983
Jake Larson	ND	1983
Harvey Lemmon	GA	1983
Frank Myatt	IA	1983
Stanley Nesemeier	IL	1983
Russ Pepper	MT	1983
Robert H. Schafer	MN	1983
Alex Stauffer	WI	1983
D. John & Lebert Shultz	MO	1983
Phillip A. Abrahamson	MN	1984
Ron Beiber	SD	1984
Jerry Chappel	VA	1984
Charles W. Druin	KY	1984
Jack Farmer	CA	1984
John B. Green	LA	1984
Ric Hoyt	OR	1984
Fred H. Johnson	OH	1984
Earl Kindig	VA	1984
Glen Klippenstein	MO	1984
A. Harvey Lemmon	GA	1984
Lawrence Meyer	IL	1984
Donn & Sylvia Mitchell	CAN	1984
Lee Nichols	IA	1984
Clair K. Parcel	KS	1984
Joe C. Powell	NC	1984
Floyd Richard	ND	1984
Robert L. Sitz	MT	1984
Ric Hoyt	OR	1984
J. Newbill Miller	VA	1985
George B. Halterman	WV	1985
David McGehee	KY	1985
Glenn L. Brinkman	TX	1985

Gordon Booth	WY	1985
Earl Schafer	MN	1985
Marvin Knowles	CA	1985
Fred Killam	IL	1985
Tom Perrier	KS	1985
Don W. Schoene	MO	1985
Everett & Ron Batho	CAN	1985
Bernard F. Pedretti	WI	1985
Arnold Wienk	SD	1985
R. C. Price	AL	1985
Clifford & Bruce Betzold	IL	1986
Gerald Hoffman	SD	1986
Delton W. Hubert	KS	1986
Dick & Ellie Larson	WI	1986
Leonard Lodden	ND	1986
Ralph McDanolds	VA	1986
W.D. Morris/James Pipkin	MO	1986
Roy D. McPhee	CA	1986
Clarence VanDyke	MT	1986
John H. Wood	SC	1986
Evin & Verne Dunn	CAN	1986
Glenn L. Brinkman	TX	1986
Jack & Gini Chase	WY	1986
Henry & Jeanette Chitty	FL	1986
Lawrence H. Graham	KY	1986
A. Lloyd Grau	NM	1986
Matthew Warren Hall	AL	1986
Richard J. Putnam	NC	1986
R.J. Steward/P.C. Morrissey	PA	1986
Leonard Wulf	MN	1986
Charles & Wynder Smith	GA	1987
Lyall Edgerton	CAN	1987
Tommy Branderberger	TX	1987
Henry Gardiner	KS	1987
Gary Klein	ND	1987
Ivan & Frank Rincker	IL	1987
Larry D. Leonhardt	WY	1987
Harold E. Pate	IL	1987
Forrest Byergo	MO	1987
Clayton Canning	CAN	1987
James Bush	SD	1987
R.J. Steward/P.C. Morrissey	MN	1987
Eldon & Richard Wiese	MN	1987
Douglas D. Bennett	TX	1988
Don & Diane Guilford & David & Carol Guilford	CAN	1988
Kenneth Gillig	MO	1988
Bill Bennett	WA	1988
Hansell Pile	KY	1988
Gino Pedretti	CA	1988
Leonard Lorenzen	OR	1988
George Schlickau	KS	1988
Hans Ulrich	CAN	1988
Donn & Sylvia Mitchell	CAN	1988
Darold Bauman	WY	1988
Glynn Debter	AL	1988
William Glanz	WY	1988
Jay P. Book	IL	1988
David Luhman	MN	1988
Scott Burtner	VA	1988

Robert E. Walton	WA	1988
Harry Airey	CAN	1989
Ed Albaugh	CA	1989
Jack & Nancy Baker	MO	1989
Ron Bowman	ND	1989
Jerry Allen Burner	VA	1989
Glynn Debter	AL	1989
Sherm & Charlie Ewing	CAN	1989
Donald Fawcett	SD	1989
Orrin Hart	CAN	1989
Leonard A. Lorenzen	OR	1989
Kenneth D. Lowe	KY	1989
Tom Mercer	WY	1989
Lynn Pelton	KS	1989
Lester H. Schafer	MN	1989
Bob R. Whitmire	GA	1989
Dr. Burleigh Anderson	PA	1990
Boyd Broyles	KY	1990
Larry Earhart	WY	1990
Steven Forrester	MI	1990
Doug Fraser	CAN	1990
Gerhard Gueggenberger	CA	1990
Douglas & Molly Hoff	SD	1990
Richard Janssen	KS	1990
Paul E. Keffaber	IN	1990
John & Chris Oltman	WI	1990
John Ragsdale	KY	1990
Otto & Otis Rincker	IL	1990
Charles & Rudy Simpson	CAN	1990
T.D. & Roger Steele	VA	1990
Bob Thomas Family	OR	1990
Ann Upchurch	AL	1991
N. Wehrmann/R. McClung	VA	1991
John Bruner	SD	1991
Ralph Bridges	GA	1991
Dave & Carol Guilford	CAN	1991
Richard/Sharon Beitelspacher	SD	1991
Tom Sonderup	NE	1991
Steve & Bill Florshcuetz	IL	1991
R. A. Brown	TX	1991
Jim Taylor	KS	1991
R.M. Felts & Son Farm	TN	1991
Jack Cowley	CA	1991
Rob & Gloria Thomas	OR	1991
James Burns & Sons	WI	1991
Jack & Gini Chase	WY	1991
Summitcrest Farms	OH	1991
Larry Wakefield	MN	1991
James R. O'Neill	IA	1991
Francis & Karol Bormann	IA	1992
Glenn Brinkman	TX	1992
Bob Buchanan Family	OR	1992
Tom & Ruth Clark	VA	1992
A. W. Compton, Jr.	AL	1992
Harold Dickson	MO	1992
Tom Drake	OK	1992
Robert Elliott & Sons	TN	1992
Dennis, David, Danny Geffert	WI	1992
Eugene B. Hook	MN	1992
Dick Montague	CA	1992

Bill Rea	PA	1992
Calvin & Gary Sandmeier	SD	1992
Leonard Wulf & Sons	MN	1992
R. A. Brown	TX	1993
Norman Bruce	IL	1993
Wes & Fran Cook	NC	1993
Clarence/Elaine/Adam Dean	SC	1993
D. Eldridge & Y. Adcock	OK	1993
Joseph Freund	CO	1993
R. B. Jarrell	TN	1993
Rueben, Leroy, Bob Littau	SD	1993
J. Newbill Miller	VA	1993
J. David Nichols	IA	1993
Miles P. "Buck" Pangburn	IA	1993
Lynn Pelton	KS	1993
Ted Seely	WY	1993
Collin Sander	SD	1993
Harrell Watts	AL	1993
Bob Zarn	MN	1993
Ken & Bonnie Bieber	SD	1994
John Blankers	MN	1994
Jere Caldwell	KY	1994
Mary Howe di'Zerega	VA	1994
Ron & Wayne Hanson	CAN	1994
Bobby F. Hayes	AL	1994
Buell Jackson	IA	1994
Richard Janssen	KS	1994
Bruce Orvis	CA	1994
John Pfeiffer Family	OK	1994
Calvin & Gary Sandmeier	SD	1994
Dave Taylor / Gary Parker	WY	1994
Bobby Aldridge	NC	1995
Gene Bedwell	IA	1995
Gordon & Mary Ann Booth	WY	1995
Ward Burroughs	CA	1995
Chris & John Christensen	SD	1995
Mary Howe de'Zerega	VA	1995
Maurice Grogan	MN	1995
Donald J. Hargrave	CAN	1995
Howard & JoAnne Hillman	SD	1995
Mack, Billy, Tom Maples	AL	1995
Mike McDowell	VA	1995
Tom Perrier	KS	1995
John Robbins	MT	1995
Thomas Simmons	VA	1995
D. Borgen & B. McCulloh	WI	1996
Chris & John Christensen	SD	1996
Frank Felton	MO	1996
Galen & Lori Fink	KS	1996
Cam, Spike, Sally Forbes	WY	1996
Mose & Dave Hebbert	NE	1996
C. Knight & B. Jacobs	OK	1996
Robert C. Miller	MN	1996
Gerald & Lois Neher	IL	1996
C. W. Pratt	VA	1996
Frank Schiefelbein	MN	1996
Ingrid & Willy Volk	NC	1996
William A. Womack, Jr.	AL	1996
Alan Albers	KS	1997
Gregg & Diane Butman	MN	1997

Blaine & Pauline Canning	CAN	1997
Jim & JoAnn Enos	IL	1997
Harold Pate	AL	1997
E. David Pease	CAN	1997
Juan Reyes	WY	1997
James I. Smith	NC	1997
Darrel Spader	SD	1997
Bob & Gloria Thomas	OR	1997
Nicholas Wehrmann & Richard McClung	VA	1997
James D. Bennett Family	VA	1998
Dick & Bonnie Helms	NE	1998
Dallis & Tammy Basel	SD	1998
Duane L. Kruse Family	IL	1998
Abigail & Mark Nelson	CA	1998
Airey Family	MB	1998
Dave & Cindy Judd	KS	1998
Earl & Nedra McKarns	OH	1998
Tom Shaw	ID	1998
Wilbur & Melva Stewart	AB	1998
Adrian Weaver & Family	CO	1998
Kelly & Lori Darr	WY	1999
Kent Klineman & Steve Munger	SD	1999
John Kluge	VA	1999
Kramer Farms	IL	1999
Noller & Frank Charolais	IA	1999
Lynn & Gary Pelton	KS	1999
Rausch Herefords	SD	1999
Duane Schieffer & Terry O'Neill	MT	1999
Tony Walden	AL	1999

SEEDSTOCK PRODUCER OF THE YEAR

John Crowe	CA	1972
Mrs. R. W. Jones	GA	1973
Carlton Corbin	OK	1974
Leslie J. Holden	MT	1975
Jack Cooper	MT	1975
Jorgensen Brothers	SD	1976
Glenn Burrows	NM	1977
James D. Bennett	VA	1978
Jim Wolfe	NE	1979
Bill Wolfe	OR	1980
Bob Dickinson	KS	1981
A.F. "Frankie" Flint	NM	1982
Bill Borror	CA	1983
Lee Nichols	IA	1984
Ric Hoyt	OR	1985
Leonard Lodoen	ND	1986
Henry Gardiner	KS	1987
W.T. "Bill" Bennett	WA	1988
Glynn Debter	AL	1989
Doug & Molly Hoff	SD	1990
Summitcrest Farms	OH	1991
Leonard Wulf & Sons	MN	1992
R. A. "Rob" Brown	TX	1993
J. David Nichols	IA	1993
Richard Janssen	KS	1994
Tom & Carolyn Perrier	KS	1995
Frank Felton	MO	1996
Bob & Gloria Thomas	OR	1997
Wehrmann Angus Ranch	VA	1997
Flying H Genetics	NE	1998
Knoll Crest Farms	VA	1998
Morven Farms	VA	1999

MORVEN FARMS
1999 Seedstock Producer of the Year

MORVEN FARMS NAMED BEEF IMPROVEMENT FEDERATION SEEDSTOCK PRODUCERS OF THE YEAR

Roanoke, Virginia – The Beef Improvement Federation (BIF) honored John Kluge's Morven Farms as the Seedstock Producer of the Year Award at the 31st Annual Convention in Roanoke, Virginia.

Beginning with the original Albemarle County land purchase in 1982, John Kluge's Morven Farms has grown to 10 individual farm tracts encompassing nearly 8,500 acres owned and 3,500 leased acres. Approximately one-fourth of this acreage is devoted to cattle; the remainder to thoroughbred horses, grain, hay and timber enterprises. These farms are home to approximately 1,000 registered Angus, Charolais and Simmental females and an additional 200-plus commercial - recipient herd. Every calf bred at Morven is by an AI sire and is performance tested and objectively measured and evaluated for economically important traits. Irregardless of breed, Morven's herd EPD averages rank within the top ten percent for growth and maternal traits. Additionally, where carcass data EPDs are available, Morven cattle are bred to be positive for both marbling and ribeye area. The breeding philosophy is best summed up as "Total Balanced Trait Selection". An aggressive on-farm embryo transfer program generates about 500 embryos per year.

Thirty Morven sires are listed in Sire Summaries in three different breeds; five more are awaiting proofs while being featured at three different AI studs. Live cattle from Morven have been sold in Australia, Brazil, Canada, Colombia, Mexico, New Zealand and Venezuela; embryos have been sold into the aforementioned countries plus Chile and Costa Rico, and nearly every state within the continental U.S. Semen has also been distributed internationally.

Morven personnel have provided technical training and consultation services in Nigeria, Poland and Russia, additionally, they have appraised cattle in Australia, Canada, and New Zealand. International agricultural specialists tour Morven on a frequent basis. Morven possesses one of the very first USDA approved quarantine/isolation facilities for exportation to Australia/New Zealand. Additionally, Morven has commercial backgrounding/finishing facilities with a one-time capacity of 2,500 head. Morven partnered with the Ukrops Bros. of Richmond, VA to help form PM BEEF LLC, an integrated, value-based beef distribution alliance.

The Beef Improvement Federation is proud to recognize Morven Farms as the 1999 BIF Seedstock Producer of the Year.

1999 SEEDSTOCK PRODUCER AWARD NOMINEES

Eagle Pass Ranch, L.P.
Kent Klineman and Steve Munger, Highmore, South Dakota

Eagle Pass Ranch is located near Highmore in central South Dakota. The ranch is rich in history. Ted and Clayton Jennings initially developed it in the 1930's and operated it as Hyland Angus. In the 1950's, they merged with the Leachman family, who had just moved west from Ankony, New York. During this period the operation was known as Ankony Hyland. Munger and Klineman purchased the ranch in 1988 from the Jennings family. They initially stocked the 50,000 acres with 4,500 Angus cross commercial cows. In 1988 they also began the most intensive breed up program in the history of the Gelbvieh breed, quite possibly the most intensive of any breed, by artificially inseminating all 4,500 cows to Gelbvieh sires. In their first ten years, they have AI'd over 25,000 cows to Gelbvieh sires and have registered over 6,000 females. They presently maintain a herd of 1,500 registered Gelbvieh females and 600 registered Angus females on 20,000 acres. The Eagle Pass Angus program started in 1991 when they purchased 100 females from the Hoff Scotch Cap program and 50 females from the Jorgenson Ideal program. They have used embryo transfer aggressively in their Angus program. transferring up to 500 embryos annually. Both spring and fall calving periods are used. They strictly adhere to a rigid culling program to assure that only the "Top Cut" bulls make it to their annual production sale the third Saturday in April.

Kramer Farms
Gene, Marvin and Keith Kramer, Farina, Illinois

The Kramer operation is a beef and grain farm with the beef cattle phase consisting of a purebred Angus herd with over 110 registered females. The Kramer Farm is located in south central Illinois near Farina in Fayette County. Gene Kramer started in the purebred Angus business over 38 years ago and now has been joined by sons, Marvin and Keith. The goal of the Kramer Angus has been to raise sound, productive cattle that are profitable for both them and their customers. When the Kramers think of a purebred beef cattle herd in Illinois it is one that is entirely dedicated to total performance and to making as much genetic advancement as possible, and certainly the Kramer herd is one that rises above all others. This is especially brought out in the selection of cattle based on balance traits with all traits being equal. The continual commitment on performance testing for over 25 years with the earlier years cooperating with the University of Illinois Beef Performance Testing Program and now with the American Angus Association AHIR records since 1980. Currently, they have 2 bulls listed in the AHIR National Sire Evaluation Summary. This continual commitment to performance testing has resulted in a remarkable improvement in weaning weights. Even though the herd started with a very respectable weaning weight averaging over 400 pounds, when implementing performance testing, through selection and use of superior sires via A.I. and natural service, improvement has increased weaning weights to over 600 pounds average in 1998. The Kramers utilize primarily a spilt calving program with about 85 percent of the calves born in the spring and the remaining 15% in the fall. Approximately 80% of the cows are bred A.I. with a first time conception rate between 70 and 80%. They breed one time with AI and then cows are naturally bred. The Kramers also utilize some embryo transfer in an effort to perpetual the outstanding females in the herd and to get more outstanding females back in the herd.

Morven Farms
John Kluge, Charlottesville, Virginia

Beginning with the original Albemarle County land purchase in 1982, John Kluge's Morven Farms has grown to 10 individual farm tracts encompassing nearly 8,500 acres owned and 3,500 leased acres. Approximately one-fourth of this acreage is devoted to cattle; the remainder to thoroughbred horses, grain, hay and timber enterprises. These farms are home to approximately 1,000 registered Angus, Charolais and Simmental females and an additional 200-plus commercial / recipient herd. Every calf bred at Morven is by an A.I. sire and is performance tested and objectively measured and evaluated for economically important traits. Irregardless of breed, Morven's herd EPD averages rank within the top ten percent for growth and maternal traits. Additionally, where carcass data EPDs are available, Morven cattle are bred to be positive for both marbling and ribeye area. The breeding philosophy is best summed up as "Total Balanced Trait Selection". An aggressive on-farm embryo transfer program generates about 500 embryos per year. Thirty Morven sires are listed in Sire Summaries in three different breeds; five more are awaiting proofs while being featured at three different A.I. studs. Live cattle from Morven have been sold in Australia, Brazil, Canada, Colombia, Mexico, New Zealand and Venezuela; embryos have been sold into the aforementioned countries plus Chile and Costa Rico, and nearly every state within the continental U.S. Semen has also been distributed internationally. Morven personnel have provided technical training and consultation services in Nigeria, Poland and Russia, additionally, they have appraised cattle in Australia, Canada, and New Zealand. International agricultural specialists tour Morven on a frequent basis. Morven possesses one of the very first USDA approved quarantine/isolation facilities for exportation to Australia/New Zealand. Additionally, Morven has commercial backgrounding/finishing, facilities with a one-time capacity of 2,500 head. Morven partnered with the Ukrops Bros. of Richmond, VA to help form PM BEEF LLC, an integrated, value-based beef distribution alliance.

Natural Bridge Angus
Kelly & Lori Darr and Family, Douglas, Wyoming

Natural Bridge Angus is located in central Wyoming, 13 miles west of Douglas off of I-25. They have been on this ranch for 7 years and previously leased a ranch near Casper, WY. The Darr's raise registered Black Angus cattle, selling bulls, steers and registered heifers. The 45-day calving season for their 130 cows begins January 15 and usually ends February 28th. They harvest 400 T of hay from 100 acres of hayground and also raise 20 acres of oats. The primary focus of their operation is to produce superior females. They strive for the best maternal traits in their cows and basically consider the bulls as a by-product. By Wyoming standards, they have a small operation, so they want every cow in the herd to have the potential to raise a herd bull for another registered operation. They feel that the quality of their cows separates them from the breeder down the road. They feel that since all producers have access to basically the same bulls through the use of AI, they need to have good cows to raise good calves. Like begets like!

Noller and Frank Charolais
David Noller and Wayne & Judy Frank, Sigourney, Iowa

The Noller & Frank Charolais operation is a classic example of the "American Dream Come True". David Noller's grandfather started farming two miles west of the southeast Iowa town of Sigourney in the early 1890's. The farm was passed down to his son Glen in 1918 and then on to his son David in 1946. David fed cattle and raised hogs, and the farm grew to over 1500 acres of owned & rented land. Although David and his wife Jean had raised a son and a daughter, neither of them chose to follow those who had gone before them in the farming and livestock business. In 1969 David had six employees and by that time had helped three young couples to start farming. The Franks were one of those employees and from the beginning they showed enthusiasm toward the farm and especially the livestock business. By 1972 the Nollers & the Franks had formed a farming partnership which has grown to the present 1130 acres of Iowa land which includes approximately 900 acres of cropland and 230 acres of permanent pasture and woods. Wayne and Judy Frank presently own 470 acres of the farm and Noller owns the rest. Although Noller had kept commercial cows since the early 50's and had added a few Charolais in the mid 60's, the Franks didn't get in the Cow-Calf business until 1975. By 1983 the Noller & Frank Charolais program was started with the purchase of breeding stock from the Garst Company and Marvin Nichols. They have increased the herd to the point that 180 cows are bred for spring calves in 1999 within a seventy-day calving season.

Pelton Simmental/Red Angus
Lynn and Gary Pelton, Burdett, Kansas

Pelton Simmental/Red Angus is a family owned and operated seedstock business located near Burdett, Kansas. Gary and Donna and their sons, Jason, Aaron and Burke; and Lynn and Sue and their daughter Shanna and son Dustin began a partnership in 1976 and later incorporated into a diversified operation consisting of 3,500 acres of grass, 3,500 acres of cultivated land and 475 head of registered Red Angus and Simmental cows. The operation owns 1,800 acres and rents 5,200 acres, including 500 acres of irrigated land. Corn, milo, wheat, alfalfa, soybeans and all cattle feed is produced by the family corporation. Winter feed sources include corn silage, alfalfa, baled milo stalks and crop residues utilized for grazing. Milo, wheat, soybeans and 70% of the alfalfa are used as cash crops. Gary manages the crops and Lynn manages the cattle operation. The purebred operation began in 1972 with the purchase of four 1/2 Simmental x 1/2 Hereford yearling open heifers at the Kansas Simmental Association state sale. In 1973, Lynn had 17 artificially inseminated (AI) calves from his dad's best Hereford cows. In 1989, Red Angus was added to the two-breed operation. Since Lynn's graduation from K-State in 1975, Pelton Simmental/Red Angus has grown into a successful, two-breed seedstock operation that annually markets 200 animals through a production sale and private treaty. Implementing an effective AI program, collecting ultrasound carcass data to direct breeding decisions, and incorporating an embryo transfer (ET) program that manages all recipient cows and most donor cows within the herd, all make the operation what it is today.

Rausch Herefords
Jerry, Vern and Shannon Rausch, Hoven, South Dakota

Brothers Jerry and Vern, and Vern's son Shannon, run a purebred Hereford and commercial ranching operation in North Central South Dakota. Jerry and Vern's older brothers and their father started the registered Hereford herd in 1946. The ranch runs 400 registered Hereford and 200 commercial baldy cows. They purchase top bull calves from other brothers' and nephews' registered herds at weaning time, to performance test and market them along with their own raised bulls. Seventy-five bulls and 125 replacement heifer calves are offered annually in Rausch Herefords Bull and Female Sale. An additional 75 bulls are sold private treaty throughout the year as are a select group of cows sold every fall. Club calves are sold private treaty and through a state association sale. The annual Rausch Hereford Bull and Female Sale is held on the third Monday of February each year. The next sale will be the 42nd annual. Just under 300 Rausch cows have qualified for the American Hereford Association's (AHA) most efficient cow and Dams of Distinction lists. They have led the Nation annually in the total number of cows to qualify for the lists for the past 18 years. South Dakota has four pronounced seasons. Rausch cows are stressed through the harsh winter and calved in the spring. They are then flushed on spring green growth and naturally bull bred on the prosperity of summer growth. The hardened fall growth adds pounds to the calves and freshens the dams. They think these, along with proper culling, are some of the major reasons that they qualify cows on the Dams of Distinction list. Rausch Herefords have merchandised close to 5,000 bulls and 5,000 females to the commercial cattle industry

Tomahawk Land & Cattle
Duane Schieffer & Terry O'Neill, Billings, Montana

For the last 20 years Tomahawk Land & Cattle has headquartered out of Shepard, Montana. The cow herd consists of 300 registered Limousin cows, 25 Red Angus cows and 25 Black Angus cows. Tomahawk calves twice per year (late February through April and September through November). Additionally, they have added cooperative herds in Montana, Nebraska and Iowa. All told they jointly calve out approximately 700 registered cows - mainly Limousin. Their customer base is the commercial cow - calf operators. The commercial operator they sell to tends to be a 400 plus cow operation. He also is more inclined to feed out his own calves and in many cases, will go to the rail as well. Over the years their customer base is highly repeatable at Tomahawk's sales. In most cases they have a continued working relationship with their customers year round. They also sell semen throughout the world. Their registered females are sold at 150% of feeder market.

Walden Farms
Tony Walden, Brantley, Alabama

Walden Farms is located in the south Alabama town of Brantley, which is approximately 40 miles north of the Florida line. Walden Farms was started in the early 1970's as a commercial operation, and in 1987 started a registered Charolais herd. They presently calve 500 registered Charolais cows in two calving seasons. The fall calving season, which is their largest, starts in early September. They also have a spring season that concludes in mid-April. The Walden's main objective is to produce bulls for the commercial market. They have a production sale each November. In 1999 they will be offering 200 bulls and 100 females for sale. Most of their cattle are sold to producers in the Southeast.

COMMERCIAL PRODUCER HONOR ROLL OF EXCELLENCE

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

Dick Coon	WA	1979
Jerry Northcutt	MO	1979
Steve McDonnell	MT	1979
Doug Vandermyde	IL	1979
Norman, Denton, & Calvin Thompson	SD	1979
Jess Kilgore	MT	1980
Robert & Lloyd Simon	IL	1980
Lee Eaton	MT	1980
Leo & Eddie Grubl	SD	1980
Roger Winn, Jr.	VA	1980
Gordon McLean	ND	1980
Ed Disterhaupt	MN	1980
Thad Snow	CAN	1980
Oren & Jerry Raburn	OR	1980
Bill Lee	KS	1980
Paul Moyer	MO	1980
G. W. Campbell	IL	1981
J. J. Feldmann	IA	1981
Henry Gardiner	KS	1981
Dan L. Weppler	MT	1981
Harvey P. Wehri	ND	1981
Dannie O'Connell	SD	1981
Wesley & Harold Arnold	SD	1981
Jim Russell & Rick Turner	MO	1981
Oren & Jerry Raburn	OR	1981
Orin Lamport	SD	1981
Leonard Wulf	MN	1981
Wm. H. Romersberger	IL	1982
Milton Krueger	MO	1982
Carl Odegard	MT	1982
Marvin & Donald Stoker	IA	1982
Sam Hands	KS	1982
Larry Campbell	KY	1982
Lloyd Atchison	CAN	1982
Earl Schmidt	MN	1982
Raymond Josephson	ND	1982
Clarence Reutter	SD	1982
Leonard Bergen	CAN	1982
Kent Brunner	KS	1983
Tom Chrystal	IA	1983
John Freitag	WI	1983
Eddie Hamilton	KY	1983
Bill Jones	MT	1983
Harry & Rick Kline	IL	1983
Charlie Kopp	OR	1983
Duwayne Olson	SD	1983
Ralph Pederson	SD	1983
Ernest & Helen Schaller	MO	1983
Al Smith	VA	1983
John Spencer	CA	1983
Bud Wishard	MN	1983
Bob & Sharon Beck	OR	1984
Leonard Fawcett	SD	1984
Fred & Lee Kummerfeld	WY	1984
Norman Coyner & Sons	VA	1984
Franklyn Esser	MO	1984
Edgar Lewis	MT	1984
Boyd Mahrt	CA	1984
Neil Moffat	CAN	1984
William H. Moss, Jr.	GA	1984
Dennis P. Solvie	MN	1984
Robert P. Stewart	KS	1984
Charlie Stokes	NC	1984
Milton Wendland	AL	1985
Bob & Sheri Schmidt	MN	1985
Delmer & Joyce Nelson	IL	1985
Harley Brockel	SD	1985

Kent Brunner	KS	1985
Glenn Harvery	OR	1985
John Maino	CA	1985
Ernie Reeves	VA	1985
John R. Rouse	WY	1985
George & Thelma Boucher	CAN	1985
Kenneth Bentz	OR	1986
Gary Johnson	KS	1986
Ralph G. Lovelady	AL	1986
Ramon H. Oliver	KY	1986
Kay Richardson	FL	1986
Mr. & Mrs. Clyde Watts	NC	1986
David & Bev Lischka	CAN	1986
Dennis & Nancy Daly	WY	1986
Carl & Fran Dobitz	SD	1986
Charles Fariss	VA	1986
David J. Forster	CA	1986
Danny Geersen	SD	1986
Oscar Bradford	AL	1987
R. J. Mawer	CAN	1987
Rodney G. Oliphant	KS	1987
David A. Reed	OR	1987
Jerry Adamson	NE	1987
Gene Adams	GA	1987
Hugh & Pauline Maize	SD	1987
P. T. McIntire & Sons	VA	1987
Frank Disterhaupt	MN	1987
Mac, Don & Joe Griffith	GA	1988
Jerry Adamson	NE	1988
Ken/Wayne/Bruce Gardiner	CAN	1988
C. L. Cook	MO	1988
C. J. & D. A. McGee	IL	1988
William E. White	KY	1988
Frederick M. Mallory	CA	1988
Stevenson Family	OR	1988
Gary Johnson	KS	1988
John McDaniel	AL	1988
William A. Stegner	ND	1988
Lee Eaton	MT	1988
Larry D. Cundall	WY	1988
Dick & Phyllis Henze	MN	1988
Jerry Adamson	NE	1989
J. W. Aylor	VA	1989
Jerry Bailey	ND	1989
James G. Guyton	WY	1989
Kent Koostra	KY	1989
Ralph G. Lovelady	AL	1989
Thomas McAvoy, Jr.	GA	1989
Bill Salton	IA	1989
Lauren & Mel Schuman	CA	1989
Jim Tesher	ND	1989
Joe Thielen	KS	1989
Eugene & Ylene Williams	MO	1989
Phillip, Patty & Greg Bartz	MO	1990
John J. Chrisman	WY	1990
Les Herbst	KY	1990
Jon C. Ferguson	KS	1990
Mike & Diana Hooper	OR	1990
James & Joan McKinlay	CAN	1990
Gilbert Meyer	SD	1990
DuWayne Olson	SD	1990
Raymond R. Peugh	IL	1990
Lewis T. Pratt	VA	1990
Ken & Wendy Sweetland	CAN	1990
Swen R. Swenson Cattle	TX	1990
Robert A. Nixon & Son	VA	1991
Murray A. Greaves	CAN	1991
James Hauff	ND	1991

J. R. Anderson	WI	1991
Ed & Rich Blair	SD	1991
Reuben & Connee Quinn	SD	1991
Dave & Sandy Umbarger	OR	1991
James A. Theeck	TX	1991
Ken Stielow	KS	1991
John E. Hanson, Jr.	CA	1991
Charles & Clyde Henderson	MO	1991
Russ Green	WY	1991
Bollman Farms	IL	1991
Craig Utesch	IA	1991
Mark Barenthsen	ND	1991
Rary Boyd	AL	1992
Charles Daniel	MO	1992
Jed Dillard	FL	1992
John & Ingrid Fairhead	NE	1992
Dale J. Fischer	IA	1992
E. Allen Grimes Family	ND	1992
Kopp Family	OR	1992
Harold/Barbara/Jeff Marshall	PA	1992
Clinton E. Martin & Sons	VA	1992
Lloyd & Pat Mitchell	CAN	1992
William Van Tassel	CAN	1992
James A. Theeck	TX	1992
Aquilla M. Ward	WV	1992
Albert Wiggins	KS	1992
Ron Wiltshire	CAN	1992
Andy Bailey	WY	1993
Leroy Beitelspacher	SD	1993
Glenn Calbaugh	WY	1993
Oscho Deal	NC	1993
Jed Dillard	FL	1993
Art Farley	IL	1993
Jon Ferguson	KS	1993
Walter Hunsuker	CA	1993
Nola & Steve Kleiboeker	MO	1993
Jim Maier	SD	1993
Bill & Jim Martin	WV	1993
Ian & Alan McKillop	ON	1993
George & Robert Pingetzer	WY	1993
Timothy D. Sutphin	VA	1993
James A. Theeck	TX	1993
Gene Thiry	MB	1993
Fran & Beth Dobitz	SD	1994
Bruce Hall	SD	1994
Lamar Ivey	AL	1994
Gordon Mau	IA	1994
Randy Mills	KS	1994
W. W. Oliver	VA	1994
Clint Reed	WY	1994
Stan Sears	CA	1994
Walter Carlee	AL	1995
Nicholas Lee Carter	KY	1995
Charles C. Clark, Jr.	VA	1995
Greg & Mary Cunningham	WY	1995
Robert & Cindy Hine	SD	1995
Walter Jr. & Evidean Major	KY	1995
Delhert Ohnemus	IA	1995
Olafson Brothers	ND	1995
Henry Stone	CA	1995
Joe Thielen	KS	1995
Jack Turnell	WY	1995
Tom Woodard	TX	1995
Jerry & Linda Bailey	ND	1996
Kory M. Bierle	SD	1996
Mavis Dummermuth	IA	1996
Terry Stuart Forst	OK	1996
Don W. Freeman	AL	1996

Lois & Frank Herbst	WY	1996
M/M George A. Horkan, Jr.	VA	1996
David Howard	IL	1996
Virgil & Mary Jo Huseman	KS	1996
Q. S. Leonard	NC	1996
Ken & Rosemary Mitchell	CAN	1996
James Sr/Jerry/James Petik	SD	1996
Ken Risler	WI	1996
Merlin Anderson	KS	1997
Joe C. Bailey	ND	1997
William R. "Bill" Brockett	VA	1997
Arnie Hansen	MT	1997
Howard McAdams, Sr & Howard McAdams, Jr.	NC	1997
Rob Orchard	WY	1997
Bill Peters	CA	1997
David Petty	IA	1997
Rosemary Rounds & Marc & Pam Scarborough	SD	1997
Morey & Pat Van Hoecke	MN	1997
Randy & Judy Mills	KS	1998
Mike & Priscilla Kasten	MO	1998
Amana Farms Inc.	IA	1998
Terry & Dianne Crisp	AB	1998
Jim & Carol Faulstich	SD	1998
James Gordon Fitzhugh	WY	1998
John B. Mitchell	VA	1998
Holzapfel Family	CA	1998
Mike Kitley	IL	1998
Wallace & Donald Schilke	ND	1998
Doug & Ann Deane and Patricia R. Spearman	CO	1998
Glenn Baumann	ND	1999
Bill Boston	IL	1999
C-J-R Christensen Ranches	WY	1999
Deseret Ranches of Alberta	CAN	1999
Ken Fear, Jr.	WY	1999
Giles Family	KS	1999
Burt Guerrieri	CO	1999
Karlen Family	SD	1999
Nick & Mary Klintworth	NE	1999
Iris, Bill & Linda Lipscomb	AL	1999
MW Hereford Ranch	NE	1999
Mossy Creek Farm	VA	1999

Ernie Reeves, Mossy Creek Farm
Co-Winner, 1999 Commercial
Producer of the Year

COMMERCIAL PRODUCER OF THE YEAR

Chan Cooper	MT	1972
Pat Wilson	FL	1973
Lloyd Nygard	ND	1974
Gene Gates	KS	1975
Ron Blake	OR	1976
Steve & Mary Garst	IA	1977
Mose Tucker	AL	1978
Bert Hawkins	OR	1979
Jess Kilgore	MT	1980
Henry Gardiner	KS	1981
Sam Hands	KS	1982
Al Smith	VA	1983
Bob & Sharon Beck	OR	1984
Glenn Harvey	OR	1985
Charles Fariss	VA	1986
Rodney G. Oliphant	KS	1987
Gary Johnson	KS	1988
Jerry Adamson	NE	1989
Mike & Diana Hopper	OR	1990
Dave & Sandy Umbarger	OR	1991
Kopp Family	OR	1992
Jon Ferguson	KS	1993
Fran & Beth Dobitz	SD	1994
Joe & Susan Thielen	KS	1995
Virgil & Mary Jo Huseman	KS	1996
Merlin & Bonnie Anderson	KS	1997
Randy & Judy Mills	KS	1998
Mike & Priscilla Kasten	MO	1998
Giles Ranch	KS	1999
Mossy Creek Farm	VA	1999

GILES RANCH
Co-Winner, 1999 Commercial Producer of the Year

GILES RANCH AND MOSSY CREEK FARM NAMED BEEF IMPROVEMENT FEDERATION COMMERCIAL PRODUCERS OF THE YEAR

Roanoke, Virginia – The Beef Improvement Federation (BIF) honored Giles Ranch Company of Ashland, Kansas and Mossy Creek Farm of Mt. Solon, Virginia as co-winners of the Commercial Producer of the Year Award at the 31st Annual Convention in Roanoke, Virginia.

Kelly Giles and the Giles Ranch Company are focused on improving the end product. The century old ranch uses leading edge technology and innovation to keep in step with changes in the beef industry. The family operation includes a commercial cow-calf herd, stocker and feeder cattle, farming and lease hunting. As a founding member of U.S. Premium Beef, a closed marketing cooperative, Kelly Giles has a good understanding of changing consumer demands and the steps needed to meet those demands. Replacement heifers are synchronized and bred AI to proven sires that excel in calving ease and carcass merit. Giles uses full brother, embryo transfer bulls on a uniform cowherd to produce a consistent calf crop. Feeder cattle are finished in custom lots and marketed through the U.S. Premium Beef. Feedlot performance and carcass data are collected and utilized to direct future breeding decisions.

The Giles Ranch also focuses on constant improvement of the natural resources. Land and water management practices have enhanced the efficiency of the cowherd and have increased wildlife populations allowing for the development of the lease-hunting program.

Mossy Creek Farm, owned and operated by Ernie Reeves, is a multigenerational family farm located at Mt. Solon, Virginia in the Central Shenandoah Valley. The 2,500-acre operation supports a 650 plus commercial cowherd and a 2,000 head backgrounding enterprise. The Angus-based cowherd calves in February and March with roughly 40 percent serving as surrogate mothers for a custom embryo recipient service. The two-year-old heifers start calving two weeks later than the cowherd in an approximate 45-day calving season. A rotational grazing program is used for all females with harvested feed needed approximately 90 days per winter (January 1 - April 1). Calves are weaned in late September - early October and then enter the backgrounding operation. Purchased calves come directly from other producers and are co-mingled and sorted by sex and size into uniform lots of 65 - 100 head for the growing phase until they reach roughly 750 lbs. At that point, 80 percent are sent to custom feedyards utilizing individual cattle management for finishing with the balance sold as feeders through Virginia Cattlemen's Association sponsored sales. Health and performance data is shared back with the producers of purchased calves. In 1998, 442 calves were fed and obtained 70 percent choice and 67 percent yield grade 1 and 2.

Reeves also practices several soil conservation and environmental management techniques which led to Mossy Creek Farm being granted the 1997 NCBA Region I Environmental Stewardship Award.

The Beef Improvement Federation is proud to recognize these two outstanding beef producers as the 1999 BIF Commercial Producers of the Year.

1999 COMMERCIAL PRODUCER AWARD NOMINEES

Karlen Family Partnership
Reliance, SD

The Karlen Family Partnership operates a diversified ranching, farming, and cattle-feeding operation in central South Dakota. The ranch began in the late 1920's under the ownership of Merrill M. Karlen and grew considerably as it diversified into farming and backgrounding under the 50 plus years of leadership from his son, Merrill, Sr. Four of Merrill Sr.'s children (Merrill, Jr., Brad, Warren, and Julie) now own the ranch and have continued its diversity and expansion. The Karlen's calve 2,500 Limousin, Angus, Gelbvieh, and a few Charolais-cross cows using a rotational crossbreeding system. They also operate a feedlot with a 5,000-head capacity. Their extensive no-till farming operation produces all of the forage and a good portion of the corn used in the feeding division. Other crops raised are spring and winter wheat, soybeans, and field peas. One of their biggest assets is the young management team that they have developed. Each member of their family partnership has their specialty in which they continually strive for improvement. Together, this family management team has built a considerable amount of financial strength and they see nothing but huge opportunities unfolding in the future of agriculture. They also see the future of their operation being carried on by the fourth generation that is actively involved in the ranch's day to day operation.

MW Hereford Ranch
Newport, NE

MW Hereford Ranch is located in north central Nebraska in the northeast area of the Sandhills. The 11,777-acre ranch consists of native range Sandhills and sub-irrigated meadows. Summer range contains warm season grasses, which offers feed for five months. Shallow well windmills and 20-foot bottomless tanks provide water. The winter headquarters consist mostly of sub-irrigated cool season grass meadows. Here water is provided to the cattle by artesian wells that flow 52 degree F. water year round. Hand-planted shelterbelts on the winter headquarters enable them to have an early spring calving season. The 1,000 females bred each year for mostly spring calving are Hereford and Hereford x Angus. By using synchronization they have a 10-day AI period. More than 650 females are bred with a 73-80% conception rate to high accuracy EPD bulls ranking in the top 20% of the breeds used. The families of Roy and Jay Stewart who are third and fourth generation Hereford breeders manage the family partnership. Roy has used some of the ground for 39 years and is continuing to expand. Most of the work is accomplished with family labor and one full-time hired man. College-age employees from agricultural schools and underprivileged, urban youth are hired for seasonal hay harvesting. They make an effort to provide non-agricultural youth the opportunity to appreciate rural living and raising livestock and expose them to ag economics.

3L Ranch, Iris, Bill and Linda Lipscomb
Prattville, Alabama

3L Ranch is located just south of Prattville, Alabama on the north bank of the Alabama River. The ranch has been in the family since 1936. It consists of approximately 630 acres of land, of which at this location, 280 acres are timber, and 280 acres are hay and pasture. They run 100 brood cows in a fall calving season. Calving runs from October 10th through December 25th. Calves are tagged, steers castrated, and dam infertility is recorded at birth. Calves and cows are worked in April. Calves are weighed in June for BCIA records. Steers and heifers, other than replacements, are sold in the Producer's Feeder Calf Sale the first Wednesday in August. Cows are pregnancy tested and worked in late August. Replacements are weaned at that time. Bulls are worked in September for breeding soundness evaluations, vaccinations, and worming.

C-J-R Christensen Ranches
Gillette, WY

C-J-R Christensen Ranches is a family operation consisting of Charles (Bud) and Alice Lee; daughter, Janet; and son, Robert, and his family. It is a 3,300-head cow-calf operation on 130,000 acres located in three states. Bud's father started the Gillette, WY home ranch in 1904. Since then the operation has been expanded to ranches at Glendo, WY in 1973; Miles City, MT in 1977; and Broken Bow, NE in 1981. Salers is the basic breed of the cow herd with some percentage Angus-Salers bulls being used. Three other breeds have been used and they are using one new breed experimentally at the present time. Two-year-old heifers start calving February 15, three-year-olds start March 15th and cows start March 25 to April 5 depending on the ranch location. All bull calves, heifer calves and Montana steer calves go to Nebraska upon weaning in October. Wyoming steer calves are wintered at Glendo. Replacement heifers are selected and AI bred in Nebraska to go back to Wyoming in July and October for the winter. Cattle from each state are identified with a different ear notch. The Montana and Nebraska heifers go back to Montana at calving time while the Wyoming cattle remain in Wyoming. They raise their own bulls from the AI program on the yearling heifers and single sire breeding of the two-year-old heifers and some older cows that have produced exceptional calves. All older cows are moved to Nebraska for more longevity (up to 15 years old). The younger cows are maintained in the harsher environments of Wyoming and Montana. Ownership is retained on all other cattle through the feedlot. Carcass information is gathered in packing houses in Lexington, NE; Sterling, CO; Garden City, KS; and Windom, MN.

Klintworth Limousin
Moorefield, NE

Nick and Mary Klintworth's cow/calf operation is located in a canyon of southwest Nebraska, six miles north of Moorefield. They have been on the 5,000 acres of native grassland for sixteen years. The cow herd consists of 300 commercial cows and about 50 purebred cows. Calving season for heifers starts February 10th with cows beginning on February 25th. The season is completed by May 1. Their operation is run with no outside help, so family members have a firm grasp on all aspects of the operation. They lease 250 acres of alfalfa and 200 acres of prairie hay to produce winter feed. Cows go to leased cornstalks from November to February to help cut feed costs. The calf crop is weaned in October and backgrounded through January. The Klintworth's began using Limousin genetics in 1984 on their British-bred cow herd to increase performance of the calves. Seeing the weights in the first Limousin-influenced calf crop was enough to convince them that they were on the right track.

Giles Ranch Company
Ashland, Kansas

The Giles family has been involved in production agriculture through many generations and over 100 years. Southwest Kansas has been the center of modern operations since the 1920's. Presently, the Giles' have ranch and farm operations in Hodgeman, Ford, Edwards, Kiowa and Clark Counties. Headquarters are located in Offerle, Bucklin and Ashland, KS. Total acreage encompasses approximately 35,000 acres of native range and 6,000 acres of cultivated land where they raise wheat, alfalfa, sorghum, and corn. The Angus-based cowherd numbers more than 1,500 head. Approximately 6,000 head of stocker cattle are backgrounded and fed out to finish by custom feedyards. Replacement heifers are synchronized and artificially inseminated (AI) to calving ease/ carcass type Angus sires. Calf birthweights and birthdate are recorded when they calve in January. Mature cows begin calving February 20 and are sorted on the fall pregnancy check to calve within a 70-day period ending April 30. Older females are bred by natural service using full sibling, embryo transfer (ET) bulls for the most consistency possible, with the exception of AI. Progeny of these matings are marketed as commercial breeding bulls, bred heifers or fed through for processing. Rate of gain, conversion (cost of gain) and carcass data all are collected and used to direct future breeding decisions based on sound data.

Deseret Ranches of Alberta Ltd.
Raymond, Alberta

Deseret Ranches of Alberta is located on the Milk River Ridge in the SW corner of the Alberta prairie. This ridge rises an additional 1,000 ft above the surrounding prairie lying parallel to the U.S. border. The Bar K 2 Ranch, on the West slope, was purchased in 1947 with the Knight Ranch, lying on the Southerly slop, being acquired the year following. Parcels were added throughout the years bringing the present ranch to over 100,000 deeded acres making it the largest ranch in Alberta and the second largest deeded ranch in Canada. The ranch is dominantly native range with significant improved pastures and some cultivated acreage for cereal grain production. A cow-calf operation has been the basis of their program; they originally sold the calves each fall upon weaning. They have since moved into retaining all of their calves for either replacements, stockers, backgrounding for later sale, or for finishing themselves. The 6,000 plus cows are calved in April/May along the Milk River where there is shelter from late storms; on reserved native and early improved grasses. Lighter calves and heifers for replacements are wintered on the ranch with larger calves going into lots within 20 miles. Being in the heart of the cattle feeding industry in Canada gives them this option. The original Hereford herd has been crossed with Black Angus since the early 60's and they have used a terminal cross with Charolais from the early 70's. They are currently introducing Gelbvieh into the herd and discontinuing the terminal cross, which gives them additional bred heifers for sale.

Glenn Baumann
Ashley, North Dakota

The Baumann's operation is located 7 miles NW of Ashley, ND in Mclnstosh County. Born and raised on the farm site, Glenn has been involved in the management and operation of the farm for more than 20 years. He is the third generation owner since his grandfather started the farm in 1930. Most of the cows in this commercial crossbred operation are Angus, Simmental and Gelbveih cross. Replacement females are kept from with the herd. They started using AI in 1984 by using Angus, Simmental and Gelbvieh in their three-breed rotational system. In 1997 they started using composite bulls of these same three breeds to obtain a more uniform set of replacement and feeder calves. The composite bulls are 50% English and 50% Continental to get away from the high percentage of Gelbvieh and Simmental bloodlines in their cows. Their herd of 140 cows is calved in the spring with the exception of 15 fall-calving cows. About 20 replacement heifers are kept each year. The 3,000 acres of owned and rented land consists of half cropland and half pasture and hayland. The pastures contain both native and tame grasses and the cropland produces wheat, barley and hay. Much of the cropland is in CRP, which has been used for emergency hay and pasture during the dry years. Heifers are synchronized with MGA and Lutalyse and are bred AI to start calving February 1st. The cows are bred for a 60-day calving period, which starts February 10th. The fall calves are bred for a 45-day period to calve between August 15 and October 1st.

Cottonwood Ranches DBA Fear Ranches, Ken Fear, Jr.
Big Piney, Wyoming

Ken has been ranching for 40 years, 30 as Fear Ranch and 10 years as Cottonwood Ranch. He and his wife Mary have raised 2 children and lots of good cattle and horse stock over the years. Their ranch is northwest of Big Piney, in Sublette county, Wyoming. This part of Wyoming has lots of public land, a long winter, and a short growing season. BLM and Forest grazing permits are extremely important to their operation. Including Federal land, the ranch extends almost 30 miles of Cottonwood creek drainage. They raise about 4500 tons of grass hay to feed cattle about 5 months of each year. The ranch has 1800 cows that are predominantly red hided crossbreds. Because of spring snow and bright sun, Red Angus and Gelbveih bulls were used to get color into their Hereford cattle. The calving season for their 325 replacement heifers begins March 25 and ends May 10th. They wean 500+ steer calves and have gone from 80% needing calving assistance down to 12-15%. The calving season for the cows is April 1 until June 1. The six-month-old steer calves have weaned at or better than 525 pounds the past few years, an increase of 85 pounds from ten years ago. Carefully selecting bulls using performance information has been instrumental in their program.

Mill Creek Ranch, Burt Guerrieri
Gunnison, Colorado

Burt Guerrieri ranches with his parents Richard and Phyliss north of Gunnison, Colorado. The ranch is located in the heart of the Rocky Mountains west of the Continental Divide. Burt is a 5th generation Gunnison county rancher, returning to the ranch in 1979 after graduating from Colorado College. They have 350 spring-calving cows and thirty summer-calving cows. They use Simmental, Angus and South Devon breeding and have positioned themselves to be on the cutting edge of beef cow genetics through the use of AI and embryo transfer. The primary focus in their cow herd is building uniform and predictable genetics packed with performance. They do this with extensive records and analysis of individual animal performance. In 1979 they ran only commercial cows, but with successive generations of cows sired by the superior genetics available through AI they have developed their cow herd to the point that they now sell mostly unregistered composite seedstock. In 1999 they will sell ninety-five yearling bulls, nineteen yearling replacement heifers, and fifty bred replacement heifers. They raise all of their own replacement heifers. The cows must survive and thrive in the harsh Gunnison climate on native mountain pastures. The elevation of Gunnison is 7,800 feet, and the ten inches of moisture they receive per year is mostly in the form of snowfall. Where they winter their cattle they will have from two to four feet of snow on the ground by mid-March and the summer country will get twice that much snow. It is typical to get many December and January nights with temperatures at less than 30 degrees below zero. In the summers all the cattle go to the lush high mountain pastures that range in elevation up to 9,500 feet.

Boston Farms, Bill Boston
Roodhouse, Illinois

Bill Boston owns and operates a 2,200-acre livestock and grain farm near Greenfield in Greene County Illinois. He currently runs 175 cows with plans for expansion to 200 cows. He feeds out all of his cattle in his own feedlot as well as purchasing additional feeder cattle from neighbors. He also operates a 4,000-head farrow to finish confinement sow operation. He uses Angus bulls on his Polled Hereford cows to produce F1 females for replacements and moderate framed easy grading market cattle. He uses the University of Illinois Beef Performance Testing Program to process his weaning weights for selection of replacement heifers, culling of low-producing cows, and identification of differences in performance from herd sires.

Boston Farms maintains a grass-legume mixture in their pastures to increase production through renovation and improvement as well as frost seeding of forages like red clover. Bill utilizes the practice of Management Intensive Grazing (MIG) in several of his pasture locations. Maintaining hay quality after harvest is of utmost importance in this operation, so Boston Farms stores as much hay as possible inside. Because they need to obtain a high percentage of live calves, Boston Farms has converted a barn into an eight-stall calving facility for close observation and assistance if needed. The practice of timed feeding has resulted in a large percentage of cows calving during the daylight hours.

Mossy Creek Farm, Ernie Reeves
Mt. Solon, Virginia

Mossy Creek Farm is a multigenerational family farm located at Mt. Solon, Virginia in the Central Shenandoah Valley. The 2,500-acre operation (half-owned and half-rented) supports a 650 plus commercial cow herd and a 2,000 head backgrounding enterprise. The Angus-based cow herd calves in February and March with roughly 40 percent serving as surrogate mothers for the custom embryo recipient service. The two-year-old heifers start calving two weeks later than the cow herd in an approximate 45-day calving season. All females utilize forage rotationally grazed with harvested feed needed approximately 90 days per winter (January 1 - April 1). Calves are weaned in late September - early October and then enter the backgrounding operation utilizing corn silage, barley silage, and alfalfa haylage. Purchased calves come directly from other producers and are co-mingled and sorted by sex and size into uniform lots of 65 - 100 head for the growing phase at 2 lbs. per day until they reach roughly 750 lbs. At that point, 80 percent are sent to custom feedyards utilizing individual cattle management for finishing with the balance sold as feeders through Virginia Cattlemen's Association sponsored sales. Health and performance data is shared back with the producers of purchased calves. In 1998, 442 calves were fed and obtained 70 percent choice and 67 percent yield grade 1 and 2. Excess females produced are marketed as bred heifers, cows, or pairs fall through spring. Open cows are sold as pregnant recipients through the ET enterprise.

AMBASSADOR AWARD RECIPIENTS

Warren Kester	Beef Magazine	MN	1986
Chester Peterson	Simmental Shield	KS	1987
Fred Knop	Drovers Journal	KS	1988
Forrest Bassford	Western Livestock Journal	CO	1989
Robert C. DeBaca	The Ideal Beef Memo	IA	1990
Dick Crow	Western Livestock Journal	CO	1991
J. T. "Johnny" Jenkins	Livestock Breeder Journal	GA	1993
Hayes Walker, III	America's Beef Cattleman	KS	1994
Nita Effertz	Beef Today	ID	1995
Ed Bible	Hereford World	MO	1996
Bill Miller	Beef Today	KS	1997
Keith Evans	American Angus Association	MO	1998
Shauna Rose Hermel	Angus Journal & Beef Magazine	MO	1999

SHAUNA ROSE HERMEL
1999 BIF Ambassador Award

SHAUNA ROSE HERMEL RECEIVES THE BEEF IMPROVEMENT FEDERATION'S 1999 AMBASSADOR AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Shauna Rose Hermel with the Ambassador Award at the group's annual convention on June 18, 1999 in Roanoke, Virginia. Hermel was selected for the honor for her dedication and contributions to the beef industry while working at the *Angus Journal* and *Beef* magazine.

Hermel grew up in the Angus business. A native of northeastern Missouri, she hails from Coon Angus Ranch, a performance-originated registered Angus herd. In addition to 4-H & FFA, she was involved in the Missouri Jr Angus and the National Jr Angus associations.

In 1987 Hermel earned a bachelor's degree in agricultural journalism at the University of Missouri-Columbia and a master's degree in agricultural journalism at the University of Wisconsin-Madison.

In 1989 Hermel joined the editorial staffs of *BEEF* and *National Hog Farmer* magazines in Minneapolis. She was promoted to associate editor of both magazines in 1992, taking on more writing responsibilities including the new *BEEF* column, 'Research Roundup'. She switched entirely to *BEEF* the following year, increasing her editing and writing responsibilities and doing the planning and production of the annual cow-calf issue.

In September 1997 she returned to her roots and accepted the position of editor of the *Angus Journal*. With the increased focus on the commercial industry the *Angus Journal* editorial team assumed the role of editing the *Angus Beef Bulletin* in September 1998. The *Bulletin* is the American Angus Association's communication vehicle to commercial producers.

Since 1992 she has earned numerous national awards from the Livestock Publications Council (LPC) and the American Agricultural Editors' Association (AAEA), including AAEA's second-place story of the year in 1995 and LPC's second place in-depth reporting single article in 1997.

She brings to the *Angus Journal* and the *Angus Beef Bulletin* a love of the Angus breed and its people, insight into the practical needs of commercial cattle production, an eye for cutting edge research and technology, and a firm conviction in the role the Angus breed must assume to help the beef industry reestablish market share at the consumer level.

Shauna resides in St. Joseph, Mo., with her husband, Todd.

BIF is a federation of state and provincial beef cattle organization and breed associations involved in beef cattle improvement. Each year BIF recognizes an individual from the livestock media who has promoted BIF principles and beef cattle performance programs.

PIONEER AWARD RECIPIENTS

Jay L. Lush	IA	1973
John H. Knox	NM	1974
Ray Woodward	ABS	1974
Fred Wilson	MT	1974
Charles E. Bell, Jr.	USDA	1974
Reuben Albaugh	CA	1974
Paul Pattengale	CO	1974
Glenn Butts	PRT	1975
Keith Gregory	MARC	1975
Braford Knapp, Jr.	USDA	1975
Forrest Bassford	WLJ	1976
Doyle Chambers	LA	1976
Mrs. Waldo Emerson Forbes	WY	1976
C. Curtis Mast	VA	1976
Dr. H. H. Stonaker	CO	1977
Ralph Bogart	OR	1977
Henry Holsman	SD	1977
Marvin Koger	FL	1977
John Lasley	FL	1977
W. L. McCormick	GA	1977
Paul Orcutt	MT	1977
J. P. Smith	PRT	1977
James B. Lingle	WYE	1978
R. Henry Mathiessen	VA	1978
Bob Priode	VA	1978
Robert Koch	MARC	1979
Mr. & Mrs. Carl Roubicek	AZ	1979
Joseph J. Urick	USDA	1979
Bryon L. Southwell	GA	1980
Richard T. "Scotty" Clark	USDA	1980
F. R. "Ferry" Carpenter	CO	1981
Clyde Reed	OK	1981
Milton England	TX	1981
L. A. Moddox	TX	1981
Charles Pratt	OK	1981
Otha Grimes	OK	1981
Mr. & Mrs. Percy Powers	TX	1982
Gordon Dickerson	NE	1982
Jim Elings	CA	1983
Jim Sanders	NV	1983
Ben Kettle	CO	1983
Carroll O. Schoonover	WY	1983
W. Dean Frischknecht	OR	1983
Bill Graham	GA	1984
Max Hammond	FL	1984
Thomas J. Marlowe	VA	1984
Mick Crandell	SD	1985
Mel Kirkiede	ND	1985
Charles R. Henderson	NY	1986
Everett J. Warwick	USDA	1986
Glenn Burrows	NM	1987
Carlton Corbin	OK	1987
Murray Corbin	OK	1987
Max Deets	KS	1987
George F. & Mattie Ellis	NM	1988
A. F. "Frankie" Flint	NM	1988
Christian A. Dinkle	SD	1988
Roy Beeby	OK	1989

Will Butts	TN	1989
John W. Massey	MO	1989
Donn & Sylvia Mitchell	CAN	1990
Hoon Song	CAN	1990
Jim Wilton	CAN	1990
Bill Long	TX	1991
Bill Turner	TX	1991
Frank Baker	AR	1992
Ron Baker	OR	1992
Bill Borror	CA	1992
Walter Rowden	AR	1992
James W. "Pete" Patterson	ND	1993
Hayes Gregory	NC	1993
James D. Bennett	VA	1993
O'Dell G. Daniel	GA	1993
M. K. "Curly" Cook	GA	1993
Dixon Hubbard	USDA	1993
Richard Willham	IA	1993
Dr. Robert C. DeBaca	IA	1994
Tom Chrystal	IA	1994
Roy A. Wallace	OH	1994
James S. Brinks	CO	1995
Robert E. Taylor	CO	1995
A. L. "Ike" Eller	VA	1996
Glynn Debter	AL	1996
Larry V. Cundiff	NE	1997
Henry Gardiner	KS	1997
Jim Leachman	MT	1997
John Crouch	MO	1998
Bob Dickinson	KS	1998
Douglas MacKenzie Fraser	AB	1998
Joseph Graham	VA	1999
John Pollack	NY	1999
Richard Quaas	NY	1999

1999 BIF PIONEER AWARDS

JOSEPH GRAHAM

JOHN POLLAK and RICHARD QUAAS

JOSEPH B. GRAHAM RECEIVES BEEF IMPROVEMENT FEDERATION PIONEER AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Joe Beard Graham with the Pioneer Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia.

Joe Beard Graham was born and raised near the village of Goshen, in Rockbridge County, VA, where he currently resides and has lived most of his life. He graduated from Goshen High School in 1938, and from Virginia Tech with a degree in Animal Husbandry in 1943. His service with the US Army 1943-1945 took him to the Pacific where he served with the Sixth Army, and later the Ninth Corps during the occupation of Japan.

Joe Graham's career has been totally in the livestock industry. From 1947 to 1952 he managed two purebred Angus herds in Virginia before returning in 1952 to Goshen to start farming and developing a purebred Angus herd for himself. In 1954 he joined the Division of Markets of the Virginia Department of Agriculture as a Livestock Grader, and served in this capacity until 1973. From 1973 to 1975 he managed Roanoke Hollins' Stockyard at Hollins, VA, served as a field man for Staunton Livestock Market from 1974-1986, and in a similar capacity with Staunton Union Stockyard from 1986 to present. He served as an official classifier for the American Angus Assn for three years.

In 1955, the first State Beef Cattle Improvement Association in the country was organized as the Virginia Beef Cattle Improvement Association. Joe Graham was employed on a part time basis to do the fieldwork and cattle weighing and grading on farms, with this work continuing well into the 1980's.

Joe Graham probably had more to do with getting the newly established Virginia BCIA performance testing program accepted and expanded in Virginia than any other one individual. He was looked to by breeders as "Mr. Virginia BCIA" for many years because he visited most of the farms where he weighed and graded calves and yearlings. In addition to his field work on the farms, he was a very important figure in establishing the central bull test stations at Culpeper and Red House, VA, and until about 1990, served as a grader and evaluator of bulls tested at Virginia central test stations. The Virginia BCIA Performance Testing Program was built in large measure based on Joe Graham's expertise and cattle knowledge, and his ability to work with purebred and commercial breeders and producers. As a result the Virginia program attained wide acclaim and served as a forerunner for national breed association performance testing programs.

In August, 1947 he married Ellen Bennett, and they have a son, Joseph B. Jr., and three daughters, Ellen, Mary and Lucy, and a total of eight grand children. Joe Graham continues to breed seedstock Angus cattle, and to teach Sunday School at the Goshen Presbyterian Church, where he is a lifelong member. His chief joys are his church, people, and livestock.

It is with great pleasure that the Beef Improvement Federation has the opportunity to recognize the accomplishments of Joe B. Graham by presenting him with the 1999 Pioneer Award.

JOHN POLLAK RECEIVES BEEF IMPROVEMENT FEDERATION PIONEER AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored John Pollak with the Pioneer Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia. The purpose of this award is to recognize individuals who have made lasting contributions to the genetic improvement of beef cattle.

John Pollak was born in Portland, Maine and grew up on Long Island, New York. He received his B.S. in Animal Science at Cornell University in 1969. He received his M.S. in 1973 and his Ph. D. in 1975 in Animal Breeding at Iowa State University. He worked as an Assistant Professor of Animal Science at the University of California - Davis from 1975 to 1980. He joined the Animal Science Department at Cornell University in 1980 and is currently a Professor in the Animal Science Department. Dr. Pollak teaches under- graduate and graduate courses in animal genetics.

John Pollak met his wife, Jane, while at Iowa State University. They have two children, J.P. and Emily. J.P. is finishing his junior year in animal science at Cornell with an interest in genetics and computers. Emily is a high school junior and a competitive swimmer.

John Pollak has been actively involved in BIF genetic prediction workshops and has spoken at several BIF conventions. He is one of the authors of the National Cattle Evaluation Section of BIF's Guidelines for Uniform Beef Improvement Programs which is used international as a standard reference on beef performance programs.

John Pollak is a true pioneer in the area of beef cattle genetic evaluation. John Pollak and Richard Quaas co-authored a classic paper on application of mixed-model methods that was published in 1980. Discussions at BIF and their presentations at the first Genetic Prediction Workshops inspired the move from sire evaluation to National Cattle Evaluation based on the animal model. This method of calculating EPD's is now the worldwide standard. There have been few advances in applied beef cattle genetic prediction in the last 20 years that have not been influenced by the work of Pollak and Quaas.

John Pollak continues to be a leader in beef cattle genetics. Recently he has been working on development and application of EPD from multiple-breed data.

BIF is pleased and honored to recognize the many contributions of John Pollak by presenting him with the BIF Pioneer Award.

RICHARD QUAAS RECEIVES BEEF IMPROVEMENT FEDERATION PIONEER AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Richard Quaas with the Pioneer Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia. This award is given to select individuals who have made lasting contributions to the genetic improvement of beef cattle.

Dr. Quaas was born in Cedar Rapids, Iowa and received a B.S. in Animal Science at Iowa State University in 1966. He attended graduate school at Colorado State University receiving his Ph. D. in 1973. He joined the Animal Science staff at Cornell University in 1973 and is currently a professor at Cornell where he teaches statistical methods in quantitative genetics and animal breeding.

Dr. Quaas has contributed to BIF's mission through his presentations at BIF conventions and his active involvement in Genetic Prediction Workshops. Dr. Quaas is one of the authors of the National Cattle Evaluation Section of BIF's Guidelines for Uniform Beef Improvement Programs, which is used internationally as a standard referees on beef performances programs.

Richard Quaas is a true pioneer in the area of beef cattle genetic evaluation. Richard Quaas and John Pollak co-authored a classic paper on application of mixed-model methods that was published in 1980. Discussions at BIF and their presentations at the first Genetic Prediction Workshops inspired the move from sire evaluation to National Cattle Evaluation based on the animal model. This method of calculating EPD's is now the worldwide standard. There have been few advances in applied beef cattle genetic prediction in the last 20 years that have not been influenced by the work of Pollak and Quaas.

Dr. Quaas continues to be a leader in beef cattle genetics. Recently he has been working on development and application of EPD from multiple-breed data.

BIF is pleased and honored to recognize the many contributions of Richard Quaas by presenting him with the BIF Pioneer Award.

CONTINUING SERVICE AWARD RECIPIENTS

Clarence Burch	OK	1972
F. R. Carpenter	CO	1973
E. J. Warwick	DC	1973
Robert DeBaca	IA	1973
Frank H. Baker	OK	1974
D. D. Bennett	OR	1974
Richard Willham	IA	1974
Larry V. Cundiff	NE	1975
Dixon D. Hubbard	DC	1975
J. David Nichols	IA	1975
A. L. Eller, Jr.	VA	1976
Ray Meyer	SD	1976
Don Vaniman	MT	1977
Lloyd Schmitt	MT	1977
Martin Jorgensen	SD	1978
James S. Brinks	CO	1978
Paul D. Miller	WI	1978
C. K. Allen	MO	1979
William Durfey	NAAB	1979
Glenn Butts	PRI	1980
Jim Gosey	NE	1980
Mark Keffeler	SD	1981
J. D. Mankin	ID	1982
Art Linton	MT	1983
James Bennett	VA	1984
M. K. Cook	GA	1984
Craig Ludwig	MO	1984
Jim Glenn	IBIA	1985
Dick Spader	MO	1985
Roy Wallace	OH	1985
Larry Benyshek	GA	1986
Ken W. Ellis	CA	1986
Earl Peterson	MT	1986
Bill Borror	CA	1987
Daryl Strohbehn	IA	1987
Jim Gibb	MO	1987
Bruce Howard	CAN	1988
Roger McCraw	NC	1989
Robert Dickinson	KS	1990
John Crouch	MO	1991
Jack Chase	WY	1992
Leonard Wulf	MN	1992
Henry W. Webster	SC	1993
Robert McGuire	AL	1993
Charles McPeake	GA	1993
Bruce E. Cunningham	MT	1994
Loren Jackson	TX	1994
Marvin D. Nichols	IA	1994
Steve Radakovich	IA	1994
Dr. Doyle Wilson	IA	1994
Paul Bennett	VA	1995
Pat Goggins	MT	1995
Brian Pogue	CAN	1995
Harlan D. Ritchie	MI	1996
Doug L. Hixon	WY	1996
Glenn Brinkman	TX	1997

Russell Danielson	ND	1997
Gene Rouse	IA	1997
Keith Bertrand	GA	1998
Richard Gilbert	TX	1998
Burke Healey	OK	1998
Bruce Golden	CO	1999
John Hough	GA	1999
Gary Johnson	KS	1999
Norman Vincil	VA	1999

1999 CONTINUING SERVICE AWARDS

JOHN HOUGH

NORM VINCIL

GARY JOHNSON

BRUCE GOLDEN RECEIVES BEEF IMPROVEMENT FEDERATION CONTINUING SERVICE AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Bruce Golden with the Continuing Service Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia.

Bruce Golden grew up in California. He received a B.S. in animal science from Washington State University in 1982 and an M.S. in animal breeding and genetics from the same institution in 1983. In 1989 he completed his Ph.D. in animal breeding and genetics at Colorado State University. Between degrees Bruce worked as a research technologist at the University of Nebraska's North Platte Station and research associate in computing at CSU. He is currently Associate professor in animal breeding at CSU where, besides his research activities, he teaches undergraduate courses in performance records and computerized livestock record management and a graduate course in genetic parameter estimation. Bruce works closely with an enthusiastic group of graduate students in animal breeding.

Bruce Golden's name has always been associated with National Cattle Evaluation. In 1986 he was the first to use a multiple-trait animal model for breed-wide genetic evaluation (Red Angus). Since then he and his associates at CSU's Center for the Genetic Evaluation of Livestock have produced genetic evaluations for numerous breeds in the U.S., Canada, and New Zealand. He consults on NCE-related subjects worldwide.

Bruce's research has included software development, parameter estimation, and new trait development. He pioneered the use of genetic groups as a method for making across-breed comparison and as a way of evaluating nonlinear relationships between traits. EPDs for fertility traits such as stayability and heifer pregnancy were developed under his guidance. His current interest include the sire summary of the future, one he believes should contain EPDs for economically relevant traits like maintenance requirement, and biometric methods for animal identification.

In academic animal breeding circles, Bruce is known as the computer guru. His reputation is well deserved. He wrote the Animal Breeders Toolkit (BLUP software) and developed efficient algorithms for computing the inbreeding coefficients necessary for the inverse of a relationship matrix.

At BIF Bruce has been active in the Genetic Prediction Committee and has authored parts of the National Cattle Evaluation section of BIF's Guidelines For Uniform Beef Improvement Programs.

Outside his profession, Bruce is a fly fisherman, guitarist, dog fanatic, gourmand and lover of things southwestern. He lives west of Fort Collins with his wife, Mary.

JOHN HOUGH RECEIVES BEEF IMPROVEMENT FEDERATION CONTINUING SERVICE AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Dr. John Hough with the Continuing Service Award at the 31st Annual Meeting and Research Symposium in Roanoke, Virginia on June 18, 1999.

John Hough was born in Emmetsburg, Iowa and received a B.S. in Animal Science at Iowa State University in 1975. After spending five years as managing partner with Circle G Angus Farms in Hampton, Georgia he returned to graduate school. Dr. Hough received his M.S. in Animal Breeding at the University of Georgia in 1984 and his Ph.D. in Animal Breeding at the University of Georgia in 1987.

Dr. Hough served four years as an Assistant Professor at Auburn University. He was Director of Education and Research for the American Polled Hereford Association from 1991-1996. With the merger of AHA and APHA, he became Director of Research and Performance at the American Hereford Association from 1996 through March 1999. Dr. Hough is currently Chief Science Officer of EPD International, Inc.

John Hough has been very active in BIF where he has served on the Board of Directors for the past six years. Dr. Hough has served as chairman of BIF's Whole Herd Analysis committee and has made several presentations at BIF conventions. Dr. Hough is author of the Integrated Genetic Systems section of BIF's Guidelines for Uniform Beef Improvement Programs, which is used internationally as a standard reference on beef performance programs.

For the last 25 years John Hough has devoted much of his life to beef cattle breeding. He has managed a purebred operation, taught animal breeding at the university level and worked in a purebred association. Some notable aspects of Dr. Hough's work have been in the areas of whole herd reporting systems, carcass EPD's, certification of ultrasound technicians and development of international cattle evaluation. During his tenure at Polled Hereford and Hereford Associations, the first North American Evaluation was developed and methods for using ultrasound data in carcass evaluation were implemented.

BIF is pleased to recognize the many contributions of Dr. John Hough by presenting him with the BIF Continuing Service Award.

GARY JOHNSON RECEIVES BEEF IMPROVEMENT FEDERATION CONTINUING SERVICE AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Gary Johnson with the Continuing Service Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia. The purpose of this award is to select individuals who have made lasting contributions to the genetic improvement of beef cattle.

Gary V. Johnson of Dwight, Kansas is a self-made cattleman. He began with 22 cows in 1966 and has expanded his operation to more than 1000 cows and heifers, 8000 acres of range land and 1,500 acres of cultivated land with the help of his wife, Jody, who is Assistant Dean for Admission at KSU School of Veterinary Medicine, and their four children.

Gary Johnson has served on the board of directors of the Beef Improvement Federation for the past eight years and is past president of BIF. He was the first commercial cattleman to be elected to the BIF board.

Gary Johnson is a cowman, not a cowboy, placing major emphasis on productivity and cost-effectiveness. His cattle operation is known for the production of functional females. Both cattle and crops on his operation have to work within their environment to stay. He has brought this philosophy to the Beef Improvement Federation. During his tenure with BIF he has worked hard to promote BIF as a bridge between university research and practical application by commercial producers.

Gary Johnson has put performance programs to the test on Johnson Farms. With his bred heifer sales he has developed a reputation for cattle that work. He has hosted tour groups from all over the United States and other countries. He has traveled the county speaking to many groups and hosted several international exchange students. Gary Johnson is a missionary for the cause of practical performance programs.

He serves on committees with the Kansas Farm Credit Association and on the Kansas Angus Association Board. He is very proud of his Kansas agriculture heritage and is the owner of a Century Farm. He is an avid supporter of 4-H and youth programs as a member of the Morris County Fairboard, and is an active member of the Lutheran Church.

The Beef Improvement Federation is pleased and honored to recognize the many contributions of Gary Johnson by presenting him with the BIF Continuing Service Award.

NORMAN VINCEL RECEIVES BEEF IMPROVEMENT FEDERATION CONTINUING SERVICE AWARD

Roanoke, Virginia - The Beef Improvement Federation (BIF) honored Norman Vincel with the Continuing Service Award at the 31st Annual Convention on June 18, 1999 in Roanoke, Virginia. The purpose of this award is to recognize individuals who have made lasting contributions to the genetic improvement of beef cattle.

Norman Vincel is a native of Newport, VA, who grew up on his family's beef cattle farm in Giles County, located in the mountains of southwest Virginia. He received a B.S. degree in Animal Science at Virginia Tech in 1973. While a student, he was a member of the Block and Bridle Club, Alpha Zeta, and was a singer with the Virginia Tech coral group, known as the New Virginians. His first job out of college was with Southern States Cooperative. He was employed by Virginia/North Carolina Select Sires, Inc., in June 1974 as Beef Coordinator. He served in this position for 17 years, during which time beef semen sales grew almost 20% annually. He was promoted to Director of Marketing in September 1991, and since that time has been responsible for planning and supervising sales and service programs for both beef and dairy in an eight state area. Norm Vincel is a cattle breeder in his own right, having been involved with Clover Hollow Herefords along with his father Bill Vincel. He also has been active in breeding purebred Simmental cattle.

In his career with the AI Industry, he has developed into a most valuable resource person regarding beef cattle genetics and reproduction. Having become very knowledgeable in effecting programs utilizing estrous synchronization in purebred and commercial beef operations. He has been very active with the National Association of Animal Breeders having served several years on the Beef Development Committee. He represented NAAB as a member of the Beef Improvement Federation Board of Directors, serving two terms, or six years, ending in 1998.

Norm Vincel has been a real servant for the beef industry in Virginia, and has developed into an industry leader. He has served on a number of committees of the Virginia Cattlemen□s Association and was recognized by that organization having been presented the Martin F. Strate Industry Service Award. He has served for many years as technical director of the Virginia Beef Cattle Improvement Association, and has been a real leader in the area of beef cattle improvement. He has been popular as a speaker on many beef cattle educational programs in Virginia, and other states in the Virginia-North Carolina Select Sires trade area.

Norm Vincel's service to the Beef Improvement Federation has been exceptional. As a board member he has served on a number of committees, including the awards committee, and for many years has read the citations for nominees for the Seedstock and Commercial Producer of the Year awards, as well as other awards presented by BIF at their annual conventions. He chaired the steering committee for the planning for the 1999 BIF Convention held in Roanoke, VA.

Beef Improvement Federation
Mid-Year Board of Directors Meeting
October 10,1998
Minutes

The mid-year Board of Directors meeting of the Beef Improvement Federation was called to order by President Jed Dillard. Minutes of the annual meeting in Calgary were approved as distributed (Doubet/Quinn). Boggs presented the financial report showing a total balance of $58,773.77 with $52,000 in a money market savings account and $6,773.77 in checking. Doubet moved and Quinn seconded to approve financial report. Discussion ensued regarding investment of funds in savings. Board voted to leave investment decision to the discretion of the Executive Board (Fink/Anderson).

Herb McLane reported on the 1998 Convention. The Calgary event drew 556 delegates and guests, of which approximately 100 were walk-ins that were not pre-registered. The proceedings were nearing completion with an estimated completion date of November 1. Herb reported revenues of $228,000 (Canadian) and current expenses of $190,000 (Canadian). Major anticipated remaining expenses were the printing and mailing costs. To reduce mailing expenses, Herb was considering bulk mailing the books to the US for further distribution. Herb reported that 40% of the revenue was from delegates, 7% from tours and 53% from partners and sponsors.

John Hall and Norm Vincel reported on plans for the 1999 Convention in Roanoke, Virginia. The meeting will be held at the historic Hotel Roanoke and Convention Center. Registration is set at $140 (early) or $180 (late). Registration includes 1 lunch, 1 awards dinner, 2 receptions and continual refreshment service. Spouse registration is $110/$130. One-day registration is $60 and student registration (no banquet) is $60. Two post-conference tours are planned as well as spouse tours. Virginia elected not to have BIF underwrite the convention budget.

After considerable discussion it was moved (Fink/Hutzel) to allow corporate sponsorships and recognition, and to give the hosts the latitude to work with sponsors. This motion was amended (Weaber/Quinn) to include Board approval. Both the amendment and the amended motion passed.

The possibility of the development of a daily convention newsletter was discussed. Consensus was to not pursue this idea at this time.

Willie Altenburg presented the Program Committee report. Two symposia were suggested; one on "Improving Profitability through Improved Efficiency" and the other on "Improving Profitability through Increased Demand". The committee report was accepted as presented (Evans/Hutzel). Committee chairs should have committee meeting agendas to the Executive Director by February 1st. The Board requested

(Evans/Quinn) that the Virginia Planning Committee pursues a new product sampling activity at the 1999 Convention.

Preliminary committee meeting topics were discussed. Emerging Technologies will discuss DNA markers; Genetic Prediction will discuss marker assisted selection, the use of percentile rank, and utilizing retail yield as a performance measure: Live Animal Evaluation will discuss public vs private bull testing, the genetic merit of ultrasound and the general merit of retail product EPD, and VIA grading systems. The other committees were still gathering topic ideas.

Larry Cundiff reported that the Genetic Prediction Committee was planning a Genetic Prediction Workshop for December 1999 in Kansas City. The proposed topic is "How Marker Assisted Selection Impacts Determination of Breeding Value". The Board approved the concept of the workshop and requested a budget by the annual meeting (Evans/Holliman).

The Board decided (Weaber/Fink) that all committee chairs will continue with the exception that Bruce Cunningham will replace John Crouch as Chair of the Live Animal Evaluation Committee. Bob Hough will assist John Hough for the year on Whole Herd Analysis.

Connee Quinn reported that the Education Committee had reconsidered the use of video as a tool for basic genetic education material. Instead they proposed partnering with Beef Magazine to publish articles from the NCBA/BIF Cattlemen's College program on "Genetic Engineering for Profit". A motion was made (Altenburg/Cunningham) to involve BIF in a cooperative venture with NCBA and Beef Magazine. After discussion regarding the potential concerns of aligning with a single publication, the motion was withdrawn. Bob Hough moved (Altenburg second) that BIF support a cooperative effort with NCBA and Pfizer (Cattlemen's College sponsor) to get the Cattlemen's College materials presented in a nationally distributed beef cattle magazine. Motion passed.

The Board voted (B. Hough/J. Hough) to provide up to $1000 of travel support for Cattlemen's College speakers. Herb McLane asked about the possibility of distributing these educational materials to the Canadian industry via the Canadian Cattlemen's Magazine or other publication. McLane was appointed to the Education Committee to assist in identifying a method for distributing these materials in Canada.

Standing committees were reviewed. J. Hough moved (Weaber second) to continue the Whole Herd Committee. Motion carried. Evans moved (Cunningham second) to continue the Multiple Trait Selection Committee. Motion carried.

The stocks of Guidelines and Proceedings were discussed. Evans moved (Quinn second) to reduce price of Guidelines to $5.00 plus postage and continue to have Guidelines posted on Web page. Motion carried. Gibb moved (Fink second) to post Proceedings on Web and print only 100 copies beyond annual meeting needs. Motion carried. It was agreed that we need to get Guidelines included in National Beef Database.

Sally Dolezal agreed to provide leadership for fact sheet development. Volunteers are needed to write and review fact sheets.

Renee Lloyd reported on activities of the NCBA IRM Coordinating Committee. DECI model is still moving forward under the leadership of Tom Jenkins at the Meat Animal Research Center. An IRM Sub-Committee called "Cattle-Sense" is developing a business plan for increasing the adoption of technologies such DECI and SPA. Anderson was appointed to represent BIF on the "Cattle –Sense" sub-committee.

Ronnie Green reported on the National Tenderness EPD project. Currently 16 breeds are involved in the project that will evaluate 10 sire groups per breed over the next 40 months. Carcass data , including Warner-Bratzler Shear and sensory evaluation will be collected on progeny. Purpose is to generate EPDs and develop relationships to DNA Mapping. A producer oversight committee has been established. Ronnie noted that the breed associations have made a major commitment to this project.

Norm Vincel distributed a handout that outlined future director elections. The by-laws provide the framework for determining board terms. Willie Altenburg questioned the possibility of annexing more states into the Western region due to the difficulty over the years of finding a large number of board candidates from the region. Following discussion, Dillard appointed a membership committee consisting of Galen Fink, Gini Chase and Jim Smith to investigate methods to balance representation.

Boggs presented the 1999 budget proposal. Anderson moved (Evans second) to accept the 1999 budget. Motion carried. Doubet moved (Holliman second) to produce only two newsletters in 1999. Carried.

It was agreed to continue the Poster Competition at the annual meeting for at least one more year.

President Dillard appointed the following committees:

Awards:	Silcox (Chair), Cunningham, Quinn, Smith
Nominating:	Hough, Anderson, Dillard

Doubet moved (Altenburg second) to adjourn the meeting. Carried.

Respectfully submitted.

MINUTES

Beef Improvement Federation
Annual Board of Directors Meeting
Roanoke, Virginia
June 16, 1999

The Annual Meeting of the Board of Directors of the Beef Improvement Federation was called to order by President Jed Dillard. The minutes of the Mid-Year Meeting were approved as distributed (Weaber/Anderson). The financial reports for 1998 and the first half of 1999 were presented by Boggs and approved (Cunningham/Anderson). Membership report indicated 26 state and provincial BCIA, 24 breed associations, 10 associate and 2 sustaining memberships. Dillard reminded the regional secretaries that director nominees must be members of paid state, provincial or breed association.

Conventions:
McLane gave a final report on 1998 Convention. There were 556 attendees and the convention cleared $20,000 Canadian. Proceedings had been distributed. Canadian and other international attendees had been direct mailed while others had been bulk mailed to the Executive Director for mailing in the US.

John Hall and Norm Vincel gave an update on the 1999 Roanoke Meeting and tours. They are anticipating 500-550 attendees. The Beef Lovers Tour is nearly full but the Valley Tour had been cancelled due to low sign-up. They recommended that BIF develop a policy on media registration.

Committee chairs reported on probable activities at their upcoming sessions. Genetic Prediction is expecting a proposal for USDA funding for a genetic evaluation center. Live Animal and Carcass Evaluation may be asked to consider ultrasound technician certification again.

Director Election:
John Hough and Willie Altenburg are completing their second terms and successors need to be elected. Sherry Doubet, S.R. Evans and Galen Fink are eligible for re-election.

Student Contests:
Cundiff reported that only two essays had been submitted in the Frank Baker Essay Contest. Green reported one competitive and one non-competitive poster contest entries. He felt the Board should discuss continuation of the contest at an upcoming meeting.

Cundiff reported on the Genetic Prediction Workshop to be held December 2-4, 1999 at the Embassy Suites in Kansas City. Three areas will be discussed:

Multi-Breed Evaluations – Dick Quaas, Chair
Marker Assisted Selection – Ronnie Green, Chair
International Evaluations – Keith Bertrand, Chair

Budget for the workshop will be presented at Friday meeting.

Homepage:
Boggs gave a demonstration of the new BIF homepage that is currently under construction. We have had some difficulty getting the domain name transferred but hope to have the page on the web soon.

Education Committee:
Quinn and Green reported on the BIF supported program at the NCBA Cattlemen's College. Program was well received at the convention and BEEF Magazine had 30 pages of text dedicated to the project. Additional copies of the BEEF Magazine special edition are available from Boggs.

2000 Convention:
Twig Marston reported on progress on the 2000 meeting to be held in Wichita, KS. Kansas State University and the Kansas Livestock Association will serve as hosts. They will have a booth and flyers will be distributed at the Roanoke meeting. Altenburg moved and Quinn seconded to officially accept the proposed dates of July 12-15, 2000. Motion passed.

Regional Realignment:
Fink reported on his committee's proposal to realign the BIF regions. They proposed keeping the East region in its current form but changing the Central and Western regions to North and South by drawing a boundary line running east –west along the southern borders of Iowa, Nebraska, Wyoming, Idaho and Oregon. There was a motion to adopt the proposal and develop a by-laws amendment to make the change (Altenburg/Quinn). After considerable discussion the proposal was tabled until the Friday board meeting (B. Hough/Cunningham).

Project Updates:
Renee Lloyd thanked everyone that helped with the BIF program at the NCBA Cattlemen's College. She also reported that the DECI program is progressing and interest is growing. Also the ADDS group is working on the beef data base CD-ROM. There is still interest in developing a series of regional IRM meetings.

ICAR (International Committee on Animal Recording) has a representative at the convention and he will speak at the Genetic Prediction Committee meeting.

Altenburg reported on the National Cattle Evaluation Summit. The four universities currently involved in genetic evaluation work met in December and proposed the development of a USDA grant to support a development project for National Cattle Evaluation. They will be seeking BIF endorsement for the project. A motion was passed (B.Hough/ Weaber) to the support the concept of NCE Center for Research and Development.

Nominating Committee:
The committee nominated Willie Altenburg for President and Galen Fink for Vice-President. A motion was made (Anderson/Doubet) and passed to cast a unanimous ballot for Altenburg and Fink.

The Awards Committee reported the following would be recognized at the Awards Banquet.

Pioneer -	Joe Graham, John Pollack and Richard Quaas
Ambassador -	Shauna Hermel
Continuing Service -	Gary Johnson, Norm Vincel, John Hough and Bruce Golden

The Mid-Year Board of Directors meeting is scheduled for December 15-16, 1999 at the Embassy Suites in Kansas City, MO.

A motion was made (Evans/Hutzel) and passed to re-appoint Don Boggs as Executive Director.

The meeting was adjourned by President Dillard.

MINUTES

Beef Improvement Federation
Board of Directors Post-Convention Meeting
June 18, 1999

Newly elected President Willie Altenburg called the meeting to order at 5:00 pm. Norm Vincel reported on the Roanoke convention. There were approximately 500 participants and the convention appears to be financially successful. Norm felt we had an outstanding program but advised that future program committees build in more time for discussion and transition between speakers.

Altenburg introduced new board members, Robert Williams of the American-International Charolais Association representing the breed associations and Terry O'Neill of Billings, MT, representing the Western Region.

Keith Bertrand discussed ICAR developments. Current discussion is to develop a book similar to the Guidelines to standardize data collection. This could pave the way for international evaluations in the future. The next ICAR meeting is in Rome, Italy in October. A motion was made (Weaber/Cunningham) and passed to spend up to $2500 for a representative (Bertrand) to attend ICAR meeting in Rome.

Boggs reported that we are nearing the end of our supply of Guidelines. It was decide to copy as needed until we can get them onto the WEB.

Crouch discussed the value of going to a "get-away" location for the mid-year meeting. After considerable debate, a motion was made (Anderson/Evans) and passed to have mid-year in Kansas City in 1999 and investigate going to Estes Park for 2000 meeting.

The Program Committee for 2000 Convention was named. Fink will serve as Chairman, with Dolezal, Green, Hough, McClung, Anderson, Boggs and representatives from the Kansas host committee.

Herb McLane pointed out that the by-laws need to be amended to replace Ag Canada with the Canadian Beef Breeds Council as the Canadian ex-officio representative.

Altenburg reminded board members that the board picture would be taken after the banquet. He then adjourned the meeting.

Beef Improvement Federation
Statement of Revenues and Expenditures
Cash Basis
January 1, 1998 to December 31, 1998

Revenues:	
Dues	$10,862.45
Guidelines and Proceedings	$2,395.10
Reimbursement	$130.00
Interest Income	$3,140.61
Total Revenues	**$16,528.16**
Expenditures	
Bank Charges	$1.00
Dues and Fees	$25.00
Clerical Assistance	$1,100.00
Legal and Accounting	$355.00
Office Expenses and Supplies	$449.26
Postage and Freight	$2,287.29
Printing	$3,384.78
Telephone	$469.43
Frank Baker Awards	$1,000.00
Poster Contest Awards	$600.00
BIF Awards	$1,980.42
Meetings Expenses - Board of Directors	$1,078.32
Total Expenditures	**$12,730.50**
Excess Revenues over Expenditures	**$3,797.66**

Beef Improvement Federation
Statement of Fund Balance

As of December 31, 1998

Assets:	
Cash in Checking Account	$5,386.69
Cash in Money Market Savings Account	$52,422.77
Total Assets	**$57,809.46**
Liabilities and Fund Balance:	
Fund Balance - January 1, 1998	$54,011.80
Current Year Excess (Deficit)	$3,797.66
Fund Balance - December 31, 1998	**$57,809.46**
Total Liabilities and Fund Balance	**$57,809.46**

1999 Member Organizations

Accelerated Genetics
Don Trimmer
E 10890 Penny Lane
Baraboo, WI 53913-9408
(608) 356-8357
dtrimmer@accelgen.com
www.accelgen.com

American Angus Association
John Crouch
3201 Frederick Blvd
St. Joseph, MO 64506
(816) 383-5100
jcrouch@angus.org
www.angus.org

American Chianina Association
Terry Atchinson
P.O. Box 890
Platte City, MO 64079
(816) 431-2808
aca@sound.net
www.chicattle.org

American Gelbvieh Association
Tom Brink
10900 Dover St.
Westminister, CO 80021
(303) 465-2339
aga@www.gelbvieh.org
www.gelbvieh.org/~aga

American Int'l Charolais Assn.
Robert Williams
P.O. Box 20247
Kansas City, MO 64195
(816) 464-5977
robertw@charolaisusa.com
www.charolaisusa.com

American Maine Anjou Assn.
John Boddicker
760 Livestock Exchange Bldg
Kansas City, MO 64102
(816) 474-9555
ANJOU@QNI.COM
www.maine-anjou.org

American Salers Association
Sherry Doubet
7383 S. Alton Way #103
Englewood, CO 80112-2302
(303) 770-9292
amsalers@aol.com
www.SalersUSA.org

American Shorthorn Assn.
Roger Hunsley
8288 Hascal St.
Omaha, NE 68124
(402) 393-7200
hunsley@beefshorthornusa.com
www.beefshorthornusa.com

American Tarentaise Assn.
Jim Spawn
P.O. Box 34705
N. Kansas City, MO 64116-1105
(816) 421-1993
jspawn321@aol.com

Barzona Breeders Assn. of America
Karen Halford
P.O.Box 631
Prescott, AZ 86302
(520) 445-5150
karenh@northlink.com

BCIA – Alabama
Dave Maples
P.O. Box 2499
Montgomery, AL 36102
(334) 265-1867

BCIA – California
Kim Bradley
5980 Cavitt Stallman Rd.
Granite Bay, CA 95746
(916) 797-0431
kbradley@cattlemen.net
www.calcattlemen.org

BCIA – Florida
Archie Davis
P.O. Box 749
Tallahassee, FL 32302

BCIA – Minnesota
James Bryan
5820 Cannondale Rd.
Red Wing, MN 55066
(612) 388-4897

BCIA – Missouri
Roger Eakins
Univ. Ext. Center Box 408
Jackson, MO 63755
(573) 243-3581
eakinsr@missouri.edu

BCIA – North Carolina
Roger McCraw
NCSU Box 7621
Raleigh, NC 27695-7621
(919) 515-2761
roger_mccraw@ncsu.edu

BCIA – North Dakota
Kris Ringwall
1133 State Ave.
Dickinson, ND 58601
(701) 483-2348
kringwall@ndsuext.nodak.edu

BCIA – Tennessee
Dave Kirkpatrick
Box 1071
Knoxville, TN 37901
dkirkpatrick@AES.gw.utk.edu
www.utextension.utk.edu/ansci/

BCIA – Utah
C. Kim Chapman
USU Extension 250 N Main
Richfield, UT 84701-2165
(435) 896-9262
kimc@ext.usu.edu
www.utahreach.usu.edu/sevier/ext

BCIA – Virginia
Scott Greiner
366 Litton Reaves Bldg VA Tech
Blacksburg, VA 24061
(540) 321-9159
sgreiner@vt.edu

BCIA – West Virginia
Jim Bostic
P.O. Box 668
Buckhannon, WV 26201
(304) 472-4020
wvbic@msys.net

BCIA – Wisconsin
John Freitag
P.O. Box 995
New Glarus, WI 53574
(800) 297-5747
wbia@msys.net
www.wisconsinbeef.com

BCIA Wyoming
Doug Hixon
Box 3684 Univ. Station
Laramie, WY 82071
(307) 766-3100
dhixon@uwyo.edu

Beef Improvement Ontario
Tim Lambert
6986 Wellington Rd 124 RR7
Guelph Ontario CAN N1H 6J4
(519) 767-2665
TLAMBERT@BIOBEEF.COM

Beefmaster Breeders United
Wendell Schronk
6800 Park Ten Blvd Suite 290
San Antonio, TX 78213
(210) 732-3132
wschronk@beefmasters.org

Canadian Angus Association
Doug Fee
#214 6715 8th St. NE
Calgary Alberta CAN T2N 1V2
(403) 571-3580
cdnangus@cadvision.com
www.cdnangus.ca

Canadian Beef Breeds Council
Herb McLane
230 6715 8th St. NE
Calgary Alberta CAN T2E 7H7
(403) 730-0350
cbbc@cadvision.com

Canadian Gelbvieh Association
Wendy Belcher
110 2116 27th Ave. NE
Calgary Alberta CAN T2E 7A6
(403) 250-8640
gelbvieh@gelbvieh.ca
www.gelbvieh.ca

Canadian Hays Converter Assn.
Teri Worms
#550 1207 11th Ave SW
Calgary Alberta CAN T3C 0M5
(403) 245-6923
haysr@cadvision.com

Canadian Hereford Association
Heather Reti
5160 Skyline Way NE
Calgary Alberta CAN T2E 6V1
(403) 275-2662
hreti@hereford.ca
www.hereford.ca

Canadian Simmental Assn.
Barry Bennett
13 – 4101 19th St. NE
Calgary Alberta CAN T2E 7C4
(403) 250-7979
cansim@simmental.com
www.simmental.com

Colorado Cattlemen's Assn.
Sue Lake
9112 CR 78
Ft. Collins, CO 80524
(970) 686-2267

Colorado Cattlemen's Assn.
Kent Lobsack
8833 Ralston Rd
Arvada, CO 80002
(303) 431-6422

Cooperative Resources Int'l
Ken Hartzell
100 MBC Drive Box 569
Shawano, WI 54166
(715) 526-2141
khartzel@crinet.net
www.crinet.com

Farmland Supreme Beef Alliance
Jim Norwood
P.O. Box 7305 Dept. 200
Kansas City, MO 64116
(816) 841-3644
jnorwood@farmland.com

Georgia Cattlemen's Assn.
Ronnie Silcox
Animal/Dairy Science Complex
Athens, GA 30602
(706) 542-9102
rsilcox@arches.uga.ecu
www.gabeef.org

Great Western Beef Expo
Jerrod Samber
508 S 10th Ave Suite 1
Sterling, CO 80751
(970) 522-3200

Indiana Beef Eval. Program
Kern Hendrix
1151 Lily ANSC Purdue RM3-266
West Lafayette, IN 47907-1151
(765) 494-4831
khendrix@ansc.purdue.edu
www.ansc.purdue.edu/ibep/

Int'l Brangus Breeders Assn.
Loren Jackson
P.O. Box 696020
San Antonio, TX 78249
(210) 696-4343
lorenj@int-brangus.org
www.int-brangus.org

Integrated Genetic Mgmt
Mark Lust
P.O. Box 283
Canyon, TX 79015
(806) 655-4570

Iowa Cattlemen's Assn.
Steve Olson
P.O. Box 1490 2055 Ironwood
Ames, IA 50014-1490
(515) 296-2266

Kansas Livestock Assn
Todd Johnson
6031 SW 37th
Topeka, KS 66614-5129
(785) 273-5115
toddj@kla.org
www.kla.org

Maryland Cattlemen's Assn.
Scott Barao
1129 Animal Science Center
College Park, MD 70742-2311
(301) 405-1394
5b13@umail.umd.edu

Michigan Cattlemen's Assn.
Bridgette Voisinet
P.O. Box 24041
Lansing, MI 48909-4041
(517) 336-6780
mcabeef@voyager.net

N. American Limousin Found.
Kent Anderson
7383 S. Alton Way Suite 100
Englewood, CO 80112
(303) 220-1693
kent@nalf.org
www.nalf.org

N. American S. Devon Assn.
Jenny Edwards
166 Hicks Road
Franklinton, NC 27525
(919) 494-1064
southdevon@aol.com

Nat'l Assn. Of Animal Breeders
Gordon Doak
P.O. Box 1033
Columbia, MO 65205-1033
(573) 445-4406
Naab-css@naab-css.org
www.naab-css.org

NM Beef Cattle Perf. Assn.
Ron Parker
Box 30003 MSC 3AE NMSU
Las Cruces, NM 88003
(505) 646-1709

NOBA/CRI
Don Hutzel
Box 607 752 E State Rt 18
Tiffin, OH 44883
(419) 447-6262
noba@crinet.com
www.crinet.com

Red Angus Association
Robert Hough
4201 I-35 North
Denton, TX 76207-3415
(940) 387-3502
bob@redangus1.org
www.redangus1.org

Santa Gertrudis Breeders
Robert Swize
P.O. Box 1257
Kingsville, TX 78364
(512) 592-9357
truegert@aol.com
www.sgbi.org

Select Sires Inc.
Roy Wallace
11740 US 42
Plain City, OH 43064-0143
(614) 873-4683

Taylors Black Simmentals
James Taylor
P.O.Box 176
Winona, KS 67764
(785) 846-7749

United Braford Breeders
Rodney Roberson
422 E. Main Suite 218
Nachogdoches, TX 75961
(409) 569-8200
ubb@brafords.org
www.brafords.org

ABLE, BILL V.
EXECUTIVE VICE PRESIDENT
AICA
PO BOX 20247
KANSAS CITY, MO 64195
WORK: (816)464-5977
FAX: (816)464-5759

ADAMS, RON
COUNTY AGENT
LSU AG CENTER
201 N VIENNA STREET
RUSTON, LA 71270
WORK: (318)251-5134
FAX: (318)251-8697

AKIN, MARK
GENERAL MANAGER
CIRCLE A RANCH
41 HWY K
IBERIA, MO 65486
WORK: (573)793-2330
FAX: (573)793-2331

ALLEN, ANDY
EXTENSION AGENT
VIRGINIA COOPERATIVE EXTENSION
PO BOX 217
FINCASTLE, VA 24090
WORK: (540)473-8260
FAX: (540)473-8379
geallen@vt.edu

ALTENBURG, WILLIAM
BEEF PROGRAM MANAGER
ALTA GENETICS
9100 NO. COUNTY RD 15
FORT COLLINS, CO 80524
WORK: (970)568-7881
FAX: (970)568-7882
willie@info2000.net

ANDERSEN, JOHN R.
G T ANGUS
3428 VALLEY WOODS DRIVE
VERONA, WI 53593
WORK: (608)833-5960
FAX: (608)833-5271

ANDERSEN, KENT
DIRECTOR OF RESEARCH/EDUCATION
NORTH AMERICAN LIMOUSIN
7383 S ALTON WAY
ENGLEWOOD, CO 80112
WORK: (303)220-1693
FAX: (303)220-1884
kent@nalf.org

ARTHUR, KIM
VIRGINIA TECH
DEPT ANIMAL SCIENCES/POULTRY
BLACKSBURG, VA 24061 0306

AVERILL, DAVID
DEVELOPMENT AGENT
STATE OF MAINE/DEPT OF AGRIC
28 STATE HOUSE STATION
AUGUSTA, ME 04333
WORK: (207)287-7521
FAX: (207)287-5576
david.averill@state.me.us

BAKER, MIKE
CORNELL UNIVERSITY
130 MORRISON HALL
ITHACA, NY 14487
WORK: (607)255-5923
FAX: (607)255-9829
mjb28@cornell.edu

BAKER, SCOTT
EXTENSION AGENT
VA COOPERATIVE EXTENSION
122 E MAIN STREET, SUITE 102
BEDFORD, VA 24523
WORK: (540)586-7675
FAX: (540)586-4214
scbaker@vt.edu

BALLARD, EDWARD
ANIMAL SYSTEMS EDUCATOR
UNIVERSITY OF ILLINOIS
1209 WENTHE DRIVE
EFFINGHAM, IL 62401 1697
WORK: (217)347-5126
FAX: (217)347-5150
ballarde@mail.aces.uiuc.edu

BARAO, SCOTT M.
BEEF EXTENSION SPECIALIST
UNIVERSITY OF MARYLAND
1129 ANIMAL SCIENCE CENTER
COLLEGE PARK, MD 20742
WORK: (301)405-1394
FAX: (301)314-9051
sb13@umail.umd.edu

BARDUGONE, JULIE
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

BAUMANN, GLENN
4340 94th STREET SE
ASHLEY, ND 58413
WORK: (701)684-6141

BEAHM, JOHN E.
LIVESTOCK MARKETING SERVICE
VA DEPARTMENT OF AGRICULTURE
PO BOX 68
DRAPER, VA 24324
WORK: (540)320-4710
FAX: (540)980-5675
jbeahm@swva.net

BEAL, LINDA
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

BEAL, W. "BILL" E.
PROFESSOR
VIRGINIA TECH
DEPT OF ANIMAL & POULTRY SCIEN
BLACKSBURG, VA 24060

BEAVERS, GREG
NORTHSTAR SELECT SIRES
8365 S. OLD SR 37
BLOOMINGTON, IN 47403
WORK: (812)824-2431
FAX: (630)578-1905
beav@writeme.com

BENNER, DON
OWNER
BENFIELD FARMS
2503 DEERFIELD VALLEY ROAD
DEERFIELD, VA 24432
WORK: (540)939-4608
FAX: (540)939-4608
benfield@cfw.com

BENNETT, BARRY
GENERAL MANAGER
CANADIAN SIMMENTAL ASSOC.
#13 4101-19th STREET NE
CALGARY, ALBERTA T2E 7C4
CANADA
WORK: 403-250-7979
FAX: 403-250-5121
cansim@simmentalc.com

BENNETT, JAMES
KNOLL CREST FARM, INC
HCR BOX 39
RED HOUSE, VA 23963

BENNETT, PAUL
KNOLL CREST FARM INC
HCR 1, BOX A34
RED HOUSE, VA 23963
WORK: (804)376-3567
FAX: (804)376-7008

BENYSHEK, LARRY
HEAD
ANIMAL & DAIRY SCIENCE, UGA
ADS BUILDING, UGA
ATHENS, GA 30602
WORK: (706)542-6259
FAX: (706)542-9316
qllb@arches.uga.edu

BERNICK, JEANNE
LIVESTOCK EDITOR
FARM JOURNAL/BEEF TODAY
11431 HWY 70 WEST, SUITE 1
CLAYTON, NC 27520
WORK: (919)550-4171
FAX: (919)550-8422
jkbernick@aol.com

BERTRAND, J. KEITH
UNIVERSITY OF GEORGIA
356 ANIM/DAIRY SCI COMPLEX
ATHENS, GA 30602 2771
WORK: (706)542-0964
FAX: (706)542-0399
jkbert@arches.uga.edu

BESSLER, JAMES
CATTLE UNDERWRITING MANAGER
AMERICAN LIVE STOCK INSURANCE
PO BOX 520
GENEVA, IL 60134 0520
WORK: (630)232-2100
FAX: (630)232-2292

BLALOCK JR., RALPH
AGRICULTURAL EXTENSION AGENT
NC COOPERATIVE EXTENSION
PO BOX 129
TARBORO, NC 27886
WORK: (252)641-7815
FAX: (252)641-7831
ralph_blalock@ncsu.edu

BOGGS, DON
EXECUTIVE DIRECTOR
BEEF IMPROVEMENT FEDERATION
BOX 2170 SDSU
BROOKINGS, SD 57007
WORK: (605)688-5166
FAX: (605)688-6170
boggsd@mg.sdstate.edu

BOLLUM, WAYNE
PUBLISHER
BEEF
7900 INTERNATIONAL DRIVE
MINNEAPOLIS, MN 55425
WORK: (612)851-4711
FAX: (612)851-4601
wayne_bollum@intertec.com

BOLZE, RON
CERTIFIED ANGUS BEEF (CAB)
1380 CO. RD. I
COLBY, KS 67701
WORK: (785)462-6404
FAX: (785)462-6789
cabrbolze@aol.com

BORGER, MICHAEL
EDUCATOR
THE OHIO STATE UNIVERSITY
ATI, 1328 DOVER ROAD
WOOSTER, OH 44691
WORK: (330)264-3911
FAX: (330)262-7634
borger.1@osu.edu

BORNEMANN, JERRY
OWNER
BORNEMANN SIMMENTALS
5415 S STATE ROAD
DURANT, MI 48429
WORK: (517)743-4509

BORROR, REBECCA
TEHAMA ANGUS RANCH
POBOX 573
BIEBER, CA 96009
WORK: (530)294-5514
FAX: (530)294-5514

BORROR, WILLIAM
PRESIDENT, AMERICAN ANGUS ASSO
TEHAMA ANGUS RANCH
PO BOX 158
TEHAMA, GA 96090

BOSTON, ANDY
EXTENSION EDUCATOR ANR
PURDUE UNIVERSITY CES
205 EAST MAIN STREET #4
PAOLI, IN 47454 1596
WORK: (812)723-7107
FAX: (812)723-4196
andy.boston@ces.purdue.edu

BOWMAN, BILL
DIRECTOR COMMERCIAL RELATIONS
AMERICAN ANGUS ASSOCIATION
3201 FREDERICK AVENUE
ST JOSEPH, MO 64506
WORK: (816)283-5109
FAX: (816)233-9703
bbowman@angus.org

BRATTON, BILL
BRATTON FARM
HCR 02, BOX 240
WARM SPRINGS, VA 24484
WORK: (540)839-2427
FAX: (540)839-2460

BRENAGER-PARKS, ELIZABETH
PFIZER ANIMAL HEALTH

BROCKETT, BILL
OWNER
VIRGINIA BEEF CORPORATION
1215 JAMES MADISON HIGHWAY
HAYMARKET, VA 22069
WORK: (703)754-8873
FAX: (703)754-0234

BROWN, DAVID
COW HERD MANAGER
WHITESTONE FARM
PO BOX 244
ALDIE, VA 20105
WORK: (540)687-3524
FAX: (703)327-4777
brocowco@aol.com

BROWN, MICHAEL D.
GRADUATE STUDENT/TECH
UNIVERSITY OF NEBRASKA GPVEC
PO BOX 348
HASTINGS, NE 68902
WORK: (402)762-4541
FAX: (402)762-4509
mbrown@gpvec.unl.edu

BROWN, TOMMY J.
REGIONAL EXTENSION ANIMAL SCI.
ALABAMA COOP EXTENSION
60 COUNTY ROAD 944
MARION JUNCTION, AL 36759
WORK: (334)874-9030
FAX: (334)874-8500
tbrown@acesag.auburn.edu

BROWN, JR, R. "ROB" A.
PARTNER
R A BROWN RANCH
PO BOX 789
THROCKMORTON, TX 76483
WORK: (940)849-0611
FAX: (940)849-3173

BROWNE, MILYSSA
VIRGINIA TECH
DEPT ANIMAL SCIENCES/POULTRY
BLACKSBURG, VA 24061 0306

BRUBAKER, TONY
HOECHTS-ROUSSEL
18216 TEMAN ROAD
BEAVERDAM, VA 23015
WORK: (804)449-6639
FAX: (804)449-6639

BRYANT, DEAN
ROSEDA FARM
15317 CARROLL ROAD
MONKTON, MD 21111
WORK: (410)472-2697
FAX: (410)472-0554
roseda@flash.net

BUCK, JAMES
MERIAL

BULLOCK, DARRH
ASSOCIATE PROFESSOR
UNIVERSITY OF KENTUCKY
804 WP GARRIGUS BLDG.
LEXINGTON, KY 40446
WORK: (606)257-7514
FAX: (606)257-3412
dbullock@ca.uky.edu

BURGETT, KEITH D.
VETERINARIAN/ANGUS CATTLE
CARROLLTON ANIMAL HOSPITAL
1246 ANTIGUA ROAD, SW
CARROLLTON, OH 44615
WORK: (330)627-5414
FAX: (330)627-6314

BYRD, JACK
OWNER
KNIBBS CREEK FARM
PO BOX 313
AMELIA, VA 23002
WORK: (804)561-2421

CALIRI, LOIS
ROANOKE TIMES

CALLE, JUAN FELIPE
ASOBRANGUS DE COLUMBIA
THISTLE FARMS
14165 WALHUNDING ROAD
SENECAVILLE, OH 43780
WORK: (704)685-5119
FAX: (800)803-8888
thistleang@aol.com

CARPENTER, JAMES
FARM OWNER
1094 ROCK CORNER ROAD
FOREST CITY, NC 28043
WORK: (828)286-9888

CARPENTER, MIKE
LIVESTOCK MARKETING SPECIALIST
VA DEPT OF AGRICULTURE
5093 SPRING HILL ROAD
MT. SOLON, VA 22843
WORK: (540)434-0779
FAX: (540)434-5607

CARSWELL, TOM
FARM OWNER
2651 PEARIDGE ROAD
BOSTIC, NC 28018
WORK: (828)287-4444

CARUTHERS, DAVID
CATTLE MANAGER
E.B. HARRIS LIVESTOCKS
RT 3, BOX 263
WARRENTON, NC 27589
WORK: (252)257-2140
gotbeef@gloryroad.net

CASH, ERSKINE
PROFESSOR OF ANIMAL SCIENCE
PENN STATE UNIVERSITY
324 HENNING BUILDING
UNIVERSITY PARK, PA 16802
WORK: (814)863-3662
FAX: (814)863-6042
ecash@das.psu.edu

CAVE, BRYAN
EXTENSION AGENT/AG & NAT RESR
NORTH CAROLINA STATE UNIV
PO BOX 324
DOBSON, NC 27017
WORK: (336)401-8025
FAX: (336)401-8025
bryan_cave@ncsu.edu

CHAPMAN, HOLLIS D.
SPECIALIST - BEEF
LSU
1129 SUNDANCE DRIVE
BATON ROUGE, LA 70810
hchapman@agctr.lsu.edu

CHASE, GALEN
SINCLAIR CATTLE COMPANY
102 W PENNSYLVANIA AVENUE
TOWSON, MD 21204
WORK: (410)583-0850
bufcrk@mcn.net

CHRISTENSEN, CHARLES M.
CO-OWNER
C-J-R CHRISTENSEN RANCHES
BOX 1269
GILLETTE, WY 82717 1269
WORK: (307)682-0190
FAX: (307)682-3920

CLARK, CHARLIE
CLARK FARMS
4672 VALLEY ROAD
SALTVILLE, VA 24370
WORK: (540)624-3272
FAX: (540)624-3411
clark@netva.com

CLAWSON, DAVID
CLAWSON RANCH
BOX 146
ENGLEWOOD, KS 67840
WORK: (316)539-2029
FAX: (316)539-2070
grove@ucom.net

COLLINS IV, JIMMY
OWNER
COLLINS FARM
201 SO. NINTH STREET
OPELIKA, AL 36801
WORK: (334)749-1221
FAX: (334)749-0808
ccpjsc@mindspring.com

COMERFORD, JOHN
EXT BEEF SPECIALIST
PENN STATE UNIVERSITY
324 HENNING BLDG
UNIVERSITY PARK, PA 16802
WORK: (814)863-3661
FAX: (814)865-7442
jcomerford@das.psu.edu

CONLEY, DARREL
COOPERATIVE EXTENSION SERVICE
NCSU
PO BOX 306
SPINDALE, NC 28160
WORK: (828)287-6010

CONNATSER, MIKE
BEEF SPECIALIST
SOUTHEAST SELECT SIRES
3238 MINT ROAD
MARYVILLE, TN 37803
WORK: (423)982-8996
FAX: (423)681-6551

COPITHORNE, RYAN
MANAGER
C.L. RANCHING
BOX 8 SITE 30, RR#2
CALGARY, ALBERTA, T2P 2G5
CANADA
WORK: 403-932-2966
FAX: 403-932-5593
clrancy@cadvision.com

COTTEN, REXFORD E.
EXTENSION AGENT AGRICULTURE
VA COOPERATIVE EXTENSION
PO BOX 205
SURRY, VA 23883
WORK: (757)294-5213
FAX: (757)294-5218

COURTER, CARLTON
VA DEPARTMENT OF AGRICULTURE

CRANE, BOB
ROCK HOLLOW FARM
17317 NW 140th STREET
ALACHUA, FL 32615 4456
WORK: (904)462-3291
FAX: (904)462-3285
robustelli@aol.com

CREWS, DENNY
RESEARCH SCIENTIST
LETHBRIDGE RESEARCH CENTER
PO BOX 3000
LETHBRIDGE, ALBERTA T1J 4B1
CANADA
WORK: (403)317-2288
FAX: (403)382-3156
dcrews@em.agr.ca

CROPP, CRAIG S.
CROPP FAMILY FARM
RR 3 BOX 447
MAX MEADOWS, VA 24360
WORK: (540)228-0778
FAX: (540)637-6012
cffbeef@tcia.net

CROUCH, JOHN
DIRECTOR OF PERFORMANCE PROG
AMERICAN ANGUS ASSOCIATION
3201 FREDERICK AVENUE
ST JOSEPH, MO 64506
WORK: (816)383-5100
FAX: (816)233-9703
jcrouch@angus.org

CUNDIFF, LARRY V.
RESEARCH LEADER
US MEAT ANIMAL RESEARCH CENTER
PO BOX 166
CLAY CENTER, NE 68933 0166
WORK: (402)762-4171
FAX: (402)762-4173
cundiff@email.marc.usda.gov

CUNNINGHAM, BRUCE
AMERICAN SIMMENTAL ASSOCIATION
1 SIMMENTAL WAY
BOZEMAN, MT 59718
WORK: (406)587-4531
FAX: (406)587-9301
cunninham@simmgene.com

DALTON, DOUG
DALTON'S ON THE SYCAMORE

DANCIGER, DAVID
OWNER
TYBAR ANGUS
1644 PRINCE CREEK ROAD
CARBONDALE, CO 81623
WORK: (970)963-1391
FAX: (970)963-0469
danciger@rof.net

DANIELSON, RUSS
NORTH DAKOTA STATE UNIVERSITY
195 HULTZ HALL
FARGO, ND 58105
WORK: (701)231-7648
FAX: (701)231-7590
rdaniels@ndsuext.nodak.edu

DEL VECCHIO, RONALD
ASSOC PROFESSOR/SPECIALIST
LOUISIANA STATE UNIVERSITY
239 KNAPP HALL/POB 25100
BATON ROUGE, LA 70894
WORK: (225)388-2219
FAX: (225)388-4857
rdelvecchio@agctr.lsu.edu

DeLUCA, MARIO
AGRICULTURAL EXTENSION AGENT
NC COOPERATIVE EXTENSION SERV
10 E COURT STREET, ROOM 226
MARION, NC 28752
WORK: (828)652-7121
FAX: (828)659-8104
mario_deluca@ncsu.edu

DeMUTH, LARRY
LIVESTOCK SPECIALIST
MISSISSIPPI STATE EXTENSION
1320 SEVEN SPRINGS ROAD
RAYMOND, MS 39154
WORK: (601)857-2284
FAX: (601)857-2358
larryd@ext.msstate.edu

DeNISE, SUE
PROFESSOR
UNIVERSITY OF ARIZONA
DEPARTMENT OF ANIMAL SCIENCES
TUCSON, AZ 85721 0038
WORK: (520)621-1972
FAX: (520)621-9435
sdenise@ag.arizona.edu

DESRANLEAU, PIERRE
BEEF COORDINATOR
QUEBEC AI UNIT (CIAQ INC)
3450 SICOTTE
ST HYACINTHE, QUEBEC J2S 7D8
CANADA
WORK: (450)774-1141
FAX: (450)774-1141

DEVITT, CROSBY
GRADUATE STUDENT
UNIVERSITY OF GUELPH
ROOM 128, ANIMAL/POULTRY SCI
GUELPH, ONTARIO N1G 2W1
CANADA
WORK: (519)824-4120
cdevitt@aps.uoguelph.ca

DILLARD, JED
PO BOX 704
MONTICELLO, FL 32345
WORK: (850)599-3546
FAX: (850)561-2151
jhare@mailer.fsu.edu

diZEREGA, MARY HOWE
PRESIDENT, AICA
OAKDALE FARM
PO BOX 660
UPPERVILLE, VA 20185
WORK: (540)364-2525
FAX: (540)364-2838
mhdiz@oakdalefarm.com

DOCKTER, DAVID
SELECT SIRES
HCO 5, BOX 45
MANDAN, ND 5855
WORK: (701)663-4175

DODD, TROY
BUSINESS MANAGER
INTEGRATED GENETIC MGMT, INC
PO BOX 1464
CANYON, TX 79015
WORK: (806)655-4570

DOLEZAL, SALLY
EXT BEEF CATTEL BREEDING SPEC
OSU - OKLAHOMA BEEF INC
201 ANIMAL SCIENCE
STILLWATER, OK 74078
WORK: (405)744-6060
FAX: (405)744-7390
slnbull@okstate.edu

DOMINGUEZ, JUAN MANUEL
ASOBRANGUS DE COLUMBIA
THISTLE FARMS
14165 WALHUNDING ROAD
SENECAVILLE, OH 43780
WORK: (704)685-5119
FAX: (800)803-8888
thistleang@aol.com

DONOGHUE, KATH
UNIVERSITY OF GEORGIA
ANIMAL/DAIRY SCIENCE COMPLEX
ATHENS, GA 30602
WORK: (706)542-0965
FAX: (706)583-0274
kdonoghu@arches.uga.edu

DORN, DAN
SUPPLY DEVELOPMENT
DECATUR COUNTY FEED YARD
RR 3 BOX 9
OBERLIN, KS 67749
WORK: (785)475-2212
FAX: (785)475-2717
ddorn@navix.net

DORR, ERIC
EXTENSION ASSOCIATE BEEF
THE OHIO STATE UNIVERSITY
10600 US HIGHWAY 42
MARYSVILLE, OH 43040
WORK: (614)873-6736
FAX: (614)873-6835
dorr16@postoffice.ag.ohio-state.edu

DOUBET, SHERRY
EXECUTIVE VICE PRESIDENT
AMERICAN SALES ASSOC.
7383 S. ALTON WAY #103
ENGLEWOOD, CO 80112
WORK: (303)770-9292
FAX: (303)770-9302
salevsusa.org

DOVELL, RICHARD "DICK" E.
487 HAMILTON CIRCLE
FRONT ROYAL, VA 22630
WORK: (540)636-6049

DRYCORN, RUSS
PFIZER ANIMAL HEALTH

DUFFELL, MARK M.
MANAGER
WHITESTONE FARM
PO 570
ALDIE, VA 20105
WORK: (703)327-4863
FAX: (703)327-4777
wstonef@aol.com

DYKERS, JR, JOHN
OWNER
NEW HOPE FARM
PO BOX 565
SILER CITY, NC 27344 9581
WORK: (919)663-2436
FAX: (919)663-2254
dykers@emji.net

EAKINS, ROGER
LIVESTOCK SPECIALIST
UNIVERSITY OF MISSOURI
PO BOX 408
JACKSON, MO 63755
WORK: (573)243-3581
FAX: (573)243-1606
eakinsr@missouri.edu

EBERSOLE, J. LLOYD
ASSISTANT MANAGER
SIRE POWER, INC
21 SIRE POWER DRIVE
TUNKHANNOCK, PA 18657
WORK: (570)836-3168
FAX: (570)836-1490
ebersole@epix.net

ELLER, IKE
VIRGINIA TECH
500 PATRICK HENRY DRIVE
BLACKSBURG, VA 24060
WORK: (540)231-5546
FAX: (540)231-4163
aeller@vt.edu

ELZO, MAURICIO A.
ASSOCIATE PROFESSOR
UNIVERSITY OF FLORIDA
202D ANIMAL SCIENCE/POB 110910
GAINESVILLE, FL 32611 0910
WORK: (352)392-7564
FAX: (352)392-7652
elzo@animal.ufl.edu

ENNS, RICHARD
ASSISTANT PROFESSOR
UNIVERSITY OF ARIZONA
PO BOX 210038
TUCSON, AZ 85720
WORK: (520)626-7266
FAX: (520)621-9435
menns@ag.ariz.edu

EUCLIDES, KEPLER
RESEARCH/PhD
EMBRAPA
PO BOX 154
CAMPO GRANDE/BRAZIL
MS
WORK: 55.67.7682000
FAX: 55.677682150
kepler@cnpgc.embrapa.br

EVANS, JOHN
WATERFORD FARM

EVANS, S. R.
EVANS ANGUS FARM
1604 LEFLORE
GREENWOOD, MS 38930
WORK: (601)453-0532
FAX: (601)453-3079
wldol@netdoOr.com

EVERSOLE, DAN
PROFESSOR-ANIMAL SCIENCE
VIRGINIA TECH
2495 BISHOP ROAD
BLACKSBURG, VA 24060 8825
WORK: (540)231-3010
deversole@vt.edu

FAGG, BYRON W.
EXTENSION EDUCATOR ANR
PURDUE UNIVERSITY CES
COURTHOUSE ANNEX 35 PUBLIC SQ
SALEM, IN 47167 2054
WORK: (812)883-4601
FAX: (812)883-3988
byron.fagg@ces.purdue.edu

FAITHFUL, DEREK
COBUNGRA CATTLE STATION
7/10 HIGH STREET YEA
VICTORIA
AUSTRALIA
WORK: 03 57 972170
FAX: 03 57 972172
lawson@ycs.com.au

FARISS, CHARLES E.
OWNER/OPERATOR
FAIRHART FARMS
165 FAIRHART LANE
RUSTBURG, VA 24588
WORK: (804)660-9417
FAX: (804)332-5230
fairhartfarm@lunchburg.net

FEAR, JR, KENNETH
MANAGER
COTTONWOOD RANCHES
PO BOX 775
BIG PINEY, WY 83113
WORK: (307)276-3517
FAX: (307)276-3232
marylf@trib.com

FELSMAN, ROBERT J.
EXTENSION LIVESTOCK SPECIALIST
UNIVERSITY OF ARKANSAS
PO BOX 4966
PINE BLUFF, AR 71611
WORK: (870)543-8530
FAX: (870)543-8166

FELTON, FRANK
912 S WALNUT STREET
MARYVILLE, MO 64468

FEUZ, BRIDGER
PE AGGEN INC.
1756 PICASSO AVENUE
DAVIS, CA 95616
WORK: (530)297-3002
FAX: (530)756-5143

FIELD, TOM
PROFESSOR
COLORADO STATE UNIVERSITY
RM 11, ANIMAL SCIENCE BLDG
FORT COLLINS, CO 80523
WORK: (970)491-6642
FAX: (970)491-5326
tfield@ceres.agsci.colostate.edu

FIGGINS, VERNON
SALES REPRESENTATIVE
ABS GLOBAL, INC
1703 FREIDENS CHURCH ROAD
MOUNT CRAWFORD, VA 22841
WORK: (540)434-8893

FIGUEIREDO, GERALDO
RESEARCHER/MSc
EMBRAPA/MINISTRY OF AGRIC BR
PB 154 CAMPO GRANDE/MS BRAZIL
CAMPO GRANDE, MS 79002-970
WORK: 55.67.7682058
FAX: 55.67.7682150
geraldo@cnpgc.embrapa.br

FINK, GALEN M.
OWNER
FINK BEEF GENETICS
7101 ANDERSON
MANHATTAN, KS 66503
WORK: (785)776-9385
finkbull@flinthills.com

FISHER, JEFF
OSU EXTENSION
120 S MARKET STREET
WAVERLY, OH 45690
WORK: (740)947-2121
FAX: (740)947-4413
fisher.7@osu.edu

FRANK, DOUG
BEEF PRODUCT MANAGER
ABS GLOBAL, INC
6908 RIVER ROAD
DeFOREST, WI 53532
WORK: (608)846-6252
FAX: (608)846-6434
dfrank@absglobal.com

FRANK, JUDY A.
NOLLER AND FRANK CHAROLAIS
18278 HWY 92
SIGOURNEY, IA 52591
WORK: (515)622-2388
FAX: (515)622-2388
nfchar@se-iowa.net

FREEMAN, TOMMY
FARM OWNER
FREEMAN FARMS
3260 WHITESIDE ROAD
FOREST CITY, NC 28043
WORK: (828)287-7436

FULK, JAY
OWNER
CEDAR RUN ANGUS
5738 CEDAR RUN TRAIL
BROADWAY, VA 22815
WORK: (540)856-3049
FAX: (540)856-8546

GARDINER, HENRY
CEO
GARDINER ANGUS RANCH INC
RT 1, BOX 290
ASHLAND, KA 67831
WORK: (316)635-2932
FAX: (316)635-2930

GARDINER, MARK R.
PRESIDENT
GARDINER ANGUS RANCH INC
RT 1, BOX 290
ASHLAND, KS 67831
WORK: (316)635-2760
FAX: (316)635-2930

GASKINS, CHARLES
ASSOCIATE PROFESSOR
WASHINGTON STATE UNIVERSITY
135 CLARK HALL
DULLMAN, WA 99164 6310
WORK: (509)335-6416
FAX: (509)335-1082
gaskins@wsu.edu

GERBER, DOUGLAS E.
OWNER
GERBER POLLED HEREFORDS
5324 STATE ROAD 227 SOUTH
RICHMOND, IN 47374
WORK: (765)935-5274
FAX: (765)966-4946
gerberph@infocom.com

GERKEN, JOHN
OWNER
HILLCROFT FARM
PO BOX 754
SILER CITY, NC 27344
WORK: (919)742-4344
gerken@emji.net

GILES, KELLY K.
OPERATOR
GILES RANCH COMPANY
ASHLAND, KS 67831
FAX: (316)635-4403
gilesbeef@aol.com

GILLESPIE, BILL A.
OWNER
GILLESPIE COVE FARM
RT 1 BOX 358
TAZEWELL, VA 24651
WORK: (540)988-5763

GLEGHORN, JUSTIN
GRADUATE STUDENT
KANSAS STATE UNIVERSITY
12175 MILITARY TRAIL
ST. GEORGE, KS 66535
WORK: (785)532-1252
FAX: (785)532-7059
jgleghor@oz.oznet.ksu.edu

GOFORTH JR., G. MARK
FARMER
603 PRINCE AVENUE
GOLDSBORO, NC 27530
WORK: (919)735-0970

GOLDWASSER, MIKE
FARMER
790 BIRCHTREE ROAD
HILLSVILLE, VA 24343
WORK: (540)728-3360
FAX: (540)728-7662
goldwasser@tcia.net

GOOD, GERALD
BAYER

GOODSON, PHIL
OWNER/MANAGER
SPRINGFIELD ANGUS LLC
PO BOX 32090
RALEIGH, NC 27622
WORK: (919)781-0710
FAX: (919)781-4650

GORDON, BRUCE
SIRE SELECTION
ALTA GENETICS
974 STRATFORD COURT
BURNSVILLE, MN 55337
WORK: (612)808-9935
FAX: (612)808-9938
gordonrb.alta@ibm.net

GORDON, JAMIE
FIVE STAR BEEF LTD
PO BOX 42
ASHBURTON
NEW ZEALAND
WORK: 0064/33081599
FAX: 0064/33088530
jamie@fivestarbeef.co.n2

GORDON, KINDRA
MANAGING EDITOR
BEEF MAGAZINE
7900 INTERNATIONAL DRIVE
MINNEAPOLIS, MN 55425
WORK: (612)851-4671
FAX: (612)851-4601
kinda_gordon@intertec.com

GOSCHA, MICHAEL
ASSISTANT MANAGER
TYBAR ANGUS
1644 PRINCE CREEK ROAD
CARBONDALE, CO 81623
WORK: (970)963-1391
FAX: (970)963-0469
danciger@rof.net

GOTHARD, MICHAEL
EXECUTIVE DIRECTOR
VIRGINIA ANGUS ASSOCIATION
RT 2, BOX 446
STAUNTON, VA 24401
WORK: (540)337-3001
FAX: (540)337-3113
vaangus@rica.net

GOTTSCHALK, ANDREW
LFG, INC
8480 EAST ORCHARD RD, STE 1250
ENGLEWOOD, CO 80111

GOULD, LOWELL
GENETICIST
LEACHMAN CATTLE CO
7 EAST AIRPORT ROAD
BILLINGS, MT 59105
WORK: (406)254-2666
FAX: (406)254-2465
lowell@leachman.com

GRAHAM, ELAINE
PRESIDENT
BEEF IMPROVEMENT ONTARIO
6986 WELLINGTON ROAD 124, RR7
GUELPH, ONTARIO N1H 6J4
CANADA
WORK: (519)767-2665
FAX: (519)767-2502

GRAYBEAL, ALAN
GRAYBEAL FARM
365 DEERCROFT DRIVE
BLACKSBURG, VA 24060
WORK: (540)953-3935

GREEN, RONNIE D.
PROFESSOR
COLORADO STATE UNIVERSITY
DEPT OF ANIMAL SCIENCES, CSU
FORT COLLINS, CO 80523 1171
WORK: (970)491-2722
FAX: (970)491-5326
rdggene@lamar.colostate.edu

GREEN, THOMAS
EDITOR
FARM CHRONICLE
PO BOX 1576
OXFORD, NC 27565
WORK: (919)690-0834
farmchrn@gloryroad.net

GREINER, SCOTT
EXTENSION BEEF SPECIALIST
VIRGINIA TECH
366 LITTON-REAVES
BLACKSBURG, VA 24061
WORK: (540)231-9159
FAX: (540)231-3713
sgreiner@vt.edu

GRIFFIN, JIM
CATTLE MANAGER
MURPHY FAMILY FARMS
PO BOX 759
ROSE HILL, NC 28458
WORK: (910)289-2111
FAX: (910)289-6442

GROCE, SAM
AGRICULTURE EXTENSION AGENT
NC COOP EXTENSION SERVICE
PO BOX 279
PITSSBORO, NC 27312
WORK: (919)542-8202
FAX: (919)542-8246
sam_groce@ncsu.edu

GROVE, CONRAD
SINCLAIR CATTLE COMPANY
102 W PENNSYLVANIA AVENUE
TOWSON, MD 21204
WORK: (410)583-0850

HALL, JOHN
EXTENSION ANIMAL SCIENTIST
VIRGINIA TECH
302 LITTON-REAVES HALL
BLACKSBURG, VA 24061
WORK: (540)231-9153
FAX: (540)231-3010
jbhall@vt.edu

HALLIWILL, CRAIG
DIRECTOR
VOYAGER FOUNDATION FARM
194 POAGUE LANE
GLASGOW, VA 24555
WORK: (540)258-1831
FAX: (250)258-2520
voyager@cfw.com

HAMILTON, SAMUEL E.
DIRECTOR, GOVERNMENT AFFAIRS
VA AGRICULTURAL COUNCIL
PO BOX 718
RICHMOND, VA 23218
WORK: (804)643-3555
FAX: (804)643-3556
va.agribusiness@att.net

HANDLEY, JOANNE
BEEF CATTLE GENETICIST
ONTARIO MIN.OF AGRICULTURE
1 STONE ROAD WEST 3rd FLOOR NE
GUELPH, ONTARIO N1G 4Y2
CANADA
WORK: 519-826-3323
FAX: 519-826-3259
jhandley@omafra.gov.on.ca

HANSEN, BERNIE
CONCEPT FOODS
PO BOX 435
ALMA, KS 66401

HARRIMAN, BOB
MIDWESTERN CATTLE SERVICES
PO BOX 209
NEW HAVEN, MO 63868
WORK: (417)861-4776
FAX: (660)693-2380

HARRIS, DOUG
SELECT SIRE
13418 OLD GORDONSVILLE ROAD
ORANGE, VA 22960

HARRIS, E. B.
OWNER
E.B. HARRIS LIVESTOCK
RT 3, BOX 107
WARRENTON, NC 27589
WORK: (252)257-2140
FAX: (252)257-1035

HARRIS, MIKE
EXTENSION AGENT
VIRGINIA COOPERATIVE EXTENSION
RT 1, BOX 642
TAZEWELL, VA 24651
WORK: (540)988-0405
FAX: (540)988-0367
jaharris@vt.edu

HARRISON, ROB
OWNER
ROUTE 2, BOX 2905
TROY, VA 22974
WORK: (804)293-5698
FAX: (804)293-3917
harrisonad@redlt.com

HASSEN, ABEBE
ASSISTANT SCIENTIST
IOWA STATE UNIVERSITY
239 KILDEE HALL
AMES, IA 50011
WORK: (515)294-0358

HAYS, CRAIG
AAACUP, MANAGER
IOWA STATE UNIVERSITY
337 KILDEE HALL
AMES, IA 50011
WORK: (515)294-5275
FAX: (515)294-3795
clhays@iastate.edu

HAZELRIGG, BRENT
PARTNER
FRANK/HAZELRIGG CATTLE COMPANY
308 WOLFE STREET
ALEXANDRIA, VA 22314
WORK: (703)698-3990
FAX: (703)698-3933
fhcattleco@aol.com

HEIDEL, RICK
EXTENSION AGENT
VIRGINIA TECH
PO BOX 590
VERONA, VA 22842 0590
WORK: (540)245-5750
FAX: (540)245-5752
rdheidel@vt.edu

HEIDT, KIM
ABS GLOBAL
6908 RIVER ROAD
DeFOREST, WI 53532
WORK: (608)846-6418
FAX: (608)846-6444
kheidt@absglobal.com

HENN, JOHN
NUTRITIONIST
BEEFWORKS/CARGILL
2309 WHITNEY STREET
ATLANTIC, IA 50022
WORK: (712)243-1629
FAX: (712)243-1522
john_e_henn@cargill.com

HENRIQUES, NIGEL
MGR, OPS & INFO SERVICES
BEEF IMPROVEMENT ONTARIO
6986 WELLINGTON ROAD 124, RR7
GUELPH, ONTARIO N1H 6J4
CANADA
WORK: 519-767-2665
FAX: 519-767-2502

HERMEL, SHAUNA ROSE
EDITOR
ANGUS JOURNAL
3201 FREDERICK AVENUE
SAINT JOSEPH, MO 64506
WORK: (816)383-5270
FAX: (816)233-6575
shermel@angusjournal.com

HERRING, ANDY
ASSISTANT PROFESSOR
TEXAS TECH UNIVERSITY
BOX 42141
LUBBOCK, TX 79409 2141
WORK: (806)742-1475
FAX: (806)742-2427
anadh@ttu.edu

HERRING, WILLIAM
ASSISTANT PROFESSOR
S-132 ANIMAL SCIENCE
COLUMBIA, MO 65211
WORK: (573)884-6860
FAX: (573)882-4798
herringw@missouri.edu

HIATT, BRUCE
VIRGINIA FARM BUREAU

HILL, KEN
SALES
VA/NC SELECT SIRES
192 NORTHBEND DRIVE
YOUNGSVILLE, NC 27596
WORK: (919)554-1280
hillfam@mindspring.com

HIXON, DOUG L.
PROFESSOR/EXTENSION SPECIALIST
UNIVERSITY OF WYOMING
PO BOX 3684
LARAMIE, WY 82071
WORK: (307)766-3100
FAX: (307)766-2355
dhixon@uwyo.edu

HOFFMAN, DAVID
LIVESTOCK SPECIALIST
UNIVERSITY OF MISSOURI
302 S MAIN, ANNEX #3
HARRISONVILLE, MO 64701
WORK: (816)380-1450
FAX: (816)380-1455
hoffmand@missouri.edu

HOGAN, ALLEN
COUNTY AGENT
LSU AGRICULTURAL CENTER
PO BOX 1407
JENNINGS, LA 70546
WORK: (318)824-1773
FAX: (318)824-0748
ahogan@agctr.lsu.edu

HOHENBOKEN, WILLIAM D.
PROFESSOR
VIRGINIA TECH
3100 LITTON REAVES/APSC
BLACKSBURG, VA 24061 0306
WORK: (540)231-4733
FAX: (540)231-3010
whohenbo@vt.edu

HOLLIMAN, JIMMY
AUBURN UNIVERSITY
60 COUNTY ROAD 944
MARION JUNCTION, AL 36759
WORK: (334)872-7878
FAX: (334)872-2013
jhollima@acesag.auburn.edu

HOLLIS, SCOTT
VA AGRIC STATISTICS SERVICE CO
PO BOX 1659
RICHMOND, VA 23218 1659
WORK: (804)771-2493
FAX: (804)771-2651
shollis@nass.usda.gov

HOLM, TOM
PE AGGEN INC.
2411 SOUTH 1070 WEST
SALT LAKE CITY, UT 84119
WORK: (801)887-1407
FAX: (801)975-1244

HOPKINS, STEVE
EXTENSION AGENT
VA COOPERATIVE EXTENSION
PO BOX 30
ORANGE, VA 22960
WORK: (540)672-1361
FAX: (540)672-0234
hoppy@vt.edu

HORKAN, JR., GEORGE
CLEREMONT FARM

HORSLEY, SHANE
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

HOUCK, BILL
ASH-WILL FARM
261 SUMMIT POINT ROAD
BERRYVILLE, VA 22611
WORK: (540)662-1108
FAX: (540)955-3962

HOUFF, DWIGHT
HOLLY HILL FARM

HOUFF, NEIL
HOUFF FEED AND FERTILIZER

HOUGH, BOB
EXECUTIVE SECRETARY
RED ANGUS ASSOCIATION
4201 I-35 NORTH
DENTON, TX 76207 3415
WORK: (940)387-3502
FAX: (940)383-4036

HOUGH, JOHN
CHIEF SCIENCE OFFICER
EPD INTERNATIONAL, INC
PO BOX 808
STATHAM, GA 30666
WORK: (770)725-9811
FAX: (770)725-5281
jhough@epdinterrational.com

HOUNSHELL, W. "BUSTER" C.
HOUNSHELL FARMS
RT 4, BOX 363
WYTHEVILLE, VA 24382
WORK: (540)686-4055

HOUSE, BRIAN
SELECT SIRES
11740 US 42 N
PLAIN CITY, OH 43064
WORK: (614)873-4683
FAX: (614)873-5751
ssbeef@aol.com

HOWETH, FRANK
OWNER
BROCK III FARMS
507 GRINDSTONE ROAD
WEATHERFORD, TX 76087
WORK: (817)923-1965
FAX: (817)599-5409
frankhoweth@brock3far,s/cp,

HUCKS, MARK
AGRICULTURAL AGENT
NC COOPERATIVE EXTENSION SERV
ROOM 102, AG CENTER DRIVE
NASHVILLE, NC 27856
WORK: (252)459-9810
FAX: (252)459-9850
mark_hucks@ncsu.edu

HUFFHINES, CRAIG
EXECUTIVE VICE PRESIDENT
AMERICAN HEREFORD ASSOCIATION
1501 WYANDOTTE
KANSAS CITY, MO 64108
WORK: (816)842-3757
FAX: (816)842-6931
chuffhin@hereford.org

HUNTRODS, RICHARD
SUPT
FELDUN PURDUE AG CENTER
RR 10 BOX 122
BEDFORD, IN 47421
WORK: (812)279-8554
FAX: (812)279-4390
huntrods@tima.com

HUPP, HAROLD
EXTENSION LIVESTOCK SPECIALIST
CLEMSON UNIVERSITY
BOX 340361
CLEMSON, SC 29634 0361
WORK: (864)656-5161
FAX: (864)656-3131
hhupp@clemson.edu

HUSFELD, DOUG
DIRECTOR/COMMERICAIL MARKETING
BEEFMASTER BREEDERS UNITED
6800 PARK TEN BLVD, #290W
SAN ANTONIO, TX 78213
WORK: (210)732-3132
FAX: (210)732-7711
dhusfield@beefmasters.org

HUTZEL, DON
GENEX CRI
BOX 607
TIFFIN, OH 44883
WORK: (419)447-6262
FAX: (419)447-6084

ISHEE, JEFF

JACKSON, LOREN
DIRECTOR OF BHIR
INT'L BRANGUS BREEDERS ASSOC
PO BOX 696020
SAN ANTONIO, TX 78269
WORK: (210)696-4343
lorenj@int-brangus.org

JENKINS, TOM
RESEARCH ANIMAL SPECIALIST
USDA-ARE-MARC
PO BOX 166, STATE SPUR 18D
CLAY CENTER, NE 68933
WORK: (402)762-4100
FAX: (702)762-4148

JIM
SOUTHERN STATES FEED DIVISION

JIROS, JOSEF
BRANCH DIRECTOR
MINISTRY OF AGRICULTURE
DOBROVICOVA 12
BRATISLAVA
SR
WORK: 42 1736 8486
FAX: 42 1730 66319

JOHNSON, GARY
JOHNSON FARMS
1654 C AVENUE
DWIGHT, KS 66849
WORK: (785)482-3362
FAX: (785)482-3362
jjohnson@vet.ksu.edu

JOHNSON, JIM
FIELDMAN
VA CATTLEMEN'S ASSOCIATION
PO BOX 9
DALEVILLE, VA 24083
WORK: (540)992-1009
FAX: (540)992-4632
vacattleman@msn.com

JOHNSON, LEE
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

JOHNSON, MARTHA
VIRGINIA BEEF EXPO
VA CATTLEMEN'S ASSOC

JOHNSON, SANDY
KANSAS STATE UNIVERSITY
PO BOX 786
COLBY, KS 67701
WORK: (785)462-6281
FAX: (785)462-2315
skjohnso@oznet.ksu.edu

JOHNSON, TODD
KANSAS LIVESTOCK ASSOC.
6031 SW 37th
TOPEKA, KS 66614
WORK: (785)273-5115
FAX: (785)273-3399
toddj@kla.org

JONES, SANDI
BEEF SPECIALIST COW/CALF
ALBERTA AGRIC FOOD & RURAL DEV
BOX 349
HANNA, ALBERTA T0J 1P0
CANADA
WORK: (403)854-5500
FAX: (403)854-5532
sandi.jones@agric.gov.ab.ca

JORDEN, JAY
PURINA MILLS

JORGENSEN, JOHN
OWNER
HEDGEAPPLE FARM
PO BOX 237
BUCKEYSTOWN, MD 21717
WORK: (301)607-4314
FAX: (301)874-2876
jasontower@msn.com

KAPPES, STEVE
RESEARCH PHYSIOLOGIST
US MEAT ANIMAL RESEARCH CENTER
PO BOX 166, SPUR 18D
CLAY CENTER, NE 68933 0166
WORK: (402)762-4363
FAX: (402)762-4390
kappes@email.marc.usda.gov

KAUFMAN, JEFF
SENIOR MANAGER
SUGAR LOAF FARMS
PO BOX 1887
STAUNTON, VA 24402
WORK: (540)885-1536
FAX: (540)885-1538

KAUFMAN, SHIRLEY
RT 1, BOX 118A
STAUNTON, VA 24401
WORK: (540)886-4274
FAX: (540)885-1538

KELLY, DALE
GENERAL MANAGER
CANADIAN CHAROLAIS
2320 41st AVENUE NE
CALGARY, ALBERTA T2E 6W8
CANADA
WORK: (403)250-9242
FAX: (403)291-9324
dkelly@charolais.com

KEMP, BOB
RESEARCH SCIENTIST
AGRICULTURE & AGRI-FOOD CANADA
POB 3000, LETHBRIDGE RES CTR
LETHBRIDGE, ALBERTA T1J 4B1
CANADA
WORK: (403)317-2243
bkemp@em.agr.ca

KERN, RICK
NCSU FARM MANAGER
NCSU
4901 REEDY CREEK ROAD
RALEIGH, NC 27607
WORK: (919)515-4687

KING, RETHEL
OWNER
IMAGE LIVESTOCK SERVICE
4594 UNION ROAD
HARRISON, AR 72601
WORK: (870)743-3440

KINZIE, LAWRENCE
MANAGER
SUGAR LOAF FARMS
PO BOX 1887
STAUNTON, VA 24402
WORK: (540)885-1536
FAX: (540)885-1538

KITE, FRANCES
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

KLUGE, JOHN
MORVEN FARMS

KNIPE, RICHARD
EXTENSION BEEF EDUCATOR
UNIVERSITY OF ILLINOIS
4550 KENNEDY DRIVE
EAST MOLINE, IN 61244
WORK: (309)792-2500
FAX: (309)792-2602
kniper@mail.aces.uiuc.edu

KOHLI, DAVE
OWNER
KOHLI FARMS
18191 TURNEY CALDWELL ROAD
CIRCLEVILLE, OH 43113
WORK: (740)869-4276
FAX: (740)869-4278
dorr16@osu.edu

KOONCE, J.
WHITESTONE FARM

KREIDLER, MICK
EDITOR - BEEF PRODUCER
FARM PROGRESS CO
6200 AURORA, SUITE 609E
DES MOINES, IO 50322 2838
WORK: (515)278-7784
FAX: (515)278-7797
mkreidler@farmprogress.com

KRESS, DON
PROFESSOR
MONTANA STATE UNIVERSITY
ANIMAL & RANGE SCI DEPT, MSU
BOZEMAN, MT 59717
WORK: (406)994-5576
FAX: (406)994-5589
dkress@montana.edu

KRIESE-ANDERSON, LISA
EXTENSION ANIMAL SCIENTIST
AUBURN UNIVERSITY
209 UPCHURCH HALL
AUBURN UNIVERSITY, AL 36849 5625
WORK: (334)844-1561
FAX: (334)844-1519
lkriese@acesag.auburn.edu

KUBE, BOB
FAUQUIER FARM

KUBEK, ALOIZ
PROFESSOR
SLOVAK AGRICULTURAL UNIV
TR. A. HLINKU 2
949 76 NITRA
SR
WORK: 42187601297
FAX: 42187511591
kubek@afnet.uniag.sr

KUCK, ALFRED L.
VICE PRESIDENT, BEEF PROGRAMS
GENEX/CRI
100 MBC DRIVE
SHAWANE, WI 54166
WORK: (715)526-7553
FAX: (715)526-3219
akuck@mail.wiscnet.net

LAMBERT, TIM
GENERAL MANAGER
BEEF IMPROVEMENT ONTARIO
6986 WELLINGTON ROAD 124, RR7
GUELPH, ONTARIO N1H 6J4
CANADA
WORK: (519)767-2665
FAX: (519)767-2502

LANCASTER, J. F.
OWNER
ANN ANGUS FARMS
RT 4, BOX 129-B
ROCKY MOUNT, NC 27801
WORK: (252)972-2333
FAX: (252)972-2833

LANE, MATTHEW
BIG DRY LIVESTOCK
BOX 12
GEM, KS 67734
WORK: (785)462-9826
FAX: (785)462-9655
malane@bigfoot.com

LARNED, GARDNER
CASTLE HILL FARM

LAUGHLIN, DON
REGIONAL MANAGER
AMERICAN ANGUS ASSOCIATION
3201 FREDERICK BLVD
ST JOSEPH, MO 64506
WORK: (816)383-5100
FAX: (816)233-9703
dlaughlin@angus.org

LAWSON, HARRY
LAWSONS YTHANBRAE
7/10 HIGH STREET
YEA VICTORIA 3717
AUSTRALIA
WORK: 61-3-57-972170
FAX: 61-3-57-972172
lawson@ycs.com.au

Le BLANC, GUY
BEEF SPECIALIST
NB DEPT OF AGRICULTURE
PO BOX 6000
FREDERICTON, NB E3B 5H1
CANADA
WORK: (506)453-2457
FAX: (506)457-7267
gleblanc@gov.nb.ca

LEE, DEUKHWAN
POST DOCTORATE
UNIVERSITY OF GEORGIA
306 ADS, UGA
ATHENS, GA 30602
WORK: (706)583-0250
FAX: (706)523-0274
dhlee@arches.uga.edu

LEECH, RANDY
MT RUSH
4220 NORTH FORK ROAD
ELLISTON, VA 24087
WORK: (540)857-3222
FAX: (540)857-3180
rleech@hsmm.com

LEECH, RODNEY
EXTENSION AGENT
BATH/HIGHLAND
PO BOX 528
MONTEREY, VA 24465
WORK: (540)468-2618
FAX: (540)468-2789
rleech@vt.edu

LEESON, BUB
SALES REPRESENTATIVE
ABS GLOBAL, INC
ROUTE 1, BOX 187
WEST UNION, WV 26456
WORK: (304)349-4656

LIND, LUKE
DIRECTOR MARKET DEVELOPMENT
CONTINENTAL GRAIN COMPANY
5408 IDYLWILD TRAIL
BOULDER, CO 80615
WORK: (303)516-5903
FAX: (303)516-5939

LINKER, DAVE
MANAGER
HICKORY HILL FARM
2246 LUSTERS GATE ROAD
BLACKSBURG, VA 24060
WORK: (540)961-3766
davelinker@aol.com

LIPSCOMB, CHUCK
OWNER
DIAMOND L FARMS
RT 2 BOX 120
LETART, WV 25253
WORK: (304)675-2020
FAX: (304)675-7787

LLOYD, RENEE
DIRECTOR, PRODUCTION SYSTEMS
NCBA
5420 S QUEBEC STREET
ENGLEWOOD, CO 80111
WORK: (303)850-3373
FAX: (303)770-7109
rlloyd@beef.org

LLOYD, RICHARD
LIVESTOCK MARKETING SPECIALIST
VDACS
PO BOX 1163
RICHMOND, VA 23218
WORK: (804)784-1241
FAX: (804)371-7788
rlloyd@vdacs.state.va.us

LOONAN, DICK
LOONAN STOCK FARM
1724 HOLLY AVENUE
COVNING, IA 50841
WORK: (515)322-3921
FAX: (515)322-3977

LOVE, CHARLIE
PHARMACIA/UPJOHN

LOVE, RANDY
FORT DODGE ANIMAL HEALTH

LOWE, JAMES
PRESIDENT
MIDWEST MICROSYSTEMS
4701 INNOVATION DRIVE
LINCOLN, NE 68251
WORK: (402)472-3980
FAX: (402)472-3982
jim@midwestmicro.com

LUST, DAVID
INSTRUCTOR
WEST TEXAS A & M UNIVERSITY
WTAMU BOX 60998
CANYON, TX 79016
WORK: (806)651-2551
FAX: (806)651-2938
dlust@mail.wtamu.edu

LUST, MARK
INTEGRATED GENETIC MANAGEMENT
44 NORTHRIDGE DRIVE
CANYON, TX 79015
WORK: (806)655-9484
FAX: (806)655-3719
elust@arn.net

MacNEIL, MICHAEL
DR
USDA-ARS
RT 1, BOX 2021
MILES CITY, MT 59301
WORK: (406)232-8213
FAX: (406)232-8209
mike@larrl.ars.usda.gov

MAJOR, JR, WALTER W.
OWNER
MAJOR FARMS
812 NORTH MAIN STREET
LAWRENCEBURG, KY 40342
WORK: (502)839-6231

MARKLEY, MIKE
OWNER
LYNROSE ANGUS
11155 FREEMANS FORD ROAD
REMINGTON, VA 22734
WORK: (540)439-2082
lmm@datatel.com

MARSHALL, LORNA
BEEF SIRE ACQUISITION MANAGER
ABS GLOBAL, INC
9550 W IOWA AVENUE
DENVER, CO 80231
WORK: (303)368-0151
FAX: (303)368-0152
lmarshall@absglobal.com

MARSTON, TWIG
EXTENSION SPECIALIST
KANSAS STATE UNIVERSITY
WEBER HALL, DEPT OF AS&I
MANHATTAN, KS 66506
WORK: (785)532-5428
FAX: (785)532-7059
twig@ksu.edu

MARTIN, LINDA C.
ASSOCIATE PROFESSOR
KANSAS STATE UNIVERSITY
129 WEBER HALL, DEPT ANIM SCI
MANHATTAN, KS 66506
WORK: (785)532-1236
FAX: (785)532-7059
lmartin@oz.oznet.ksu.edu

MASSIE JR., JAMES P.
OWNER/OPERATOR
COPELEY FARMS
801 ROCK CASTLE ROAD
GOOCHLAND, VA 23063
WORK: (804)784-5034
FAX: (804)457-2212
copeley@aol.com

MATHIEWS, GARY
PUREBRED CATTLE FOREMAN
DESERET CATTLE & CITRUS
13754 DESERET LANE
SAINT CLOUD, FL 34773
WORK: (407)892-3672
FAX: (407)892-0491
gmathiews@fmc-slc.com

MAXEY, HANK
MAXEY FARMS
1221 CLIMAX ROAD
CHATHAM, VA 24531
WORK: (804)432-3246

McCAULEY, JIM
OWNER
CLOVER PADDOCKS
PO BOX 351
BURLINGTON, NC 27216
WORK: (336)229-9590

McCLURE, WALTER
DISTRICT SALES MANAGER
ABS GLOBAL, INC
265 HILLCREST DRIVE
ROCKY MOUNT, VA 24151
WORK: (540)483-7219
FAX: (540)483-9326
wmcclure@absglobal.com

McCOLLUM, MARTHA
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

McCOY, JOHN W.
BROOKWOOD FARMS
PO BOX 1303
FRANKLIN, WV 26807
WORK: (304)358-7191
FAX: (304)358-2304

McCOY, TERRI L.
BROOKWOOD FARMS
PO BOX 1303
FRANKLIN, WV 26807
WORK: (304)358-7191
FAX: (304)358-2304

McCRAW, ROGER
PROFESSOR
NORTH CAROLINA STATE UNIV
BOX 7621
RALEIGH, NC 27695 7621
WORK: (919)515-7722
FAX: (919)515-9061
roger_mccraw@ncsu.edu

McCURRY, JESSE
INTERN
NATIONAL CATTLEMAN'S BEEF
1301 PENNSYLVANIA AVE, STE 3
WASHINGTON, DC 20004
WORK: (202)879-9128
FAX: (202)638-6067
jmccurry@beef.org

McCUTCHEON, JOHN
COUNTY AGENT
WVU EXTENSION SERVICE
PO BOX 586
LEWISBURG, WV 24901
WORK: (304)647-7408
FAX: (304)647-7418
jmccutch@wvu.edu

McDOWELL, ANGELA
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

McDOWELL, MIKE
OWNER
LOCUST LEVEL FARMS
12065 CHATHAM ROAD
VERNON HILL, VA 24597
WORK: (804)349-3779
FAX: (804)349-1715

McKARNS, EARL J.
OWNER - SELF EMPLOYED FARMER
SHAMROCK VALE FARMS
8002 MERLIN ROAD, NE
KENSINGTON, OH 44427
WORK: (330)223-1050
FAX: (330)223-1050
shamrock@valunet.com

McKINNON, BILL
VIRGINIA TECH
368 LITTON REAVES HALL
BLACKSBURG, VA 24061
WORK: (540)231-9160
FAX: (540)231-3713
bnckinno@vt.edu

McLANE, HERB
EXECUTIVE VICE PRESIDENT
CANADIAN BEEF BREEDS COUNCIL
230-6715 8th ST. NE
CALGARY, ALBERTA T2E 7H7
CANADA
WORK: 403-730-0350
FAX: 403-275-8490
hjmc@cadvision.com

McPEAKE, STANLEY R.
EXTENSION LIVESTOCK SPECIALIST
UNIV OF ARKANSAS EXTENSION
PO BOX 391
LITTLE ROCK, AR
WORK: (501)671-2162
FAX: (501)671-2185
smcpeake@uaex.edu

McSPADDEN, W. B.
WHITE OAK FARM

MEADOWS, ANDREW
DVM
SPRINGWOOD LIVESTOCK MGMT SERV
118 CULPEPPER AVENUE
BUCHANAN, VA 24066
WORK: (540)254-2710
FAX: (540)254-2710
springwooodlivestockmgt@worldnet.att.net

MEARS, TIM
DVM
COMMONWEALTH VET CLINIC
RT 6, BOX 108
WAYNESBORO, VA 22980
WORK: (540)942-9777

MIDDLETON, BRETT
ASSISTANT RESEARCH SPECIALIST
UNIVERSITY OF GEORGIA
ANIMAL SCIENCE COMPLEX
ATHENS, GA 30602
WORK: (706)542-0986
brettm@arches.uga.edu

MIGALA, JR, DAVID
355 DUNCAN ROAD
RUTHERFORDTON, NC 28139
WORK: (704)473-7951

MILLER, BILL
DIRECTOR OF COMMUNICATIONS
US PREMIUM BEEF, LTD
1193 FOUR MILE ROAD
COUNCIL GROVE, KS 66846
WORK: (316)767-7041
FAX: (316)767-7028
btbill@midusa.net

MILLER, DALE
BEEF SPECIALIST
NC STATE UNIVERSITY
BOX 7621
RALEIGH, NC 27695 7621
WORK: (919)515-7772
FAX: (919)515-9061
dale_miller@ncsu.edu

MILLER, STEPHEN
GENETICIST
CTR FOR GENETIC IMPROV LIVESTK
UNIV OF GUELPH/ANIM POUL SCI
GUELPH, ONTARIO N1G 2W1
CANADA
WORK: (519)827-4120
FAX: (514)767-0573
millers@wright.aps.uoguelph.com

MILLS, RANDY
OWNER/RANCHER
DOYLE CREEK LANE & CATTLE
107 MAIN
FLORENCE, KS 66851
WORK: (316)878-4567
HOME: (316)878-4466

MINISH, GARY L.
PROFESSOR/DEPARTMENT HEAD
VIRGINIA TECH
3460 LITTON REAVES
BLACKSBURG, VA 24061 0306
WORK: (540)231-9157
FAX: (540)231-3010
minish@vt.edu

MINISH, ROBERTA
VIRGINIA TECH
COLLEGE/HUMAN RESOURCES & EDUC
BLACKSBURG, VA 24061

MITCHELL, JOHN
FALLING SPRINGS FARM INC
5525 HOT SPRINGS ROAD
HOT SPRINGS, VA 24445
WORK: (540)962-4327
FAX: (540)962-8503
hmi@cfw.com

MOLDENHAUER, MARCINE
VALUE ADDED PROCUREMENT MGR
EXCEL CORPORATION
PO BOX 2519
WICHITA, KS 67201
WORK: (316)291-2783
FAX: (316)291-2709

MOORE, PEGGY R.
PRM POLLED HEREFORDS
2671 MORRISON VIOLA ROAD
MORRISON, TN 37357
WORK: (931)635-3152

MOORE, RODNEY
DISTRICT SALES REPRESENTATIVE
ABS GLOBAL, INC
390 CARDIGAN CIRCLE
LILBURN, GA 30247
WORK: (770)564-8968
FAX: (770)381-0984
rmoore@absglobal.com

MORRIS, PAUL
COUNTY AGENT
LA COOP EXTENSION SERVICE
820 MAIN STREET
MANY, LA 71449
WORK: (318)256-3406
FAX: (318)256-6339
pmorris@agctr.lsu.edu

MOSER, DAN
ASSISTANT PROFESSOR
KANSAS STATE UNIVERSITY
223 WEBER HALL
MANHATTAN, KS 66506 0201
WORK: (785)532-2459
FAX: (785)532-7059
dmoser@ksu.edu

MOYER, LAWRENCE
OWNER/SPECIAL SERVICE
MOYER PACKING COMPANY
PO BOX 395
SOUDERTON, PA 18964
WORK: (215)723-5559
FAX: (215)723-8096
larrymyr@mopac.com

NEALE, SPENCER
ASSISTANT DIRECTOR
VA FARM BUREAU FEDERATION
PO BOX 27552
RICHMOND, VA 23261
WORK: (804)784-1341
FAX: (804)784-2588
sneal@vafb.com

NICHOLS, DAVE
NICHOLS FARMS
2188 CLAY AVENUE
BRIDGEWATER, VA 50837
WORK: (515)369-2829
HOME: (712)762-3810

NIESLANIK, MARK
MANAGER
TYBAR ANGUS
1644 PRINCE CREEK ROAD
CARBONDALE, CO 81623
WORK: (970)963-1391
FAX: (970)963-0469
danciger@rof.net

NIXON, TOM
OWNER/MANAGER
GLENMARY FARM
21496 RIVER ROAD
RAPIDAN, VA 22733
WORK: (540)672-7396
FAX: (540)672-3579

NOLLER, DAVID E.
NOLLER AND FRANK CHAROLAIS
18278 HWY 92
SIGOURNEY, IA 52591
WORK: (515)622-3357
FAX: (515)622-2388
nfchar@se-iowa.net

NORWOOD, JIM
MANAGER
FARMLAND IND
7508 N PALMER AVENUE
KANSAS CITY, MO 64158
WORK: (816)891-3644
FAX: (816)891-2339
jnorwood@farmland.com

O'BELL, DWAYNE
ASST DIRECTOR OF MARKETING
WEST VA DEPT OF AGRICULTURE
1900 KANAWHA BLVD E, STATE CAP
CHARLESTON, WV 25305
WORK: (304)558-2211
FAX: (304)558-2270

O'DELL, IRVIN
77 LITTLE LEFT HAND ROAD
AMMA, WV 25005
WORK: (304)565-9301

O'NEILL, TERRY
OWNER
TOMAHAWK LAND & CATTLE
PO BOX 30435
BILLINGS, MT 59107
WORK: (406)373-6016
FAX: (406)376-6048
tomahawk@mcn.net

OLIVER, WILLIAM W.
GENERAL MANAGER
ELDON FARMS
4432 SPERRYVILLE PIKE
WOODVILLE, VA 22749
WORK: (540)987-8305
FAX: (540)987-8306
wwo@monumental.com

OLSON, LARRY
EXTENSION ANIMAL SCIENTIST
CLEMSON UNIVERSITY
EDISTO REC/PO BOX 247
BLACKSVILLE, SC 29817
WORK: (803)284-3343
FAX: (803)284-3684
lolson@clemson.edu

OROZCO, CLARA INEZ
ASOBRANGUS DE COLUMBIA
THISTLE FARMS
14165 WALHUNDING ROAD
SENECAVILLE, OH 43780
WORK: (704)685-5119
FAX: (800)803-3888
thistleang@aol.com

ORTH, J. NEIL
EXECUTIVE VICE PRESIDENT
INT'L BRANGUS BREEDERS ASSOC
5750 EPSILON
SAN ANTONIO, TX 78269
WORK: (210)696-8231
FAX: (210)696-8718

OSBORNE, PHIL
EXTENSION SPECIALIST
WEST VIRGINIA UNIVERSITY
BOX 6108, AG SCIENCE BLDG
MORGANTOWN, WV 26506 6108
WORK: (304)293-3391
p_osborne@wvu.edu

OWENS, ROBERT
MANAGER/DVM
HPH COMPANY
806 TIPPERARY, BOX 743
O'NEILL, NB 68763
WORK: (402)925-5432
FAX: (402)925-5953
bobo@msbna.com

PARKS, MARTHA
INDIANA BEEF CATTLE ASSOC
8770 GUION ROAD, SUITE A
INDIANAPOLIS, IN 46268
WORK: (317)872-2333
FAX: (317)872-2364
pganderson@iquest.net

PELTON, LORNA
PRIDE LIVESTOCK CO
9687 KEMP ROAD
COLLEGE STATION, TX 77845
WORK: (409)846-9499
FAX: (709)691-8947

PELTON, LYNN
PELTON SIMMENTAL/RED ANGUS
HC 2, BOX 41
BURDETT, KS 67523
WORK: (316)525-6632
FAX: (316)525-6413
lspelton@ruraltel.net

PERKINS, TOMMY
ASSOCIATE PROFESSOR
SW MISSOURI STATE UNIV
901 S. NATIONAL AVENUE
SPRINGFIELD, MO 65804
WORK: (417)836-5020
FAX: (417)836-6979
tlp643f@mail.smsu.edu

PERSINGER JR., JASPER B.
OWNER
POTTS CREEK FARM
2917 POTTS CREEK ROAD
COVINGTON, VA 24426
WORK: (540)747-3261

PETERS, LARRY
MANAGER
BENT TREE FARMS
1270 CO RD 256
FT. PAYNE, AL 35967
WORK: (256)845-3009
FAX: (256)845-0170

PLYLER, BUNDY
AGRICULTURAL EXTENSION AGENT
NC COOPERATIVE EXTENSION
740 GLOVER ST/HENDERSON CO CTR
HENDERSONVILLE, NC 28792 4470
WORK: (828)697-4891
FAX: (828)697-4581
bundy_plyler@ncsu.edu

POGUE, BRIAN
MAP MANAGER
BEEF IMPROVEMENT ONTARIO
6986 WELLINGTON ROAD 124, RR7
GUELPH, ONTARIO N1H 6J4
CANADA
WORK: 519-767-2665
FAX: 519-767-2502

POLLAK, JOHN
PROFESSOR
CORNELL UNIVERSITY
B47 MORRISON HALL
ITHACA, NY 14853
WORK: (607)255-2846
FAX: (607)254-5413
ejp6@cornell.edu

PORTERIE, CELINE
STUDENT INTERN
N AMERICAN LIMOUSIN FOUNDATION
PO BOX 4467
ENGLEWOOD, CO 80155
WORK: (303)220-1693
FAX: (303)220-1884
jedwards@nalf.org

POTTER, DEE
EXTENSION EDUCATOR
UM COOPERATIVE EXTENSION
13 HALL STREET
FORT KENT, ME 04743
WORK: (207)834-3905
FAX: (207)834-3906
dpotter@umext.maine.edu

POWELL, JR, WILLIAM D.
AMERICAN ANGUS ASSOCIATION
PO BOX 295
THURMONT, MD 21788 0295
WORK: (301)271-2767
FAX: (301)271-3987

PRATT, C. W.
LIVESTOCK MARKETING VDACS
ECHO RIDGE FARM/VDACS
461 NICKS CREEK ROAD
ATKINS, VA 24311
WORK: (540)783-3038
FAX: (540)783-3038

QUAAS, RICHARD
PROFESSOR
CORNELL UNIVERSITY
847 MORRISON HALL
ITHACA, NY 14853
WORK: (607)255-2853
FAX: (607)254-5413
rlq1@cornell.edu

QUINN, CONNIE
HC 66 BOX 16
CHADRON, NE 69337
WORK: (605)867-1071
FAX: (605)867-1071
crq@lilly.com

RAMSAY, CHIP
CATTLE MANAGER
DESERET CATTLE & CITRUS
13754 DESERET LANE
SAINT CLOUD, FL 34773
WORK: (407)892-3672
FAX: (407)892-0491
kramsay@fmc-slc.com

RAMSEY, RAY
MLE MARKETING

RANKIN, BOBBY J.
DEPT HEAD, ANIMAL SCIENCES
NEW MEXICO STATE UNIVERSITY
3007 BOWMAN STREET
LAS CRUCES, NM 88005
WORK: (505)646-2515
FAX: (505)646-5441
brankin@nmsu.edu

REAVES, ERNIE
MOSSY CREEK FARM
686 NATURAL CHIMNEY ROAD
MT. SOLON, VA 22843
WORK: (540)350-2490

REDMAN, DAVID E.
EXTENSION EDUCATOR ANR
PURDUE UNIVERSITY CES
1410 I STREET
BEDFORD, IN 47421 2054
WORK: (812)275-4623
FAX: (812)275-4131
dave.rodman@ces.purdue.edu

REECY, JAMES
ASSISTANT PROFESSOR
IOWA STATE UNIVERSITY
2255 KILDEE HALL, DEPT ANM SCI
AMES, IA 50014
FAX: (515)294-2401
jreecy@iastate.edu

REEVES, JIM
EXECUTIVE VICE PRESIDENT
AMERICAN BRAHMAN BREEDERS ASSO
1313 LA CONCHA LANE
HOUSTON, TX 77054
WORK: (713)795-4444
FAX: (713)795-4450
jreeves@brahman.org

REYNOLDS, REGGIE
EXECUTIVE SECRETARY
VA CATTLEMEN'S ASSOCIATION
PO BOX 9
DALEVILLE, VA 24083
WORK: (540)992-1009
FAX: (540)992-4632

RICHARDSON, DONALD R.
DUNROVIN FARM
3473 DUNROVIN FARM
CROZET, VA 22932
WORK: (804)823-4438
FAX: (804)293-2367
dunrovin@esinet.net

RICHMOND, DAVID
EXTENSION AGENT
WEST VIRIGINIA UNIVERSITY
200 1/2 S KANAWHA STREET
BECKLY, WV 25832
WORK: (304)255-9321
FAX: (304)255-9323
drichmon@wvu.edu

RILEY, JACK
KANSAS STATE UNIVERSITY
232 WEBER HALL/AHIMAL SCI.
MANHATTAN, KS 66506
WORK: (785)532-7624
FAX: (785)432-7059
jriley@oz.oznet.ksu.edu

RINGWALL, KRIS
DR
NORTH DAKOTA STATE UNIVERSITY
1133 STATE AVENUE
DICKINSON, ND 58601
WORK: (701)483-2427
FAX: (701)483-2005
kringwall@ndsuext.nodak.edu

RITCHIE, HARLAN
DISTINGUISHED PROFESSOR ANM SC
MICHIGAN STATE UNIVERSITY
2265A ANTHONY HALL/ANIMAL SCI
EAST LANSING, MI 48824
WORK: (517)355-8409
FAX: (517)432-0147
ritchieh@pilot.msu.edu

ROBERTS, SPENCER
SALES REPRESENTATIVE
ABS GLOBAL, INC
11716 CAMELOT WAY
FREDERICKSBURG, VA 22407
WORK: (540)785-0612

ROBINSON, KINCKLE
PART OWNER
KINDON FARMS
RT 1 BOX 17
PAMPLIN, VA 23958
WORK: (804)352-7111
FAX: (804)352-2555

RODGERS, JOHNNY
PURINA MILLS

ROGERS, SID
OWNER
ROLLING HILLS FARM
420 N HAYFIELD ROAD
WINCHESTER, VA 22603
WORK: (703)836-2696
FAX: (703)836-2571
72773.1451@compuserve.com

ROTERT, JOHN E.
OWNER
MIDWESTERN CATTLE SERVICE
577 SW HWY K
MONTROSE, MO 64770
WORK: (660)693-4844
FAX: (660)693-2380

ROUSE, GENE
PROFESSOR
IOWA STATE UNIVERSITY
337 KILDEE HALL
AMES, IA 50011
WORK: (515)294-5641
FAX: (515)294-3795
grouse@iastate.edu

RUMPH, JANICE
GRADUATE STUDENT
UNIVERSITY OF NEBRASKA
A218C ANIMAL SCIENCE BLDG
LINCOLN, NE 68583
WORK: (402)472-6409
ansc451@unlvm.unl.edu

RUSNAK, RICHARD
DIRECTOR
BREEDERS ASSOCIATION/ZCHSSP
DOPRVANA 14
93403 LEVICE
SR
WORK: 42 1813 6229 669

SALLY, LIBBY
BREED DEVELOPMENT
CANADIAN ANGUS ASSOCIATION
24, 6715 8th ST. NE
CALGARY, ALBERTA T2E 7H7
CANADA
WORK: 403-571-3580
FAX: 403-561-3599
esally@cdnangus.ca

SALZER, TROY
EXTENSION EDUCATOR
UNIVERSITY OF MINNESOTA
PO BOX 307
CARLTON, MN 55718
WORK: (218)384-3511
FAX: (218)384-3511
tsalzer@extension.umn.edu

SANSON, DAVE
ASSOCIATE PROFESSCR
ROSEPINE RESEARCH STATION
PO BOX 26
ROSEPINE, LA 70659
WORK: (318)463-7708
FAX: (318)463-9981
dsanson@acgtr.lsu.edu

SAUNDERS, JANE
TUCKAHOE POINT FARM

SAXE, TOM
EXTENSION EDUCATOR ANIM.SYST.
UNIVERSITY OF ILLINOIS
4112 N. WATER TOWER PL
MT.VERNON, IL 62864
WORK: (618)242-9310
FAX: (618)242-9433
saxet@mail.aces.uiuc.edu

SAYRE, NED
WAFFLE MILL FARM
3330 COOL BRANCH ROAD
CHURCHVILLE, MD 21028
WORK: (410)937-3633
angusbull@compuserve.com

SCHAFER, DAVID
MANAGER
CSU, SAN JUAN BASIN RES CENTER
18683 HWY 140
HESPERUS, CO 81326
WORK: (970)385-4574
FAX: (970)385-4892
dschafer@ops.agsci.colostate.edu

SCHILD, HANS J.
HEAD BIOMETRICS DEPARTMENT
LKV-BAYERN
HAYDNSTR. 11
MUNICH 80336
GERMANY
WORK: 49-8954434863
FAX: 49-8954434810
lkv-bayern.schild@t-online.de

SCHLEGEL, MICHAEL
INSTRUCTOR
DELAWARE VALLEY COLLEGE
700 E BUTLER AVENUE
DOYLESTOWN, PA 18901 2697
WORK: (215)489-2420
FAX: (215)489-2347
schlegem@devalcol.edu

SCHULTZ, KEVIN
SANDHILL FARMS
BOX 76
HAVILAND, KS 67059
WORK: (316)348-4611
FAX: (316)348-2476
kevin@sandhillfarms.com

SCHUMANN, BRYCE
ASST DIRECTOR FEEDER-PACKER RL
CERTIFIED ANGUS BEEF PROGRAM
1107 HYLTON HEIGHTS ROAD
MANHATTAN, KS 66502
WORK: (785)539-0123
FAX: (785)539-2883
bschumann@cabprogram.com

SCHUTTE, BILYNN
RESEARCH & CARCASS COORDINATOR
RED ANGUS ASSOCIATION
4201 I-35 NORTH
DENTON, TX 76207 3415
WORK: (940)387-3502
FAX: (940)383-4036

SEIBERT, DAVE
UNIVERSITY OF ILLINOIS
904 CHELSEA
WASHINGTON, IL 61571
WORK: (309)694-9897
FAX: (309)694-7882
seibertd@mail.aces.uiuc.edu

SEYMOUR, DAVID
EXTENSION AGENT
WEST VIRGINIA UNIVERSITY
PO BOX 96
FRANKLIN, WV 26807 9303
WORK: (304)358-2286

SEYMOUR, FRANK
GOLDSBORO HOG FARMS
105 NW 4th STREET
SNOW HILL, NC 28530
WORK: (919)778-3130
FAX: (919)778-5762
fseymour@gmcom.net

SHANKS, BRUCE
GRADUATE RESEARCH ASSISTANT
MONTANA STATE UNIVERSITY
33336 E. FRONTAGE ROAD
BOZEMAN, MT 59715
WORK: (406)575-7309
bruceshanks@yahoo.com

SHERMAN, GARY B.
FOOD ANIMAL VETERINARIAN
UNIVERSITY OF NEBRASKA
PO BOX 187
CLAY CENTER, NE 68933
WORK: (402)762-4503
FAX: (402)762-4509
gsherman@unl.edu

SIEBER, MARTIN
PO BOX 1033
COLUMBIA, MO 65205
WORK: (573)445-4406
FAX: (573)446-2279
mseiber@naab-css.org

SILCOX, RONNIE
THE UNIVERSITY OF GEORGIA
ANIMAL & DAIRY SCIENCE COMPLEX
ATHENS, GA 30602
WORK: (706)542-9102
FAX: (706)542-9316
rsilcox@arches.uga.edu

SILVA, LUIZ OTAVIO
RESEARCHER/PhD
EMBRAPA/MINISTRY OF AGR BR
PB 154 CAMPO GRANDE/BRAZIL
CGR-BRAZIL
MS
WORK: 55.67.7682000
FAX: 55.67.7682150
locs@cnpgc.embrapa.br

SIMMONS, ROY
ROCKINGHAM PRECAST

SIMMS, DANNY D.
1707 N. 214th STREET
ELKHORN, NE 68022
WORK: (462)431-5193
FAX: (402)431-5130
dsmims@agp.com

SINK, AMANDA
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

SIROLLI, RYAN
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

SLUSHER, TERRY
RT 2 BOX 612
FLOYD, VA 24091
WORK: (540)789-7023

SMITH, ANDY
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

SMITH, DANIEL
2508 STAMPING GROUND ROAD
STAMPING GROUND, KY 40379
WORK: (606)333-0807

SMITH, OREN
OWNER
OAL HILL ANGUS FARM
37 OLD TRAIL ROAD
AVELLA, PA 15312
WORK: (724)345-3589
ohangus@pulsenet.com

SNEAD, GEORGE C.
MOUNTAIN BRANCH FARM
RT 1, BOX 1450
NEW CASTLE, VA 24127
WORK: (540)853-2306

SNELLING, WARREN
BEEFBOOSTER MANAGEMENT LTD
26, 3515 27th STREET NE
CALGARY, AB T1Y5E4
CANADA
WORK: 403-291-9771
FAX: 403-291-9559
wsnell@beefbooster.com

SPADER, RICHARD L.
EXECUTIVE VICE PRESIDENT
AMERICAN ANGUS ASSOCIATION
3201 FREDERICK AVENUE
ST JOSEPH, MO 64506
WORK: (816)383-5100
FAX: (816)233-9703
rspader@angus.org

STEELE, ROGER
STEELE CATTLE SERVICES
3582 ROANOKE ROAD
DALEVILLE, VA 24083 3209

STEELE, T. D.
MILL BRAE RANCH
210 FIRST STREET, SUITE 510
ROANOKE, VA 24011
WORK: (540)982-8042
FAX: (540)982-8524

SUNDSTROM, BRIAN
BREEDPLAN AUSTRALIA
A.B.R.I.
ARMIDALE, 2351
AUSTRALIA
WORK: 61-26-773-3555
FAX: 61-26-772-5376
sundstrom@abri.une.edu.au

SUTPHIN, TIM
5660 THORNSPRING CH ROAD
DUBLIN, VA 24084
WORK: (540)230-7037

SWIGER, ANDY
VIRGINIA TECH
COLLEGE OF AGR & LIFE SCIENCES

SWORD, CHUCK
OWNER/OPERATOR
CHAR-NO FARM
195 SCOTT ROAD
WILLIAMSON, GA 30292
WORK: (770)227-9241
FAX: (770)227-0777
cnffarm@aol.com

SWORD, NORMA H.
OWNER/ADMINISTRATOR
CHAR-NO FARM
195 SCOTT ROAD
WILLIAMSON, GA 30292
WORK: (770)227-9241
FAX: (770)227-0777
cnffarm@aol.com

TAIT, JR, RICH
IOWA STATE UNIVERSITY
42 KILDEE HALL
AMES, IA 50011
WORK: (515)294-5275
rtait@iastate.edu

TAYLOR, JEREMY
PROFESSOR
TEXAS A & M UNIVERSITY
ROOM 432 KLEBERG
COLLEGE STATION, TX 77843 2471
WORK: (409)845-2616
FAX: (409)845-6970
jtaylor@acs.tamu.edu

THALLMAN, MARK
RESEARCH GENETICIST
US MEAT ANIMAL RESEARCH CENTER
PO BOX 166
CLAY CENTER, NE 68933
WORK: (402)762-4261
FAX: (402)762-4173
thallman@email.marc.usda.gov

THOMAS, MILT
PROFESSOR
NEW MEXICO STATE UNIVERSITY
328 KNOX HALL, NMSU
LAS CRUCES, NM 80003
WORK: (505)646-34
FAX: (505)646-5441
milthoma@nmsu.edu

THOMPSON, BILL
OWNER
MOUNTAIN MEADOWS FARM
1295 PARK AVENUE
CLIFTON FORGE, VA 24422
WORK: (540)962-7507
FAX: (540)962-7508

THOMPSON, MARY JANE
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

TOWER, JASON
MANAGER
HEDGEAPPLE FARM
PO BOX 342
BUCKEYSTOWN, MD 21717
WORK: (301)607-4020
FAX: (301)874-2876
jasontower@msn.com

TRIMMER JR., DON
BEEF GENETICS MANAGER
ACCELERATED GENETICS
E 10890 PENNY LANE
BARABOO, WI 53913
WORK: (608)356-8357
FAX: (608)356-4387
dtrimmer@acce/gen.com

TUCKER, BILL
OWNER
TUCKER FAMILY FARMS
713 INDIAN CREEK ROAD
AMHERST, VA 24521
WORK: (804)277-5059
FAX: (804)277-5032
watucker@aol.com

TUCKER, H. Q.
VETERINARIAN-OWNER
AMERICAN TARENTAISE
116 LANDON LANE
ORANGE, VA 22960
WORK: (540)672-2950
FAX: (540)672-0918

TURNER, STEPHEN K.
C&S FARM ENTERPRISES SIMMENTAL
14722 DANVILLE PIKE
LAUREL FORK, VA 24352 3760
WORK: (540)728-8221
FAX: (540)398-2757

TURNER, THOMAS B.
PROFESSOR
THE OHIO STATE UNIVERSITY
2029 FYFFE
COLUMBUS, OH 43210
WORK: (614)292-4528
FAX: (614)292-2929
turner.is@osu.edu

UDEN, VANCE
OWNER
TC RANCH
RR 2, BOX 119
FRANKLIN, NE 68939
WORK: (308)425-3675
FAX: (308)425-3685
tcranch@gtmc.net

Van VLECK, DALE
RESEARCH GENETICIST
ARS-USDA/UNL
930 EVERGREEN DRIVE
LINCOLN, NE 68510
WORK: (402)472-6010
FAX: (402)472-6362
ansc418@unlvm.unl.edu

VanHEUVELEN, DAVID
WOLF CREEK SOFTWARD
200 TERRACE ROAD
CHAMBERLAIN, SD 57325
WORK: (605)734-0200
FAX: (605)734-0200
cowcalf@wcenet.com

VENNER, JAMES
NATIONAL SWINE REGISTRY
1769 US 52 WEST, POB 2417
WEST LAFAYETTE, IN 47906

VINCEL, NORM
DIRECTOR OF MARKETING
SELECT SIRES
PO BOX 370
ROCKY MOUNT, VA 24151
WORK: (540)483-5123
FAX: (540)483-7286
ssires@swva.net

WALLACE, ROY
SELECT SIRES
11740 US 42N
PLAIN CITY, OH 43064
WORK: (614)873-4683
FAX: (614)873-5751

WALLACE, WILLIAM
ASST SPECIALIST BEEF CATTLE
UNIVERSITY-ARKANSAS-CES
2301 S.UNIVERSITY AVENUE
LITTLE ROCK, AR 72204
WORK: (501)671-2235
FAX: (501)671-2185
bwallace@uaex.edu

WAMPLER, BILL D.
PTR.
CHAS. W. WAMPLER & SONS
1847 SUNNY SLOPE LANE
HARRISONBURG, VA

WARD, JEFF
MANAGER
SINCLAIR CATTLE COMPANY
102 W PENNSYLVANIA AVENUE
TOWSON, MD 21204
WORK: (410)583-0850

WARDEN, DUANE
WARDENS FARM
20054 PERRY ROAD
COUNCIL BLUFFS, IA 51503 8836
WORK: (712)323-2387
FAX: (712)323-2387

WATTS, JR, HARRELL
AMERICAN SIMMENTAL ASSOCIATION
PO BOX 26
SARDIS, AL 36775
WORK: (334)874-4813
FAX: (334)875-5372

WEABER, BOB
DIRECTOR, EDUCATION/RESEARCH
AMERICAN GELBVIEH ASSOCIATION
10900 DOVER STREET
WESTMINISTER, CO 80021
WORK: (303)465-2333
FAX: (303)465-2339
aga@www.gelbvieh.org

WEBB, MITCH
MERIAL

WEIBERT, CAROL
OFFICE MANAGER
DECATUR COUNTY FEED YARD, LLC
RR 3, BOX 9
OBERLIN, KS 67749
WORK: (785)475-2212
FAX: (785)475-2717
feedyard@nwkansas.com

WEISGERBER, CLEVE
COUNTY AGENT
LSU AGRICULTURAL CENTER
PO BOX 559
LEESVILLE, LA 71496
WORK: (318)239-3231
FAX: (318)239-3232
cweisgerber@agctr.lsu.edu

WHISNANT, SCOTT
ASSISTANT PROFESSOR
NC STATE UNIVERSITY
NCSU, BOX 7621, DEPT ANIM SCI
RALEIGH, NC 27695 7621
WORK: (919)513-1115
FAX: (919)515-7780

WHITE, TERESA
SALES REPRESENTATIVE
ELANCO ANIMAL HEALTH
104 JEFFERSON COURT
STEPHENS CITY, VA 22655
WORK: (540)868-1758
FAX: (540)868-1756
tkayw@lilly.com

WHITING, JOHN
MANAGER
PROVENSIRES
PO BOX 1244
MIDLOTHIAN, VA 23113
WORK: (804)598-6405
FAX: (804)598-6459

WHITTIER, W. DEE
COLLEGE VET MED, VIRGINIA TECH
PHASE II, LACS
BLACKSBURG, VA 24061 0442
WORK: (540)231-9041
FAX: (540)231-7367
dwit@vt.edu

WIEBERT, S. WARREN
OWNER/GENERAL MANAGER
DECATUR COUNTY FEEDYARD, LLC
RR3, BOX 9
OBERLINE, KS 67749
WORK: (785)475-2212
FAX: (785)475-2717
feedyard@nwkansas.com

WILLIAMS, ALLEN
EXTENSION BEEF SPECIALIST
MISSISSIPPI STATE UNIV.
1764 LISA LANE
STARKVILLE, MS 39759
WORK: (601)325-7466
FAX: (601)325-8873
awilliams@ads.msstate.edu

WILLIAMS, DWIGHT
DIVISIONAL SALES MANAGER
ABS GLOBAL, INC
15 DANABE DRIVE
HEIDELBERG, ONTARIO NOB I40
CANADA
WORK: (519)699-5435
FAX: (519)699-5840
dwilliams@absglobal.com

WILLIAMS, ROBERT
DIRECTOR OF BREED IMPROVEMENT
AMERICAN/INTL CHAROLAIS..
PO BOX 20247
KANSAS CITY, MO 64152
WORK: (816)464-5977
FAX: (816)464-5759
robertw@charolaisusa.com

WILSON, BILL
WILSON FARMS INC
2900 MOONLIGHT ROAD
SCOTLAND NECK, NC 27874
WORK: (252)536-1961
wrw0024@aol.com

WILSON, DOYLE
PROFESSOR
IOWA STATE UNIVERSITY
239 KILDEE HALL
AMES, IA 50011
WORK: (515)294-6914
FAX: (515)597-2588
dewilson@iastate.edu

WINDER, JOHN
NOBLE FOUNDATION
PO BOX 2180
ARDMORE, OK 73402
WORK: (580)223-5810
FAX: (580)221-7320
jawinder@noble.org

WISE, MARCUS
HERDSMAN
SUGAR LOAF FARMS
PO BOX 2887
STAUNTON, VA 24402
WORK: (540)885-1536
FAX: (540)885-1538

WOHLFORD, DAVID
GRADUATE STUDENT
AUBURN UNIVERSITY
209 UPCHURCH HALL
AUBURN, AL 36842
WORK: (334)844-1540
FAX: (334)844-1519
wohlfdl@acesag.auburn.edu

WOOD, CINDY
ASSOCIATE PROFESSOR
VIRGINIA TECH
3400 LITTON REAVES HALL
BLACKSBURG, VA 24061 0306
WORK: (540)231-6936
FAX: (540)231-3010
piglady@vt.edu

WOODDISSE, RON
DIRECTOR
CANADIAN SIMMENTAL ASSOC.
RR #1
PALMERSTON, ONTARIO NOG 2PO
CANADA
WORK: 519-638-3571
FAX: 519-638-5135

WRIGHT, MARTHA
LIVESTOCK SPECIALIST
CORNELL COOPERATIVE EXT.
480 NORTH MAIN STREET
CANANDAIGUA, NY 14424
WORK: (716)394-3977
FAX: (716)394-0377
maw32@cornell.edu

WULF, DUANE
SOUTH DAKOTA STATE UNIVERSITY
PO BOX 2170/DEPT ANIM/RANGE SC
BROOKINGS, SD 57007
WORK: (605)688-5451
FAX: (605)688-6170
wulfd@ur.sdstate.edu

WULF, JERRY
HERDSMAN
WULF LIMOUSIN FARMS
RT 2, BOX 81
HANCOCK, MN 56244
WORK: (320)392-5988
FAX: (320)392-5988

WYDNER, FRED
VIRGINIA TECH
ANIM SCI/POULTRY/LITTON REAVES
BLACKSBURG, VA 24061 0306

YONTZ, LILLIAN
OWNER
THISTLE FARMS
14165 WALHUNDING ROAD
SENECAVILLE, OH 43780
FAX: (800)803-8888
thistleang@aol.com

YORK, WAYNE
FARM OWNER
216 PINEY MOUNTAIN CH ROAD
ELLENBORO, NC 28040
WORK: (828)453-8453

ZELLER, DAVE
DIRECTOR, LUSTK. OPERATIONS
MORVER FARMS
3201 ELLESLIE DRIVE
CHARLOTTESVILLE, VA 22902
WORK: (804)293-3978
FAX: (804)977-8247

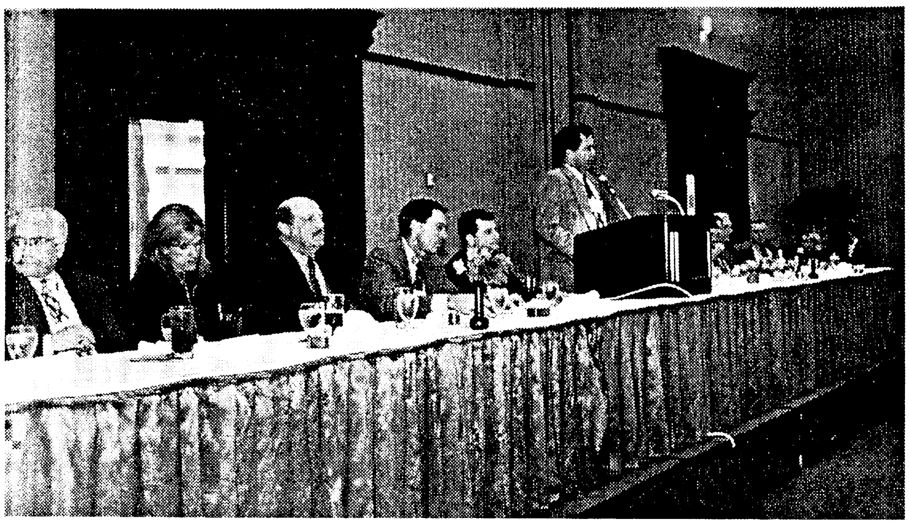
ZIMMERMAN, BILL
ONE PENNY RANCH
2101 2nd STREET, SW
BUFFALO, MN 55313
WORK: (612)682-4112
FAX: (612)682-4113
zimme025@tc.umn.edu

ZOELLER, DAVE
MORVEN FARM

BIF Board of Directors

1999 - 2000 BIF President, Willie Altenburg
and 1998 - 1999 President, Jed Dillard

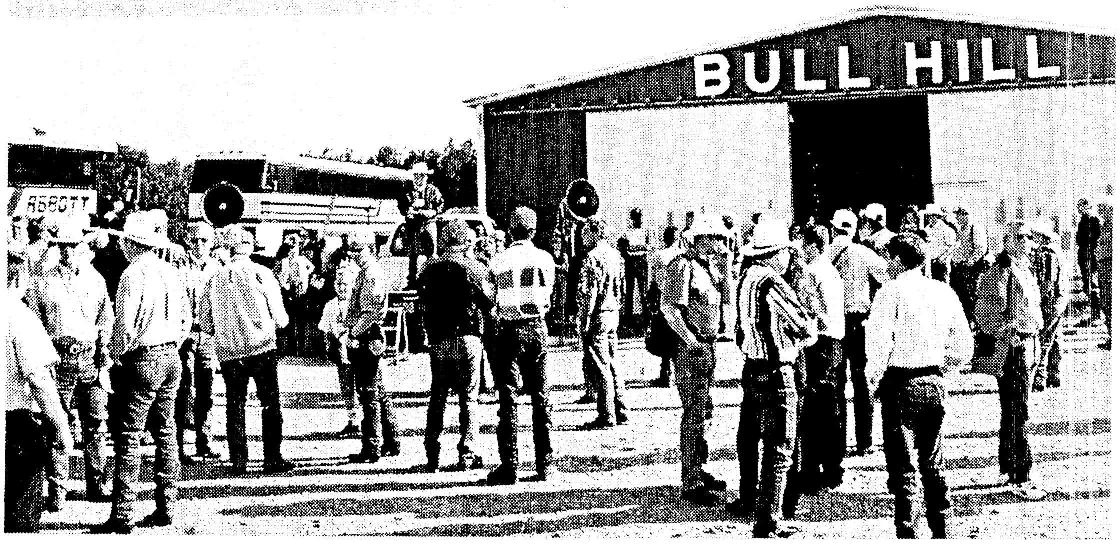
1999 BIF Co-Host,
Scott Greiner

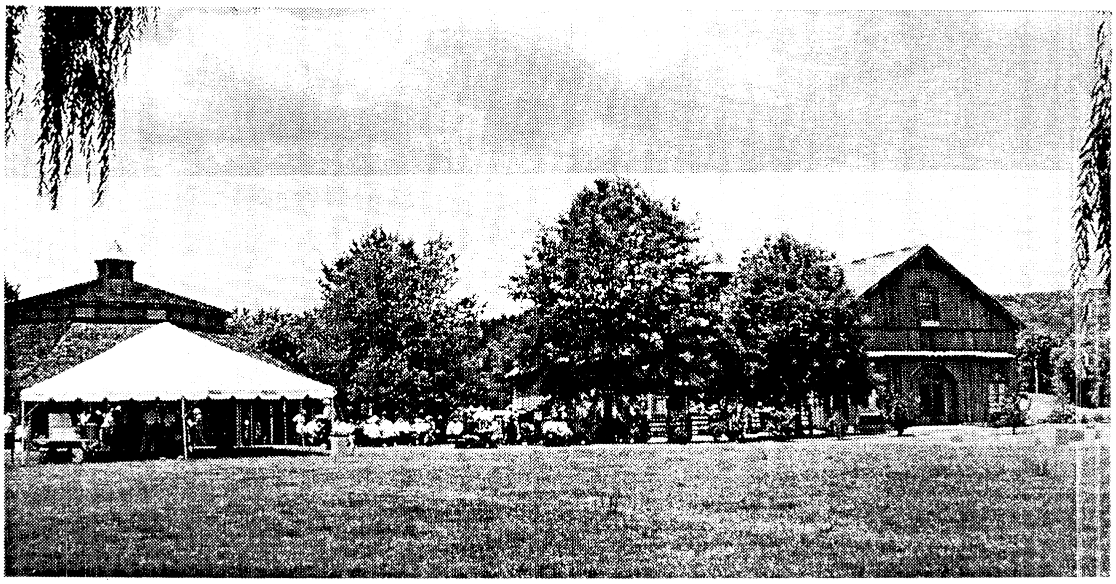


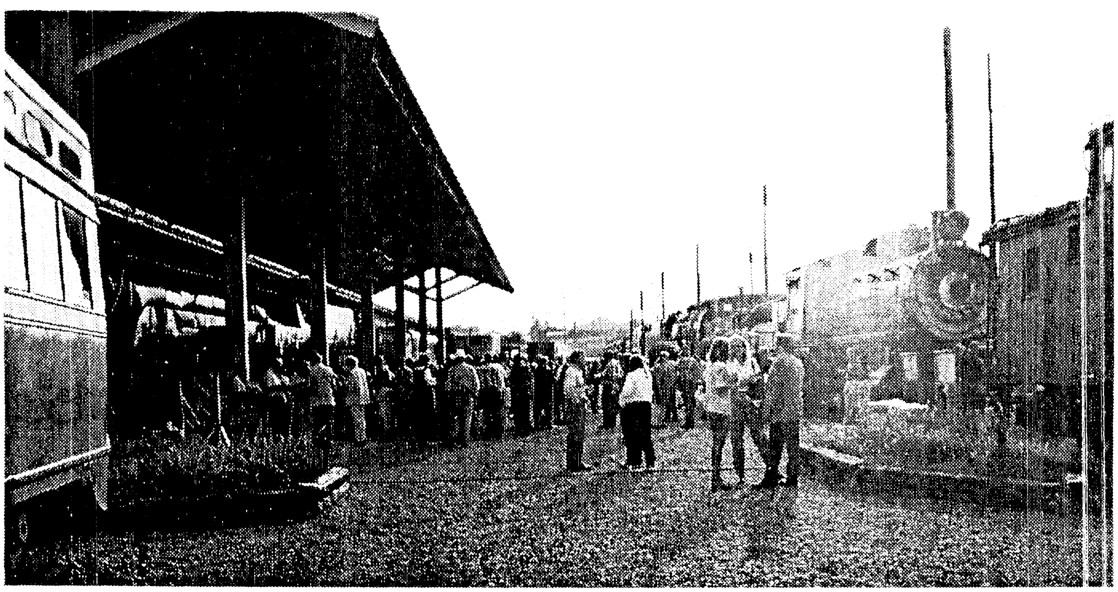
Banquet Time
Jed Dillard, presiding

"Thanks for the memories, Ike !

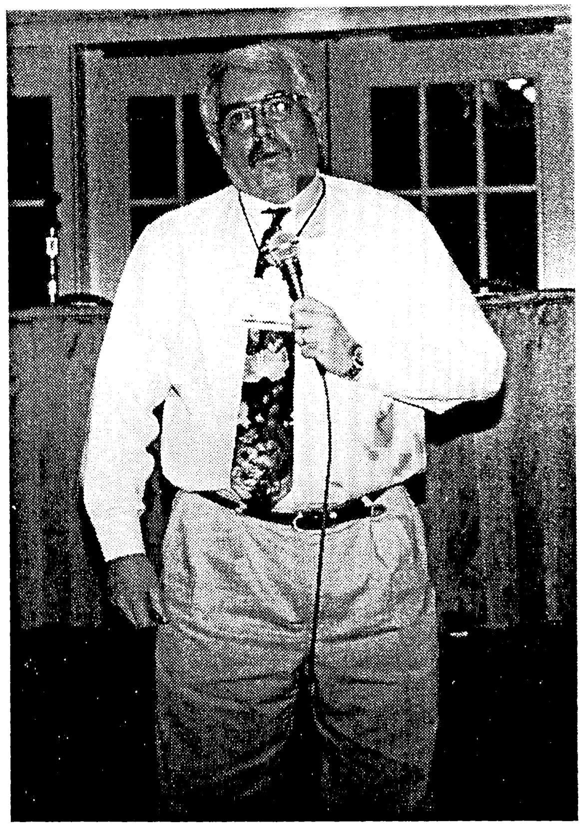
Ike Eller, John Mitchell
and Scott Greiner


BULL HILL

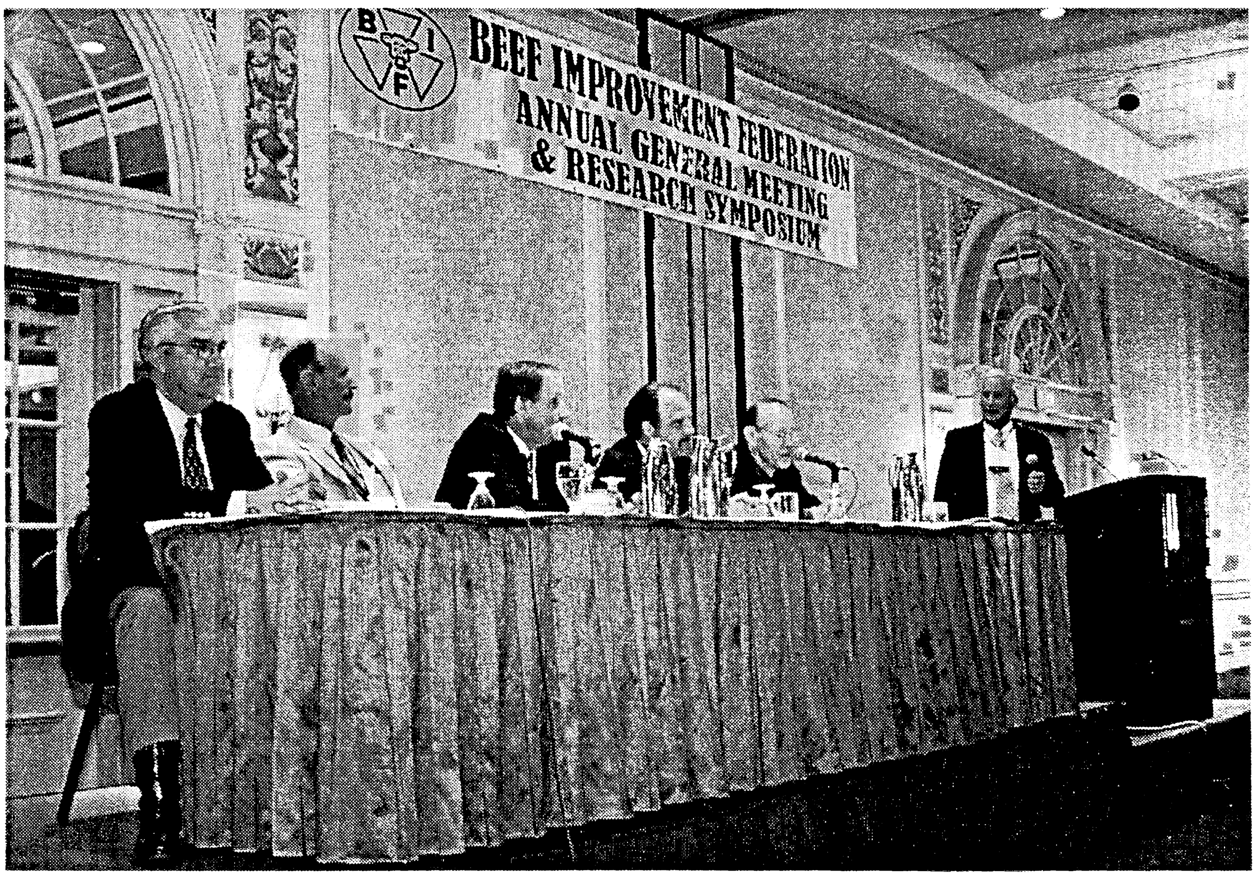




Perfect Attendance



Karoke Night at BIF




BIF 2000
July 12-15 Wichita, Kansas

1999 Convention Sponsors

ABS
Accelerated Genetics
Alta Genetics
Ashby Embryos
Bayer
Bill Wampler
Bleak Hill Farm
Castle Hill
Center for Organization & Technological Advance
Clear View Farm
Cleremont Farm
Clifton Farm
Cooperative Resources International
Copley Farm
Daltons on the Sycamore
Dunrovin Farm
Echo Ridge Farm
Elanco Animal Health
Falling Springs Farm
Farm Credit
Fauquier Farm
Fort Dodge Animal Health
Glen Hill Farms
Glenara Farm
Hoechst-Roussel Vet
Holly Hill
Houff Feed & Fertilizer
Hounshell Farm
Knoll Crest Farm
Lazy Lane Farms, Inc.
Locust Level
Mapleton Farm
Merial
Morven Farms
Mossy Creek Farm
North American Breeders, Inc.
Oakdale Farm
Pfizer Animal Health
Pharmacia & the Upjohn Co.
Purina
Rockingham Precast
Rolling Hills Farm
Select Sires
Sire Power
Southern States Feed Division & MLE Marketing
Stuart Land & Cattle Co.
Tuckahoe Point Farm
Tucker Family Farms
Tye Brook Angus
Vance Farms
Virginia Angus Association
Virginia Beef Corp.
Virginia Beef Expo
Virginia Cattle Industry Board
Waterford Farm
Wehrmann Angus
White Oak Farm
Whitestone Farm

1999 Convention Hosts

Virginia Beef Cattle Improvement Association

Virginia Cattlemen's Association

Virginia Department of Agriculture and Consumer Sciences

Virginia Tech College of Agriculture and Life Sciences

Virginia Tech Division of Continuing Education

Virginia Tech Center for Organizational and Technological Advancement