PROCEEDINGS

BEEF IMPROVEMENT FEDERATION

27TH RESEARCH SYMPOSIUM & ANNUAL MEETING

HOLIDAY INN
SHERIDAN, WYOMING
MAY 31 - JUNE 3, 1995

1995 BEEF IMPROVEMENT FEDERATION
BOARD OF DIRECTORS

NAME	YEAR TERM EXPIRES	REPRESENTING
Willie Altenburg	1996	Western BCIA
Kent Anderson	1997	Breed Association
Paul Bennett	1996	Eastern BCIA
Glenn Brinkman	1996	Central BCIA
John Crouch	1998	Breed Association
Jed Dillard	1998	Eastern BCIA
Burke Healey	1998	At - Large
John Hough	1996	Breed Association
Roger Hunsley	1998	Breed Association
Doug Husfeld	1997	Breed Association
Gary Johnson	1997	Central BCIA
Lee Leachman	1997	At - Large
Craig Ludwig	1996	Breed Association
Roy McPhee	1998	Western BCIA

Don Boggs	Central Region BIF Secretary
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Ronnie Green	Western Region BIF Secretary
Dan Kniffen	NCA
Mike Schutz	Canadian Beef Improvement
Ronnie Silcox	Eastern Region BIF Secretary
Norman Vincel	NAAB
Richard Willham	BIF Historian

1995 Beef Improvement Federation Conference
Sheridan Holiday Inn
Sheridan, Wyoming
May 31 - June 3, 1995

WEDNESDAY, May 31, 1995

3:00 PM	**BIF Board of Directors Meeting**
7:00 PM	**NAAB Symposium:** Roy Wallace, Select Sires, Inc., Moderator
7:00 PM	**"The Postpartum Cow: Methods of Shortening the Postpartum Interval"**- Robert Short, USDA-ARS - Miles City, MT
7:45 PM	**"Estrous Synchronization Programs - What Works and What Doesn't"** - William E. Beal, VPI & SU
8:30 PM	**"Which Biotechnologies Can Contribute to Profitable Beef Production?"** - George Seidel, Jr., Colorado State University

THURSDAY, June 1, 1995

8:00 AM	**WELCOME** Steven Horn, Dean UW College of Agriculture Robert Pingetzer, President WBCIA

"GENETIC MECHANISMS FOR REDUCING PRODUCTION COSTS"
Doug Hixon, University of Wyoming
Moderator

8:15 AM	**"Genetics from Conception to Consumption"** Bryan Melton, Iowa State University
9:00 AM	**"How do you Determine Critical Cost Control Points in a Cow/Calf Production System?"** (SPA-DATA) Troy Marshall, Cattle-Fax, Denver, Colorado
9:45 AM	**BREAK**
10:15 AM	**"Is it Possible to Decrease Costs in an Age of Increasing Technology?"** Ronnie Green, Colorado State University

11:00 AM **"Economic Impact of EPDs - Present and Future"**
Kent Anderson, North American Limousin Foundation

11:45 AM **Regional Caucuses To Elect Directors**

ANNUAL MEETING LUNCHEON
MC - Paul Bennett, BIF President

2:00 - 5:00 **COMMITTEE MEETINGS**

INTEGRATED GENETIC SYSTEMS

Review of BIF Guidelines Revisions
- Utilization Section
- Purpose and Overview
- IRM Concept and SPA
- Seed Stock Program
- Commercial Program
- Systems and Interactions

Genetics/Production/Economics
- Round Table Discussion
  Troy Marshall, Cattle-Fax
  Bryan Melton, Iowa State University
  Larry Benyshek, University of Georgia

Future Direction for the Integrated Genetic Systems Committee

CENTRAL TEST and GROWTH

Heifer Development Programs
Guidelines Revisions

REPRODUCTION

"Genetic Relationship Between Pelvic Area Measurements and Subsequent Calving Ability"
- Lisa Kriese, Auburn University

"Inventory-Based Recording Programs for Seedstock Breeders"
- Jim Gibb, American Gelbvieh Assoc.

Revision of Guidelines

6:30 PM **RECEPTION AT KING ROPES & SADDLERY**
Hors d'oeuvres served

FRIDAY, June 2, 1995

"MARKETING TARGET ENDPOINTS vs. THE OPTIMUM COW"
Don Boggs, South Dakota State University
Moderator

8:00 AM — **"Carcass Targets and Price Differentials of the Big Three"**
Glen Dolezal, Oklahoma State University

8:45 AM — **"The Optimum Cow - What Criteria Must She Meet?"**
Harlan Ritchie, Michigan State University

9:30 AM — **BREAK**

10:00 AM — **"Genetic Relationships Between Production and Carcass Traits"**
John Pollak, Cornell University

10:45 AM — **"How Feedlot Management Can Use or Abuse Genetics"**
Bill Mies, Texas A & M University

11:30 AM — **Questions Directed Toward Panel of Morning Speakers**

12:00 — **AWARDS LUNCHEON**
MC - Glenn Brinkman, BIF Vice-President
Introduction of Seedstock and Commercial Producer Award Nominees with Slide Presentation

2:00 - 5:00 PM — **COMMITTEE MEETINGS**

GENETIC PREDICTION

- **BIF Guidelines Report**
- **Across Breed EPDs Report**
- **EPDs for Stayability**

BIOTECHNOLOGY

- **"Breakthrough in Gene Markers for the Bovine Genome"**
  Jerry Taylor, Texas A&M University

LIVE ANIMAL and CARCASS EVALUATION

- **Ultrasound Validation Research on Live Cattle for Determining Carcass Merit**
- **Guidelines for Incorporating Ultrasonic Live Animal Measurements into Carcass Evaluation**
- **Alternative Methods of Determining Carcass Merit in Live Animals**

6:00 PM No Host Social

6:30 PM **AWARDS BANQUET**
MC - Jack Chase, BIF Past President, Leiter, WY

SATURDAY, June 3, 1995

8:00 AM **Tour - "Matching Genetics to Available Resources - Practical Application"**

- **Padlock Ranch,** Ranchester, Wyoming
- **Beckton Red Angus,** Sheridan, Wyoming

LUNCH AT BECKTON

- **Sheridan Ranch,** Deseret Intermountain Ranches of Wyoming, Leiter, Wyoming
- **Buffalo Creek Red Angus,** Leiter, Wyoming

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MANAGEMENT OF COWS FOR HIGH REPRODUCTIVE RATES

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Introduction

Reproductive rate is a major determinate of efficiency and profitability in a cow-calf operation with puberty being the first component of reproduction that will have an impact. Producers need to be aware of management alternatives that affect puberty and fertility in replacement heifers because early pregnancy will program replacement heifers to have high reproductive potential for their lifetime. Postpartum anestrus and rebreeding is the next component of reproduction to be concerned with and is the topic of this presentation.

Background

Most beef production systems are based on an annual calving season with the length of this season being quite variable. In order for any system to be efficient and remain on an annual cycle, cows should rebreed within 82 days of calving (assuming a 283 day gestation period). Many factors work against that time line and cause a period of time during which cows are infertile. Anestrus is the main factor which works against a cow rebreeding within 82 days after calving and is a major contributor to reproductive losses and infertility (Bellows and Short, 1994; Short et al., 1990). Anestrus is a condition that exists in most mammals to allow a period of time after parturition for the dam to recuperate after pregnancy and is defined as the time after parturition during which estrous cycles do not occur. The length of this period in cattle is measured from calving to the first detected estrus and is commonly referred to as postpartum interval. Postpartum intervals will typically range from 35 to 70 days in reasonably managed beef cows. However, it is possible to have intervals as short as 10 to 20 days in well-nourished, nonsuckled cows and over 100 days in suckled, nutritionally stressed cows.

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[1]U.S. Department of Agriculture, Agricultural Research Service, Northern Plains Area, is an Equal Opportunity/Affirmative Action employer and all Agency services are available without discrimination.

Length of the postpartum interval is affected by several minor factors such as season, breed, parity, dystocia, presence of a bull, uterine palpation and carryover effects from the previous pregnancy, but the greatest effects are from nutrition and suckling (Short et al., 1990). The control of postpartum interval is complicated not only because so many factors are involved but also because these factors interrelate with each other (i.e., response to nutrition differences will depend on suckling status and vis versa). The number of reports in the literature on experiments related to postpartum anestrus has become quite large, so rather than cover in detail all relevant literature, we will rely heavily on conclusions drawn from several recent reviews (Nett, 1987; Randel, 1990; Short and Adams 1988; Short et al., 1990a; Williams, 1990). Please consult these reviews for a complete listing of references because only ones not cited in those reviews are cited in this presentation.

Role of Suckling and Lactation in Postpartum Anestrus

The physical and behavioral responses associated with suckling and the physiological processes associated with milk production (lactation) are all involved with causing anestrus. A calf must be present for maximal response because milked cows have shorter intervals than do suckled cows. Since beef cattle are not normally milked, the combined effects of lactation and suckling will be subsequently referred to as the effects of suckling. The mechanisms through which suckling exerts its effects are more easily understood by using Figure 1 (from Short et al., 1990) to illustrate the steps that a cow goes through in resuming normal estrous cycles.

Step 1. There is a 2 to 3 week period after calving during which the pituitary replenishes its stores of gonadotropins and the pituitary and hypothalamus regain their capacity to respond to appropriate stimuli. The hypothalamus regains its capacity to release gonadotropin releasing hormone (GnRH) in response to the appropriate stimulus (rising estrogen concentrations in the blood), and the pituitary regains its ability to release luteinizing hormone (LH) in response to GnRH. The hypothalamus releases pulses of GnRH under the control of the "pulse generator" at a low frequency (every 4 to 8 hours). The inhibitory effects of suckling are on the hypothalamus and not the pituitary (Zalesky et al., 1990). The ovary also is functional at the end of this period because a follicle will ovulate in response to a surge of LH. Recent evidence shows that a dominate follicle develops quite early after calving (Savio et al., 1990). At the end of this period "all systems are go", but the inhibitory influences of suckling prevent progressing through the next steps.

Steps 2 to 6. Once a cow is released from the inhibitory effects of suckling, either by weaning the calf or allowing the effects to wane with time, this series of steps starts to occur. This series of steps is the same as that which occurs before any estrus and ovulation (Walters et al., 1982). Frequency of pulse releases of GnRH from the hypothalamus increases to one every 1 to 2 hours with a corresponding increase in pulse frequency of LH release from the pituitary. The increased gonadotropin stimulation available to the ovary initiates follicular maturation resulting in an increased estrogen production. The hypothalamic-pituitary unit responds to the rising estrogen concentrations with an ovulatory release of LH and behavioral estrus. The mature follicle responds to the LH surge by ovulating and releasing an ovum.

Steps 7a or 7b. If the cow is bred and becomes pregnant, then she will proceed through pregnancy and parturition (step 7b) and start postpartum anestrus over again. If the cow doesn't become pregnant (either not bred or pregnancy fails, step 7a), then prostaglandin $F2_\alpha$ (PGF) will cause the corpus luteum (CL) to regress, and she will start the estrous cycle over at step 2 or, in a few cases, will become anestrus due to seasonal, nutritional or other factors.

The mechanism through which suckling inhibits a cow from progressing beyond step 1 is complicated and not well understood. The presence of a cow's own calf and the act of suckling create a multitude of metabolic, neural (both tactile and olfactory) and psychological messages. These combined messages apparently inhibit the pulse generator in the hypothalamus so that frequency of GnRH pulses is low. The direct neural messages transmitted from the udder during suckling do not appear to have a significant involvement in the inhibitory process. Recent experiments from Kansas (Viker et al., 1989) with mastectomized cows have shown that just the presence of a cow's calf will cause the same inhibition as in an intact cow that is suckled by her calf.

Metabolites, such as glucose, circulating in the blood also may be part of the inhibitory control mechanism as well as the endogenous opioid peptide (EOP) system (Myers et al., 1989). Endogenous opioid peptides are chemicals in the body similar to morphine that help translate neural signals into physiological responses. The EOP system in the brain and hypothalamus may partially translate the messages generated by suckling into an inhibitory effect on GnRH release (Rund et al., 1989; Short et al., 1990).

Management Alternatives to Lessen the Impact of Anestrus

Several options may be considered to minimize postpartum anestrus and its potential for decreasing fertility. In considering these options in a management plan, the cost of implementing them must be balanced against the potential benefits to make sure there is an economical as well as a biological benefit. The use of an economic model similar to that presented for age at first breeding of heifers (Short et al., 1990) would be appropriate. These options by category are:

Nutrition. The most common problem encountered when prolonged postpartum intervals occur in a herd is poor nutrition at one or more stages of the production cycle. Resumption of estrous cycles after calving is a body function that has a fairly low priority compared to other functions such as lactation, activity, growth and basic body maintenance. The competition for and partitioning of nutrients in a cow is illustrated in Figure 2 (from Short and Adams, 1988). Suckling greatly exaggerates the effects of poor nutrition, so nutritional and body reserve deficiencies are usually the first place to look when problems with postpartum anestrus are encountered.

Condition scoring to estimate fatness or nutrient reserves is a useful tool for monitoring nutritional management and is becoming widely accepted in the industry. This system is quite easy to use with the first step being becoming familiar with a system for assigning condition scores. Most commonly scores from 1 to 9 are assigned with the thinnest possible being 1 and fattest possible being 9 (other systems use a 10 point scale or a 5 point scale with or without half points). The actual scale is not as important as becoming proficient in assigning scores and using them in management decisions. Normally when a 9 or 10 point scale is used the goal should be to have cows at about 5 or 6 around calving to maximize rebreeding potential (Figure 3, Selk et al., 1988, Wetteman, 1994). This recommendation assumes adequate forage will be available between calving and rebreeding to allow some weight gain or at least no weight loss. Decisions need to be made at strategic points about stocking rates, pasture movements, weaning time, sorting thin cows and supplement or feeding strategies. At these strategic points, condition scores should be assigned to each cow (or at least enough cows to estimate the herd average) to estimate how the herd is doing. Management adjustments can then be made to arrive at the desired goal before breeding.

Length of breeding season. Length of the breeding season has a very direct effect on whether postpartum anestrus is a potential problem. This relationship is illustrated in Figure 4 (from Short et al., 1990). This figure was originally used to show the four major factors that contribute to postpartum infertility of which anestrus has the most practical significance. In this figure the bold curved line shows the increase in potential fertility that occurs as time postpartum progresses. By forty days postpartum, potential fertility is quite high, assuming there are no severe problems with prolonged anestrus. Superimposed on the fertility graph is an illustration of the effects of the length of the breeding season. When cows are bred in a 45 day breeding season, they will be from 35 to 82 days postpartum at the beginning of the next breeding season, and most of them will have a high potential fertility at the beginning of the breeding season. As the length of the breeding season increases to 60 or 80 days, more cows are in the early postpartum period at the beginning of the next breeding season. When breeding seasons are longer than 80 days, some cows won't even have calved at the start of the next breeding season. Breeding seasons that are 45 days or less have several advantages that include weaning a larger, more uniform calf crop, but there also is an advantage in alleviating many of the problems due to anestrus.

Weaning. This option includes a wide array of possibilities from partial and temporary weaning to complete weaning and the weaning treatments can occur anywhere from right after calving up to 9 or 10 months after calving. In order for a weaning treatment to have an immediate effect on postpartum reproduction, it must occur before or early in the breeding season. Partial weaning is when calves are separated from their dams for most of the day and then are allowed one or two short periods during the day to suckle. Temporary weaning is when calves are completely removed from their dams for a short time (usually 2 to 4 days). Both temporary weaning and partial weaning can increase the number of cows that return to estrus during the breeding season. However, the response to these treatments is variable and management of these options is somewhat difficult. To maximize response of temporary weaning, the length of time calves and cows are separated needs to be longer than four days (Shively and Williams, 1989). However, prolonging the interval beyond four days will potentially decrease milk production and weaning weights. Until more is known about the causes of variation in response and how to manage correctly, temporary and partial weaning have limited practical applications.

If prolonged anestrus is a problem in a herd, then a more sure short-term solution may be complete weaning shortly before the beginning of the breeding season. Assuming that body condition scores are reasonable (BCS≥4) and most calves are over 20 days old, then most cows that are anestrus will return to estrus in 4 to 10 days. This treatment can be quite effective in inducing and synchronizing estrus in anestrus cows, and the early weaned calves can be successfully reared on a forage (grazed or harvested) and concentrate diet. However, this option has more severe economic limitations and must be carefully evaluated before implementing.

The weaning options that have the most practical application in the long run and will affect postpartum anestrus have to do with the age of calf at normal weaning. Most cow-calf operations wean their calves somewhere around six or seven months of age, but it would not be uncommon to delay weaning to 8 or 10 months. Manipulating age at weaning in the range of 6 to 10 months will have no immediate effect on anestrus and rebreeding because if cows are calving on an annual basis, the breeding season should already have passed. The potential benefits of altering age at weaning at this stage will not be realized until the next breeding season. The primary objective to consider at this point is body condition at calving time the next year. Cows that calve in late winter or early spring are normally wintered in situations where quantity and quality of feed (mainly forage) is low, and the cows often are subjected to environmental stress (cold temperatures). This limited availability of feed and cold stress makes it hard to recover from body condition scores that are too low going into the winter.

Data from a recent study at LARRL in Miles City illustrate how changing weaning age can affect body weight and BCS. Forty-eight cows that calved in April were assigned at random to have their calves weaned in September (weaned) or December (suckled). Half of the cows in each weaning age treatment received .75 lb. of supplemental protein per day and half received no supplement. All cows grazed on native range forage during the study and the study was repeated for four years.. Changes in body weight (Figure5) and BCS (Figure 6) were quite dramatic. In the first year the losses induced by late weaning were almost completely prevented by protein supplementation, and supplementing the normal weaning age cows resulted in marked improvements. These effects were less dramatic in subsequent years when forage was more plentiful and higher quality. We conclude from these data that weaning age and protein supplementation during the fall can be effective tools for manipulating BCS but the effects are variable and depend on the conditions that exist in any given year. If cows are going into the fall in poor condition and forage is limited in amount or quantity, it would not be wise to wean late even with supplementation. If cows are thin enough to require an increase in BCS, then supplemental protein along with weaning at 5 to 6 months of age can help cows recover. Remember, however, supplemental protein will only work if sufficient energy is available from grazed forage.

Estrous synchronization. Synchronization of estrus is a useful tool for shortening the breeding season, concentrating labor and making the use of AI more feasible for beef cattle. Odde (1990) reviewed the use of estrous synchronization in postpartum cows. A secondary benefit is realized in postpartum cows when synchronization treatments include the use of progesterone or a progestin. Progestins in the synchronization treatment will induce some cows that are anestrus to start estrous cycles. Therefore, if many of the cows in the herd are anestrus, then a higher percentage of cows will be bred in treatments that include a progestin. Progestin treatments should not exceed 10 to 12 days for maximum fertility. If treatments are to be longer, they should be given as a pretreatment with breeding occurring at the second posttreatment estrus. The best treatment is feeding melengesterol acetate (MGA) for 14 days with an injection of a prostaglandin 16 to 18 days after the last MGA feeding. Cows are detected for estrus after injection of prostaglandin and bred by AI. Conception rates of 50 to 80% are obtained with this treatment (Patterson, 1990). A disadvantage of this treatment is that it is long and difficult to use if calving seasons are greater than 50 days.

Bull. Presence of a bull during the postpartum period will decrease the interval to first estrus (Zalesky et al., 1984, Custer et al., 1990). The mechanisms involved with this effect are not known, but it may be advantageous to use a sterile teaser bull to run with postpartum cows before the breeding season starts to stimulate earlier resumption of estrous cycles. The effect is seen over a wide range of time after calving (Fernandez et al., 1993) so the same set of teasers can be used on successive calving groups or in a group with a wide range of postpartum intervals. Care should be used in selecting these teaser bulls to insure that they are sound and free of disease. Information is needed to understand more about the situations in which this treatment will work, how beneficial it is and how response can be maximized (i.e., what is the best cow:bull ratio?). Recent experiments have shown it may be possible to use a cow or steer treated with androgens rather than a bull.

Dystocia. Cows that have dystocia (calving difficulty) have longer postpartum intervals. Management systems which minimize dystocia will not only save more calves but will also have higher rebreeding rates of the cows the next breeding season (Bellows and Short, 1994).

Summary

Anestrus is one of the major problems that has the potential to lower fertility in beef cattle. Suckling and poor nutrition are the main causes of anestrus. Solving nutritional problems and using condition scores to monitor nutritional status can partially overcome anestrus, but other management decisions can also reduce the negative effects of suckling and nutritionally induced anestrus. Shortening breeding seasons to ≤45 days, using appropriate weaning times, synchronizing estrus with a treatment that includes a progestin, using a teaser bull before the breeding season and minimizing dystocia are all management options which can decrease the effects of anestrus. Depending on forage availability and quality, weaning age and protein supplementation in the fall can be considered to manipulate forage utilization and BCS. The decision of whether to include any of these options should include an assessment of

the value of the increased production potential in relationship to the anticipated cost of implementing these practices.

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Figure 1. A model depicting the hormonal control of estrus and ovulation in postpartum cows (from Short et al., 1990a).

Figure 2. Partitioning of nutrients in a cow with nutrient intake varying in quality and quantity (from Short and Adams, 1988).

Figure 3. Relationship between precalving BCS and pregnancy rate the following summer (from Selk et al., 1988).

Figure 4. Relationship of length of the breeding season to fertility during the postpartum period (from Short et al., 1990a).

Figure 5. Weight changes of cows from September to December when calves were weaned in September or December. Half of the cows in each weaning treatment received no supplement and half received .75 pounds per day of supplement (30% protein).

Figure 6. Changes in body condition score of cows shown in Figure 5.

Figure 1.

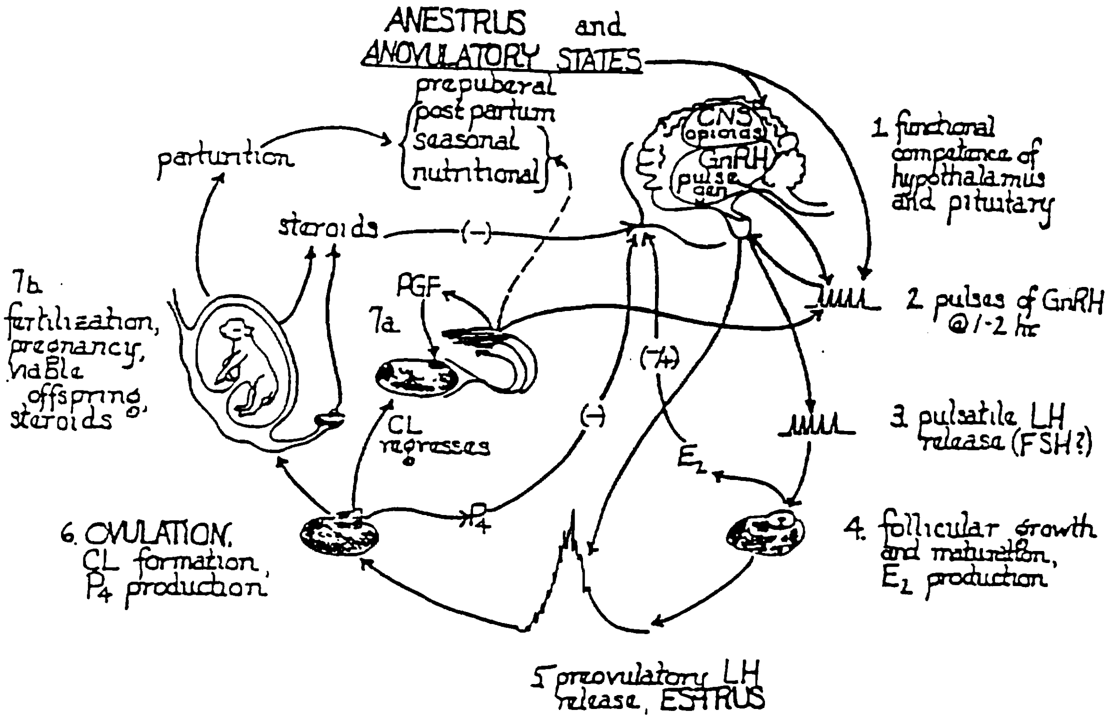


Figure 2.

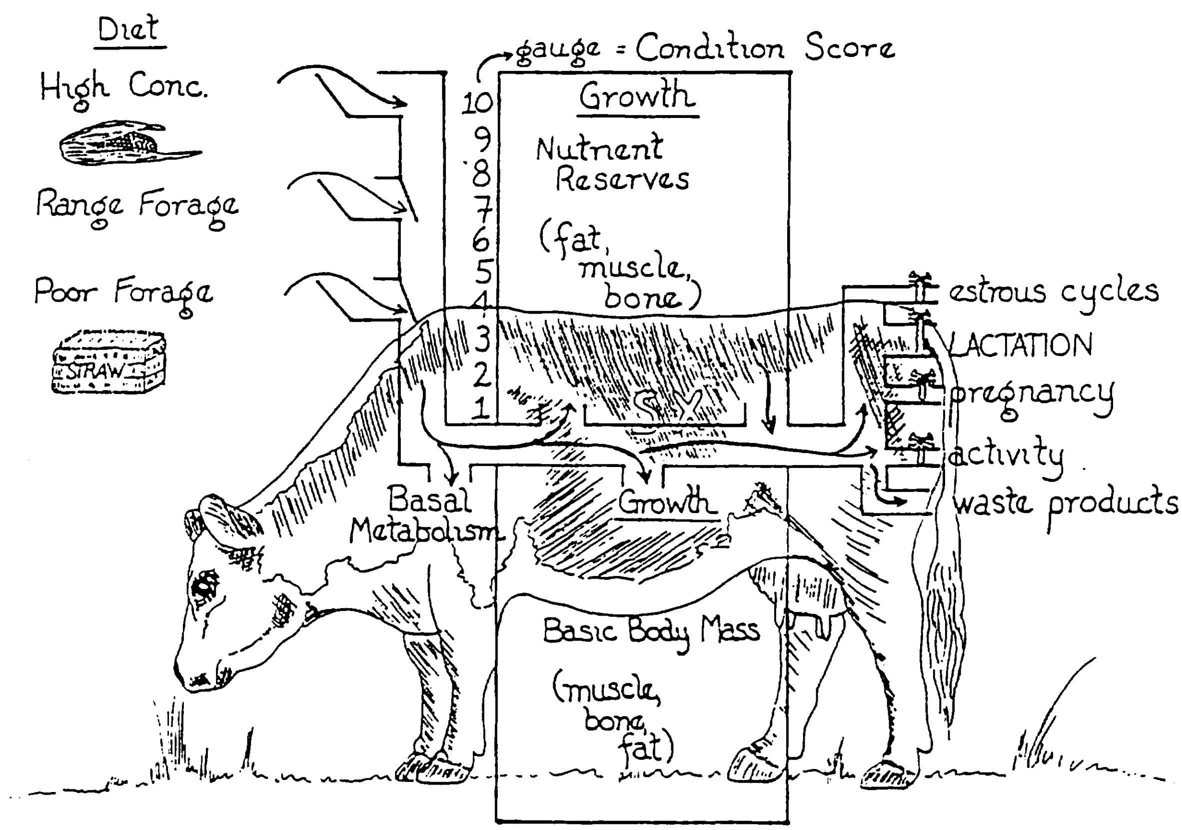


Figure 3.

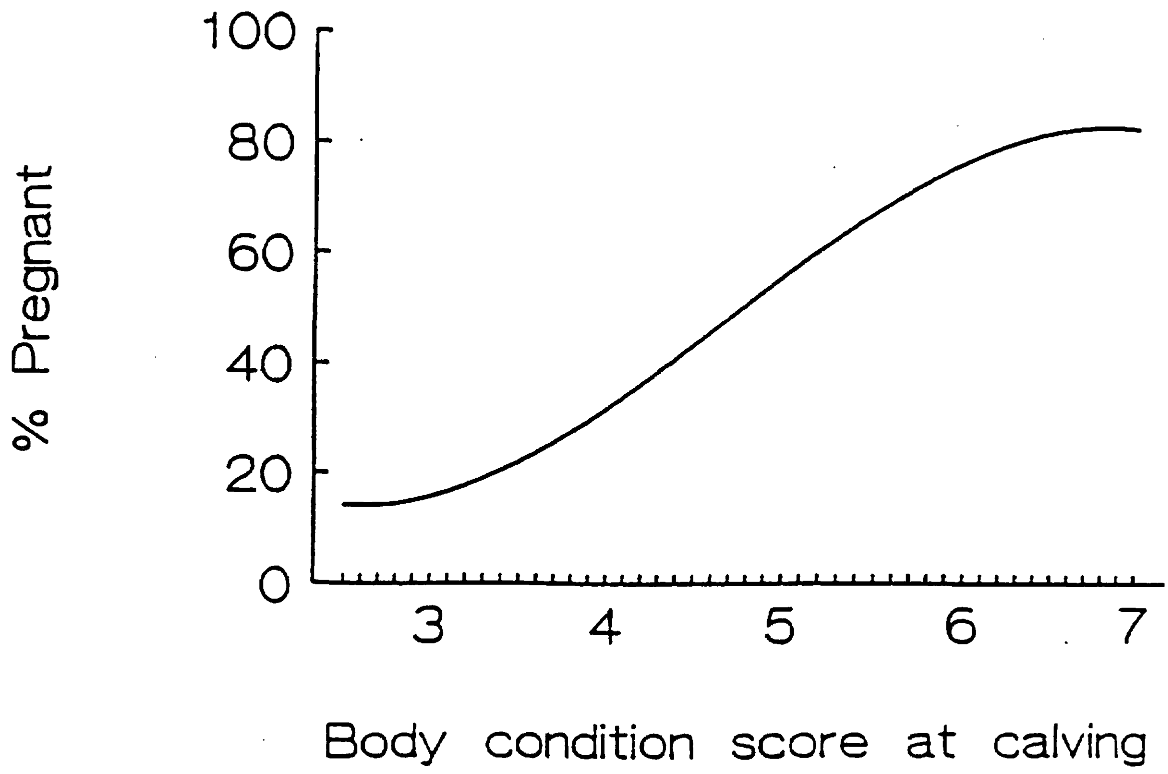


Figure 4.

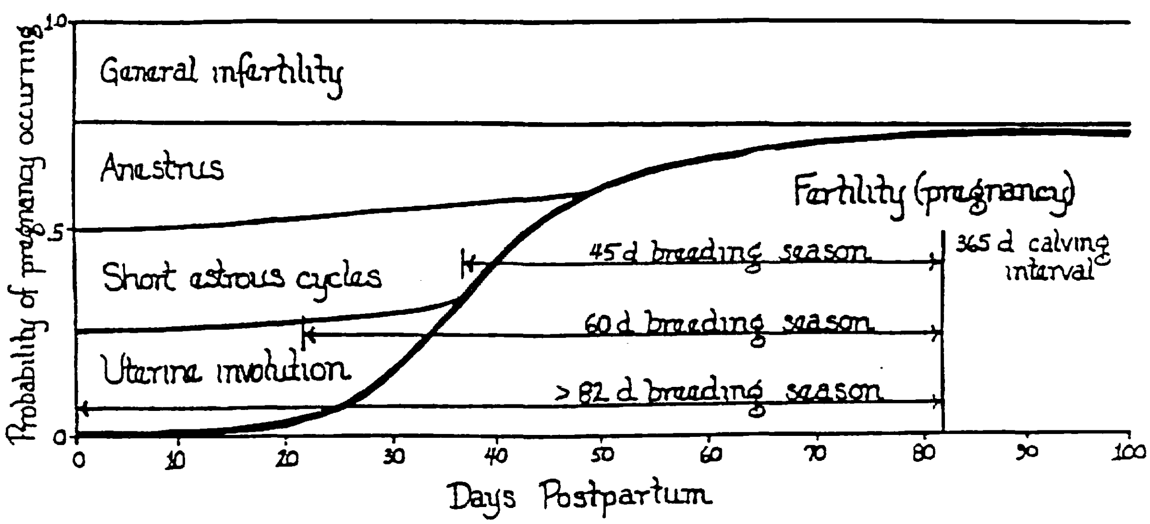


Figure 5.

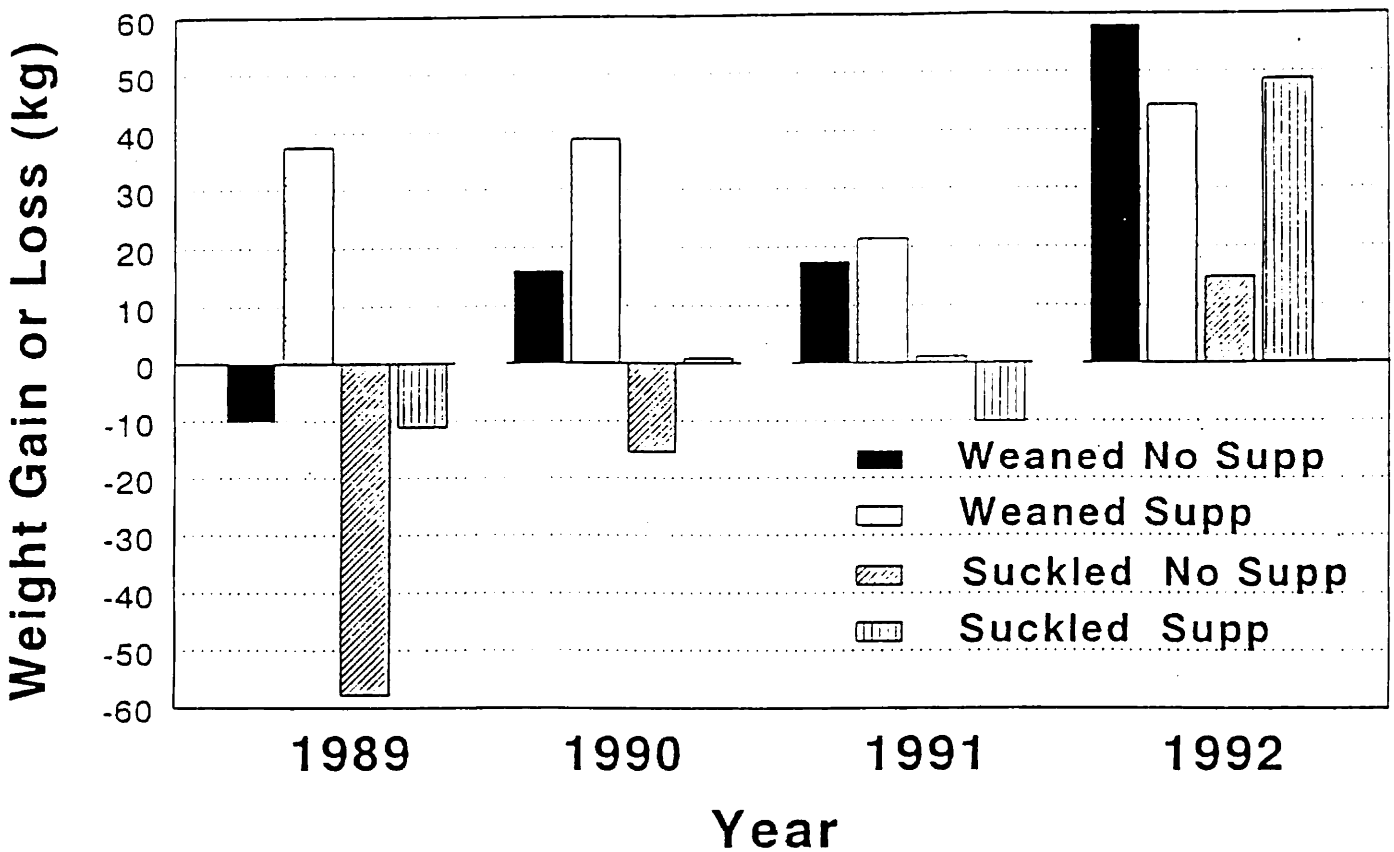
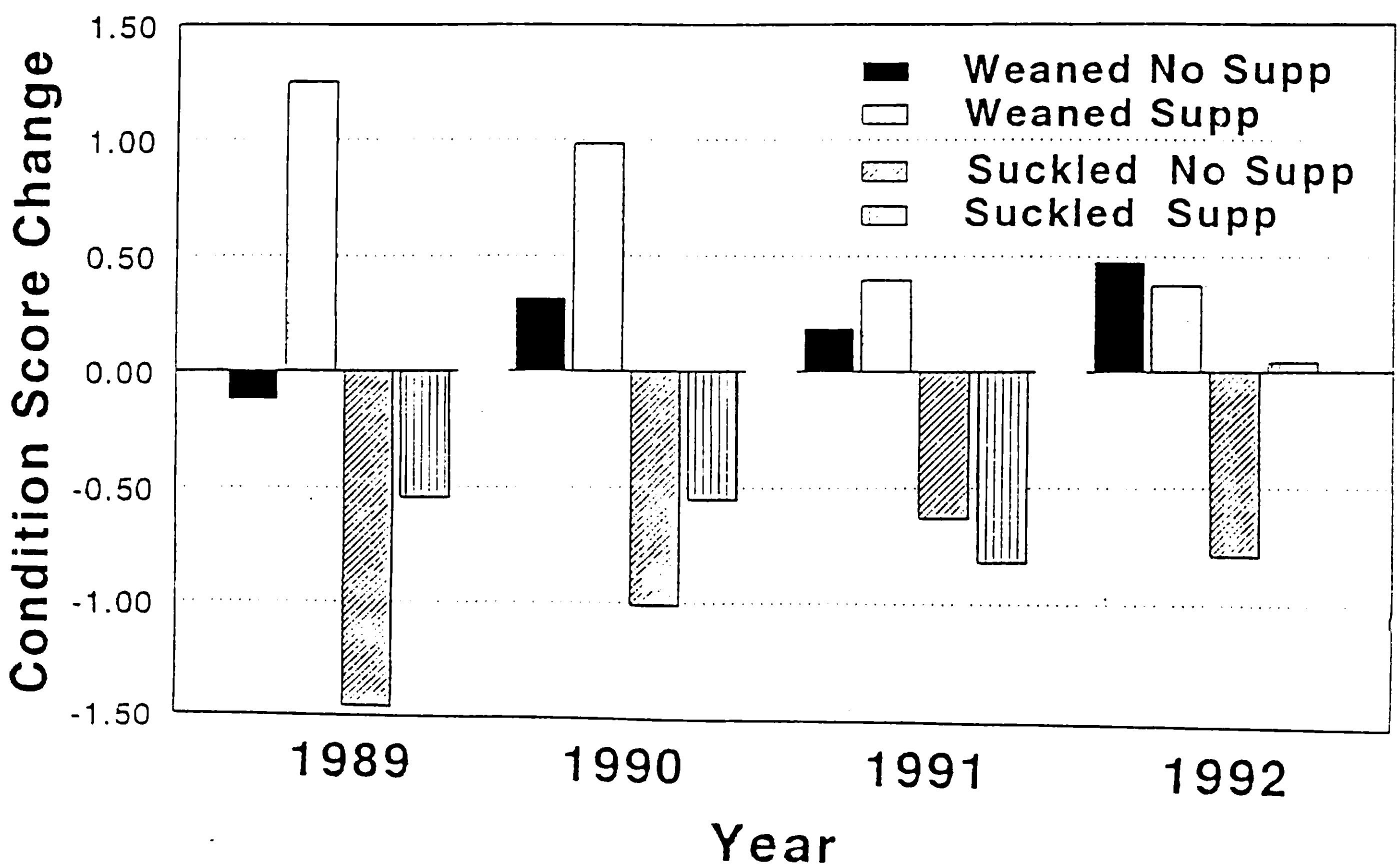


Figure 6.



ESTRUS SYNCHRONIZATION PROGRAMS
What Works and What Doesn't

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INTRODUCTION

Estrus synchronization facilitates the use of artificial insemination (AI) in beef cattle. Increased understanding of estrus synchronization products can increase their performance and raise producer confidence in estrus synchronization. Increased confidence in estrus synchronization will simultaneously increase the use and success of AI.

Today there are almost as many estrus synchronization systems as there are breeds of cattle. Most treatments are effective, but each commercial product and each variation in the way a product is used imposes certain advantages and limitations[1] . Understanding those advantages and limitations leads to better decision making on which estrus synchronization product is best for a specific situation. This paper is meant to be a common sense approach to understanding the most common estrus synchronization products and their uses.

SYNCHRONIZATION OF CYCLING COWS OR HEIFERS

There are currently several products approved for estrus synchronization or estrus suppression in cattle (Table 1). Those products can be divided into two groups, prostaglandin products (Lutalyse, Bovilene and Estrumate) and progestins (SYNCRO-MATE-B and MGA). The various products have been used alone or have been combined to synchronize estrus.

PROSTAGLANDINS - There are three approved prostaglandin products, each contains prostaglandin $F_2\alpha$ ($PGF_2\alpha$) or an analogue of that compound. All prostaglandin products synchronize estrus by regressing the corpus luteum (CL) and hastening the onset of estrus (shortening the estrous cycle) in cycling cows or heifers. Prostaglandin products have no effect on noncycling prepubertal heifers or noncycling postpartum cows. Despite differing opinions, there has been no scientific study showing a difference in the effectiveness of one prostaglandin product versus another for estrus synchronization.

Prostaglandins are effective when administered on days 6 through 17 of the estrous cycle (Lauderdale, 1972). Injection of $PGF_2\alpha$ has no effect on animals that have been in heat during the 5 days prior to injection. Although $PGF_2\alpha$ does not shorten the cycle of cows treated on days 17

[1] mention of commercial products does not imply endorsement of those products or services named nor criticism of similar ones not mentioned

to 21, those cows naturally exhibit estrus within 5 days after treatment. Hence, on average a single injection of $PGF_2\alpha$ is expected to synchronize estrus in about 80% of the cycling animals in a herd.

Several treatment schemes using $PGF_2\alpha$ have been devised in an effort to synchronize estrus in all cycling cows or heifers. Heat detection and breeding for 5 days, then injecting $PGF_2\alpha$ eliminates unresponsive cows early in the cycle before the others are treated to synchronize estrus. Conversely, giving two injections of $PGF_2\alpha$ 10 to 14 days apart is expected to synchronize estrus in most cycling animals after the first injection (except day 1-5) and is expected to synchronize all cows after the second injection because none are in the early stage of the cycle at the time of the second injection.

Table 1. Products Approved for Synchronization or Suppression of Estrus[a]

Product	Supplier	Dose	Approved label use
Lutalyse®	The Upjohn Company Kalamazoo, MI 49001	25 mg (5 cc, im)	Beef cattle Dairy heifers Milked cows
Estrumate®	Mobay Corporation Shawnee, KS 66201	0.5 mg (2 cc, im)	Beef cattle Dairy heifers Milked cows
Bovilene®	Syntex Animal Health West Des Moines, IA 50304	1 mg (2 cc, subcut.)	Beef cattle Dairy heifers
SYNCRO-MATE-B®	Sanofi Animal Health Overland Park, KS 66212	Implant 6 mg N[b] Inject 3 mg N[b] and 5 mg EV[c] (im)	Beef cattle Dairy heifers
Melengestrol acetate® (MGA)	The Upjohn Company Kalamazoo, MI 49001	0.5 mg MGA/d (oral)	Beef heifers (estrus suppression)

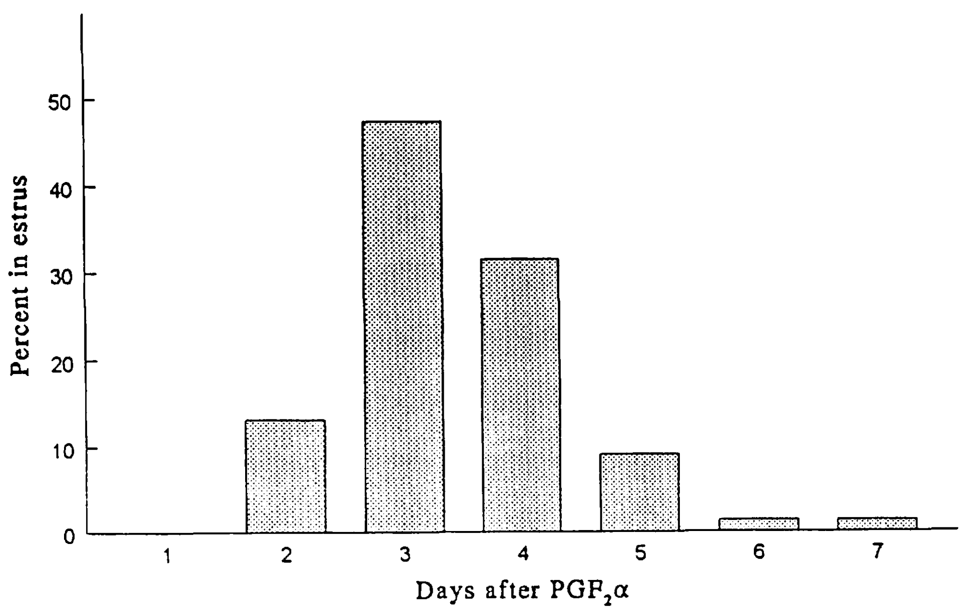
[a] Strict adherence to label warnings and precautions should be observed.
[b] Quantity of norgestomet contained in the ear implant or injection.
[c] Quantity of estradiol valerate contained in the injection.

Despite being based on a sound theory, two-injection schemes of $PGF_2\alpha$ administration usually do not synchronize estrus in 100% of the cycling animals. Failure of $PGF_2\alpha$ to synchronize estrus in all cattle between day 6 and 17 of the estrous cycle is related to the day of the estrous cycle when animals are treated.. Chenault (unpublished data) summarized the effect of day of the estrous cycle on percent of cattle synchronized by a single injection of $PGF_2\alpha$. He noted that while the majority of cattle responded when treated between days 5 and 17, synchronized estrus response was lowest (67%) among heifers treated on day 5 through 9, moderate (77%) when heifers were treated on day 9 through 12 and highest (>91%) among those injected after day 12 of the cycle.

One method suggested for improving the effectiveness of $PGF_{2\alpha}$ is multiple injections separated by 12 to 24 hours. However, only one controlled study has been reported which supports this idea. Cornwell et al. (1985) reported that more Brahman-cross heifers injected on day 7 of the estrous cycle with a "split-dose" $PGF_{2\alpha}$ injection regime (12.5 mg Lutalyse injected twice at a 24-hr interval) exhibited a synchronized estrus (97%) than heifers that received a single $PGF_2\alpha$ injection (25 mg; 69%). We have repeated this experiment in English-bred heifers but have not recorded low estrus responses to the single dose of $PGF_2\alpha$ administered on days 6 to 10 of the cycle, nor could we consistently demonstrate an advantage in estrus response of heifers treated with the split-dose.

The timing of estrus in response to $PGF_2\alpha$ injection that would be expected for an entire herd is depicted in Figure 1. The average interval from injection of prostaglandin to estrus is usually 2.5 to 3 days. Variation in the timing of estrus may be created in part by differences among cows in the rate of regression of the CL following treatment, but the timing of estrus has also been related to the stage of the cycle during which an animal is treated. In four studies, estrus was observed an average of 48 to 59 hr after treatment with a prostaglandin product administered on day 5 to 8 of the estrous cycle (King et al., 1982; Stevenson et al., 1984; Tanabe and Hahn, 1984; Watts and Fuquay, 1985). In contrast, the average time of estrus was 53 to 72 hr if heifers in the same studies were treated between day 12 and 15 of the estrous cycle. Hence, while estrus is synchronized within a 5-day period following $PGF_2\alpha$ treatment, the "tightness" of synchrony is reduced by the variation due to differences in the stage of the estrous cycle at the time of treatment.

Figure 1. Distribution of estrus following administration of $PGF_2\alpha$ (adapted from Smith et al., 1984)



Fertility is high following prostaglandin synchronization. Most studies report that conception rates are similar for cows or heifers synchronized with $PGF_2\alpha$ and those bred after a naturally-occurring heat. In one of the largest experiments (3,443 head) Moody and Lauderdale (1977) reported that cows or heifers bred 12 hr after detection of a $PGF_2\alpha$ synchronized estrus had a conception rate of 59% (Table 2). Untreated cows and heifers in the same herds achieved a 62% conception rate when bred 12 hr after a natural heat. While some studies have demonstrated a tendency for animals treated with $PGF_2\alpha$ late in the estrous cycle to have higher fertility, that trend has been inconsistent (Table 3).

The use of timed breeding following $PGF_2\alpha$ synchronization has not been as successful as breeding 12 hr after standing estrus (Table 2). Moody and Lauderdale (1977) demonstrated that when compared to breeding after heat detection, conception rate was 10 % lower for animals bred 80 hr after $PGF_2\alpha$ administration and without regard to a detected heat. The synchronized pregnancy rate, however, was not different for the timed bred group or the group bred 12 hr after detection of estrus. In a large trial using 45 herds Fogwell et al. (1986) recorded a 20% lower pregnancy rate when they compared timed breeding at 80 hr post-$PGF_2\alpha$ to breeding 12 hr after detecting a synchronized estrus (Table 4). Some time-bred groups have acceptable conception rates, however, as demonstrated in Table 4, there is more variation and a greater incidence of very low conception rates when timed breeding is used after $PGF_2\alpha$. This range in fertility and the occasional occurrence of very low conception rates of cattle timed bred after $PGF_2\alpha$ is most likely related to the greater variation in the timing of estrus following $PGF_2\alpha$ treatment as compared to other synchronization programs.

Best Use: Prostaglandin products must be used on cycling animals. Avoid the use in herds with many prepubertal heifers or postpartum anestrous cows. Common treatment schemes usually result in a high estrus response (>80%) in cycling heifers or cows. When breeding occurs after heat detection, fertility is similar to breeding after a natural heat, but timed breeding is not recommended.

MGA and PROSTAGLANDIN - A method used to allow a single injection of prostaglandin to synchronize estrus in all animals involves the combined use of melengestrol acetate and $PGF_2\alpha$. Melengestrol acetate (MGA) is an orally-active progestin that can be fed to suppress estrus in cows or heifers. Feeding MGA (.5 mg/hd/d) for 14 days suppresses estrus until 2 to 6 days after the last feeding of MGA. The estrus immediately following MGA feeding is less fertile and animals should not be bred at that time, but the timing of that estrus can be used to enhance the response to a single injection of $PGF_2\alpha$. If one injection of $PGF_2\alpha$ is administered 17 days after the last feeding of MGA, all animals synchronized by the MGA are between days 11 and 16 of the estrous cycle when $PGF_2\alpha$ is administered. Hence, not only are unresponsive cattle (days 1-5) avoided, most of the cattle synchronized by the MGA are at the stage of the estrous cycle (>day 12) when they are most responsive to $PGF_2\alpha$ administration (see above). Furthermore, animals treated with $PGF_2\alpha$ late in the estrous cycle have excellent fertility (Table 3). This MGA^{14}-$PGF_2\alpha^{17}$ system has become extremely popular for use with replacement heifers and has worked well when heifers are already on feed and confined prior to breeding.

Table 2. Estrus Response and Fertility of 3443 Cows or Heifers Artificially Inseminated After a Spontaneous Estrus or After Estrus Synchronization with Lutalyse

	Estrus response[a]	Conception rate[b]	Pregnancy rate[c]
Control (21 days)	85%	62%	53%
Synchronized (5 days)			
Bred by estrus[d]	66%	59%	39%
Timed insemination[e]	NA	49%	41%

(Moody and Lauderdale, 1977)

[a] Detected in estrus within 120 hr after treatment or 21 days (Control)

[b] Conception rate = no. pregnant/no. inseminated x 100.

[c] Pregnancy rate = no. pregnant /no. in group x 100.

[d] Only cows observed in estrus were inseminated 12 hr after estrous detection.

[e] All cows inseminated 80 hr after second Lutalyse administration.

Table 3. Variations in First-Service Pregnancy Rates of Heifers Injected with Prostaglandin $F_2\alpha$ at Various Stages of the Estrous Cycle

	Stage of Cycle[a]		
Reference	d 5 to 8	d 8 to 11	d 12 to 15
King et al. (1982)	22/32 (69)[b]	--	21/29 (72)
Stevenson et al. (1984)	28/38 (74)	--	29/43 (67)
Tanabe and Hahn (1984)	36/50 (72)	39/50 (78)	39/50 (78)
Watts and Fuquay (1985)	21/37 (57)	54/87 (62)	47/60 (78)
Weighted average	107/157 (68)	98/137 (68)	136/182 (75)

Adapted from Stevenson (1994)

[a] Stage of the estrous cycle when $PGF_2\alpha$ was injected (d 0 = estrus).

[b] Percentage pregnancy rate after inseminations based on detected estrus.

Table 4. Fertility of Heifers in 45 Herds with Different Schedules for Insemination after Synchronization with Prostaglandin $F_2\alpha$ ($PGF_2\alpha$)

		Pregnancy rate, %[a]			
Time of insemination	No.	Mean	Min.	Max.	Range
At estrus after $PGF_2\alpha$	2025	60.9	33.3	92.3	59.0
80 h after $PGF_2\alpha$	561	40.6	6.7	85.7	79.9

Adapted from Fogwell et al. (1986).

a Pregnancy rate = no. pregnant /no. in group x 100.

The most dramatic demonstration of the MGA^{14}-$PGF_2\alpha^{17}$ treatment was an experiment conducted by Brown et al. (1988) in which heifers were treated with SYNCRO-MATE-B (SMB) or MGA^{14}-$PGF_2\alpha^{17}$ (Table 5). The heifers fed MGA and injected with $PGF_2\alpha$ 17 days later had a slightly lower estrus response rate, however the conception rate of heifers bred 12 hr after estrus in the MGA^{14}-$PGF_2\alpha^{17}$ group was 28% higher. This enabled more heifers treated with MG^{A14}-$PGF_2\alpha^{17}$ to become pregnant to the synchronized breeding (57 vs 37%). The great difference between SMB and MGA^{14}-$PGF_2\alpha^{17}$ observed in this experiment may not occur in every case, however, this experiment demonstrates the potential of the MGA^{14}-$PGF_2\alpha^{17}$ treatment to enhance pregnancy rates.

Table 5. Estrus Response, Conception Rate and Pregnancy Rate of Heifers Synchronized with SMB or MGA^{14}-$PGF_2\alpha^{17}$

Treatment	No.	Estrus response[a]	Conception rate[b]	Pregnancy rate[c]
SMB	153	90.2%	40.6%	36.6%
MGA^{14}-$PGF_2\alpha^{17}$	157	83.4%	68.7%	57.3%

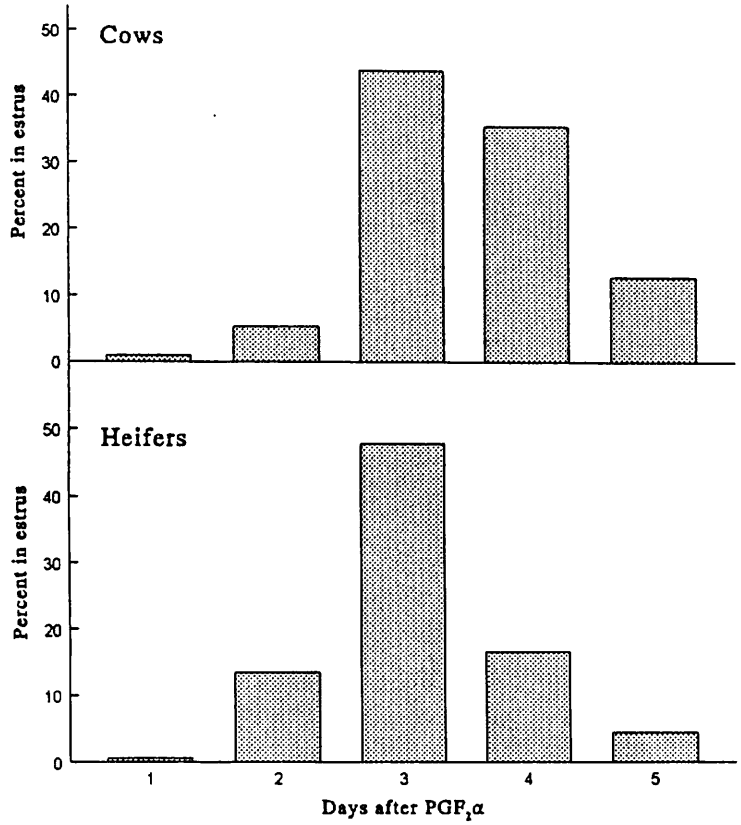
(Brown et al., 1988)
[a] Detected in estrus within 120 hr after treatment
[b] Conception rate = no. pregnant/no. inseminated x 100.
[c] Pregnancy rate = no. pregnant /no. in group x 100.

The "tightness" of synchrony of the estrus response following MGA^{14}-$PGF_2\alpha^{17}$ has not been compared directly with that following $PGF_2\alpha$ alone. On the other hand, it is reasonable to expect that there would be less variation in the estrus response of animals treated with MGA^{14}-$PGF_2\alpha^{17}$ because there is less variation in the stage of cycle when $PGF_2\alpha$ is administered in the MGA^{14}-$PGF_2\alpha^{17}$ system than when $PGF_2\alpha$ is injected alone. The distribution in the timing of estrus in cows or heifers following treatment with MGA^{14}-$PGF_2\alpha^{17}$ is depicted in Figure 2.

The degree of synchrony[2] following treatment with MGA^{14}-$PGF_2\alpha^{17}$ has ranged from 56 to 72%. (Brown et al., 1988; King et al., 1994). The high degree of synchrony (72%) following the MGA^{14}-$PGF_2\alpha^{17}$ treatment reported by Brown et al (1988) was similar to the degree of synchrony following SMB (79%). However, when King et al (1994) attempted to timed breed all MGA^{14}-$PGF_2\alpha^{17}$ heifers 72 hr after $PGF_2\alpha$ treatment, synchronized pregnancy rates following timed breeding were lower than pregnancy rates of synchronized heifers bred 12 hr after detection of estrus in one of three trials (29 vs 57, 37 vs 35 and 61 vs 58%, respectively). They noted that timed insemination was unsuccessful in a trial in which the estrus response rate was high (79%), but the degree of synchrony was lowest (56%). Hence, while the MGA^{14}-$PGF_2\alpha^{17}$ treatment may improve the synchrony of estrus over administration of $PGF_2\alpha$ alone, enough variation in the timing of estrus still exists to make sole use of timed breeding a risk.

[2] number in heat during peak 24-hr/number exhibiting synchronized estrus x 100

Figure 2. The distribution of estrus following treatment of cows or heifers with MGA^{14}-$PGF_2\alpha^{17}$ (Adapted from Yelich et al., 1995 and Brown et al., 1988)



In contrast to the results reported by King et al (1994), Larson et al. (1992) recently reported that timed insemination in conjunction with MGA^{14}-$PGF_2\alpha^{17}$ increased synchronized pregnancy rate in a three-herd study in which only 65% of the pubertal heifers exhibited heat after the MGA^{14}-$PGF_2\alpha^{17}$ treatment. A greater proportion, 52%, of the heifers bred at 72 hr after the $PGF_2\alpha$ injection became pregnant compared to heifers bred 12 hr after detection of a synchronized estrus, 43%. The solution to the problem of whether to use timed insemination in conjunction with the MGA^{14}-$PGF_2\alpha^{17}$ treatment may be to use a modified timed insemination system employed in trials at Kansas State University. Peters et al. (1993) compared insemination of synchronized heifers 12 hr after estrus detection to a system in which heifers were bred 12 hr after estrus and any heifer not detected in estrus was inseminated at 72 hr after the $PGF_2\alpha$ injection. Based on the results at five ranches (634 head), if they would have only inseminated heifers detected in estrus during the three days following treatment, synchronized pregnancy rate would have been 35.6%. However, the synchronized pregnancy rate was increased to 48.4% by also timed inseminating all heifers not detected in estrus by 72 hr after the $PGF_2\alpha$ injection.

Application of the MGA^{14}-$PGF_2\alpha^{17}$ treatment to lactating beef cows has been less common than its use with heifers. Use of the MGA^{14}-$PGF_2\alpha^{17}$ treatment is complicated by the fact that many cows have not calved or have calved only recently when the treatment must begin, 31 days prior to beginning the breeding season. Often cows are not confined to drylots prior to breeding, hence, achieving adequate intake of MGA may be difficult. Finally, the number of noncyclic postpartum cows and cows in poorer body condition can reduce the effectiveness of the treatment.

The estrus response and pregnancy rates of cows treated with MGA^{14}-$PGF_2\alpha^{17}$ in four different trials are summarized in Table 6. The estrus response varied from 32 to 79% and was closely related to the body condition score of the animals at the outset of treatment (Table 6). Conception rate was consistently high, indicating that the cows which responded to the MGA^{14}-$PGF_2\alpha^{17}$ treatment exhibited fertility comparable to untreated animals. It should be noted that Patterson et al. (1995) reported a higher twinning rate among cows treated with MGA^{14}-$PGF_2\alpha^{17}$ (15%) than among untreated control cows. If twinning is consistently related to the treatment, it may affect its popularity.

Synchronization of cows with MGA^{14}-$PGF_2\alpha^{17}$ has been combined with 48-hr calf removal in an attempt to improve the estrus response (Patterson et al., 1990; Yelich et al., 1995). Calves were removed from their dams for 48 hr starting on the second day after the last day of MGA feeding. Calf removal did not significantly increase the proportion of cows exhibiting a synchronized estrus, however, in one study calf removal improved synchronized pregnancy rate and was more effective in getting cows bred earlier in the breeding season (Yelich et al., 1995b).

Table 6. Estrus Response, Fertility and Pregnancy Rates of Postpartum Cows in four trials Synchronized with MGA^{14}-$PGF_2\alpha^{17}$

		Synchronized				Body
Trial	No.	Estrus response[a]	Conception rate[b]	Pregnancy rate[c]	Days postpartum	condition score
Patterson et al. (1995)	68	76%	88%	67%	44 (NA)	5.9
Yelich et al. (1995a)	154	79%	78%	61%	48 (5-87)[d]	5.7
	117	32%	68%	21%	41 (6-76)	4.0
Yelich et al. (1995b)	54	65%	69%	44%	46 (9-76)	3.9

[a] Detected in estrus within 120 hr after treatment
[b] Conception rate = no. pregnant/no. inseminated x 100.
[c] Pregnancy rate = no. pregnant /no. in group x 100.
[d] Range in days postpartum at beginning of treatment

Timed insemination of lactating cows synchronized with the MGA^{14}-$PGF_2\alpha^{17}$ system has not been reported. Successful time breeding, however, is unlikely. Yelich et al. (1995) reported that less than 50% of the cows responding to the MGA^{14}-$PGF_2\alpha^{17}$ treatment exhibit estrus within a 24-hr period. Such a low degree of synchrony reduces the chance of timed breeding being successful.

Best Uses: *MGA^{14}-$PGF_2\alpha^{17}$ is an excellent system for synchronizing estrus in beef heifers. The treatment fits most heifer development programs and when heifers are bred after a detected heat, this program consistently results in a synchronized pregnancy rate above 50%. The use of MGA^{14}-$PGF_2\alpha^{17}$ with cows or in conjunction with timed insemination produces more variable results.*

SYNCRO-MATE-B - . SYNCRO-MATE-B (SMB) consists of a subcutaneous implant containing norgestomet inserted in the ear for 9 days plus an intramuscular injection of estradiol valerate and norgestomet administered at the time of implant insertion. The SMB treatment of cyclic heifers is usually followed by a high incidence (>90%) of estrus during the 5 days following implant removal. Odde (1990) reviewed 15 trials conducted with 1032 pubertal heifers that were observed for signs of estrus following SMB. Of those heifers, 92.5% were observed in estrus within 5 d after implant removal

The failure to achieve synchronization rates of 100% in cyclic heifers or cows treated with SMB is related to the response of animals treated at different stages of the estrous cycle. In particular, SMB fails to consistently synchronize estrus when administered early in the estrous cycle. Reports by Miksch et al. (1978) indicated that the SMB treatment was effective in only 80 to 86% of the heifers that began treatment on d 1 through 8 of the cycle. Pratt et al. (1991), however, reported that estrus was synchronized in only 48% of the cows treated on d 3, but that synchronization was 100% when treatment began on d 9 of the estrous cycle.

The research reports cited above document the inability of SMB to consistently synchronize estrus when administered early in the estrous cycle. Developing a more consistent method for synchronizing estrus of animals early in the estrous cycle (< d 9) or devising a method to avoid the initiation of treatment during that phase of the cycle are the only apparent means of improving the estrus response of animals treated with SMB.

The distribution of estrus following SMB treatment is highly synchronized (Table 7). In 15 separate trials in which the standard SMB treatment was used to synchronize estrus in 736 cows or heifers, a majority (65%) of the animals were observed in estrus between 24 and 48 h after implant removal (Miksch et al., 1978; Spitzer et al., 1978).

The "tight" synchrony of estrus that occurs following either SMB treatment of heifers or SMB treatment and 48-h calf removal in postpartum beef cows makes these treatments logical for use with timed insemination. The recommendation for timed breeding of SMB-treated cattle is to inseminate each animal between 48 and 54 h after implant removal. Synchronized pregnancy rates reported for heifers bred at a timed insemination after SMB treatment were higher (55%) than pregnancy rates for heifers bred 12 h after estrus detection (44%) in trials where the two methods were directly compared (Miksch et al., 1978; Spitzer et al., 1978). Mares et al. (1977) reported similar results in herds in which the majority of the heifers were cycling prior to SMB treatment. Pregnancy rates following timed breeding were higher (51%) than when SMB-treated heifers were inseminated 12 hr after estrus detection (39%). One of the advantages of SMB treatment is the tight synchrony of estrus which makes this treatment compatible with timed insemination.

Table 7. The Number of Cows or Heifers in Estrus at 24-h Intervals Following SYNCRO-MATE-B Treatment to Synchronize Estrus

Reference	No. treated	Hours after implant removal 0-24	24-48	48-72	72-96	96-120
Miksch et al. 1978	18	0	11	4	2	0
	44	0	14	21	3	3
	44	0	9	15	8	7
	23	0	9	10	3	1
	21	0	14	2	2	0
	22	0	13	3	2	4
	18	4	12	0	0	2
	17	1	13	1	1	0
	50	12	29	3	2	1
	119	0	93	8	5	2
Spitzer et al. 1978	78	5	54	11	5	3
	98	16	70	8	3	0
	56	17	32	3	2	1
	39	1	22	8	3	0
	99	4	65	19	3	5
Total	746	60	460	116	44	29
Proportion of those observed in estrus		8.4%	64.9%	16.4%	6.2%	4.1%

Conception rates of cattle treated with SMB have been reported to be not significantly different from those of untreated controls in the same trial (see Odde, 1990). However, upon closer inspection of the fertility of cattle treated with SMB, it became apparent that while the reduction in conception rates of all the animals treated may not have been statistically significant, the conception rates of those cattle that began SMB treatment late in the estrous cycle (> d 14) were significantly lower (Table 8).

Table 8. Estrus Response and Conception Rate of Postpartum Cows at Various Stages of the Estrous Cycle at the Beginning of SMB Treatment

Stage of the estrous cycle	Estrus response[a]	Conception rate[b]
Early (d 1-6)	46.7%	71.4%
Middle (d 7-12)	75.0%	83.3%
Late (> d 12)	73.1%	52.6%

(W. E. Beal, unpublished data)

[a] Detected in estrus within 120 hr after treatment

[b] Conception rate = no. pregnant/no. inseminated x 100.

Improving fertility at the estrus immediately following progestin administration depends on avoiding beginning treatment when the animals are late (>d 14) in the estrous cycle. Given with the need to avoid treatment early in the estrous cycle in order to maximize estrus response, this suggests that for the best results, SMB treatment should begin between d 8 and d 12 of the estrous cycle. Experiments are currently underway to determine the benefits of pretreating cows with MGA or $PGF_{2}\alpha$ prior to SMB to improve estrus response and fertility by controlling the stage of the cycle at the beginning of SMB treatment.

> *<u>Best Use</u>: SYNCRO-MATE-B is very effective in synchronizing estrus in cycling cows and heifers. The degree of synchrony of estrus is greater than that with other products. Hence, if timed breeding is necessary, SMB is the treatment of choice. Fertility following SMB treatment depends on the stage of the estrous cycle during which treatment is initiated. The lower fertility of animals treated beginning late in the cycle may reduce the conception rates of an entire herd treated with SMB to just slightly below that following a natural estrus.*

SYNCHRONIZATION OF NONCYCLIC POSTPARTUM COWS

The ovaries of well-nourished postpartum, suckled beef cows are capable of ovulating and initiating estrous cycles within 2 weeks after calving (Short et al., 1995). The suckling stimulus of the calf, however, usually inhibits the cow from initiating estrous cycles for 45 (mature cows) to 65 days (first-calf heifers) after calving. Often this prevents a cow from cycling or becoming pregnant at the beginning of the breeding season. Estrus synchronization treatments, particularly those involving progestins (SMB or MGA), can be used to "induce" estrus in some noncyclic postpartum cows. This effect is enhanced if the calves are temporarily weaned from the cows.

The most dramatic success of inducing estrus in noncyclic cows was reported by Smith et al. (1979). They evaluated the effects of treatment with SMB and 48-hr calf removal alone or in combination on the estrus response and pregnancy rate of noncyclic cows in three trials (Table 9). SYNCRO-MATE-B alone was able to induce estrus sooner and in a larger proportion of the cows than was calf removal alone. However, the most effective treatment for inducing a synchronized estrus was the combination of SMB treatment and 48-hr calf removal beginning at the time of implant removal. The combined effect of SMB and calf removal resulted in a synchronized pregnancy rate of 44, 46 and 35% in herds in which fewer than 25% of the cows were cycling prior to treatment. Kiser et al. (1980) demonstrated that it was necessary to remove calves for 48 hr, rather than 24 hr, in conjunction with SMB to induce estrus in noncyclic cows. He also noted that the beneficial effects of SMB and calf removal were not evident in herds where cows were in marginal (≤ BCS 4) body condition.

Fertility of noncyclic cows induced to exhibit estrus in response to SMB or SMB plus calf removal should not be expected to be equal to that of animals exhibiting estrous cycles prior to the breeding season. We compared conception rates of cycling animals synchronized with SMB or $PGF_2\alpha$ to that of noncyclic cows after estrus was induced with SMB. Conception rates of cyclic cows synchronized with SMB (35/58; 60%) or $PGF_2\alpha$ (54/84; 64%) were both greater than the conception rate of noncyclic cows bred after an induced estrus (24/55; 44%). Hence, if SMB and/or calf removal is used to induce estrus in some noncyclic cows, lower fertility should be expected following the induced estrus.

Table 9. Estrus Response and Fertility of Postpartum Cows Treated with SYNCRO-MATE-B (SMB) and 48-hr Calf Removal (CR).

Treatment	No.	Estrus response (%)[a]		Pregnancy rate (%)[b]	
		4 days	21 days	4 days	21 days
Trial I					
SMB	18	61	61	17	--
SMB + CR[c]	18	78	78	44	--
Trial II					
CR[d]	22	32	73	14	27
SMB + CR	24	96	96	46	58
Trial III					
Control	52	11	31	8	17
CR	52	19	62	18	44
SMB	53	60	68	27	40
SMB + CR	53	85	88	35	58

Adapted from Smith et al. (1979)
[a] Detected in estrus within 120 hr after treatment
[b] Pregnancy rate = no. pregnant /no. in group x 100.
[c] 48-hr calf removal at SMB implant removal.
[d] 48-hr calf removal at beginning of breeding season.

Feeding MGA can induce estrus in noncyclic cows (Beal and Good, 1986). However, both Yelich et al. (1995a) and Patterson et al. (1995) reported that MGA feeding as part of the MGA^{14}- $PGF_2\alpha^{17}$ synchronization system did not induce estrus in noncyclic cows in those experiments. Furthermore, when calf removal was added to the MGA^{14}- $PGF_2\alpha^{17}$ system, the percentage of noncyclic cows induced to exhibit estrus was only 14% greater than in the untreated control group (Yelich t al., 1995b). It is unclear whether the MGA^{14}- $PGF_2\alpha^{17}$ is less effective than SMB in inducing estrus in noncyclic postpartum cows or if the body condition of cows or some other factor limited its effect in the studies performed to date.

SUMMARY

There is no ONE perfect estrus synchronization product or system that works in all situations. Product satisfaction depends on the synchronization system in which a product is used and upon the expectations of the beef producer. It is important to understand the weaknesses and strengths of each synchronization and AI system, such that the chances for success can be maximized. The preceding paper was intended to explain differences in the estrus response and fertility of cattle synchronized with currently-available estrus synchronization products. It was not intended to promote one product over the other, however it should be clear that different products work better or worse in certain situations. The key to successful synchronization is to have realistic expectations and to pick the synchronization and AI system which is best suited for YOUR needs.

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REPRODUCTIVE BIOTECHNOLOGIES FOR PROFITABLE BEEF PRODUCTION

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The word biotechnology means different things to different people. By my definition, reproductive biotechnologies include estrus synchronization, artificial insemination, superovulation, embryo recovery and transfer techniques, cryopreservation of sperm and embryos, sexing semen, in vitro fertilization, bisection and cloning of embryos by nuclear transplantation, biopsy of embryos for sex determination and other genetic analyses, and transgenic technology. The list could be expanded to include genotyping of calves for various purposes including eliminating those with deleterious recessive alleles, selecting those with desirable alleles, sorting out parentage in multiple sire breeding pastures, or applying principles of marker-assisted selection. All of these biotechnologies can be applied profitably in some circumstances, but none of them will be universally profitable. Keeping good records and using them for selective breeding probably are more important for profitable beef production than any of the biotechnologies just listed. Currently, in my opinion, estrus synchronization and artificial insemination are easily the most important and widely applicable of these biotechnologies. However, my assignment is to provide information about the newer, less frequently used biotechnologies.

Superovulation and Embryo Cryopreservation and Transfer

Embryo recovery and transfer and the related biotechnologies of superovulation and cryopreservation of embryos are part of a stable, mature industry that results in 40,000-50,000 calves of beef breeds annually in the United States and Canada. Although this represents only 1 per 700 to 800 beef calves born, these animals are used extensively for breeding purposes, and end up in the pedigrees of increasing numbers of the bulls used for artificial insemination and natural breeding. Embryo transfer procedures, costs, and applications are discussed in detail by Seidel and Seidel (1991), Elsden and Seidel (1995), and numerous others.

Costs of embryo transfer

In some unusual situations, costs over those of conventional reproduction can be under $200 per calf produced by embryo transfer. However, in most cases this figure is in the $500-1,000 range. The highest costs occur when incompletely trained personnel work with poorly managed cattle so that low pregnancy rates occur.

Although counter-intuitive, easily the major cost of embryo transfer under most circumstances is for recipients. Delaying pregnancy in normal, healthy cattle is expensive, and embryo transfer almost always causes such delays. This is because recipients are kept nonpregnant until embryos are recovered from donors, or if frozen embryos are used, pregnancy rates are reduced 10-15%. In either case, the net result is some delay in getting the recipient pregnant relative to conventional reproduction. It is important to note that good recipients are above average in maternal traits such as fertility and milk production, and should be healthy and large enough to calve easily. They obviously need not come from the top of the herd, but for good results, they should not be culls either.

In addition to feed and maintenance costs such as vaccinations, conscientious estrus detection is essential, and reproductive cycles of donors and recipients must coincide. The extra costs of synchronization and appropriate record keeping are relatively low.

Costs for embryo transfer services vary widely and depend primarily on the volume of work and the skill and reputation of the personnel hired. The cost of drugs for superovulation is in the $50-60 range per donor. Charges per donor for collecting embryos usually are in the $100-200 range, and charges for embryo transfer are $50-100 per recipient. For freezing, charges usually are $25-50 per embryo, but often are waived if the same personnel also transfer the embryos. Some embryo transfer practitioners charge $100-125 per hour for services plus actual costs of supplies. It is essential to evaluate the whole package when contracting embryo transfer work.

Ranchers can learn to do embryo transfer themselves, although some minimal involvement of veterinarians is required to purchase superovulation drugs. The most expensive embryo transfer programs often are those in which ranchers attempt the embryo transfer work but have insufficient training and skills. Some of the least expensive programs are those in which ranchers acquire the requisite skills and then practice on cull cattle. The costs of acquiring such skills usually are thousands of dollars. Fees for embryo transfer training can be as high as $3,000 to 4,000; they can be much lower for more superficial programs. Considerable experience with artificial insemination is a pre-requisite for embryo transfer training. In most casts, the major cost of training is in the low success rates obtained after training but before becoming proficient. Most people have quite low rates of success for their first 10-25 donors and 50-100 recipients. Some never become really proficient. On the average, those who obtain more comprehensive training will have a shorter period of low success than those with the more superficial training. However, there are great differences among individuals; also, a considerable element of luck is involved. Unless one plans to transfer hundreds of embryos per year, in most cases it is less expensive to hire a professional than to invest in training.

In some situations, the best approach is to learn only a part of the embryo transfer process, and when that is mastered, learn another step. For example, one might learn to thaw and transfer frozen embryos as a first step.

<u>Success rates of embryo transfer</u>

The variability in response of donors to superovulation is huge. The number of good embryos recovered per normal fertile donor ranges from zero to 40 or more, with an average of about 6 with good management. The most common result, zero embryos, occurs for 20-25% of donors. A typical response of 4 to 8 embryos occurs about 30% of the time; 1 to 3 good embryos are recovered from about 25% of donors, and 9 or more from 20%.

Some causes of this great variability are starting to be understood, but research findings have not yet led to reliable improvements in superovulation procedures. Cryopreservation of embryos has been used to deal with this variability, resulting in banking embryos. When donors produce excess embryos, they are deposited in the bank; when insufficient unfrozen embryos are available to make full use of recipients, embryos are withdrawn from the bank and thawed. The somewhat lower pregnancy rates with frozen embryos are compensated for by much lower recipient needs, because extra recipients are not needed for those days that donors produce large numbers of embryos. Note that if embryos are not frozen and embryos must be discarded when large numbers are produced, the average number of embryos transferred per donor drops way below the average of 6 available when all embryos are included.

At least 12 to 15 recipients are required to determine statistically meaningful pregnancy rates. Under absolutely ideal conditions, pregnancy rates with unfrozen embryos can exceed 70%. However, under most field conditions, pregnancy rates are in the 60% range with good management and unfrozen embryos. With frozen embryos, pregnancy rates are about 10 percentage points lower than with unfrozen ones. Note that increasing pregnancy rates from 50 to 60% actually results in 20% more calves (10 ÷ 50). With poor nutrition or marginal management of recipients, pregnancy rates can be much lower than the figures quoted above. Excellent heat detection is essential for success.

Even with good management, pregnancy rates occasionally are low; in some cases it is not possible to identify the cause. In other cases, the cause is clear but reasonable. For example, in a herd I manage, we synchronize estrus of cattle 40 to 80 days post-partum. Those that are thin or less than 60 days post-partum are not ideal recipients from a fertility standpoint, but we use them anyway so as not to spread out the breeding season. Thus, we sacrifice some fertility to keep breeding and calving seasons manageable.

Future of embryo transfer

Numbers of embryos transferred have remained remarkable stable over the past decade; the extent of use varies somewhat with changes in tax laws and the economic health of the industry. It appears that these trends will continue. Embryo transfer costs are simply too high to be of use in routine beef production; nearly all use is with registered cows. Thus, the main profitable application remains to produce extra breeding animals for sale. There are a few niche applications, such as changing from grade to registered cattle, circumventing infertility, and exporting embryos. The latter is very appropriate because there is less chance of spreading disease with embryos than when importing/exporting semen or cattle (Wrathall, 1995). A number of countries will accept imported embryos, but not animals, because of this safety factor.

As new techniques such as inexpensive, reliable procedures for sexing or cloning of embryos become available, embryo transfer will be used more and more. Under some circumstances, embryo transfer may be used for reliable production of twins. I do not, however, expect to see a great increase in use of this technology for the next 3 to 5 years.

In Vitro Fertilization

The reproductive biotechnology that has made the greatest leap from the laboratory to application in the past 3 years is in vitro fertilization. It appears that about 4,000 calves will be born as a result of these methods in the United States and Canada in 1995. Procedures are sufficiently complicated that they require a centralized laboratory for most of the process (Hasler et al., 1995). There are only about 10 centers that provide these services on a routine basis.

In vitro fertilization procedures

Oocytes (unfertilized ova) usually are recovered from donor cows by inserting a long needle through the anterior vaginal wall and into the ovary to aspirate follicles. This is usually monitored via ultrasound with a probe in the rectum. Thus, the technique is called transvaginal ultrasound-guided oocyte aspiration. This technique can be done with or without giving superovulation drugs first, and at any time of the reproductive cycle, even including the first 100 days of pregnancy. Ovaries can be aspirated every 3 to 4 days, but weekly is more common. On the order of 6-8 oocytes are recovered per session (Looney et al., 1994), but this varies considerably, depending on hormonal treatments to the donor, frequency of collection, stage of the cycle, age of the donor, etc. About 40% of the oocytes are abnormal and discarded. Such procedures have been done successfully for individual donors on a weekly basis for more than 1 year.

The next step is maturation of the oocytes, a process that requires incubating them for 20-24 hours. Sperm that have been incubated for 1-3 hours for capacitation are then added, and the gametes co-incubated overnight. Usually 75% of the 3-5 normal oocytes are fertilized, and these are cultured for 5-6 days more so that they develop to the late morula or early blastocyst stage. This is necessary to get reasonable pregnancy rates with nonsurgical transfer to the uterus. On the average, 1 to 2 normal, transferable embryos result from the 2 to 4 oocytes that were fertilized. Pregnancy rates usually are in the 40-50% range, so the net average result is less than one calf per procedure. The most common result is no pregnancy, but in some cases 6 or more pregnancies result. Even with an average of half a calf per try, if it is repeated weekly, this results in 26 calves per year; over 100 pregnancies per donor per year can be produced in some instances. There is some evidence that some calves produced in this way are abnormal (Behboodi et al., 1995). These abnormalities are discussed in more detail later. Pregnancy rates with cryopreserved, in vitro fertilized embryos are very low with current procedures.

Applications of in vitro fertilization in cattle

Currently, in vitro fertilization procedures require great attention to detail and are 20 to 50% more costly per calf produced than routine embryo transfer. However, there are several important applications. One of these is circumventing infertility, which is the major application of this procedure in women. Cows with blocked oviducts, which prevent fertilization and recovery of embryos with routine methods, and cows that do not respond well to superovulation are excellent candidates for this technology (Looney et al., 1994). Another application is to obtain more pregnancies than with conventional embryo transfer procedures, or to obtain additional pregnancies when donors are pregnant. Still another application is to obtain pregnancies from a cow that is about to be euthanized or even one that has already died. If the ovaries are recovered within a few hours of death, it often is possible to successfully mature and fertilize the recovered oocytes. In fact, for routine research purposes, we obtain ovaries from a slaughterhouse and use these as a source of oocytes.

This concept can be expanded to include propagating slaughtered heifers with especially good carcass traits, or making inexpensive embryos to use in twinning projects, or combining in vitro fertilization with sexing to produce pregnancies of one sex. Such mass production applications already are occurring in Japan, the United Kingdom, Ireland, and other countries where calves are worth more than in North America.

Future of in vitro fertilization

Although one can mass produce in vitro fertilized embryos at relatively low cost, the extra expense of embryo transfer is prohibitive to application in most cases. In vitro fertilization techniques definitely fill a niche, however, and are here to stay. Because of costs and complexities of the technology, I do not foresee the replacement of traditional embryo transfer technology with in vitro fertilization to any extent within the next 3 to 5 years. However, this is a new and exciting technology, and procedures may develop that greatly simplify the procedures and also increase success rates.

Sexing Embryos

There are many methods of sexing embryos (Anderson, 1987; Seidel, 1988). These methods have limitations including the stage of embryo that is sexable, accuracy, minor damage to the embryo, time required, and cost. Also, these are methods for diagnosing rather than controlling sex, with the result that half of the embryos processed will be of the less desired sex.

The only sexing method available commercially at this time is to biopsy the embryo by cutting off a few cells with a microblade and analyzing the DNA for presence of a Y-chromosome using the polymerase chain reaction and other molecular techniques (Bondioli et al., 1989; Herr and Reed, 1991; Thibier and Nibart, 1995). This method is successful for more than 90% of embryos with skilled technicians; the diagnosis is unclear for about 5% of embryos and wrong for 2-3 % (e.g. Thibier and Nibart, 1995). Other drawbacks include the time and skill required to biopsy embryos and that sexing cryopreserved embryos has a higher rate of failure than sexing fresh embryos.

Costs and benefits of sexing embryos

Assessing the costs of sexing embryos is complicated by the unclear diagnosis for around 5% of embryos and the wrong diagnosis for about 2%. Retaining embryos of the "wrong" sex and discarding those of the "correct" sex can be costly in some situations (Seidel, 1985). However, since sexing embryos permits more efficient use of recipients, there can be considerable genetic and economic benefits, although these benefits are not easy to quantify.

In most herds, the best strategy is to obtain male offspring from the very best cows to use as breeding bulls, females from the next best portion of the herd to use as replacements, and males from the rest of the herd for beef since males gain weight more efficiently than females. Thus, for optimum theoretical efficiency, the sex of each individual calf should be specified.

When animals are used or sold for breeding purposes, the value of one sex over the other can be thousands of dollars. However, with very valuable embryos, few will be discarded, even if sexed, because both sexes are valuable. The situation becomes even more complex when considering the general economic laws of scarcity and value. Full sib calves decrease markedly in value per calf as numbers available for sale increase. Because of these kinds of considerations, only rarely will it be worth more than $300-400 per calf to be able to discard embryos of the less desired sex. For sexing on a large enough scale to justify the training, reagents, and equipment required, this figure is likely to be under $200 per calf, which equals $50 per sexed embryo if half of the embryos are discarded and 50% of transferred embryos result in a live calf. This figure applies to herds selling breeding animals; economic advantages of sexing are closer to $50/sexed calf for the vast majority of herds in North America.

A simple example of the practical economic value of sexing when offspring are not used for breeding purposes is from a herd of beef cattle that I manage. Most of the cows are crossbreds of Hereford and/or Angus breeds. The bulls are Charolais. This results in a terminal cross, so steers and heifers are sold for meat at weaning at about 8 months of age. Over the past 4 years, the heifer calves averaged 489 lbs when sold at an average price of .85/lb ($417). Under identical management, the steers averaged 519 lbs when sold on the same date as heifers at an average of .92/lb ($477), a $60 advantage due to sex (an average of $30 per calf). Note that this herd would be managed quite differently if sexing were used. Replacement heifers sired by bulls that transmit good maternal traits would be obtained from about 20% of the cows (those with best maternal traits), and the remaining cows would produce terminal-cross bull calves. The economic advantage per sexed calf likely would exceed $50 over conventional reproduction because of raising rather than purchasing replacement females. Unfortunately, costs of sexing and embryo recovery and transfer likely would greatly exceed $50/calf, especially if pregnancy rates were lower than with artificial insemination. Also note that 40 cows would need to receive embryos to get 20 to have desired calves if pregnancy rates are 50%.

The long-term prospects for sexing embryos are very good if rapid, non-invasive procedures are developed that are accurate and inexpensive. A cost of $10-20 per embryo sexed would be very attractive for herds that already use embryo transfer procedures. In fact, low cost, accurate sexing technology would greatly expand use of embryo transfer; sexing costs might thus be justifiably subsidized by other parts of the embryo transfer industry under some circumstances. Willett and Hillers (1994) explain methods of evaluating the economics of sexing from the standpoints of companies that provide such services and farmers who use the services.

Technologies that may replace sexing embryos

If reliable sexing of sperm were available at low cost, sexing of embryos would become obsolete. It already is possible to sort sperm with 90% accuracy by flow cytometry, and the current rates of 10^5 sexed sperm per hour (Johnson et al., 1994) make it feasible to use this method with in vitro fertilization. This combination of technologies might be used to produce thousands of calves per year in the near future.

Another technology that minimizes the need for sexing is cloning by nuclear transplantation. Once sex of one embryo is determined, all cloned embryos in the same set will be of the same sex.

Another competing technology that is beginning to be used widely is sexing fetuses by ultrasonography. Between 60 and 70 days of gestation, this technology appears to be more than 95% accurate with skilled technicians (Curran, 1992). In most cases, this information is used for advertising purposes prior to selling pregnant cows, not for deciding which pregnancies to abort.

Bisection of Embryos

Simple bisection of embryos was described by several researchers more than a decade ago (Williams et al., 1984). In addition to providing identical twins for research, more calves are produced per two demi-embryos than per whole embryo. The procedure can be done with rather simple equipment by a technician with minimal training. The procedures are not difficult, but some people do not have sufficient patience to become comfortable with the technique. One problem is making the necessary microtools; these are not readily available at low cost. The main cost of splitting is labor; total costs are about $50 per embryo split. However, embryo transfer companies rarely charge clients for splitting because the companies do more business by transferring twice as many embryos.

Efficacy of bisection of embryos

In each of six studies reporting in excess of 100 pregnancies, approximately 50% or more of demi-embryos transferred singly resulted in pregnancy (Arave et al., 1987; Baker and Shea, 1985; Gray et al., 1991; Leibo and Rall, 1987; Takeda et al., 1986; Williams et al., 1984). These studies show that about 50% more calves are obtained when embryos are bisected, than when they are transferred whole. Pregnancy rates for demi-embryos are about 10-15 percentage points lower than for whole embryos. A perplexing question arises as to why such a simple, efficacious technology is not applied more widely. The following reasons may explain much of this paradox:

1. Splitting embryos takes time when time is at a premium. In commercial embryo transfer, one or two people often do the actual embryo transfer work. Recovering, isolating, transferring, and freezing embryos along with the associated paperwork requires intense concentration on the tasks at hand. Superimposing splitting on top of this work can be difficult.

2. Splitting does not work well when combined with cryopreservation because combining the two techniques results in markedly lowered pregnancy rates. Many farms use frozen embryos primarily or exclusively.

3. In most cases, farmers do not want large numbers of calves from individual donors. This is due in part to lack of a market for excess bulls from some cows, a problem that would be solved by sexing embryos.

4. Lowered pregnancy rates per recipient, for example, from 65% to 50% for whole versus half embryos, represent a considerable cost in many embryo transfer programs because of more nonpregnant recipients.

Likely, there are additional reasons for the relatively infrequent commercial use of splitting technology. It appears that only 1 to 2% of calves from embryo transfer in North America result from bisected embryos.

Long-term prospects for bisection of embryos

A major problem with sexing embryos is that only half are of the desired sex. Since bisection doubles the number to transfer, combining sexing and splitting makes practical sense, especially since microsurgery already is being done with either technology. Removal of a few cells used for sexing would be expected to have little effect on pregnancy rates of the demi-embryos because a few cells often adhere to the microblade during bisection anyway. There still is the problem of reduced pregnancy rates if embryos are sexed, split, and frozen.

Technologies that may replace bisection of embryos

Efficacious sexing of semen would replace some splitting of embryos when sexing is part of the reason for splitting. Sexed semen procedures are much simpler for the farmer. Embryos derived by in vitro fertilization of slaughterhouse oocytes are another competing technology because the cost of additional embryos could be lower than the cost of increasing numbers by splitting. Of course, the major technology that would make splitting obsolete is reliable cloning by nuclear transplantation. One could make many copies of embryos with this technology rather than only two.

Cloning by Nuclear Transplantation

Procedures for cloning cattle by nuclear transplantation are derived from those of Willadsen (1986). The current standard procedure for cloning by nuclear transplantation is to remove the chromosomes from in-vitro-matured oocytes microsurgically and then fuse individual cells of morula-stage embryos to these oocytes by electrical pulses (Westhusin et al., 1992). This typically results in 20 to 30 genetically identical 1-cell embryos then are cultured in vitro for a week and transferred to recipients nonsurgically after reaching the morula to early blastocyst stage. To obtain larger sets of genetically identical embryos, morulae are cloned serially, and frequently some are cryopreserved for future cloning.

More than 1000 calves have been produced with these procedures, almost all at private companies (Seidel, 1992; Westhusin et al., 1992). This work takes such huge resources, and is so expensive that very few nuclear transplantation calves have been produced at universities or publicly financed research institutes. While considerable advances and refinements have been made in this field within the past few years, I am aware of only one program currently operating to produce calves by nuclear transplantation on a regular basis, and this program has a research focus.

Efficacy of cloning embryos

Published reports indicate that procedures are not very efficacious if measured by sets of three or more identical calves produced per starting embryo. It appears that most attempts are complete failures, with no calves produced. On the other hand, a few attempts produced spectacular results, with six or more calves per clutch. The average result appears to be about one calf per cloning attempt per embryo. Perhaps recent work that is yet unpublished is more efficacious. A major problem is the difficulty in marshalling the resources required to do all parts of the process effectively. The personnel, equipment, and animals needed for producing large numbers of cloned, full-term pregnancies represent a huge investment.

Despite these problems, several privately funded initiatives resulted in producing large numbers of calves from cloned embryos. The cause of failure of these projects was a large proportion of phenotypically abnormal calves with high rates of neonatal mortality. Many of the calves have been larger than normal, in some cases weighing 50% more than breed average. Weights among genetically identical members of a set are highly variable. Present information indicates that these effects are not genetic. Differences in size among calves become relatively small by a few months after birth (Wilson et al., 1995). Also, it appears that large size and other abnormalities are not transmitted to offspring.

Obviously there can be considerable dystocia with such large calves. This has been the accepted explanation for the high rate of neonatal death, often approaching 50%. However, it appears that large calf size is not the primary problem.

Colleagues at Colorado State University (Adams et al.,1994; Garry et al., 1994) have studied parturition and neonatal characteristics of more than 70 calves produced by nuclear transplantation (Westhusin et al., 1992). Most of the calves were highly abnormal metabolically, regardless of size; most were taken by elective caesarian section to circumvent dystocia. The calves tended to be hypoxic, hypoglycemic, and developed hypothermia easily. They had extremely high insulin concentrations in blood. Also, some recipients showed subtle, abnormal aspects of impending parturition, including lack of progression from stage-1 to stage-2 labor. Interestingly, if the calves were given appropriate supportive therapy such as a warm environment, intravenous glucose, and oxygen, they stabilized rapidly and became well adjusted to extrauterine life within 1 to 2 days. There was no correlation between birth weight and severity of the neonatal metabolic disturbances.

It is worth noting that neonatal abnormalities similar to those that crippled the commercial application of cloning by nuclear transplantation are being seen in a number of other situations involving long-term culture of embryos (Behboodi et al., 1995; Farin and Farin, 1995). There is some evidence that the incidence of abnormally large lambs can be reduced markedly by making small changes in media for culturing ovine embryos (Thompson et al., 1994). It is likely that some or all of the problems with abnormal calves from nuclear transplantation can be solved by modifying the media used for the process.

Long-term prospects for cloning embryos

In many ways cloning by nuclear transplantation provides the ultimate biotechnology for animal breeding because of the complete genetic predictability of the product. Of course, cloning would not be used in isolation, but combined with other technologies, including transgenics, crossing clonal lines, cryopreservation, etc. Also, concerns about decreasing genetic variation can easily be addressed by having numerous clonal lines; this will occur anyway because optimal genotypes for individual environments and management practices will vary greatly, even within a local area. Such considerations, and strategies to deal with them, have been analyzed by Smith (1989). Even with dangers of susceptibility to disease etc., in many management situations with agricultural crops and poultry, efficiencies relating to homogeneity and predictability frequently are overriding. Fringe benefits of cloning such as automatic sex selection also are of value.

Cloning by nuclear transplantation will have limited application until the following are dealt with: (1) low efficiency and predictability of success, (2) abnormal neonates, and (3) high costs. It is likely that these problems will be solved, perhaps within several years. Another important aspect of this technology for cattle is the long-term commitment required to allow some cloned members of a clutch to reach 30 months of age so that their true phenotypic performance can be assessed; frozen embryos can then be amplified to make more copies.

The challenge to commercial application will be organizational; a very long-term plan will be needed along with huge financial resources and an infrastructure to apply the technology. Efficiencies of cattle production could be enhanced markedly with this technology (Smith, 1989). Because of the long time required to characterize clonal lines from frozen embryos, it likely will be 12-15 years before cloning by nuclear transplantation will be used on a large scale in cattle.

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Conception to Consumption: The Economics of Genetic Improvement[1]

by

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From all appearances, the U.S. beef industry is on the brink of yet another *"hard time"*. At the time of this writing, Omaha slaughter steer prices have fallen about 20 percent from their high in March 1993 of near $82.50 per cwt.. Furthermore, that may be the good news. By some estimates, slaughter steer prices will fall to $60.00 per cwt. or less within the next 6 to 18 months (about a 30 percent decline) and feed prices will continue their recent rise. Both will reduce the profit margin in cattle feeding, and as these losses make their way through the marketing chain every segment of the industry -- from breeder to consumer -- will be affected.

It is little consolation, but the beef industry has survived hard times before. It is likely to survive this one as well -- and probably those that the future undoubtedly holds. The beef industry, like any other, is dynamic in nature; it has both ups and downs. The only constant is that the long-term survival of the beef industry depends on its ability to adapt to ever-changing economic conditions -- conditions that are not as producers might wish them to be, but as they actually are. Unfortunately, these changes frequently require adjustments in both the structure and make-up of the industry. Old ways must give way to new, and producers who are unwilling or unprepared to change must be forced out of the industry to make room for the growth of those who will.

In the beef industry, the process can be slow and painful. Hard times bring economic losses that stress everyone involved. However, these losses affect the least profitable producers proportionately more than their efficient counterparts, and as their losses mount, they will be forced to leave the industry. As a result, there is an essential pruning of the beef industry -- in much the same way that pruning a fruit tree makes room for new growth that enhances the productivity and life of the tree. In this respect, hard times may actually enhance the long-term health of the industry. They are the economic equivalent to natural selection to insure the survival of the industry by culling those least economically fit to be members. Hence, the central

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issues are less involved with the survival of the industry than with the survival of individual producers, the short-term effects of hard times, and the nature of the long-term changes that these periodic hard times may cause in the industry.

In this paper we focus on the role that genetics can play in these three issues. In doing so, we bring genetics squarely into the economic arena by considering the profit effects of genetic change for individual producers under both current and projected future beef market conditions. We do this through the application of an integrated (bioeconomic) model of beef genetics to analyze a specific, empirical example. We then summarize the implications of these findings and methods for future research and development, and for beef production in general.[2]

The Economics of Genetic Change

To appreciate the role of genetics in beef production, we must first agree that commercial beef producers must be motivated by profit. Without profit they cannot (and probably should not) survive hard times. Genetics can affect a producer's profit through its effect on (1) the quantity of product, (2) the cost incurred in its production, or (3) the quality of the product and thus, its price. However, economic theory tells us that the first two effects are essentially the same. That is, if the cost of producing a given product with a given market or sales price declines, the profit maximizing producer will increase the quantity of that product. Accordingly, genetic changes can be thought of in terms of their profit effects on beef (1) quantity and (2) quality. The economic value of a specific genetic trait is thus defined as the sum of these effects on profit arising from an incremental increase in the level of the trait. For the *k*th trait this economic value (a_k), following Hazel, can be shown to be (see Melton, Heady, and Willham and Melton, Willham, and Heady for a more complete description of an economic value's derivation).

1) $$a_k = \frac{\text{change in profit}}{\text{increase in the } k\text{th trait}} = \text{product price}\left(\frac{\text{change in quantity}}{\text{increase in the } k\text{th trait}}\right) + \text{quantity}\left(\frac{\text{change in price}}{\text{increase in the } k\text{th trait}}\right).$$

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[2] For the reader's reference, we have also prepared an appendix that presents the theoretical basis for the bioeconomic model used in this paper which is available on request. At points some of the derivations are mathematical and technical in nature. For the reader familiar with these methods the derivations are intended to provide a reference. However, the reader unfamiliar with these methods should not be overpowered by the mathematics. Much of the mathematics can be skipped, at least in a preliminary reading, and still provide the reader with a basic understanding of the concepts involved.

The first term on the right-hand-side of equation (1) is the quantity effect of a genetic change. It relates the change in profit that would result at a given market (product) price from changing product quantity through genetics. The second term relates the quality effects on profit of a genetic trait in that is reflects the price change that would accompany an increase in the level of the *k*th trait at the same quantity. From this expression, two issues become immediately apparant in a bioeconomic analysis. First, the economic value of a trait depends on the prevailing market price for the product which, in turn, depends on the market in question. Second, the economic value of a trait depends on the prevailing level (quantity) of production, which economic theory tells us (for the profit maximizing producer) depends on the levels of available resources or inputs and their prices.

In addition, the effect of an increase in the level of genetic trait may not be constant at all levels of the trait. That is, if a trait is at a very low level (such as g_0), there may be a large value associated increasing it (a_0), as depicted in Figure 1. However, if the trait is already at a relatively high level, the value of an incremental increase may be negligible. Furthermore, if the trait displays an intermediate optimum -- a level that for a given set of prices and resources results in the maximum profit -- higher levels may have negative economic values (an additional increase in the trait's level may reduce profit). Hence, the level of a trait may also affect its value.

A producer typically has different levels of resources that distinguish his or her specific operation from all others -- including different levels of all genetic traits considered simultaneously. Furthermore, different producers typically face different prices for both inputs or products, especially if they market differently, and both prices and resource levels change over time. Hence, the economic value of a genetic trait is not a global constant. Economic values are individualized and apply to a specific producer, the resources or inputs that define that production operation, and the prices faced by that producer at a point in time. A series of complex interrelationships exist that are specific to a producer and may affect or shift the economic value of each trait, even with a comparable technology. The economic value of a trait may thus change for changes in the level of the trait, input or output price changes, or changes in the levels of other traits (Figure 2). Each of these effects must be reflected in a bioeconomic model if we are to correctly estimate the economic values of genetically influenced traits.

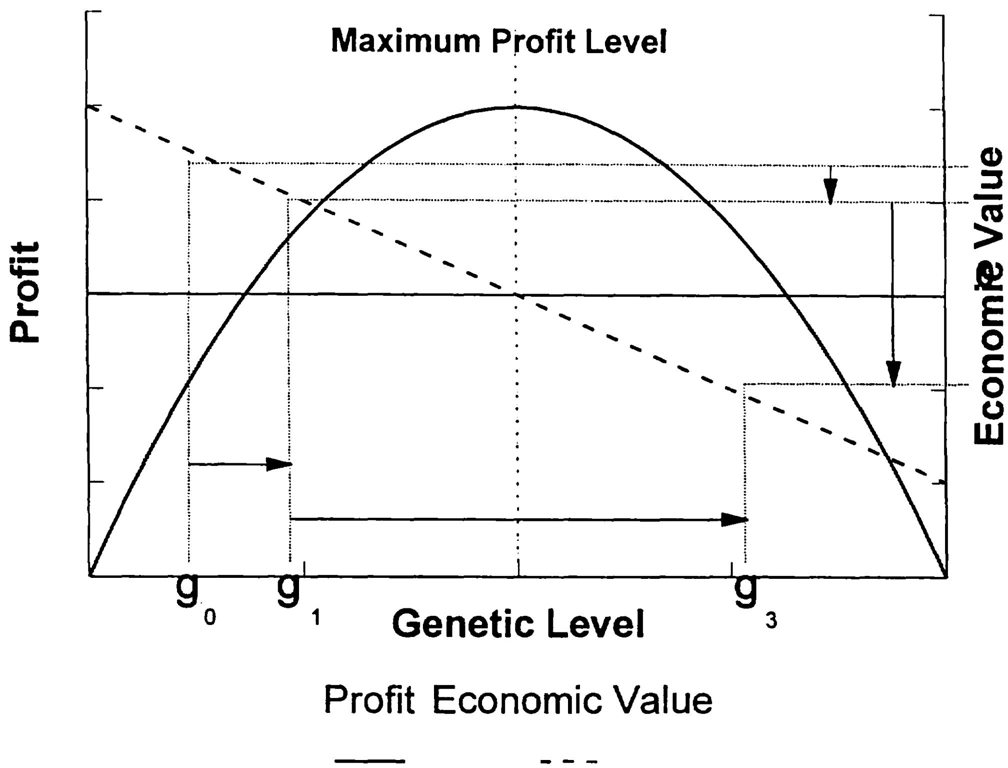

Figure 1. Profit effects of a genetic change.

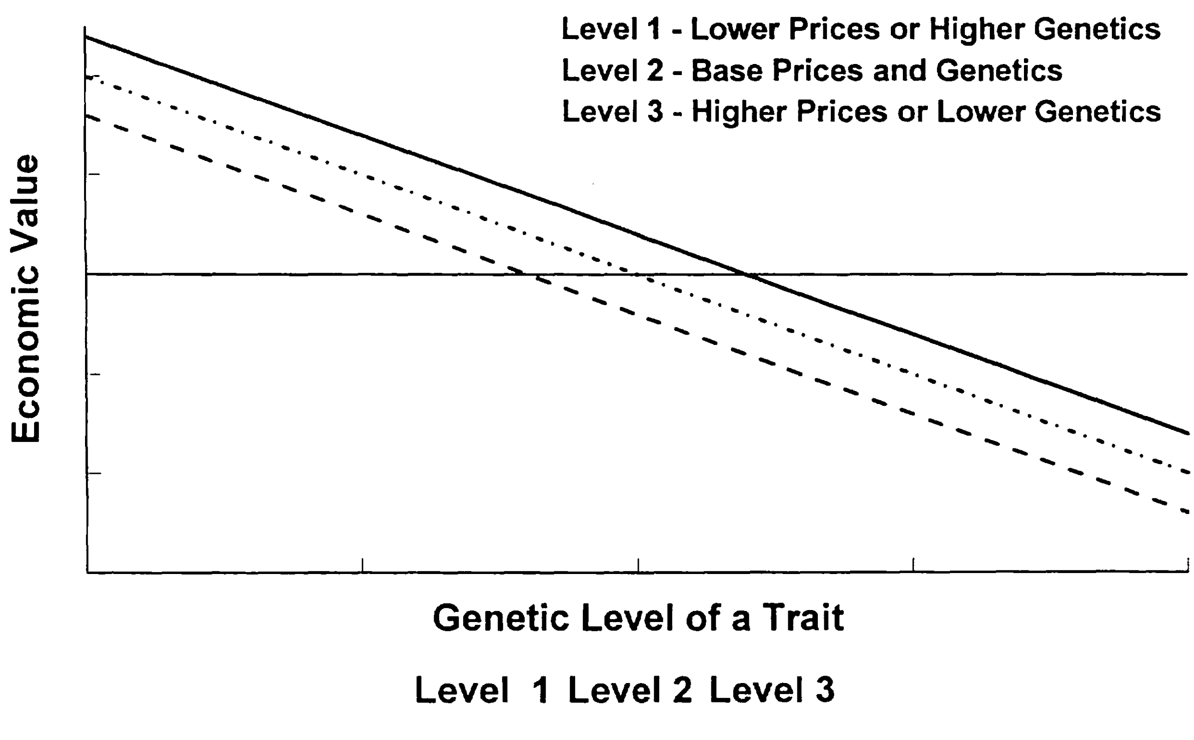

Figure 2. Shifts in economic value from price and genetic level changes.

Estimation of Economic Values: An Empirical Example

The preceding discussion of economic values suggests that, like blind men describing elephants, it depends on where you stand. The economic value of a trait depends on the individual production conditions and the prevailing market prices. Hence, the analysis of genetic change must be cast in terms of some specific set of circumstances. For this purpose, we define two (extreme) alternatives: (1) a fully integrated firm who owns the seedstock and markets retail beef to the final consumer in much the same manner as the overall industry, and (2) a typical cow-calf producer who sells weaned calves at an average market price. The first of these represents full verticle integration and thus is the epitome of value-added marketing. The second is more representative of current market standards in which little if any of the value of post-weaning or carcass superiority accrues to the producer who sells weaned calves at the prevailing average market price. We then relate these base solutions to other alternatives by looking at the effects on economic values of relaxing certain key assumptions.

Full Value Added: The Integrated, Industry-Representative, Firm

In deriving economic values, we first consider a base solution appropriate to a firm representative of the overall U.S. beef industry. That is, we assume a single-producer firm that integrates all aspects of beef production, processing, and marketing from conception to final consumption (retail product) by marketing closely trimmed (1/4 inch fat) retail beef. In this manner we assure that all cost saving or value enhancing changes in genetic characteristics can be directly related to their effect on the profit of the producer who makes the genetic change. As a result, we are able to initially avoid any economic distortions that may potentially arise from either market or industry structure. The resulting structure would appear approximately as depicted in Figure 3.

The choice of characteristics to be valued is more difficult. Each different observation of an animal may be viewed as measuring a characteristic. However, if one is to take this view literally, the number of possible characteristics approaches infinity and quickly becomes so large as to be practically meaningless. For example, the weight of an animal at 200 days of age is typically not the same as its weight at 210 days of age. Hence, the two might be viewed as different characteristics, although as a practical matter they are more likely to be different observations of the same (underlying) genetic characteristic.

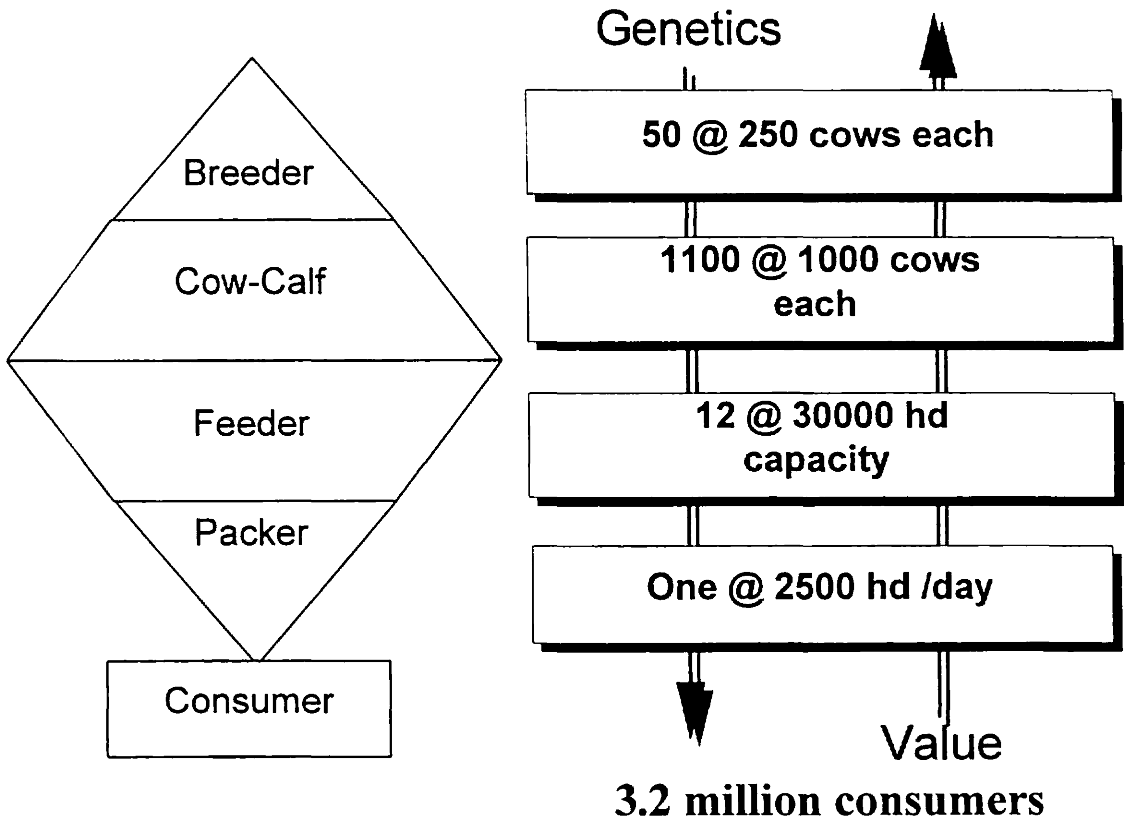

Figure 3. Structure and scale of the U.S. beef industry.

For purposes of this paper a more workable alternative is suggested by the physiology of beef production, processing, and marketing. Specifically, we can conveniently think of the over-all beef production-consumption process as being divided into three overlapping phases as follows:

- the reproduction phase, characterized by the breeding, conception, birth and early nurturing of an animal;
- the production phase in which the composition and mass of the animal is altered by its growth and weight gain; and
- the consumption phase, characterized by the slaughter and consumption or other use of the animal's (disassembled) constituent parts (products).

A reasonably complete representation of the overall process can then be obtained by selecting a limited number of characteristics from each phase that are believed to be (1) economically important in that phase and (2) not highly correlated with one another, especially within a phase.[3] The characteristics selected for this study meet these criteria (Table 1). One can argue with the 16 characteristics selected, the phase to which they are specified to apply, or the infinite number of characteristics excluded. For example, some might prefer to see USDA Yield Grade (USDA-YG) included. As a practical matter, however, USDA-YG is an index that approximates or estimates retail product percent, which is included. Similarly, marbling score conveys much of the information embodied in USDA Quality Grade. In short, these characteristics and classifications appear to represent a reasonable starting point for a broad-based analysis of the U.S. beef industry, while providing a workable total number of characteristics with approximately equal representation from each phase of beef production.

Table 1. Selected Beef Characteristics by Phase.

Characteristic	**Mean**	**Std. Dev. (pheno)**	**Phase**		
			Reprod.	**Prod.**	**Cons.**
Gestation Length (days)	286.88	5.53			
Weaning Rate (percent)	0.83	0.10	x		
Birth Weight (kg)	40.02	9.48	x		
Lactation Ability (Milk	3.55	2.25	x		
Rate of Maturity (Growth)	1.73	0.75	x		
Weaning Weight (kg)	190.37	59.78	x	x	
Feed Conversion	0.12	0.03		x	
Mature Cow Weight (kg)	518.35	145.52	x		x
Post-Weaning Rate of	1.05	0.26		x	
Slaughter Weight (kg)	517.14	181.96		x	x
Carcass Weight (kg)	294.57	33.70		x	x
Retail Product (percent)	0.7	0.09		x	x
Marbling Score (1-=sl-)	9.8	4.48		x	x
Tenderness Score (0-100)	45.23	24.55			x
Flavor Score (0-100)	47.75	21.27			x
Juiciness Score (0-100)	44.56	22.92			x

3 The degree of correlation between characteristics should be judged in the context of their multi-trait correlations as opposed to the simple correlation between any pair of characteristics. For example, weaning weight may not be highly correlated with birth weight, but it is nearly perfectly correlated with a linear combination of birth weight and pre-weaning rate of growth (pre-weaning average daily weight gain).

The economic values of these characteristics are estimated for a representative West Texas producer-feeder-packer-processor-marketer using average long-term price ratios typical of 1980-84 (Table 2). The economic values of the first 13 characteristics are estimated using data from the Germ Plasm Evaluation trials conducted at the U.S. Meat Animal Research Center, Clay Center, Nebraska (for a summary of the values used and computational method used see Melton, Colette, and Willham). However, these data do not include measurements of beef characteristics associated with consumer preference (e.g., flavor, juiciness, or tenderness). Furthermore, the literature of animal science includes few examples of these data and none that display the degree of underlying economic sophistication that would be necessary to correctly estimate economic values. Hence, the first 13 characteristics are valued on the basis of average carcass prices adjusted for carcass yield and quality grade price differences.

Table 2. Estimated Economic Values for an Integrated Beef Firm.

Characteristic		**t-value**
Production Effects (per Head Economic Values)		
Gestation Length (days)	-8.17	-0.96
Weaning Rate	220.36	0.82
Birth Weight (kg)	-4.59	-0.58
Lactation Ability (Milk Production)	24.72	1.05
Rate of Maturity	-213.55	-0.94
Weaning Weight (kg)	2.67	0.94
Feed Conversion Efficiency (kg/Mcal)	4,474.65	1.71
Mature Cow Weight (kg)	-0.23	-0.23
Post-Weaning Rate of Gain (kg/d)	-200.69	-0.81
Slaughter Weight (kg)	-0.98	-1.87
Carcass Weight (kg)	0.18	0.25
Retail Product	1,998.44	1.75
Marbling Score (10=sl^{-})	-9.84	-0.71
Market Price Effects		
Tenderness Score (0-100)	0.43	0.24
Flavor Score (0-100)	7.71	4.05
Juiciness Score (0-100)	3.15	1.79

The economic values of the remaining three characteristics (associated with consumer judgments of meat quality) are estimated for retail meat from a pilot project study conducted for the National Pork Producer's Council as part of the National Pork Quality Audit (Melton, 1994; Melton, Huffman, and Shogren, 1995). Although based on pork trials, it is reasonable to believe that these values are also applicable to beef when adjusted for differences in average beef versus pork prices. This is based on the assumption that consumer preferences for meat quality characteristics are consistent, regardless of meat source. That is, they do not prefer tough meat whether it is beef or pork. Because of this method of derivation, the results must be separated between average production effects (per head in the herd) for the first 13 characteristics and average market price effects (per kg of retail meat sales times an average of 206.2 kg of retail product per head) for the remaining three characteristics. Their sum reflects the total effect of the genetic change shown in equation (1).

The interpretation of these results is relatively straight-forward. The coefficient (a_k) is the single year effect on per head profits for the industry representative producer of increasing the mean level of the characteristic by one unit. The t-values reflect statistical confidence in the coefficient estimate where t-values less than 2.0 in absolute value indicate that we can not be statistically sure, with 95% confidence, that the effect is not zero. For example, the coefficient value for gestation length indicates that increasing gestation length by one day (on average) will reduce profits by $8.17 per head, but that effect is not significantly different from zero in a statistical sense (t value=-.96).

It is important to note that only one of the coefficients (economic values) is statistically significant at a 5 percent level. This finding may indicate that despite our efforts to select relatively independent characteristics, a high degree of linear correlation remains between at least some of the characteristics. This would be expected if the actual number of genetic (production) characteristics is considerably smaller than the 13 selected. If so, many of these characteristics would actually represent alternate observations or measurements of the same underlying characteristic. Hence they are correlated. To explore this possibility, only those characteristics that improve (reduce) the Mean Square Error (MSE) of the model are estimated and all others are assumed to be zero (Table 3).[4]

Table 3. Minimum MSE Estimated Economic Values.

Characteristic		**t-value**
Production Effects (per Head Economic Values)		
Weaning Weight (kg)	0.64	2.60
Feed Conversion Efficiency (kg/Mcal)	2,736.07	3.45
Post-Weaning Rate of Gain (kg/d)	-178.84	-3.00
Marbling Score (10=sl^{-})	-10.87	-2.64
Market Price Effects		
Flavor Score (0-100)	7.94	4.67
Juiciness Score (0-100)	3.38	2.15

The number of characteristics is reduced considerably by this method. Of the original 13 production characteristics, only four (now statistically significant) characteristics are required to predict profit effects with minimum error variance (Table 3, top panel). These include characteristics that can be broadly categorized as reflecting (1) the total size or number of cells (weaning weight), the rate of growth or size change (average daily gain), (3) the composition of growth (marbling score), and (4) the metabolic efficiency of growth (feed conversion). Despite eliminating 9 of 13 characteristics, the R^2 value, reflecting the proportion of the variance in profit explained by the statistical model, is reduced only slightly (from .62 to .57).

Negative economic values for average daily gain and marbling score with positive values for weaning weight and feed conversion efficiency tend to emphasize the high cost of U.S. grain-fed beef. Specifically, a high rate of weight gain requires more feed to achieve that potential. Similarly, more feed is required for fat deposition than lean. However, either improved feed efficiency or greater weaning weight can reduce post-weaning feed requirements. The economic

[4] If a set of independent variables is highly correlated, fewer than the total number may be required to adequately explain the variance in a dependent variable. One method of evaluating this is the Mean Square Error (MSE) of the regression model. Highly correlated dependent variables may reduce the Sum of Squares Error (SSE), but they also reduce the degrees of freedom for error (dfe) such that MSE rises (i.e., MSE=SSE/dfe). The statistical model with the best predictive ability is the one with the least error variance, as estimated by the MSE. Hence, it is that model which includes only the set of dependent variables (from amongst all possible) that result in a reduction in the MSE (to a minimum).

values shown in Table 3 reflect the cost (or cost savings) of feed embodied in a genetic change, especially in post-weaning production.

The number of consumer characteristics, as reflected in market price, is also reduced slightly by eliminating tenderness from the minimum MSE model (Table 3, bottom panel). The t-values of the remaining characteristics improve as a result, but the drop in the R^2 value (from .2683 to .2682) is negligible. Despite its statistical non-significance in explaining the purchase price, the interest in tenderness among members of the beef industry (Morgan, 1992) warrants its continued inclusion in this study. Hence, we reject the minimum MSE results (Table 3) in favor the model of economic values that includes tenderness (Table 2).

The reader may initially be surprised by the relatively low economic values attributable to meat characteristics, especially tenderness. Equally disconcerting to some may be the low R^2 of these models, indicating that only about one-fourth of the variance in price can be explained by a combination of meat tenderness, flavor, and juiciness. These findings seem to contradict prior research which found that tenderness is an especially important consideration to meat consumers (Morgan et al, 1991; Savell et al, 1987 and 1989 and Morgan, 1992). However, when put in perspective, there may not be a contradiction at all.

Prior research regarding consumer meat preferences has largely been both hypothetical (no transaction occurs) and descriptive in nature. That is, consumers have been asked to judge a piece of meat against an unspecified standard on an ambiguous scale (Savell et al, 1987 and 1989; Morgan et al, 1991). They have not been asked to bid on and purchase a piece of meat (evaluate it on a common dollar scale) after having tasted a sample and being allowed to evaluate its eating characteristics. A considerable body of theory and empirical research in economics suggests that the latter method is strongly preferred to the descriptive and hypothetical method, which tends to yield inflated and largely unreliable answers. However, to relate the two methods, one to the other, the NPPC study also asked consumers to evaluate the product in subjective terms -- reflecting how they judge the overall acceptability of the meat. This measure, which we refer to as *"eatability,"* corresponds to the consumer evaluations used in many prior studies and in which meat is "ranked" according to relative consumer acceptability.

The effects of each characteristic on meat eatability are shown in Table 4, along with the effects of eatability on meat price. These results explain much of the apparent inconsistency between this and prior studies. Tenderness and flavor are major determinants of consumer acceptability (eatability) of meat products; each accounts for about 40% of consumer preferences and is highly significant. Furthermore, the three characteristics chosen for this study jointly explain nearly 85% of the variability in consumer preferences. However, overall eatability explains only about one-fourth of the variance in consumer price, a result comparable to those shown in Tables 2 and 3. Hence, we may conclude that consumer judgments regarding meat acceptability (or non-acceptability) do not directly translate into differences in either the price or quantity of meat purchased and that these important relationships can not be properly examined except in the context of market price-quantity (or demand) relationships.

Table 4. Effects of Meat Characteristics on Consumer Acceptability.

	Effect	t-value
Effects of Meat Characteristics on Eatability		**R^2=.8403**
Tenderness	0.41	10.00
Flavor	0.45	9.96
Juiciness	0.13	3.23
Effects of Eatability on Meat Price		**R^2=.2835**
Eatability	104.15	9.42

Such a finding supports the belief that meat quality characteristics such as tenderness are important components of overall meat acceptability. However, they contribute relatively little to explaining how consumer meat preferences (and acceptability) are eventually expressed in the market. Instead, meat quality is only one consideration in the consumer purchase decision -- with respect to either bid prices or quantity purchases. The nature and magnitude of the other factors considered by consumers, their price-quantity effects, and the nature of their interactions with product quality can not be specified for beef at this time. They may, however, reasonably include such elements as the prices of substitutes, ease of preparation, and various socioeconomic concerns. Additional study of the type currently underway by NPPC will be required in the future to address these complex economic issues impacting beef consumption.

The estimated economic values are adjusted for time over a total of 6 generations assuming (1) a discount rate of 5%, (2) a two year lag between selection and production, and (3) a total economic life of 10 years. Furthermore, it is assumed that reproduction traits are expressed within two years of selection while production and consumption traits require upwards of three years. The time adjusted economic values are summarized in Table 5 where, as previously, all other characteristics have a zero economic value.

Table 5. Time Adjusted Economic Values for an Integrated Firm.

Characteristic	Economic Value
Production Effects (per Head Economic Values)	
Weaning Weight (kg)	5.98
Feed Conversion Efficiency (kg/Mcal)	24,738.21
Post-Weaning Rate of Gain (kg/d)	-1,616.98
Marbling Score (10=sl˚)	-95.06
Market Price Effects	
Tenderness Score (0-100)	3.51
Flavor Score (0-100)	67.44
Juiciness Score (0-100)	27.59

The Commercial Cow-Calf Producer: The Segregated Beef Industry

Although the broader industry implications are important, more relevant to today's commercial producer is the value of genetic change given the prevailing structure of the industry. Our representative firm was assumed to be engaged in all phases of the industry culminating with retail sales to the final consumer. In fact, the prevailing industry structure is one of highly specialized, often competitive sectors (Figure 4). That is, few cow-calf producers own their cattle post-weaning and few live-animal producers slaughter, package, wholesale, or retail their beef. As a result, most commercial cow-calf producers (who make the genetic decisions) can be compensated for those decisions that influence post-weaning performance or consumer quality only through differential prices received at weaning.

Market signals, in the form of different prices, indicate the appropriate genetic emphasis. Absent those signals, there is no economic incentive for change. Hence, if consumers want a different beef product, they must pay price differences. Furthermore, those price differences must make their way through all segments of the industry to the cow-calf producer and breeder.

However, that transmission is not always clear, nor do we envision it as the straight line flow of value and market information we might prefer.

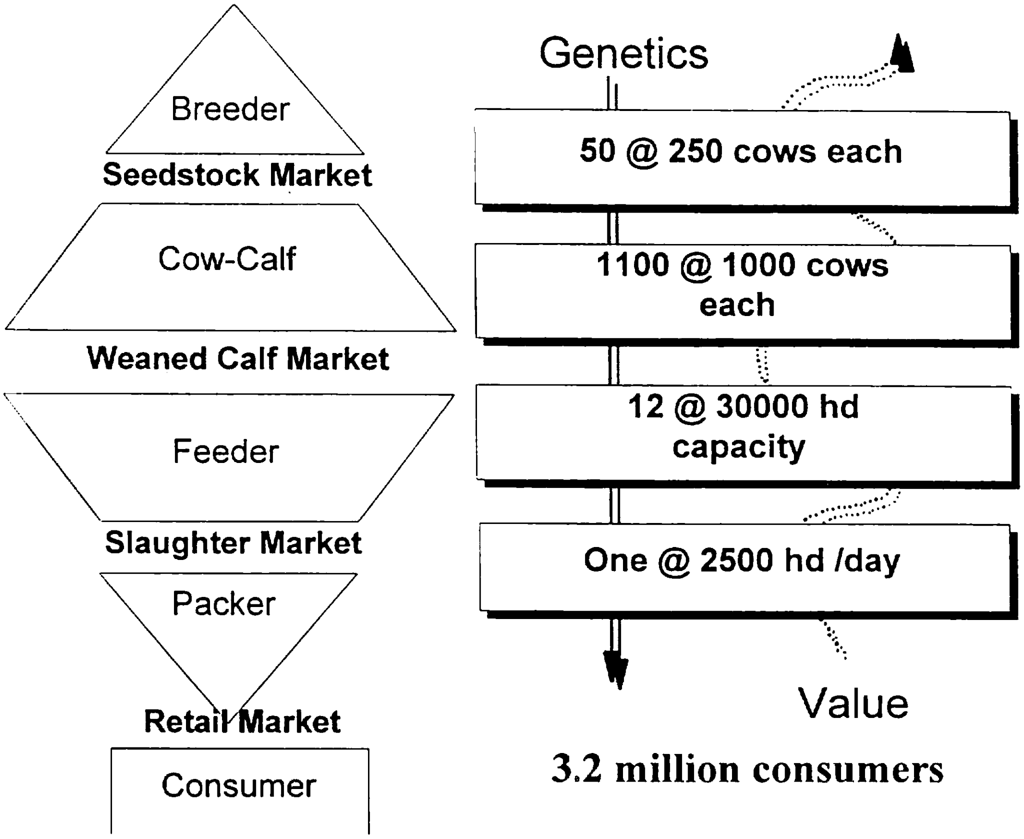

Figure 4. Segregation of the beef industry into specialized sectors.

Although physical differences (weight, lot size, sex, etc.) affect price, Schroeder et al (1991) found the price differentials attributable to breed to be small. This finding supports what many already believe:

> *"The current beef market, at least at the weaned calf level, is dominated by "average price purchasing" in which genetic post-weaning or consumption superiority (or inferiority) is not adequately reflected by price premiums (discounts)."*

Hence, cow-calf producers do not receive clear price signals regarding meat quality. Their selection emphasis should thus be different from that of the integrated firm. To address these issues the economic values of the characteristics are re-estimated for a producer identical to the first except that calves are sold at weaning for a prevailing market price (per unit weight) that results in different prices only by calf weight and sex (Table 6). Hence, no price adjustment is made for USDA-YG or other qualitative carcass measures that can not be observed at weaning.

Table 6. Economic Values for a commercial cow-calf producer selling weaned calves.

Characteristic (unit)	All Characteristics		Minimum MSE		Time Adjusted
	Value	t-value	Value	t-value	Value
Gestation Length	-0.78	-0.78			0.00
Weaning Rate	392.23	11.6	392.63	17.83	3,795.91
Birth Weight	-0.62	-0.64			0.00
Lactation Ability	1.81	0.57	2.01	2.08	19.42
Rate of Maturity	-17.09	-0.64			0.00
Weaning Weight	1.56	4.66	1.35	35.4	12.58
Feed Conversion Efficiency	-45.31	-0.13			0.00
Mature Cow Weight	-0.10	-0.87	-0.05	-1.92	-0.43
Post-Weaning Rate of Gain	-42.31	-1.36	-42.87	-4.74	-251.84
Slaughter Weight	-0.02	-0.36			0.00
Carcass Weight	0.06	0.71			0.00
Retail Product	211.97	1.51	117.88	2.76	1,082.47
Marbling Score	4.04	2.47	3.45	3.82	31.71
Tenderness Score	0		0		0
Flavor Score	0		0		0
Juiciness Score	0		0		0

Cursory comparison of these results to those obtained for the integrated industry representative firm (Tables 2, 3, and 5) illustrates the greater value to cow-calf producers of maternal and reproductive characteristics. Furthermore, consumer judgments of quality such as tenderness, flavor, and juiciness have no value to the commercial cow-calf producer who (1) does not typically know these values and (2) is not compensated for them. It is also interesting to note that although the producer selling weaned calves is not differentially compensated for superior carcass quality (retail product percent or marbling), these characteristics have positive economic values. However, the economic value of retail product, for instance, is only 20% of its value to the industry representative firm who derives a direct benefit from increased yield. Finally, a significantly greater portion of the variance in profits of a cow-calf producer can be explained by genetics than is possible for an industry representative firm (as judged by the R^2 values). This finding may be partially attributed to the fact that the industry representative firm is highly idealized (it does not actually exist). In other words, we can better describe something that actually exists (the current structure) than something we imagine (an aggregate, integrated industry). Other characteristics, factors, or interactions that are not considered in this study may significantly impact industry profits and their exclusion reduces the R^2 values for the industry representative firm. However, all of these results are to be expected given the prevailing industry structure.

Despite the contrast between these results, it is interesting to note that the minimum MSE models for both include a limited number of characteristics including some reflecting (1) size, (2) growth, (3) efficiency, and (4) composition. This finding supports our hypothesis that the actual number of identifiably distinct genetic characteristics of economic importance may be rather small.

The greatest time-adjusted economic value to commercial cow-calf producers is for increased weaning rate (3,796). Without a calf to sell no other characteristic has much meaning. Accordingly, pre-weaning and maternal characteristics dominante economic values -- so much so that some post-weaning production and consumption characteristics (such as post-weaning average daily gain) actually have a negative economic value in the cow-calf producer's program of genetic selection.

Relative economic weights

There are clearly differences in the economic values between these two alternatives. Those differences can be analyzed by comparing traits or groups of traits in terms of their absolute economic values, relative economic values, or economic weights. Relative economic values are expressed in terms of the values of all traits relative to one trait selected as the standard (i.e., it is a ratio of economic values where one arbitrarily selected trait has a value of one). As such, it differs little from the absolute economic values we have already discussed except in scale. However, this concept differs from relative economic weights that are defined as the portion of overall net economic merit or aggregate breeding value attributed to a characteristic or set of characteristics on a standardized or comparable scale basis. To compute this value we assume that negative and positive genetic change are equally important, but in opposite directions. The relative economic weight for a characteristic is then the standardized weight (per standard deviation) applied to a characteristic by a profit maximizing firm divided by the sum of these standardized weights for all characteristics, independent of sign. That is, we compute the change in profit or net economic merit (aggregate breeding value) that would result from a one standard deviation improvement (either plus or minus) in every trait. The amount of that increase due to a standard deviation improvement in each trait is the trait's economic value times its standard deviation (Table 7).

Table 7. Standardized (per std. dev.) Economic Weights by Industry Phase.

Phase	Reproduction	Production	Consumption	Adj. Overall	Ratio
		Industry Representative Firm			
Reproduction	0	175.13	0	87.57	1
Production	175.13	627.14	285.68	857.55	9.79
Consumption	0	285.68	1,041.35	1,184.19	13.52
Overall[1]	175.13	1,087.95	1,327.03	2,129.31	
		Commercial Cow-Calf			
Reproduction	139.58	368.42	46.41	346.99	3.24
Production	368.42	38.74	167.55	306.72	2.87
Consumption	46.41	167.55	0	106.98	1
Overall	554.4	574.7	213.95	760.69	

[1] Row overall totals will not sum due to double-counting of overlapping traits. These are adjusted when computing the adjusted overall.

These results highlight the differences between our two scenarios. The fully integrated firm has a much larger profit potential than the cow-calf producer. Such a firm is able to market a higher value product, which enhances the value of the genetics embodied in that product. Hence, we estimate the total economic benefit of enhanced genetics for this firm to be about three times as great as for the commercial cow-calf producer selling weaned calves at an average market price($2129 versus $761). Such a finding supports our belief that cattlemen must increasingly market products rather than selling commodities.

The differences between these firms extend to their relative economic weighting of the different traits. The fully integrated firm places a considerable value on consumer traits (nearly half of the value) because this firm is able to respond directly to what consumers will pay for product changes. The relative economic value of consumer traits is about 13.5 times as great as reproductive. However, the opposite situation exists for the commercial cow-calf producer who does not see any value from consumer choice. This producer places 3.24 times greater value on reproduction than consumption and, without overlapping traits, the difference would be much larger.

Extensions and Implications of the Results

Differences in economic values help explain the interest in value-added marketing. However, these values should not be taken to represent values appropriate for the overall industry and suggest other discrepancies that warrant attention. Some of these issues can be addressed, at least in a cursory fashion, relative to the economic values estimated for our representative production scenarios.

Value-added Marketing: Formula Sales of Slaughter Cattle

Differences in management and marketing structure clearly affect economic values. The fully integrated, industry representative firm, for example, captures all of the value-added benefit of post-weaning production, processing, and marketing activities. The cow-calf firm, selling weaned calves, captures essentially none of the value-added post-weaning benefit. The differences between these firms are clear and provide some of the motivation behind the recent interest in strategic alliances and formula pricing. The former is an attempt to capture value-added benefits by variations of retained ownership, while the latter is an attempt to more equitably allocate the total benefits in a value-added framework. That is, the formula should insure that each participant receives an equitable portion of the total value based on their individual contribution to that total. Hence, the two are often be implemented in tandem.

To illustrate these effects on the economic values of characteristics, we consider an alternative pricing formula currently in commercial use (Minnie Lou Bradley, 1994). According to this formula slaughter steers receive a premium for USDA quality grades (associated with marbling score) above High Select (marbling score of 9) and USDA yield grades (associated with retail product percent) better than 2.6. Similarly, they receive a discount for lower quality grades or worse yields. The maximum premiums for quality and yield grade are $.07 and $.09 per pound of hot carcass weight, respectively. Retail sales, and thus consumer meat values, are not considered in the strategic alliance-formula pricing scenario.

Table 8. Economic values for formula sales of slaughter beef.

Characteristic	Value	t-value
Per Head Economic Values		R^2=.6713
Gestation Length (days)	-3.33	-0.70
Weaning Rate	711.88	4.59
Birth Weight (kg)	8.46	1.88
Lactation Ability (Milk Production)	15.13	1.00
Rate of Maturity	-186.97	-1.46
Weaning Weight (kg)	2.04	1.29
Feed Conversion Efficiency (kg/Mcal)	1,454.29	0.88
Mature Cow Weight (kg)	-0.92	-1.64
Post-Weaning Rate of Gain (kg/d)	-12.07	-0.08
Slaughter Weight (kg)	0.81	2.67
Carcass Weight (kg)	-0.35	-0.85
Retail Product	1,576.19	2.46
Marbling Score (10=sl^{-})	18.3	2.42
Tenderness Score	0	
Flavor Score	0	
Juiciness Score	0	

These results demonstrate the effects of formula pricing to induce value-added marketing. When compared to the results for a cow-calf producer (Table 6), we see that substantially greater value is attached to carcass traits (retail product and marbling score). Hence, the producer derives greater value than the sale of weaned calves, but less than the value for a fully integrated firm (Table 2). At this point it is important to recognize that there is not a "correct" formula. Presumably, any formula adopted would reflect the value associated with the processor purchasing under that formula. One might attach a premium to marbling, while another might attach a greater premium to carcass weight. It, like other economic values, depends on subsequent markets and the value that can be realized in those markets.

Implications for the U.S. Beef Industry

Results presented thus far are for individual firms. They do not reflect the values that would apply to the overall or aggregate beef industry if all producer made the genetic changes suggested. Even those for the fully integrated, industry resentative firm should not be taken as the results for the aggregate industry, although they encompass all functions of the industry. The reason for this is that the demand curve for beef, relating the quantity of beef demanded to its price, is downward sloped. That is, a lower price is required to market a larger quantity. The representative firm is assumed to have a fixed (constant) average beef price. When genetic change is extended to the industry the result is (1) a cost savings or (2) increased output (beef). Both cause beef market supplies to increase and price to decline.

Economists frequently examine market price-quantity relationships in the context of what is termed the price elasticity of demand, defined as the percentage change in quantity for a percentage change in price. Melton and Huffman (1993) have recently estimated the retail price elasticity of beef demand in a full expenditure model to be -.309. Thus, a 1% increase in aggregate beef production might be expected to result in a 3.24% decline in average retail beef price.

Assuming a constant herd size and culling age, the maximum genetic response per generation is fully defined by the heritability of the characteristic (or an index of multiple characteristics) and its phenotypic variance. Based on the results obtained for the representative industry firm and assuming all genetic progress translates directly into expanded supplies, the rate of expansion per generation could be as high as 12%. Hence, average beef prices (in real dollars) might be expected to decline by about 40% per generation. This does not mean that either economic values or profit will necessarily fall. If the beef supply is expanded by reducing cost, as with a genetic technological change, the cost reduction might be larger than the revenue reduction and profit might increase.

Although relative economic values may not necessarily change, in the example for the industry representative firm the absolute values of the seven characteristics with non-zero values may be smaller. Hence, they will be closer in value to those that have zero values and relative economic values will change. Additional research, beyond the scope of this paper, will be required to quantify the aggregate effects of genetic change on the industry in either absolute or relative terms.

Implications for the BQA

Results presented in this study also raise serious doubts regarding the economic values and intensity of interest focused on the BQA results (1992). The BQA results argue that the economic loss to the beef industry due to "beef quality defects" is about $280 per head for every steer and heifer slaughtered in the U.S. However, results of this study suggest that the estimated economic loss may be incorrect and that the producer emphasis and interest generated in carcass characteristics by this large value may be overstated if not entirely misplaced. In short, carcass characteristics, in any scenario considered in this study, simply do not seem to merit the attention demanded by the BQA based on their economic values to producers (relative to other characteristics). We believe, for reasons discussed below, that the BQA values are incorrect.

Many have erroneously interpreted this amount, representing nearly 25% of total slaughter value in 1991, to be the amount of profits foregone by the industry because of carcass quality "defects". In point of fact, the losses estimated in the BQA do not correspond to profits. Instead, they are more nearly indicative of foregone revenues. That is, they do not take account of the costs that would be incurred by the industry to capture these additional revenues and thereby arrive at an estimate of the net profit to potentially be lost or gained in the industry. As a very simply example, injection-site blemishes are estimated to account for a loss of $1.74 per head. While unnecessary or poorly placed injections may occur, the study does not consider the necessary injections that may save an animal's life or enhance their performance or the cost (in terms of dead, sick, or poor performing animals) that would be born by the industry if these injections were not given. In other words, if the (opportunity) cost of an action taken to increase revenues exceeds the revenues to be gained, the producer and the industry will be worse off. In short, the BQA estimates fail to take account of important components of profit that result in overstatements of the possible losses that can conceivably be attributed to carcass quality.

Furthermore, the estimate of $279.82 per head in lost revenue (revenue foregone) may also be biased, if for no other reason than its implicit assumption of fixed (industry) market prices at 1991 prevailing levels. For example, one can assume, at the extreme, that the capture of this additional $279.82 in revenue, would be achieved by the industry marketing additional beef. That is, surplus fat would have a higher value if it were beef and marketed as such. Economic principles dictate that as cost is reduced, the supply of a product will increase. Because the BQA estimate of $279.82 per head represents 25% of the total value of beef supplied in 1991, the capture of this "loss" would be achieved by reducing cost, which has the effect of increasing the quantity of beef supplied by about 25%.

However, introductory economics also tells us that price declines when quantity increases. For beef, as with most agricultural commodities, we should expect the price decline (as a percentage) to exceed the quantity increase. In fact, as we showed previously, price will decline when supply is expanded and by proportionately more than the expanded supply (Melton and Huffman, 1993). The price reduction (in real dollars) that would be required to absorb this additional per capita quantity of beef might be three times as great on a percentage basis (i.e., 1991 prices for slaughter steers would be about $.20 per pound instead of $.80 per pound, all other things being equal). When these price-quantity changes are recognized and taken account of, the "remedy" of beef quality "defects" identified by the National Beef Quality Audit might actually be expected to cause industry total revenues to fall dramatically -- despite cost reductions (Figure 5).

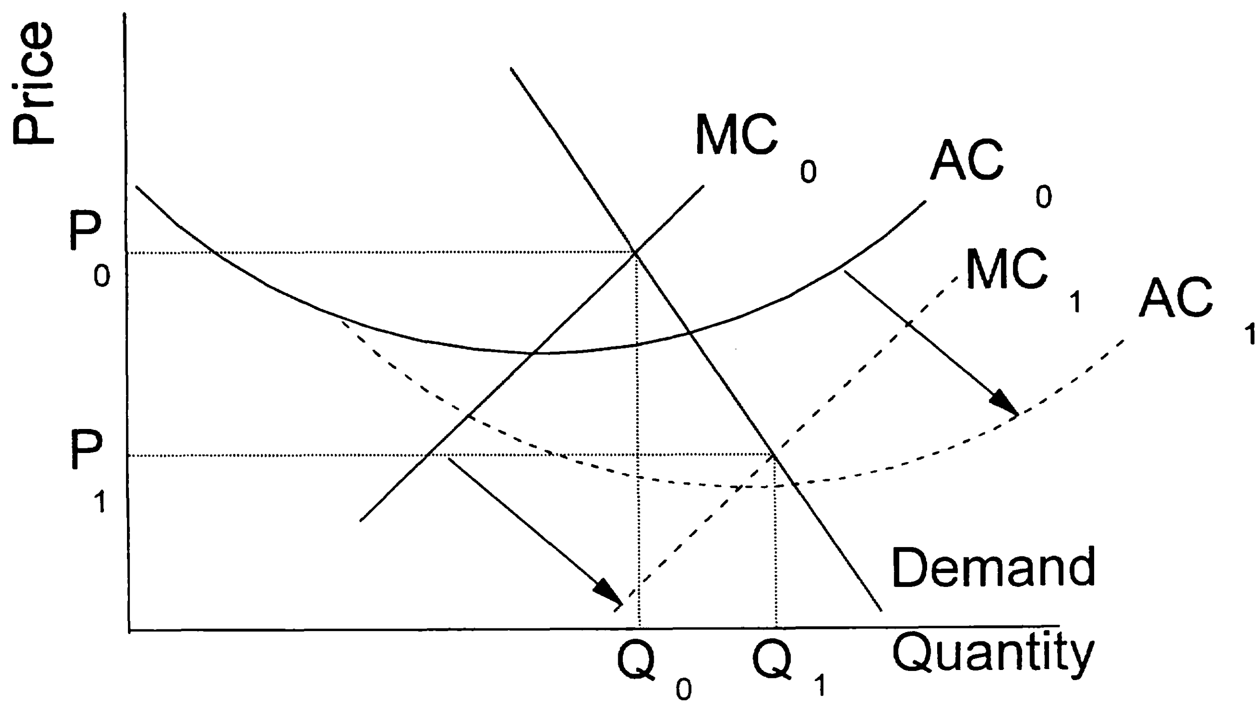

Figure 5. Effects of cost reduction on beef industry revenues.

Many readers will also be inclined to dispute the relatively low emphasis these results suggest should be applied to qualitative carcass characteristics for either the industry or the cow-calf producer. Some will argue that the "true" economic values of these characteristics, including tenderness, are greater than indicated by this study. However, there are alternatives to genetic change readily available to improve tenderness and other beef quality characteristics if these are economically significant problems. These alternatives would logically be pursued by a profit maximizing industry if the value contributed by their remedy exceeded the cost of remedy. Hence, these alternatives provide an independent basis for judging the validity of the economic values estimated for qualitative characteristics such as tenderness and provide additional insights to the potential long-run effects on the industry.

For example, estimates are that tenderness problems could be remedied in the 15-20% of carcass that are "unacceptable" through such treatments as calcium chloride injections or increased aging administered at the packing level. These results suggest that the industry average cost of remedying tenderness problems by these methods would would be $.90 to $1.35 per head (Melton, 1994d). However, the BQA (1992) suggests that the value of remedy is (the majority of) $2.89 per head. If the revenues foregone by a profit maximizing industry, or a firm in that industry, due to tenderness problems were actually $2.89 per head, it is rational for that firm to expend $.90 to $1.35 per head to remedy it because a net benefit (profit) of $1.55 to $2.00 per head would result. Given that these existing alternatives are not being widely employed, we may conclude that the potential revenue to be gained from improved tenderness is less than $2.89 per head, and in fact, it is less than $1.35 per head. This smaller value is consistent with the relatively small economic value ($.43 per head) attributed to short-run consumer-based characteristics like tenderness and lend further support to our contention that the BQA values for attributes such as tenderness are overstated.

Further evidence in support of this position (the relatively low economic value of tenderness) is provided by results linking meat acceptability to consumer price. Results of this study show that meat tenderness, flavor, and juiciness explain about 85% of the variance in consumer judgments of meat acceptability. Furthermore, a 1% increase in tenderness increases the overall acceptability of the meat by .4%. This finding is in general agreement with other studies that have found tenderness to be a major factor influencing consumer acceptability of meat.

However, this study also demonstrates that consumer judgments regarding meat acceptability do not explain the majority of price differences. In fact, neither acceptability nor a combination of tenderness, flavor, and juiciness explained 30% of the variance in meat price. Other factors, such as prices of substitutes and complements, income, or socio-economic concerns must account for much of the difference in meat price and these can not be remedied nor changed by the beef producer. The low correspondence (correlation) between meat quality characteristics and price support the contention of this paper that such characteristics should not receive large weights in the breeding program of a profit maximizing firm or industry. That is, producers must be motivated not by what consumers say they want, but by what they are willing to pay to fulfill their wants.

Other readers will contend that these "low" economic values may be correct now, but that qualitative characteristics are more important in the long-run to prevent continued erosion of beef market share and the "destruction" of the beef industry. Of course in the long-run, if long enough, anything is possible. However, by some estimates beef tenderness problems have been with us since the widespread adoption of "boxed-beef" nearly a quarter-century ago. As yet, its effects on beef market share and price have not been dramatic and the beef market will continue to change. For example, in a study of over 30 years of price and cost data Melton and Huffman (1993) found that most (about 90%) of the decline in beef's market share can be directly attributed to other factors, most notably including relative price changes between beef and other goods (including dairy, pork and poultry). Many of these price changes are associated with changes in the relative cost of production. The more beef is standardized, the more it is viewed as a commodity rather than a product. Hence, the more responsive it is to the prices of substitutes and the less qualitative differences contribute to value. In fact, the more direct way to receive "value-added" compensation is by marketing products (as demanded by consumers) rather than selling commoditites which are freely substitutable.

These results also strongly suggest that beef producers need not be altruistic to preserve their industry over the long-run. The long-term survival and prosperity of the industry depends on its economic viability, which is better served by improving its competitiveness, profitability, and economic efficiency than by (unduly) focusing on characteristics that customers may want, but for which they are unwilling or unable to pay. As evidence of this one need look no further than the leather industry. Thirty years ago over 80 percent of the hides produced in the U.S. were processed into leather goods in the U.S. By 1993 this had fallen to about 25 percent. The industry has been lost to overseas competitors, not because U.S. leather was of inferior quality, but because U.S. costs were too high and profits were too low to remain price competitive for the consumer's dollar. Furthermore, Total Quality Management or Quality for Quality's sake has not prevented other businesses once listed as the most excellent companies in America (Peters, 1982) from getting into financial trouble and will not protect the beef industy.

In short, the BQA identifies many of the characteristics of carcasses that warrant attention. However, the values attributed to these characteristics appear to be significantly overstated. The exaggerated values contribute to an unwarranted over-reaction in the industry that sometimes seems to verge on a knee-jerk panic. The attention warranted by these characteristics should be based on their contribution to producer profits, which according to the results of this study, is much less that proposed (or interpreted) in BQA results. Additional research is required to correctly state the values of "carcass defects" before producers can rationally judge the relative attention that should be devoted to their remedy.

Summary

The results presented in this paper are more complicated than the "rule-of-thumb" weighting proposed by Trenkle and Willham (1977). For many, their complexity may be overpowering. However, in the information age of high-speed personal computing we must accept that complex calculations are no longer beyond the reach of individual producers if the proper software is available. Thus one need not be intimidated by the complexity of the results or the computations required to obtain them. It is much more important that their broader implications be understood.

First, this paper has shown that economic values are individualized values that depend not only the industry structure, but on the individual producer and his (or her) endowment of resources, prices, the production environment, and the genetic level of the herd. Hence, completely different economic values and animals may be required to maximize the profits of two different producers.

This caveat aside, this paper has also shown (through analyses of representative firms) that the number of economically important genetic characteristics (genotypes) may be much smaller than the number of measurements (phenotypes). In other words, the traditional model of animal breeding that requires a one-to-one correspondence of phenotype and genotype may be inappropriate for commercial application. Additional research is required to investigate this phenomena more fully and, if necessary, to develop alternative statistical and economic models of genetic action.

Results of the representative firm analysis highlight the differences that exist between firms, including those due to industry structure. A firm representing the overall beef industry controls production (and product) from conception to consumption. As a result, the net economic benefits of any genetic decision accrue directly to the firm -- without structural or market distortion. Under these idealized conditions, negative economic values result from increased post-weaning rate of gain and marbling score, reflecting the high share of total cost occurring in post weaning fed beef production. Positive economic values are associated with improved weaning weight, feed efficiency, tenderness, flavor, and juiciness, although tenderness has a very small and statistically insignificant economic value. Post-weaning characteristics should receive much less economic attention from this firm whos marketing should be dominated by consumers and their preferences.

Although these results provide some useful insights, the assumptions of an industry representative firm are so idealized as to be essentially meaningless to an individual producer. Almost no producers involved in breeding decisions are also directly engaged in the post-weaning production and consumption phases of the industry. Furthermore, there is limited potential for this to occur in the foreseeable future unless it is by virtue of "top-down" vertical integration following the model of U.S. poultry production. An alternative, reflecting this fact and the prevailing industry structure, is examined by assuming a commercial cow-calf producer that markets weaned calves -- as most in the U.S. do. These results reflect the differences between a producer compensated for the value and quality (yield grade differences, etc.) of his (or her) product and those that market in the traditional manner in which final or intermediate quality is not fully recognized.

The economic values are dramatically different for this firm than for the industry. Pre-weaning or reproductive characteristics (weaning rate, lactation ability, and weaning weight) become much more important, with weaning rate having the largest single economic impact ($3.796 for a one percent increase in weaning rate). Production and consumption characteristics (post-weaning rate of gain, retail product percent, marbling score, and consumption characteristics) are not only less important, but in many instances the direction of the emphasis is reversed -- from a positive weight by the industry to a negative weight by the individual cow-calf producer.

The emphasis in selection for a cow-calf producer is skewed toward pre-weaning characteristics, with an overall weight of nearly 50%. These results confirm what many already know: "What may be good for the industry may not be good for individual producers who must bear its cost." For the industry to achieve the genetic changes that are in its long-run overall best interest, the cow-calf producer must be differentially compensated for the efforts and cost required. Current structures do not achieve this. Recent strategic alliance programs have attempted to address this issue, but only in a very limited (and somewhat idealized) fashion. Considerably more research and effort will be required in the future to address these issue in the context of the broader beef industry, as illustrated by example analyzed regarding the formula sale of slaughter beef.

Results of this study also highlight potential flaws in the National Beef Quality Audit (1992) and its interpretation. The relatively small values and selection weights associated with consumption characteristics, and especially those reflecting consumer judgments of quality, seem to contradict the National Beef Quality Audit's (1992) finding of an average loss of $279.82 per head attributed to "quality defects."

Many have erroneously interpreted this amount, representing nearly 25% of total slaughter value, to be the amount of profits foregone by the industry because of carcass quality. In point of fact, the losses estimated in the National Beef Quality Audit (1992) do not correspond to profits. Instead, they are more nearly indicative of foregone revenues and do not take account of the costs that would be incurred by the industry to capture these additional revenues.

Furthermore, the estimate of $279.82 per head in lost revenue (revenue foregone) may also be biased, if for no other reason than its implicit assumption of fixed (industry) market prices at 1991 prevailing levels. For example, one can assume, at the extreme, that the capture of this additional $279.82 in revenue, would be achieved by the industry marketing additional beef. The quantity of beef supplied would then increase by about 25%. Some estimates are that the price reduction (in real dollars) that would be required to absorb this additional per capita quantity might be three times as great on a percentage basis (i.e., 1991 prices for slaughter steers would be about $.20 per pound). When these price-quantity changes are recognized and taken account of, the "remedy" of beef quality "defects" identified by the National Beef Quality Audit might actually be expected to cause industry total revenues to fall. Without corresponding reductions in cost, industry profits would become (almost universally) so negative that what happened to the industry in 1973-75 would look insignificant.

Further evidence in support of the values proposed in this study is provided for the consumer characteristic of tenderness, which has lately garnered specific attention among members of the industry. This evidence takes two forms: (1) an analysis of the differences between consumer acceptability and willingness to pay (price) and (2) an analysis of some of the "non-genetic" alternatives that could be employed by packers or meat wholesalers/retailers to remedy tenderness problems.

The study shows that meat tenderness, flavor, and juiciness explain about 85% of the variance in consumer judgments of meat acceptability. This finding is in general agreement with other studies that have found tenderness to be a major factor influencing consumer acceptability of meat. However, this study also demonstrates that consumer judgments regarding meat acceptability do not explain the majority of price differences. In fact, neither acceptability nor a combination of tenderness, flavor, and juiciness explained over about 28% of the variance in meat price. Other factors, such as prices of substitutes and complements, income, or socio-economic concerns must account for much of the difference in meat price and these can not be remedied nor changed by the beef producer.

Additionally, alternatives to breeding exist as means to remedy beef tenderness problems. These include both mechanical and biochemical means at virtually every stage of production, although only increased aging and aging with calcium chloride injections at the packer level are considered in this study. These results suggest that the industry average cost of remedying tenderness problems (in the estimated 15% of the carcass exhibiting these problems) would be $.90 to $1.35 per head. If the revenues foregone by a profit maximizing industry, or a firm in that industry, due to tenderness problems were $2.89 per head, as suggested by the BQA, it is rational for that firm to expend $.90 to $1.35 per head to remedy it because a net benefit (profit) of $1.55 to $2.00 per year would result. Because it is not being done, we may assume that the true value is smaller -- a finding consistent with the relatively small economic value estimated in this paper.

In many ways this study raises more questions than answers. However, in a larger sense that may be its greatest contribution to the industry. It recognizes that the U.S. beef industry is not one-dimensional and, as a result, there is no single-characteristic panacea to the problems confronting the industry. The problems, like the industry itself, are multi-dimensional. The *"correct"* solution requires a balance that can not be achieved by a quick-fix nor by remedies that fail to (correctly) recognize the inherent economic consequences -- not only for the industry, but for individual producers who must bear the cost and whose profits and survival rest on these decisions.[5]

Recommendations for the Future

The beef industry is struggling to define its current and future priorities in the face of difficult economic times. As the industry looks to the future, we judge the following to be some of the more important implications and recommendations growing out of this study:

1. Economic values of characteristics are individualized; they depend on the resources, prices, management, genetic levels and the environment prevailing for an individual firm. Just as there is nearly infinite variety in the producers that comprise the U.S. beef industry, there is a wide range of economic values. Hence, what is best for one, is likely not to be best for all -- nor perhaps even for one other. Methods of deriving individualized economic values, including more complete consideration of genetic by environmental interactions, will increase the industry's profitable genetic progress and reduce the dependence of its members on "single-answer" solutions that really fit no one.

2. The number of economically important genetic characteristics (genotypes) in beef cattle is probably <u>much</u> <u>smaller</u> than the number of characteristics measured (phenotypes). More rapid genetic progress, with greater profit potential, would be possible if these genotypes were more fully defined and the number of phenotypic measurements were reduced to include those that best predict the unobserved genotypes.

3. The beef industry is far from a single entity. It is more nearly a collection of competitive "sub-industries" that happen to deal in a common commodity -- the beef animal. As such, changes that benefit one sub-industry may be at the expense of another. Economic values that fail to recognize these fundamental structural and market differences are more likely to transfer costs and benefits between sub-industries (i.e., from packer to feeder or cow-calf producer) than to the enhance the total. This fact contributes to the marked differences in economic values and selection weights found for the industry representative firm and the commercial cow-calf producer used as examples in this paper. If the cow-calf producer is to make genetic changes that enhance post-weaning performance or carcass characteristics, he (she) must receive differential (quality based)

[5] Total Quality Management (TQM), which motivated much of the recent attention on beef quality, is but one component of a solution, as evidenced by the fact that many of the firms cited for excellence in the pioneering essay on TQM by Peters (1982) are currently "down-sizing," in financial distress, or bankrupt.

prices for weaned calves -- something that does not occur under the current industry structure. Methods that recognize the contribution of each sub-industry and individual firm, such as value-added marketing, must be developed if each member of the industry is to be fairly compensated for its contribution to revenue and the cost it bears.

4. Greater total production (and market share) is not, in itself, the answer to the beef industry's problems. With greater production, average beef prices will fall by proportionately more than output expands, as the current market illustrates. As a result, total revenue to the beef industry will decline and, unless cost is reduced by proportionately more, industry profit will also fall. The industry must, therefore, sharpen its focus on promoting profitable change -- accepting in the process that the greatest possible level of production (or market share) may not be the most profitable. In the same vein, the industry must become increasingly a marketer of products than a seller of commodities.

5. Consumer preferences are certainly important in any market, but only to the extent that those preferences are translated into price differences. Such qualitative meat characteristics as tenderness, flavor, and juiciness are key determinants of aggregate consumer acceptability, but not of price. The industry must focus on those characteristics that result in real value for the producer, as indicated by cost and/or price differences. In this respect the industry must realize that beef is increasingly viewed as a "commodity" rather than a "product." Efforts to "standardize" beef will accentuate its commodity image and make it even more difficult to translate qualitative differences between animals or carcasses into real price differences. Assuming, as this research indicates, that qualitative differences will persist, consideration should be given to developing quality differentiated markets (such as in Japan and other areas of the world) that will effectively accommodate (and capitalize on) beef as a qualitatively varied product capable of satisfying the real and varied quality demands of consumers.

6. Economic values are intended to guide the industry (and its individual members) in very practical issues related to profitability and survival. That does not mean that the underlying economics must be either naive or simplistic, nor that economic considerations (and problems) warrant less scientific sophistication than those of a breeding, nutritional, or physiologic nature. Hence, the industry should not be satisfied with over-simplified or partial answers and should concentrate on bringing greater economic sophistication to bear.

Some readers may find other aspects of this paper more significant or to have greater implications for future priorities in the beef industry. However, it is felt that these six points provide a diverse base on which to build an enhanced understanding, without attempting to be all encompassing. Furthermore, the provide concrete steps that can be taken that will have direct implications for the profit of commercial beef producers.

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Appendix: The Theoretical Basis of the Bioeconomic Model

An Economic Model of Beef Genetics

At each stage of beef production the process can be represented mathematically by an implicit transformation or production function (F) relating the quantity of multiple products (Y_i for $i=1$ *to* m) that result from the use of multiple inputs (X_j for $j=1$ *to* $n+1$) for a given technology,

2) $$F(Y_1, Y_2, \ldots, Y_i, \ldots Y_m, X_1, X_2, \ldots, X_j, \ldots, X_n, X_{n+1}) = 0.$$

That is, the amount of each product (e.g., Y_i = beef, fat, bone, waste, etc.) per unit time depends on the amount of each input supplied (e.g., X_j = feed, labor, capital, etc.) in the production process as defined by a technology represented mathematically as the implicit transformation function (F). If we define the last input (X_{n+1}) as the animal or herd of animals, then genetics can be introduced to the production process by re-writing the transformation function on a per animal or herd basis as

2.a) $$F(Y_1, Y_2, \ldots, Y_i, \ldots Y_m, X_1, X_2, \ldots, X_j, \ldots, X_n, g_1, g_2, \ldots, g_k, \ldots, g_s) = 0$$

where g_k is the level of the kth genetic trait, and the animal or herd is represented in terms of all (s) of the genetic characteristics it embodies.

At any point in time, or over a reasonably short period of time, the genetics of the animal or herd is fixed. That is, genetic change occurs only over time and the producer cannot freely vary the level of traits within each production period. Thus, the genetics are a type of technological constraint to production. The producer must do the best he or she can with the current genetics.

Beef producers have a variety of objectives or goals that guide their production decisions. Some are guided by tradition; others produce out of a sheer love of the animals. However, to a greater or lesser degree, each producer is motivated by profit. For purposes of this paper we ignore other goals affecting beef production decisions and assume the producer is exclusively motivated by maximizing profit. As such, we define a *"normative"* or standard basis to which individual producers may compare their own (less profit motivated) decisions. Accordingly, the profit accruing to the beef production process in the current production period is

3) $$\pi = \sum_i P_i Y_i - \sum_j w_j X_j + \sum_k \lambda_k (g_k^0 - g_k)$$
$$+\lambda_F F(Y_1, Y_2, \ldots, Y_i, \ldots Y_m, X_1, X_2, \ldots, X_j, \ldots, X_n, g_1, g_2, \ldots, g_k, \ldots, g_s)$$

where P_i is the price received for the ith product, w_j is the price paid for the jth input, λ_k is the Lagrangean multiplier reflecting the constraint that the producer's use of the kth genetic input is equal the current level of the input (g^0), and λ_F is the Lagrangean multiplier constraining the producer to adhere to the limits of the technology defined by the transformation function.[6]

The first-order conditions necessary to maximize profit are

3.a) $$\frac{\partial\pi}{\partial Y_i} = P_i + \lambda_F \frac{\partial F}{\partial Y_i} = 0 \qquad i = 1, 2, \ldots m$$

3.b) $$\frac{\partial\pi}{\partial X_j} = -w_j + \lambda_F \frac{\partial F}{\partial X_j} = 0 \qquad j = 1, 2, \ldots, n$$

3.c) $$\frac{\partial\pi}{\partial g_k} = \sum_i Y_i \frac{\partial P_i}{\partial g_k} - \lambda_k + \lambda_F \frac{\partial F}{\partial g_k} = \qquad k = 1, 2, \ldots, s$$

3.d) $$\frac{\partial\pi}{\partial \lambda_k} = g_k^0 - g_k = 0 \qquad k = 1, 2, \ldots, s$$

and

3.e) $$\frac{\partial\pi}{\partial \lambda_F} = F(Y_1, Y_2, \ldots, Y_i, \ldots Y_m, X_1, X_2, \ldots, X_j, \ldots, X_n, g_1, g_2, \ldots, g_k, \ldots, g_s) = 0$$

Although this representation assumes that prices for products and inputs are fixed with respect to their quantities, we do recognize and take account of the fact that the level of a genetic trait may affect the quality of the products and thus the prices received (equation 2.c). For simplicity, we also assume that second-order conditions necessary to insure that the solution is a maximum rather than a minimum profit are satisfied and solve these $i+j+2s+1$ first-order conditions simultaneously to obtain profit maximizing levels of input use and production.

Various relationships among products and inputs can be derived from these first-order conditions. However, for purposes of this paper the most significant is the value of a genetic trait. Hazel, in his initial development of a multi-trait selection index, noted that (pp. 477)

"It is logical to weight the gain for each trait by the relative economic value of the trait ...",

where the relative economic value of a trait

"... depends upon the amount by which profit may be expected to increase for each unit improvement in the trait."

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6 The equality of the Lagrangean forces technical efficiency in that the producer must neither exceed nor fall short of the transformation function. That is, for a given input use the producer gets the maximum amount of product allowed under the specified technology, but no more.

Hazel's definition presupposes that the direction of change that constitutes an improvement is known. That is, reducing some traits may be an improvement while increasing others is an improvement. As a result, all economic values are positive, but the genetic change may be either positive or negative. We modify this definition slightly to define the economic value of the *k*th trait (a_k) as *the effect on profit of an* *increase* *in the level of the genetic trait.* Hence, an economic value may be either positive or negative depending upon the direction of genetic change that constitutes an improvement (in profit). Thus, the economic value of the *k*th trait in terms of our profit function is

4) $$a_k = \frac{\partial \pi}{\partial g_k^0} = \lambda_k .$$[7]

By additionally manipulating the first-order conditions it can be shown that the economic value of the *k*th trait is

4.a) $$a_k = \lambda_k = \sum_i Y_i \frac{\partial P_i}{\partial g_k} + \lambda_F \frac{\partial F}{\partial g_k}, \text{ where at the optimum } \lambda_F \frac{\partial F}{\partial g_k} = \sum_i P_i \frac{\partial Y_i}{\partial g_k}$$

(see Melton, Willham, and Heady for a more complete derivation of these relationships).

Thus, the economic value of a genetic trait depends on the sum of (1) its affect on product quality and prices received and (2) its ability to shift the transformation function and the value of that shift (i.e., causing more product to be available for sale at the same level of input use or less input needed to get the same level of production). Hence, it is a reflection of the profit effect that a genetic change has on quality and the prevailing level of production technology. In fact, genetics is most easily viewed as an essential form of livestock production technology that may affect both product *quality* and production efficiency (*quantity* per unit input).

The source of a trait's economic value is important. Some traits may have large quality effects but virtually no quantity effects. Furthermore, depending on the market structure in question some traits that have quality effects may not result in a non-zero economic value. For example, we can assume that more tender or flavorful beef has a positive effect on quality as perceived by a consumer. Furthermore, the consumer would be willing to pay more for this higher quality and the trait would thus have a positive economic value. However, the majority of beef

[7] It is worthwhile to note that the economic value of the *k*th trait is properly expressed in terms of the effect on profit of a (marginal) increase in the current level of the trait holding all other variables constant. This reflects the fact that producers are constrained to use the existing level of genetics in their production decisions. The issue is then what it would be worth (in terms of more or less profit) to relax that constraint and thereby (marginally) increase the level of the trait from its current level holding all other variables constant.

slaughter animals are produced by commercial cow-calf operators who sell weaned calves to a stocker or feeder who then adds value and sells them to a packer, then a wholesaler, and eventually a retailer before the final sale occurs to the consumer. Most of these sales are "at the average" price, especially those from cow-calf producer to stocker or feeder. Hence, the cow-calf producer, who must make the genetic choices that affect beef quality, does not receive any price difference for either superior or inferior meat quality (as perceived by the consumer). Although the trait has a value, that value is not translated through the marketing channel to the cow-calf producer who makes the genetic choice and, from his or her perspective, it has no value.

Quality traits are not the only ones affected by average price marketing. Superior post-weaning performance (e.g., high feed efficiency, rapid rate of weight gain, high carcass cut-out) is seldom differentially priced at the cow-calf level, although broad discounts may be applied (by groups, herds, or breeds) for inferior performance or value. Hence, the estimation of economic values depends upon the marketing system of the breeder. Those producers that market weaned calves have different economic values for the same traits (animals) than those that produce the calves and market slaughter beef. Furthermore, the value of a trait to the integrated industry, from conception to consumption, is likely to be quite different than its value to an individual breeder or cow-calf producer as later stages in the market channel receive market signals (premiums or discounts) for the level of genetics which they had no hand in producing.

Further Implications of Economic Values

This expression for economic value has implications beyond identifying the sources of a trait's value. For instance, equation (3.a) makes no assumption about the relationship between the *k*th trait and either output (Y_i) or price (P_i) level. Although the values of the partial derivatives may be constant, for many traits it is more likely that these partial derivatives are themselves functions of the trait's level. As a result, the economic value of the trait will differ at each level of the trait. To illustrate, assume that when all other variables in the profit equation are held constant the profit effect of a genetic trait can be expressed as a quadratic function of the trait's level,

5) $$\pi = b_0 + b_1 g_k - b_2 g_k^2$$

The economic value of the trait is then a linear function of the trait's level,

5.a) $$a_k = \frac{\partial \pi}{\partial g_k} = b_1 - 2b_2 g_k$$

and the economic value of the trait declines at every greater level of the trait. Graphically this results in a relationship as depicted in Figure 1.

According to equation (2.d), the economic value appropriate to any specific analysis or estimation depends on the prevailing level of the trait (g^0), which is superimposed on Figure 1. Hence, although the economic value of the trait changes at each level, it is fixed at each point in time according to the currently prevailing level of the trait in the herd. As the trait's level changes (say from g^0 to g^1), so does the economic value of the trait (from a^0 to a^1). Economic values should thus be re-estimated as the herd mean changes because economic values will also likely change. Furthermore, not all traits' economic values will change by the same proportion if the slope of the profit function is not identical for all traits. The economic values of some traits may be very close to constant and change little, but others will change dramatically as the level of the trait changes.

Figure 1 also suggests another important concept related to genetics and economic values. Of late *"target levels"* have generated considerable interest among animal breeders. Target levels refer to the *"ideal"* level of traits and assume that breeders will find the best way to reach them once they have been defined. This approach is motivated by perceived weaknesses in the more traditional method of selection indexes (as developed by Hazel). Specifically, the selection index method specifies the direction of change and the relative importance of the traits, but not the *"end"* point. By implication, one could select in the prescribed direction, at the same relative intensity, forever with equal (economic) results. As a result, the selection index is much like a road map to genetic change that provides a direction and speed, but no ultimate destination. Defining a target level attempts to remedy this deficiency by providing an indication of the desired ending level of the trait, but without any indication of the direction or speed warranted in changing the trait from its current level.

However, Figure 1 illustrates that when genetic change is cast in an economic framework, these two genetic concepts (selection and target levels) are closely related. At the level g^0 the producer should increase the level of the trait with a relatively high economic value (a^0). However, as the genetic level approaches the maximum profit level, the economic value of the trait approaches zero -- implying less emphasis should be devoted to further increasing it. In short, the target level, defined as the profit maximizing level of the trait, is related to the trait's economic value such that at the profit maximizing level the economic value of the trait is zero.[8] Furthermore, if the breeder exceeds the profit maximizing level, the economic value of the trait becomes negative -- signaling that the level of the trait should be reduced.

The reader should also be aware that this result depends on the non-constant nature of economic values. If an economic value were constant, there would be no (optimum) limit to the level of the trait and the target level would be undefined (equal to infinity). Unfortunately, if a trait has a non-constant economic value, but that variability is not recognized, the optimal level of the trait will be exceeded if the breeder continues to increase the level of the trait. In other words, simply assuming that a trait has a linear effect on profit and its economic value is thus constant, can represent a serious error -- as evidenced by the changes in beef animal size that have occurred over the last 40 years as a the size pendulum has swung from one extreme to another.

A final and somewhat subtle implication of this derivation is the interrelationship that must exist between genetics (economic values of traits), input levels, and prices. When the first-order conditions for profit maximization are solved simultaneously we obtain, in addition to the economic values of the traits, the profit maximizing levels of each product and input. The profit maximizing levels of each input will depend on output prices, input prices, the levels of all traits, and the technology of production. Normally this will be a function that economists refer to as the *derived demand* function that can be written as the implicit function (d_j) for the jth input as

6) $$X_j^d = d_j(P_1, P_2, \ldots, P_i, \ldots, P_m, w_1, w_2, \ldots, w_j, \ldots, w_n, g_1^0, g_2^0, \ldots, g_k^0, \ldots, g_l).$$

It reflects the fact that demand for an input by a profit maximizing firm depends on or is derived from the values (prices) of the products resulting from that input's use, prices of substitute inputs, the input's own price, and the prevailing technology -- including genetics.

The profit maximizing economic value of a trait will similarly depend on output prices, input prices, the level of the trait and all other traits, and the technology of production. However, because value rather than quantity is the dependent variable of the function (on the left-hand-side), it is more correctly viewed as an inverse derived demand function. Hence the profit maximizing economic value of the kth trait can be expressed as an implicit inverse derived demand function (d_k^{-1}),

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8 Some readers may find this result disconcerting. However, one must remember that the economic value of a trait is defined as the change in profit due to changing the level of the trait. At the profit maximizing level no additional profit is possible. Hence, the trait's economic value should be zero, as indicated.

7) $a_k = d_k^{-1}(P_1, P_2, \ldots, P_i, \ldots, P_m, w_1, w_2, \ldots, w_j, \ldots, w_n, g_1^0, g_2^0, \ldots, g_k^0, \ldots, g_\theta)$,

which may be of any functional form as determined by the technology represented in the original transformation function (F). The economic value of the trait depends on its own level, but that value changes or shifts in response to changes in product prices, input prices, the levels of other traits, or technology. This relationship is depicted graphically in Figure 2 for a linear economic value as used in our prior example. It shows that typically the economic value of a trait increases (+) as prices increase, but decreases (-) as the levels of other traits increase (and vice-a-versa). Higher prices thus tend to make genetics more important, but traits can sometimes be substituted for one another so that a very high level of one trait may offset a lower level of another trait and thereby reduce its economic value. For example, increased weaning weight may partially offset a low weaning rate since their product is the total weight weaned.

The significance of these relationships is that the economic value of a trait will not only change with changes in the level of the trait; it may also change as the prevailing input and output prices change or as the levels of other traits change. Thus, as the average price of, say, beef falls, the economic values of all traits are likely to fall, although relative economic values (of one trait to another) are not likely to change dramatically in response to a general increase in the price of all beef products. Relative values will, however, change if one beef product's price changes relative to other products or if the prices of inputs change. The effects of the former price change are easy to see. If the price of meat increases relative to fat then traits reflecting lean yield are likely to increase in (relative) economic value. However, the later are not nearly so intuitive.

A change in input prices must be cast in terms of the inputs themselves. A higher price represents a greater scarcity of the input. Thus, traits that increase the efficiency of input use will be more affected by an input price change than others. For example, when feed is surplus (either in terms of low grain prices or abundant pasture), its price is low and the economic value of a trait like feed conversion is low. However, as feed becomes scarce and its price increases the economic value of feed conversion increases relative to other traits. Hence, resource scarcity and input prices may dramatically alter relative economic values -- suggesting that economic values are highly individualized to the producer in question. Economic values are not global constants. They are uniquely dependent on the environment (defined in terms of both market prices and resources available) in which production occurs and must thus be estimated for each individual circumstance.

Modifications to the Economic Model

Thus far the economic model has been represented as static in nature. That is, it reflects values and optimal allocations at a point in time corresponding to a single production period. In practice, commercial beef production is dynamic. It occurs over time and time itself is a key element in the process. This is especially true for genetics that, by nature, must change over time rather than within a single production period.

The introduction of time to an economic analysis of genetics considerably complicates the analysis. For example, the time between the decision and the realization of its consequences must be accounted for. That is, different production processes require different amounts of time. The producer selling weaned calves typically receives payment for a genetic change sooner than the producer selling slaughter animals, although the values themselves may be quite different. Hence, the time duration of alternative production processes and marketing alternatives must be accounted for.

In addition, the long-term economic effects of a current decision on future production periods must be accounted for. If the producer makes a genetic change in the current period, that change will be exhibited throughout the *"economic life"* of the animals. Furthermore, if the producer retains the progeny of these *"genetically different"* animals, the effects of the genetic change will persist in the herd forever (at one half per generation for single sex selection).

In both cases time will affect the profit attributable to a genetic change and thus the economic value of the trait. Time delays between the decision and its realization will reduce value. Cumulative genetic gains will increase the total value attributable to a current decision, but at reduce marginal values in subsequent years. Longer-term changes require projections or guesses about future conditions that are more uncertain and thus more risky as they extend further into the future. Each of these time effects will effect the economic values of the traits and must be accounted for.

To illustrate these effects, we first define an applicable discount rate for time (ρ) as

8) $\rho = \tau + \delta + \varepsilon$

where τ is the real, risk-free rate of time preference for income, δ is the rate of risk adjustment, and ε is the rate of inflation. The reader should first realize that ρ is not the market interest rate. It is the discount rate applicable to specific producer for a specific decision. Hence, it reflects individual conditions and preferences that may be reflected in the producer's demand for credit. However, this differs considerably from market interest rates that reflect aggregate credit supply and demand conditions.

In this representation, τ is designated to be the real (no inflation), risk-free rate of time preference. It is the rate at which a producer equates current income to future income if there were no risk or inflation associated with future income. Hence, it relates to the producer's preference for income today instead of tomorrow. Typically, τ is 1 to 3 percent per annum.

The value of δ reflects the producer's risk preference for the specific decision in question. That is, it is the individual producer's judgment of how risky the decision may be and his or her ability and desire to bear that risk. Typically, the decision that carries with it the highest potential income (return) also carries the greatest risk. Producers with limited equity may view such high risk as unacceptable if they are risk averse and δ may thus be quite large. Typically, a traditional agricultural decision, of short to intermediate duration, carries with it a risk premium of about 3 to 5 percent. More aggressive decisions or those of longer duration can have much larger risk premiums, approaching the venture capital rate for untested and untried investments of about 35 to 40 percent per year.

The inflation rate (ε) reflects changes in the general price level in the overall economy and is beyond the control of the individual producer. Hence, it is more appropriate to assume that ε is zero and cast all analyses of future returns in terms of real current dollars. That is, returns are adjusted only to the extent that one or more prices is expected to change from its current level disproportionately to the average rate at which all prices may change. Combining these values, we thus estimate that the appropriate agricultural discount rate is typically in the range of 4 to 8 percent per annum, with an average of about 6 percent. The reader must, however, bear in mind that, like economic values, the appropriate discount rate is individualized.[9] Furthermore, it differs from one trait to another since some may carry with them greater risk.

The value to a producer of one dollar received at some time (T) in the future is

[9] It may be at the lower level of this range or less for producers that are risk loving or neutral and much higher (up to 40 percent or more) for producers that are highly risk averse or for decisions that are especially risky.

$$\frac{1}{(1+\rho)^T}.$$

The present economic value of a genetic decision (change) in the current period ($t = 0$), but which will not be received or realized until some time in the future (T) is thus based on the function

9) $$a_{k(t=0)} = \frac{a_{k(t=T)}}{(1+\rho_k)^T}$$

where ρ_k is the discount rate for changes in the kth trait.

We say that time adjustments to genetic economic values are based on this function because of the different roles that time can play. Equation (8) is appropriate when the current decision provides an economic effect only in one future time period. For example, if a producer considers using a new bull to change average weaning weight and will use that bull only once without retaining any of his progeny, then all of the economic value of the genetic change in weaning weight will occur when that bull's calves are sold at weaning. This is typically 16 months after breeding (nine months of gestation plus seven months nursing). When the discount rate is expressed on a monthly basis, the economic value of weaning weight (a_{ww}) for this situation is

$$a_{ww(t=0)} = \frac{a_{ww(t=16)}}{\left(1+\frac{\rho_{ww}}{12}\right)^{16}}.$$

Furthermore, if the producer sold slaughter animals rather than weaned calves, the economic value of weaning weight would be reduced because of the added time required from weaning to slaughter. The producer may also view retaining calves to feed as more risky than selling weaned calves, which could cause a higher discount rate to be applied and thus further lower the economic value. Similarly, the economic value of changing a different trait, such as carcass weight, may take longer to be realized. The longer it takes to realize the economic benefit (profit) of the genetic change, the less (economically) valuable it is -- because of time itself and, in some cases, because of the added risk associated with projecting market and environmental conditions further into the future.

Although this may seem complex, it is the most simple inclusion of time. We have already suggested that the economic effects of genetics may occur over multiple time periods. If, for example, the progeny of our hypothetical bull were retained for breeding rather than being sold, the economic value would be much more complex. No return would be generated from animals retained from the first generation and the economic returns generated by these animals in subsequent generations would be far removed from the current period. The retained progeny's economic value for weaning weight would be not be realized for 40 months (when the first calf of the bull's progeny are marketed), assuming the bull's progeny produce progeny themselves at 24 months of age. However, the value thus generated would repeat in each year of the progeny's economic life. Assuming the progeny remain in production for five years (l=1,2,...,5), that economic value would be

$$a_{ww(t=0)} = \alpha\frac{a_{ww(t=16)}}{\left(1+\frac{\rho_{ww}}{12}\right)^{16}} + \frac{(1-\alpha)}{\left(1+\frac{\rho_{ww}}{12}\right)^{40}}\left[\sum_{l=1}^{5}\frac{a_{ww(t=40+12l)}}{\left(1+\frac{\rho_{ww}}{12}\right)^{12l}}\right]$$

where α is the proportion of progeny (in the first generation) sold at weaning and 1-α is the proportion retained. Furthermore, if any of the progeny from subsequent generations are also retained for breeding, the economic value will increase by the discounted value generated by these additional generations through infinity.[10,11] Thus, the economic value can become a quite lengthy and complex mathematical function when time is considered.

Breeding Applications of Economics

The essence of genetics in any commercial application is change. Accordingly, animal breeding, as either a discipline or practice, can be viewed as the development and application of methods intended to change the genetic mean of an animal population or herd. The economic model of genetics just developed provides insights to the economic consequences of such changes and thus guidance in the application of animal breeding methods. However, the two should not be viewed as mutually independent or as one having greater priority than the other. Knowing the economic value of a change, without having the means of accomplishing the change, is as useless (and dangerous) as knowing how to make genetic changes without any reasonable guidance as to what changes should be made.

In developing the economic model of genetics we have referred to Hazel's pioneering work in multi-trait selection and the development of a selection index. Hazel's work is key

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10 This derivation also suggests additional issues that should be incorporated in a comprehensive economic analysis of genetics. Among these are the economic life of an animal in the herd and the effects of a variable herd size arising from culling without replacements or herd expansion. Melton (1980) and Trapp (1989) address some of these issues, but additional research, including consideration of optimal firm growth over time, will be required to fully incorporate these issues.

11 The economic value of the genetic change would fall by half in each subsequent generation if only the female (or male) progeny are retained. Thus, in four generations only one-eighth of the genetic gain remains ($.5^4$).

because it recognizes that commercial producers are motivated by economic considerations and thus integrated economics with animal breeding concepts. However, it also provides a base in animal breeding which we can extend to encompass more modern and broadly defined animal breeding methods. Hence, it is appropriate at this point to briefly review that work.

Hazel proposed that when the economic values of traits are known, a breeding index, which he referred to as an aggregate breeding value (**H**) could be constructed for *s* traits (in matrix notation) as

10) $$\mathbf{H} = \mathbf{Ga} = \sum_k (g_k - \bar{g}_k)a_k$$

where **G** is a *s* order row vector of breeding values for the animal (expressed as deviations from trait means) and **a** is a *s* rank column vector of economic values. An index based on the phenotypic expression of the *s* traits (**I**) could then be constructed by selecting weights (**b** = a *s* rank column vector) for the observed deviations of the trait levels from the mean (**P** = a *s* order row vector) so as to maximize the correlation between **I** and **H.** Thus,

11) $$\mathbf{I} = \mathbf{Pb} \text{ where } \mathbf{b} = (\mathbf{P}'\mathbf{P})^{-1}\mathbf{G}'\mathbf{Ga}.$$

Hence, the selection weights are derived by weighting the product of the (inverse) phenotypic (**P'P**) and genetic (**G'G**) covariance matrices by the economic values of the traits.

In the half-century since Hazel initially proposed the selection index, considerable progress has been made in the technical sophistication of both animal breeding and economic methods. Furthermore, the selection index was initially envisioned only for intra-population (herd) selection, as evidenced by the specification of (additive) breeding values in **G**. However, many of the properties of the a selection index which contributed to its theoretic appeal in 1943 persist today.

Economic values are measured in units of dollars. Hence, **H** is also in dollars. It provides an indication of the economic value of an animal based on the genetic levels of its embodied traits. However, from equation (10) we see that **b** (and thus **I**) must also be in units of dollars because variances and covariances are pure numbers (without units). Hence, both **I** and **H** are dollar measures of *"net economic merit"* -- one phenotypic and one genetic.

Not only does this cast genetics in common terms (dollars), it casts the breeding problem in terms that are meaningful to commercial producers. Furthermore, it reduces the problem of multi-trait selection to one of single-trait selection wherein the trait of interest is net economic merit. As such, it addresses the fundamental underlying problem of multiple (economically important) traits: simultaneous selection for multiple traits in a fixed herd size reduces the rate of genetic change possible in any one trait.

However, commercial producers are no longer constrained to select from within their own herd. They can now purchase replacement seedstock, especially bulls or semen, from a variety of sources. Furthermore, with the widespread adoption of crossbreeding in commercial herds, the introduction of artificial insemination and other reproductive technologies, and the wider choice of genetic types currently available, the breeding decision has become much more complicated than Hazel could have envisioned in 1943. Commercial producers now need to know the net economic merit all *"potential replacements"* in the broad population of beef animals. Furthermore, they need to know those values in the context of their individual production environment, including recognition of both the prevailing market conditions and physical resources.

To explore the implications of this informational need, we define a rather traditional, if somewhat over-simplified, model of animal breeding in which we partition some of the determinants of a trait's observed level ,

12) $$P_k = \mu_k + B_{ik} + R_{jk} + A_k + B_{ik}R_{jk} + B_{ik}A_k + R_{jk}A_k + e_{ijk}$$

where P_k is the phenotype of an animal for the *k*th trait, μ_k is the overall population mean for the trait in question, B_{ik} is the *i*th breed effect, R_{jk} is the *j*th herd effect within breed, A_k is the additive genetic effect, and e_{ijk} is the residual reflecting random deviations unaccounted for in the model (i.e., higher order interactions and random environmental effects).[12] All variables are expressed as deviations with expected values of zero except μ. Thus, the breed effect attributable to the *i*th breed is $B_{ik} = \bar{B}_{ik} - \mu_k$ where $\bar{B}_{ik}$ is the mean of the *i*th breed and μ is the overall mean. Similarly, the *j*th herd effect is expressed in terms of how a particular herd (of a given breed) differs from all herds of that breed, i.e., $R_{jk} = \bar{R}_{jk} - \bar{B}_{ik}$.[13]

Hazel envisioned the selection index exclusively in terms of the additive genetic component (A) of equation (11). However, commercial beef producers are more concerned with what they can market, which turns their primary focus to the phenotype. From equation (11) we see

[12] In this representation the herd effect can be viewed as a portion of the environmental effect in that it includes the basic environment in which the herd is observed. The model can, and probably should, also be expanded to include genetic interactions (either by genetics or environment) representing both breed and additive genetic effects.

[13] Additional sophistication can be added to this model by separating sire and dam effects in the progeny. However, for purposes of this paper the separation of parental effects tends to add more complexity than required to illustrate the relevant concepts and issues.

that commercial producers can increase P_k by changing A_k, but they can also increase P_k by changing either B_{ik} or R_{jk}. Furthermore, the interactions between these variables may play an important role in defining the eventual level of P_k.

The herd effect defined in this model corresponds closely to our previous economic model. Among other things, it represents the producer controlled environment -- including such variables as the nutritional plane of the herd, the herd health, and so on. As a result, it reflects the level of all inputs to the production process (the X variables) shown in equation (1) and relates to genetics indirectly through interactions with breed and additive genetic effects -- as shown previously for the economic model. Accordingly, we can further partition the herd effects into effects arising from (1) fixed geo-climatic environment (R^g_{jk}), (2) producer controlled inputs (R^x_{jk}), and (3) random geo-climatic environment (R^e_{jk}) such as drought, etc. which can reasonably be included in the overall error term (e_{ijk} in equation (11)).

Commercial producers attempt to alter the genetics of their herd in light of these herd effects and their interactions. They do this through their choice of breed or breeds (B) in a crossbreeding situation and individuals within the breed (A). Hence, both B and A, as well as their interactions (one with another or with the determinants of herd environment), are potentially important considerations to commercial beef producers. The combination of these decisions reflects what is commonly referred to as *"adaptability"*: some genotypes are better adapted to a given production or market environment than others. Plant breeders have recognized and historically made more effective use of adaptability than animal breeders, which may partially explain the greater rates of return to research and development observed in plant sciences (Huffman and Evenson).

The aggregate breeding value must then be slightly redefined to derive an *"aggregate genetic value"* (H*),

13) $$H^* = \sum_k a_k[B_{ik} + R_{jk} + A_k + B_{ik}R_{jk} + B_{ik}A_k + R_{jk}A_k]$$

where, as previously, a_k is the economic value of the kth trait. We ignore the residual terms (e_{ijk}) and random herd effects because producers cannot reasonably make decisions on the basis of variables over which they have no control. Even with these simplifications, the aggregate genetic value is more complex than Hazel proposed because it recognizes that commercial producers can select breeds as well as animals within a breed. Furthermore, they select for a specific herd or environment, not just within the herd. If these variables affect profits, they must be considered, and if there are interactions between the variables, as shown in equation (12), the expression for aggregate genetic value becomes even more complex.

The index formula specified by equation (10) is unchanged by these modifications. Hence, the selection weights (**b***) that maximize the correlation between the index (**I**) and the aggregate genetic value (**H*** where **G*** = the terms within brackets on the right-hand-side of equation (12)) are also essentially unchanged,

$$\mathbf{b}^* = (\mathbf{P}'\mathbf{P})^{-1}(\mathbf{G}^{*\prime}\mathbf{G}^*)\mathbf{a} \ ,$$

but their interpretation is different. For example, the diagonal elements of Hazel's initial genetic covaraince matrix are the additive genetic variances of the traits, i.e., $V(A_k)$. Thus, if the covariances between traits are zero, the selection weight for the *k*th trait is

$$b_k = \frac{V(A_k)}{V(P_k)} a_k = h_k^2 a_k,$$

where h_k^2 is the heritability of the *k*th trait. However, the *k*th diagonal element of **G*'G*** for the overall population of all potential replacements (all beef cattle) is more complex:[14]

$$V(A_k)+V(B_k)+V(R_k) + 2COV(A_k,B_k) + 2COV(A_k,R_k) + 2COV(B_k,R_k).$$

Hence, the selection weights in this revised breeding model are also more complex in that they depend on the additive, breed, and herd variances, as well as the possible covariances between these variables.

Where selection occurs within an existing herd, as for reared replacements, breed and herd effects can be ignored. However, modern breeding practices are not so restricted and commercial producers can also select across breeds and herds. Such flexibility complicates the selection decision beyond that envisioned by Hazel, but modern breeding methods have also provided a potential solution. When Hazel proposed the selection index, breeding values for individual animals were not available. Selection had to be based on phenotypic values that could be observed. With modern methods of animal breeding, sire selection, at least, no longer necessarily faces that limitation.

In recent years animal breeders have increasingly estimated and made use of EPDs (expected progeny differences) in their breeding decisions, where a sire's EPD for the *k*th trait is

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[14] This expression excludes the covariances of interactions for simplicity without significant loss of generality.

equal to one-half of his additive genetic effect $\left(\frac{A_k}{2}\right)$. If multivariate EPDs (taking account of the genetic covariances between traits) were estimated for economically important traits and comparable estimates were made of the controlled or fixed herd and breed effects for these traits, a producer could select sires based on their aggregate genetic value without the necessity of computing a selection index. That is, once economic values are estimated, selection decisions could be based directly on the value of H^* for each individual, where the value of R_{jk} is fixed for the specific herd or producer in question, but its effect is unique to that herd or producer. Such a procedure should be at least as accurate as a selection index such as Hazel proposed because it reduces the number of computational steps (the computation of phenotypic covariances and selection weights). Furthermore, to the extent that the correlation between the index value (I) and H or H^* is less than one, selection decisions based on the aggregate breeding value or, in across breed or herd decisions, the aggregate genetic value would actually relect net economic merit more accurately and would thus be preferred.

The Importance of Being a Low-Cost Producer in Today's Market Environment.

Current Market Conditions

Total cattle numbers were 3% larger on July 1, 1995, compared to a year earlier. Cattle inventories have been increasing since 1990 and the peak numbers for the decade should be reached during 1996-1997. Peak beef output for the current cattle cycle is projected for 1997. Weights are expected to remain large and total beef production should equal or exceed the levels we experienced in the mid 1970's. The result of these larger numbers is a lower price structure for all classes of cattle and extremely tight or negative margins for the average cow/calf producer over the next several years.

Costs of Production

In order to manage an operation's production costs, you need to know what your production costs are and you have to have a means to monitor those costs so you can assess your progress. The National Cattlemen's SPA (Standardized Performance Analysis), database allows you to accurately express your costs on a per cow or per hundredweight basis. SPA helps the producer decide which costs can be managed and which costs should be managed.

The goal is to make a profit after direct and indirect costs, overhead and a sufficient return to management are figured in. Tax forms are not an accurate picture of the financial performance or standing of an operation and they are not intended to be. That is why a producers own individual records as they relate to the operation are so important.

Lowering one's costs of production requires a new paradigm or way of thinking. Becoming a low-cost producer is a life long commitment. The wrong message is sent when we talk about lowering costs and all we talk about is lowering input costs. We are actually talking about having the means to determine if a decision increases the bottom-line performance of an enterprise. Additional expenses can be positive if they are offset by an incrementally larger increase in revenues. Three areas that Cattle-Fax surveys have shown that low-cost producers spend more on than high-cost producers are genetics, herd health and pasture expenses. Knowing where to cut expenses is a difficult challenge as profit is determined by many traits and there are numerous interrelations to account for.

SPA enables a producer to reduce costs by illustrating an operation's strengths and weaknesses and to make decisions based on information and analysis-not emotions or opinions. SPA enables you to have written goals which should include projected cash flows and financial statements. SPA gives you a report card to see how you compare both within your region and nationally.

There are tremendous differences between break-even prices for cow/calf producers. The SPA data-base would show a difference of $249 per cow between the lower one-third and upper one-third of producers in terms of costs of production. Cattle-Fax survey data would show that the three areas that have the largest impact on production costs are winter feed costs, debt and miscellaneous expenses. Miscellaneous expenses include the small every day expenses like fuel, labor, bailing twine etc.. They make up less than 20% of the typical cow/calf budget but over 40% of the difference between high-cost and low-cost producers. This points out that there are opportunities on almost all operations to lower production costs without sacrificing productivity, and small expense items should not be overlooked.

Cattle-Fax went back and surveyed their low-cost producers and asked them how they lower their feed costs. We found they utilize volume and seasonal discounts to lower their feed costs. They work to reduce feed waste, and utilize rotational grazing, grass stock piling, residues and crop aftermath. Whenever possible they strive to have the cow harvest the forage rather to mechanically harvest it and feed it back to the cows. In some instances it may be cheaper to buy feed than to raise it.

Conclusion

You must be able to measure the financial position of your operation and it's enterprises in order to manage them correctly. The cost of knowing is nothing compared to the cost of not knowing. Being a low-cost producer requires a long-term commitment and a different attitude but it can dramatically affect the profitability of an operation and even its viability. SPA enables a producer to get an accurate picture and information upon which to base decisions. Accurate information is the key to putting together the profitability puzzle.

Is It Possible To Decrease Costs In An Era Of Increasing Technology?

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The current economic environment in which cattle producers operate is a challenging one. Prices for the primary product of the cow-calf sector (i.e. calf weight) have generally been very favorable during the late 1980s and early 1990s. However, this scenario has dramatically changed in the past year as we are now entering the "trough" of the cattle cycle. Thus, unlike the immediate past, we are once again becoming more focused on finding means to allow the lowering of input costs of production. However, in the age of increasing use of "hi-tech" in all businesses and walks of life, the producer is faced with a dilemma: How can I spend less in my production system if I am forced into using more and more technology in order to remain competitive?

When the author was initially approached about preparing a presentation on this topic, he was unsure of his ability to adequately address the question. The request raised the question of whether his research efforts over the past several years had really been focused on development of technology that would allow for lowering of production costs. What an eye-opener! Needless to say, this question is a difficult one to answer. Perhaps it would be more appropriate to title the content of this paper something along the lines of: ***"How Does a Beef Cattle Producer Surf Through the Hi-Tech Era?"***. This seems to be the real question.

Is This More of a Concern in 1995 than in 1968?

One could argue that beef cattle producers have always been concerned with how to properly evaluate new technologies. After all, any industry which stands still regarding adoption of new technology is either stagnant, or more likely, dying a slow death. Thus, if we have always been concerned with this question, is it any more relevant today than 27 years ago when the Beef Improvement Federation was meeting for the first time?

If you follow the projections of futurists such as Naisbitt (author of the book Megatrends and Megatrends 2000), you have heard terms such as the "information age". Most of us would not have much difficulty in acknowledging the fact that we do live in a society that is accumulating information at a phenomenal pace. While it is wonderful that we have all of this new information, the flip-side is that it can become like the "weight of the world" on our shoulders. The problem becomes one of how to sift all of this information down into a usable form.

I like to poke fun at my friends in the IRM arena. Most of us are now quite familiar with the IRM concept. Several years ago, some forward thinking scientists, producers and extension educators put their heads together and came up with what was then the Integrated Reproductive Management program. A few years later, this evolved into what we now know as Integrated Resource Management, a more holistic approach to optimizing cattle production to the available environmental resource base. In 1995, I think a more fitting term might be ***Integrated Information Management*** (I tried as hard as I could to come up with an "R" word but the only thing I came up with was **I**ntegrated **R**edundancy **M**anagement!).

Furthermore, it is important to point out the critical need for developing this "sifting" skill. Many of you may have heard some of the controversy surrounding a recently published book entitled The Bell Curve (Herrnstein and Murray, 1994). One of the less controversial points made in this book is that in the future the ability to effectively evaluate and use new technology will cause the gap between the so-called "haves" and "have-nots" to widen. In essence, those beef cattle producers who will be the most financially successful in the future will be those who have the ability (either innate or learned) to sort out the most effective technologies for use in their production systems. Thus, the inescapable answer to the original question is that this topic is definitely more relevant today than in the past, and, will most likely become increasingly relevant in the future.

A Framework for Evaluation of New Technology

Given that this critical talent of technology evaluation is becoming more important as we move farther into the information and technology age, what type of evaluation criteria and framework should a producer be operating within? When first considering technology and cost reduction, the two seem somewhat diametrically opposed. After all, when you use new technology you have to pay for its use. This necessitates the proper evaluation of the effects of adopting the technology on inputs and outputs of the production system.

Typically, beef cattle producers look at outputs (i.e. income) more than inputs. Even when we evaluate profitability, we still may not be accounting fully for all of the give and take between input costs and output value. Dickerson (1984) has proposed on numerous occasions that the ***best evaluation criteria is the ratio of input costs per unit of output product value.*** This criteria then allows one to determine the impact of the technology adoption in relative terms on both costs and returns.

When devising a framework for technology evaluation, we could take a very technical approach rooted in agricultural production economics theory. Terms such as marginal returns, law of diminishing returns, rapid adopters of technology, risk takers versus risk averters, etc. come to mind. We also could discuss, as George Seidel did earlier at this same meeting, how early benefits from the use of a technology may accrue to the early producers who adopt, but in the long term those benefits may largely accrue to the consumer of the product. I have chosen to take a more pragmatic approach to devising this framework.

I would propose that there are four questions which should be answered when considering adoption of any new technology. It is of utmost importance that all of these be answered only in the context of the individual's production system (or in one closely mirroring it). If a seedstock producer, there may also be some benefit to being able to answer these questions within the context of the production system of his/her ultimate commercial customer. The four questions, quite simply, are:

Does the adoption of the technology:

I. Reduce, not change, or increase input costs?
II. Increase or not change output amount?
III. Increase, not change, or decrease output value per unit?
IV. Increase, not change, or reduce "peace of mind"?

The first question deals solely with costs while the second and third together reflect total change on income. In this day and age, one could argue that the last one, while subjective in nature, may be very important. We live in a fast-paced, stress-inducing society. For example, my wife Jane and I are fortunate enough to have three young children (ages 6, 4 and 1). We live our life in a blur. At our house, most days it is pop something in the microwave, grab it and go. Life under those conditions is better when one has "peace of mind" in regards to as many things as possible. The beef cattle business is no different.

Shown in table 1 is a simple schematic of the possible outcomes to questions one through three above. What proves to be very interesting about this table is that the only times that adopting new technology makes sense are on the diagonal and above. The instances of a definite yes are only those that have favorable or neutral effects on cost reduction. No rocket science here, but not always the way that we think, however.

Table 1. Responses to Technology Evaluation as Affected by Impact on Total System Output Value and Total System Input Costs

Total System Output Value	Total System Input Costs: Increase	Not Change	Decrease
Increase	Depends	YES	DEFINITELY
Not Change	NO	Rare -- NO	YES
Decrease	NO	NO	Depends

Examples of Current Technologies for Evaluation

Now that we have devised a general framework for technology evaluation, it would be helpful to push a few relatively new or developing technologies through the system as examples. Since the Beef Improvement Federation is designed to provide uniform guidelines for performance recording to allow genetic improvement, most of these will take on a "genetics" flavor. The list includes:

1) Within breed EPD / National Cattle Evaluation
    a) New trait development within breed
    b) Selection Index Methodology
2) Across Breed Comparison EPD
    a) Inter-Breed Data Sharing / Networking
3) Data Recording
    a) Electronic ID
    b) Chuteside electronic data gathering
    c) Electronic data transmission

d) Real-time Ultrasound
e) Strategic Alliances / Information Feedback
4) DNA Technologies
a) DNA Fingerprinting for Identification
b) Marker Assisted Selection
5) Mating Systems
a) Composite Cattle Breeding / Hybrid Seedstock
6) Cost Analysis / IRM-SPA

Within-Breed National Cattle Evaluation. The first general group of these technologies deals with ways to help us define genetic differences in performance for economically important traits. None of us would argue the fact that within-breed national cattle evaluation programs have been very successful over the past fifteen years. All of the major beef cattle breeds now have comprehensive NCE programs in place for birth, weaning and postweaning gain growth performance as well as the weaning maternal indirect estimate of milk production. A glance at the genetic trend graphs for these traits in any of the sire summaries shows significant progress since 1985. Beyond those traits, there is variation among the breed programs in other measures of performance for which EPD are computed.

Some badly needed, relatively simple, and cheap tools are now being developed and implemented by some breeds to broaden the scope of NCE programs into the reproductive efficiency arena. Bryan Melton has pointed out elsewhere in this proceedings that reproductive efficiency is paramount in importance relative to growth and carcass performance. Scrotal circumference in yearling bulls is a relatively simple technology which fits into the favorable part of table 1. I have heard Jim Brinks say on numerous occasions that when he and others first started talking about this trait as an indicator of inherent fertility, they were met with much skepticism. The same reaction was encountered when the favorable genetic relationship was uncovered between scrotal circumference and age at puberty in daughters. We now generally accept these concepts as proven fact. Scrotal circumference EPD will be a very helpful technology as it becomes more universally available.

Another newer technology is that of "stayability". This is the brain-child of Bruce Golden, Warren Snelling and others at Colorado State and is now implemented in the Red Angus NCE program. Basically, this EPD measures the genetic potential of a cow's likelihood of still being in the herd at a break-even age of six years. This EPD then measures not only fertility but also differences in milk production, growth and soundness. It is hopefully also a predictor of ultimate cow longevity. This is an excellent example of a cost-lowering and potentially value-adding technology. Warren Snelling defines this new trait in greater detail elsewhere in this proceedings.

We also hear more and more about the need for placing carcass EPD into NCE programs. Traditionally, we have been concerned with a carcass lean yield type of EPD and a carcass quality type of EPD to simulate the USDA yield and grade system. Real-time ultrasound technology borrowed from the human medical diagnostics field has been studied extensively for application to this purpose. This is an example of a technology attempting to be adopted by the beef cattle industry to allow circumvention of cost and labor intensive carcass progeny testing. However, it also is an example of a technology which still is unresolved due to our lack of information regarding whether ultrasonic measurements on yearling seedstock are measuring the same genetic traits observed in a physiological different slaughter progeny.

In the past year, we have heard increasing amounts of emphasis placed on the "tenderness" issue. The merger of the industry organizations and development of the long range plan for the beef cattle industry has seen this elevated to forefront status. The stated goal of the long range plan is "to reduce the toughness of beef by 50% by 1997". The National Beef Tenderness Conference was held in April of 1994 by NCA and much discussion has been engaged about how to give producers technology which will help them to achieve this goal. So...are we headed for some type of tenderness EPD? If so, how? Any technology here would most likely increase cost of production but how much would it add to product value?

The last type of technology innovation being considered in within-breed NCE programs deals with selection index methodology. Scott Newman presented some thinking in this area at last year's 4th BIF Genetic Prediction Workshop. We have also heard this concept mentioned by several of the other speakers at this meeting. The idea is that maybe we need to boil down several components of performance into multi-trait selection indexes based upon relative economic weightings and genetic and phenotypic parameters of the traits. This type of technology would be designed to allow producers to better match genetic potential for maternal performance versus terminal performance by combining traits. It may also help with the peace of mind element by reducing information overload as we continue to add new traits to NCE programs. The swine industry is already starting to use this type of approach. Kent Andersen talks about this further in the following paper in these proceedings.

Across-Breed Comparison EPD. What about across-breed EPD? Much discussion has been given to this idea at the BIF meetings over the past five years. We now have the across-breed comparison table based upon the U. S. Meat Animal Research Center Germ Plasm Evaluation Program results. The hope is that producers would be able to use this to compare sires across breeds after they have determined optimal breeds to fit their production environments. However, we know that these table values are not perfect. Serious discussion and initial implementation has now been undertaken by several breed associations to establish an inter-breed network to share data between breeds. This is a first step to allow inter-breed cattle evaluation to occur. What type of technology is this? It should not dramatically affect costs but it would hopefully have favorable effects on output value by refining selection decisions.

Data Procurement/Storage. Another example of a new technology area is so-called "information feedback". The Strategic Alliances project of 1993 (NCA, 1993) is an example of how information from one sector of the beef cattle industry can be used to help ultimate product value in other sectors. We know that we want to improve the quality of our product, but how can we do it if we do not know what it is? This makes our perspective shift to a "gate to plate" frame rather than an isolationist cow-calf producer frame. However, such a production philosophy requires identification integrity through to the box and perhaps in some cases the ultimate consumer. Technologies such as electronic identification have been discussed at this meeting a few years ago. One of my colleagues at Colorado State, Jack Whittier, has done a substantial amount of work with electronic ID while on the faculty at the University of Missouri. The technology is fairly simple to use, basically consisting of a computer chip placed on the animal in the form of an eartag. The eartag is read by a radio transponder and then information on that animal can be directly linked at chuteside. The benefits for genetic improvement are obvious, assuming that the eartag stays with the animal throughout the various phases of the system. The problem is what happens to that ID integrity at the time of slaughter.

It is also fairly easy to see where we are headed as an industry in handling data. It is already possible to transfer data from chuteside to ranch office computer to breed association to location of NCE analysis. The electronic age is truly amazing! This will only continue to improve and become cheaper and cheaper as an unavoidable technology. This is an area where the concept of "life-long learning" becomes key. Because one did not grow up in the computer age does not exempt them from needing to learn how to function effectively in that age. We have people like Bob Long and Gordon Dickerson, who have become computer-jocks extraordinnaire in their retirement years, to prove to us that this is entirely possible. Computer-aided tools of financial and production analysis like the IRM-SPA program discussed by Troy Marshall immediately preceding this paper are only one example of extremely useful (and cheap) technology from this area. These technologies are ways of fine-tuning how we look at our production systems that we have not really had in a structured way before.

DNA Technologies. Perhaps the newest area of technology development to most of us is in the "DNA and gene revolution". BIF joined this revolution last year when it established for the first time a Biotechnology Committee under the leadership of Burke Healey. We now have technology called DNA fingerprinting that allows us to verify parentage on multi-sired calves. This allows the use of more information in NCE programs to improve the accuracy of EPD. Great technology, but currently also a pretty expensive one ($25 per sample). With time, it is a technology which will cheapen and become very useful to genetic improvement programs.

In the animal breeding and genetics research community we now hear the term Marker Assisted Selection tossed around a lot. The idea here is that markers from the developing gene map of cattle will be able to be scored to assist in prediction of economically important traits. This technology is based on the idea that DNA markers will segregate with quantitative trait loci (QTL) (i.e. that they will be closely linked) and that these QTLs exist for our traits. Jerry Taylor at Texas A&M reports on the industry funded carcass gene mapping project in the proceedings of the Biotechnology Committee elsewhere in this meeting. Again, great potential in this technology but one that is virtually unknown in length of time horizon for adoption. While most of us have been amazed at the rapid progress in the mapping of the bovine genome and the derivation of theory in regards to marker assisted selection, it is still a mystery in many respects.

Mating Systems Technology. The last, and perhaps most controversial, technology example to be examined here is that of composite cattle breeding. Since the publication of results of the Germ Plasm Utilization Project at the U. S. Meat Animal Research Center by Gregory et al. (1993), we have heard a significant amount of discussion on this topic. A Composite Cattle Breeders Alliance has been formed for sharing of ideas and information, an entire session was devoted to this idea and covered by Jim Gosey, Don Kress and Rick Bourdon at last year's BIF meeting in Des Moines and a large amount of dialogue has occurred in the industry's popular press medium. Surprisingly, it has become a very polarizing issue. One is sort of reminded of some of the industry's discussion a few years ago regarding the value of marbling in the USDA quality grading system. You either hate it or you love it. The basic pro- argument goes something like this....use of composites allows simultaneous use of breed complementarity, matching of breeds to environments and utilization of a large fraction of initial heterosis. All of this is achievable while significantly lowering labor and management costs from reduction of breeding groups and inter-generational genetic variation experienced in the use of rotational and rota-terminal crossing systems. The basic con- argument is....genetic variation should be increased in the composite, you must avoid inbreeding as much as possible and you must be a relatively large producer (approximately 500 females or more) to effectively develop a composite population. While the latter two are constraints, to some degree, on this technology, the first one has been shown in the USMARC work to not be true. In the end, this is an example of a technology which should simultaneously reduce input costs by reducing labor and management and better matching cows to environments while hopefully also increasing total output value. However, it obviously will not be feasible for all producers. The use of hybrid seedstock is proving to be widely successful in the swine and poultry industries. None of us need to be reminded that they are our primary competitors. While we operate under a much more diverse set of conditions than either of these industries, use of this type of technology will be helpful in the long run. However, it obviously will not be feasible for all producers for the reasons mentioned above. Perhaps this technology is the best current example of an inappropriate response in the industry to evaluating and adopting change.

Variation in Technology Evaluation Philosophy?

Just like cattle, we humans exhibit variation in the way that we approach things. Evaluation and adoption of new technology is no exception. I spent a long time in preparation for this presentation in thinking about a classification system for technology evaluators. The resulting system shown in table 1 was developed based upon personal experiences.

The first class of technology evaluators are the "risk takers". These people have to try a little bit of everything immediately when it becomes available. The next group are what I refer to as the "sifters". These folks like to sit back and watch what the risk takers do and then only implement what proved to be successful for them. I'll use myself as a personal example here. While living in Lubbock, Texas, I became good friends with one of the graduate students working with me by the name of Sam Jackson. Sam and I both grew up on farms and ranches and since we were stuck in the middle of a city of 185,000 people on a little dirt lot, we wanted to "farm". So we both made the backyards of our houses into gardens. Now, being the risk taker in this case, I like to try everything, just like we did in our family garden while growing up in Virginia. Needless to say, the high plains of Texas is not exactly the Shenandoah Valley of Virginia. So....Dr. Jackson let me go my merry way in the first year and silently watched me put out all of these different items in my garden. The venture, as most things go, become a little competition between the two of us to see who could have the best garden. The following year, lo and behold, everything that I found that worked in my garden showed up in Sam's, i.e. Sam the "sifter". You can probably think of people just like Sam and I.

The third class of evaluators are what I have termed the "it ain't broke" crowd. These people are not really averse to new technology, they are just not necessarily looking for change. They are the people who have reached some comfortable level of production. I remember my late father as one of these people. We had our cattle operation there in southwestern Virginia. Young son was sent down the road 45 miles to "the college" to get educated. As Paul Bennett will attest, I would go home every few weeks loaded with new "knowledge" I had gleaned in Blacksburg. I would immediately start in on my father to tell him how far he was missing the boat. His typical response was....."it ain't broke". He was not really scared of change, he really did not campaign against change, he just was not looking to change.

The most dangerous type of technology evaluator is the "It ain't broke AND IT DON'T NEED FIXIN!" one. These people not only are not looking for change, they are averse to it. Change scares them, they feel threatened by it and their human response is therefore to go into a defensive posture. This often equally applies to organizations.

The last type of technology evaluator is the "quiet adopter". These people sit quietly by and watch everything around them. They then quietly adopt what they see proven effective over time without raising any ruckus or telling anyone they are doing it. I think we can all think of these successful people. My grandfather was a quiet adopter. He quietly observed the development of things around him and adopted new things as they were proven effective during the 1950s and 1960s. The result is that my four uncles continue to benefit in 1995 from the operation of a profitable dairy cattle operation in southwestern Virginia.

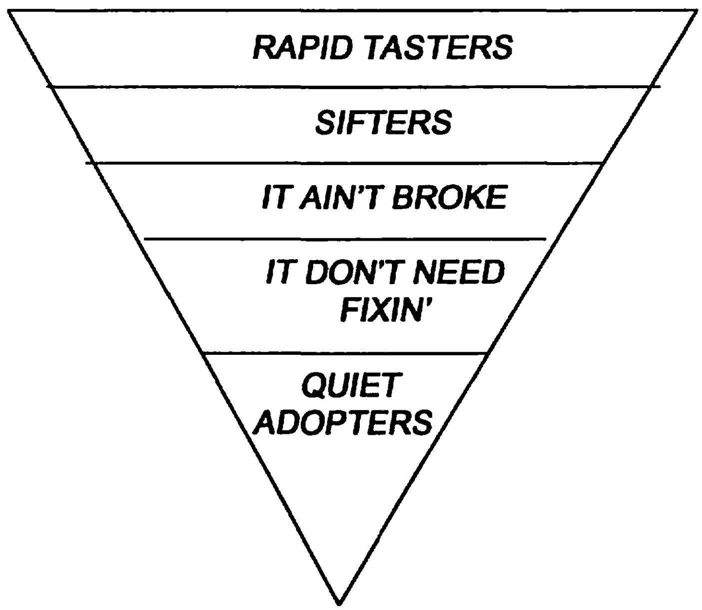

Figure 1. Different Classes of Technology Evaluators

This categorization of technology evaluators leads to a basic generality. We should all beware of those that overpromote a new technology ("risk-takers"). Likewise we should be very cautious of those who have an agenda in preaching against technological change ("it ain't broke and it don't need fixin'"). In 99% of the cases, there is some intermediate optimum that says that the technology may be very useful for some, but not for all. If that is the case, then in the long run the technology will be beneficial overall for the industry.

Concluding Philosophy

In bringing this topic to a close, a final checksheet of concerns will be proposed. For any producer, thinking of technology adoption using this checksheet may be very prudent.

Before adopting new technology in the current era:

1) **Have a good fix on your input costs relative to output product value.**
   You cannot know what effect technology adoption will have on your system unless you know where you are at the current time.

2) **INSIST that the benefits of the new technology be proven in a production system paralleling yours as closely as possible.**
   In the past this was easier than now or likely to be in the future because each state and geographic locale had a state and federally funded experiment station with a cow herd for applied research used to test the theories developed in university basic research programs. There are unfortunately few of these cow herds left nationally. For example, our CSU Beef Improvement Center at Saratoga, WY has a 450 head Angus cow herd. We are grappling with some of the technologies mentioned above in this paper. With fewer programs like this one surviving the budget ax, more of this "show me" type of research is being transferred into the hands of private industry.

3) **Do not accept research results unless they are presented in an economic and NOT GRANT $ GENERATING framework.**
   The current climate in the research community is one of grappling for research funding. While this competitive environment ultimately leads to greater research productivity, it also carries along with it the impetus to "oversell" the merits of one's research in order to justify the expense of the next "phase of the project". The basic idea here is to not get the cart before the horse. Several of our technologies coming out of research programs have to some degree fallen victim to this problem. Ultrasound of the 1980s, nuclear transfer and DNA technologies (e.g. "the ___________ gene", take your pick of a trait and fill in the blank) all come to mind here. Not all of the apples in the bushel are bad, but those rare few really leave a bad taste in the mouth.

4) **Only use technology in an effectively proven manner.**
   I.E. Read the label. If you do not do something according to the instructions, you should not be surprised when it fails. We can think of misuses of within-breed EPD and crossbreeding systems. Across-breed EPD are a useful tool, if used appropriately.

5) **Be willing to embrace technology once it passes the litmus test.**
   I.E. We must be willing to change and to learn new things.

6) **Be willing to tie to and adapt with competitors rather than working against competitors.**

Even though we enjoy the benefits of living in a free enterprise system, there are times when the betterment of the whole is as important as the betterment of the individual. Some of these technologies will ultimately require some partnering to be effective at the industry level.

7) **Be able to realize that the beef cattle industry is not immune to new technology.**

Those with the ability to effectively use foresight in evaluation of new technology will be the survivors. For example, breed associations might benefit in the future by establishing DNA repositories now for assistance as markers/genes become identified affecting quantitative traits. We do not really know when that will happen, but it will happen. Prior planning prevents poor performance? A personal colleague by the name of Tom Field has been known to use a slide in presentations captioned "What if you raised sows, not cows?"

8) **Realize that those technologies which seek to simultaneously improve reproductive efficiency without substantially increasing production costs or lowering output value will be the most beneficial.**

The relative economic values of various categories of traits still place reproductive efficiency of the nation's cow herd as foremost in importance (see Melton in these proceedings). It seems that this fact is inescapable.

This has been an extremely interesting presentation to prepare. Hopefully it has provided some food for your thoughts.

Acknowledgments

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OPPORTUNITIES TO REDUCE COSTS THROUGH THE USE OF EPDs

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INTRODUCTION

Wouldn't it be nice if expected progeny differences (EPDs) were directly available for measures of economic efficiency. For any given situation, breeding profitable cattle would be easier if EPDs were available for measures such as the expected dollars gained or lost due to the overall genetic differences between animals available for selection. Even though breeding profitable cattle is not that simple, there are still opportunities to reduce costs through the use of existing and future EPDs.

As a prerequisite, it should go without saying that in order to fully exploit opportunities to reduce costs through the use of EPDs, producers must know their costs as well as their EPDs. It follows that financial records must be used in conjunction with production records in order to gain a feel for the economic impacts of selection practices over time. In this scenario, intensive record keeping efforts are required to move in the direction of becoming a "lower" cost, more efficient producer.

In addition to a more concentrated record keeping effort, producers wishing to maximize net income over time must be open minded and willing to accept and use appropriate new technologies as they become available. Innovation has been the trademark of most successful companies. Financial success in the future is likely to be closely tied to a producers ability to process large amounts of information into useful knowledge and use it to make smarter business decisions than their competitors. The purpose here is to explore, in a simplified manner, opportunities to reduce costs through the use of genetic information.

THE BASICS OF USING EPDs

Perhaps one of the most simplistic ways of defining how to use EPDs is to think of them as warning labels. Just as the surgeon general warns us of the dangers of smoking and alcohol consumption, EPDs are warning labels which can help us avoid production of cattle which may be genetically hazardous to profitability. For example, a high birth weight EPD warns us that offspring are likely to be large at birth with a greater chance of calving difficulty. Costs associated with calving problems may be incurred. Low weaning and yearling EPDs warn us that we may be disappointed in the "weigh-up" of our calves. Less pounds sold equate to less dollars returned if costs are equal. Conversely, a favorable EPD profile for any given animal can be thought of as a "seal of approval", indicating a greater likelihood of satisfactory performance and associated economic rewards.

A COWBOY EXPLANATION OF HOW EPDs ARE CALCULATED

It is human nature to be skeptical of that which we do not totally understand. However, from the computers in our offices to the cars we drive, life is filled with products and services which most of us do not fully comprehend. Fortunately, we can take advantage of the benefits which most products and services offer without total understanding. EPDs are no different.

Conceptually, the calculation of EPDs is not difficult to understand. Most of us have had the opportunity to know some very accomplished and time tested seedstock producers. Typically, the ones I have met have had at least two traits in common. First, these breeders are astute observers of livestock, and recognize differences in performance of animals across many traits. Second, these breeders are usually good students of the pedigrees of animals and possess the ability to attach pedigree information to their observations of differences in animal performance.

Calculation of EPDs is merely a more objective and comprehensive extension of the thinking of these accomplished seedstock producers. Performance data is adjusted to remove environmental differences, attached to pedigree information, weighted according to the heritability of the trait and genetic level of mates and group competition, and expressed in the form of expected genetic differences. The EPDs rank animals according to the expected differences in performance of offspring. When combined with good common sense as it relates to traits for which EPDs are not available, this basic understanding is essentially all that is necessary to make smart within breed selections.

HOW WIDELY ARE EPDs USED?

Relative to all the educational efforts involving the understanding and use of EPDs, widespread acceptance has been slow to evolve. In the 1992 Cow/Calf Health and Productivity Audit (CHAPA) conducted by the United States Department of Agriculture, producers were asked to rank the importance of ten different factors when purchasing or selecting bulls (CHAPA, 1994). For each of the factors, producers ranked the relative level of importance by identifying each factor as extremely, very, moderate or not important. As illustrated in figure 1, the percent of operations surveyed which ranked EPDs as extremely or very important was the lowest of all ten factors studied. While other surveys have suggested that the use and importance of EPDs has likely increased since 1992, these results indicate that considerable opportunities exist to more fully utilize EPDs in the selection process (Drovers Journal, 1995).

SPECIFIC OPPORTUNITIES - REDUCING COSTS THROUGH BUILDING CATTLE WITH HIGH FERTILITY

While the exact costs associated with reproductive failure are unknown, the consensus is that reproduction is the single most economically important trait area, especially if survivability is included in your definition of reproductive performance. Achieving the economically "right" level of expressed reproductive performance revolves around balancing the genetics for inherent fertility of the cow herd against the environmental factors which challenge expression of fertility traits.

Theoretically, a high level of inherent fertility should act as a buffer, or insurance policy toward various challenges to expressed or realized fertility. Said another way, the costs associated with low expressed reproductive performance due to the availability or cost of feed in relation to the nutritional requirements of animals may be avoided or reduced if cattle are genetically designed with high inherent fertility. Thus, building cattle with high inherent fertility should allow producers to build more flexible cowherds which are more buffered to environmental stresses, less subject to reproductive failure if optimums for milk production and/or mature size are accidentally overstepped, and more capable of acceptable production when provided less feed or other inputs.

Over the years, the primary method by which producers have placed selection emphasis on reproductive traits has been through selection of sires for adjusted yearling scrotal circumference. Researcher from Nebraska, Colorado and Montana have reported favorable and high relationships between scrotal circumference of bulls and age at puberty in heifers (Brinks et al. 1978; Lunstra, 1982; King et al. 1983).

As the amount of scrotal data has increased, several breeds have started calculating and publishing EPDs for scrotal circumference. Compared to adjusted measurements, scrotal EPDs represent more refined estimates of genetic differences among animals. At this time, it seems logical for the seedstock industry to furnish EPDs for this trait on a more widespread basis to facilitate improvements in inherent fertility.

The Red Angus Association of America and Colorado State University have recently developed EPDs for another reproductive/survivability trait called stayability (Golden, 1995). Stayability EPDs predict genetic differences in the likelihood or probability that daughters of animals in question will remain in production until they are at least six years of age. For the Red Angus population, stayability EPDs are expressed as deviations from a 50% probability of remaining in production beyond the above age.

As an example of how to interpret stayability EPDs, consider the following two sites and their stayability EPDs of -5% for sire A and +5% for sire B:

	Stayability
Sire A	- 5%
Sire B	+ 5%
Difference	10%

If both sires were bred to comparable sets of cows, 10% more of sire B's daughters are expected to remain in production until the age of six years as compared to sire A's daughters. Stated another way, each daughter of sire B is expected to have a 10% greater likelihood of staying in production to the break-even age as compared to daughters of sire A. Because of the costs associated with developing heifers to replace culled cows, the use of stayability EPDs represents an opportunity for cost reduction.

In addition to the obvious benefits of calving ease as it relates to expressed reproduction, at least two other traits may provide additional benefits. Gestation length EPDs are available for some breeds and allow producers to gain a few extra days of postpartum interval through selection for shorter gestation lengths. It also seems to be within the realm of possibility that EPDs could be developed for condition score of cows, which could provide breeders with an indication of genetic differences in fleshing ability. Overall, when combined with EPDs for growth, milk and mature size, EPDs for scrotal circumference, stayability, calving ease, gestation length and body condition of cows could offer producers with powerful genetic tools to build more environmentally adapted and economically efficient cows.

As one last strategy for building cattle with adaptability and high potential for expressed fertility, commercial producers should consider purchasing seedstock from suppliers which have produced and selected cattle under similar management to that of their own operations. Seldom do seedstock suppliers advertise whole herd measures of performance such as the percentage of open cows, the pounds of calf weaned per cow exposed or information about their production costs. These measures impact the net returns of commercial cow-calf customers using their genetics.

REDUCING COSTS ASSOCIATED WITH CALVING DIFFICULTY

Calving difficulty is generally associated with increases in calf mortality, susceptibility to disease in calves, veterinary and labor costs, delayed return to estrus, lower conception rates, and cow mortality (Andersen et al. 1993). Calving difficulty has been estimated to cost cow-calf producers $850 million annually in the U.S. because of calf losses at birth. While primarily a problem in first-calf heifers, building cattle which calve without assistance is of concern because of selection emphasis on growth traits.

Depending upon the breed of cattle, EPDs are available for birth weight, direct and maternal calving ease (heifers and cows) and gestation length. Each of these tools offers producers the opportunity to reduce the magnitude of lost revenue due to dystocia. In addition to the breeds already offering EPDs for calving ease, a number of other breeds currently are conducting research projects which are expected to result in calving ease EPDs on a more widespread basis in the near future. Technically, use of advanced, multiple trait, threshold models for calculating these EPDs promises to comprehensively combine information from various traits into potentially easy to use genetic values expressed as probabilities of unassisted births. From a more applied standpoint, opportunities for selective breeding to reduce calving problems and improve most traits exist at three points: 1) When sires are selected to produce replacements, 2) when heifers are selected from the pool of replacements, and 3) when service sires are picked to breed with selected heifers.

REDUCING COSTS THROUGH BENDING THE GROWTH CURVE

Over time, one of the most concentrated areas of selection emphasis has been in the effort to produce cattle which have sensible birth weights (calve easily) and at the same time high growth, especially to yearling age. Because of the relationship between birth weight and mature as well as carcass weight, such selection has generally resulted in cattle which calve easily, grow rapidly and then mature at a reasonable size. It would be interesting to know the relationship between differences in the shape of growth curves and corresponding differences in the inherent efficiency of growth and development.

EPDs for birth, weaning and yearling weight will continue to allow us to avoid the costs associated with calving difficulty without overly sacrificing the economic benefits of rapid growth. Greater availability of EPDs for mature cow weight will facilitate more efficient selection for the remainder of the growth curve and help us avoid producing cattle of inappropriate mature sizes. While curve bending animals are likely to always be "in style", it will become increasingly important to make sure that such animals do not possess any major genetic problems in other important traits for a given situation.

REDUCING COSTS THROUGH MINIMIZING CARCASS PROBLEMS

Since completion of the National Beef Quality Audit and Strategic Alliances Field Study, a great deal of attention has been directed toward carcass traits. Generally, these studies have helped us all gain a better appreciation for the negative economic consequences of producing carcasses with certain problems or nonconformities. At the risk of oversimplifying carcass problems recognized by these studies, problems with a genetic origin primarily include production of carcasses which are excessively fat, are too heavy, or which lack sufficient red meat yield or have insufficient marbling. As discovery of carcass value becomes more widely based on appropriate size, red meat yield and indications of expected palatability, these traits and others will warrant attention.

The American Angus Association leads other breed associations in pursuit of carcass data collection and in describing genetic differences in carcass traits within their breed. With the expectation that EPDs for carcass traits are likely to be more widely available for several breeds (especially for A.I. sires), many questions have been raised as to how such information should most wisely be used without unfavorable correlated responses in other traits. Until such questions can be resolved, a judicious approach might be to avoid or limit the use of "outlier" sires with major problems in one or more carcass traits through the use of EPDs for carcass weight, ribeye area, fat thickness and marbling. Because of the threshold nature of some carcass traits, creatively expressing carcass EPDs as probability values of acceptable carcass merit may offer a means by which to more appropriately describe genetic differences. For specialty markets, producers may want to more specifically emphasize certain combinations of carcass traits.

The key appears to be one of genetically designing groups of cattle with carcasses which do not receive any major economic discounts, while at the same time balancing selection for other economically important production traits. It is important to watch for research breakthroughs in molecular genetics, new post-mortem processing techniques, as well as further advances in the use of ultrasound technologies which may offer very rapid quality control for some carcass and palatability characteristics and adjust selection strategies accordingly. As a side-note, remember that other aspects of production influence the variability of carcass traits among a group of cattle. For instance, a shorter calving season which results in less variation in age at slaughter among a given group of cattle should also contribute to less variation in carcass traits and fewer outlier cattle which are discounted for one reason or another.

REDUCING COSTS THROUGH MATCHING MILK AND SIZE TO FEED RESOURCES

As an industry, for as long as I can remember we have been talking about matching milk production and cow size to available resources. Clearly, this is important since feed costs are typically the largest single expense item for cow-calf producers. Obviously, efficient cows are those which require low input in relation to their output. EPDs for milk production are available in most breeds and several breeds are in varying stages of describing genetic differences in mature cow size.

Knowing what levels of milk and size are most appropriate for any given situation is no easy task, and is usually discovered through trial and error. The Beef Improvement Federation Fact Sheet entitled "The Systems Concept of Beef Production" includes a useful reference table of optimal genetic potentials for cattle in various production environments and breed roles (Bourdon, 1992). At present, at least some seedstock and commercial producers appear to be somewhat preoccupied with selection for maximum levels of milk EPDs. Depending upon the availability and cost of feed resources, the length of time feeder cattle are owned following weaning, and interactions between milk production and other traits such as expressed fertility, this selection practice may not maximize net returns. Each incremental change in milk EPD represents a change in associated maintenance costs and a change in revenue received for pounds of weaning weight. Unfortunately, we currently can only make educated guesses as to the point of diminishing returns relative to the level of milk production for various production situations.

CONVENIENCE TRAITS AND COST REDUCTION

There are a number of additional traits which contribute to the production of problem free cattle besides reproduction, calving ease, growth and carcass traits. For lack of a better term, these traits can be classified as convenience traits. These include such characteristics as soundness of teats and udders as well as feet and legs, muscularity, docility, body capacity, fleshing ability and other factors which contribute to hassle-free longevity.

The term convenience should not be interpreted to imply that these traits are universally less important than other traits. On the contrary, unacceptable levels of some of these traits may be of greater threat to longevity, doing ability and ultimately net return than traits which frequently receive more emphasis. Minimizing the number of animals which must be prematurely culled due to problems with convenience traits saves cattlemen the costs associated with replacing these animals in the breeding herd and reductions in performance of related traits.

Through their Genetic Trait Summary (GTS) program, the American Breeders Service (ABS) has assumed a leadership role in quantifying genetic differences in convenience traits. This information can help producers zero-in on A.I. sires which have the documented genetic ability to fix or avoid problems. Although less quantified, most other semen suppliers can provide similar information based on their observations of offspring from sires in their bull studs. Additionally, some breed associations have included some of these traits in their genetic evaluation programs, and are likely to offer EPDs for some of these traits in the future.

COMBINING EPDs AND HYBRID VIGOR TO REDUCE COSTS

In my opinion, it should go without saying that commercial producers are advised to capitalize on both EPDs and hybrid vigor to reduce costs. One of the primary goals of seedstock producers should be to provide genetic inputs which help their users manage genetic antagonisms, both through the use of EPDs and through planned crossbreeding systems which blend the attributes of two or more breeds. An excellent discussion of this topic is included in the 1994 Proceedings of the Beef Improvement Federation (Kress, 1994; Gosey, 1994 and Bourdon, 1994). Cattle breeders should also be advised to stay abreast of developments in the areas of across breed EPD comparisons, EPDs for hybrid cattle and international genetic evaluation advancements.

OPPORTUNITIES FOR SIMPLIFICATION

The thought of EPDs for a greater number of traits should not be viewed as frustrating or intimidating by cattle breeders. On the contrary, more comprehensive information will empower breeders with tools to more appropriately match genetic inputs to specific production situations for the purpose of maximizing net returns. Over time, it is possible that EPDs for some traits could either be eliminated if not economically meaningful, or combined with information on other traits in the form of simplified indexes. Table 1 provides a summary of genetic evaluation efforts currently underway by various breeds (Cunningham, 1994).

SUMMARY

Effective use of EPDs to reduce costs involves combining a working knowledge of both EPDs and production costs/returns and how each interact over time. As EPDs are introduced for additional traits, the degree of emphasis given to each trait in selection programs should be evaluated according to the anticipated impact on net returns. More comprehensive descriptions of genetic differences among animals is expected to encourage a better understanding of the relative importance of levels of performance in various traits and corresponding changes in economic efficiency for different production situations. The ability to translate large amounts of information into knowledge which results in smart decision making will become increasingly important for creating economic prosperity.

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Figure 1. Factors in Purchasing or Selecting a Bull by Level of Importance

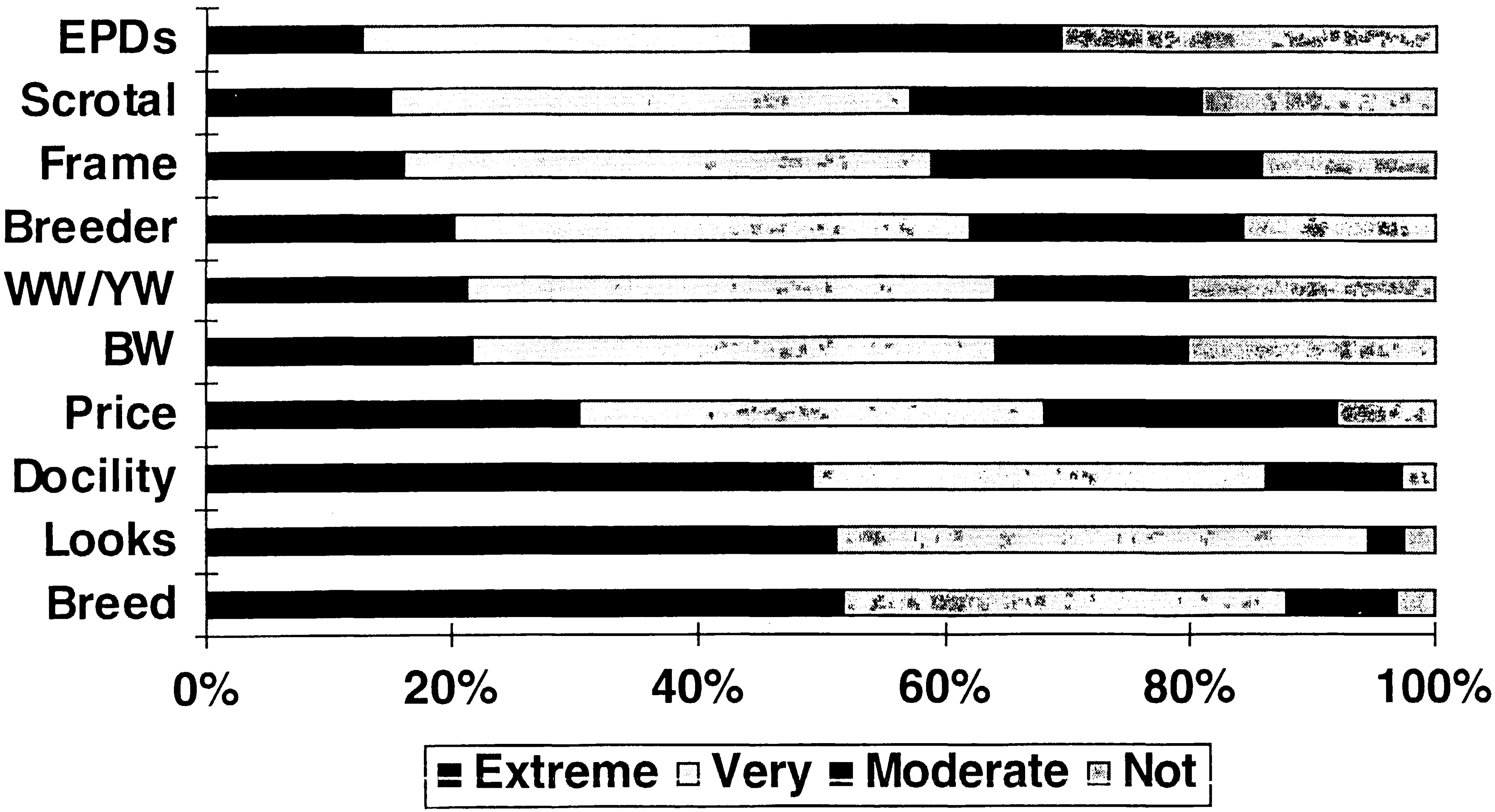

Table 1. Genetic Evaluations Provided by Beef Breed Associations[3]

Trait	AAA[1]	ASA	ATA	AICA	AGA	IBBA	AHA	AMAA	RAAA	APHA	NALF	ABBA	BBU	ACA	ASA
Birth Wt. (d)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Birth Wt. (m)	R	P								C	C				
Weaning Wt. (d)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Weaning Wt. (m)	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
Total Maternal	Y	Y		Y	Y	Y	Y		Y	Y	Y				Y
Yearling Wt.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Calving Ease (d)	R	Y	Y		Y					C	R				
Calving Ease (m)	R	Y	Y		Y					C	R				
PPA[2]		Y													
Carcass Wt.	Y	Y		Y							Y			R	
Rib Eye Area	Y										Y			R	
Marbling Score	Y	Y		Y							Y			R	
% Retail Cuts		Y		Y											
Fat Thickness	Y										Y			R	
Scrotal Cir.	Y				R	R	Y			Y	Y				
Dau. Mature Wt.	Y				R					R	R				
Dau. Mature Ht.	Y				R					R	R				
Gestation Length		P	R		Y						Y				
Yearling Hip Ht.	R						Y			C	R				
Calving Date		R			R										
Stayability									R		R				
Disposition Score											R				

[1]AAA=American Angus Assn.; ASA=American Simmental Assn.; ATA=American Tarentaise Assn.; AICA=American International Charolais Assn.; AGA=American Gelbvieh Assn.; IBBA=International Brangus Breeders Assn.; AHA=American Hereford Assn.; AMAA=American Maine-Anjou Assn.; RAAA=Red Angus Assn. of America; APHA=American Polled Hereford Assn.; NALF=North American Limousin Foundation; ABBA=American Brahman Breeders Assn.; BBU=Beefmaster Breeders Universal; ACA=American Chianina Assn.; ASA=American Shorthorn Assn.

[2]PPA=Predicted Producing Ability.

[3]Y=EPD currently available; R=Research in progress; P=Genetic evaluation conducted in the past but not presently being performed; C=EPD calculated but not reported.

Carcass Targets and Price Differentials of the Big Three

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Identification of carcass-based targets aimed at specification production for the beef industry is not new. During the 1980's it became popular to categorize beef production for three primary targets/markets: "High Quality" (Average Choice to High Prime) for the food service or Hotel, Restaurant, and Institutional trade (HRI), "Intermediate Quality" (Low Choice) for the retail segment as well as some HRI trade, and "Acceptable Quality" or "Lean/Lite Beef" (Low Select and High Select) to appeal to consumers with diet/health interests (Smith, 1988). It was during this period that universities, industry organizations and associations further identified values or ranges for specific carcass traits to define specification production. Fortunately, a majority of the values for these traits are still "on-target" to meet packer markets in the mid 1990's.

Numerous surveys, research projects and task forces with subsequent recommendations have transpired since the 1980's to further define and hopefully refine carcass targets as we know them today. Researchers conducted the National Market Basket Survey (Savell et al., 1991) that led to closely-trimmed beef (0.25 in or less) at retail along with the renaming of the U.S. Good quality grade to U.S. Select to enhance consumer appeal. Morgan et al. (1991) reported considerable variation in our beef supplies at retail in a National Beef Tenderness Survey. In the fall of 1991, the National Beef Quality Audit (Lorenzen et al., 1993) was conducted to characterize the consist of the U.S. fed beef supply relative to defects, carcass quality and quantity. As a result of the findings in these surveys, the National Cattlemen's Association (NCA) formed a Value-Based Marketing Task Force (1990) with the goal of reducing excess trimmable fat by 20 percent in the U.S. beef supply by 1995. A Strategic Alliance Field Study (Eilers et al., 1995) demonstrated that a portion of the lost opportunities for profit associated with management could be recovered through an alliance between producer, feeder, packer, and retailer. NCA followed this with a National Beef Tenderness Plan (1994) to reduce product toughness by 50 percent by 1997. Now in 1995, the National Beef Quality Audit is being repeated as a follow-up report card for the industry and a Carcass Instrument Assessment Study will begin later this summer in a plant environment.

Despite all of these efforts, progress toward true value-based marketing has been slow to develop and more importantly, slow to provide incentives or rewards for those producers who adopt the recommended genetic and managerial changes. Producers are wondering "why not", "when", and "how much" will ultimately be passed back to reward their efforts to improve the beef industry. Have the carcass targets changed and if so, what are the current targets in the eyes of packers?

To address my topic and to answer some of these questions I interviewed representatives from each of the top three beef packing firms. IBP, Monfort, and Excel have a combined annual slaughter capacity of approximately 20,500,000 head representing approximately 78.9 percent of the total 1994 U.S. fed steer and heifer slaughter.

Packer Interviews

Types of Markets. All three packers cite box beef markets in retail, food service (HRI) and export for which they buy and fabricate beef. On a tonnage basis, percentage consist for their boxed beef mix is approximately 52 percent (50 to 55%) for the retail segment, 35 percent (30 to 38%) for food service, and 13 percent (12 to 15%) for the export trade.

Quality Grade Levels. All three packers fabricate U.S. Prime, U.S. Choice, U.S. Select and no-roll carcasses for boxed-beef markets. Likewise, all three identify and fabricate carcasses qualifying as Certified Angus Beef (CAB). Additional packer quality brands resembling CAB are Sterling Silver (Excel Corporation) as well as Chef's Exclusive and Supreme Angus (Monfort). Since the USDA grade change from U.S. Good to U.S. Select in 1987, demand for no-roll boxed-beef products has continually declined. One packer reported no-roll boxed beef currently exists as less than 5 percent of the total boxed-beef mix.

Quality grade demand is highly market specific. A majority of the export and food service markets purchase boxed beef of U.S. Choice or higher quality. A representative grade consist for these markets may was reported as: Export (25% U.S. Prime, 12% CAB and 63% U.S. Choice) and Food Service (30% U.S. Prime, 6 to 10% CAB and 54 to 60% U.S. Choice). The retail segment markets U.S. Choice, U.S. Select and no-roll or specialty grades (Value-Max is Excel's brand name for Holstein beef). One packer characterized retail demand as 9% CAB, 41% U.S. Choice and 50% other (U.S. Select and no-roll).

Yield Grade. Yield grades were designed to estimate the percentage of carcass weight in boneless, closely-trimmed (0.5 inch) round, loin, rib and chuck. Severe discounts are frequently applied to carcasses with yield grades of 4 or 5 for excess trimmable fat. All packers claim to limit their box beef mix to yield grade 3 or better (maximum yield grade of 3.9) carcasses. The only exception was a specialty box customer that accepts some yield grade 4. Aside from a few isolated cases with formulas, none of the packers are regularly using the USDA option of splitting yield grades 2 (2A = 2.0 to 2.49; 2B = 2.5 to 2.99) and 3 (3A = 3.0 to 3.49; 3B = 3.5 to 3.99) as recommended by the National Cattlemen's Association Carcass Grading Task Force. Instead, many are using their own systems to further segregate carcasses within yield grades (muscle score system or hot fat trim determinations). One of the packers plans to implement the yield grade split in the future to better predict boxed beef yields and labor needs as well as to provide additional information (good or bad) for buyers and producers. All of the packers agreed that yield grade 3B carcasses are too fat for closely-trimmed boxed beef fabrication. Yield grade 3A carcasses are now considered "par" for progressive fabrication cutting specifications.

Carcass Weight. Carcass weight sorting has become more simplified today and exists primarily as light versus heavy. Two of the top three packers identified 550 and

950 pounds as their minimum and maximum carcass weights, respectively, for boxed-beef fabrication. Relative to the minimum, do not be surprised if it increases to 600 pounds in the future. The maximum weight (950 pounds) is predicated on not only subprimal portion size but also worker safety. Carcasses weighing 700 to 799 pounds still provide the most flexibility for multiple fabrication specifications.

Ribeye Area / Muscling. Muscling has become increasingly more important with closely-trimmed boxed beef. As our industry becomes more consistent in managing for fat targets (0.4 inch), muscularity will become the most influential determinant of boneless, closely-trimmed cutability.

Two of the packers use 10.0 square inches as the minimum for boxed beef. The other considers 11.6 square inches as the minimum to keep angularity out of their boxed beef mix. The upper end of muscling is more difficult to assess especially since most customers base their orders on a subprimal weight basis (light, average, and heavy strip loins) instead of ribeye area. Regardless, packers have problems meeting a majority of the portion size demands once ribeyes surpass 15.0 to 16.5 square inches.

Box Beef Categories. Three primary categories of boxed beef are available in the U.S. -- Commodity-trimmed (maximum of 1.0 inch of residual external fat), Closely-trimmed (either 0.25 inch, 0.12 inch, or denuded 0.00 inch residual fat levels), and Specialty or Premium (Branded, CAB, Value-Max, etc.). These categories appear simple enough for daily management through fabrication. However, consider the many combinations available to properly identify and label individual subprimals (Institutional Meat Purchase Specification Codes): bone-in versus boneless (greater than 80 %), fat trim end point (1.00, 0.25, 0.12, or 0.00 inch), quality grade level (U.S. Prime, CAB or Specialty, U.S. Choice, U.S. Select, no-roll), weight classification (heavy versus light) and in some cases biological type (native versus dairy) and individual plants have at least 4,000 different product codes for boxed-beef items. Individual plants handle at least 1,500 different product codes each day of operation.

Closely-trimmed Boxed Beef. Presently, closely-trimmed boxed beef is estimated to represent approximately 35 to 40 percent of the total boxed beef mix. Will closely-trimmed boxed beef levels ever reach 75 percent of the mix, and if so, when? All three packers agreed that sales of closely-trimmed boxed beef have stalled and probably will not reach 75 percent of the total boxed beef mix for another five to ten years. Apparently, there are still retailers that 1) feel closely-trimmed boxed beef is overpriced relative to commodity trim, and 2) are not convinced of the added value in closely-trimmed compared to commodity-trimmed boxed beef.

The closely-trimmed boxed beef portion of the mix is difficult to estimate because packers seldom fabricate all of the possible subprimals from an entire carcass or side into closely-trimmed products. Many of the retailers accustomed to purchasing closely-trimmed boxed beef have become very selective in their subprimal purchases creating a range in demand across subprimals. Thus, packers tend to fabricate specific subprimals as closely-trimmed dependent on demand in a "cut-to-order" fashion.

Packers were asked if their companies envisioned case-ready beef for the future. All three responded yes, contingent upon closely-trimmed boxed beef demand (75 percent or more), to meet a diet/health niche, or in the form of case-ready plus tray-ready products. These products will more than likely be highly retail cut dependent.

Slaughter Cattle Purchases. Packer representatives were asked to identify their highest priority considerations when purchasing slaughter cattle. Packer A responded market, select suppliers, uniformity for specifications ("blacks", lean, etc.), and grade (quality and yield). Packer B cited quality defined as cut size, carcass weight, and breed. Also, Packer B expressed a willingness to pay \$ 2.00 to \$ 3.00 / cwt. more for the right type of cattle as long as they could discount lower quality cattle. Packer C listed price, weight (yield), quality grade, muscling (cutability) and misfits as their primary considerations.

Objective Determination of Value.

It has been estimated that over 80 % of the fed steer and heifer carcasses are fabricated for boxed beef. Accordingly, packers and their customers think pieces (subprimals) not carcasses for a majority of their market transactions. We developed a computer program based on fabrication data from 341 steer carcasses (weight range = 626 to 979 pounds; 67% U.S. Choice, 33% U.S. Select; fat thickness = 0.16 to 1.0 inch; ribeye area = 9.5 to 16.9 square inches) to estimate live and carcass values originating from boxed beef subprimals. Slaughter cost, drop credit, fabrication cost, quality grade, yield grade and biological type (native versus dairy) are important considerations for calculating an individual animal's value.

Slaughter Cost. Packer slaughter cost may range from \$25.00 to \$40.00 per head and is highly dependent on the chain speed or amount of down time, the availability of cattle and animal defects (non-conformities). Currently, I propose a slaughter cost of \$35.00 per head.

Drop Credit. The value of the hide, edible organs and glands, as well as all renderable products (meat and bone meal, blood meal, tallow, etc.) contribute to drop credit. A realistic drop credit value for late May 1995 was \$9.09 per hundred pounds of live weight.

Fabrication Cost. The cost to fabricate carcasses into box beef subprimals varies with carcass grade, carcass type (native versus dairy), and cutting specification (bone-in versus boneless and level of fat trim) and may easily range from \$35.00 to \$60.00 per carcass. At present, I estimate fabrication cost at \$50.00 per carcass for a progressive HRI cutting specification (98% boneless) for both commodity and closely-trimmed fat trim levels. Separate fabrication cost inputs may be necessary to reflect additional labor expenses incurred for the closely-trimmed subprimals depending on the yield grade of a carcass (3A, 3B or especially yield grade 4).

Quality Grade. Quality grade price spreads are highly seasonal. Late May 1995 carcass equivalent spreads based from U.S. Choice were -\$8.00/cwt. for U.S. Select and -\$32.00/cwt. for U.S. Standard. The OSU pricing program uses inputs from packer or market report wholesale prices for either U.S. Choice or U.S. Select on an individual subprimal basis.

Yield Grade. Box beef cut-out is highly dependent on the yield grade of a carcass, especially for the closely-trimmed end point. The OSU pricing program estimates individual subprimal yields for carcasses of yield grades 1 (1.6), 2 (2.5), 3 (3.4) and 4 (4.3).

Boxed Beef Subprimals. Subprimals and lean trim generated through fabrication may be categorized as major (n = 9), minor (loose meats), 75% lean trim, and 50% lean trim. Yields for these items are estimated for each yield grade category and prices (wholesale) are applied separately for quality grades (U.S. Choice versus U.S. Select) when appropriate. An example of the OSU pricing program boxed beef subprimal and lean trim pricing matrix is presented in Table 1.

Table 1. Pricing Matrix for Boxed Beef Items[a]

IMPS Number	*Item*	*U.S. Choice*	*U.S. Select*
112A	**Ribeye < 11 lb.**	$ 400.00	$ 330.00
112A	**Ribeye > 11 lb.**	$ 405.00	$ 340.00
114	**Shoulder Clod**	$ 95.00	$ 95.00
116A	**Chuck Roll**	$ 115.00	$ 108.00
120	Brisket	$ 88.00	$ 88.00
167	**Knuckle**	$ 121.00	$ 111.00
168	**Inside Round**	$ 145.00	$ 133.00
170	**Gooseneck Round**	$ 105.00	$ 105.00
180	**Strip Loin < 12 lb.**	$ 350.00	$ 270.00
180	**Strip Loin 12 to 13.9 lb.**	$ 350.00	$ 275.00
180	**Strip Loin 14 lb. or >**	$ 355.00	$ 275.00
184	**Top Butt < 12 lb.**	$ 215.00	$ 170.00
184	**Top Butt 12 lb. or >**	$ 215.00	$ 175.00
185A	Bottom Sirloin Ball Tip < 2 lb.	$ 157.00	$ 155.00
185B	Bottom Sirloin Ball Tip 2 lb. or >	$ 175.00	$ 175.00
185C	Bottom Sirloin Tri-Tip	$ 190.00	$ 180.00
189A	**Tenderloin < 5 lb.**	$ 670.00	$ 610.00
189A	**Tenderloin 5 lb. or >**	$ 687.00	$ 630.00
193	Flank Steak	$ 270.00	$ 270.00
------------	Inside Skirt	$ 166.00	$ 166.00
------------	Cap & Wedge Meat	$ 115.00	$ 115.00
------------	Back Ribs	$ 48.00	$ 48.00
------------	75% Lean Trim	$ 72.00	$ 72.00
------------	50 % Lean Trim	$ 41.00	$ 41.00

[a]Prices reflect the commodity-trimmed boxed beef subprimal market on May 30, 1995. The nine major subprimals are in bold.

The estimated carcass and live values for a 750 pound steer carcass dressing 63.75 percent (1176 pound live weight) grading U.S. Choice with a yield grade of 2 on a commodity-trimmed boxed beef basis were $110.68 and $70.56 per hundred pounds, respectively using May 30, 1995 wholesale prices (Table 2).

Table 2. Value Determination for a Commodity-Trimmed U.S. Choice, Yield Grade 2[a]

Carcass Weight, lb.	=	750	Live Weight, lb.	=	1176
Quality Grade (Ch or Se)	=	Choice	Gross Carcass Value	=	$808.14
Yield Grade (1, 2, 3, or 4)	=	2	Gross Drop Credit	=	$106.94
Drop Credit	=	$9.09	Gross Live Value	=	$915.08
Kill + Fab Cost	=	$85.00	**Net Carcass Value**	=	**$110.68**
Dressing Percent	=	63.75	**Net Live Value**	=	**$70.56**

[a]Prices reflect the commodity-trimmed boxed beef subprimal market on May 30, 1995.

Value estimates for the same animal using closely-trimmed wholesale boxed beef prices were $124.94 and $79.65 per hundred pounds for carcass and live weight bases, respectively (Table 3).

Table 3. Value Determination for a Closely-Trimmed U.S. Choice, Yield Grade 2[a].

Carcass Weight, lb.	=	750	Live Weight, lb.	=	1176
Quality Grade (Ch or Se)	=	Choice	Gross Carcass Value	=	$915.12
Yield Grade (1, 2, 3, or 4)	=	2	Gross Drop Credit	=	$106.94
Drop Credit	=	$9.09	Gross Live Value	=	$1022.06
Kill + Fab Cost	=	$85.00	**Net Carcass Value**	=	**$124.94**
Dressing Percent	=	63.75	**Net Live Value**	=	**$79.65**

[a]Prices reflect the closely-trimmed boxed beef subprimal market on May 30, 1995.

The absolute value difference between commodity and closely-trimmed boxed beef wholesale prices for a U.S. Choice yield grade 2 steer carcass was $106.98 (Table 4). This added value for closely-trimmed boxed beef is, in part, associated with the removal of excess waste (fat and steak tails) resulting in increased subprimal yields for retailers and food service.

Table 4. Value Difference Between Closely- and Commodity-Trimmed Boxed Beef[a]

Carcass Weight	750 lb.
Quality Grade	U.S. Choice
Yield Grade	2
Closely-trimmed Net Value	$937.06
Commodity-Trimmed Net Value	$830.08
Total Dollar Difference Per Carcass	**$106.98**

[a]Prices reflect the commodity- and closely-trimmed boxed beef subprimal market on May 30, 1995.

The OSU pricing grids for various options related to level of trim (commodity versus closely), quality grade (U.S. Choice versus U.S. Select), and yield grade (1, 2, 3, or 4) are presented in Tables 5 and 6 for carcass and live weight end points, respectively. As expected, the price differentials between yield grades become larger with the additional fat removal associated with closely-trimmed fabrication.

Table 5. Carcass Equivalent Value Determinations from Commodity- and Closely-Trimmed Boxed Beef Stratified by Quality and Yield Grades[a]

Yield	*Commodity - Trimmed*		*Closely - Trimmed*	
Grade	*Choice*	*Select*	*Choice*	*Select*
1	$ 115.43	$ 105.72	$ 132.61	$ 120.46
2	$ 110.68	$ 101.37	$ 124.94	$ 113.60
3	$ 106.01	$ 97.27	$ 118.22	$ 107.60
4	$ 103.55	$ 94.94	$ 113.30	$ 103.21

[a]Prices reflect the commodity- and closely-trimmed boxed beef subprimal markets on May 30, 1995.

Table 6. Live Value Determinations from Commodity- and Closely-Trimmed Boxed Beef Stratified by Quality and Yield Grade[a]

Yield	*Commodity - Trimmed*		*Closely - Trimmed*	
Grade	*Choice*	*Select*	*Choice*	*Select*
1	$ 73.59	$ 67.40	$ 84.54	$ 76.79
2	$ 70.56	$ 64.63	$ 79.65	$ 72.42
3	$ 67.58	$ 62.01	$ 75.37	$ 68.60
4	$ 66.01	$ 60.52	$ 72.23	$ 65.79

[a]Prices reflect the commodity- and closely-trimmed boxed beef subprimal market on May 30, 1995.

It has been stated many times that true value-based marketing must be assessed on an individual animal basis. That is to say, if all carcasses fit the industry specifications for weight and grade then grids as outlined in Tables 7 and 8 could be used to negotiate relative prices. To date, however, most feedlots manage and market cattle on a lot basis. Therefore, it is important to consider all carcasses; those that conform to specifications ("fit") and are fabricated for boxed beef as well as those that do not conform because of defects or short-falls ("misfits") and are marketed as carcasses.

To demonstrate the impact of lack of uniformity in the carcasses produced we calculated as an example the live value for a lot of average slaughter steers (n = 100) where 86 carcasses conformed and were sent through fabrication and 14 were non-conformers and were marketed as carcasses. Table 7 reflects the 86 carcasses that conformed to weight (550 to 950 lb.) and grade (U.S. Prime, U.S. Choice, U.S. Select; Yield Grade 3 or better) specifications for boxed beef fabrication. A live price was determined using commodity-trimmed boxed beef prices predicted in the OSU model for the quality and yield grade consist with U.S. Choice, Yield Grade 3 as the base. The average live value ($ / cwt.) for these 86 conformers was $67.18.

Table 7. Live Value Determinations from Commodity-Trimmed Boxed Beef on a Lot Basis[a]

Grade Consist		*Relative Value*		*Lot Adjustment*
U.S. Prime (1 %; YG 3)		$ 13.70	=	0.14
U.S. Choice (51 %)				
4 %	YG 1	6.01	=	0.24
13 %	YG 2	2.98	=	0.39
34 %	YG 3	Base	=	$ 67.58
U.S. Select (34 %)				
7 %	YG 1	(0.18)	=	(0.01)
13 %	YG 2	(2.95)	=	(0.38)
14 %	YG 3	(5.57)	=	(0.78)
Adjusted Live Value/cwt.				**$ 67.18**

[a]Prices reflect the commodity-trimmed boxed beef subprimal market on May 30, 1995.

Lot value adjustments for the 14 carcasses that did not conform due to problems in weight, grade, or defects are reported in Table 8. These discounts ($/cwt. carcass weight) from U.S. Choice, Yield Grade 3 carcasses reflect typical prices received by packers for carcass sales in late May of 1995. The average discount for these 14 affect all 100 steers in the lot by $2.85 per hundred pounds of carcass weight or $1.82 per hundred pounds of live weight ($2.85 X 63.75% dress).

Therefore, the average live value for this lot of 100 steers would be $65.36 per hundred pounds of live weight (86 carcasses fabbed at $67.18 minus the $1.82 discount for the 14 non-conformers = $65.36). A representative cash market price for May 30, 1995 was $64.50. Notice, this lot of 100 steers should have been worth approximately $2.68 per hundred pounds more than the cash market if all 100 of their carcasses conformed to fabrication specifications.

Table 8. Value Adjustments for Non-Conforming Carcasses[a]

Grade Consist	*Relative Value*		*Lot Adjustment*
5 % Yield Grade 4 or 5	($ 15.00)	=	(0.75)
4 % Extremes in Weight	($ 15.00)	=	(0.60)
2 % Dark Cutters	($ 30.00)	=	(0.60)
3 % U.S. Standard	($ 30.00)	=	(0.90)
Carcass Discount / cwt.			**($ 2.85)**
Adjustment to Lot Live Value / cwt. (63.75 % Dress)			**($ 1.82)**

[a]Prices reflect carcass prices on May 30, 1995.

Using the same lot consist, live value was determined using closely-trimmed instead of commodity-trimmed boxed beef prices for the 86 carcasses fabricated. The average live value for the steers that produced these 86 carcasses should have been $75.15 per hundred pounds. Again, considering the discounts associated with the 14 non-conformers, the average lot price for these 100 steers would calculate to $73.33, approximately $8.83 per hundred pounds more than the cash market ($64.50) in late May.

Table 9. Live Value Determinations from Closely-Trimmed Boxed Beef on a Lot Basis[a]

Grade Consist		*Relative Value*		*Lot Adjustment*
U.S. Prime (1 %; YG 3)		$ 4.52	=	0.05
U.S. Choice (51 %)				
4 %	YG 1	9.17	=	0.37
13 %	YG 2	4.28	=	0.56
34 %	YG 3	Base	=	$ 75.37
U.S. Select (34 %)				
7 %	YG 1	1.42	=	0.10
13 %	YG 2	(2.95)	=	(0.35)
14 %	YG 3	(6.77)	=	(0.95)
Adjusted Live Value / cwt.				**$ 75.15**

[a]Prices reflect the closely-trimmed boxed beef subprimal market on May 30, 1995.

Summary

- The two primary markets for U.S. beef are retail (approximately 52 percent) versus food service / HRI and export (approximately 48 percent).
- U.S. Choice, yield grade 3A or better carcasses weighing 600 to 950 pounds are considered "par" in progressive pricing formulas.
- Inasmuch as possible, pricing should be structured to reflect true cutability differences between yield grades.

- Closely-trimmed boxed beef is currently marketed as value-added. Currently, holding prices constant and increasing the demand for closely-trimmed boxed beef by 10% should correspond to a \$0.70/cwt increase in live value.
- I propose the following targets (Tables 10 and 11) with optimum as well as acceptable carcass trait ranges to meet market demands.

Table 10. Food Service (HRI) / Export Target

Carcass Weight---------	700 to 799 lb. (600 to 950 lb.)[a]
Fat Thickness-----------	0.40 in. (0.25 to 0.50 in.)
Ribeye Area ------------	13.8 sq. in. (11.8 to 15.8 sq. in.)
Yield Grade-------------	3A or better (< 3.5)
Quality Grade ----------	Avg. Choice or > (Low Choice through Prime)

[a]Initial range or value represents the optimum; values in parentheses reflect an acceptable range.

Table 11. Retail Target

Carcass Weight-----	700 to 799 lb. (600 to 950)
Fat Thickness -------	0.40 in. (0.25 to 0.50)
Ribeye Area---------	13.8 sq. in. (11.8 to 15.8)
Yield Grade ---------	2B or better (<3.0)
Quality Grade-------	High Select or >

[a]Initial range or value represents the optimum; values in parentheses reflect an acceptable range.

- An equally important target for all market segments should include producing beef with "no defects", "no pathogens", and "no residues".

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THE OPTIMUM COW--WHAT CRITERIA MUST SHE MEET?[1]

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Introduction

I would like to take poetic license and change the title of this presentation to "Search for the Elusive Optimum Cow," because she is indeed an elusive beast. I have searched for her for over 20 years. I have not yet found her, but I believe I am getting close. During this search, I have heard her defined in numerous ways: the high performance cow, the mini-care cow, the low-maintenance cow, and the biologically efficient cow, to mention a few. The latter definition served as the focal point of the "The Beef Cow Efficiency Forum," held in 1984 at Colorado State University and Michigan State University (Ritchie and Hawkins, 1984). The purpose of this conference was to review the research that had been conducted to date on beef production efficiency. The ultimate objective was to identify potential means for improving beef production efficiency, particularly in the cow-calf segment of the industry.

Biological Efficiency

Efficiency can be expressed in two ways: 1) biological efficiency, and 2) economic efficiency. Economic efficiency was covered only lightly in the 1984 Forum because up to that time research conducted on the subject was somewhat limited.

Dickerson (1984) estimated that an average of only 6% of the total life cycle dietary energy expanded in beef production is used for protein deposition in market progeny. Pork and broiler chicken production are much more efficient at 14% and 21%, respectively, although it should be noted that a high percentage of the total life cycle diet used in beef production is composed of high-fiber forages which cannot be utilized by monogastric species such as swine, poultry and humans. Nonetheless, it remains clear that beef production is a relatively inefficient process from the standpoint of total energy expenditure. This begs the question, "Why is it inefficient?"

Maintenance

One explanation for the energetic inefficiency of beef production is the high cost of maintenance. At the 1984 Forum, it was 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 (Johnson, 1984). Therefore, a

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[1]Presented at Beef Improvement Federation Annual Conference, May 31-June 3, 1995, Sheridan, WY.

staggering 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 beef cows is moderate to high, which suggests there may be opportunities to select for more biologically efficient cows (Anderson, 1980; Carstens et al., 1989; DiConstanzo et al., 1990). Unfortunately, there is currently no simple and inexpensive method for evaluating the maintenance requirements of individual cattle.

U.S. MARC workers (Ferrell and Jenkins, 1984) reported that breedtypes differ in their maintenance requirement, as shown in Table 1. Not only did the heavier-milking breeds, Jersey and Simmental, exhibit greater maintenance needs during lactation but during the dry period as well. Texas researchers later reported similar results (Solis et al., 1988). In a review of the literature, Ferrell and Jenkins (1985), 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." They went on to propose that the increased maintenance requirement of high producing animals can be largely accounted for by their increased mass of visceral organs, especially the gastrointestinal tract and liver, which have a very high rate of energy expenditure. Furthermore, the increased lean tissue mass in heavier-muscled animals may result in a higher energy expenditure because research has shown that more energy is required to maintain a given weight of body protein than a comparable weight of body fat (Pullar and Webster, 1977; Thompson et al., 1983; DiConstanzo et al., 1990).

Table 1. Estimates of metabolizable energy (ME) required for maintenance of four biological types of nonpregnant, nonlactating cows[a]

Breed of cow	Maintenance requirement (Kilocalories ME per kg metabolic body weight per day)
Angus X Hereford	130
Charolais X British	129
Jersey X British	145
Simmental X British	160

[a]Ferrell and Jenkins. 1984. J. Anim. Sci. 58:234.

Based upon these studies, and those of other researchers, high maintenance cows tend to have the following characteristics: high milk production, high visceral organ weight, high body lean mass, low body fat mass, high output, and high input. Conversely, low maintenance cows tend to be: low in milk production, low in visceral organ weight, low in body lean mass, high in body fat mass, low output, and low input. All of this implies that there is a need for balance based upon the production environment and the market requirements for a given region and/or for a given farm or ranch.

Measures of Biological Efficiency

The measures of beef cow biological efficiency up to weaning time that have been commonly used in research studies include the following: 1) lb calf weaned per cow exposed; 2) lb calf weaned per cow exposed per lb cow weight; 3) lb calf weaned per cow exposed per unit of feed energy consumed. In studies that have involved retained ownership up to slaughter time, measures of efficiency have included: 1) lb slaughter progeny weight per unit of feed energy consumed by cow and slaughter progeny; 2) lb carcass weight per unit of feed energy consumed by cow and slaughter progeny; 3) lb edible beef per unit of feed energy consumed by cow and slaughter progeny. In some retained ownership trials, reproductive rate was included in the efficiency equation, whereas in others it was not.

Summary of Beef Cow Biological Efficiency

In summarizing the 1984 Beef Cow Efficiency Forum, the following conclusions were drawn:

- Measures of mature cow size (weight, height, etc.) are not correlated with biological efficiency.

- Acceptable market weight range should be a major consideration when decisions are made regarding breed size and mating systems.

- Large differences in reproductive rate have a profound impact on cow efficiency and tend to over-ride all other factors including calf weight, feed consumption, etc.

- Under a liberal feed supply and/or a relatively stress-free environment, there is a tendency for larger, heavier-milking biological types to be more efficient than moderate types.

- Under a restricted feed supply and/or a stressful environment, biological types having moderate size and moderate milk tend to be better adapted and excel larger, heavier-milking types in efficiency.

The latter two conclusions were confirmed recently in an extensive 5-yr 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, Simmental, Charolais, Gelbvieh, Braunvieh and Limousin improved markedly when their intake went from 3,500 to 7,000 kg. Morris et al. (1993) reported a similar genotype by environment interaction for 11 breeds differing in genetic potential for production in three geographical locations. Although not shown here, Jenkins and Ferrell (1994) calculated the dry matter intake required to maximize efficiency for each of the breeds. When this was done, there was a wide range in intake (3,790 to 8,009 kg) but a relatively narrow range in efficiency (35.1 to 47.1 g) among breeds.

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

	Dry matter intake, kg/cow/yr	
Breed	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. Anim. Sci. 72:2787.

Economic Efficiency

Since the 1984 Beef Cow Efficiency Forum, a number of research teams have included measures of economic efficiency in the design of their experiments.

Merlyn Nielsen and his colleagues at the University of Nebraska conducted a classic study on economic efficiency of three biological types of cows that differed in milk production but were similar in body size (Van Oijen et al., 1993). Low milk cows were Hereford X Angus crosses, medium cows were Red Poll X Angus crosses, and high cows were Milking Shorthorn X Angus crosses. All three groups were fed in a manner that allowed them to express their milk production potential. Results are summarized in Table 3.

manner that allowed them to express their milk production potential. Results are summarized in Table 3.

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 mature 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 3. Economic efficiency of beef production from three milk groups[a]

		Sale time	
Cow milk group	205-d milk prod., lb[b]	Weaning	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. J. Anim. Sci. 71:44.
[b]Cows 4 yrs and older.

Table 4 demonstrates the effect of cow culling age on efficiency (Kress et al., 1988). The measure of economic efficiency was $ cost per 100 lb of slaughter progeny weight. This study illustrates that longevity (stayability) has economic value. Cost of production declined as cows stayed in the herd for a greater number of years. One breed association, Red Angus, is now including EPDs for stayability in its cattle evaluation program and other associations are considering it.

Table 4. Effect of cow culling age on beef herd efficiency[a]

	Measure of efficiency	
Maximum cow culling age, years	Biological (lb TDN/lb slaughter wt)	Economic ($ cost/cwt slaughter wt)
7	10.09	74.83
9	9.78	72.12
11	9.55	69.39
13	9.30	68.03
15	9.10	67.57

[a]Kress et al., 1988. J. Anim. Sci. 66 (Suppl. I):175.

Data in Table 5 are adapted from an Agriculture Canada study which placed an economic value on the contribution of various traits to net income per cow. Conception rate, calving rate, and calf mortality ranked ahead of other traits in their effect on net income. These results are in agreement with data in Table 6, which summarizes results from two studies, one in the U.S. (Melton, 1994) and another in Australia (Barwick and Nicol, 1993). In both cases, the relative value of reproductive traits was approximately 50% of the total. Table 7 likewise illustrates the importance of reproduction on economic value (Lust, 1989). In this study, adjusting total cost per pound of retail yield for weaning percentage resulted in a significant re-ranking of the selected Hereford group from first to fourth. This group had undergone single-trait selection for yearling weight for a period of 20 years, which eventually resulted in extremely high birth weights, increased calf losses, and a lower weaning rate. MacNeil et al. (1994) and MacNeil and Newman (1994) recently reported that relative economic value of traits varies according to mating system as well as breedtypes or strains used in the mating system. Their research showed that maternal strains improve profitability through increased female fertility and calf survival, reduced cow size, and easier fleshing. In achieving maximum profitability, these strains sacrifice potential for growth and carcass cutability. Improvement in profitability in terminal sire strains results from increased male fertility, calf survival, genetic potential for growth, and carcass cutability..

Table 5. Contribution of various beef cattle traits to net farm income[a]

Trait	Contribution to net farm income $/cow
Conception rate, 1% increase	6.34
Winter feed, 1% increase	-1.28
Calving rate, 1% increase	3.59
Birth weight, 1% increase	0.46
Difficult calvings, 1% increase	-1.80
Postnatal calf death loss, 1% increase	-3.59
Weaning weight, 1% increase	3.30
Price of steer calves, 1% increase	3.30

[a]Adapted from Agriculture Canada data.

Table 6. Relative value of beef industry traits (weighted for economic value)

Industry phase	U.S.A., Melton (1994)	Australia, Barwick & Nicol (1993)[a]
Reproduction	47	50
Growth	23	27
Product	30	23[b]
	100	100

[a]Courtesy of Gibb (1995).
[b]Marbling not included as a value-determing trait.

Table 7. Effect of 20 years of selection and crossbreeding, total cost/retail yield[a]

		Total cost/lb retail yield	
		Unadj. for repro. rate	Adj. for repro. rate
Breeding group	% calves weaned	-- Dollars/lb and rank --	
Unselected Hereford	86	1.42 (4)	1.56 (3)
Selected Hereford	74	1.35 (1)	1.65 (4)
Her X Ang X Sh	89	1.38 (2T)	1.49 (2)
Sim X Gelb X Hol	91	1.38 (2T)	1.47 (1)

[a]Adapted from Lust, D.G. 1989. M.S. Thesis. Michigan State Univ., East Lansing.

Biological types of cows may change rank in profit when raised in different environments, as shown in Table 8. In this study (Smith, 1987 a,b), three breedtypes were maintained in each of two environments: Brandon, Manitoba, a fertile mixed farming region where feed resources are relatively abundant, and Manyberries, Alberta, a more stressful environment where feed resources are more restrictive. The Brandon environment allowed a relatively heavy-milking biological type, the 1/2-Simmental, to emerge as the most profitable cow group. But in the more stressful Manyberries environment, a moderate-milking biological type, the 1/2-Charolais, surpassed the Simmental cross as the most profitable group.

Table 8. Net income per cow relative to Hereford X Angus crosses[a]

	Location	
Breed of cow	Manitoba	Alberta
	Net income/cow relative to A X H, $	
Angus X Hereford	0	0
Charolais X British	+16	+19
Simmental X British	+28	+9

[a]Adapted from Smith et al., 1987. Agriculture Canada Tech. Bull. Nos. 12107.1 and 12107.2.

Jim Wilton's research group at the University of Guelph (Armstrong et al., 1990) evaluated annual net returns (income minus variable costs) for four mating systems and two resource constraints, feed supply (198 tons dry matter/year) or herd size (100 cows). Results are shown in Table 9. When feed supply was the resource constraint, the range in average annual net return was only $778 ($9292 vs. $8514). When herd size was constrained, there was a change in rank and the spread in net return between larger and smaller breedtypes became wider.

Table 9. Annual net returns for 4 mating systems and 2 resource constraints[a]

Mating system	Feed supply constraint (198 T. DM)	Herd size constraint (100 cows)
	Annual net returns and rank	
Purebred Herefords	$8846 (3)	$14,351 (4)
Small rotational cross (Ang x Gelb x Pinz x Tar)	$9192 (2)	$17,970 (3)
Large rotational cross (Char x M-A x Sim)	$9292 (1)	$20,371 (1)
Large rotational cross cows mated to Angus sires	$8514 (4)	$18,285 (2)

[a]Armstrong et al. 1990. J. Anim. Sci. 68:1857.

In a simulation study, North Carolina State University scientists (Lamb and Tess, 1989) estimated total gross income generated by various mating systems in a small 30-cow, one-bull herd over a 21-year time period (Table 10). Crossbreds or composites exceeded purebreds by 9 to 14%. Three-breed rotations were 4% higher in gross income than 2-breed rotations. A four-breed composite produced only slightly less income than the 3-breed rotations. Interestingly, there was little difference between natural service and A.I. systems. But this is understandable because, in many instances, natural service bulls are direct sons of heavily-used A.I. sires.

Table 10. Total gross income from various mating systems over a 21-year period in a one-bull 30-cow herd[a]

Mating system	Total gross income, $ (PB = 100)
Purebred	100[c]
2-breed rotation (natural service)[b]	109[d]
3-breed rotation (natural service)[b]	113[d,e]
2-breed rotation (A.I.)	110[d,e]
3-breed rotation (A.I.)	114[e]
4-breed composite	112[d,e]

[a]Lamb and Tess. 1989. J. Anim. Sci. 67:28.
[b]Natural service; sire-breed changed every 4 yrs.
[c,d,e]Means within rows differ ($P < .05$).

In a subsequent simulation study, Tess et al. (1993 a,b) compared the economic efficiency of three mating systems (purebred, 2-breed rotation and 3-breed rotation) using five different breeds (Angus, Charolais, Hereford, Limousin and Simmental) for a 100-cow herd in the southeastern U.S. As shown in Table 11, rotational crossbreeding reduced the cost of producing a pound of steer calf equivalent weight at weaning time by 15% ($0.87 vs. $1.02/lb). The average cost of the ten 2-breed rotations was identical to that of the ten 3-breed rotations. Using these data, together with assumptions based on data from composite populations at U.S. MARC (Gregory et al., 1992), this author estimated the cost of producing a weaned steer calf in 2- and 3-breed composite systems at $0.91/lb. However, this value may be a slight over-estimate because it was assumed in my calculations that total annual cost in composite systems would be identical to that in the comparable rotational systems. In reality, annual costs may be slightly lower in composite systems than costs in rotational systems using the same breeds.

Table 11. Economic efficiency of various mating systems (cow-calf production)[a]

Mating system	Production cost/lb steer calf equivalent wt sold, $/lb
Purebreds (avg. of 5)[a]	$1.02
2-breed rotations (avg. of 10)	$0.87
3-breed rotations (avg. of 10)	$0.87
2-breed composite[c]	$0.91
3-breed composite[c]	$0.91

[a]Tess et al., 1993a. Montana Agr. Exp. Sta. Publ. Vol. 10, Issue 1.
[b]Purebreds: Angus, Charolais, Hereford, Limousin, Simmental.
[c]Estimated from data presented by Tess et al. (1993a), and Gregory et al. (1992).

Table 12 shows that if calves in these systems were fed to Low Choice finish, the rotational systems had a 13% advantage ($0.91 vs. $1.04) in dollar input cost per dollar carcass value over the average of the purebreds. An examination of results of specific breed crosses revealed the following:

- When calves were sold at weaning time:
  - Among 2-breed rotations, British X British crosses were most economically efficient, followed by British X Continental crosses.
  - Among 3-breed rotations, those using 2 British breeds and 1 Continental were most efficient, followed by those using 2 Continentals and 1 British.
- When calves were fed to Low Choice finish and priced on carcass value with <u>no penalties</u> for light or heavy weight carcasses:

- Among 2-breed rotations, those using either 1 or 2 Continental breeds were more economically efficient than British X British crosses.

- Among 3-breed rotations, it made little difference whether 1, 2, or 3 Continental breeds were used in the cross.

- When calves were fed to Low Choice finish and priced on carcass value, including discounts for light and heavy weight carcasses as is the normal practice in most U.S. market channels:

  - Among 2-breed rotations, British X British crosses were most economically efficient, followed by British X Continental crosses.

  - Among 3-breed rotations, it made little difference whether 2 British or 2 Continental breeds were used in the cross.

- When calves were fed to Low Choice finish and priced on the basis of lean product weight, crosses using Charolais and/or Simmental were more economically efficient than other 2- or 3-breed combinations.

Table 12. Economic efficiency of integrated beef production (fed to Low Choice finish)[a]

Mating System	$ input cost/$ carcass value, $/$[b]
Purebreds (avg. of 5)[c]	$1.04
2-breed rotations (avg. of 10)	$0.91
3-breed rotations (avg. of 10)	$0.91

[a]Tess et al., 1993 b. Montana Agr. Exp. Sta. Publ. Vol. 10, Issue 1.
[b]Heavy and light carcasses were discounted.
[c]Purebreds: Angus, Charolais, Hereford, Limousin, Simmental.

Montana workers (Davis et al., 1994) recently 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 at the Havre Research Center in north central Montana, a region that is typical of a northern range semi-arid 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 1/2-Simmental cows over the other breedtypes. They were closely followed by 1/4-Simmental, 3/4-Simmental, straightbred Hereford, and Angus X Hereford.

As shown in Table 13, when there were no resource constraints, economic efficiency, expressed as annual net profit per cow exposed, was highest for the two F_1 groups, Angus X Hereford and Simmental X Hereford, followed by the 1/4- and 3/4-Simmental groups, respectively. When ranch size was set at 2,700 AUM (animal unit months) of range forage (Table 14) it was necessary to adjust herd size in accordance with biological type. Nevertheless, rank of the cow breed groups in annual net profit to the ranch did not change from their rank in Table 12. This study could be summarized as follows:

- Calf weight weaned per cow exposed was closely related to net profit.
- Interestingly, feed energy consumed per pound of total weight sold (weaned calves + cull cows) was not closely related to profit.
- Minimizing feed input per unit of output did not necessarily enhance net profit. This led the authors to propose that recommendations based on measures of energy conversion may be questionable.
- F_1 dams (A X H and S X H) yielded consistently higher profits than either straightbred Herefords or 3/4-Simmentals, with 1/4-Simmentals being intermediate.
- Maternal hetrosis effects on increasing profit were large and highly significant.
- Percentage increase in dollar output from maternal heterosis was only half negated by increased feed costs (25 vs. 12%).
- Maternal breed effects were much smaller than maternal heterosis effects and generally were not significant.
- Substituting Simmental dams for Hereford dams increased annual cost per cow exposed and reduced longevity, but was offset by greater output, resulting in no significant difference in profit.

Because of the beef industry's stated need for a dramatic improvement in uniformity and consistency, one is occasionally lulled into thinking about abandoning crossbreeding and returning to straightbreeding. However, the compelling evidence in this study favoring the use of the crossbred cow as a means of harvesting the significant economic benefits of maternal heterosis quickly dispels that notion.

Table 13. Economic performance of five biological types of cows (no resource constraints)[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]
1/4 Simmental, 3/4 Hereford	425[c,d]	34[c,d]
1/2 Simmental, 1/2 Hereford	437[c]	46[b,c]
3/4 Simmental, 1/4 Hereford	482[b]	19[d]

[a]Davis et al., 1994. J. Anim. Sci. 72:2591.
[b,c,d,e]Means within columns differ (P<.05).

Table 14. Economic performance of five biological types of cows (fixed forage resource base)[a,b]

Dam breed group	Herd size, cows exposed/yr	Net profit, $/yr
Angus X Hereford	340[e]	13,935[c]
Hereford X Hereford	381[c]	-8,947[f]
1/4 Simmental, 3/4 Hereford	357[d]	7,853[d]
1/2 Simmental, 1/2 Hereford	330[f]	10,407[c,d]
3/4 Simmental, 1/4 Hereford	334[e,f]	2,068[e]

[a]Davis et al., 1994. J. Anim. Sci. 72:2591.
[b]Ranch size set at 2,700 AUM of range forage.
[c,d,e,f]Means within columns differ (P<.05).

Preliminary results of another study that is currently being conducted by the Montana research team are summarized in Table 15 (Davis et al., 1995; Hirsch et al., 1995; Kress et al., 1995). Three breedtypes of cows, similar in body size, are maintained at the Havre Research Center: 1) straightbred Herefords; 2) Hereford X Tarentaise; 3) straightbred Tarentaise. As shown in Table 15, the F_1 and straightbred Tarentaise groups were heavier milking and produced more pounds of weaned calf than the straightbred Hereford group. Interestingly, the three groups did not differ in fecal output. Because fecal output is related to dietary intake, this finding implies that the three groups were similar in forage intake and that the F_1 and straightbred Tarentaise groups were more biologically efficient than the straightbred Hereford group. Although not shown here, the straightbred Tarentaise cows carried less body condition, which accounted for their lower body weight. In spite of their lower body condition, fertility of the straightbred Tarentaise group was comparable to that of the other groups. An analysis of genetic components showed that breed effects were significant for maternal milk and maternal weaning weight. Heterosis effects were significant for individual and maternal milk and for individual and maternal weaning weight.

Table 15. Productivity of three biological types of cows[a]

Item	-- Cow breed group --		
	Her X Her	Her X Tar	Tar X Tar
Pregnancy rate, %	79	82	79
Milk prod. at 130 d, lb/d	16.3[b]	20.3[c]	22.0[c]
Cow wt at 130 d, lb	1164[b]	1155[b]	1087[c]
Calf wean wt, lb	487[b]	532[c]	528[c]
Wean wt/cow exp, lb	326[b]	381[c]	354[d]
Fecal output, g/d	3220	3239	3182

[a]Davis et al.; Hirsch et al.; Kress et al. 1995. Proc. Western Section, ASAS.
[b,c,d]Means within rows 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 the southern regions of the U.S. As shown in Table 16 (Peacock et al., 1981), this is especially evident in Brahman X British crosses, which exceeded British X Continental crosses by 22% in biological efficiency; Brahman X Continental crosses were intermediate. Even in a northern environment (south-central Nebraska), Green et al. (1991) reported an advantage in biological efficiency of over 4% for *Bos indicus* X *Bos taurus* F_1 females compared to *Bos taurus* X *Bos taurus* F_1 females. 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).

Table 16. Production efficiency of different breedtypes of cows[a]

Breedtype of cow	Production efficiency[b] (Brit. X Cont. = 100)
Brahman X British	122
Brahman X Continental	108
British X Continental	100

[a]Adapted from Peacock et al. 1981. J. Anim. Sci. 52:1007.
[b]Prod. eff. = (Wean. wt ÷ cow wt.) X wean. rate.

Because previous research has demonstrated that beef toughness tends to increase as percentage of *Bos indicus* breeding increases, there is some degree of discrimination in the marketplace against fed cattle containing certain levels of *Bos indicus* genetics. However, there was consensus among industry leaders attending the National Beef Tenderness Conference (Lambert, 1994) that acceptable palatability could be generally anticipated from genotypes with no more than 1/4 to 3/8 *Bos indicus* breeding. For example, a carcass produced by mating a half-blood Brahman female to a *Bos taurus* breed of bull would be expected to provide acceptable tenderness. Discarding the maternal advantages in the southern U.S. of the *Bos indicus* crossbred female to achieve a small improvement in palatability does not appear to be warranted. Introduction of the Senepol and more recently the Tuli, both of which are believed to have not descended from *Bos indicus*, offer another heat-tolerant alternative for the southern U.S.

After reviewing the large body of literature (only some of which is presented here) in the preparation of this paper,it became clear that the crossbred cow offers so much maternal heterosis that she becomes a necessary ingredient for maximizing profit in a commercial cow-calf herd. 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, 1990). Following are four (by no means all) examples of matching breedtypes to different production environments:

- 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: British X *Bos indicus*.

When one imposes market requirements into the construction of the optimum crossbred cow, the task becomes more complex, especially for rotational crossbreeding systems. Market requirements are more easily handled in terminal sire crossbreeding systems. Well-devised composite systems can also make the inclusion of market specifications an easier task.

As a final note regarding economic efficiency, a paper by Melton and Colette (1993) presents an interesting analysis of various criteria for evaluating beef production efficiency. They contend that output:input ratios, which have often been used as indicators of economic efficiency, may lead to erroneous conclusions regarding the true commercial applicability of the breedtypes evaluated. Their reasoning is twofold: 1) most studies evaluate breedtypes within an unrealistically narrow range of input use values; and 2) output:input ratios fail to reflect consistently the long-term economic objectives of commercial cow-calf producers. They suggest that a preferred criterion for evaluating economic efficiency would be "net present value" computed under alternative scenarios regarding prices and production conditions. Net present value is defined as the sum of future net returns over multiple cattle generations discounted back to the present time. The discount rate accounts for risk and the time preference of money. For most agricultural investments, the annual discount rate is 3-5%. In an excellent review of systems research, Tess (1995) dicusses these and other issues related to evaluating economic efficiency.

Search for the Optimum Cow, Continued!

The search for the optimum cow is rigorous and seems never-ending. In recent years, the potential emergence of value-based marketing and an increased emphasis on the end-product has added a new dimension to the search. Dikeman (1995) stated it well when he recently said, "The challenge to the beef industry is to retain marketshare by reducing fat and increasing palatability and consistency, while at the same time improving production efficiency and sustaining profitability." Based upon his review of research, Tess (1995) suggested that consideration of all such factors "will favor intermediate genotypes or crossbred combinations of different biological types." Field (1994) cautioned cow-calf producers that before focusing extreme selection pressure on carcass traits, it is important to establish whether or not change in their herds is in fact needed. In other words, producers must ascertain their own position relative to current and potential future price discounts in the marketplace.

As noted before, the optimum cow is really a moving target in that she must vary with the production environment and the requirements of the marketplace. Nonetheless, Bob Taylor (1994) has provided the industry with some realistic optimum ranges that would fit many commercial situations across the U.S. Taylor also makes an important point when he says, "Maximum profitability is usually achieved before maximum productivity," a statement that is in agreement with the economic principle that says the profit maximizing level of input use and subsequent output is less than the output maximizing level.

In the final analysis, each producer must analyze his own situation and fit the cow to that situation, but with a look to the future and with enough flexibility to make subtle alterations as conditions change. As an example of two commercial operations that have set goals and have been able to adapt to changing conditions, Tables 17 and 18 list maximum specifications for Jack Maddux, Wauneta, Nebraska, and goals for Rob Brown, Throckmorton, Texas, that were presented at a conference in December, 1992.

Table 17. Maximums for a commercial herd in southwest Nebraska[a]

• Birth weight	100 lb
• Weaning weight	600 lb
• Commercial cow size	1200 lb
• Frame score	6
• Carcass weight	800 lb (1250 live)

[a]Jack Maddux, Wauneta, NE (Amer. Simmental Assoc. Focus 2000 Conf., Dec. 11-12, 1992, Columbia, MO).

Table 18. Goals for a commercial herd in west Texas[a]

• Calves weaned/cows exposed, 93% or better.
• Wean 600- to 650-lb calves at 7½ mo that are 50-60% of their dam's weight.
• Retain ownership and slaughter steers weighing 1200 to 1300 lb at 15 mos of age, with a feed conversion of 6:1 or better, and 60% grading Choice.
• Select for as much early growth as possible, within a moderate birth wt range.
• Targeted frame size range for Simmental commercial bulls of 5.5 to 7.5.
[a]Rob Brown, Throckmorton, TX (Amer. Simmental Assoc. Focus 2000 Conf., Dec. 11-12, 1992, Columbia, MO).

In conclusion, I pose the following questions and answers as food for thought:

- Is there an optimum cow? --Yes, for a given production and marketing environment.
- Have we fully characterized those optimum cows? --No, but we are getting closer.
- What is impeding our progress? --Antagonisms between reproduction, growth, and carcass traits.
- Is there a solution? --Perhaps. Development of selection indexes within a production/marketing environment is a possibility.
- Is it do-able? --I'm not certain. I would hope so!

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GENETIC RELATIONSHIP BETWEEN CARCASS TRAITS AND PRODUCTION TRAITS

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Introduction

The theme of this presentation is the concept of genetic relationships. The discussion will center on what genetic relationships are and why they exist, the importance of knowing genetic relationships, and the use of these relationships in selection programs. Carcass traits and their relationship to production traits are of particular interest to the symposium. Tables containing estimates of genetic relationships among various carcass and production traits are contained in the appendix. These tables represent a sampling of the research devoted to the subject. However, the general discussion in this paper applies to any combination of traits-- for example, between reproductive and production traits.

The reason why the focus is on carcass traits particularly (or reproductive traits) is simply that no real effective industry-wide selection program exists for these traits. Their importance is not in question. The problem stems from the difficulty in obtaining data of sufficient quantity and quality to set the foundation for a successful program.

Genetic Correlations

The standardized measure of the degree to which two traits are related is called the correlation. There are two types of correlations that producers need to be aware of-- the phenotypic and the genetic. The *phenotypic correlation* is a measure of the degree of association between an animal's performance in two traits. This association is what the producer sees in his herd as typical patterns of performance. For example, light birth weight animals are likely to be below average at weaning. The *genetic correlation* is considered most often as the degree of relationship between the breeding values (or EPDs) for the two traits. The impact of this correlation can also be seen by examining the sire summaries available for most breeds. For example, if one looks at the ranks of bulls for yearling weight, the top ranking bulls are also likely to sire the largest calves at birth. There is a fairly strong, positive genetic correlation between these two traits that is included in many national cattle evaluations.

Correlations may be antagonistic, which is counter to the direction we want a particular combination of traits to go. In the yearling and birth weight example, increased birth weight may not be desirable. Selection exclusively for higher yearling weight is expected to result in higher birth weights. An example of a negative correlation, albeit a controversial one, is between direct and maternal performance for weaning weight. A negative correlation indicates that if selection is for increased performance in one trait, we will likely decrease performance in the other. With weaning weight, a negative correlation between direct and maternal effects would indicate that selection for growth would adversely affect maternal performance. Many traits of economic interest are correlated to some degree.

Correlations are standardized to take on values from -1 to +1. The closer the value is to either +1 or -1, the greater the degree of association. Two traits with a correlation of -.8 are more closely associated than two traits with a correlation of .6 since -.8 is closer to -1 than .6 is to +1. A perfect correlation is either -1 or +1. An intuitive interpretation of the impact of a correlation's magnitude is to think in terms of exceptions to a general rule. If the correlation is positive, then the general rule is that animals that are above average in performance for one trait will be above average in performance for the other. If the correlation is negative, then the general rule is that animals above average for one trait are below average for the other. One exception to the general rule for a negative correlation would be animals that are above average in both traits. How many exceptions to the general rule exist in the population (how easy they are to find) depends on the magnitude of the correlation. For high correlations (those close to ± 1), fewer exceptions exist. For correlations close to zero, there are many exceptions. If the correlation is zero, the traits are not exhibiting a relationship. Figure 1 contains two graphic depictions of traits that have negative correlations. Notice in both graphs that most animals fall in the +,- and -,+ quadrants. The exceptions fall in the +,+ and -,- quadrants. The top graph depicts two traits that have a lower correlation (closer to zero) than the two traits in the bottom graph. There are fewer exceptions represented in the bottom graph.

Two reasons why a genetic correlation might exist are:

1. linkage (temporary), and
2. pleiotrophy (permanent).

Linkage occurs when two loci are located in close proximity to each other on a chromosome. The closer they are to each other, the tighter the linkage. If beneficial genes for one trait are closely associated with poor genes for a second trait, an analysis of the performance of animals for these two traits will detect a negative association. Selection for the beneficial genes for the first trait will carry along the closely linked, poor genes of the second trait. The reason an association caused by linkage is considered temporary is that crossing over of genetic material does occur, and linkage groups tend to break apart as genes are passed through generations. *Pleiotrophy* is when a particular gene influences more than one trait. If a gene has a beneficial impact on one trait but a detrimental impact on a second trait, then a negative association will be observed in performance of animals for those two traits. If a gene has a beneficial impact in both traits, then a positive association will be observed. This is considered for all practical purposes to be a permanent effect.

Selection

Selection is the process of choosing individuals to be parents of the next generation. The objective of selection, simply stated, is to accumulate and increase the frequency of beneficial genes in the population. This is a fairly straightforward concept when focusing on a single trait. The goals are clear, there is little ambiguity as to what defines better-performing animals, and breeding programs are less complicated. However, those involved in programs for genetic improvement of domestic livestock species have come to appreciate how complex the requirements are for performance of animals in modern production systems. This realization has led to an appropriate increase in the focus on multiple traits.

Multiple trait selection is an attempt to identify breeding animals that are superior for several traits. The increase in complexity becomes intuitively obvious. Animals must now carry genes that have value to the breeding program for more than one trait. The more traits included in the selection program, the more difficult it is to find individuals superior for all of them. Recalling Figure 1, the difficulty in finding superior animals is amplified for traits that have a negative correlation. Multiple trait selection also has an added level of complexity if economic weights are used to combine traits of importance into a *selection index value*. The correlations are used in multiple trait selection and evaluation.

Multiple trait evaluations use genetic relationships to obtain information for one trait that is contained in the observation for the correlated trait. One example of the value of this is yearling weight evaluations. If the progeny of a particular bull have had only birth weight recorded at the time the evaluation is run, those records are used for the yearling weight evaluation by using the correlation between birth and yearling weights. Hence, new information is incorporated before actual observations for the trait are obtained.

With multiple trait selection, objectives are set for improving the traits in question. However, there still needs to be an awareness of what is happening to traits that are not considered for selection but are correlated to those that are. For example, little information is available on the genetic trends for marbling, cutability, rib eye area, or reproductive capability. Yet changes in livestock populations may occur in these traits in response to selection for the other traits.

Selection response

Two types of response to selection occur in selection programs. The first, and most obvious, is the response observed in the trait(s) of interest, often referred to as *direct response*. Figure 2 shows the genetic trends in bulls reported in the 1995 North American Hereford Sire Report for weaning weight and yearling weight. Performance records and EPDs have been available to help producers select animals to generate such trends. For most breeds reporting trends, similar results are observed. The second type of response to selection is the change in traits that are correlated to those under selection. Any trait that is genetically correlated to a trait under effective selection is likely to change. This change is referred to as a *correlated response.*

Factors that influence the direct response to selection are:

1- intensity of selection,
2- accuracy of evaluation,
3- generation interval, and
4- genetic variation.

The factors that influence a correlated response to selection are:

1- the magnitude of the direct response for the trait under selection, and
2- the sign (+ or -) and magnitude of the genetic relationship to the trait under direct selection.

The direction of the correlated response is predicted by the sign.

Carcass Traits

Direct selection for carcass traits has presented several challenges to the beef industry. First, effective selection requires data. The data are used in evaluation systems to identify the genetic merit of individuals. In general, the data sets available for carcass traits are quite limited in their scope. Collection is a real problem for the industry. Still, several evaluations are being done to help identify individuals for selection. An obvious opportunity is to create a system that generates more data. This does not hold much promise.

Carcass evaluations are done using carcass data only. For example, the American Simmental evaluation for carcass traits is a multiple trait evaluation but considers only the carcass traits and their genetic relationships where important. An opportunity to expand the number of animals available with carcass evaluations is to include the carcass data as part of the multiple trait evaluation system for the production traits. Those animals with carcass information on relatives (e.g., progeny) would be evaluated as in the current carcass system. However, the number of animals in the system related to those with carcass data would be expanded. Assume that a bull has progeny with carcass information. All progeny of the bull in the weight trait analysis will receive an evaluation based on his. Also, the genetic relationships among production traits currently in the weight trait analysis and the carcass traits could be included. Hence, any animal with an observation for birth, weaning or yearling weight would receive evaluations for the carcass traits of interest. This approach is discussed in Woodward *et. al.* (1992). An added advantage of this approach is the possibility of removing selection bias if decisions on which animals ultimately are measured for carcass traits are based at all on their performance in growth. To be sure, such an approach would generate evaluations with relatively low accuracies for all individuals without progeny data. Hence, even though all animals would be evaluated for carcass traits, the value of doing so would be minimal.

The concept of incorporating carcass evaluation into evaluation for weight traits, however, raises the question as to what the nature and magnitude of the correlations might be among various carcass traits and the other traits of economic interest. The tables in the appendix summarize results from various studies in which the relationship between carcass traits and weight traits were examined. It is not surprising that carcass traits that are growth related have high genetic correlations; e.g. carcass weight and rib eye area. Other traits have low to moderate genetic correlations, both positive and negative.

The correlations shown in the appendix indicate that indirect selection for carcass traits has been going on for years. This selection has not been through a designed breeding program but rather has been a response to selection for other traits. It is important to remember that correlated responses can potentially occur for any set of correlated traits. The industry has increased growth in virtually all breeds. From Figure 2, the change for Herefords is well demonstrated. Response to these changes in carcass traits again depends on the sign (predicting direction) and magnitude of the correlations.

The beef industry has not adopted the concepts of index selection to any great amount. Indices for particularly useful objectives have been suggested, e.g. restricting birth weight response to selection for weaning or yearling weight. If a desired objective is to control or enhance changes in carcass traits occurring as a correlated response to growth selection, then indices could be useful. They are particularly so if the correlated response is undesirable. For example, from Dinkle and Busch (1973), negative correlations among weaning weight and grade, marbling and dressing percent were reported, albeit small in magnitude. Tables 8 and 9 contain predictions of correlated responses to selection for weight obtained in two studies. The desire may be to prevent directional change for those traits in response to weaning weight or yearling weight selection. Restricted indices are one method for choosing individuals to meet that goal.

Much work is currently going on in the area of live animal evaluation of carcass traits that promises to expand the number of animals available for measurement (even to potential breeding stock). Progress in this area is well document in BIF reports and presentations from the Live Animal Evaluation Committee. This approach is promising. Conceptually, programs using live animal measures will still rely on genetic relationships and correlated responses. First, there is the relationship of the live animal measures taken on slaughter animals and the conventional measures of carcass merit. Evaluations and selection would be for the live animal measures and the desired response for the conventional measures. The hope is that increased numbers of observations could be generated in live animals to offset the use of a correlation especially if the correlation is high. Second, live animal measures can and are being taken on breeding animals. The growth environment of the breeding animals differs from that of slaughter animals so the expression of the live animal measures may be different, yet correlated. If measuring breeding animals is successful and measures are even moderately correlated, this is the future of carcass trait selection, in our opinion.

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APPENDIX: TABLES OF GENETIC CORRELATIONS

Table 1. Genetic correlations (adapted from Jensen et al., 1991).

	Weight 28 days [a]	Daily gain [b] Period 1	Daily gain [c] Period 2
Dressing percent	-.25	-.04	-.25
Carcass grade	-.28	.13	.14
Fat grade	.21	.24	-.26
Lean percent	-.14	.18	.59
Fat percent	-.07	-.21	-.62

[a] Calf weight at 28 days.
[b] Daily gain from 28 days to 200 kg.
[c] Daily gain from 200 kg to slaughter.

Table 2. Genetic correlations (adapted from Arnold et al., 1991)

	WWT	YWT	Total ADG
Backfat	.03	.06	-.07
Long. muscle area	-.02	-.03	-.05
Degree of marbling	-.07	-.06	-.10
Carcass weight	.02	.17	.05

Table 3. Genetic correlations (adapted from Koch et al., 1982)

	BW	ADG to weaning	ADG (Feed lot)
Fat thickness	-.27	.04	.05
REA	.31	.49	.34
Marbling	.31	.31	.15
Cold side weight	.60	.73	.89
Retail product weight	.56	.62	.73

Table 4. Genetic correlations (adapted from Dinkle and Busch, 1973)

	WW	ADG postweaning	Final weight
REA	.53	.66	.81
Fat	-.13	-.03	-.12
Cutability	.12	.09	.16
Grade	-.17	.08	-.14
Marbling	-.12	.10	.01
Dressing %	-.09	-.18	-.18

Table 5. Genetic correlations and standard errors (adapted from Koch, 1978)

	Weaning weight	Yearling weight	Daily gain
Carcass weight	.48 ± .25	.96 ± .03	.78 ± .11
Ribeye area	.16 ± .50	.01 ± .46	-.07 ± .38
Fat thickness	.59 ± .34	.86 ± .24	.62 ± .35
Marbling	-.02 ± .47	-.57 ± .41	-.62 ± .35
Retail product	-.37 ± .36	.85 ± .11	.73 ± .20

Table 6. Genetic correlations (adapted from Lamb et al., 1990)

	Weaning weight	Postweaning gain	Slaughter weight
Fat	.13 (.53)[a]		
REA	.49 (.41)	.48 (.25)	.51 (.24)
Marbling	.71 (.24)	.48 (.23)	.60 (.20)
Rind	.49 (.41)	.05 (.34)	.24 (.34)

[a] Phenotypic correlations in parentheses.

Table 7. Genetic correlations (adapted from Wilson et al., 1976)

	Weaning weight
Retail cut	.36 (.66)[a]
Cutability	-.19 (.19)
Marbling	-.85 (-.21)

[a] Phenotypic correlations in parentheses.

Table 8. Genetic correlations with carcass weight and correlated response of carcass traits to selection for carcass weight (adapted from Cundiff et al., 1971).

	Correlation	Correlated response
Marbling	.23 (.17)[a]	.2 (score)
Fat thickness	.34 (.38)	.07 (cm)
L. dorsi area	.66 (.52)	1.9 (cm^2)
Cutability	-.33 (-.44)	-.2 (%)
Retail product	.86 (.91)	8.4 (kg)

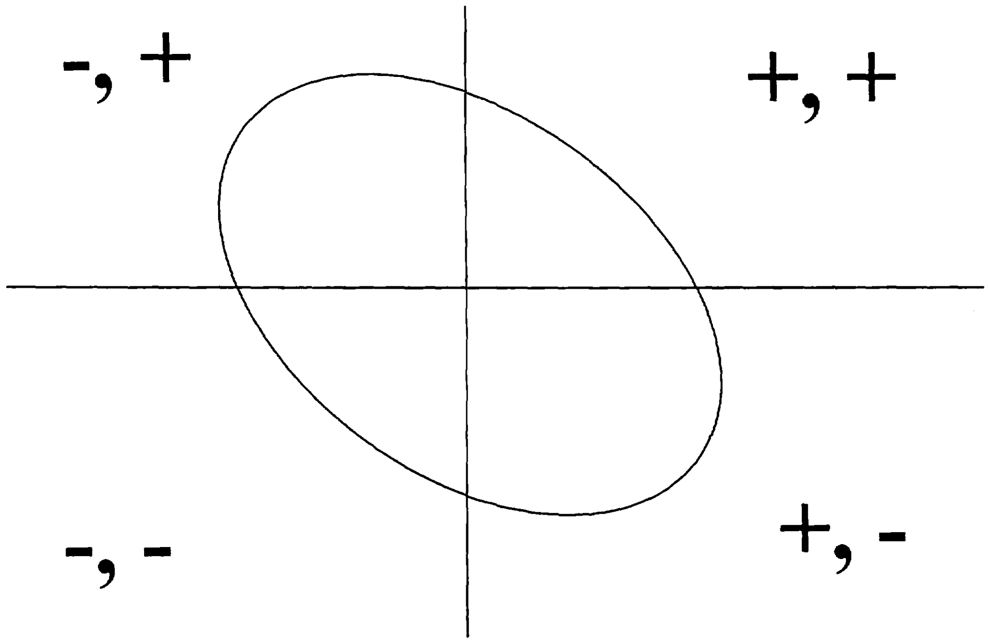
[a] Phenotypic correlations in parentheses.

Table 9. Correlated response in carcass traits to selection for weaning or yearling weight, adjusted for slaughter age (A) or slaughter weight (W). Response is in units of traits (adapted from Koch, 1978).

	Selection for			
	Weaning weight		Yearling weight	
Trait	A	W	A	W
Ribeye area (cm2)	.30		.00	
Fat thickness (mm)	1.49	.31	2.58	-.13
Marbling (score)	-.03	.16	-.88	-.41
Retail product (kg)	1.67	-.10	4.60	.52
Fat trim (kg)	3.21	-.36	7.50	-.83

Figure 1. Graphic depictions of negative correlations between two traits.

A. NEGATIVE CORRELATION BETWEEN TWO TRAITS (CLOSE TO 0)



B. NEGATIVE CORRELATION BETWEEN TWO TRAITS (CLOSE TO -1)

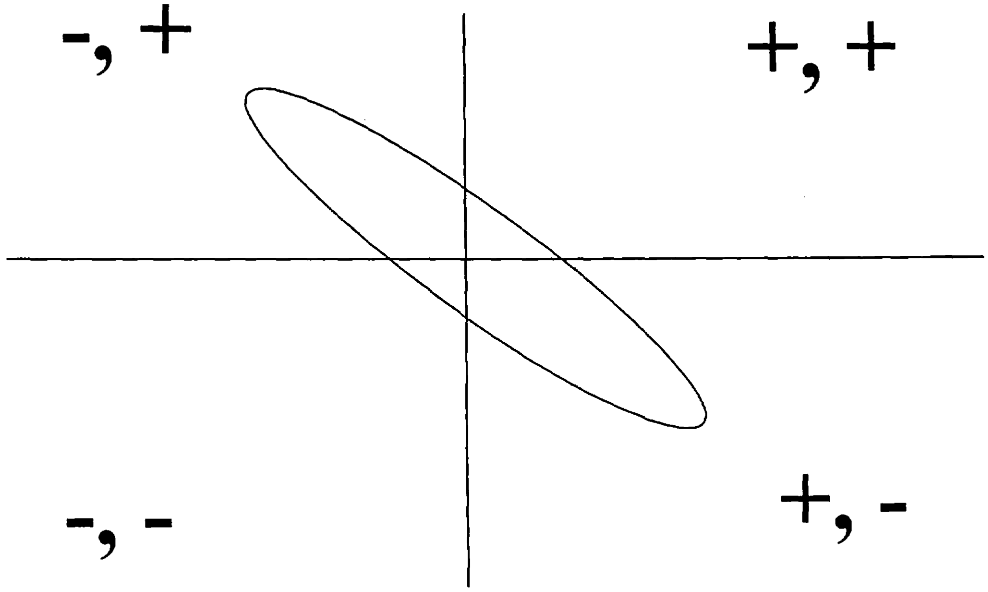
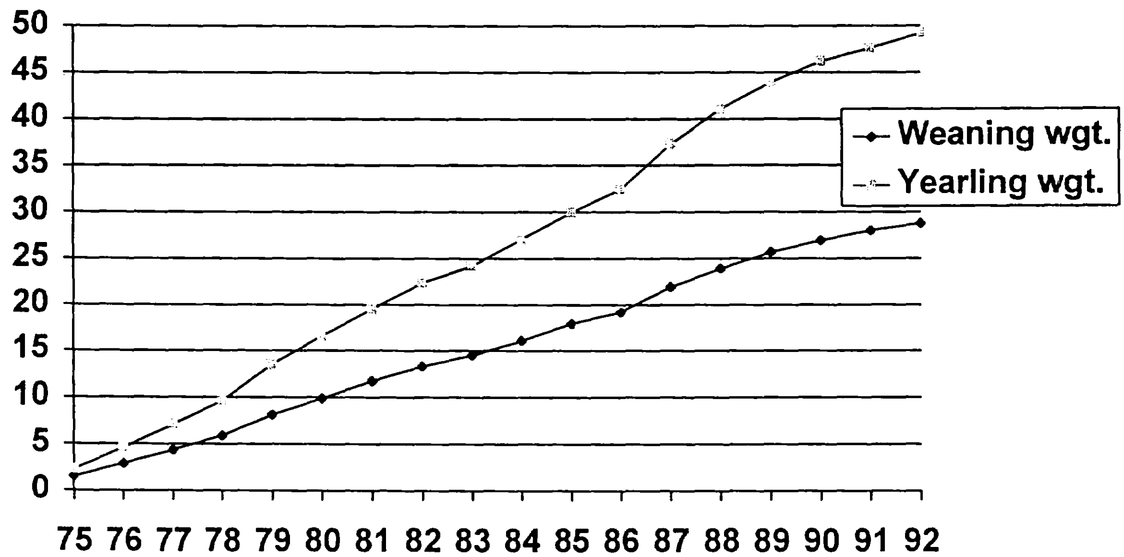


Figure 2.

GENETIC TRENDS FROM 1995 NORTH AMERICAN HEREFORD SIRE EVALUATION



HOW FEEDYARDS USE/ABUSE GENETICS

By William L. Mies

Feedyard Managers must operate on perceptions of the genetics in any given pen of cattle. These perceptions are usually inaccurate due to a lack of knowledge about the cattle prior to arrival in the feedyard. Cattle put together from several sources will always be an exercise in dealing with averages. Single source pens of cattle are really the only cattle that feedyards can attempt to manage to their most efficient endpoint. The major missing piece of information about a group of calves from a single source is their ability to reach various quality grade endpoints.

PERCEPTION: If the cattle are calf-feds they will not grade well because they are so young.

FACT: Research data clearly shows that age does not have an influence on ability to grade USDA Choice.

RESULT: Feedyards tend to overfeed calf-feds more than they do yearling cattle.

PERCEPTION: Cattle with Continental European genetics have difficulty grading USDA Choice and thus should be fed to the maximum fat endpoint without exceeding weight.

FACT: Continental European cattle are variable in their ability to grade USDA Choice and thus have their own unique endpoints.

RESULT: Continental European cattle are fed beyond their most efficient fat endpoints in hopes that more USDA Choice carcasses will result.

PERCEPTION: Cattle with Brahman genetics have difficulty grading USDA Choice and therefore must be fed to fat endpoints that improve chances for grading without creating Yield Grade 4's and 5's.

FACT: Because the breeds used in combination with Brahman genetics are variable in ability to grade USDA Choice, the Brahman influenced cattle also cover the range of ability to grade Choice.

RESULT: Brahman influenced cattle are fed to fat endpoints that compromises their maximum efficiencies.

PERCEPTION: External fat is correlated 1:1 with marbling.

FACT: While the correlation is positive, it is usually less than .5.

RESULT: If no prior knowledge is available, the tendency is to error on the side of overfeeding to try to maximize the percentage of the cattle in the USDA Choice grade.

CONCLUSION: If the cattle business continues to operate on averages and perceptions, we will continue to abuse genetics in feedyards.

CONCLUSION: Information transfer from producer to feedyard and back to the producer is the key to using genetics properly in feedyards.

Minutes of the Meeting

Integrated Genetic System Committee
June 1, 1995
Sheridan, WY

Committee chairman Dr. John Hough called the meeting to order at 2:00 pm. and reviewed the committee structure to those in attendance.

The first order of business was to review possible changes in the Guidelines publication. The Board has decided to change the outline of the book to make it more "user friendly" and the utilization section will include categories on IRM, seedstock production, commercial production, and systems (including SPA.)

Dr. Dan Kniffen from the National Cattleman's Association discussed the IRM section by describing the history and current status of the IRM effort. More than 40 states now have some type of IRM program in place. He listed tools that are available for producers to use including the "redbook" published by NCA, the IRM Desk Record, and others. An outline was presented to compare seedstock SPA guidelines with those for commercial SPA.

Dr. John Comerford from Penn State presented suggested revisions for the commercial section which included the addition of IRM guidelines and the use of EPDs in commercial beef sire selection. It was suggested that the current Table 7.2 be revised to a "problem/solution" format. The suggested table that included average values and production goals should be regionalized and include information from high and low profit herds from IRM data.

Dr. Darrh Bullock from the University of Kentucky reviewed suggested changes for the purebred section that included more emphasis on the use of EPDs in the genetic improvement program. Other suggestions included guidelines for setting up contemporary groups, use of sires to improve connectedness, accuracies, and the use of multiple sires.

A roundtable discussion was held among Dr. Larry Benyshek from the University of Georgia, Dr. Bryan Melton from Iowa State University, and Troy Marshall from CattleFax. Benyshek discussed the use of a multiple trait index for genetic improvement programs. He indicated there are now good breeding values available that can accurately reflect economics. The index should zero in on traits that are most important and not become cumbersome and complex to use.

Further discussion of retained ownership and genetic resistance to disease programs was presented by Marshall. These tools should become part of a marketing program if genetic improvement is to have value to consumers.

Considerable discussion was held on how the economic weights for a selection index could be determined. Melton indicated they should be individual to producers because of the wide variations in economic and environmental conditions. He indicated a computer program could be written that would be flexible enough to determine the weights based on individual records and the farm or ranch history. One key concept that must be studied is how the values would have to be changed when describing the production cycle from producers to consumers.

Hough then closed the meeting with a discussion of the topics that should be included for next year's meeting. This will include further development of the selection index concept and should include information from economists on how to develop the economic weights, plus some information on cost-cutting innovations producers can use. There was some further discussion about application of the seedstock SPA program in cooperation with breed associations. There was a motion from Dr. Jim Gibb,seconded by Jim Bradford, to have BIF help deliver the seedstock SPA program with cooperation from breed associations. Motion passed.

The meeting was adjourned at 5:00 pm.

D. The Integrated Genetic Systems Concept for Cattle Production and Improvement.

This introduction introduces the systems concept of integrated genetic management. The systems concept is extremely complex and incorporates many factors important to beef cattle enterprises. A system of many components affects net return in the beef cattle business. Determining the most appropriate animal for a specific situation is quite difficult because of a variety of factors and trade-offs.

1. General Conclusions from Systems Research.

Systems research has shown there are optimum levels of production that best fit with each combination of environment / management / economic conditions. Increasing production efficiency results in increasing herd gross revenue, decreasing herd input costs, or both. Ranking genotypes based on biological productivity many be different from rankings based on economic return.

2. Using the Systems Concept for Beef Improvement.

General guidelines pertaining to beef improvement systems were outlined ten years ago in a BIF-sponsored workshop. The National Cattlemen's Association has sponsored the Integrated Resource Management (IRM) program along with the Standardized Performance Analysis program. The IRM program has stressed the integrated approach to managing beef cattle systems.

3. Interactions Related to Beef Improvement.

A host of interactions exists involving any biological system. Most noteworthy are the interactions between an animal's genotype and the production environment. Interactions also exist between a production systems and the prevailing economic environment. Net economic return is extremely dependent upon the interactions that exist in integrated beef cattle system.

a. Matching Genetic Potential for Different Traits in Varying Production Environments.

An attempt is made to characterize production environments and list likely ranges for optimal levels of several important traits within those environments. Production environments are characterized by feed availability and degree of environmental stress.

b. Calving Distribution Report.

An example of reproductive management is given grouping cows by season of calving, age and calving periods. Average calving percentages and performance values are listed.

INTEGRATED GENETIC SYSTEMS
Dr. Dan Kniffen

IRM Concept

At its inception, Integrated Reproductive Management (IRM) had two basic concepts: team problem solving and measurement allows management. As IRM developed it became obvious that reproduction was only a part of the model so it was expanded to Integrated Resource Management. All the pieces of the model needed to be included for optimum use of all resources. The need to measure production variables lead to the development of the IRM tools.

The National IRM Coordinating Committee, which is composed of beef producers and beef industry support persons, has played a key role in the development of many of the IRM tools. As a measurement need is identified, tools are developed to make the measurements. One of the recently developed tools is the Standardized Performance Analysis Program (SPA). This tool is used to measure production and financial performance. SPA should help producers determine when they have attained an optimum level of performance given their resources. As changes are made in management, SPA will measure the impact on all resources and if the change has improved production efficiency. Three SPA programs have been developed: commercial cow-calf, seedstock and stocker feeder. The cow-calf and seedstock program are similar up to the weaning of the calves. The stocker feeder program will evaluate performance from weaning to finishing. Group carcass data can also be recorded.

The SPA Guidelines are partially contained in the most recent version of the BIF Guidelines. Through the joint effort of BIF and NCA, hopefully, many of the seedstock associates will generate a SPA report for their members.

Revision of the Commercial Programs Section
Beef Improvement Federation Guidelines
Sheridan, WY
Dr. John Comerford

The revisions in Section 7 of the Guidelines were primarily an update of the tools that are available for commercial producers to use in their program. This included an expansion of guides for using EPDs in the selection of both bulls and replacement heifers, the addition of economic markers for commercial beef production, the use of composite breeds and summary production and economic information from the SPA database for commercial producers. It was emphasized that Table 7.2 should be more user friendly, so changes were discussed that would include both animal and economic measurements that are available for commercial producers to help them be successful.

BIF GUIDELINES REVISIONS: GUIDELINES FOR PERFORMANCE PROGRAMS FOR SEEDSTOCK PRODUCERS AND THEIR ORGANIZATIONS

K. D. Bullock
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INTRODUCTION

These guidelines were previously written by Dave Notter and were in very good shape to start with. The majority of the revisions were in updating information and techniques available. The following outline is what was presented at BIF:

REVISIONS

1. Structure and headings remain relatively the same.
2. Some editing, some rewrites.
3. More emphasis on EPDs, much less emphasis on ratios.
4. Included information on non-traditional traits and EPD
    a. pelvic area
    b. scrotal circumference
    c. carcass traits
    d. mature size
5. Discussion on setting up contemporary groups, including connectedness.
6. Discussion on Acc. and reducing risk by using multiple sires.
7. Removed information on central processing.
8. Updated future opportunities.
    a. new EPDs
    b. integrating economic information
    c. electronic transfer
    d. continual computation of EPDs and online availability
9. Various outdated eliminations.

WHAT ELSE IS NEEDED?

1. Genetic correlation section.
2. Discussion of organized marketing (fed calves).
    a. CAB, CHB, etc.
    b. formula marketing with breed emphasis
    c. individual breeders buy back programs
3. Others?

SUMMARY

Other than clarification of some of the edits, there was very little discussion on specific changes or additions that needed to be made. Therefore, a decision will be made whether to include the genetic correlation and/or organized marketing section and the rest will remail relatively the same.

Central Test and Growth Committee Meeting
Sheridan, Wyoming
Minutes

The meeting was called to order by Chairman Ronnie Silcox at 2:00 pm, on June 1, 1995 in the Holiday Inn, Sheridan, Wyoming. Silcox welcomed participants and described the format of BIF committee meetings. He encouraged all those present to be active in the committee discussion. Silcox summarized the agenda to be covered during the meeting. Attendees were encouraged to sign the roll sheet.

Silcox introduced Hayes Walker and described Mr. Walker's list of bull tests which is summarized annually in the American Beef Cattleman magazine. The list of test stations was circulated, and Silcox asked that any changes be noted so that Mr. Walker could update the list.

Silcox introduced Dave Patterson and Darrh Bullock from University of Kentucky to give a presentation about the Kentucky Heifer Development Program. The committee received a handout describing the requirements of the heifer program. Patterson outlined the purpose and requirements of the program, using the Bourbon County heifer program as an example. Patterson asked for comments from Walter and Evidean Major, Kentucky cattle producers using this program and sale. Mr. and Mrs. Major shared their experiences with the committee.

Darrh Bullock continued the Kentucky presentation by summarizing his analysis of pelvic growth in beef heifers and the effects on puberty. Bullock and Patterson answered questions about the details of their program.

Silcox distributed a list of steer feedouts by state. The list had been prepared by John Hough, American Polled Hereford Association. Roger McCraw outlined the necessary steer feedout guidelines for uniformity of data, so that data could be used by breed associations. The guidelines were reported as designed by the committee consisting of John Hough, John Crouch, Keith Bertrand, Robert Stuart, and Roger McCraw. Carl Cooper, Hitch Enterprises, recommended that steers be tattooed to match ear tag number. A discussion of data integrity and age of steers was held. It was recommended to keep the feedout committee alive to follow up on the findings of the BIF Live Animal and Carcass Evaluation Committee.

Silcox conducted the discussion of BIF Guidelines revisions. Andra Nelson, University of Georgia, presented her research on age of dam adjustment factors (discrete vs. continuous) using American Hereford Association data. Discussion was held. Silcox described the age of dam tables to be printed in the revised BIF Guidelines. Silcox commented that adjustment factors from breed associations will be incorporated into the Appendix of age of dam adjustments.

Silcox distributed copies of revisions to the frame score guidelines. The frame tables included mature cow and bull measures.

Silcox and Sally Northcutt each gave comments on the central bull test section of the guidelines. Both indicated that changes to this section were minimal. The example bull report was replaced by a list of suggested items to be presented on bull test reports. Modifications to the central bull test section were coordinated by Sally Northcutt, Ronnie Silcox and Darrh Bullock.

Silcox adjourned the committee meeting at 4:00 pm.

Respectfully submitted,

Sally L. Northcutt

Sally L. Northcutt
Secretary

THE KENTUCKY CERTIFIED REPLACEMENT HEIFER PROGRAM

D. J. Patterson and K. D. Bullock
University of Kentucky, Lexington

Introduction. This program was initiated to develop select offerings of replacement beef heifers and provide alternative market outlets for interested producers. Nine counties in Kentucky have participated in the replacement heifer program, including Bourbon, Franklin, Grant, Harrison, Mason, Madison, Muhlenberg, Scott and Wayne counties. Sales in these counties are coordinated by the Cooperative Extension Service, the Kentucky Department of Agriculture, and the Kentucky Cattlemen's Association. These programs emphasize management, uniformity and quality. Screening and performance requirements are rigorous and based on the most current information in the area of beef heifer development.

The *Bourbon County Livestock Improvement Association's Elite Heifer Sale* is the largest sale of its kind in Kentucky. Two sales are held annually in Paris, Kentucky, a spring sale offering open heifers, ready to breed, and a fall bred heifer sale. Results from 9 Bourbon County Elite Heifer sales over the past 5 years are summarized in table 1. These sales, along with others in Kentucky, have been extremely successful and serve as a viable means of rural economic development as seen from table 1.

Table 1. Results of the Bourbon County Livestock Improvement Association's Elite Heifer Sales

Sale offering	Number sold	Gross sales	Avg.
Open heifers (1991-1995)	1,171	$740,583	$632
Bred heifers (1991-1994)	1,398	$1,183,243	$846
Total	2,569	$1,923,826	$749

Minimum requirements for the Kentucky Certified Replacement Heifer Program:

The rules for heifers eligible to begin the program are flexible in order to encourage as many producers as possible to participate. Some sales place limits on the number of heifers that can be consigned to a single sale, whereas others place no limits on numbers per consignor. There are no restrictions as to breed or breed cross.

Ownership: The minimum number of days of ownership for heifers selling as open heifers is 120 days. Bred heifers must have been owned at the time of breeding or 120 days prior to sale, whichever is the longer period of time.

Vaccination: Heifers must be vaccinated for IBR, PI-3, BVD, BRSV, Hemophilus somnus, Leptospirosis, Vibriosis, Brucellosis and a minimum of 4 strains of Clostridia (chauvoei, novyi, septicum and sordelli). Various products may be used on bred heifers provided label recommendations concerning booster vaccinations are adhered to. Initial vaccinations and boosters must be administered between 6 months and 2 weeks prior to sale date with the exception of Brucellosis which must meet state regulations of 4 to 10 months of age. It is recommended that heifers be tested free of Johnnes and Anaplasmosis prior to sale day.

Parasite control: All heifers must be treated for internal and external parasites within 45 days of sale. Products for internal parasite control must have a label claim for all stages of the parasite life cycle.

Surgery: Heifers must be polled or dehorned and completely healed by sale day.

Implants and MGA: It is recommended that heifers not be implanted. If heifers are implanted, it is required that only FDA approved products for replacement heifers be used and administered according to label guidelines. Long term use of MGA is prohibited. Use of MGA for periods of up to 14 days to synchronize estrus is permitted.

On farm inspection: Heifers will be screened on the farm of origin prior to sale by a certified (trained in the use of USDA feeder cattle and cow grades) screening committee for frame, muscle, structural soundness and general sale acceptability. All heifers must meet a minimum projected frame score of Medium using USDA system for grades of cows (Medium = a mature weight of 900 to 1100 pounds with .2 inches of backfat at the 12th rib). Heifers must meet a muscle score of 1 using the USDA feeder cattle scoring system. It is recommended that heifers projecting a frame score in the upper part of Large (a mature weight of 1500 lbs or above) not be accepted.

Reproductive traits: Open heifers that are 15 months of age or less must have a reproductive tract score of 2 or greater on sale day. Open heifers that are older than 15 months of age must have a reproductive tract score of 4 or 5 on sale day. All open heifers must have a yearling pelvic measurement of 150 square centimeters or greater. All bred heifers must be pregnancy checked and certified to be safe in calf on or before the day of sale. Open heifers must be pregnancy checked and certified to be open. If an open heifer is proven by veterinary exam within 30 days after sale to be bred, the consignor will replace the heifer or make a financial settlement with the buyer. The consignor guarantees bred heifers to be safe in calf. If a heifer is proven by veterinary exam within 30 days after sale to be open, the consignor will replace the heifer or make a financial settlement with the buyer.

Weight and body condition: All heifers must be weighed and bred heifers are required to be condition scored. Open heifers must weigh 600 pounds or greater if they are English or crosses between English breeds. If open heifers are exotic or crosses with exotic breeds, they must weigh 700 pounds or more. Bred heifers calving in the Spring must weigh a minimum of 800 pounds and receive a minimum condition score of 5 if selling in Spring sales. A minimum weight of 750 pounds and condition score of 5 for spring calving heifers is necessary when selling in Fall sales. Heifers bred to calve in the Fall must have a minimum weight of 800 pounds and condition score of 5 if selling in Fall sales or 750 pounds and condition score of 5 if selling in Spring sales.

Blemishes: Heifers with active cases of Pinkeye or scars resulting from Pinkeye that are considered to be detrimental to vision will not be eligible for sale.

Sire requirements: Bred heifers must have been serviced by bulls of known ID and breed. All service sires must have complete EPD information. Major emphasis will be placed on birth weight and calving ease EPD's, but it will be advantageous to select bulls with balanced proofs to ensure buyer satisfaction. There will be no restrictions in terms of the breed of bull that can be used on these heifers as long as EPD's for BW and/or calving ease meet the requirements in table 2. Approval of bulls must take place before the breeding season begins.

Certification: All heifers must be eartagged with the Certified Replacement Heifer eartag and accompanied to sale with a signed and completed Certified Replacement Heifer certificate. All consignments must have an Official Health Certificate.

Table 2. Heifer acceptable sire BW EPD's.		
	Maximum BW EPD	Minimum Calving Ease EPD
Angus	+2.0	
Brangus	-0.1	
Gelbvieh	-4.0	110
Limousin	-1.1	
Polled Hereford	+2.0	
Salers	-0.2	
Shorthorn	+0.5	
Simmental	-1.5	+4.5
Tarentaise	+0.5	105.4

PELVIC GROWTH IN BEEF HEIFERS AND THE EFFECTS OF PUBERTY

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INTRODUCTION

Pelvic measurements on heifers can be used to assist producers in reducing the incidence of dystocia (Deutscher, 1989). A common practice is to measure heifers at yearling age and cull those that do not meet minimum requirements set by the producer. This practice combined with selection of service sires with acceptable birth weight EPD has reduced the incidence and severity of calving difficulty.

It has been shown that heifers can have different pelvic area growth coefficients at yearling age (BIF, 1990; Bullock, 1992). Beef Improvement Federation guidelines recommend an adjustment of .27 cm^2 / day, while Bullock (1992) reported a coefficient of .36 cm^2 / day. These differences could be due to differences in breed type, management, statistical methods, or possibly differences in pubertal patterns. If the onset of puberty has an effect on pelvic growth then pre-pubertal heifers, at yearling age, would be discriminated against using an independent culling level for pelvic area. Therefore, the purpose of this study was to determine the relationship between pelvic area and puberty.

MATERIALS AND METHODS

Data were collected on 78 Angus and 59 Brangus heifers at the University of Kentucky research farm. When the average age of the heifers was approximately one year they were weighed, and pelvic height and width were measured (YW, YPH and YPW, respectively). Blood samples were obtained and progesterone concentrations measured on consecutive weeks to determine which heifers were pubertal (pre-pubertal, PRE; pubertal, PUB) (Table 1). Two weeks prior to the earliest expected heifer calving date, the heifers were weighed and pelvic height and width were measured (PCW, PCPH and PCPW, respectively). Yearling and pre-calving pelvic area were calculated using the appropriate measures (YPA and PCPA, respectively). Pelvic measurements were recorded one month prior to and one month after the yearling measurements were obtained. Yearling pelvic growth rate (height, width and area) was calculated as the difference in these measurements divided by the number of days (YPHR, YPWR and YPAR, respectively).

Three separate analyses were computed using SAS (1988) GLM procedures. The first analyzed yearling data (YPH, YPW and YPA), the second pre-calving data (PCPH, PCPW and PCPA) and the third yearling pelvic growth rate (YPHR, YPWR and YPAR). The statistical model used to analyze the first two were the same and included the effects of puberty (PRE or PUB at yearling; P), year (1992 or 1993; Y), breed (Angus or Brangus; B), sire within breed (S) and appropriate interactions with age (A) and weight (W) fit as covariates. The statistical model for yearling pelvic growth rate was the same, except did not include the covariates.

RESULTS AND DISCUSSION

Least square means and standard deviations for the yearling, pre-calving and growth rates are presented in Tables 2, 3 and 4, respectively. The results indicate there was a significant difference in P, for YPW (PRE=11.0, PUB=11.6; $p<.01$) and YPA (PRE=165.0, PUB=176.6; $p<.01$) (Table 2). However, by pre-calving, there were no significant differences in P. These results indicate that puberty is playing a role in pelvic size at yearling age, but once heifers reach puberty the effects are no longer present. Therefore, using an independent culling level for pelvic size on heifers that are at different stages in their reproductive development appears to be more restrictive for those that are pre-pubertal. There were no significant differences in P for yearling pelvic growth rate (Table 4).

There were significant breed differences for pelvic size, with Brangus having greater pelvic height and area than Angus, at yearling age and pre-calving (Tables 1 and 2). This is likely due to the increase in frame size observed in the Brangus heifers. There were no significant differences for any of the interactions.

The analysis of yearling pelvic growth rate resulted in no significant differences for any of the effects.

CONCLUSIONS

These data indicate that puberty positively influences pelvic width and resulting pelvic area in yearling heifers, however, these differences do not carry through to calving as 2-yr-olds. These data suggest that selection/culling decisions based on pelvic measurements and contemporary grouping for genetic analysis of pelvic measurements should include consideration of pubertal status at time of examination.

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TABLES

Table 1. Breakdown of heifers in pelvic/puberty study[a].

1992				1993			
Angus		Brangus		Angus		Brangus	
PRE	PUB	PRE	PUB	PRE	PUB	PRE	PUB
13	25	35	3	16	24	17	4

[a]PRE = heifers that had not reached puberty at a year of age; PUB = heifers that had reached puberty at a year of age.

Table 2. Least square means and standard errors of yearling pelvic measurements[a].

Trait[b]	PRE	PUB	Angus	Brangus
YPH	15.0±.2[c]	15.2±.2[c]	14.6±.1[d]	15.6±.3[e]
YPW	11.0±.1[f]	11.6±.2[g]	11.3±.1[h]	11.3±.3[h]
YPA	165.0±3.2[i]	176.6±4.0[j]	165.3±2.1[k]	176.4±5.8[l]

[a]PRE = heifers that had not reached puberty at a year of age; PUB = heifers that had reached puberty at a year of age.
[b]YPH, YPW and YPA = yearling pelvic height, width and area, respectively.
Superscripts that are similar within an effect (Puberty or Breed) and trait are not significantly different.

Table 3. Least square means and standard errors of pre-calving pelvic measurements[a].

Trait[b]	PRE	PUB	Angus	Brangus
YPH	19.1±.2[c]	19.0±.3[c]	18.5±.1[d]	19.6±.3[e]
YPW	13.9±.2[f]	14.0±.2[f]	14.0±.1[g]	14.0±.3[g]
YPA	265.6±5.1[h]	267.0±6.3[h]	258.5±3.3[i]	274.1±7.8[j]

[a]PRE = heifers that had not reached puberty at a year of age; PUB = heifers that had reached puberty at a year of age.
[b]YPH, YPW and YPA = yearling pelvic height, width and area, respectively.
Superscripts that are similar within an effect (Puberty or Breed) and trait are not significantly different.

Table 4. Least square means and standard errors of yearling growth rates[a].

Trait[b]	PRE	PUB	Angus	Brangus
YPH	.009±.002[c]	.013±.003[c]	.011±.002[d]	.011±.004[d]
YPW	.007±.002[e]	.007±.003[e]	.009±.001[f]	.006±.003[f]
YPA	.21±.04[g]	.26±.06[g]	.26±.02[h]	.21±.07[h]

[a]PRE = heifers that had not reached puberty at a year of age; PUB = heifers that had reached puberty at a year of age.
[b]YPH, YPW and YPA = yearling pelvic height, width and area, respectively.
Superscripts that are similar within an effect (Puberty or Breed) and trait are not significantly different.

USING PREBREEDING WEIGHT, REPRODUCTIVE TRACT SCORE AND PELVIC AREA TO EVALUATE PREBREEDING DEVELOPMENT OF REPLACEMENT BEEF HEIFERS

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Background. Selection and management of replacement beef heifers involve decisions that affect future productivity of an entire herd. Programs to develop heifers have therefore focused on the physiological processes that influence puberty (Patterson et al., 1992). Age at puberty is most important as a production trait when heifers are bred to calve as 2-yr-olds and in systems that impose restricted breeding periods (Ferrel, 1982).

The number of heifers that become pregnant during their first breeding season and within a defined time period is correlated with the number that exhibit estrus early in the breeding season. Heifers that calve first as 2-yr-olds produce more calves during a lifetime than do heifers that calve first at 3 years (Short and Bellows, 1971).

The decision to breed heifers as yearlings involves careful consideration of the economics of production, the reproduction status, and breed type or genetic make-up of the heifers involved. A number of factors influence the ability of a cow to calve in a given year and successively over a number of years. Heifers that calve early during their first calving season have higher lifetime calf production than those that calve late. Because most calves are weaned at a particular time rather than on a weight-constant or age constant basis, calves born late in the normal calving season are usually lighter than those born early. This tends to decrease the total lifetime productivity of their dams (Short et al., 1990).

Current management recommendations advocate that heifers bred to calve as 2-yr-olds be exposed for breeding before mature herdmates, and that early calving periods be used as a means of increasing production efficiency. This practice often results in heifers being bred on their pubertal estrus (Wiltbank, 1970). Fertility of heifers that are bred at the pubertal estrus was 21% lower than those bred on their third estrus (Byerley et al., 1987). This means that heifers should reach puberty 1 to 3 months before the average age at which they are to be bred. Earlier age at puberty in relation to breeding is to ensure that a high percentage of heifers are cycling and that the effects of lowered potential fertility at the pubertal estrus are minimized (Short et al., 1990).

Replacement heifers are typically selected according to size and appearance. Colorado researchers suggest that in many cases, these subjective methods of selection have not afforded suitable focus on reproductive traits. The ability to identify heifers with the greatest reproductive potential prior to the breeding season should result in increased reproductive efficiency.

The reproductive tract scoring system. The reproductive tract scoring (RTS) system estimates pubertal status via rectal palpation of the uterine horns and ovaries (Anderson et al., 1991; table 1). A RTS of 1 is assigned to heifers with infantile tracts, as indicated by small, toneless uterine horns and small ovaries devoid of significant structures. Heifers scored as 1 are likely the furthest from cycling at the time of examination. Heifers given a RTS of 2 are thought to be closer to cycling than those scoring 1, due primarily to larger uterine horns and ovaries. Those heifers assigned a RTS of 3 are thought to be on the verge of cycling, based on uterine tone, and palpable follicles. Heifers assigned a score of 4 are considered to be cycling as indicated by uterine tone and coiling of the uterine horns, as well as uterine size and follicular growth. Heifers assigned a score of 4 do not have an easily distinguished corpus luteum. Heifers with tract scores of 5 are similar to those scoring 4, except for the presence of a palpable corpus luteum.

Table 1. Reproductive tract scoring system (from Anderson et al., 1991)

RTS	Uterine Horns	Ovarian length (mm)	Ovarian height (mm)	Ovarian width (mm)	Ovarian structures
1	Immature, < 20 mm diameter, no tone	15	10	8	No palpable follicles
2	20-25 mm diameter, no tone	18	12	10	8 mm follicles
3	20-25 mm diameter, slight tone	22	15	10	8-10 mm follicles
4	30 mm diameter, good tone	30	16	12	> 10 mm follicles, corpus luteum possible
5	> 30 mm diameter	> 32	20	15	Corpus luteum present

Kentucky field data. Establishment of a data base in Kentucky is currently underway using the reproductive tract scoring system as a means of evaluating heifer development. Weight (W), reproductive tract score (RTS), pelvic height (PH), pelvic width (PW), and pelvic area (PA) were determined for 2,664 heifers from 19 farms. Measurements were obtained within 2 wk prior to administration of the 14-17 day melengestrol acetate, prostaglandin (PG) system to synchronize estrus. Heifers were observed for signs of behavioral estrus from 36 through 108 hours after PG. Heifers were inseminated within 12 hr after standing estrus and pregnancy was determined within 120 days of the synchronized period. Estrous response (ER), synchronized conception rate (SCR), synchronized pregnancy rate (SPR), and pregnancy rate (PR) at the end of the breeding season were determined. A summary of the reproductive data is shown in table 2.

Table 2. Reproductive summary.

RTS	W (lbs)	PH (cm)	PW (cm)	PA (cm^2)	ER (%)	SCR (%)	SPR (%)	PR (%)
1	594^{a}	13.9^{a}	10.9^{a}	152^{a}	54^{a}	65^{a}	34^{a}	65^{a}
2	620^{b}	14.1^{a}	11.2^{a}	158^{a}	66^{b}	77^{b}	58^{b}	91^{b}
3	697^{c}	14.5^{b}	11.4^{b}	166^{b}	76^{c}	78^{b}	60^{b}	93^{b}
4	733^{d}	14.7^{c}	11.7^{c}	172^{c}	83^{d}	79^{b}	65^{b}	93^{b}
5	754^{d}	14.7^{c}	11.7^{c}	172^{c}	86^{d}	78^{b}	66^{b}	93^{b}

^{a,b,c,d}Unlike superscripts within columns denote significance ($p < .05$).

Reproductive tract score was correlated with prebreeding weight ($r=.39; P<.001$), pelvic height ($r=.30; P<.001$), pelvic width ($r=.34; P<.001$) and pelvic area ($r=.36; P<.001$; table 3). Prebreeding weight was correlated with pelvic height ($r=.53; P<.01$), pelvic width ($r=.46; P<.01$) and pelvic area ($r=.58; P<.01$; table 4).

Table 3. Correlations involving reproductive tract score, prebreeding weight, pelvic height, pelvic width, and total pelvic area.

	Prebreeding weight	Pelvic height	Pelvic width	Pelvic area
RTS	r=.39*	r=.30*	r=.34*	r=.36*

*Denotes significance ($P<.01$).

Table 4. Correlations involving prebreeding weight, pelvic height, pelvic width and total pelvic area.

	Pelvic height	Pelvic width	Pelvic area
Prebreeding weight	r=.53*	r=.46*	r=.58*

*Denotes significance ($P<.01$).

Poor reproductive performance of heifers with RTS of 1 indicate the importance of identifying and culling these heifers before the breeding season begins. The other interesting observation from these data is the potential benefit derived from placing heifers on a synchronization treatment that includes a progestogen. The potential to jump start prepubertal heifers following short-term progestogen treatment needs to be thoroughly researched. The critical age and/or weight at which time a heifer's reproductive endocrine system becomes capable of responding to a short-term progestogen resulting in estrus and ovulation has not been identified.

Summary. These data indicate that RTS, W, and PA can be used effectively to assess development and reproductive potential of replacement beef heifers. Correlations among RTS, PA and W should be researched more thoroughly to elucidate cause and effect relationships between and/or among these various traits. A better understanding of these relationships should lead to improved methods of evaluating development of heifers prior to the breeding period and enhance available criteria to make decisions regarding culling and/or selection.

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State Programs Offering Carcass Feedback

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Feedout Programs:

Alabama	Lisa Kriese, Auburn University, 334/844-1561
Arizona	Contact Richard Rice, University of Arizona, 602/621-7244
Arkansas	Arkansas Steer Feedout and Carcass Project, Kelly Gage, 501/671-2000
California	Cal Poly Steer Performance Test, Beef Cattle Evaluation Center, Mike Hall, 805/756-2685
Colorado	Washington Co. Cattlemen's Assn., Dr. Tim Stanton, 303/491-6905 Great Western Beef Expo, Sherman Mauck, 303/522-3200 Southeastern Co. Feedlot, Leonard Pruitt, 719/336-7734
Florida	Pasture to Plate, Robert Sand, 904/392-7529
Georgia	Georgia Beef Challenge, Paul Wal, 912/474-6560
Idaho	Steer-A-Year Program, UI Coop. Ext. System, 208/547-4354 A to Z Retained Ownership, Patrick Momont, 208/459-6365 Inside Beef Program, Dan D. Hinman, 208/459-6365
Iowa	Midcrest Area Cattle Evaluation Program, Russ Bredahl, 515/782-8426 Tri-County Steer Carcass Futurity, Darrell Busby, 712/482-6449 Woodbury Co. Cattlemen Steer Feeding Project, Russ Olson, 712/364-3003 Washington County Central Feedlot Test, James Frier, 319/653-4514 LDH-Wapello Steer Test, Ron Stout, 319/523-6184
Kansas	Commercial Cattle Improvement Program, Dean Haddock, Guaranty State Bank and Trust, 913/738-3501 Pratt County Steer Futurity, Marvin Reynolds, 316/672-6121
Kentucky	Kentucky FACTS, John Johns, 606/257-2853
Louisiana	Louisiana Calf to Carcass, LSU Cooperative Ext. Service, Dr. Hollis Chapman, 504/388-2219
Michigan	Michigan Cattlemen's Assn. Steer Evaluation, Cindy Reisig, 517/669-8589

Minnesota	Univ. of Minnesota Carcass Merit Program, Harvey Peterson, 218/281-8109
Mississippi	Farm to Feedlot, Blair McKinley, 601/325-3516
Missouri	Missouri Beef Cattle Feedout, Dave Lalman 314/882-7519; Eldon Cole, 417/466-3197
Montana	Montana State University, Roger Brownson, 406/994-3414
Nebraska	Nebraska Cattlemen's Steer Test, Don Clanton, 308/532-1971 Sandhills Cattle Assn., Ronna Morris, 402/376-2310
Nevada	Nevada Cattle Futurity, Ron Torrell, 702/738-7291
New York	Contact Ted Perry, Cornell University Cooperative Ext. Service, 607/255-5923
North Carolina	North Carolina Steer Feedout Program, Roger McCraw, 919/515-2761 or Dale Miller, 919/515-7772
North Dakota	Contact Kris Ringwall, North Dakota State University, Dickenson Research Ext. Center, 701/227-2348
Oklahoma	Oklahoma Steer Feedout, Greg Highfill, 405/237-7677
Oregon	Umatilla County Steer Futurity, Randy Mills, 503/276-7111, Ext. 235
Pennsylvania	Pennsylvania Feedlot Test, John Comerford, 814/863-3661
South Carolina	South Carolina Cattlemen's Assn., Steve McGill, 803/348-3737
South Dakota	South Dakota State Univ. Feedout Program, John Wagner, 605/688-5165
Tennessee	Tenn. Cattlemen's Assn. Cattle Feeding Test, Wendy Miles, 615/896-2333
Texas	Texas A&M Ranch to Rail, John McNeill, 409/845-3579
Utah	Will They Work Program, Norris Stenquist, 801/797-2142
Virginia	Virginia Tech. Retained Ownership, Bill McKinnon, 703/231-8160
West Virginia	West Virginia University, Wayne Wagner, 304/293-3392
Wisconsin	Contact Michael Siemens, University of Wisconsin, 608/263-4304
Wyoming	Wyoming Beef Cattle Improvement Assn., Doug Hixon, 307/766-3100

GUIDELINES FOR CARCASS DATA COLLECTION FROM STATE SPONSORED FEEDOUT PROGRAMS

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Background

Steer feedouts have been conducted in several states during the past 4 to 5 years. These were initiated and conducted by state extension services or state cattlemen's associations and in some cases by the joint efforts of these two groups. The purpose in most cases was to get feedlot performance and carcass data for each participant to use in evaluating either his sires or his herd. Most participants could not get this information on their cattle without the availability of these steer feedout programs.

The programs generated much interest among both commercial and purebred breeders and have grown steadily in numbers of participants. The database being accumulated has expanded dramatically. However, use of the data to date has terminated at the producer level.

Several of those closely involved with the conduct of the programs have discussed the data that is available and have considered the potential for further usefulness of the data in evaluating sires for carcass traits. These evaluations would be performed by respective breed associations. For this to be accomplished there is a need for identification of the data that must be reported. There is also a need for coordination of data collection and transmission to the breed associations.

Committee Recommendations

At the meeting of the Central Test and Growth Committee in June of 1994, Chairman Silcox appointed a committee to develop recommendations on the data that would be needed for evaluations and how the data would be collected and reported to breed associations. The committee consisted of John Hough, American Polled Hereford Association, Chairman; Keith Bertrand, University of Georgia; Robert Stewart, University of Georgia; John Crouch, American Angus Association; and Roger McCraw, North Carolina State University.

The committee recommends that the following data be the minimum collected and reported for potential use in sire evaluations.

Reporting of Data

Feedout program sponsors provide the data to participants in the program. The committee recommends that participants have the responsibility of submitting data, as described above, on their animals to the respective breed associations. Standardized reporting forms could be developed and provided to program sponsors for distribution to participants.

Summary

The committee has concluded that state sponsored feedout programs may generate data of quality and quantity to have potential for use in breed association sire evaluation programs for carcass traits. If the data proves to be useful, this would be an economical means of acquiring the data.

The guidelines presented here only pertain to appropriate data to be collected for use in EPD calculations by breed associations. State sponsors of the feedout programs will determine the overall guidelines and protocol for the conduct of their feedout program. Definition of contemporary groups, determination of reference sires, design of programs for calculating EPD's, and data utilization will be the responsibility of each breed association. Feedout program participants would be responsible for reporting the data to the respective breed associations.

It is anticipated that the Live Animal and Carcass Evaluation Committee will develop the overall guidelines and design the data entry forms for use in reporting the data.

DATA COLLECTION
STATE FEEDOUT PROGRAMS

Descriptive Information

- Owner
- Sex of animal
- Date of birth
- Breed of sire
- Sire's registration number
- Breed of dam
- Dam's ID (registration number if available)
- Birth year of dam

Contemporary Group Information

- Date on feed
- Feeding group
- Slaughter date

Carcass Information

- Starting weight
- Slaughter weight
- Hot carcass weight
- Marbling score
- Fat thickness
- Ribeye area
- Percent KPH fat
- Length of chill (24, 48 hours, etc.)

REPRODUCTION COMMITTEE
Minutes
June 1, 1995
Sheridan, WY

The meeting was called to order by Chairman Bruce E. Cunningham at 2:15 p.m., June 1, 1995.

Chairman Cunningham gave an introduction and described the purpose of the ReproductionCommittee to those in attendance. Also, he went through the list of agenda items.

Lisa Kriese from Auburn University, Auburn, Alabama discussed the relationship between pelvic area in young bulls and the subsequent calving ability of their daughters. Pelvic area in males and females had a moderate to high heritability, however, the genetic correlation between pelvic area in yearling bulls and yearling heifers was about +0.62, indicating that pelvic area for each sex should be treated as a different trait. If producers selected bulls based on pelvic area to reduce calving difficulty in their daughters, selection of bulls one standard deviation above average for pelvic area would reduce the average calving ease score of daughters' calves by .1 unit per generation. If the average generation interval was 6 years, then the amount of genetic change per year would be -.02 units per year. Dr. Kriese indicated that pelvic area should be used as a culling tool, particularly for yearling heifers, not as a selection tool for reducing calving difficulty.

Jim Gibb, from the American Gelbvieh Association, lead a discussion regarding whole herd record keeping and how the breed associations were designing and implementing whole herd programs. Dr. Gibb asked Richard Gilbert, from the Red Angus Association of America, and Bruce Cunningham, from the American Simmental Association, to describe the record keeping programs being implemented at those two Associations. Dr. Gibb described what the plans were for the Gelbvieh Association for whole herd recording. The primary reason for developing whole-herd record programs was to improve the quality of the information for calculating EPDs and helping breeders to have more complete information for decision making.

Chairman Cunningham described the current process for revising the BIF guidelines and told the audience that following the meeting if anyone wanted a copy of the initial draft of the Reproduction section to see him after the meeting.. After the meeting, fourteen copies of the guidelines draft were distributed to interested people.

After asking the committee if there was any additional business to be discussed by the committee, the Reproduction committee adjourned at 4:00 p.m.

Respectfully submitted by,
Bruce E. Cunningham, PhD.,
Chairman

GENETIC RELATIONSHIPS BETWEEN PELVIC AREA MEASUREMENTS AND SUBSEQUENT CALVING ABILITY

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Introduction

In recent years, expected progeny difference (EPD) technology has allowed breeders to produce progeny to fit various breed and market niches. It has allowed many breeders and producers to have the mindset all traits can be corrected through genetic selection practices. Many calves produced through EPD technology have rapid growth rates, which may also increase birth weights. It has been well documented dystocia (calving difficulty) is caused by a disportionate difference between dam pelvic area and calf birth weight (Bellows, et al, 1971; Rice and Wiltbank, 1972). However, a calf must be born alive without difficulty to prevent economic losses in the cowherd. It is known dystocia can increase calf losses and labor or veterinary costs, and reduce milk production and postpartum conception rates (Anderson and Bellows, 1967; Brinks et al., 1973; Brinks, 1994).

Several studies have suggested selection for increased pelvic area will reduce dystocia in first-calf heifers (Deutscher, 1978; Benyshek and Little, 1982, Green et al., 1986; Naazie et al., 1991). An equal number of studies suggest genetic selection for increased pelvic area will not substantially reduce dystocia in first-calf heifers (Cook et al., 1993; Heinrich, 1993; Kriese et al., 1994). The purpose of this paper is two-fold. First to discuss the inheritance of male and female yearling pelvic area and of maternal calving ease in 2-year-old heifers. Secondly to investigate the genetic relationship between pelvic area in yearling bulls and maternal calving ease in first-calf heifers.

Genetics of Maternal Calving Ease

Data used in analysis of the calving ease trait is based on the recommended BIF scoring system (1990) seen in Table 1. Generally, only first-calf heifer records are analyzed since most dystocia occurs in this age class. Additionally, calving ease scores of 5 are excluded from analyses since there does not appear to be a genetic cause for abnormal presentations.

Table 1. Recommended BIF Calving Ease

Score	Description
1	No difficulty or assistance
2	Minor difficulty, hand assistance
3	Major difficulty. mechanical assistance
4	C-section or other surgery
5	Abnormal presentations

Calving ease is a trait which has a direct and maternal component. The definition of direct calving ease is the ability of the calf to be born. Maternal calving ease is the ability of a cow to have a calf. The focus of this discussion will be on maternal calving ease, since maternal calving ease is affected by genes partially controlling pelvic measurements, uterine environment and hormonal control.

Many times calving ease scores are grouped into two categories: no assistance (scores 1 and 2) and assistance (scores 3 and 4). This grouping represents the incidence of calving difficulty, while analyzing actual scores (scores 1 through 4) represents the degree of calving difficulty.

Whether calving ease is analyzed as an actual score or as a binary trait (no assistance v.s. assistance), calving ease is a subjective score. Producers must decide how difficult a birth it was and record their numerical assessment. Differences between producer scoring abilities will become part of the contemporary group effect. Another unique characteristic with calving ease data is most births have no calving difficulty, which causes the data to be skewed toward the lower end of the scale. This can present problems in analysis.

In the literature, there are several heritability (h^2) estimates of maternal calving ease (Table 2). Each study used different analysis techniques and breeds to find their heritability estimates. The range of actual score heritability estimates were .11 to .41, while binary score heritability estimates ranged from .09 to .15. Burfening and coworkers (1978) examined American Simmental Association 2-year-old records. Cubas et al. (1991) examined American Angus Association records and included all cow age records in the analysis. The heritability estimates with the inclusion of all cow age records did not differ from analyses of only 2-year-old records. Burfening and coworkers analyzed both 2-year-old records and all cow age records. They found little difference in the two heritability estimates which concurs with the Cubas study results.

Table 2. Heritability estimates of maternal calving ease found in the literature

	Actual Score	Binary Score
Burfening et al., 1978	.24	.15
Cubas et al., 1991	.20	--
Naazie et al., 1991	.41	.12
Kriese, et al., 1994	.11	.09
Average h^2 estimate	.24	.12

Calving records of 547 composite breed heifers reared at the University of Alberta produced the largest heritability estimate of maternal calving ease (Naazie et al., 1991). These researchers concluded selection to reduce calving difficulty would probably increase dam weights at first calving. Kriese and coworkers (1994) analyzed 2-year-old calving records from the Germ Plasm Utilization Project at the U.S. Meat Animal Research Center (MARC). This analysis produced the lowest heritability estimate for actual calving ease scores.

Three studies also analyzed calving ease scores as a binary score (0=no assistance, 1= assistance) and reported very similar estimates to one another. All estimates were lower than actual score estimates. This is due to a reduction in variation of the data by making it binary in nature.

Averaging heritability estimates from the four studies results in a heritability estimate of .24 for actual calving ease scores and .12 for binary calving ease scores. If calving ease score was directly selected for, it is probable an improvement in calving ease score would be seen. Progress will be slowed if more than one trait is being selected for. However, as stated earlier, many times there is little or no variation in calving ease scores. It is not unusual to have a contemporary group with a calving ease score of 1. Thus, it becomes difficult to directly select for calving ease. Little genetic progress would be expected if the incidence of calving difficulty (binary score) would be directly selected for.

Genetics of Yearling Pelvic Area

Pelvic area is determined by measuring internal pelvic width and height and multiplying the values together. Measurements should be taken by experienced technicians for accurate, repeatable results (Holzer and Schlote, 1984; Wolverton et al., 1990).

Several studies have determined heritability estimates for pelvic measurements in bulls or females. Results are summarized in Table 3. The range of pelvic area heritabilities were from .04 to .77.

Table 3. Heritability estimates of pelvic area found in the literature

	No. of Cattle	h^2 estimate	Breeds included
Neville et al., 1978 Reidsville Tifton	 134 79	 .24 .04	 Angus. Polled Hereford, Simmental
Benyshek & Little, 1982	715	.53	Simmental
Green et al., 1984	340	.61	Hereford (all cow ages)
Holzer & Schlote, 1984	1400	.36	Simmental
Morrison et al., 1986	703	.68	(all cow ages)
Nelson et al., 1986	256	.68	Hereford bulls
Anderson et al, 1991		.46	
Naazie et al, 1991	649	.77	Composite heifers

In studies using yearling heifers, Neville and coworkers (1978) examined two groups of replacement heifers under different management schemes and reported a heritability estimate for pelvic area of .24 at Reidsville and .04 at Tifton. Similar results were found by Holzer and Schlote (1984) with Simmental 2-year-olds (.36) and Anderson et al. (1991) with females from the San Juan Basin Research Center(.46). Larger heritability estimates were reported by Benyshek and Little (1982) with Simmental 2-year-olds (.53) and Naazie and coworkers (1991) with composite heifers (.77). Studies including all cow ages (Green et al., 1984; Morrison et al., 1986) reported higher heritability estimates for pelvic area (.61 and .68) than most studies. One study (Nelson et al., 1986) measured 256 sire-son pairs of Hereford bulls and found a .68 heritability estimate for pelvic area which indicated perhaps bulls inherited pelvic measurements in the same manner as females. The average pelvic area heritability estimate is .48 from the literature.

However, the question to be answered is whether pelvic area in bulls is genetically the same trait as pelvic area in heifers. Ultimately, the question to be asked is whether selection of potential sires for increased pelvic area would transfer that advantage to female offspring and reduce calving difficulty in 2-year-old females.

Table 4. Heritability estimates of and genetic correlations between male and female pelvic area

	Heritability		
	Bulls	Heifers	Genetic Correlation
Green et al., 1986	.40	.56	.60
Kriese et al., 1994	.24	.25	.61

Two studies have examined whether pelvic area is the same trait in both sexes. Green and coworkers (1986) measured 900 yearling Hereford bulls and heifers to estimate heritability by sex for pelvic area and estimate the genetic correlation between male and female pelvic area. Kriese et al. (1994) analyzed 4531 yearling bull and 5715 yearling heifer pelvic area records from 12 breed groups generated through the Germ Plasm Utilization project at MARC. Results of each study are in Table 4. In the Green study, heritability estimates of yearling bull pelvic area was smaller than estimates in yearling heifers. The Kriese study reported similar heritability estimates for yearling bulls and heifers. The important aspect to note is the genetic correlation between male and female pelvic area, In both studies it was reported as .6. If pelvic area was the same trait in both sexes, the genetic correlation would be 1.0. This genetic correlation of .6 indicates many of the same genes are regulating pelvic area in yearling bulls anf heifers, but there are some differences in regulation between the sexes. This genetic correlation of .6 also indicates selection of a superior bull for pelvic area can not pass on half of his superiority to his daughters. In essence, the traits must be considered correlated traits and a correlated response must be determined for future daughters.

The equation to determine the amount of genetic change seen in daughters with one generation of selection for sire pelvic area is :

$$\text{Correlated Response for Daughters} = \frac{.5\ r_{12} h_1 h_2 \sigma_{p_2}}{\sigma_{p_1}} * (X_1 - \overline{X})$$

where:

r_{12} is the genetic correlation between yearling bull and heifer pelvic area
h_1 is the square root of the heritability for yearling bull pelvic area
h_2 is the square root of the heritability for yearling heifer pelvic area
σ_{p2} is the standard deviation for yearling heifer pelvic area in the population
σ_{p1} is the standard deviation for yearling bull pelvic area in the population

and

$X_1 - \overline{X}$ is the difference between the bull selected (X_1) and the group he came from.

Table 5 is an indication of the genetic change for pelvic area in daughters given her sire is one standard deviation above the mean of his group he was selected. In Table 5 the results of Green et al. and Kriese et al. were both used to show the difference between using different heritability estimates. Also different standard deviations were used to show the effect of selection when variation in the population is larger. The last two lines in the paper show the expected genetic change in daughter's pelvic area if yearling bull and heifer pelvic area were the same trait. From this table, if sires were selected based on increased pelvic area, a small positive genetic change will be seen in daughter yearling pelvic area.

Table 5. Expected genetic change in daughter yearling pelvic area per generation given the sire is one standard deviation above the mean for yearling pelvic area

Heritability- Yrl. Pelvic Area		Genetic Correlation	σ_{p1} (cm^2)	σ_{p2} (cm^2)	Change in daughter yrl. pelvic area
Male	Female				
.24	.25	.61	17.99	17.34	1.30
.40	.56	.60	17.99	17.34	2.46
.40	.56	.60	27.0	25.0	3.55
.40	.56	.60	51.0	50.0	7.14
.24	.25	1.0	17.99	17.34	2.12
.40	.56	1.0	17.99	17.34	4.10

Birth Weight and Pelvic Area Relationships

The next question becomes what happens to calf birth weight as yearling heifer pelvic area increases. Price and Wiltbank (1977) reported as heifer weight and pelvic area increased, average birth weight of calves increased. They reported with every 20 cm^2 increase of pelvic area in heifers ranging between 140 and 250 cm^2, calf birth weight increased 3.5 lbs. Laster (1974) also concluded 2-year-old heifers with larger pelvic openings have proportionately larger calves. Benyshek and Little (1982) reported a genetic correlation between pelvic area and birth weight in Simmental 2-year-old heifers of .73. Anderson et al. (1991) also reported a positive genetic correlation of .25 between pelvic area and calf birth weight. These two genetic correlations also indicate as pelvic area of yearling heifers increase, the birth weight of their calves will also increase. It appears an additional amount of the genetic advantage of selecting bulls superior for pelvic area can be nullified in his daughters with larger yearling pelvic areas due to increased calf birth weights these daughters will produce.

Pelvic Area and Calving Difficulty

The genetic response equation outlined above can also be used to determine the reduction in calving difficulty scores in 2-year-old heifers given their sires were selected on pelvic area. Kriese and coworkers (1991) reported the genetic correlation between yearling bull pelvic area and 2-yr-old calving ease scores as -.25. This indicates as yearling bull pelvic area increases, calving difficulty in 2-year-old heifers should decrease, Table 6 looks at various heritability estimates of yearling male pelvic area and 2-year-old calving scores. Again, sires were selected one standard deviation above the average for yearling pelvic area. It does not appear much genetic change can be realized for reduction in calving difficulty scores by using sires superior for yearling pelvic area. In cases examined in Table 6, less than .1 of a calving ease score will be seen per generation.

Table 6. Expected change in daughter calving difficulty score per generation given the sire is one standard deviation above average for yearling pelvic area

Heritability					
male yrl. pelvic area	2-yr-old calving difficulty	Genetic Correlation	σ_{p1} (cm^2)	σ_{p2} (units)	Change in calving difficulty score (units)
.24	.11	-.25	17.99	1.58	-.03
.24	.24	-.25	17.99	1.58	-.05
.40	.24	-.25	17.99	1.58	-.06

Possible Alternatives to Reduce Dystocia in 2-year-old Heifers

However, losses due to dystocia are important and need to be minimized. From the above studies, it does not appear to be feasible to decrease dystocia in 2-yr-old daughters genetically by selecting sires with larger yearling pelvic areas.

There are two strategies which may be more effective in reducing dystocia. The first strategy involves culling potential replacement females with extreme yearling pelvic areas. Heifers with small yearling pelvic areas need to be removed from the herd as well as heifers with extremely large yearling pelvic areas. As discussed previously, heifers with larger pelvic areas tend to have calves with heavier birth weights. Potential replàcement heifers with yearling pelvic areas four standard deviations above the mean, should be culled from the herd. Deutscher and Zerfoss (1983) have developed a ratio to assist in making culling decisions on replacement heifers with small pelvic areas. They found if the ratio between yearling heifer pelvic area measurement snd calf birth weight was lower than 2, calving ease scores of 3 or 4 would result. Ratios of 2 or higher would result in calving ease scores of 1 or 2. If a 75 pound calf was desired, the minimum yearling pelvic area for a heifer would be:

$$\text{Ratio} = \frac{\text{Yearling Heifer Pelvic Area}}{\text{Calf Birth Weight}}$$

$$2 = \frac{\text{Yearling Heifer Pelvic Area}}{75} = 150 \text{ cm}^2$$

Substituting in 2 for the minimum desired ratio and 75 for the calf birth weight results in a minimum yearling pelvic area in the heifer of 150 cm^2 . Thus, the resultant calf from this replacement heifer should be born with a calving ease score of 1 or 2.

The other strategy is to use birth weight EPDs. A study by Cook et al. (1993) suggested the use of high accuracy, low birth weight EPD sires was more effective than selecting replacement heifers on large yearling pelvic area. This study found with each 2.2 pound decrease in sire birth weight EPDs, calving difficulty score decreased by .12 units. Additionally, the incidence (assistance v.s. no assistance) of calving difficulty was reduced by 4%.

The best strategy to reduce dystocia in 2-year-old daughters will probably be a combination of the above two practices. Cull replacement heifers with small yearling pelvic area measurements and use high accuracy, low birth weight EPD sires on these first-calf heifers. Care should be taken to select low birth weight EPD sires which also possess acceptable levels of weaning and yearling weight growth.

Conclusions

Calving difficulty is primarily caused by an incorrect ratio between the dam pelvic area and calf birth weight. Many researches have hypothesized selection of larger yearling pelvic area bulls and heifers will have a desirable effect on reducing calving difficulty. Although pelvic area heritability estimates for yearling bulls and heifers indicate genetic selection could be successful, two research studies have found pelvic area is not the same trait in bulls and heifers. This will slow genetic progress since the traits are now defined as correlated traits and the full genetic difference will not be passed from sires to female offspring. Additional research has also shown females with increased pelvic areas generally have calves with heavier birth weights and is supported by estimates of posite genetic correlations between calf birth weight and yearling pelvic area.

Heritability estimates for maternal calving ease are generally lower than yearling pelvic area estimates. However, if directly selected for, calving difficulty can be reduced.

The genetic correlation between yearling pelvic area in bulls and 2-year-old calving ease is reported to be -.25. Given this, selecting sires one standard deviation above the mean for yearling pelvic area will only reduce calving difficulty scores by a maximum of .08 units per generation in their 2-year-old daughters. This response will be decreased if calving ease is not the only trait of importance in the herd.

It appears a better strategy in reducing calving difficulty is a combination of culling replacement heifers for pelvic area extremes and using high accuracy, low birth weight EPD sires. Studies indicate calving difficulty scores will be reduced .12 units per generation with every 2.2 lbs decrease in sire birth weight EPDs. Additionally, acceptable measures of growth can be maintained in the resultant calves.

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Inventory-Based Performance Programs For Breed Associations

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There are three categories of inventory-based performance programs. The first will be referred to as an Inventory-Based Fee Structure (IBFS). The American Red Angus Association is currently implementing this system where nearly all fees are collected on a "per cow" basis, with all other services provided at little or no cost. The Australian Hereford Association has had a similar fee structure in place for several years. The second category is based on a herd assessment fee ($2.00 to $2.50 depending on the association), plus fees for registrations, transfers and other association services. The third type of inventory-based program is voluntary, with no herd assessment fee, however, members are given the opportunity to indicate when cows are removed from the herd.

Benefits of Inventory-Based Performance Programs

Benefits of an Inventory-Based Performance Program (IBPP) depend on the category. Advantages of a complete IBFS are: 1) its simplicity for association members and the association; 2) members know at the beginning of the year how much they will owe the association, and 3) a higher percentage of bulls are likely to be registered allowing the association to do a better job of tracking commercial bull buyers.

In addition to the above mentioned benefits exclusive to a IBFS system, there are numerous other advantages that apply to a herd assessment system. The herd assessment creates an economic incentive for producers to remove cows from inventory yielding a much cleaner and more accurate inventory. A cleaner inventory provides for more accurate cow disposal information, more accurate fertility information, and more current pre-printed registration application forms. In addition, the merging of financial and production information such as cow/calf and seedstock SPA is easier and more reliable.

Many breed and commercial programs have extensive disposal codes (see Appendix A), that allow producers to indicate why a cow was culled. As more disposal data are collected, it is easier to evaluate genetic information in some of the key functional traits affecting stayability. Disposal data also provide valuable management information regardless of whether or not genetic variation exists.

Associations that do not provide an economic incentive to indicate why cows are removed from the herd are less likely to have accurate cow disposal information.

Overview Of How Different Systems Work

The Red Angus Association sends each member a preliminary inventory based on the previous year's inventory, plus disposal and transfer information reported to the Association by either January 1 for spring calving herds, or July 1 for fall calving herds. Members are asked to return the inventory to the Association with all changes and corrections by February 1 (spring calving), or August 1 (fall calving). The Association then sends out invoices for the first installment, plus pre-printed worksheets. The first installment payments are due August 1 (spring calving), and February 1 (fall calving). Invoices for the second installment payments are sent out in November (spring calving) and May (fall calving), with the second installment payments due December 1 (spring calving) and June 1 (fall calving). So far, acceptance of this system by members of the Red Angus Association has been very good.

The herd assessment systems used by the American Salers Association and the American Gelbvieh Association and as an option by the American Simmental Association, are based on a $2.00 to $2.50 per cow fee paid once each year. Members are sent pre-printed reports and asked to return the forms with the assessment fees. Members are also asked to provide the reason for removing a cow from inventory.

Associations with voluntary inventory programs usually charge a performance fee, in addition to registration and transfer fees. Members voluntarily remove cows from inventory by indicating status of the dam on registration application forms of their progeny.

Use of Disposal Code Information

Information derived from disposal information can be very useful. The American Gelbvieh Association recently analyzed some of its cow disposal data with useful results. For example, Gelbvieh females with a +6 or higher milk EPD were culled more than twice as often for infertility compared to females with a -6 or lower milk EPD (52% versus 25% of identified cullings in each groups, respectively). In addition, females with -6 or lower milk EPDs were culled almost three times as often for "inferior production" compared to females with +6 or higher EPDs for milk (25% versus 10% of identified cullings in each group, respectively).

This information is useful as it relates to identifying optimum levels of milk EPD within certain environments. It's also interesting to note that females with calving ease EPDs less than 95 (100 is average; higher values=easier calving) are five times more likely to be culled due to calving difficulty than females with calving EPDs greater than 105 (2.8% versus 14.2% of identified cullings in each group, respectively). While not surprising, these data help validate Gelbvieh calving ease EPDs.

It's easy to imagine the use of this information for helping producers understand how EPDs may be used to help match genetics and the environment. Without an Inventory-Based Performance Program, these data would be difficult to obtain.

As accurate disposal information, the merging of financial and performance data and simplified billing systems become more important to seedstock producers, Inventory-Based Performance Programs will undoubtedly become more common.

Disposal Codes for Cows
(Appendix A)

Reasons for cow disposal:

Angus

1. Open
2. Poor maternal milk
3. Poor growth EPDs
4. Mastitis/milk problems
5. Feet/leg problems
6. Body Condition
7. Temperament
8. Udder problems
9. Genetic defects
10. Health problems
11. Reproductive disease
12. Died natural death (old age)
13. Sold as purebred
14. Sold as commercial
15. Struck by lightening
16. Died at calving
17. Died-accidental
18. Died-respiratory disease
19. Died-digestive disease
20. Died-poisonous plants
21. Died-other health problems
22. Died-other

Brangus

D13 died-from disease or injury
D14 died-calving trouble
D15 died-unknown cause
D21 sold-for breeding use
D22 sold-slaughtered because of age
D23 sold-poor record-light calves
D24 sold-poor fertility
D27 sold-because of physical defects

Hereford

D13 died-disease or injury
D14 died-calving trouble
D15 died-unknown causes
D21 sold-for breeding use
D22 sold-slaughtered because of age
D23 sold-poor record-light calves
D24 sold-poor fertility or failed to calve
D25 sold-poor quality of calves
D26 sold-bad temperament
D27 sold-physical defects
D28 sold-inherited defects
D29 sold-lost 1 or more calves

Salers

0. Still in herd
1. Sold for breeding
2. Sold for feeding
3. Fertility problems
4. Inferior production
5. Injury/disease/death
6. Age
7. Remove from inventory

Gelbvieh

0. No code for animals still in herd
1. Sold-as a breeding animal-certificate transferred
2. Sold-as a breeding animal-not transferred
3. Sold-as a feeder calf
4. Died-illness
5. Died-injury
6. Died-calving difficulty
7. Died-old age
8. Died-other
9. Culled-inferior production
10. Culled-infertile
11. Culled-illness
12. Culled-injury
13. Culled-poor temperament
14. Culled or died-genetic defect
15. Culled-bad feet
16. Culled-poor udder/teats
17. Culled-prolapse
18. Culled-calving difficulty
19. Culled-structurally unsound
20. Culled-old age
21. Culled-other

Limousin

A. Cow used as an embryo donor or recipient
B. Cow or heifer did not conceive or she aborted, but has been retained for breeding
C. Cow or heifer did not conceive or she aborted, was culled and should be removed from the herd inventory
D. Cow had calf that died at birth or within 72 hours due to calving difficulty, but retained for breeding
E. Cow had calf that died at birth or within 72 hours due to calving difficulty, was culled and should be removed from the herd inventory
F. Cow had calf that died or following birth for reasons other than calving difficulty, but was retained for breeding
G. Cow had calf that died at or following birth for reasons other than calving difficulty, was culled and should be removed from herd inventory
H. Cow was culled because of unacceptable disposition, remove from herd inventory
I. Cow was culled due to teat and/or udder problems, remove from herd inventory
J. Cow was culled due to old age, including no teeth, remove from herd inventory
K. Cow was culled due to unsoundness of feet and legs, remove from herd inventory
L. Cow was culled because of inferior calf weaning weight, remove from cow inventory
M. Cow was sold with papers, submit transfer to NALF
N. Cow was sold without papers and should be removed from herd inventory
O. Cow died or was sold to slaughter for reasons other than those listed above (please return registration certificate to NALF-cow) will be removed from herd inventory)

Polled Hereford

0. Still in herd or sold with papers
1. Sold as a breeding animal without papers
2. Sold as a feeder calf
3. Died, illness
4. Died, injury
5. Died, calving difficulty
6. Died, old age
7. Died, other
8. Culled, inferior production
9. Culled, infertile
10. Culled, illness
11. Culled, injury
12. Culled, poor temperament
13. Culled or died, genetic defect
14. Culled, bad feet
15. Culled, poor udder
16. Culled, prolapse
17. Culled, cancer eye
18. Culled, structurally unsound
19. Culled, old age
20. Culled, other

GENETIC PREDICTION COMMITTEE MEETING

Chairman, Larry Cundiff called the meeting to order at 2:07 p.m., June 2, 1995, in the Holiday Inn of Sheridan, WY, at the 27th Annual Meeting of the Beef Improvement Federation. Five items were on the agenda. The room was full and there were many standing.

Cundiff introduced the guidelines editor, Curt Bailey. Cundiff described the guidelines and its publication. Thanks go to Dale Van Vleck for his work on the current draft of our part of the guidelines. Curt then described the editorial procedure. Standardization will be the issue. The next revision will be out 1 SEPT 95 and this will be reviewed for the mid-year board meeting. Our writing of the guidelines began with the 1994 Genetic Prediction Workshop. Cundiff distributed the draft to a number of people belonging to the committee. Cundiff called for additions and corrections. No additions or corrections came from the committee. Cundiff reported that Spike Forbes provided an addition on contemporary groups (See attached).

Cundiff then introduced the topic on across breed EPD's. He introduced Dale Van Vleck to cover the updated breed means and adjustment factors for across breed EPD's. Dale presented the tables and described the results. For 1995 a new model was used. It was a mixed model. Deviations were from the Angus means. More data was available this year for some breeds. Analysis is on a tight time frame. We do need to report EPD's promptly. Dale described the procedure, but did not discuss prediction error variance of estimates since no one asked. Amount of information was described. Tables will be in the report. Discussion followed on several of the tables. Dale gave an example of the use of one of the tables.

Cundiff then introduced Darrh Bullock of the University of Kentucky to report on work he did with the Polled and Horned Herefords data. He tested the across breed EPD tables. Estimates were very close to expectation (zero) for birth weight, direct weaning weight, and yearling weight; but, not for milk. Darh noted the existing problems. Comparisons between values for the same bull were different. He reported on what is needed. The Bullock paper is attached to this committee report. He answered several questions from the committee. This created considerable discussion at the break.

A short break was taken.

Then Cundiff introduced Lou Gasbarre, USDA, ARS, Beltsville, MD, to present a research report on genetic resistance to GI nematodes. This work was done using the Wye Plantation herd of the University of Maryland. Lou and Eldon Leighton worked on this study. He discussed the parasite system and then described the system to control it. Differences among animals were investigated. Repeatability of egg count i.e., .6-.7. There were significant sire effects in progeny egg counts. Within a herd of BoLA homogygous black Angus, they made selections of sires with high and low egg counts. The heritability was 20-30%. Control may be gene identification. Questions were answered.

Then Cundiff introduced Warren Snelling who discussed his Ph.D. work at Colorado State University. The topic was a genetic evaluation of stayability. EPD's for stayability were presented. Further work by Bruce Golden was discussed also. Red Angus, Barzona, and

Charolais were using stayability. Questions were answered.

Cundiff introduced Richard Willham who announced plans for a Genetic Prediction Workshop dealing with ultrasound use in genetic prediction of body composition. The workshop would be held 8-9 DEC 1995 at the Embassy Suites at the Kansas City International Airport. One day would be a symposium with invited and review papers. The second day would be devoted to several workshops dealing with future research needs, genetic prediction technology development, and guidelines for use by producer. Combining live ultrasound data with carcass data to make genetic predictions for body composition is a primary issue. If parties are interested in attending, they should notify R. Willham at Iowa State University.

1993 AVERAGE EPD's FOR EACH BREED

For selection of breeding stock, it is important to know how EPD's for an individual animal compare to the current breed average. Mean non-parent expected progeny differences (EPD's) are tabulated for each breed. These are useful for making comparisons within breeds. They cannot be used to compare different breeds because EPD's are estimated from separate analyses for each breed. The means are for all calves born in 1993 from the 1994-95 genetic evaluations. The 1993 calves were chosen because limited data were available on 1994 calves (i.e., yearling weight) in the 1994-95 genetic evaluations.

1993 ALL ANIMAL NON-PARENT MEAN EPD's FROM 1994-95 GENETIC EVALUATIONS

Breed	Birth wt lb	Wean. wt lb	Yrlg. wt lb	Maternal Milk lb	Maternal Total lb	Yrlg ht in	Scot. circ. cm	Calving ease Direct %	Calving ease Maternal %	Gestation length d	Stay-ability
Angus	+3.2	+24.9	+41.6	+10.3	+20.35						
Beefmaster	+.48	+7.6	+14.2	+5.5							
Brahman	+1.06	+8.34	+14.18	+3.95							
Brangus	+1.5	+14.9	+25.8	+1.0	+8.4						
Charolais	+1.58	+8.98	+13.51	+0.97							
Gelbvieh	+0.2	+4.5	+8.5	+1.8	+4.2			100.3[a]	101.2[a]	-.1	
Hereford	+3.1	+24.8	+42.1	+10.1		+0.7	+0.2				
Limousin	+1.2	+6.5	+12.0	+.4			+.02				
Maine Anjou	-.10	+0.7	+1.0	-0.1							
Pinzgauer	-0.1	+0.2	+0.8	-0.5	-.04						
P. Hereford	+3.1	+23.4	+39.5	+6.3							
Red Angus	+0.28	+20.01	+31.65	+7.66	+17.67						+4.43
Salers	+0.8	+8.0	+13.4	+2.4	6.4		+0.0				
Shorthorn	+2.0	+13.0	+20.6	+3.0							
Simmental	+0.4	+7.1	+12.2	+0.5	+4.1			1.8%[a]	2.8%[a]		
Tarentaise	+2.52	+9.5	+15.2	+0.8							

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

TESTING THE APPLICATION OF ACROSS BREED EPDS USING DUAL REGISTERED HEREFORD AND POLLED HEREFORD BULLS

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INTRODUCTION

The technology has been available for several years to adjust the Expected Progeny Differences (EPD) of bulls of different breeds to the same base for direct comparison (Notter and Cundiff, 1991). Using this technology, across breed adjustment factors have been computed and published in the BIF proceedings since 1992 (Nunez-Dominguez et al., 1992; Cundiff, 1993; Barkhouse et al., 1994). Consequently, these values have been highly publicized in several popular press articles and breed association advertisements and it can easily be assumed that these adjustment factors are being used by commercial producers in their selection decisions. If these correction factors are incorrect or suitable for only a specific environment, then producers may not be improving their selection process by comparing bulls' EPD across breeds.

The best method to determine if bulls of different breeds can be compared using these adjustment factors would be to design studies in several diverse locations that directly compare sires of different breeds based on their across breed adjusted EPD. If expected differences are similar to actual differences, then it could be assumed that the adjustment factors are correct. Unfortunately, this type of study is very costly and time consuming. A second opportunity to test the effectiveness of the across breed adjustment factors is to identify bulls in two different associations (with two sets of EPD) and adjust each of their EPD with their respective breeds adjustment factors. This will give each bull two adjusted EPD, which should be similar if the adjustment factors are correct for those breeds. The only breeds known to allow dual registration are the American Hereford Association (AHA) and the American Polled Hereford Association (APHA) which are both included in the across breed adjustment table. The purpose of this study was to determine if bulls dual registered in these associations had similar EPD after their respective adjustments.

MATERIALS AND METHODS

Data, provided by the University of Georgia in cooperation with the American Hereford Association and the American Polled Hereford Association, included all dual registered sires and their EPD from both associations for birth weight (BW), weaning weight direct (WWD), weaning weight milk (WWM) and yearling weight (YW). Each bulls EPD were then adjusted using the appropriate adjustment factor from the across breed adjustment factor table (Barkhouse et al., 1994). In other words, each bull's AHA EPD were adjusted using his AHA adjustment factors and his APHA EPD were adjusted using his corresponding APHA adjustment factor resulting in each bull having two across breed adjusted EPD for each of the four traits. The average across breed adjusted EPD from each association are presented in Table 1.

The differences between each bulls AHA across breed adjusted EPD and APHA across breed adjusted EPD were then calculated. Both actual difference means (Table 2), subtracting the AHA value from the APHA value, and absolute value means (Table 3) were computed. Also, mean actual (Table 4) and absolute value (Table 5) differences were computed for only those bulls that had greater than .5 accuracy values in both associations for that trait.

RESULTS

To observe how well the across breed EPD tables are adjusting these breeds it is necessary to look at the actual difference means (Tables 2 and 4). These means are expected to equal zero since the same bull is being adjusted, in two associations, to a comparable base. The average difference between the APHA values and AHA values was not significantly different from zero for BW, WWD or YW when all bulls were compared or only the bulls with greater than .5 accuracy in both associations for those traits. However, the average difference between the bulls' WWM values were great with the average APHA corrected EPD being 24.4 lbs lighter than the average AHA corrected EPD. When only high accuracy bulls were compared, this difference increased to 27.8 lbs in favor of the AHA corrected EPD.

If differences are what is important and not necessarily which of the bulls' two EPD are larger or smaller, then it is necessary to calculate the mean absolute values (Tables 3 and 5). These values are not only a reflection of errors in the across breed adjustments, but also in bulls potentially re-ranking within the two associations. When observing the mean values and standard deviations for BW, WWD and YW, it appears that these means are significantly different from zero, however, when working with absolute values this determination can not be made. It is unlikely that the means for these three traits are different from zero. The mean difference for WWM is likely different from zero when all bulls or just the high accuracy bulls are included.

DISCUSSION

These results indicate that the across breed adjustment factors for BW, WWD and YW between Hereford and Polled Hereford bulls, that are dual registered in both associations, appear to be correct. The correction factor for WWM appears to be grossly incorrect and favor each bull's AHA milk EPD. There are few arguments that there is a serious problem with the WWM adjustment factor between these two breeds, but there is much room for discussion on whether this study should cast doubts on the entire table.

There are two primary areas of concern:

1. Although the average actual difference for BW, WWD and YW were not significantly different from zero, there was a tremendous amount of variation in these differences indicated by large standard deviations and ranges. This basically means that using large numbers of bulls, from these two breeds, based on their across breed adjusted EPD is relatively safe, for these three traits. Some will be as expected, some better than expected, and some will be worse. However, when dealing with only a small number of bulls the chances of using the wrong bull are of great concern. Some will argue that this is the same chance that we take with low accuracy EPD bulls within a breed. This is true to a point, when using a small number of low accuracy sires the risk of making a mistake is higher than when using a large number of low accuracy sires. The difference is that within breed EPD give producers a means of measuring that risk by providing accuracy values. Three factors are involved when attempting to compare bulls of different breeds, each bulls' within breed accuracy value and the error associated with calculating the across breed adjustment factor. Van Vleck and Cundiff (1994) have developed a means of

calculating confidence ranges for across breed comparisons, but the use of these values have not occurred at this time. Most breeders know there are associated risk in sire selection, but having an idea of what that risk is is a necessity.

2. The extreme difference in the two breeds WWM values is of great concern, remembering that this difference involves trying to compare the same bull in two associations. Hereford and Polled Hereford cattle are two of the most similar breeds listed in the across breed adjustment table and these results show that there are problems with the across breed adjustment factor for WWM. When trying to compare other breeds of great biological differences, the potential for errors exist. Given these results in an ideal situation, it is easy to speculate that there may be other problems elsewhere in the table.

Just as many observed the great difference between the Hereford and Polled Hereford values for milk and thought something must be wrong, there are other comparisons in the table that appear visually disturbing. Unfortunately, testing these comparisons will be much more difficult and costly.

IMPLICATIONS

The desire among producers for a reliable means of comparing bulls of different breeds is great and would be a useful selection tool. However, the results of this study indicate some concern about the current published adjustment factors. Hopefully, this will lead to more research to both find potential problems and techniques to improve the adjustment factors. Also, producers need to be aware that information is available to determine associated risk when comparing bulls of different breeds, similar to accuracy values used within breed, and should be demanding these values.

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Table 1. Average across breed adjusted EPD for bulls dual registered in AHA and APHA.

Trait	N	AHA adj. EPD	APHA adj. EPD
BIRTH WT.	4374	6.9	7.0
WEAN. DIR.	6117	12.1	15.3
YEAR. WT.	6117	16.0	15.0
WEAN. MILK	6117	-2.2	-26.4

Table 2. Average actual differences of bulls' APHA across breed adjusted EPD minus his AHA across breed adjusted EPD.

Trait	N	AVE	SD	MAX / MIN
BIRTH WT.	4374	0.1	1.9	11.7 / -8.9
WEAN. DIR.	6117	3.2	11.1	42.9 / -46.4
YEAR. WT.	6117	-1.0	17.6	65.4 / -77.2
WEAN. MILK	6117	-24.4	8.5	14.3 / -61.3

Table 3. Average absolute value differences of AHA and APHA across breed adjusted EPD.

Trait	N	AVE	SD	MAX / MIN
BIRTH WT.	4374	1.4	1.3	11.7 / 0.0
WEAN. DIR.	6117	9.2	7.1	46.4 / 0.0
YEAR. WT.	6117	13.4	11.5	77.2 / 0.0
WEAN. MILK	6117	24.5	8.4	61.3 / 0.2

Table 4. Average actual differences of bulls' APHA across breed adjusted EPD minus their AHA across breed adjusted EPD when accuracy values in both associations were greater than .5.

Trait	N	AVE	SD	MAX / MIN
BIRTH WT.	425	.7	2.1	7.3 / -6.6
WEAN. DIR.	466	-1.2	10.4	35.8 / -34.2
YEAR. WT.	229	-9.0	16.1	52.5 / -54.3
WEAN. MILK	173	-27.8	9.9	-8.4 / -59.1

Table 5. Average absolute value differences of AHA and APHA across breed adjusted EPD when accuracy values in both associations were greater than .5.

Trait	N	AVE	SD	MAX / MIN
BIRTH WT.	425	1.7	1.4	7.3 / 0.0
WEAN. DIR.	466	8.0	6.8	35.8 / 0.1
YEAR. WT.	229	14.6	11.2	54.3 / 0.0
WEAN. MILK	173	27.8	9.9	59.1 / 8.4

IMPLEMENTATION OF STAYABILITY IN NATIONAL CATTLE EVALUATIONS[1]

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Introduction

Expected progeny differences for stayability of beef females were developed as a tool to assist selection for sustained reproductive ability. Due to the relationship between the time a cow remains in production and the income she generates, stayability EPD also indicate components of cow profitability. Stayability EPD can be obtained from routinely reported information with no requirement for additional data collection. With these attributes, stayability may merit consideration in national cattle evaluation programs, although shortcomings certainly exist. This paper describes stayability EPD and problems encountered with implementation of national cattle evaluations for stayability.

Stayability traits

A general definition of stayability is the probability of survival to a specific age, given opportunity to reach that age (Hudson and Van Vleck, 1981). This definition offers considerable flexibility in specification of stayability traits. Depending on available information, trait definitions may consider survival to an age reflecting some potential number of calves weaned. Weaning a specific number of calves or calving after a specific age may also be used to define stayability traits. Opportunity to reach an age depends on a cow's current age; cows younger than the desired age have not had the opportunity to reach that age. In addition, opportunity may be restricted to heifers selected to be exposed to breeding or females that became dams. Binary observations indicating survival or failure to survive to the target age are assigned to cows that have had an opportunity to survive.

Evaluations of stayability for the American Gelbvieh Association (AGA, Hyde et al., 1995) and the Red Angus Association of America (RAAA, Snelling et al., 1994) considered the probability of a cow having a calf reported at age six or later, given she had a calf reported at age five or earlier. This definition of stayability is designated by S(6|5). The target age of six was chosen because it is near the breakeven age for many economic conditions (Table 1) and provides some indication of sustained reproduction to maturity. To measure reproduction, this trait depends on culling for reproductive failure, as a cow is unlikely to remain in a herd as a six-year-

[1] USDA, Agricultural Research Service, Northern Plains Area, is an equal opportunity/affirmative action employer and all agency services are available without discrimination. Cooperation of Montana Agric. Exp. Sta., Montana State Univ. is recognized.

old if she has not raised calves previously. Having a calf reported at age five or earlier was required to indicate which females entered production and had an opportunity to raise calves beyond the age of six.

Table 1. Breakeven ownership period of a cow (years).[a]

Replacement Heifer Value	Salvage Value	Net Return/Cow[b] $50	$100	$150
$500	$400	4	2	1
	450	2	1	1
	500	1	1	1
$600	$400	8	3	2
	450	6	2	2
	500	5	2	1
$700	$400	14	5	3
	450	12	4	3
	500	10	3	2

[a]Dalsted and Gutierrez, 1989.
[b]90% weaning rate and 5% discount rate.

Because a successful observation for S(6|5) does not require a cow to raise a calf in consecutive years from ages two through six, this trait definition does not provide a strict measure of continuous reproductive performance. A more appropriate measure of reproduction would require calves every year, but may not be entirely feasible using historical records. These records do not indicate whether a cow missed calves due to reproductive failure or failure to report calves to the breed association. Using S(6|5), a similar problem may occur with cows that continued to raise calves beyond the age of six with none of those calves reported.

Complete reporting and consideration of reasons for disposal will help to alleviate these problems. With known reproductive histories, unsuccessful observations may be assigned to cows allowed to remain in production following reproductive failure. Disposal codes may further identify which cows had opportunity to remain in production. Collection of this information may be enhanced by inventory based recording programs, although there will be some lag between the time procedures are implemented and the data is useful for stayability evaluations (Hyde et al., 1995). Meanwhile, analysis of data from herds with complete records should be beneficial to refine definitions of stayability traits. These analyses may explore differences in EPD and heritability estimates resulting from treatment of stayability as a composite measure of culling versus culling for infertility or other reasons.

Contemporary groups for the AGA and RAAA stayability evaluations were based on a cow's breeder and birth year, as well as breeder of her calves. Cow breeder and birth year were needed to group cows subject to similar management and environments during development as heifers. Calf breeder indicated changes in ownership, and presumably changes in management and environmental conditions later in life. Observations of cows in contemporary groups with no variation were discarded, because the nonlinear threshold model procedures used for analysis of binary stayability traits would not converge with contemporary groups containing all observations in a single category.

Analysis of stayability

Because observations of stayability are binary, indicating success or failure, methods based on a threshold model (Gianola and Foulley, 1983; Harville and Mee, 1984) were used to estimate heritability and predict genetic merit. Heritability of stayability was estimated using marginal maximum likelihood (MML), an expectation maximization-like procedure (Hoeschele et al., 1987), and Method R, involving regression of low accuracy predictions on high accuracy predictions (Reverter et al., 1994).

Within-herd heritability estimates for S(6|2) were obtained from Angus and Red Angus seedstock herds (Snelling et al., 1995). This trait is the same as S(6|5) except that consecutive calves from age two through six were required because open cows were culled. Using MML, estimates were .14 for the Angus herd and .11 for the Red Angus herd. Method R estimates were .22 for the Angus herd and .12 for the Red Angus herd. In across-herd analyses of AGA data using Method R, Hyde et al. (1995) were unable to obtain a reliable estimate of S(6|5) heritability.

For both AGA and RAAA analyses, threshold model predictions of genetic merit were obtained with single-trait animal models that included contemporary group as a fixed effect. In the AGA analysis, a heritability of .20 was assumed. The RAAA analysis used a heritability of .10, based on estimates from a Red Angus herd. The value of assumed heritability used in these single-trait analyses may not be extremely critical. Within-herd analyses with the same threshold model procedures indicated that predicted animal rankings were not affected by use of different heritability estimates (Snelling et al., 1995). Predictions from the threshold model were translated from the underlying scale to percent probabilities, with stayability EPD expressed as deviations from a probability of 50%. The EPD translated to a probability scale may be more readily understood than EPD expressed on a difficult to explain, underlying standard normal scale.

Results

Genetic and environmental trends from the RAAA stayability evaluation are shown in Figure 1. The general decline in average contemporary group effects over time suggests increased culling pressure on young cows. From 1950 until about 1970, there was little change in average genetic merit for stayability. After 1970, there has been a gradual increase in mean stayability EPD of animals born each year. The time of this increase corresponds to the time culling open cows and fertility testing bulls became prevalent. These practices may have resulted in selection of parents with superior genetic merit for stayability.

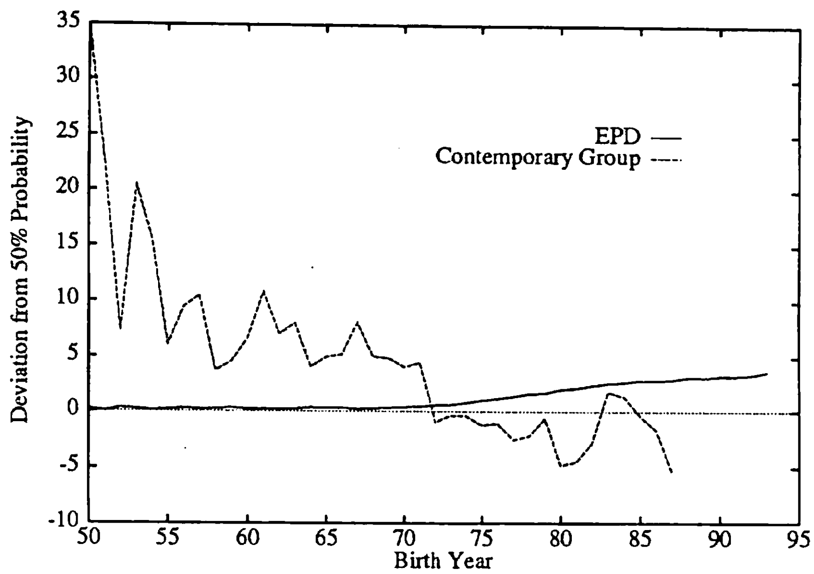

Figure 1. Mean stayability EPD and contemporary group effects by birth year.

Sires in the RAAA analysis had stayability EPD ranging from -12 to +14, indicating the sire with the highest EPD should have 26% more daughters in production at age six than the sire with the lowest EPD. A comparison of birth weight, weaning weight, milk and yearling weight EPD of all sires and high stayability sires shows the high stayability sires have ranges of other EPD similar to the ranges found in all sires (Table 2). These results indicate stayability may be included in selection criteria without placing severe restrictions on selection for other EPD.

Table 2. Ranges of weight EPD among all sires and sires ranking in the highest 20% for S(6|5) EPD.

Trait	Sires	Minimum	Maximum
Birth Weight	All	-10.0	13.7
	Top 20% S(6|5)	-10.0	13.7
Weaning Weight direct	All	-40.1	70.4
	Top 20% S(6|5)	-24.6	70.4
Weaning Weight maternal	All	-34.0	31.1
	Top 20% S(6|5)	-27.7	31.1
Yearling Weight	All	-63.6	109.0
	Top 20% S(6|5)	-38.1	109.0

While results of the RAAA evaluation were encouraging, problems with the AGA data prevented evaluation of the entire population (Hyde et al., 1995). The most significant problems were contemporary groups with no variation and inadequate pedigree information. Sires were unknown for 68% of animals represented in the analysis. These problems may be partly attributed to a grading up program. With grading up, the historic pedigree and calving information needed for stayability EPD may not be available. Also, breeders that are grading up their herds may be less likely to keep a low percentage cow if a higher percentage replacement heifer is available.

Utilizing stayability EPD

The emphasis placed on stayability in selection decisions should vary according to the needs and goals of individual situations. Stayability EPD may provide an opportunity for genetic improvement of reproduction in herds where fertility is a problem and relatively few cows survive to the breakeven age. In herds where a larger portion of cows survive past the breakeven age, genetic improvement of stayability may allow the same phenotypic expression of stayability in a less favorable environment. In other words, the same stayability performance may be achieved with less feed.

Stayability EPD provide an additional piece of information to consider in conjunction with other information used to make selection decisions. When selecting sires of potential replacement heifers, stayability may merit some emphasis, along with weaning weight, milk, and other traits with or without EPD available. One strategy may be to identify potential sires acceptable for other selection criteria, then use those with the highest stayability EPD or at least eliminate those with extremely low stayability EPD. Stayability should receive no consideration in selection of terminal sires, because their daughters should not have the opportunity to enter or stay in production.

Further understanding of relationships between stayability, other traits, production environments and profitability should contribute to utilization of stayability EPD. Research into the genetic relationships between stayability and other traits could indicate the influence selection for stayability may have on other traits. Such research may also reveal indicators of stayability that can be measured earlier in life. Under different production environments, the economic value of stayability will vary, along with the level of stayability and other EPD acceptable for those conditions. Also, certain environments and management practices may either mask or magnify expression of genetic merit for reproduction and stayability.

Summary

Stayability EPD predict genetic merit for the probability that a cow will remain in production for several years. Because a cow must raise a number of calves to pay for her development and maintenance, these EPD provide some indication of which parents are likely to produce profitable daughters. Because successful reproduction is required for a cow to remain in production, these EPD also provide a tool to select for sustained reproductive performance.

Successful implementation of stayability in the RAAA national cattle evaluation provides encouragement for development of stayability EPD by other beef breed associations. By using historical data, some breed associations may be able to obtain stayability EPD immediately. Difficulties encountered with stayability analysis for the AGA indicated problems associated with use of historical data lacking sufficient pedigree and birth information. While improved data collection procedures may improve the quality of information available for stayability evaluations, this information may not be useful for a number of years.

Further research of stayability may refine trait definitions and determine the types of information most useful in future stayability evaluations. Investigations to establish relationships between stayability and other traits, examine environmental influences on stayability, and assess economic value of stayability EPD are also needed to better understand applications of stayability to improve beef cattle.

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GENETICALLY CONTROLLED RESISTANCE TO GASTROINTESTINAL NEMATODES INFECTIONS OF CATTLE

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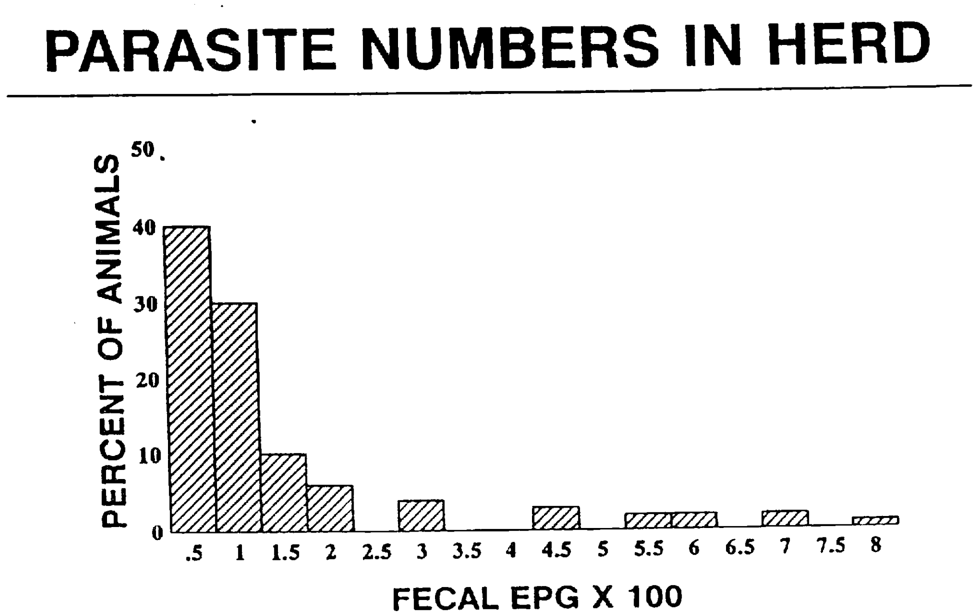
Biology of Cattle Gastrointestinal Nematodes

Gastrointestinal (GI) nematodes, or as they are more commonly called roundworms, can severely affect the efficient raising of cattle on pastures. These parasites live within the digestive system of the host where they interfere with normal digestive activity, and may also cause severe losses of blood and tissue fluids as a result of their feeding activity. The most important of the species found in the US is the medium brown stomach worm, Ostertagia ostertagi. This parasite lives in the abomasum or true stomach where it disrupts the beginning of protein digestion. In addition, the parasite may also cause severe imbalances in tissue protein and electrolyte levels leading to some of the classic signs of severe parasitism such as "bottlejaw". The American pharmaceutical industry estimates that GI nematodes, including Ostertagia, can result in losses that lie between $20 and $200 dollars per animal per year (Anonymous, 1991). An important component of these economic losses is cost of the anthelmintics used to control these parasites. Current control practices rely on the repeated administration of anthelmintics to a large percentage of the cattle herd. Although treatment programs vary from locality to locality, recommended treatments may be as extreme as 6 treatments per year (Barao, 1987).

Historically such treatments were given when clinical signs of parasitism became evident, and thus were therapeutic in nature. More recently, because the detrimental effects of the parasites are a function of the number of parasites in the host, the target of modern parasite control programs is to reduce parasite transmission to prevent reaching a point where economic loss is evident. Such "strategic" treatment protocols take into account several aspects of the life cycle of the parasites. Adults of the parasites reside in some portion of the digestive tract. Here the adults mate, and the females lay eggs which are passed in the feces of the host. Within the protective covering of the fecal pat, the eggs hatch and first-stage larvae emerges and begin development. These larvae undergo 2 molts to the infective third-stage which leave the fecal pat, and are then distributed on the pasture by both their own movement, and by environmental forces such as rain. The infective larvae are then ingested by cattle during grazing. Once in the host, the parasites undergo 2 additional molts to the adult stage, and the cycle is completed. The development and survival of the larvae on pasture is controlled by moisture and temperature, and transmission is minimal in periods of extreme dryness or cold. In addition, after an appropriate level of parasite exposure, the immune system of most cattle begins to reduce the number of parasite eggs passed in the feces. This lowering of the number of parasite eggs can be the result of immune responses that reduce the number of parasites that establish in the host, and/or be the result of immune responses that somehow damage the worms and reduce the number of eggs that an individual female worm can lay. As such, under similar environmental conditions, the number of larvae that an individual animal has the opportunity to ingest is a function of the number of eggs passed by the herd, and thus is a function of the overall immune status of the animals. During periods when highly susceptible cattle, such as calves, are on the pastures, overall parasite transmission increases, and the potential for economic loss also increases.

The number of parasites in individuals in a herd does not follow a normal distribution. In a normally distributed population, a few animals would pass low numbers of eggs, a few would pass high numbers of eggs, and the remainder of the animals would be intermediate. The shape of the distribution of the fecal egg (EPG) values would thus approximate a bell shape. In parasite infections the distributions conform more to what has been termed an "overdispersed" distribution (Crofton, 1971a&b). In such a distribution, most animals have very low EPG values, and a very small percentage of animals have high EPG values. Figure 1 shows an example of EPG values seen in calves on pasture. In cattle, 15-25% of the animals may account for 60-80% of the eggs deposited on the pastures, and as such these few animals may be responsible for the majority of the parasite transmission.

Figure 1. Typical distribution of fecal EPG values in pastured cattle. The figure illustrates that among animals of a similar age most animals have low EPG values, leaving a very small percentage of the cattle with high EPG values.



Genetic control of anti-parasite immunity

Recent studies have indicated that the genetic make-up of the host can significantly influence the number of eggs an individual animal passes in their feces (Leighton et al. 1989, Gasbarre et al. 1990 & 1993). These studies demonstrated that fecal EPG values are strongly influenced by the sire and sex of the individual animal. Males have higher EPG values than do females, and the heritability of fecal EPG values is approximately 0.2-0.3. In addition, specific immune responses such as anti-parasite antibody responses may have heritabilities as high as 0.8-0.9. Because the high EPG value calves can play such an important role in overall parasite transmission, subsequent studies have focused on the definition of the factors and mechanisms which render these animals highly susceptible to the parasites. Certain bulls have been found to produce high EPG calves at higher than expected frequencies, and the risk of a given bull producing such high EPG animals may be nearly 20 times greater than if a different bull was used (Table 1).

Table 1. Risk factor associated with using certain sires.

SIRE IDENTIFICATION	PERCENTAGE HIGH EPG CALVES	RISK OF PRODUCING HIGH EPG CALF
AAA	0.0	1.0
BBB	13.0	2.96
CCC	50.0	18.3

Based upon these demonstrations that host genetics strongly influences fecal EPG values, and thus is important in determining the level of parasite transmission in a cattle herd, studies to select for high and low EPG cattle were undertaken. The purpose of these studies was to use these cattle to define the mechanisms that control immunity to the parasites, and to begin to identify the genes that are involved. Cattle were first produced that were identical across their major histocompatibility complex (MHC). This gene complex is important for the communication between cells of the immune system. By working with MHC defined animals, cells from individuals can be mixed together without the rejection characteristic of tissue or organ transplants across this genetic barrier. The bovine MHC is called the BoLA (bovine leucocyte antigen) complex. We have shown that this complex in itself has little effect on resistance to the parasites. A BoLA type was chosen that is commonly found in all cattle breeds so far tested, and in both resistant and susceptible individuals. Once a core group of BoLA compatible cattle were produced, semen from bulls which produced either a disproportionate number of high or low EPG offspring was used to produce the desired high and low EPG phenotypes. Cattle produced from these selections are being tested on pastures that contain the 2 most economically important nematode genera in the US: Ostertagia and Cooperia.

To date, 77 such cattle have been produced and tested. Several important characteristics of these cattle have been documented. First, there are really 3 types of EPG phenotypes in cattle pastured for the first time. The first type maintains a low EPG value from the initial exposure onward. The second type shows increasing EPG values throughout the first 2-3 months of exposure, and then they regulate their EPG value so that by 4 months after exposure their EPG value are indistinguishable from the always low calves. The final EPG type reaches very high EPG values, and maintains these high levels. The 3 phenotypes exist at roughly 1:2:1 ratio respectively. Calculated differently, within 3-4 months of parasite exposure approximately 75% of the cattle have low EPG values. These results strongly support and further define the EPG distributions seen in cattle raised under commercial conditions. In addition, upon re-exposure, cattle of the first 2 types show low EPG values, while the high EPG calves remain susceptible.

Immunity against the parasites functions in 2 ways. Within 4 months of initial exposure, cattle may become resistant to reinfection by the intestinal worm Cooperia. In contrast, 4 months is an insufficient time for the cattle to become refractory to the establishment of Ostertagia, but they do reduce the number of eggs passed by the parasites, and as such can reduce the intensity of transmission of the parasite. Because Ostertagia is the more economically important parasite, studies of specific anti-parasite immune responses have focused on it. Ostertagia infections are very potent stimulators of the bovine immune system. In susceptible cattle the local lymphoid organs (abomasal lymph nodes) are greatly enlarged. This enlargement is directly correlated with parasite numbers, and may result in as much as a 50 fold increase in the size of the lymph nodes. As the lymph nodes enlarge, the normal ratio of the different lymphocyte subpopulations is disturbed. In a normal abomasal lymph node, T and B lymphocytes exist in an approximate 60:40 ratio. As Ostertagia numbers increase, the ratio of T lymphocytes decreases, and there is a concomitant increase in the percentage of B lymphocytes.

Current studies are focused upon the identification of factors that influence the ability of cattle to become immune to the parasites, and the definition of the immune mechanisms that are responsible for protective immunity. The cattle selected for high and low EPG values are central to these studies as they will allow the identification of protective versus non-protective immune responses. In addition, studies have been initiated to identify the genes that are important in immunity to the parasites, and to place the candidate genes in the linkage map of the bovine genome. Finally, efforts are underway to identify genetic or physiologic markers which will rapidly and cheaply define resistant and susceptible cattle.

Application of this technology:

With the exception of arid regions of the US, GI nematodes can be a serious constraint on the efficient raising of cattle on pastures. To date these losses have been minimized by the extensive, albeit costly use of modern anthelmintics. In the future additional means to control the parasites will become increasingly important. Anthelmintic resistance to all currently used classes of anthelmintics has been reported throughout the world including the US in other ruminant species. Anthelmintic resistance in cattle nematodes is less common (Craig, 1993), but many experts feel that substantial anthelmintic resistance by cattle parasites is present in a number of countries. In addition, American consumers are becoming increasingly concerned over potential drug residues in their food and in the environment. That some of the newest anthelmintics may pose environmental threats has been extensively explored (for review see Herd et al., 1993). Also, the increasing costs associated with the development of new classes of drugs has caused many of the pharmaceutical companies to severely limit new drug discovery and licensing. Finally, the efforts towards more intensive grazing patterns that more fully utilize forage may intensify the potential for parasite exposure and thus entail heavier anthelmintic usage. Given these considerations, it will be important that future parasite control programs more efficiently use existing drugs and develop adjuncts to drug control whenever feasible.

One potential adjunct to current methods is the use of the bovine immune system and the bovine genome to control losses due to parasites. Because a few animals in the herd are responsible for the bulk of parasite transmission, these animals should be the focus of control procedures. The key to the use of such systems will be the rapid and inexpensive identification of these animals. As we develop these identification protocols, it will become feasible to selectively treat only the high EPG animals. Such treatment could encompass removal of the animals from the herd if there are no compelling reasons to keep the animals. Another approach is to selectively drug treat these susceptible cattle. Such treatment would be advantageous because it would cost between one-fourth and one-sixth that of treating the entire herd. Such treatment would yield approximately the same effect (Anderson and May, 1989), and it would also avoid placing the strong selective pressure for anthelmintic resistance on the parasites that treatment of 100% of the animals exerts. Finally, as we gain more information on the nature of the protective immune responses, susceptible cattle will become better targets for immunotherapeutic programs, such as vaccination or immuno-enhancement with immune modulators. Such treatments will likely be relatively expensive, and thus impractical for use in the entire herd. As the tools become available for the development of these procedures it will be necessary to modify current management programs from those which are solely dependent of heavy drug usage to more integrated pest management programs that will ensure the continued efficiency of American cattle production while enhancing the sustainability of agricultural practices.

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MIXED MODEL METHODS TO ESTIMATE BREED COMPARISONS FOR GROWTH AND MATERNAL TRAITS ADJUSTED TO A 1993 BASE

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INTRODUCTION

Breed means adjusted for genetic trend and sire sampling using data from the Germplasm Evaluation (GPE) program at the U. S. Meat Animal Research Center (MARC) were reported by Notter and Cundiff (1991), Nuñez-Dominguez et al. (1993), and Cundiff (1993). The 1994 report (Barkhouse, et al., 1994) used a sire model to estimate breed contrasts. Barkhouse et al. (1995) added a dam effect to account for merit of mates. This report is an update of previous reports using mixed model methods and EPDs from the most recent breed evaluations to adjust MARC breed means to a 1993 all animal (non-parent) basis.

The current analysis differs from the first analyses in that mixed model procedures, not least squares analyses, were used to obtain MARC breed means. The models for direct genetic effects included random sire and random mate (dam) effects. The model for maternal genetic effects included random maternal grandsire and daughter within maternal grandsire effects. Weaning weight was calculated at 205 days rather than at 200 days as in analyses prior to 1994. Several Brahman sires and maternal grandsires were added this year. The EPDs for 12 Angus sires (maternal grandsires) were not available this year in contrast to last year. One Polled Hereford bull born in 1971 had an EPD for the first time. He had 38 progeny and 14 daughters with 71 grand progeny in the MARC data. An EPD from the breed association is required to include progeny records in the MARC analysis. Breed solutions to mixed model equations were constrained to be differences from Angus. The raw Angus means were added to construct the equivalent of least squares means. Equivalent tables of differences from Angus are listed as a basis for discussion.

MATERIALS AND METHODS

Analysis of direct genetic effects on birth weight, weaning weight, and yearling weight of F_1 progeny. Data from MARC were obtained on F_1 calves by 13 sire breeds mated to Hereford, Angus or MARC III composite dams. Edits to the data resulted in 4,703 records for birth weight (BWT), 4,241 records for 205-day weight (WWT), and 3,917 records for 365-day weight (YWT). Only records of progeny of sires with breed association EPD were analyzed. Progeny of pure breed matings were excluded as were records of progeny of Polled by Horned Hereford matings. Table 1 shows the number of sires with WWT EPDs and the number of F_1 progeny weaned.

Two analyses, similar to those outlined by Notter and Cundiff (1991), were performed. The objective of the first analysis was to obtain MARC sire breed means for BWT, WWT, and YWT. A mixed model was used with fixed effects for breed of dam (Hereford, Angus, MARC III), birth year (1970-76, 86-90, 92-93), sex of calf (heifer, steer), age of dam (2, 3, 4, or $\geq$ 5 yr), breed of sire, and a fixed covariate for Julian birth date. Random effects for sires nested within sire breeds, and dams nested within breed of mate were included in the model. Sire breed means at MARC were obtained from solutions to the mixed model equations after jointly estimating variance components due to sire, dam, and residual effects with the MTDFREML package (Boldman et al., 1993). Angus breed of sire effects were constrained to zero. The raw mean for Angus-sired progeny was added to the solutions to demonstrate relative body weights.

The objective of the second analysis was to obtain the regressions of calf performance (BWT, WWT, YWT) on sire EPD. The model included the previous fixed effects as well as a term for the regression of calf performance on the sire EPD reported by the corresponding breed association. Pooled regressions of calf performance on sire EPD were used to adjust sire breed means at MARC from the mixed model analysis to a 1993 base as follows (Notter and Cundiff, 1991) for each breed of sire:

$$\text{Adjusted 1993 breed mean (i)} = \text{MARC(i)} + b[\text{EPD(i)}_{1993} - \text{EPD(i)}_{MARC}] \qquad [1]$$

where,

MARC(i) = estimate of the i^{th} breed mean obtained from mixed model analysis,

b = pooled regression coefficient of calf performance on sire EPD (lb/lb) obtained from the fixed effects analysis including sire EPD as a regression variable, (1.11 for BWT, .91 for WWT, and 1.29 for YWT),

EPD(i)_{1993} = average EPD for all animals of breed i born in 1993, and

EPD(i)_{MARC} = average EPD of bulls of breed i having progeny recorded at MARC weighted by number of progeny at MARC.

Analysis of maternal genetic effects on direct weaning weight and milk of 3-breed-cross progeny. Edited data for weaning weight (MWWT, n=6577) from top cross progeny obtained from pasture mating of purebred sires (mostly Charolais) to F_1 cows produced by the 13 maternal grandsire breeds and three maternal granddam breeds (Hereford, Angus, MARC III composite) were used in analyses similar to those described above to estimate maternal grandsire breed effects as a step in estimating breed effects for milk. The first analysis used a mixed model which included fixed effects for cycle (C; 1-5), cow age (A; 2, 3, 4, ≥ 5), CxA, birth year nested within CxA, sex of calf, breed of maternal granddam (MGD line), breed of maternal grandsire (MGS line), and breed of sire nested within CxA, and random effects for maternal grandsires (MGS) nested within MGS breed and for daughters nested within MGS. Solutions for maternal grandsire breeds means at MARC were obtained from the mixed model equations after jointly estimating components of variance. As with direct breed effects, Angus solutions were constrained to be zero and the raw Angus mean added to those solutions.

The second analysis included pooled regressions of calf performance on EPDs for both weaning weight and milk of the MGS. Pooled regressions of calf performance were used to adjust the MWWT means at MARC to a 1993 base as follows for each breed of maternal grandsire:

$$\text{Adjusted 1993 MWWT(i)} = \text{MARC(i)}_{MGS} + b_{WW}[\text{WWT EPD(i)}_{1993} - \text{WWT EPD(i)}_{MARC}] + b_{MILK}[\text{Milk EPD(i)}_{1993} - \text{Milk EPD(i)}_{MARC}] \quad [2]$$

where,

MARC(i)_{MGS} = estimate of the i^{th} MGS breed mean obtained from the mixed model analysis,

b_{WW} = .51, the pooled regression of calf weaning weight on WWT EPD of the MGS,

b_{MILK} = 1.21, the pooled regression of calf weaning weight on Milk EPD of the MGS,

WWT EPD(i)_{1993} = average WWT EPD for all animals of breed i born in 1993,

WWT EPD(i)_{MARC} = average WWT EPD of bulls of breed i having grand progeny recorded at MARC weighted by number of grand progeny at MARC,

$\text{MILK EPD(i)}_{1993}$ = average MILK EPD for all animals of breed i born in 1993,

and

$MILK\ EPD(i)_{MARC}$ = average MILK EPD of bulls of breed i having grand progeny recorded at MARC weighted by number of grand progeny at MARC.

Adjusted means for maternal milk were obtained as follows:

$$\text{Adjusted milk (i)} = [MWWT_{adj}(i) - MWWT_{adj}] - .5[WWT_{adj}(i) - WWT_{adj}]$$

where, as obtained from equations [1] and [2],

$MWWT_{adj}(i)$ = mean maternal weaning weight adjusted to a 1993 base for the i^{th} breed (equation [2]),

$MWWT_{adj}$ = mean maternal weaning weight adjusted to a 1993 base over the 13 breeds (unweighted),

$WWT_{adj}(i)$ = direct weaning weight mean adjusted to a 1993 base for the i^{th} breed (equation [1]), and

WWT_{adj} = direct weaning weight mean adjusted to a 1993 base over the 13 breeds (unweighted).

RESULTS AND DISCUSSION

Mean EPDs of sires (BWT, WWT, YWT) and maternal grandsires (MWWT,MILK) from the most recent breed association evaluations of the MARC sires as well as mean 1993 EPDs (all animal, non-parent) are shown in Table 2 by breed. The 1993 means were generally larger than the MARC EPDs except for most traits for Maine Anjou and Salers. Note that progeny of 12 Angus bulls with records in the 1994 report were excluded because of lack of EPD and that the number of Brahman sires with EPDs increased from 18 to 26 for the direct analysis and from 6 to 19 for the maternal analysis. The number of Pinzgauer bulls with progeny increased from 11 to 16 and those with grand progeny from 11 to 15. The number of Polled Hereford MGS increased from 21 to 26. One of those bulls had 38 progeny and 71 grand progeny with records at MARC. Average BIF accuracies for EPD of bulls weighted by number of progeny and grand progeny at MARC are shown by breed in Table 3.

MARC sire breed means obtained from the mixed model analyses are shown in Tables 4a and 4b. Rankings were similar to those reported by Cundiff et al. (1986) and Nuñez-Dominguez et al. (1993).

Pooled regression coefficients of calf BWT, WWT, and YWT on respective sire EPD's were 1.11 ± .07, 0.91 ± .08, and 1.29 ± .07, respectively. These regression coefficients are similar to those reported (Notter and Cundiff, 1991; Nuñez-Dominguez et al., 1993; Cundiff, 1993; and Barkhouse et al., 1994). As in previous years, the pooled YWT regression was significantly different from the expected value of 1.0 ($P < .05$). The tests for homogeneity of regressions across sire breeds were generally not significant, but the tests for homogeneity of regressions between dam breeds were significant for WWT and YWT, and also between sexes for YWT (see Table 10). In contrast to results reported by Nuñez-Dominguez et al. (1993) and Barkhouse et al. (1994), heifers (1.3) and steers (1.2) had similar regressions for YWT as well as for BWT and WWT. Pooled regression coefficients for calf weaning weight on direct WWT and MILK EPDs of the MGS were .51 ± .06 and 1.21 ± .09, respectively. These estimates are similar to previous estimates (Notter and Cundiff, 1991; Nuñez-Dominguez et al., 1993; Cundiff, 1993; and Barkhouse et al., 1994), but are not significantly different from their theoretical values (.5 and 1.0, respectively). Table 11 presents regressions by breed of maternal grand sire.

MARC sire breed means adjusted to a 1993 base shown in Tables 5a and 5b generally increased with adjustment for trend and sires sampled at MARC.

The adjusted means can be used to calculate adjustment factors (Table 6) to calculate across breed EPDs (see Cundiff, 1994):

$A_j = (M_j - M_b) - [EPD(i)_{1993} - EPD(b)_{1993}]$,

where,

A_j = adjustment factor to add to EPD of a bull of j^{th} breed,

M_j = adjusted 1993 breed mean (j) (equation [1] or [2]),

M_b = adjusted 1993 base breed (b) mean (equation [1] or [2]),

$EPD(i)_{1993}$ = average EPD for all breed i animals born in 1993, and

$EPD(b)_{1993}$ = average EPD for all base breed animals born in 1993.

Estimates of variance components are shown in Table 8. The estimates for the sire component of variance decreased by about 25% as compared to 1994 when the dam effect was not in the model. The dam component of variance was in all cases larger than the sire component. The estimates of variance components for the maternal analyses were similar to those reported last year.

Variances of across breed EPDs. Two alternatives for calculating differences in progeny expected for pairs of bulls of different breeds are: 1) add the difference in within breed EPDs to the difference in adjusted breed means from Table 6, and 2) add the difference in within breed EPDs to the difference from the base breed in Table 6. The prediction error variance for the first case can be approximated as shown by Van Vleck and Cundiff (1994) from the variance of the breed contrast from the mixed model analysis of MARC progeny after accounting for adjustment for trends. These adjustments for variances of mixed model contrasts are shown in Table 7 using variances estimated from MARC data and used in estimating breed means (Table 8). Tables 9a and 9b show the variances due to breed differences to be added to the within breed prediction error variances for a pair of bulls of different breeds. The standard error of prediction of the difference expected in progeny of the two bulls is the square root of that sum. With the alternative of a base breed, an easily applied procedure is to add the variance of the adjusted difference from the base breed to the within breed prediction error variance of each bull (Van Vleck, 1994); that is, each bull will have a total prediction error variance much as is usually done within breed. Bulls of the base breed will not have anything added to the prediction error variance within the base breed. This procedure needs to use the entries from the column and row for the base breed. For example, if a Polled Hereford bull has PEV of 300 for YWT, then the PEV for his EPD as a difference from an Angus bull with zero EPD is calculated as 51.3 + 300 = 351.3 with corresponding standard error of prediction, 18.7.

A similar approximation for the PEV for milk has now been developed (Van Vleck, to be published). The adjustments are shown in the right column of Table 7. In contrast to BWT, WWT, and YWT, for which the adjustment is negative, the adjustment for MILK is positive, although not very large except for Tarentaise, a breed with only 6 maternal grandsires included in the MARC analysis.

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Table 1. Number of sires and maternal grandsires (MGS) having weaning weight EPDs and number of progeny and grand progeny weaned

Breed	Direct		Maternal	
	Sires	F_1 progeny	MGS	Top-cross progeny
P. Hereford	30	414	26	465
Hereford	36	400	26	560
Angus	56	464	38	424
Shorthorn	25	170	22	255
Brahman	26	334	19	218
Simmental	27	366	27	796
Limousin	20	338	20	764
Charolais	60	483	54	854
Maine-Anjou	15	155	14	357
Gelbvieh	24	336	24	644
Pinzgauer	16	415	15	545
Tarentaise	7	191	6	341
Salers	26	175	24	354
Total	368	4241	315	5777

Table 2. Mean EPDs (lb) of sires used at MARC and mean EPDs of all animals born in 1993 from most recent evaluation for each breed[a]

	BWT		WWT		YWT		MILK	
Sire breed	1993	MARC	1993	MARC	1993	MARC	1993	MARC
P. Hereford	3.10	2.84	23.4	13.9	39.5	25.2	6.3	1.6
Hereford	3.10	0.68	24.8	8.3	42.1	13.0	10.1	-1.2
Angus	3.20	2.82	24.9	19.1	41.6	30.9	10.3	2.9
Shorthorn	2.00	1.01	13.0	8.0	20.6	15.5	3.0	8.1
Brahman	1.06	1.01	8.3	6.1	14.2	9.0	4.0	2.0
Simmental	0.40	-0.37	7.1	-15.5	12.2	-26.1	0.5	-1.2
Limousin	1.20	-0.76	6.5	-7.6	12.0	-11.5	0.4	.3
Charolais	1.58	1.48	9.0	1.2	13.5	3.3	1.0	1.5
Maine-Anjou	-0.10	1.07	0.7	2.8	1.0	4.3	-0.1	-1.4
Gelbvieh	0.20	-1.37	4.5	-2.8	8.5	-5.3	1.8	-.2
Pinzgauer	-0.10	-0.40	0.2	-6.1	0.8	-9.8	-0.5	3.6
Tarentaise	2.52	1.66	9.5	-4.9	15.2	-0.2	0.8	4.7
Salers	0.80	1.12	8.0	8.0	13.4	13.5	2.4	5.7

[a]Mean EPD for bulls at MARC are weighted by number of progeny or by the number of grandprogeny at MARC.

Table 3. Mean weighted accuracies for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), and milk (MILK) for bulls used at MARC

Breed	BWT	WWT	YWT	MILK
P. Hereford	.59	.60	.47	.37
Hereford	.60	.67	.58	.54
Angus	.79	.80	.72	.64
Shorthorn	.78	.77	.64	.74
Brahman	.53	.59	.38	.40
Simmental	.96	.96	.96	.96
Limousin	.96	.96	.93	.92
Charolais	.75	.75	.74	.72
Maine-Anjou	.38	.40	.21	.26
Gelbvieh	.68	.61	.55	.64
Pinzgauer	.78	.68	.62	.63
Tarentaise	.96	.95	.94	.95
Salers	.82	.75	.61	.73

Table 4a. Estimates (lbs) of sire breed effects for birth weight (BWT), 205-day weight (WWT), 365-day weight (YWT), and maternal grandsire breed effects for 205-day weight (MWWT) from mixed model analyses of MARC records with raw Angus means added to solutions obtained with the Angus solution constrained to zero

Sire/MGS breed	BWT	WWT	YWT	MWWT[a]
P. Hereford	90.8	499	852	479
Hereford	90.4	490	843	490
Angus	86.4	493	854	492
Shorthorn	93.7	512	880	527
Brahman	100.3	520	828	542
Simmental	94.8	514	879	533
Limousin	90.8	501	842	495
Charolais	95.9	518	890	514
Maine-Anjou	97.5	515	883	529
Gelbvieh	93.0	519	872	534
Pinzgauer	93.0	502	849	520
Tarantaise	91.3	504	842	528
Salers	92.2	511	876	527

Table 4b. Estimates (lbs) of sire breed effects for birth weight (BWT), 205-day weight (WWT), 365-day weight (YWT), and maternal grandsire breed effects for 205-day weight (MWWT) from mixed model analyses of MARC records with the Angus solution constrained to zero

Sire/MGS breed	BWT	WWT	YWT	MWWT[a]
P. Hereford	4.4	6	-2	-13
Hereford	4.0	-3	-11	-2
Angus	0	0	0	0
Shorthorn	7.3	19	26	35
Brahman	13.9	27	-26	50
Simmental	8.4	21	25	41
Limousin	4.4	8	-12	3
Charolais	9.5	25	36	22
Maine-Anjou	11.1	22	29	37
Gelbvieh	6.6	26	18	42
Pinzgauer	6.6	9	-5	28
Tarantaise	4.9	11	-12	36
Salers	5.8	18	22	35

[a]Maternal grandsire breed effects.

Table 5a. Sire and maternal grandsire breed means (lb) from mixed model analyses of MARC records adjusted for genetic trend to 1993 mean EPDs

				Maternal	
Breed	BWT	WWT	YWT	MWWT	MILK
P. Hereford	91.1	508	871	497	-23.0
Hereford	93.1	505	881	515	-3.6
Angus	86.8	498	868	509	-5.7
Shorthorn	94.8	517	886	523	-.6
Brahman	100.4	522	834	547	20.9
Simmental	95.7	535	928	547	13.8
Limousin	93.0	514	872	502	-20.1
Charolais	96.0	525	904	518	-10.1
Maine-Anjou	96.2	513	879	530	8.2
Gelbvieh	94.7	526	889	540	11.9
Pinzgauer	93.3	507	862	517	-2.1
Tarentaise	92.3	517	862	531	6.8
Salers	91.8	511	876	524	2.7

Table 5b. Sire and maternal grandsire breed means (lb) from mixed model analyses of MARC records adjusted for genetic trend to 1993 mean EPDs as a difference from Angus

				Maternal	
Breed	BWT	WWT	YWT	MWWT	MILK
P. Hereford	4.3	10	3	-12	-17.3
Hereford	6.3	7	13	6	2.1
Angus	0	0	0	0	0
Shorthorn	8.0	19	18	14	5.1
Brahman	13.6	24	-34	38	26.6
Simmental	8.9	37	60	38	19.5
Limousin	6.2	16	4	-7	-14.4
Charolais	9.2	27	36	9	-4.4
Maine-Anjou	9.4	15	11	21	13.9
Gelbvieh	7.9	28	21	31	17.6
Pinzgauer	6.5	9	-6	8	3.6
Tarentaise	5.5	19	-6	22	12.5
Salers	5.0	13	8	15	8.4

Table 6. Factors (lb) to adjust within breed EPDs to Angus base[a]

Breed	BWT	WWT	YWT	MILK
P. Hereford	4.4	12.5	5.1	-13.3
Hereford	6.4	7.1	12.5	2.3
Angus	0	0	0	0
Shorthorn	9.2	30.9	39.0	12.4
Brahman	15.7	40.6	-6.6	32.9
Simmental	11.7	54.8	89.4	29.3
Limousin	8.2	34.4	33.6	-4.5
Charolais	10.8	42.9	64.1	4.9
Maine-Anjou	12.7	39.3	51.9	24.3
Gelbvieh	10.9	48.4	54.1	26.1
Pinzgauer	9.8	33.7	34.8	14.4
Tarentaise	6.2	34.4	20.4	22.0
Salers	7.4	29.9	36.2	16.3

[a]Table 5a or 5b difference from Angus minus 1993 mean EPD difference from Angus from Table 2.

Table 7. Adjustments (lb^2) for variances of adjusted breed means due to accuracy of EPDs and number of bulls at MARC having EPDs

Breed	BWT	WWT	YWT	MILK
P. Hereford	-.28	-3.76	-15.28	4.81
Hereford	-.18	-3.96	-11.73	4.97
Angus	-.17	-2.63	-10.92	4.18
Shorthorn	-.43	-5.95	-25.77	4.35
Brahman	-.31	-4.73	-17.56	5.48
Simmental	-.35	-5.88	-24.26	5.01
Limousin	-.45	-7.33	-30.36	6.54
Charolais	-.12	-2.08	-8.11	1.81
Maine-Anjou	-.40	-5.59	-17.84	2.80
Gelbvieh	-.32	-4.36	-16.43	4.59
Pinzgauer	-.58	-8.49	-34.69	8.33
Tarentaise	-.57	-12.55	-32.39	35.54
Salers	-.43	-5.72	-24.68	3.70

Table 8. REML estimates of variance components (lb^2) for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), and maternal weaning weight (MWWT) from mixed model analyses

			Direct	Maternal
Analysis	BWT	WWT	YWT	MWWT
Direct				
Sire within breed	11.3	148	753	
Dam within breed	32.1	1128	1590	
Residual	67.6	1558	4249	
Maternal				
MGS within MGS breed				182
Dam within MGS				828
Residual				1243

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

	PH	HH	AN	SH	BR	SI	LI	CH	MA	GE	PI	TA	SA
PH	.0	.9	.7	1.3	.8	1.4	1.5	1.0	2.1	1.3	1.2	2.8	1.3
HH	68.0	.0	.8	1.2	1.0	1.2	1.2	.8	2.0	1.1	1.1	2.8	1.1
AN	51.3	61.2	.0	1.1	.7	1.2	1.3	.8	2.0	1.1	1.1	2.7	1.1
SH	93.4	88.1	81.9	.0	1.5	1.6	1.7	1.1	2.3	1.3	1.4	3.1	1.1
BR	71.1	86.8	65.6	117.4	.0	1.6	1.6	1.2	2.2	1.4	1.2	2.8	1.4
SI	97.9	87.8	85.8	115.2	120.8	.0	.8	.8	2.4	1.6	1.5	3.2	1.6
LI	100.0	89.2	87.8	118.0	122.5	57.9	.0	.9	2.5	1.6	1.6	3.3	1.6
CH	70.3	61.6	58.7	74.9	92.7	58.3	61.2	.0	2.0	1.1	1.1	2.8	1.0
MA	151.9	146.9	143.6	167.3	172.8	173.7	175.5	145.3	.0	1.6	2.1	3.8	2.3
GE	91.5	85.2	82.4	95.9	110.7	111.2	112.1	76.8	119.5	.0	1.2	3.0	1.3
PI	87.0	84.5	80.2	101.0	96.7	112.3	114.5	80.7	158.0	94.0	.0	2.5	1.3
TA	198.8	197.8	193.6	222.8	203.9	226.7	229.6	199.0	270.1	212.9	175.7	.0	3.1
SA	91.4	85.4	80.3	81.4	115.5	113.5	116.2	73.3	165.4	94.7	100.6	221.2	.0

[a]For example, a Polled Hereford bull has within breed PEV of 300 for YWT and that for a Shorthorn bull is 200. Then the PEV for the difference in EPDs for the two bulls is 93.4 + 300 + 200 = 593.4 with SEP = 24.4.

9b. Variances (lb^2) of adjusted breed differences to add to sum of within breed prediction error variances to obtain variance of difference of across breed EPDs for bulls of two different breeds. Weaning weight direct above diagonal and milk (weaning weight) below the diagonal

	PH	HH	AN	SH	BR	SI	LI	CH	MA	GE	PI	TA	SA
PH	.0	18.3	16.0	30.5	18.5	29.3	30.1	21.5	44.7	27.0	23.1	47.1	29.8
HH	61.6	.0	17.4	27.5	21.8	24.9	25.5	17.5	41.8	23.7	21.4	45.7	26.5
AN	61.9	59.8	.0	27.7	17.8	26.4	27.1	18.8	43.0	25.0	22.1	46.6	27.1
SH	76.4	70.8	69.0	.0	36.0	37.3	38.3	25.7	52.6	31.1	31.4	58.4	28.3
BR	82.5	86.9	82.3	104.6	.0	34.1	34.8	26.3	49.2	30.8	23.6	46.6	35.2
SI	74.7	64.4	65.9	83.5	103.1	.0	16.6	16.5	52.8	33.6	32.3	57.5	36.5
LI	78.6	68.2	70.2	87.7	107.0	50.2	.0	17.6	53.3	33.8	33.1	58.5	36.6
CH	54.7	46.4	46.4	58.3	82.8	42.1	46.3	.0	44.4	23.6	23.4	49.5	25.0
MA	92.2	87.1s	87.9	103.2	119.5	102.9	106.9	82.2	.0	33.1	45.7	70.6	51.9
GE	65.2	59.8	58.8	69.4	92.5	73.6	77.6	50.7	70.4	.0	26.6	53.2	30.6
PI	73.6	70.2	70.7	83.5	87.5	85.6	89.7	63.9	101.8	73.1	.0	38.6	31.2
TA	143.9	141.2	142.7	159.3	151.7	158.1	162.2	137.8	172.9	146.6	133.7	.0	57.8
SA	68.4	62.8	61.8	65.7	96.9	76.1	80.2	50.9	95.6	62.0	76.4	151.7	.0

Table 10. 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

	BWT	WWT	YWT
Pooled	1.11 ± .07	.91 ± .08	1.29 ± .07[a]
Sire breed			
P. Hereford	1.3 ± .1[a]	1.0 ± .1	1.2 ± .1
Hereford	1.0 ± .2	.8 ± .2	1.3 ± .2
Angus	.8 ± .2	.6 ± .2	1.4 ± .2
Shorthorn	.7 ± .5	.3 ± .5	.9 ± .4
Brahman	1.5 ± .3	.9 ± .3	.7 ± .3
Simmental	1.4 ± .3	1.0 ± .3	1.5 ± .3
Limousin	1.2 ± .4	1.3 ± .5	2.1 ± .5[a]
Charolais	1.2 ± .2	.8 ± .2	1.3 ± .2
Maine-Anjou	.3 ± .5	.6 ± .6	.9 ± .8
Gelbvieh	.7 ± .3	.7 ± .5	.9 ± .3
Pinzgauer	1.2 ± .2	1.3 ± .2	1.5 ± .2[a]
Tarentaise	.9 ± .9	.8 ± .7	1.5 ± .9
Salers	1.0 ± .4	.9 ± .6	1.2 ± .6
Dam breed			
Hereford	1.1 ± .1	.4 ± .1[a]	1.0 ± .1
Angus	1.3 ± .1[a]	1.1 ± .1	1.4 ± .1[a]
MARC III	.8 ± .2	.9 ± .2	1.4 ± .2
Sex of calf			
Heifer	1.1 ± .1	.9 ± .1	1.3 ± .1[a]
Steer	1.1 ± .1	.9 ± .1	1.2 ± .1

[a] Significantly different from theoretical regression coefficient of 1.0 ($P \leq .05$).

Table 11. Pooled regression coefficients (lb/lb) for progeny performance on sire EPD for weaning weight (WWT) and milk (MILK) and by breed of maternal grandsire, breed of maternal grandam, and sex

Type of regression	WWT	MILK
Pooled	.51 ± .06	1.21 ± .09[a]
Breed of maternal grandsire		
P. Hereford	.85 ± .12	.56 ± .28
Hereford	.43 ± .19	1.32 ± .24
Angus	.40 ± .26	1.34 ± .36
Shorthorn	.52 ± .34	.68 ± .38
Brahman	1.97 ± .44[a]	1.16 ± 1.36
Simmental	.48 ± .22	1.20 ± .63
Limousin	.74 ± .34	2.52 ± .34[a]
Charolais	.05 ± .18[a]	.83 ± .25
Maine-Anjou	-.10 ± .41	.78 ± .84
Gelbvieh	.64 ± .30	1.35 ± .37
Pinzgauer	.48 ± .15	.39 ± .36
Tarentaise	.18 ± .72	.77 ± .82
Salers	1.02 ± .35	2.53 ± .34[a]
Breed of maternal grandam		
Hereford	.31 ± .10[a]	1.24 ± .15
Angus	.60 ± .07	1.20 ± .12
MARC III	.78 ± .47	-.48 ± 1.29
Sex of calf		
Heifer	.47 ± .08	1.32 ± .13[a]
Steer	.56 ± .08	1.12 ± .13[a]

[a]Significantly different from theoretical regression coefficient ($P \leq .05$).

ASSIGNMENT OF RISK TO ACROSS-BREED EPDs WITH TABLES OF VARIANCES OF ESTIMATES OF BREED DIFFERENCES

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Prediction Error Variance and Standard Error of Prediction for a Bull

A basic principle of genetic evaluation is that only differences in breeding values can be estimated, i.e., differences in expected progeny differences (EPDs) for pairs of bulls. For within-breed national cattle evaluations, this concept has been simplified to the difference between a bull and an average bull for the breed. One advantage of this simplification is that the variance of prediction error between the PD for a bull and an average bull depends only on the accuracy of the evaluation of the bull because the variance of prediction error for the average of all bulls is essentially zero.

Thus, the prediction error variance, that is, the variance of (true PD - EPD) is $PEV = (1 - r_{BIF})^2\sigma_s^2$ where r_{BIF} is BIF accuracy defined as $1 - (PEV/\sigma_s^2)^{.5}$ and σ_s^2 is the sire component of variance or variance of PD. The squareroot of PEV is the standard error of prediction, $SEP = (1 - r_{BIF})\sigma_s$ which can be used to establish confidence ranges around the EPD. This formula shows that $(1 - r_{BIF})$ is proportional to SEP and so as r_{BIF} becomes close to perfect (=1), the SEP goes to zero. In other words, r_{BIF} is a logical measure of risk of a bull with an EPD expressed as a difference from the average of bulls of the breed.

Standard Error of Prediction for Progeny of Two Bulls of Same Breed

The prediction error variance between two bulls, however, is more complicated as both bulls have prediction errors associated with their EPDs. The SEP for the progeny difference between bulls 1 and 2 of the same breed is:

$$SEP = \sqrt{(1 - r_{BIF_1})^2 + (1 - r_{BIF_2})^2}\ \sigma_s.$$

This expression does not simplify very well unless $r_{BIF_1} = r_{BIF_2} = r_{BIF}$

In the equal BIF accuracy case

$$SEP = \sqrt{2\,(1 - r_{BIF})^2}\ \sigma_s = \sqrt{2}(1 - r_{BIF})\ \sigma_s.$$

The factor of 2 comes from predicting the difference between progeny of one bull and progeny of another.

Standard Error of Prediction of Progeny of Two Bulls of Different Breeds

For the across-breed comparison of two bulls, the estimate of the difference between breed effects is added to the difference in within-breed EPDs of the two bulls. The difference in breed effects comes from the across breed table (Table 6 of the previous paper) which is the breed difference estimated from records of MARC animals adjusted by within-breed EPD of their sires to a 1993 base and then to the base used in the Angus evaluation.

For example, suppose the WWT EPD of a Simmental bull is +25 and the WWT EPD of a Pinzgauer bull is +20. Then the predicted difference between progeny of the two bulls is $(A_{SIM} - A_{PIN}) + (EPD_{SIM} - EPD_{PIN}) = (54.8 - 33.7) + (25 - 20) = 21.1 + 5.0 = 26.5$ where A_{SIM} and A_{PIN} are the breed adjustment factors from Table 6. Progeny of the Simmental bull would be predicted to be 26.5 heavier at weaning than progeny of the Pinzgauer bull when mated to the same group of cows of another breed, e.g., to Hereford cows.

The standard error of prediction for across-breed EPDs will include a portion of variance due to estimating the breed differences between Simmental and Pinzgauer in addition to the errors due to predicting the within-breed EPDs for the two bulls. Suppose that the BIF accuracies are .75 for the Simmental bull and .50 for the Pinzgauer bull. Now σ_s is also needed. From the MARC analyses, σ_s was $\sqrt{148} = 12.2$ (see Table 8 of previous paper).

The across-breed prediction error variance is

$PEV = V(A_{SIM} - A_{PIN}) + PEV(EPD_{SIM} - EPD_{PIN})$ and SEP will be the squareroot of PEV.

The $V(A_{SIM} - A_{PIN})$ component comes from an above diagonal element of Table 9b of the previous paper at the intersection of the Simmental row and the Pinzgauer column, 32.3. The second component works the same way as for two bulls of the same breed so that

$$PEV(EPD_{SIM} - EPD_{PIN}) = \left[(1 - r_{BIF_{SIM}})^2 + (1 - r_{BIF_{PIN}})^2\right]\sigma_s^2$$

$$= [1 - .75)^2 + (1 - .50)^2]\,12.2^2 = [.0625 + .25]\,(148) = 46.25.$$

The across breed PEV is 32.3 + 46.25 = 78.55. The across breed SEP is $\sqrt{78.55} = 8.9$

Confidence Ranges from SEP of Progeny Differences

The slightly more complicated stuff now begins. The difference in expected progeny of the two bulls is 26.5 and the SEP is 8.9 which corresponds to a 68% confidence range, i.e., there is a 68% chance the true progeny difference will be in the range of 26.5 - 8.9 = 17.6 to 26.5 + 8.9 = 35.4. The true progeny difference has a 16% chance of being greater than 35.4. The chance is also 16% that the true progeny difference is less than 17.6. A 90% confidence range would use ± 1.65 (8.9) = ± 14.7 to establish the lower (26.5 - 14.7 = 11.8) and upper (26.5 + 14.7 = 41.2) bounds. Then 5% would be the chance of the progeny difference being greater than 41.2 as well as of being less than 11.8.

If the estimation of breed differences is ignored, the incorrect PEV would be 46.25 with SEP of 6.8. In this case, ignoring the estimation of the breed adjustment factors does not change the SEP very much because the adjusted breed differences are estimated quite accurately.

Prediction error variances and standard errors of prediction for BWT and YWT can be worked out similarly using entries from Table 9a and the corresponding variances of sire effects of 11.3 for BWT and 753 for YWT from Table 8.

Standard Error of Prediction for MILK

Prediction error variances for MILK EPD can be obtained similarly as well. The steps to arrive at the variances of adjusted breed differences given in the lower triangular part of Table 9b are more complicated. That variance involves one-fourth of the variance of differences between breeds of sire for weaning weight and the variance of differences between the same breeds of maternal grandsire for weaning weight plus adjustments to the variance due to correlations between the breed of sire and breed of grandsire effects and adjustments for genetic trend due to sires and maternal grandsires used at MARC based on their EPDs for weaning weight and for milk. The net result of those adjustments is the lower triangular part of Table 9b. The other necessary step is to determine the appropriate sire component of variance for MILK. The maternal grandsire component of variance shown in Table 8 also contains one-fourth of the sire component for direct weaning weight. Thus, the appropriate sire component for maternal MILK is 182 - 1/4(148) = 145.

For an example, suppose a Charolais bull has a MILK EPD of +10.0 with BIF accuracy of .80 and a Gelbvieh bull has a MILK EPD of +5.0 with BIF accuracy of .60. The expected progeny difference for the Charolais minus the Gelbvieh bull is:

$$EPD_{DIF} = (A_{CHA} - A_{GEL}) + (EPD_{CHA} - EPD_{GEL})$$

$$= (-4.4 - 17.6) + (10.0 - 5.0) = -22.0 + 5.0 = -17.0.$$

Thus, expected contribution of milk of daughters of the Charolais bull to the weaning weight of their calves is less than that for daughters of the Gelbvieh bull by 17 lb. From the other way around, the daughters of the Gelbvieh bull would be expected to have heavier calves at weaning by 17 lb compared to calves of daughters of the Charolais bull due to maternal milk.

The standard error of prediction for this difference can be calculated as before. The prediction error variance is the variance of estimates of breed difference of 50.7 (from lower triangular part of Table 9b) + $[(1-.80)^2 + (1-.60)^2](145) = 50.7 + 29.0 = 79.7$ so that $SEP = \sqrt{79.7} = 8.9$. If the variance of the estimates of breed differences had been ignored, the SEP would have been $\sqrt{29.0} = 5.4$. Thus, even though the proportion of the PEV due to estimation of breed differences is larger than that due to both within-breed PEV, 50.7 vs 29.0, the net effect on SEP is not large, although SEP is underestimated if estimates of breed effects are ignored in the calculations. This does not mean, however, that the estimates of breed differences can be ignored in predicting the difference in milk for daughters of bulls of two breeds. In this case, the best prediction is -17.0. If breed differences had been ignored, the ranking would have been reversed as 10.0 - 5.0 = 5.0. The reversal would be due to the bias of -22.0 that would result from ignoring breed differences and different base years in the NCE for the two breeds.

What has been demonstrated is that the most appropriate measure of uncertainty or risk is the standard error of prediction for progeny or daughter (milk) performance of pairs of bulls. This SEP is increased somewhat due to variances of estimates of differences between breeds. For across-breed EPD there is no short-hand measure of risk, such as $1 - r_{BIF}$ for within-breed EPD.

LITERATURE CITED

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BIOTECHNOLOGY COMMITTEE MINUTES

June 2, 1995

The meeting of the Biotechnology Committee was convened by Chairman Burke Healey at 2:00 p.m. on Friday, June 2, 1995. Approximately 45 BIF members were in attendance when the meeting was called to order. After a few opening remarks, Chairman Healey introduced Dr. Jerry F. Taylor, Ph.D., Professor of Animal Science at Texas A & M University, College Station, Texas.

Dr. Taylor was the featured speaker for the session and his paper is included in the proceedings herein. Following the presentation and a short break, Chairman Healey reconvened the session and a lively question and answer session ensued, with members of the audience in the session questioning Dr. Taylor on a myriad of subjects pertaining to both his lecture and slide presentation.

Chairman Healey then passed out a draft for the Biotechnology section of the proposed revision for the BIF Guidelines. Healey explained that the Guidelines were being revised and that each section was being reviewed by the pertinent committee. Healey reported the draft as he was presenting it to the committee had been authored primarily by Dr. Sue DeNise, Ph.D. from Arizona University and Dr. Daniel Pomp, Ph.D. at Oklahoma State University, and it had also undergone additional review by several other authorities. Much discussion followed and several edits were suggested. In general, the committee members in attendance felt the section as proposed could be more positive. As a consequence, some edits of a more positive nature were made after a vote was taken by Healey on each proposed edit All the edits carried either unanimously or by overwhelming majorities. Healey was directed to present the final draft recommendation for the Biotechnology Section of the Guidelines to the BIF Executive Board of Directors as finalized at the meeting by the committee.

There being no further business to come before the committee, Chairman Healey adjourned the meeting at 4:30 p.m.

LOCALIZATION OF GENES INFLUENCING CARCASS MERIT IN A *BOS INDICUS* X *BOS TAURUS* CROSS

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Introduction

A major goal of livestock genomic research has been the positional cloning of economic trait loci (ETLs). The positional cloning of ETLs localized by linkage or interval analysis (HALEY and KNOTT 1992) requires: 1) the ability to target new polymorphisms to the interval bracketed by markers that contains an ETL, 2) a sufficient number of meioses within the resource families to identify individuals that are recombinant for new markers that lie closer to the ETL thus reducing the length of the interval containing the ETL, 3) the evaluation of the relationship between physical and genetic distances within this interval, and 4) the availability of large fragment DNA libraries to facilitate physical mapping and the construction of overlapping clones containing a contiguous stretch of DNA spanning the interval and containing the ETL.

At least three bovine gene maps suitable for localizing ETLs exist: the GenMark microsatellite/VNTR map now owned by American Breeders' Service (private); the microsatellite/SSCP map produced by USDA-MARC at Clay Center, Nebraska (BISHOP *et al.* 1994) and the microsatellite/RFLP map produced by an international bovine genome effort (BARENDSE *et al.*. 1994), and an additional 75 microsatellite markers have been developed in our laboratories at Texas A&M (AREVELO *et al.* 1994; HOLDER *et al.* 1994; BHEBHE *et al.* 1994; BURNS *et al.* 1995a,b,c; DAVIS and TAYLOR, unpublished results). The combined public markers provide a 20 cM microsatellite map with approximately 90% coverage of the bovine genome and the use of these maps has led to the rapid localization of ETLs, e.g., horn development (GEORGES *et al.* 1993a; BRENNEMAN *et al.* 1995), Weaver disease (GEORGES *et al.* 1993b), milk production (BOVENHUIS and WELLER 1994; GEORGES *et al.* 1995) and red/black coat color (KAPPES, TAYLOR and DAVIS, unpublished data).

This paper will describe the progress that we have made in localizing certain ETLs influencing carcass merit and growth to bovine chromosomes, including applications of our bovine large DNA fragment Bacterial Artificial Chromosome (BAC) library for the functional and positional cloning of these genes.

The Texas A&M University "Angleton" Project

Texas A&M University and the Texas Agricultural Experiment Station have dedicated the cattle and technical resources of the Angleton Research Station to the development of a resource herd segregating for genes responsible for variation in growth and carcass quality traits. A competitive grant from the Meat Board of the National Live Stock and Meat Board was awarded to develop a 20 cM genetic map based on microsatellite markers in these cattle families and to screen these markers for associations with ETLs associated with variation in carcass quality traits.

The Angleton Research Station has 218 Brahman x Hereford recipient cows producing backcross and F_2 progeny according to a double reciprocal backcross design from parents of two subspecies, Brahman (*Bos indicus*) and Angus (*Bos taurus*) by multiple ovulation and embryo transfer (MOET). The mating scheme includes four replicates of all possible reciprocal crosses (four Brahman, Angus, F_1 Angus x Brahman and F_1 Brahman x Angus bulls and donor cows, respectively). Cows are implanted up to three times per breeding season to maximize the conception rate. The average pregnancy rate per transfer from 392 transfers in 1993-94 was 57.9%. The MOET program is designed to run for five years to produce approximately 620 calves with 20 fullsibs per family. The project has now produced approximately 500 progeny and, of these, 249 have been slaughtered for carcass data. While all progeny will be slaughtered, DNA and tissue libraries will be maintained representing every animal involved in the breeding program to allow for additional analyses as new markers or phenotypic measures become available. Surplus embryos of each family have been stored to provide a resource for future studies. Table 1 contains a description of the structure of the families for the first 209 slaughter animals that was used for constructing the genetic maps and for interval mapping to localize the ETLs that are reported here.

The Angleton progeny are recorded for horn/polled status, coat color, coat speckling, structural, health, weight for age and growth characteristics. All progeny are carried through feedlot and carcass evaluation stages, with slaughter after about 150 days on feed. Carcass evaluation data are obtained at slaughter describing maturity, marbling, quality grade, yield grade, fat thickness, ribeye area, percentage kidney-pelvic-heart (KPH) fat and carcass weight. Tissue samples are brought to the Meats and Muscle Biology Laboratory at Texas A&M University for determination of extractable lipids, moisture content, protein content, collagen analysis, 9-10-11th rib dissection, Warner-Bratzler shear force, descriptive sensory analysis (taste panel), fragmentation index, calcium dependent protease analysis, sarcomere length, fatty acid and cholesterol composition of longissimus dorsi, and stearyl coA desaturase and fatty acid elongase activity in longissimus dorsi. We are also recording the following measures for intermuscular and subcutaneous adipose tissue: rates of incorporation of acetate, glucose, and palmitate; activity of fatty acid elongase and stearyl coA desaturase; fatty acid composition; cholesterol content; and cellularity.

The Angleton mapping families currently comprise 451 individuals from grandparent, parent and progeny generations. We have completed sex average and sex specific genetic maps of bovine chromosomes 1 - 6, 18, 21 and 23 spanning 806.9 cM or approximately 29% of the 2,800 cM bovine genome. These chromosomes are saturated to an average of 6.9 cM by 113 microsatellites and 4 protein markers. Our intent has been to align the recently published maps produced by the USDA Clay Center (BISHOP *et al.* 1994) and international consortium (BARENDSE *et al.* 1994) groups and to integrate the 75 microsatellites developed in our laboratories (see e.g., AREVELO *et al.* 1994; HOLDER *et al.* 1994; BHEBHE *et al.* 1994; BURNS *et al.* 1995a,b,c) into a single bovine genetic map. Our data for chromosome 23 have been contributed to the international BTA23 consortium formed at the 30th annual meeting of the International Society for Animal Genetics in Prague (July 25-28, 1994) and a consensus map of this chromosome has been completed (BEEVER *et al.* 1995). We have also scored 40 microsatellites spanning chromosomes 7, 8, 15 and the X chromosome and are currently in the process of constructing maps for these chromosomes. Finally, we have genotyped our families for 24 microsatellite and 12 blood group and isozyme loci which have yet to be incorporated into chromosome maps. For the purpose of screening for ETLs, we estimate that these 189 scored loci span approximately 1,900 cM or 68% of the bovine genome. In this process we confirm that the polled locus maps toward the centromere of chromosome 1 (BRENNEMAN *et al.* 1995) and in collaboration with the USDA Clay Center group we have now constructed a genetic map of the chromosome containing the red/black coat color locus and have developed markers flanking this locus at 1 cM and 11 cM (KAPPES, TAYLOR and DAVIS, unpublished data).

Table 1. Structure and breed composition of reciprocal backcross and F_2 *Bos indicus* x *Bos taurus* fullsib resource families

Population[a]	Family	Sire	Dam	No. of Progeny Male	No. of Progeny Female
(AB)A	1	U3065[d]	X18[b]	0	1
	1A	U3065	Z6[d]	9	4
	7	819X4[d]	T27[d]	4	5
(BA)A	2	2850[d]	X18	4	0
	2A	2850	Z6	5	2
	6	2855[d]	X26[d]	4	3
	8	58[b]	T27	1	9
B(AB)	10	1/8[d]	32T[b]	8	7
	12	57[d]	X3616[d]	9	1
	14	176[d]	X3713[d]	7	6
A(AB)	11	Independence[c]	X3616	4	1
	13	888020[d]	X3713	6	3
	15	Y6[d]	804/R2[c]	12	9
A(BA)	17	T5[d]	2853[d]	7	7
B(BA)	18	1/8	2853	8	4
(AB)B	25	U3065	5/6[d]	4	6
	28	2860[d]	613/5[d]	6	4
	31	819X4	748/7[b]	2	1
	37	U3065	748/7	0	1
(BA)B	26	2850	5/6[d]	4	5
	38	2850	617/5[b]	0	2
(BA)(AB)	34	2850	X3713	3	6
	36	2850	804/R2	9	6

[a]A = Angus, B = Brahman, AB and BA are Angus and Brahman sired F_1 crossbreds respectively. (AB)A denotes an Angus backcross produced by mating an AB sire to an A dam, etc.

[b]Neither parent genotyped.

[c]One parent genotyped.

[d]Both parents genotyped.

Figure 1 illustrates our sex-averaged genetic map of bovine chromosome 2. All maps were constructed by sequential use of the TWOPOINT, BUILD, FLIPS and CHROMPIC options of the general pedigree mapping software CRI-MAP V2.4 (GREEN *et al.* 1990) with genotypes from 280 individuals from the three generational Angleton resource families. The average number of informative meioses for the chromosome 2 microsatellites was 293 and with the sole exception of ARO28 the locus order for all loci is supported by a LOD score of at least 3.0. The map for chromosome 2 evidences our success in aligning the maps of BISHOP *et al.* (1994) and BARENDSE *et al.* (1994) and in integrating seven new microsatellites produced at Texas A&M University into the framework of a single map. In addition, we have shown that an unassigned linkage group in the map of BISHOP *et al.* (1994) comprising microsatellites OarFCB11, BM2113, BM4117, BM1223 and BM6444 maps to chromosome 2.

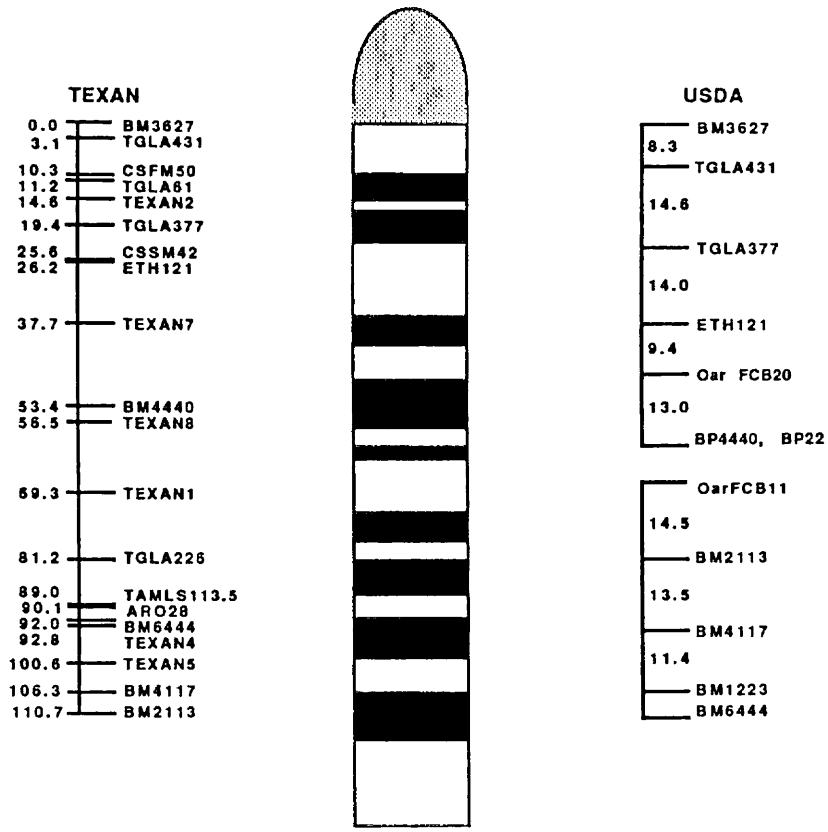

FIGURE 1: Angleton sex averaged genetic map of bovine chromosome 2.

The currently available number of slaughtered cattle provides sufficient statistical power to detect the presence of major genes responsible for differences between Angus and Brahman assuming these subspecies to be fixed for alternate alleles at the ETL of interest. The most powerful statistical approach to detect ETL is interval mapping (DARVASI *et al.* 1993; HALEY and KNOTT 1992, 1994; JANSEN 1993; JANSEN and STAM 1994; ZHENG 1994) which employs the method of maximum likelihood estimation utilizing all marker information on each chromosome to simultaneously estimate the map position of an ETL and the additive and dominance effects of the ETL for each phenotype. The weight of evidence supporting the presence of an ETL can be determined by the LOD score (logarithm base 10 of the ratio of likelihood assuming no ETL to the likelihood evaluated at the most likely position of an ETL on the chromosome), or equivalently, by application of the Neyman-Pearson likelihood ratio test (HALEY and KNOTT 1992).

We modified the algorithm of HALEY and KNOTT (1992) to utilize all phase known information in F_2 families and to use the Kosambi mapping function which allows for interference in recombination to screen for the presence of ETLs for seventeen postslaughter phenotypes on bovine autosomes 1 - 6, 21 and 23 in 209 slaughtered cattle. In our three generation pedigrees, the CHROMPIC output from CRI-MAP V2.4 provided the phase known genetic architecture of the maternally and paternally inherited chromosomes for each animal in the mapping population. The identification of recombination points on each chromosome in conjunction with the pedigree of each animal provided the basis for the construction of an identity by descent map for each chromosome and each animal (NELSON *et al.* 1993), from which we determined the breed of origin of each marker on the maternally and paternally inherited chromosomes. Accordingly, genotypes for each animal were identified as being AA, AB, BA or BB (where, e.g., AB denotes that an animal inherited an Angus allele on the maternally inherited chromosome and a Brahman allele on the paternally inherited chromosome) for each marker locus in the estimated gene order from the sex averaged genetic map for the chromosome. For each phenotype and chromosome, the likelihood ratio statistic is evaluated as the position of a putative ETL is moved incrementally along the chromosome. Conditional on the position of the ETL, the analysis is equivalent to fitting a linear model for observations and the likelihood is maximized by performing a grid search on the position of the putative ETL for which the parameter space is defined by the length of the chromosome. For each ETL map position, the evidence for the existence of an ETL is calculated as the logarithm odds, or LOD score, which was computed as $.5n\log_{10}(RSS_{reduced}/RSS_{full})$ for n the sample size and RSS denoting residual sum of squares under the reduced (no ETL) and full (single ETL) models respectively.

Figure 2 presents interval maps of two bovine autosomes for selected postslaughter phenotypes. Dashed lines on the LOD axis at 2.0 and 3.0 signify critical values for accepting the alternative hypothesis of the presence of an ETL at significance levels of about .02 and .004, respectively. The estimated map position of the ETL within each chromosome, additive (a) and dominance (d) effects and magnitude of each ETL effect ($|2a|/\sigma$) are reported in Table 2. The values for 2a represent the difference between animals that are homozygous for Angus alleles and animals that are homozygous for Brahman alleles at the ETL, while the values for d represent the deviation of animals that are heterozygous for an Angus and a Brahman allele from the average of Angus and Brahman homozygotes. Hence at a map position 68 to 69 cM within our linkage group for bovine autosome A there is extremely strong evidence (LOD > 3.0) for an ETL of major effect on Slaughter Weight and on Hot Carcass Weight. At this locus animals that were homozygous for Angus alleles are estimated to be 45.9 kg heavier at slaughter and have carcasses 31.1 kg heavier than animals homozygous for Brahman alleles. These differences represent 1.1 and 1.08 within ETL phenotypic standard deviations for Slaughter Weight and Hot Carcass Weight respectively, qualifying this locus to be a major gene influencing weight. In fact, of particular interest, this locus has a detectable effect on all weights postweaning, but not on birth weight suggesting that selection for alleles conferring increased weight at this locus may not have an impact on birth weight and calving ease. There is also strong evidence for an ETL influencing the cholesterol content of fat and KPH fat 37 cM along our linkage group for autosome A. At this locus animals that are homozygous for Angus alleles are estimated to have .49% less KPH fat and 23.4 mg/100 g less cholesterol in the fat than animals homozygous for Brahman alleles. Although the support is not yet convincing, there is evidence for an ETL influencing marbling on autosome B (LOD = 1.6; $P < .10$). Animals homozygous for Angus alleles at this locus are estimated to have over one-half a marbling grade more marbling than animals homozygous for Brahman alleles. We are in the process of reanalyzing our data including an additional 40 head of cattle that were slaughtered this Spring to determine whether the support for this ETL is increased. However, at this stage it appears clear that a number of loci will be identified that have economic significance for growth and carcass quality.

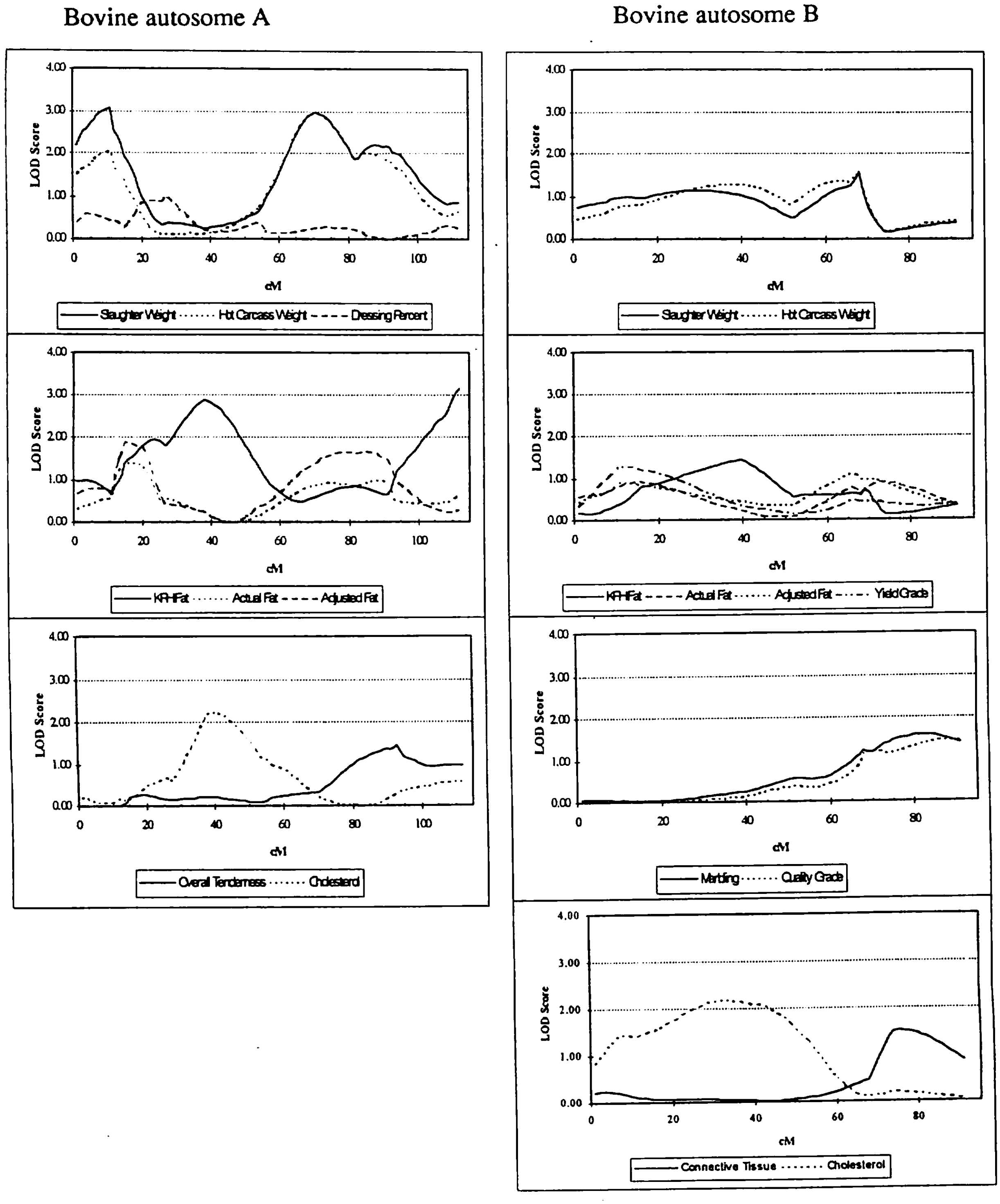

FIGURE 2: Interval maps for bovine autosomes A and B indicating evidence of ETLs for growth, carcass composition and quality and fat cholesterol level. The X axis denotes the genetic map of each chromosome. The Y axis is the LOD score with dashed lines at P=.02 and .004 respectively.

Table 2. Estimated map position of ETLs for two bovine chromosomes, additive (a) and dominance (d) effects and magnitude of each ETL effect ($|2a|/\sigma$).

Phenotype	Parameter Estimates[1]			
	Map position (cM)	2a	d	$\|2a\|/\sigma$
	Chromosome A			
Slaughter Weight (kg)	10	27.6	14.6	.65
	69	45.9	14.4	1.1
Hot Carcass Weight (kg)	10	16.1	7.7	.55
	68	31.1	8.8	1.08
Kidney-Pelvic-Heart Fat (%)	37	-.49	-.07	.96
	110	.03	.30	.06
Actual Fat (cm)	14	-.13	.12	.33
Adjusted Fat (cm)	19	-.21	.09	.56
	75	.31	.02	.82
Overall Tenderness[2]	91	.46	-.06	.71
Cholesterol (mg/100 g)	37	-23.4	-8.9	.70
	Chromosome B			
Slaughter Weight (kg)	30	2.8	19.4	.07
	66	16.0	15.4	.37
Hot Carcass Weight (kg)	31	6.0	13.9	.02
	59	15.8	10.2	.53
Kidney-Pelvic-Heart Fat (%)	38	.39	.11	.75
Adjusted Fat (cm)	11	-.11	.12	.31
Yield Grade[3]	11	-.23	.23	.38
Quality Grade[4]	89	29.4	1.5	.74
Marbling[5]	84	53.8	-15.1	.74
Connective Tissue[6]	72	-.20	-.17	.40
Cholesterol (mg/100 g)	33	4.5	16.7	.13

[1]Map position relative to centromere; 2a = Angus homozygote - Brahman homozygote difference; d = Angus x Brahman herozygote - (Angus homozygote + Brahman homozygote)/2; $|2a|/\sigma$ = proportion of within breed type and ETL genotype phenotypic variance due to Angus versus Brahman difference.

[2]Continuous scale with 1 = Extremely tough and 8 = Extremely tender.

[3]Continuous scale from 0 to 5 with lower scores producing higher yields.

[4]Continuous scale with higher scores producing higher quality carcasses.

[5]Continuous scale with higher scores producing higher degrees of intramuscular fatness.

[6]Continuous scale with higher scores producing higher amounts of connective tissue.

Current Directions

The markers that we have identified as flanking ETLs influencing growth and carcass traits probably have immediate application for marker assisted selection in synthetic populations involving Brahman and the British breeds. However, because we have slaughtered relatively few animals, we have not yet determined whether there is variation among Brahman and Angus ETL alleles and we do not know whether there is linkage equilibrium or disequilibrium between the markers and ETLs in the U.S. cattle populations. Furthermore, we have performed interval mapping utilizing a model parameterized only to allow the presence of a single ETL on each chromosome and this model must be extended to allow for the presence of two or more putative ETLs on each chromosome in order to enhance the level of confidence associated with the estimation of map position and additive and dominance affects associated with ETL genotypes. Following this, we will initiate the research to positionally clone these ETLs and to identify the sequence variation associated with the detected phenotypic differences. This will allow for the direct selection for the desirable alleles of these ETL in any population of cattle.

Our approach utilizes the comparative human and bovine maps to identify both candidate genes (functional cloning) and genes that can be used to target new markers to the chromosomal region containing the ETLs. The high degree of conservation of the mammalian genomes ensures the preservation of loci, but not necessarily gene order, within small conserved chromosomal regions (WOMACK and MOLL 1986). This fact, combined with the wealth of human mapping data, provides an enormous resource for genomic research in livestock species. Unfortunately, polymorphisms have generally not been detected for most anchor loci upon which the comparative maps are based, and this has greatly limited the power of this approach on the scale necessary to isolate ETL. However, this can be accomplished through the identification of clones from large DNA fragment libraries containing the target sequences and then deriving new microsatellite markers from these clones. We have recently been successful in the genetic and physical mapping of Type I loci through the use of clones isolated from a bovine BAC library created in our laboratories. BAC clones containing Type I loci of interest are identified in the library by the polymerase chain reaction (PCR), and the entire screening process requires only three days (CAI *et al.* 1993, 1995). To be most effective, this approach requires sufficient resolution of the comparative maps to allow the identification of Type I loci within a target interval. Ideally, this strategy for site directed selection of markers should allow the resolution of an interval containing an ETL to be reduced to about 2-3 cM.

Our BAC library currently consists of 23,040 clones with an average insert size of 146 kb and with a 70% probability of containing a unique DNA sequence. Based on restriction fragment comparisons, the bovine inserts have been demonstrated to be stable for at least 100 generations of cell growth. No chimeric clones were detected by fluorescence *in situ* hybridization (FISH) of 11 large (~300 kb), size selected clones to bovine metaphase chromosomes (CAI *et al.* 1995). When the library comprised only 19,600 clones, PCR-based screening yielded at least one copy of nineteen of 28 (68%) sequences (Table 3) which was consistent with the 64% probability of this library containing a unique sequence. A BAC clone containing the 3β-hydroxy-5-ene steroid dehydrogenase (3β-HSD) gene was physically mapped to bovine chromosome 3 by FISH and two new microsatellite markers isolated from this clone were genetically mapped to chromosome 3 with no recombinants in 193 meioses. Chromosome walking to the clones contiguous to the 3β-HSD BAC clone has successfully been performed (CAI *et al.* 1995). By September 1996, we expect to have produced 60,000 clones, or about 3 bovine haploid genome equivalents to achieve a 95% probability of the library containing a unique DNA sequence. Access to this library is currently available for collaborative research.

Table 3. Results of PCR screening of the bovine BAC library for single copy DNA sequences.

Locus	No. BAC clones	Source
TAMULS113.3[1]	2	L.C. SKOW, Texas A&M
ETH225[1]	2	BARENDSE *et al.* 1994
ETH1113[1]	0	BARENDSE *et al.* 1994
Cytochrome P450, subfamily XX1	2	L.C. SKOW, Texas A&M
Bovine NRAMP	2	J.W. TEMPLETON, Texas A&M
MHC DYα	1	L.C. SKOW, Texas A&M
Interstitial retinol binding protein	0	MOORE *et al.* 1991
Heat Shock Protein Family 70.2	13	L.C. SKOW, Texas A&M
Glucoceribrocidase	1	CAI *et al.* 1995
3β-hydroxy-5-ene steroid dehydrogenase	2	CAI *et al.* 1995
Butyrophilin	0	C. TAYLOR, VIAS, Australia
Calpastatin	0	CAI *et al.* 1995
MHC Class I	3	L.C. SKOW, Texas A&M
Heat Shock Protein 70.1	1	L.C. SKOW, Texas A&M
Leukemia inhibitor factor	4	J.A. PIEDRAHITA, Texas A&M
Prolactin	1	CAI *et al.* 1995
Placental Lactogen	1	CAI *et al.* 1995
Growth Hormone	1	CAI *et al.* 1995
Growth Hormone Receptor	0	CAI *et al.* 1995
Insulin Like Growth Factor 1	0	CAI *et al.* 1995
Insulin Like Growth Factor 1 Receptor	4	CAI *et al.* 1995
Insulin Like Growth Factor 2	0	CAI *et al.* 1995
Somatostatin	1	CAI *et al.* 1995
5-hydroxy tryptamine receptor-2	5	B. KIRKPATRICK, Univ. Wisc.
Glial fibrillary acid protein 1	0	B. KIRKPATRICK, Univ. Wisc.
Glial fibrillary acid protein 2	1	B. KIRKPATRICK, Univ. Wisc.
Histamine H1 receptor	2	B. BARENDSE, CSIRO, Australia
Interferon α receptor	0	B. BARENDSE, CSIRO, Australia

[1]Microsatellite loci.

After screening our BAC library for clones containing the microsatellite markers that bracket an ETL, these clones will be used in FISH experiments to align the physical and genetic maps in the regions of interest. Based on recombination studies, one cM is about 10^6 base pairs for mammalian genomes (SHOWS *et al.* 1980). However, recombination frequencies differ among genders and the relationship between physical and genetic distance varies throughout the genome. Then we shall identify genes in the human map that appear to map to the homologous region of the bovine chromosome containing the ETL, design PCR primers for regions conserved across mammalian species, verify the identity of each locus by sequencing the PCR amplification product and rescreen our BAC library for clones containing these sequences. After sequencing each clone to validate the presence of the desired bovine gene homolog, we will determine the physical map location of the locus through FISH of the clone. For clones that map within the region of interest, we shall derive new microsatellite markers from the clones and test these for recombination with the ETL. In the event that the BAC clone containing the target sequence does not contain a polymorphic microsatellite, we shall walk to contiguous clones from which polymorphic microsatellites can be derived. By this process we shall enhance the bovine and human comparative maps of the chromosomes of interest, generate markers flanking the ETL to a resolution of 2-3 cM from which a chromosome walk toward the ETL can begin, or we will identify the ETL itself from the selected candidate genes and will examine allele sequences among the Angleton parents for these loci in order to determine the sequence variation putatively associated with the observed phenotypic variation.

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Alternative Methods of Determining Carcass Merit in Live Cattle

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This report is divided into two sections with respect to evaluating alternative methods to determine carcass merit in live cattle,

- Retail Product
- Relationships between retail product predictors

Currently retail product yield is predicted in the carcass by fat cover and rib eye area combined with hot carcass weight. Fat cover is the parameter in the yield grading equation that has the greatest impact on predicting retail yield. However, in the future when cattle are processed with less outside fat cover, variation in fat cover will be reduced and be less predictive of retail product differences. Rib eye area is the traditional measure of muscle. It is easy to measure, however, additional measures of muscle to predict percent or pounds of muscle in a beef carcass would be useful. In this report, visual muscle scores were assessed using a scale ranging from 1 = light muscled to 9 = heavy muscled. This system was developed by Bob Long formerly at Texas Tech.

Additional fat measurements evaluated in this report include:

- Body wall thickness – a measurement taken 1.5 in. laterally to the longissimus dorsi. Body wall thickness has been used to predict percentage of retail cuts in lamb carcasses. Limited work has been done with body wall thickness in cattle and reported by R. Green in the proceedings from the 1994 BIF Conference.

- Rump fat – a measurement taken at the Aus meat P8 site (over the gluteus medius muscle in the rump.) Rump fat measures are used frequently in Australia. Rump fat may be most useful in leaner cattle who may have more variation in rump fat than fat measured at the 12th rib.

During the summer of 1994, May through July, 287 steers from Cycle V of the Meat Animal Research Center GPE project were scanned before slaughter using an ALOKA 500V real-time ultrasound machine with an attached 17 cm linear array transducer. Ultrasound measurements of 12th rib fat thickness rib eye area, rump fat thickness, and body wall thickness were taken. In addition, visual muscle scores were recorded for each steer. The preliminary data in this report is from the first 143 cattle scanned, for which interpretation of ultrasound images has been completed.

Means and standard deviations of live animal, carcass and ultrasound measurements are shown in Tables 1 and 2.

Presented at the Live Animal and Carcass Evaluation Committee meeting of the 27th Annual Conference of the Beef Improvement Federation, May 31 – June 3, 1995, Sheridan, WY.

Table 1. Means and standard deviations of live animal, carcass and ultrasound measurements, n = 142

Final weight, lbs.	1153 ± 134
Carcass weight, lbs.	697 ± 81
Carcass fat thickness, in.	.36 ± .15
RTU fat thickness, in.	.37 ± .13
Carcass REA, sq. in.	11.54 ± 1.19
RTU REA, sq. in.	11.75 ± 1.12
Carcass yield grade	2.88 ± .63

Table 2. Means and standard deviations of live animal, carcass and ultrasound measurements, n = 142

RTU rump fat thickness, in.	.38 ± .10
RTU body wall thickness, in.	2.01 ± .30
Muscle score	4.46 ± 1.46
Retail product - .3' trim, lbs.	234 ± 28
Retail product - .3' trim, %	70.9 ± 3.7

Research at Iowa State University and other institutions has documented the potential for real time ultrasound to accurately predict carcass traits. Correlations between ultrasound and carcass measurements for 12th rib fat thickness and rib eye area were 0.90 for both traits. Accuracy of ultrasound measurements is shown in Table 3. These results are consistent with literature estimates and are reflective of the accuracy of real time ultrasound if done by a well-trained experienced technician.

Table 3. Accuracy of ultrasound measurements

	Fat thickness, in	REA, in^2
Bias (C-U)	-.01	-.21
Mean absolute difference	.05	.41
Standard error of prediction	.07	.51

Preliminary analysis for the potential of ultrasound and live animal measures to predict percent or pounds of retail product is shown in the following four tables (Tables 4–7). These tables relate that R^2 values for possible regression models are similar for a combination of ultrasound and live measures when compared to carcass measures. A step wise regression procedure was used and the tables reflect the importance of each parameter measured in predicting retail product. For example, predicting percent retail product from ultrasound and live animal measures (Table 4) indicates the RTU measured fat thickness accounted for 55 percent of the variation in retail product, while the combination of fat thickness and REA accounted for 60 percent of the variation.

Because of the importance of final weight or carcass weight pounds of retail product, R^2 values for predicting pounds of retail product are higher than those for predicting percent.

Table 4. Prediction of percent retail product using ultrasound (RTU) and live animal measures

	R^2	MSE
RTU fat thickness	.55	2.49
RTU fat th., REA	.60	2.33
RTU fat th., REA, rump fat	.64	2.23
RTU fat th., REA, rump fat, body wall	.65	2.20
RTU fat th., REA, rump fat, body wall, final live wt.	.66	2.17
RTU fat th., REA, rump fat, body wall, final live wt., muscle score	.68	2.12

Table 5. Prediction of percent retail product using carcass measures

	R^2	MSE
Carcass fat thickness	.52	2.55
Carcass fat th., REA	.60	2.33
Carcass fat th., REA, carcass wt.	.65	2.19
Carcass fat th., REA, carcass wt., KPH	.68	2.12
Carcass fat th., REA, carcass wt., KPH, muscle score	.69	2.07

Table 6. Prediction of pounds of retail product using real time ultrasound (RTU) and live animal measures

	R^2	MSE
final live wt.	.68	16.0
final live wt., muscle score	.79	13.1
final live wt., muscle score, RTU fat th.	.83	11.8
final live wt., muscle score, RTU fat th., RTU REA	.84	11.0
final live wt., muscle score, RTU fat th., RTU REA, RTU rump fat	.87	10.5

Table 7. Prediction of pounds of retail product using carcass measures

	R^2	MSE
Carcass wt.	.79	12.9
Carcass wt., fat th.	.88	9.9
Carcass wt., fat th., REA	.91	8.6
Carcass wt., fat th., REA, muscle score	.92	8.3
Carcass wt., fat th., REA, muscle score, KPH	.92	8.1

Currently, the remainder of the ultrasound images are being processed and analyzed. Several questions may be addressed with this data set relative to the potential for ultrasound measured traits to predict product. Once the data set is complete, prediction equations may be developed. Other measures, such as rump muscle depth, ribeye depth, or others may also be explored. The diverse sire lines used in the GPE study may be looked at separately in order to determine the potential accuracy of prediction within a group of cattle with less variation and more similar composition. This will be important to the application of prediction models to breeding cattle for use in genetic evaluation programs. Carcass quality measures (percent intramuscular fat, marbling score, shear force) of the GPD cattle will be used to verify and test ultrasound-predicted carcass quality traits in the live animal.

Recent literature reviews express concern when fat cover and rib eye area real time ultrasound measurements on yearling bulls and replacement heifers are compared to carcass data collected on steers and the genetic correlations between these two traits is not of the same magnitude and direction.

During the period of growth when these measurements were taken, a number of factors must be taken into consideration:

I. Environment has a much greater impact on fat deposition than on muscle
II. Carcass measurements taken on steer progeny has been evaluated at a number of end points
   - constant age
   - constant weight
   - constant composition or fat cover
III. Young bulls and replacement heifers are being evaluated at a constant age
IV. Bulls are depositing muscle at a faster rate than steers – steers may not be depositing additional muscle
V. Steers are depositing fat at a faster rate than bulls – bulls may not be depositing additional fat

In summary, measuring two carcass parameters with two technologies on two sexes and at two end points would you expect the genetic correlation to be of the same magnitude and in the same direction.

The potential to serially scan large numbers of cattle with real time ultrasound technology offers the opportunity to better understand biological growth. Thus, resulting in a better understanding of the relationship between fat and muscle deposition on steers, heifers and bulls.

Validation of Real-Time Ultrasound Measurements on Live Angus Cattle to Predict Body Composition Traits: Project Progress Report

Kurt L. Steinkamp
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Since 1989, Iowa State University (ISU) has been working with several cooperator seedstock herds and consolidated a large number of real-time ultrasound (RTU) measurements and images from yearling Angus cattle into one research database. These measurements collected by BIF certified technicians include external fat thickness (12th- 13th rib fat), 12th and 13th rib cross sectional area, and intramuscular percentage of fat in the *longissimus dorsi* (ribeye) muscle at the 11-13th rib positions. This report is from an ongoing validation program in cooperation with the American Angus Association to compare the previously mentioned RTU measurements with their sire expected progeny differences (EPDs).

Research at ISU reports standard error of prediction (SEP) for external fat thickness of $\pm$.11 inches, $\pm$.97 sq. inches for ribeye area, and $\pm$1.2 percent for intramuscular fat. The correlation between ultrasound predicted percent fat and percent intramuscular fat by ether extract analysis was reported to be .75. While the correlation between marbling score and intramuscular fat by ether extract analysis was also .75.

The preliminary bull data in this report is from 1,919 yearling bulls representing 224 different sires from 31 contemporary groups and 19 different herds. Seventy five of the 224 sires represented in the current database have carcass EPDs.

All RTU measured traits were first adjusted to a constant age. Contemporary group was assumed to be a group of animals of the same sex scanned at the same location on the same date. These contemporary groups were then evaluated for sire connectiveness. Sire least squares means using contemporary group as a fixed effect were then calculated for ultrasound measurements of ribeye area, fat thickness, and percent intramuscular fat. These sire least squares means were then regressed on the sires' corresponding carcass EPDs to obtain Pearson and Spearman correlations.

The preliminary heifer data in this report is from 703 heifers representing 108 sires from 10 contemporary groups and 7 herds.

Thirty four of these 108 sires represented in the database have carcass EPDs. The same previously mentioned approach was used to analyze the heifer database.

Ultrasound adjustments for bulls

adjusted percent fat = -1.74 + (pfat +(0.012 x age) - (0.00004 x age^2)) + 2.30

adjusted ribeye area = 6.99 + (ribeye area -6.99)/age) x 365

Ultrasound adjustments for heifers

adjusted percent fat = -3.11 + ((pfat + 3.11)/age) x 365

adjusted ribeye area = 3.74 + ((ribeye area -3.74)/age) x 365

Table 1. Means and standard errors of bull traits

RTU intramuscular fat, %	2.30±.49
RTU REA, sq. in.	11.82±1.34
RTU fat thickness, in.	.30±.10
Age	361±24.27

Table 2. Means and standard errors of heifer traits

RTU intramuscular fat, %	2.37±.63
RTU REA, sq. in.	9.43±1.39
RTU fat thickness, in.	.25±.09
Age	363±25.41

Table 3. Correlation between ultrasound measured traits of bulls

	%IMF	REA	Fat thickness
%IMF	1.00	.13	.50
REA	.13	1.00	.37
Fat thickness	.50	.37	1.00

Table 4. Correlation between ultrasound measured traits of heifers			
	%IMF	REA	Fat thickness
%IMF	1.00	.40	.62
REA	.40	1.00	.55
Fat thickness	.62	.55	1.00

Table 5. Correlation coefficients between sires' progeny ultrasound measured traits and their corresponding carcass EPD: sires with 10 or more bull progeny		
	Pearson	Spearman
%IMF	.49	.42
REA	.67	.53
Fat thickness	.44	.50

Table 6. Spearman rank correlations of least squares means for sire effect between sex classes of progeny				
Number of sires	Bull and heifer progeny	%IMF	REA	Fat thickness
41	≥5	.26	.52	.40
20	≥10	.39	.69	.81
9	≥15	.80	.75	.85

REPORT OF BIF LIVE ANIMAL & CARCASS EVALUATION SUBCOMMITTEE ON ULTRASOUND

By William Herring

William Herring reported on the May 24, 1995 meeting of the ultrasound subcommittee. The subcommittee met at the American Polled Hereford Association headquarters in Kansas City. A summarization of the following minutes was included:

The meeting was called to order at 7:30 am by Chairperson John Crouch. Those present included: John Crouch, American Angus Association; Loren Jackson, International Brangus Breeders Association; Doyle Wilson, Iowa State University; Gene Rouse, Iowa State University; Mark Thallman, Camp Cooley Ranch; John Hough, American Polled Hereford Association; William Herring, University of Missouri; Lloyd Solomon and Craig Thompson, Critical Vision, Inc.; Craig Hays, Animal Insights; and Jerry Hill, Corometrics Medical Systems, Inc. Crouch informed the group the purpose of the meeting was to allocate as many resources as possible in order to set the blueprint for ultrasound in the beef cattle industry. Crouch requested Herring record the minutes and a report be given to the Live Animal and Carcass Evaluation Committee at the 1995 BIF Annual Meeting, in Sheridan, Wyoming.

Wilson updated the group on the Iowa State University percentage intramuscular fat prediction model that is being licensed with Corometrics Medical Systems, Inc. Older models included variables of age and backfat thickness. Validations of models, new and old, have taken place with a random selected subset of data. Newer models do not include age or fat thickness. Also, different equations have been developed for animals that have been pre-classified into high and low predicted percentage intramuscular fat groups. Currently, there is an ISU graduate student investigating the relationship between predicted percentage intramuscular fat and carcass EPD based on Angus field data.

Rouse informed the group that Solomon is converting computer algorithms to be PC driven for the ISU %IM software. The software is being licensed with Corometrics and will be made available to ultrasound technicians.

A brief overview of the work between ISU and MARC using ultrasound to predict weight and percentage retail product was given by Rouse. Results at this point are promising and the project is being repeated this year.

Rouse also reported on BIF guidelines for technician certification. A successful training workshop was held in January, 1995. Iowa State would be willing to host one certification session per year. However, if other sessions are needed, another location, probably in the South, would be chosen. ISU staff would be willing to assist in a second certification program. Hough noted that Arkansas might be interested in hosting a certification. Wilson suggested that training guidelines be set forth. Thallman requested that informal coordination take place between training and certification programs. ISU would be willing to host more than one training session per year. Wilson said ISU could accommodate up to 56 people in a certification.

Hays suggested that during certification, all participants interpret all images in one room at a single time. Wilson and Rouse said ISU could make the necessary accommodations. This change will take place beginning with the June, 1995 certification. Wilson stated that those teams using the same equipment would be split into different certification sessions. Certification will only be for both 12-13 rib fat thickness and ribeye area. No technicians will be certified for only one trait. Certification will be for both capturing and interpreting images. No technicians will be certified for only image capturing or only image interpretation. Predicting percentage intramuscular fat will not be included this year. During the 1995 certification, correct technique for longitudinal scans will be demonstrated. Certification will be valid for 3 years beginning in 1995. Those technicians certified this year will not have to be re-certified until 1998.

Wilson raised the question of what certification really meant. The group agreed that "certification" may not be the appropriate word to use. The ongoing BIF Certifications are really "proficiency testing". It was suggested that BIF seek legal counsel on this matter. The group agreed.

Various available prediction systems for predicting intramuscular fat and marbling were discussed. The group concluded that all available systems undergo some validation procedure, In July, the University of Georgia will provide a group of fed cattle for this procedure (pending funding). Developers of all systems will be invited to participate. Independent, certified technicians will be used to measure cattle with all systems. Drs. Larry Benyshek and Keith Bertrand will provide a proposal to this committee for the validation procedure. Auburn University as well as the University of Missouri would also be willing to participate.

Wilson presented ideas on central image processing (CIP). He suggested CIP for interpretation and processing of breed data (adjustments, etc.). He pointed out that accuracy could be increased due to rejection of poor images. However, the success of CIP would depend on quick turnaround time and cost. Discussion from the group was mostly positive. Hough said the concept would have to be proven to breeders, and Jackson commented the process could not be mandatory. Herring also voiced concerns about why images might be rejected. If the poor quality images were the result of an association with an animal's trait expression, then this could result in problems with data truncation and genetic prediction.

Wilson suggested there should be a priority of phantom development. Currently there is no standard for calibrating Real Time Ultrasound (RTU) machines. Equipment may vary due to equipment wear, type of standoff guide, temperature, humidity, etc. Hill of Corometrics stated that animal scientists should take the lead in developing these phantoms. Crouch appointed a subcommittee for RTU hardware/software/system testing and development led by Herring, Thallman, Rouse, and Hill.

At this point, Hill, Solomon, and Thompson excused themselves from the meeting.

A symposium to address use of RTU for EPD was suggested by Wilson. Wilson will prepare a formal request for Richard Willham to present to Larry Cundiff asking for this topic be addressed at the next Genetic Prediction Workshop. Hopefully, this could take place in November or December of 1995.

Hough led the discussion about BIF guidelines for RTU. It was decided that traits to be recorded included: ultrasound backfat, ribeye area, and unadjusted percentage intramuscular fat; weight; animal tattoo; sire and dam registration number; technician; and ultrasound system/software. In order to measure RTU percentage intramuscular fat, technicians should be BIF certified to collect RTU backfat and ribeye area. Hardware recommendations, such as suggested video boards, made by software manufacturers should be followed by technicians that use that system. Data collected on breeding cattle should fall within the yearling weight age and contemporary group guidelines set for by each individual breed association. Other guidelines on BIF certification have already been presented in written form by Drs. Wilson and Rouse. At this point the group identified research priorities that will have to be answered before further recommendations can be made:

* adjustment factors for RTU measurements
* when to measure bulls and heifers
* contemporary group definitions
* trait selection: marbling or % intramuscular fat
* genetic parameter estimation: identify relationships between sexes/carcass measurement/RTU measurements
* genetic models
* understanding effects of selection on RTU traits of breeding animals versus carcass traits
* environmental effects on RTU systems/hardware/software
* validation of various RTU systems currently being used

Finally, Rouse briefly discussed ISU involvement in hot carcass scanning. Before adjourning, the group agreed and recommended that ultrasound companies involved in livestock measurements should make phantom development a priority by their own research and development groups.

PROGRESS REPORT: PREDICTING INTRAMUSCULAR FAT PERCENTAGE USING REAL-TIME ULTRASOUND[1]

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This progress report summarizes some of the recent developments at Iowa State University (ISU) that are focused on improving image processing and prediction models for intramuscular fat percentage (IFATP) in live animals. A major thrust of the recent research has been to develop prediction models that are independent of covariates such as animal age and external fat cover thickness. Some of the early work at ISU included these variables because they are phenotypically related to intramuscular fat deposition, and they did improve prediction accuracies. However, it is believed that the prediction models would be much more robust for industry use if these types of variables were eliminated and if the prediction would be specifically from only image processing algorithms.

During 1991 through 1994, 720 bulls and steers were scanned from the ISU breeding project by using a real-time ultrasound (RTU) Aloka 500 machine with a 17 cm, 3.5 Mhz transducer. A longitudinal image obtained without a guide placed across the 11^{th}, 12^{th} and 13^{th} ribs was used to collect a *longissimus dorsi* (*ld*) to compute the image processing parameters. Image processing parameters included: Fourier parameters (13), histogram parameters (17), texture parameters at four different angles (4*24) and gradient parameters.

Animals were slaughtered and a rib slice of the *ld* between the 12^{th} and 13^{th} ribs was collected to measure the actual percent IFAT. Correlations of the image processing parameters with actual percent IFAT and cross-correlations along them were calculated to discard parameters highly correlated with each other. Stepwise selection based on root mean square error, Cp Mallows' statistic as a measure of bias, and R^2 were used to determine the best parameters to be included in the prediction model for IFATP. Data were ramdomly divided into two sets: one set was used to develop the model and the other was used to validate it.

Two models were developed to predict IFATP. One model was based on image analysis parameters only; the other model included image analysis parameters plus ultrasound-measured 12-13th rib fat cover thickness. Both models were validated with a set of 318 independent images. The images belonged to animals with an actual IFATP mean of 4.91 $\pm$ 2.03% with a range of 1.61 to 14.09%. The regression of the predicted on the actual IFATP resulted in a slope of 0.97 and an intercept of 0.47 (not statistically different from zero) indicating the model was unbiased. The distribution of the residuals indicated they were uncorrelated having a mean of zero. The distribution of the residuals

[1] Presented at the Live Animal and Carcass Evaluation Committee meeting of the 27th Annual Conference of the Beef Improvement Federation, May 31 - June 3, 1995, Sheridan, WY.

also indicated that IFATP was predicted with an error <0.5% in 30% of the animals, <1% in the 53%, <1.5% in the 73% and <2% in 84.3% of the animals. Correlation between actual and predicted IFATP was 0.6. If actual percent IFAT was: a) smaller than 3%, the mean of absolute residuals was 1.03 with a maximum residual of 2.82; b) between 3 and 6%, the mean of absolute residual was 0.85 with a maximum of 2.78; c) between 6 and 9%, the mean absolute residual was 1.65 with a maximum of 4.24; and d) if larger than 9% (10 animals) the mean was 5.32 with a maximum of 8.46. Very similar results were obtained for the model that included fat thickness.

In conclusion, the validation of the models shows the appropriateness of real-time ultrasound and image processing algorthms to predict IFATP. The similarity of the validation results for both models, with and without fat thickness, demonstrated the robustness of the model based only on image processing parameters.

GENETIC EVALUATION OF REPRODUCTION TRAITS: POSSIBILITIES AND PROBLEMS

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INTRODUCTION

In the past twenty years, the availability of expected progeny differences (EPD) has enabled beef producers to better identify animals that meet their specifications for growth and maternal traits. More recently, genetic evaluation programs have expanded to include carcass characteristics, yet reproductive traits, recognized to be most important to production efficiency and profitability, have received little or no emphasis in these programs. In general, reproductive traits have lower heritabilities than growth or carcass traits, and data on these traits are often inconvenient to collect. Necessary management practices such as fixed calving seasons, artificial insemination, and estrus synchronization may confound the expression of fertility under commercial conditions.

Trenkle and Willham (1977) estimated reproduction traits to be five times as economically important as production traits to beef breeding herds. Melton (1995) found reproduction traits to be twice as economically important as production traits to a commercial cow-calf producer. A Cattle-Fax (1993) survey of 317 cow-calf producers revealed low-cost producers have a higher percentage of calves born and weaned per cow exposed than high-cost producers. If beef is to remain cost competitive with pork and poultry, producers must strive to lower their costs of production. Genetic evaluation of reproduction traits would give producers a much needed tool to improve cow herd efficiency and reduce costs.

REVIEW OF LITERATURE

Many measures of fertility have been studied by various researchers, often in hope of finding traits suitable for inclusion in national cattle evaluation programs.

Some measures of fertility studied include age at puberty, age at first calving, calving date, calving interval, conception rate, scrotal circumference and stayability. Currently, with the notable exception of stayability in Red Angus, scrotal circumference is the only trait included in such programs with a significant impact on reproduction.

Age at puberty

In order for producers to maintain a short calving season without greatly decreasing conception rate, heifers must reach puberty at an early age. A variety of heritability estimates for age at puberty are reported in the literature, ranging from .10 to .67, (Smith et al., 1989a; Arije and Wiltbank, 1971; Morris et al., 1992; King et al., 1983; MacNeil et al., 1984). In a review of genetic effects on beef heifer puberty, Martin et al. (1992) summarized nine studies and reported an average of heritability estimates of .40.

Considerable genetic variation exists for age at puberty across breeds (Cundiff et al., 1986). Faster growing breeds with greater mature size tend to be older and heavier at puberty than do breeds with slower growth rate and smaller mature size. Breeds historically selected for milk production seem to reach puberty earlier than do breeds of similar mature size and retail product with no historical selection emphasis on milk production (Gregory et al., 1991). However, pregnancy rate does not differ between breed groups that reach puberty at younger ages and those breed groups that reach puberty at older ages. Crossbred heifers generally reach puberty earlier than purebreds, and this advantage is retained in advanced generations of composite populations (Gregory et al., 1991). However, age at puberty is subject to seasonal effects (Smith et al., 1989a), and since determination of age at puberty requires estrus detection or a taking of blood samples prior to breeding season, measurement under commercial conditions is not practical.

Age at first calving

Age at first breeding and age at first calving have been studied as easy to measure predictors of age at puberty and overall fertility. Earlier calving heifers are biologically and economically more efficient because a greater proportion of their annual production cycle is in a productive (lactating) mode (Marshall et al., 1990) and wean more total calf weight in their lifetime than late calving heifers (Paloma et al., 1992) . Lifetime costs per unit output value are lower when heifers are managed to calve first at two rather than three years of age (Núñez-Dominguez et al., 1991). However, heritabilities for these predictor traits have been lower then for age at puberty, ranging from .01 to .23 (Smith et al., 1989a; Azzam and Nielson, 1987; Bourdon and Brinks, 1982; Meacham and Notter, 1987; Toelle and Robison, 1985).

Smith et al. (1989a) found a heritability estimate of .01 for age at first calving, but an estimate of .36 for the heritability of age at second calving. In contrast, Meacham and Notter (1987) reported heritability estimates of .17 and .07 for age at first and second calvings, respectively, and a genetic correlation between the two traits of .66. Buddenberg et al. (1990) found age at first calving much more heritable (.39) than age at second calving (.13). Before age at first or second calving can be used in genetic improvement programs, further studies are needed to clear up this discrepancy.

Calving date

Calving date has been suggested as a reproduction trait available in breed association databases that may potentially be useful in identifying brood cows with superior fertility. Calving date is less biased by fixed breeding seasons than calving interval (Bourdon and Brinks, 1983). Earlier studies found heritability estimates for calving date ranging from 0 to .16 (Buddenberg et al, 1990; López de Torre and Brinks, 1990; Rege and Famula, 1993). In Australia, Breedplan provides a genetic evaluation for Angus cattle including estimated breeding values for days to calving, using scrotal circumference as a correlated trait (Cunningham, 1993). More recently, as a trait of the dam, heritability of calving date has been estimated to be .03 (MacNeil and Newman, 1994) when the additive effects of the calf and contemporary mating group effects are considered. Many studies of calving date exclude cows not calving. However, as pointed out by Notter (1988), open cows are likely to be genetically worst in ability to conceive during a restricted mating period and ignoring these may remove the most important information. Therefore, calving date, although readily available in field data, does not appear as useful for genetic evaluation as previously thought.

Calving interval

Another commonly used measure of cow fertility is calving interval. Postpartum interval, the period from calving until first estrus, has also been studied. Several breed associations include a limit on maximum calving interval for recognition in superior cow programs. Nevertheless, the heritability of calving interval in published studies averages .01 (Koots et al., 1994). Furthermore, calving interval is biased by a fixed calving season (Marshall et al., 1990). The ideal beef cow would calve the first day of calving season each year, and would have a calving interval of 365 days. Heifers that calve later in the season will have more opportunity to reduce their calving interval than those that calve earlier. Paloma et al. (1992) reported that under a fixed breeding season, earlier calving cows had greater first and second calving intervals than late calving cows. According to Notter and Johnson (1987), analyses of postpartum interval should consider that cows mated in the first 21 days of the breeding season may have a shorter true postpartum interval than observed, postpartum interval is not measurable for cows not cycling by the end of the breeding season, and postpartum interval may be biased in cows whose calf died at or shortly after birth.

Conception rate

An economic simulation model was used by Werth et al. (1991) to show that when first-service conception rate is low (< 60%), an extended breeding season (120 days) increases net income, due to a total increase in number of cows bred. Accordingly, higher first-service conception rates are necessary to maximize net income when breeding seasons are shorter (70 days or less). Nonetheless, conception rate and calving rate, like calving interval, have been shown to have low heritability, with published estimates ranging from .02 to .06 (Notter et al., 1993; Meyer et al., 1990; MacNeil et al., 1984; Toelle and Robison, 1985) In contrast, Toelle and Robison (1985) reported a higher estimate of .27 when infertile cows were eliminated from their study. Mackinnon et al. (1990) was successful in increasing pregnancy rate in *Bos indicus* females under tropical conditions using direct selection. Conception rate is influenced by service sire effects (Dearborn et al., 1973), and unsuccessful services are not currently recorded in breed association databases.

Scrotal circumference

Of all measures of fertility in beef cattle, scrotal circumference (SC) is the most easily measured and most widely used. Furthermore, SC expected progeny differences are currently published by many breed associations. SC has been shown to be a good indicator of male fertility and age at puberty in both males and female relatives.

Numerous heritability estimates have been published for yearling SC, averaging .48 (Koots et al., 1994). SC is a good predictor of testicular mass and can be measured with high repeatability (Hahn et al., 1969). Although favorably correlated with sperm output (Neely et al., 1982) and percentage of live sperm, SC has a negative relationship with semen concentration and motility (Knights et al., 1984). SC is also positively correlated with growth traits. Bulls with larger SC tend to be heavier at birth, weaning and a year of age (Latimer et al., 1982; Bourdon and Brinks, 1986).

Although yearling SC has been shown to be moderately to highly heritable, Toelle and Robison (1985) reported a heritability for 205 day SC of only .08. This suggests weaning may be too early to obtain a SC measurement, since most bull calves have not reached puberty at this age. However, the heritability of SC-increase between weaning and one year of age was .56. This suggests postweaning SC-increase, although requiring an additional measurement, may be a more accurate measure of genetic merit for fertility.

The favorable relationship between SC in bulls and fertility traits in females is well documented. Genetic correlations greater in magnitude than -.70 between scrotal circumference in bulls and age of puberty in heifers have been reported (King et al., 1983; Toelle and Robison, 1985; Brinks et al., 1978). Meyer et al.

(1991) estimated genetic correlations between scrotal circumference and age at calving to be somewhat lower, ranging from -.25 to -.41.

Mackinnon et al. (1990) compared bulls resulting from line selection for high or low pregnancy rate and found high line bulls had significantly greater SC than low line bulls. By selecting for high SC, Morris et al. (1993) found greater reduction in age at puberty in heifers than by selecting for reduced age at puberty directly. However, Smith et al. (1989b) reported a favorable, but non-significant regression of age of puberty on sire scrotal circumference of -.796 d/cm. Similarly, Moser et al. (1994) found no significant difference in age at puberty between heifers sired by large or small scrotal circumference sires, and reported a non-significant regression of age of puberty on sire scrotal circumference of -.895 d/cm. The amount of variation in the beef cattle population for scrotal circumference may limit the amount of progress made in improvement of fertility via this selection strategy.

Stayability

Stayability is defined as the probability of surviving to a specific age, given the opportunity to reach that age (Hudson and Van Vleck, 1981). Originally researched in dairy cattle, stayability may be an indicator of female fertility that can be calculated from current breed association field data. Producers routinely cull non-productive females from the herd, thus, those cows that remain in the herd to an older age should be more fertile than those culled.

Snelling and Golden (1994) analyzed stayability data from two herds and found heritability estimates ranging from .02 to .22 for various measures of stayability listed in table 1. Stayability has been incorporated into the Red Angus Association of America national cattle evaluation (Snelling et al., 1994). This analysis used the stayability trait S(6 | 5), the probability of a cow having a calf after the age of six, given she had a calf before the age of six. The range of S(6 | 5) EPD among Red Angus sires was from -11.8 to 14.2, indicating the highest ranking sire for this trait should have greater than 25% more daughters in production at six years of age than the lowest ranking sire (Snelling and Golden, 1994). Sires ranking in the top 20% for S(6 | 5) had similar ranges of birth weight, weaning weight, maternal weaning weight, and yearling weight EPD in comparison to all sires evaluated. S(6 | 5) does not provide as clear a measure of fertility as S(3 | 2), S(6 | 2), S(9 | 2) or S(12 | 2) (see table 1), since cows are not required to have a calf recorded every year to receive a successful observation. However, these more stringent measures of stayability can only be used if a record is submitted to the recording association on every calf produced by a cow, not just those to be registered.

Inventory-based recording

To effectively conduct a national cattle evaluation program for reproduction traits, breed associations must increase the amount of data collected. An ideal inventory-based data reporting scheme has been proposed by D.R. Notter (Cunningham, 1993). The system would consist of one record per cow per year, and include accurate information on reproductive/culling status, identity of service sires, duration of breeding season and all artificial insemination dates recorded. To reduce recording bias, breed associations should not charge fees for processing data on non-registered animals.

Selection index

As genetic evaluation programs expand to include a greater number of traits, selection of individuals that will contribute optimum trait combinations becomes more difficult. The desired result of selection is not necessarily an improvement in a particular trait, but an improvement in the aggregate genotype for fertility. Harris and Newman (1992) acknowledged the need for genetic evaluation programs to provide information on the economic importance of traits and trait combinations, and to identify animals that possess optimum trait combinations.

Stewart et al. (1990) developed multitrait selection indexes currently published in swine sire summaries. These include sow productivity index, based solely on maternal data; maternal line index, combining growth and maternal traits; terminal sire index emphasizing postweaning growth and carcass merit, and general index for breeders that have not developed specialized lines. Although beef cattle are required to perform under a much wider range of environmental conditions than are swine, maximization of fertility at a given level of inputs is a common goal. Combining information on several traits known to influence fertility into a "Reproduction Index EPD", as suggested by Notter and Johnson (1987), may be more useful to producers than individual expected progeny differences for each reproduction trait.

CONCLUSIONS AND IMPLICATIONS TO GENETIC IMPROVEMENT OF BEEF CATTLE

Average heritability estimates of reproduction traits are summarized in table 2. Of the traits studies, those with highest heritability are age at puberty, conception rate, SC and stayability. Current breed association databases include measurement of SC, and with a shift to an inventory-based data collection system calving date, calving interval, conception rate, and stayability could potentially be analyzed.

Before national cattle evaluation for reproduction traits can occur, recording associations must expand their data collection scheme by moving to an inventory-based system that collects more information about the reproductive performance of each animal. Imposing an annual fee for each animal registered instead of a fixed fee for lifetime registration would promote greater reporting of culling. Eliminating any charge for processing data on non-registered cattle would also encourage producers to report data on entire contemporary groups, rather than a selection portion of each group.

In order for producers to gain maximum genetic improvement from evaluation of reproduction traits, data on individual traits should be combined into a fertility index. Weighting expected progeny differences for calving date, stayability and scrotal circumference by their physiological and economic importance to produce such an index would provide a useful tool for genetic improvement of beef cattle and reduction of production costs to the cow-calf operator.

Table 1. Stayability traits examined in within-herd and RAAA analyses.[a]

S(3 | 2)[b]	probability of a cow having two calves by three years of age given she first calved as a two-year-old
S(6 | 2)[b]	probability of a cow having five calves by six years of age given she first calved as a two-year-old
S(9 | 2)[b]	probability of a cow having eight calves by nine years of age given she first calved as a two-year-old
S(12 | 2)[b]	probability of a female having eleven calves by twelve years of age given she first calved as a two-year-old
S(6 | 5)[c]	probability of a female having at least one calf at or after age six given she had calved at least once by age five

[a]adapted from Snelling and Golden, 1994.

[b]within-herd.

[c]Red Angus Association of America (RAAA) national cattle evaluation.

Table 2. Average heritability estimates for selected reproduction traits.

Trait		Average h^2	Number of estimates
Age at puberty in heifers[a]		.40	9
Age at first calving[b]		.06[c]	7
Calving date[b]		.08[c]	7
Calving interval[b]		.01[c]	3
Conception rate[b]			
	cows	.17[c]	21
	heifers	.05[c]	9
Scrotal circumference[bd]		.48[c]	25
Stayability[e]			
	S(3 | 2)	.09	4
	S(6 | 2)	.15	4
	S(9 | 2)	.13	4
	S(12 | 2)	.15	3

[a]Martin et al., 1992.

[b]Koots et al., 1994.

[c]average weighted by inverse of estimated sampling variance.

[d]adjusted to 365 days of age

[e]Snelling and Golden, 1993.

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Improving Carcass Merit in Cattle With Brahman Breeding

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Introduction

Crossbreeding has become the predominant system of mating in the United States beef industry. By providing for the use of non-additive variation among breeds, or heterosis, and the combination of desirable traits from different breeds (complimentarity), the use of crossbreeding along with accurate selection procedures can increase the efficiency of beef production. Traits that are economically important, namely reproductive performance, growth rate and efficiency and carcass traits, can be significantly improved through crossbreeding among cattle that are dissimilar in genetic history as a result of complimentarity and heterosis (Cundiff, 1970).

The need for cattle adapted to the environment in which they are produced is of primary importance in maintaining high levels of productivity. The interaction of genetic and environmental effects can have great economic impact on the beef production enterprise. The adaptability of the Brahman (the predominant *Bos indicus* breed in the United States) and its crosses to the semitropical and tropical environment of the Gulf Coast Region of the United States has resulted in the extensive use of these cattle in that region. To some extent, the superiority of the Brahman crossbred has been shown in other regions of the country as well. The relatively large amounts of heterosis obtained through crossbreeding between the Brahman and cattle of non-zebu inheritance are considered to contribute significantly to increased production levels in herds across several regions of the United States.

Crossbreeding systems which utilize a high percentage of Brahman influence produce feeder-stocker calves with distinct "zebu characteristics," including excess loose skin about the throat and underline, the characteristic thoracic hump and long, pendulous ears. At market, these calves often receive price discrimination from the feeder and packer segments of the beef industry. Phillips et al. (1986) reported that feeder calves that phenotypically showed fifty percent or more Brahman breed composition were discounted from $2.70 to 3.20 per 45.4 kg live weight. This price discrimination has been largely attributed to less desirable yield and quality grades found among carcasses produced by cattle with high percentages of Brahman breed composition.

Price discounts applied to high percentage Brahman or zebu cattle have prompted cattlemen and researchers to investigate the use of crossbreeding systems which produce calves with lower percentage Brahman breeding while maintaining acceptable levels of heterosis and environmental adaptability in the herd (Crews, 1992). Studies which characterize the effects of Brahman breeding on carcass composition are, in some respects, conflicting. The objectives this paper are to review literature which documents the effects of Brahman influence at varying percentages of breed composition on carcass composition and meat quality and to identify those related topics which warrant further study. A clear understanding of the relationships among breed composition and carcass traits is needed as the production of zebu and zebu crossbred types continues to be of importance in the U.S. beef industry.

Review of Literature

To date, results of studies have not been reported where cattle were selected on the basis of carcass composition. Although several studies have reported genetic parameters for traits associated with carcass composition, the effects of genetic selection for carcass traits remains a subject of speculation. It is evident that a lack of carcass information exists which can be traced to genetic origin. The lack of information available to producers has been cited (NCA, 1992) as one of the primary reasons for the current lack of conformity in fresh beef.

The National Beef Quality Audit - 1991 (Lorenzen et al., 1993) represents a current survey of carcass composition in the United States. Compared to a similar survey study conducted by the U.S. Department of Agriculture (1974), the Beef Quality Audit documented changes in the beef industry during a seventeen year period. During this period, the beef industry experienced several changes, most notably, the influence of increased amounts of Continental European breeding in slaughter cattle, increasing diet and health concerns of consumers and an increase in the use of widely variable germ plasm in crossbreeding to produce weaned calves that enter the beef production cycle. The executive summary of the National Beef Quality Audit (NCA, 1992) reported comparative means for measures of carcass composition from the two studies (Table 1). The more recent survey indicated that in nearly twenty years, carcass weights had increased approximately 36 kg, and ribeye area had increased by 7 cm^2. Kidney, pelvic and heart fat had decreased from 3.0% to 2.2%. However, external fat (1.47 vs 1.49 cm) and ribeye area per 45.4 kg hot carcass (10.98 vs 11.26 cm^2) did not significantly change. Also, marbling score, the primary determinant of USDA quality grade, had decreased from "Small-plus" to "Small-minus". The influence of the larger, later maturing Continental breeds is evidenced by the increased size or weight of carcasses and the increase in ribeye area, however, the current desire of consumers to buy a leaner beef product has not been targeted since the mean degree of external fat had not changed in the 17 yr between the two studies. This comparison further indicates that live cattle are being fed to fatness end points in the industry, and therefore, over the past 20 years, have produced carcasses with relatively constant amounts of external fat.

Carcass Yield

The USDA yield grade was developed as a numerical method for prediction of percentage boneless, closely trimmed retail cuts obtainable from the beef round, loin, rib and chuck primals, and is based on the proportion of fat and muscle to carcass weight (USDA, 1989). Fatter, less muscular beef carcasses receive less desirable (higher) yield grades than those which are lighter, leaner and more muscular.

NCA (1992) reported that from 1974 to 1991, the mean USDA yield grade had decreased from 3.4 to 3.2, indicating a slight improvement in carcass yield. However, the reduction in kidney, pelvic and heart fat probably accounts for most of this decrease. It is reasonable to assume some progress has been made towards a leaner product since the significant increase in carcass weight did not result in a comparable decrease in yield, as the yield grade equation tends to favor lighter carcasses. A significant body of data has been generated to compare the carcass yield among different breeds and their crosses. The results, or breed rankings, of these studies often appear to be conflicting, due to the variation in the feeding end point or stage of growth at which cattle are compared. Breed rankings differ depending on the breeds compared and feeding end point, suggesting that the interaction of biological type (breed) x feeding regime significantly affects carcass composition.

Carcass fatness and weight are more heavily weighted components in the yield grade equation, therefore, some studies have specifically compared cattle at equitable fatness or weight end points. As the industry continues to value a .64 cm trim level on beef primals, studies designed to compare the carcass composition of breeds at a fatness end point may better evaluate the usefulness of breeds in terms of the carcass product.

Crossbreeding studies have estimated the effects of heterosis on carcass composition. Comerford et al. (1988), comparing cattle produced from a diallel among the Polled Hereford, Limousin, Simmental and Brahman breeds, gave heterosis estimates of 10% for hot carcass weight among crosses involving the Brahman. Peacock et al. (1979) reported 19.8% heterosis for the same trait in Brahman x Angus F_1 steers. Peacock and coworkers found that the effects of Brahman breeding (50%) added approximately 2.3 kg to hot carcass weight. DeRouen et al. (1992) reported positive additive and nonadditive effects of Brahman breeding on hot carcass weight among steers from several crossbred mating schemes. In the Beef Quality Audit, Lorenzen et al. (1993) reported, however, that steers and heifers whose carcasses showed *Bos indicus* characteristics (thoracic hump > 10.2 cm), were lighter than those of dairy and native (non-dairy and non-*Bos indicus*) steers and heifers. The *Bos indicus* classification of Lorenzen and coworkers most likely included purebred zebu cattle as well as their crosses. Several other researchers have reported that Brahman crossbred steers had heavier hot carcass weights than their *Bos taurus* contemporaries when compared after a constant length of feeding period (Koch et al., 1982; Young et al., 1978). Huffman et al. (1990) reported that among steers of 0, 25, 50 and 75% Brahman (B) breeding, the 1/2- and 3/4-B steers had heavier hot carcasses than either Angus or 1/4-B steers when compared at an equitable degree of finish. Lopes

(1986), however, found no difference in hot carcass weight between Brahman x Hereford F_1 and Hereford steers fed to 1.0 cm outside fat. Similarly, Cesar (1984) reported no differences in the hot carcass weights of Brahman x European and European x European crossbred steers fed to 1.0 cm subcutaneous fat. It is evident that breed differences in carcass weight are reduced when the carcasses are compared at similar outside fat levels rather than after constant numbers of days on feed.

Studies have also shown that cattle with Brahman influence have smaller gastrointestinal tracts relative to body weight than cattle with only *Bos taurus* breeding (Huffman, et al., 1990; Lopes, 1986; Carpenter et al., 1961). Often, researchers report similar slaughter weights (live) for cattle, and subsequently report significantly different hot carcass weights, reflecting differences in dressing percentage, and some have attributed these differences to gastrointestinal fill. Sanders and Paschal (1987) stated that the zebu-sired steers in their study had heavier hot carcass weights and higher dressing percentages than Angus- and Senepol-sired steers. Huffman et al. (1990) reported that 3/4-Brahman steers had less rumen fill than 1/4-Brahman steers. Carpenter et al. (1961) found a negative and linear effect of increased percentage Brahman breeding (25 to 100%) on rumen fill, however, they found no significant differences in dressing percentage among breed types.

Crockett et al. (1979) compared the carcass traits of steers that had been fed a constant number of days and found that Brahman, Beefmaster and Brangus cross steers were fatter than Limousin, Simmental and Maine Anjou crosses. Peacock et al. (1979) likewise reported that carcasses from Brahman x Angus steers were fatter than those of Charolais crosses. Comerford et al. (1988), in a study comparing steers produced from a diallel among the Polled Hereford, Simmental, Limousin and Brahman breeds, reported that, at an average age of 440 d and 401 kg live slaughter weight, Brahman cross steers had more outside fat (1.03 cm) than Limousin (.88 cm) and Simmental (.82 cm), but less than Polled Hereford (1.23 cm) cross steers. Peacock and coworkers reported a direct effect of Brahman breeding of +.18 cm on outside fatness. Gregory et al. (1994) concluded that composite populations and breeds provide an opportunity to use breed differences and heterosis to increase rate of fat deposition. These and other studies indicate that levels of heterosis are high among first crosses involving the Brahman for traits associated with growth rate and fat deposition. Crews (1992) reported that Brahman x Angus F_1 steers reached 1.0 cm outside fat approximately 32 d faster than steers sired by Braford, Simbrah, Senepol or Simmental bulls.

Savell et al. (1988) reported that 63% of separable fat in beef primals was seam (intermuscular) fat. The National Beef Quality Audit (1992) attributed a potential profit loss of approximately $63 to the production of excessive seam fat. Breed differences in pattern of seam fat deposition have been reported. Lunt et al. (1985) showed that straightbred Brahman steers had a smaller percentage of carcass weight as seam fat than Angus steers at five feeding end points. Christensen et al. (1991) showed no differences in amount of intermuscular fat among steers of varying amount of Brahman breeding fed to 1.0 cm outside fat. There is a need, however, to investigate differences in the pattern of fat deposition over time on feed among various breed types. There is evidence that cattle with Brahman breeding deposit fat throughout the carcass in a different pattern than do cattle with only *Bos taurus* breeding.

The area of M. *longissimus* (ribeye) at the interface of the 12-13th ribs is a common measure of carcass muscling, and remains the only estimate of muscularity used to calculate USDA yield grade. Comerford et al. (1988) reported heterosis estimates of 6.2 to 10.3% for ribeye area. Comerford and coworkers found that at a constant age, Brahman cross steers had ribeye areas that were 10 cm^2 smaller than those of Limousin and Simmental cross steers, but that the Brahman cross steers also had lighter carcasses. These data were in agreement with those of Crockett et al. (1979), who reported that Brahman and Brahman-derivative sires produced steers with smaller ribeyes than did Simmental, Limousin and Maine Anjou sires. Huffman et al. (1990) found that ribeye area did not differ among steers varying in percentage Brahman from 0 to 25%, however, 1/4-Brahman and Angus steers had more ribeye area per 100 kg hot carcass than 1/2- and 3/4-Brahman steers. Similarly, Peacock et al. (1979) showed that Angus steers had larger weight-adjusted ribeye area than other breed types, including Brahman crosses. Lopes (1986) reported larger ribeyes among Hereford steers than among Hereford x Brahman F_1 steers. Sanders and Paschal (1987) stated that ribeye area per kg hot carcass weight was equal among Senepol- and zebu-sired steers (.256 cm^2), but Angus steers had larger ribeye area per kg hot carcass weight (.266 cm^2). The phenotypic correlation between ribeye area and carcass weight has been estimated to be greater than +.50 (Crews, 1992).

The fat deposited in the kidney, pelvic and heart (KPH) regions of the beef carcass is commonly estimated as a percentage of hot carcass weight, and is included in the USDA yield grading standards as an estimate of internal fat (USDA, 1989). Breed differences in KPH fat have been shown to exist, but results are conflicting. As a factor in the yield grade equation, KPH fat has the least impact on beef yield grade. Comerford et al. (1988) reported that Polled Hereford steers tended to have more internal fat than did Brahman steers, although the differences were not significant. Cesar (1984) also reported that European crossbred steers tended to have more KPH fat than Brahman x European crossbreds. Huffman et al. (1990) found no significant difference in KPH fat among steers of 0, 25, 50 and 75% Brahman breeding. Kidney pelvic and heart fat, however, is correlated with intermuscular fat, and may therefore, convey more information than its weight in the yield grade equation reflects.

The USDA yield grade is an estimate of boneless, closely trimmed retail cuts expected to be obtained from beef carcass primals. Yield grade is heavily influenced by fatness, whereby fatter, heavier and less muscular carcasses typically receive less desirable yield grades while more desirable yield grades indicate leaner, lighter, more muscular carcasses. Comerford et al. (1988) and Crockett et al. (1979) reported that yield grades of Brahman-influenced steers were more desirable than those of British-sired steers, but less desirable than those of Continental-sired carcasses. Huffman et al. (1990) showed that the yield grade of 3/4-Brahman steers was less desirable than yield grades of Angus, 1/4- and 1/2-Brahman steers. Huffman and coworkers stated that the steers with lower percentages of Brahman breeding had more weight adjusted ribeye area which resulted in more desirable yield grades when steers were compared at an equitable degree of fatness. DeRouen et al. (1992) reported that although direct additive genetic effects of Brahman breeding were negative and undesirable for retail yield, individual heterotic effects were significantly positive (desirable) for this trait. Further, Crews (1992) reported that steers produced from "composite x composite" matings (Braford, Simbrah and Senepol bulls mated to 50% *Bos indicus*-50% *Bos taurus* cows) fed to 1.0 cm outside fat did not significantly differ in yield grade or ribeye area per unit carcass weight. The steers in this study ranged from 25 to 43% *Bos indicus* influence. Crews concluded that slaughter at equitable fatness reduced among breed variation in yield grade. When fatness is held constant or experimentally controlled, variation in yield grade becomes primarily a function of ribeye area per unit carcass weight. Huffman et al. (1990) stated that one-fourth or less Brahman breeding did not decrease carcass yield. Compared to steers with higher percentages of Brahman breeding, their Angus and 1/4-Brahman steers were equally efficient in the feedlot and produced more valuable carcasses, thus, there was little advantage to increasing the percentage of Brahman breeding beyond 25%.

Carcass Quality

Morgan et al. (1991) indicated that the single most important consumer component of beef palatability was tenderness. Further, the National Beef Quality Audit (NCA, 1992) attributed a lost profit potential of approximately $25 per head to defects associated with marbling and palatability, or carcass quality. Consumers prefer leaner beef, but also beef that has superior palatability. Although the relationship between tenderness and marbling is low, increased marbling decreases the probability that beef will be perceived by the consumer to be dry, flavorless and tough. Tenderness is not as yet directly measured in carcasses to determine quality grade. Further, variation in tenderness decreases the consistency of the U.S. Choice and Select quality grades. Young beef carcasses (9 to 30 mo of age) which typically receive the A (young) maturity score vary in quality grade due primarily to marbling score. Brahman breeding has been consistently associated with lower marbling scores. After constant feeding periods, several researchers have reported that cattle with Brahman and other zebu breeding produce carcasses that receive lower marbling scores than cattle without *Bos indicus* influence (Comerford et al., 1988; Koch et al., 1982; Peacock et al., 1982). DeRouen et al. (1992) reported that the breed direct genetic effects of the Brahman were large and negative for marbling score. Crouse et al. (1989) showed that increasing percentages of Brahman and Sahiwal breeding was associated with lower marbling scores. This was supported by the work of Huffman et al. (1990), who reported lower marbling scores for cattle with increased percentages of Brahman breeding when compared at equitable external fat. Crews (1992) further found that the variability in marbling score was higher among steers with 50% Brahman breeding when compared to steers with 25 or 43% *Bos indicus* breeding.

Tenderness is typically measured objectively by Warner-Bratzler shear force and also by means of trained sensory panels. Many researchers have found that cattle with Brahman breeding produce meat that is less tender than do cattle with predominantly *Bos taurus* breeding. Lopes (1986) reported that the Warner-Bratzler shear force means of F_1 Brahman x Hereford steers were 1.5 kg higher (less desirable) than those of straightbred Hereford steers. He supported the findings of Cesar (1984) who reported that Brahman x European crossbred steers had tougher loin steaks than European x European crossbred steers. Several researchers have shown than an increase in percentage Brahman or zebu breeding was associated with increased Warner-Bratzler shear force values and decreased sensory panel ratings for tenderness (Shackelford et al., 1991; Huffman et al., 1990; Crouse et al., 1989, Carpenter et al., 1961). Koch et al. (1982) reported that 14% of Brahman and 20% of Sahiwal crossbreds fell below minimum acceptable tenderness levels, and that *Bos indicus* cattle were more variable in tenderness than were *Bos taurus* cattle. DeRouen et al. (1992) found positively large and desirable direct heterotic genetic effects of Brahman breeding on Warner-Bratzler shear force means. Johnson et al. (1990) concluded that differences in tenderness between breed groups varying in percentage Brahman were not attributable to the effects of cold shortening or in the amount or integrity of connective tissue; i.e. fragmentation index and percent soluble collagen did not differ among steers with Brahman breeding from 0 to 75%. The 10-d postmortem aging study of Johnson and coworkers revealed a differential breed group response to postmortem aging, suggesting that breed groups differed in the amount and(or) activity of endogenous proteolytic enzymes. Likewise, Whipple et al. (1990) found no differences among breed types in sarcomere length, fiber type or soluble collagen. Shackelford et al. (1991) found reduced calpain (neutral, calcium-dependent protease) activity due to higher levels of calpastatin (calpain-inhibitor) binding in Brahman crossbreds. A significantly large effort is underway wherein scientists are attempting to understand the calpain/calpastatin system in cattle. It appears from the data currently available that a portion of the lower tenderness and higher variability in tenderness associated with Brahman-influenced cattle may be due in part to calpastatin activity. Estimates of calpastatin heritability ($h^2 = .65 \pm .19$) and the genetic correlation of calpastatin activity with retail product yield ($r_g = -.63 \pm .15$) led Shackelford et al. (1994) to suggest selection against calpastatin activity as an approach to improving beef tenderness.

Conclusions and Implications

The National Beef Quality Audit-1991 clearly indicates that a large amount of potential profit is lost during the beef production cycle, due in part either to mismanagement of acceptable genetics or to genetic nonconformity. Nearly one-third of the cattle graded U.S. Choice in the audit were yield grade two or better, indicating that the genetic resources to produce lean carcasses with acceptable marbling levels are available. The Quality Audit further indicates that an excessive number of cattle are produced which are unlikely to produce desirable carcasses under current industry standards. If selection for superior carcass composition, or carcass merit, is to be successful, economic signals must be sent back through the cycle to the genetic source. The most significant opportunities to improve the consistency and acceptability of beef can be related to genetic management. Economic incentive must be given at all levels of the beef cycle for the production of cattle which target the consumer demands for a leaner, more consistently palatable beef product. Further study will be required if the beef industry is to identify genetic resources which produce superior carcasses, and more importantly, those which do not conform.

The combining ability and heterosis gained through the use of Brahman genetics are positive and desirable for most economically important beef production traits. The adaptability of the Brahman and its crosses often mandates the use of some percentage Brahman breeding in semi-tropical environments. The positive effects of crossbreeding programs utilizing *Bos indicus* germ plasm on growth rate and weight allows for efficient beef production. Since no breed boasts superior performance for all traits of economic importance, selection and management for carcass merit could be used in improvement programs. Research indicates that cattle with approximately 25% zebu influence are comparable in carcass composition to cattle with no *Bos indicus* breeding. Crossbreeding systems utilizing "composite x composite" matings among Brahman-derivative breeds, or terminal systems which maintain lower levels of zebu influence in beef calves could be considered superior in the Gulf Coast Region of the United States. Continued investigation of the proteolytic enzyme systems influencing tenderness may yield methods for improving tenderness in Brahman-influenced cattle. Identification of cattle and lines which consistently produce lean (USDA yield grade 2 or better) and palatable (marbling scores of Select-plus or better) carcasses would also be effective. Of greater importance may be the identification and elimination of cattle and lines with unacceptable carcass composition under current industry standards. All segments of the market chain must become responsive to the consumer desire for leanness and palatability. The improvement of carcass merit in cattle with Brahman influence depends upon genetic management and an emphasis on a product-targeted concept.

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Table 1. Comparison of carcass traits between two U.S. beef cooler audits.[a]

Trait	Year	
	1991	1974
Carcass weight, kg	344.2	307.99
Fat thickness, cm	1.498	1.473
Ribeye area, cm^2	83.23	76.13
KPH fat, %	2.2	3.0
USDA yield grade	3.2	3.4
Marbling score	Small-minus	Small-plus

[a] Adapted from National Beef Cattle Quality Audit Executive Summary (NCA, 1992)

MINUTES OF BEEF IMPROVEMENT FEDERATION
MIDYEAR BOARD OF DIRECTORS MEETING
Barclay Lodge
YMCA of the Rockies
Estes Park, Colorado
October 21, 1994

The Beef Improvement Federation Board of Directors held it's Midyear Board meeting at the Barclay Lodge, YMCA of the Rockies in Estes Park, Colorado, on October 21, 1994.

Board members present for the meeting were Paul Bennett, President, Ron Bolze, Executive Director, Willie Altenburg, Kent Anderson, Glenn Brinkman, John Crouch, Larry Cundiff, Burke Healey, Doug Hixon, John Hough, Roger Hunsley, Doug Husfeld, Gary Johnson, Dan Kniffen, Marvin Nichols, Ronnie Silcox, Normal Vincel, and Richard Willham. Board members not in attendance were Don Boggs, Paola de Rose, Jed Dillard, Lee Leachman, Craig Ludwig, Roy McPhee, and Gary Weber.

Also attending the meeting was Bruce Cunningham, Chairman of the Reproduction Committee.

President Bennett called the meeting to order at approximately 8:23 A.M. on Friday, October 21, 1994, and the following items of business were transacted.

President Bennett cleared the agenda. One additional item was added to the agenda. John Hough requested that the Board discuss the Cattle-Fax Standardized Performance Analysis (SPA) proposal.

MINUTES OF THE PREVIOUS MEETING - Copies of the minutes from the previous Board meeting held May 31 - June 3, 1994, at the University Park Holiday Inn, West Des Moines, Iowa, were distributed by Bolze. Crouch moved to approve and wave reading of the minutes. Altenburg seconded and the minutes were approved.

FINANCIAL REPORT - Bolze provided copies of the statement of assets, liabilities and fund balance (cash basis); and copies of the statement of revenues and expenses (cash basis) for the period of time including January 1, 1994 -

October 15, 1994. Healey moved to approve the financial report. Hough seconded and the financial report was approved.

1994 CONVENTION FINANCIAL REPORT - Bolze provided copies of the 1994 Des Moines, Iowa convention financial report. Nichols reported that the Iowa Cattlemen's Association had $4,781.07 left after paying all bills. Nichols indicated that these excess funds would be utilized to recruit and provide training for young cattle producers that have the potential to provide future leadership for Iowa Cattlemen's Association and the National Cattlemen's Association. Altenburg applauded the efforts of Nichols, Strohbehn, Willham, Wilson, Rouse and others which hosted the excellent 1994 convention in Des Moines, Iowa.

1995 WYOMING CONVENTION REPORT - Glenn Brinkman, Chairman of the 1995 Wyoming Convention Planning Committee consisting of Hixon, Dillard, Vincel, Altenburg, Anderson, Bennett and Bolze, reported that the committee had met the previous day. Hixon, representing the hosting organization, the Wyoming Beef Cattle Improvement Association, distributed a tentative convention program and budget. The two general session themes were entitled "Genetic Mechanisms For Reducing Production Costs" and "Market Target Endpoints Versus The Optimum Cow". The Board discussed the various topics and potential back-up speakers. Hixon proposed registration alternatives to accommodate additional convention attendees including single day, spouse and student attendance. Hough moved and Willham seconded convention program and budget approval. Motion carried. Hixon indicated that the Wyoming Beef Cattle Improvement Association would split potential 1995 convention profits in exchange for BIF underwriting potential convention losses up to $5,000.

FRANK BAKER MEMORIAL SCHOLARSHIP AWARDS - Larry Cundiff, Chairman of the Frank Baker Memorial Scholarship Awards Committee also including Willham and Silcox, reported that topic areas for essays submitted by animal breeding graduate student applicants would be expanded for 1995. Two recipients would be recognized and receive $500 scholarships in 1995 to help defray costs of convention attendance. Crouch recognized the committee members' efforts.

GUIDELINES REVISION REPORT - Richard Willham, Chairman of the Guidelines Revision Outline Committee also including, Cunningham, Crouch, Silcox, Hough, Cundiff and Healey, reported that the committee had met the previous day. Willham proposed the following Guidelines Revision Outline:

Outline	Responsibility
I. **INTRODUCTION**	Bolze
II. **EVALUATION**	
A. Breeding Herd	
1. Reproduction	
2. Body Condition	Cunningham
3. Cow Efficiency	
4. Mature Size	
B. Progeny	
1. Growth & Efficiency	Silcox
a. Birth	
b. Weaning	
c. Post Weaning	
d. Frame Score	
2. Composition	Crouch
a. Live	
b. Carcass	
3. Behavior	Crouch
4. Reproduction	Cunningham
5. Central Test	Silcox
C. Biotechnology	Healey
III. **PREDICTION**	Willham & Cundiff
IV. **UTILIZATION**	Hough
A. IRM Concept	
B. Seedstock Program	
C. Commercial Program	
D. Systems	
1. Interactions	
2. SPA	

V. APPENDICES Vincel, Silcox, Hough

VI. GLOSSARY Boggs

VII. INDEX Editor

Willham reported that the committee proposed that BIF fund and pay for the expertise of an editor to be responsible for Guidelines revision with the cost estimated to be from $2000 - $4000. Names suggested included Curt Bailey, Jim Brinks, Bill McGee, Ike Eller, Bill Hoenboken and Curly Cook. An understanding of Beef Cattle Animal Breeding and BIF would be helpful. The editor would work with the writers starting with the drafts. The time line suggested for Guidelines revision is for the writers to develop a draft of these sections and circulate these to their writing committees prior to the 1995 BIF meeting in Wyoming. At the Wyoming meeting, committee meetings would be devoted to the study and rewrite of the drafts. These corrected and updated drafts would be presented for Board approval at the 1995 Midyear Board meeting. After the editor incorporated the changes, the revised Guidelines would be published and ready for distribution in early 1996, possible at the 1996 convention in Alabama. Brinkman suggested sub-committee review. Further discussion revealed that many BIF standing committees already have sub-committees challenged with rewriting specific Guidelines sections. Crouch questioned standing committee open discussion resulting in input for incorporation into the Guidelines revision process. Healey reminded the Board that recently approved BIF by-laws changes specifically provided for the opportunity for committee attendees to have direct input into committee decision. Healey suggested not printing a complete list of authors as part of Guidelines revisions. Vincel moved and Johnson seconded to encourage Willham and Cundiff to secure an editor and offer $2000 for editing services plus an additional $2000 to cover editor travel expenses to the Wyoming convention and 1995 Midyear Board meeting. Motion carried. Willham moved and Healey seconded the Guidelines revision time line. Motion carried.

BEEF INDUSTRY LONG RANGE PLAN - Burke Healey reported on the latest developments with the Beef Industry Long Range Plan. He reported on the likely positions to be adopted by the Beef Industry Council of the National Livestock and Meat Board, Meat Export Federation, Cattlemens Beef Promotion and Research Board and the National Cattlemen's Association. Kniffen indicated that the four separate organizations' issues management teams have started to function as a single unit already. Discussion followed concerning potential implications for BIF.

WRCC-100 REPORT - Richard Willham distributed copies of the WRCC-100 report for the National Coordinating Committee entitled "Statistical and Computer Strategies For National Beef Cattle Evaluation". This committee provided a forum for scientists to discuss and coordinate new technologies for use by BIF. Committee objectives include development of EPDs for economic traits. Development or more efficient computer strategies for larger data sets, development of procedures to allow comparison of EPDs across breeds, development of genetic prediction for crossbred populations and publishing recommendations for use by BIF, breed associations and extension specialists.

NC-196 REPORT - Richard Willham distributed copies of the report of Continuation of Research Project NC-196 entitled "The Genetic and Performance Prediction of Body Composition in Beef Cattle". Objectives of the project involve development of a breed difference table for body composition, production of EPDs for body composition based on both live animal ultrasound and carcass measures, and development of objective methods for evaluating carcasses for retail product characteristics using ultrasound.

SELECTION INDEX WORKSHOP REPORT - Richard Willham distributed copies of a proposal outlining details of a workshop on breeding objectives for North American Beef Production. The proposed workshop originated as a result of a series of Selection Index Meetings. The workshop is at the interface between the BIF Genetic Prediction and the BIF Integrated Genetic Systems Committees. Willham moved for BIF to financially support the workshop. Discussion followed concerning the role of BIF in the development of indexing procedures. Willham moved to retract the workshop funding proposal. Healey seconded and the motion carried.

STANDING COMMITTEE REPORTS

A. GENETIC PREDICTION - Larry Cundiff, Chairman.

Larry Cundiff reported that a rough draft of the Genetic Prediction section for the Guidelines revision process was complete. Cundiff also reported that Dave Daley of the Composite Cattle Breeders Alliance (CCBA) has recommended that methodology for generation of EPDs for crossbred populations be developed by the BIF Genetic Prediction Committee. Creation of a separate committee was not viewed as necessary. No Board action required.

B. INTEGRATED GENETIC SYSTEMS - John Hough, Chairman.
John Hough reported that a writing committee is currently working on Guidelines revision. Hough distributed copies of a Cattle-Fax proposal targeted to the Beef Breed Coalition requesting financial assistance for Standardized Performance Analysis (SPA)-Seedstock support and data development. Objectives of the proposal were to facilitate the use of the SPA-Seedstock Program among seedstock producers and for Cattle-Fax and the Beef Breeds Coalition to form a joint effort aimed at providing support to SPA-Seedstock users. No Board action required. Kniffen indicated that the use of Quicken software has simplified the use of SPA-Seedstock. Healey envisioned and promoted National level breed association processing of seedstock records through SPA-Seedstock. Discussion followed concerning the merits of whole herd/inventory based reporting systems. Kniffen reported that changes had been made in the 1995 IRM Red Books to promote the concept of whole herd/inventory based reporting. No Board action required.

C. LIVE ANIMAL AND CARCASS EVALUATION-John Crouch, Chairman.
John Crouch reported that the Live Animal and Carcass Evaluation section of the Guidelines is being revised to incorporate docility scores, body condition scores, frame scores, using performance information in the showring, and structured sire evaluation for carcass traits authored by Kent Anderson, Sally Northcutt, Robert Schalles, Jim Leachman and Doyle Wilson, respectively. Crouch indicated that potential topics for the next committee meeting would include Prediction of % Carcass Fat by Ultrasound Measurement and Standardization of Warner Bratsler Shear Force Values. Crouch reported that Jim Stouffer, from Cornell, has developed computer software capability to analyze % fat at the same time the ultrasound measurement is taken. In addition, Crouch reported that an Iowa State University Ultrasound Training Program is scheduled for January 8-11, 1995 and the Ultrasound Certification Process is scheduled for May/June, 1995 with specific dates reported later. No Board action required.

D. BIOTECHNOLOGY - Burke Healey, Chairman.
Burke Healey indicated that a writing committee was currently developing a Biotechnology Guidelines section including reference to gene markers, marker assisted selection and other biotechnological concepts. No Board action required.

E. CENTRAL TEST AND GROWTH - Ronnie Silcox, Chairman.
Ronnie Silcox reported that Hough had developed a national listing of state level steer feedouts. The listing appeared in the most recent BIF Update. Silcox reported that a sub-committee was developing general guidelines for State Feedout Programs. Silcox distributed copies of a publication authored by Silcox and Northcutt, entitled "Post Weaning Evaluation Programs for Beef Bulls" that has application to on-farm bull test procedures. The publication was referred to Don Boggs, Coordinator of BIF fact sheets, for potential fact sheet development. Silcox indicated that a writing sub-committee was currently revising the Central Bull Test section of the Guidelines. No Board action required.

F. REPRODUCTION - Bruce Cunningham, Chairman.
Bruce Cunningham reported that the Reproduction section for Guidelines revision would incorporate yearling scrotal circumference adjustment equations developed by Robert Schalles. The new Breeding Soundness Evaluation (BSE) format as approved by the Society for Theriogenology would be included. Other potential inclusions involved genetic prediction of reproductive traits including Calving Date EPDs and Stayability EPDs as developed by Mike McNeil and Bruce Golden, respectively. Hunsley questioned current industry emphasis on carcass characteristics given the incomplete knowledge of the impact of carcass trait selection on reproductive traits. Crouch suggested that the research committee NC-196 (Genetic and Performance Prediction of Body Composition in Beef Cattle) focus research efforts on carcass trait selection and its impact on subsequent maternal and reproductive traits. Cundiff indicated that the Meat Animal Research Center (MARC) Germ Plasm Evaluation (GPE) data strongly suggests between breed positive puberty/marbling relationships. However, the within breed question remains unanswered. Cundiff suggested research to compare steer carcass data to lifetime reproductivity/productivity of 1/2 sibling sisters. Anderson suggested evaluation of scrotal circumference to 1/2 sibling steer carcass characteristics. Altenburg questioned how many breed associations have or are considering inventory based cow herd recording systems. Kniffen explained inventory based cow herd recording procedures currently incorporated into Commercial Cow/Calf SPA and Seedstock SPA. Hixon questioned the repeatability of pelvic area measurement and suggested it's use as an independent culling level only. Cunningham agreed to arrange for discussion of inventory based cow herd reporting and the utility of pelvic area measurements at the 1995 convention Reproduction Committee meeting. No Board action required.

1995 BIF OPERATING BUDGET - Ron Bolze distributed copies of a proposed 1995 BIF operating budget. Crouch moved to approve loan of BIF funds to the Wyoming Beef Cattle Improvement Association to cover some preliminary 1995 convention expenses. Altenburg seconded. Healey amended the original motion to place a $2000 upper limit on fund transfer. Hunsley seconded. The amended motion carried. Brinkman moved and Crouch seconded for revised 1995 budget approval. Motion carried.

NOMINATING COMMITTEE - President Bennett appointed the nominating committee to include Altenburg, Chairman, Anderson, Boggs, Hunsley and McPhee.

AWARDS COMMITTEE - President Bennett appointed the awards committee to include Vincel, Chairman, Johnson, Husfeld, Healey and Dillard. The Executive Director will handle 1995 Seedstock and Commercial Producer awards. The Awards Committee will handle Ambassador, Pioneer and Continuing Service awards. Brinkman initiated discussion on the number of awards was derived. Vincel proposed a change in award presentation format with introduction consisting of five slides presented per commercial and seedstock producer nominee.

1995 MIDYEAR BOARD MEETING - Ron Bolze solicited Board input into time and location for the 1995 BIF Midyear Board meeting. Potential pros and cons were discussed for both Kansas City and Estes Park. Board majority preferred to return to the Barclay Lodge, YMCA of the Rockies, Estes Park, Colorado. The only open dates were Friday and Saturday, October 27 and 28, 1995. Dates were confirmed and reservations were made.

There being no further business, President Bennett adjourned the 1994 Midyear Board meeting at 4:30 P.M.

Respectively Submitted,

Ron Bolze
Executive Director
Beef Improvement Federation

BEEF IMPROVEMENT FEDERATION

STATEMENT OF ASSETS, LIABILITIES AND FUND BALANCE
CASH BASIS
December 31, 1994

ASSETS

Cash In Bank	$11,718.44
Certificate of Deposit	36,758.37
Total Current Assets	48,476.81
Total Assets	$48,476.81

LIABILITIES & FUND BALANCE

Current Liabilities	$ 0.00
Fund Balance - December 31, 1993	43,152.40
Current Year Excess	5,324.41
Total Fund Balance - December 31, 1994	48,476.81
Total Liabilities and Fund Balance	$48,476.81

See Attached Accountant's Compilation Report

BEEF IMPROVEMENT FEDERATION

STATEMENT OF REVENUES AND EXPENSES
CASH BASIS
For The Twelve Months Ending December 31, 1994

REVENUES

Dues	$ 11,172.21	
Proceedings & Guidelines	2,318.11	
History Sales	1,007.90	
Reimbursements (Board Member-Midyear)	3,583.20	
Interest	1,679.08	
Total Revenues		$ 19,760.50

EXPENSES

Payroll Tax	$ 6.06	
Bank Charges	10.00	
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Office Expense	176.95	
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Printing	1,170.74	
Miscellaneous	653.00	
Postage & Freight	3,640.65	
Convention Awards, Plaques	2,622.43	
Total Expenses		$ 14,436.09
Excess of Revenue over Expense		$ 5,324.41

See Attached Accountant's Compilation Report

ROGER D KOUGH
ACCREDITED BUSINESS ACCOUNTANT
190 WEST 6TH STREET
COLBY, KANSAS 67701
(913) 462-3182

Beef Improvement Federation
Ron Bolze, Executive Director
Colby, Kansas

I have compiled the accompanying statement of assets and liabilities - cash basis - of The Beef Improvement Federation, a not for profit organization, as of December 31, 1994 and the related statement of revenues and expenses - cash basis - for the twelve months then ended. The financial statements have been prepared on the cash basis of accounting, which is a comprehensive basis of accounting other than generally accepted accounting principles.

A compilation is limited to presenting, in the form of financial statements, information that is the representation of the officers of the Federation. I have not audited or reviewed the accompanying financial statements and, accordingly, do not express an opinion or any other form of assurance on them.

Management has elected to omit substantially all of the disclosures required by generally accepted accounting principles. If the omitted disclosures were included in the financial statements, they might influence the user's conclusions about the Federation's financial position, results of operation, and cash flows. Accordingly, these financial statements are not designed for those who are not informed about such matters.

The effects on these financial statements of the above described adjustments, required under generally accepted accounting principles have not been determined by management.

Respectfully Submitted,

Roger D Kough

Roger D. Kough

Agenda
BIF Board of Directors Meeting
Holiday Inn
Sheridan, Wyoming
Wednesday, May 31, 1995

1) Clear Agenda - Paul Bennett
2) Minutes of Previous Meeting - Ron Bolze
3) Financial Report - Ron Bolze
4) Membership Report - Ron Bolze
5) Historian and Archive Report - Richard Willham
6) Report on Wyoming Convention - Doug Hixon; Jack & Gini Chase
7) Plans for 1996 Convention in Alabama - Dave Maples & Lisa Kriese
8) Proposal for 1997 Convention in North Dakota - Kris Ringwall
9) Guidelines - Revision Progress - Curtis Bailey
10) Standing Committee Reports - Plans for the Convention
    a) Biotechnology - Burke Healey
    b) Central Test and Growth - Ronnie Silcox
    c) Genetic Prediction - Larry Cundiff
    d) Intergrated Genetic Systems - John Hough
    e) Live Animal and Carcass Evaluation - John Crouch
    f) Reproduction - Bruce Cunningham
11) Frank Baker Scholarship Awards - Larry Cundiff
12) Election of New Officers - Nominations Committee
    Willie Altenburg, Chairman
13) Awards - Awards Committee, Norman Vincel, Chairman
14) Plans for New Director Caucuses - Norman Vincel
15) Midyear Board Meeting - October 27 - 29, Estes Park, Colorado
    Ron Bolze
16) Western Regional Secretary Replacement - Doug Hixon
17) New Business - Paul Bennett
18) Adjourn

MINUTES OF BEEF IMPROVEMENT FEDERATION
BOARD OF DIRECTORS MEETING
Atrium Hotel and Conference Center
Holiday Inn
Sheridan, Wyoming
May 31 - June 3, 1995

The Beef Improvement Federation Board of Directors held it's convention at the Holiday Inn in Sheridan, Wyoming on May 31 through June 3, 1995.

Board members present for the meeting were Glenn Brinkman, Vice President; Ron Bolze, Executive Director; Willie Altenburg, Don Boggs, John Crouch, Jed Dillard, Burke Healey, Doug Hixon, Roger Hunsley, John Hough, Doug Husfeld, Gary Johnson, Dan Kniffen, Lee Leachman, Craig Ludwig, Marvin Nichols, Mike Schutz, Ronnie Silcox, Norman Vincel and Richard Willham. Board members not in attendance due primarily to airline flight delays were Kent Anderson, Paul Bennett, Larry Cundiff and Roy McPhee.

Also attending the meeting were Bruce Cunningham, Chairman of the Reproduction Committee; Curt Bailey, Editor of the Guidelines revision process; Lisa Kriese, representing the 1996 convention hosts; Kris Ringwall and Michelle Weber, representing the 1997 convention hosts; and Wanda Cerkoney and Jodi Bierk, National Western Stock Show Leadership Scholarship recipients from the University of Wyoming.

Vice President Brinkman called the meeting to order at approximately 3:20 P.M. on Wednesday, May 31, 1995 and the following items of business were transacted.

Vice President Brinkman cleared the agenda. Two additional items were added to the agenda. Bolze requested that Healey provide an update on current status of the approved merger of The National Cattlemen's Association (NCA), Beef Industry Council (BIC) to the National Livestock and Meat Board, Cattlemen's Beef Promotion and Research Board (CBB) and the Meat Export Federation (MEF). Hough requested discussion of a proposed Genetic Prediction workshop focusing on ultrasound applications.

Bolze circulated a Board of Directors listing for correction of addresses and phone numbers. Kniffen suggested inclusion of E-Mail addresses where appropriate.

MINUTES OF THE PREVIOUS MEETING - Bolze distributed copies of the minutes from the previous Midyear Board Meeting held October 21, 1994 at the Barclay Lodge, YMCA of the Rockies, Estes Park, Colorado. Crouch moved to approve and wave reading of the minutes. Leachman seconded and the minutes were approved as written.

FINANCIAL REPORT - Bolze provided copies of the statement of assets, liabilities and fund balance (cash basis) for December 31, 1994 and May 31, 1995. Bolze also provided copies of the statement of revenues and expenses (cash basis) for the periods of time including January

1, 1994 - December 31, 1994 and January 1, 1995 - May 31, 1995. Brinkman suggested that the 1994 financial report reflect Board members reimbursement to BIF for Midyear Board Meeting expenses. Boggs questioned minimal printing and no telephone expenses. Crouch expressed that BIF should cover expenses. Bolze expressed that Kansas State University administrators were aware of the situation and content to cover expenses if funds were available. No approval of financial report was necessary.

MEMBERSHIP REPORT - Bolze distributed copies of the membership report. The report showed that 33 state organizations, 27 breed associations and 21 other firms or individuals had paid membership dues as of May 31, 1995. Bolze indicated that dues solicitation notices had been mailed to all previously paid membership organizations the second week of January, 1995. Second notices were sent to all unpaid memberships in early April, 1995 along with telephone contact.

PLANS FOR 1995 CONVENTION - Vice President Brinkman recognized Doug Hixon as convention host and Hixon brought the Board up to date on convention activities and preregistration numbers. The Board expressed thanks to Hixon, the University of Wyoming Animal Science Department and the Wyoming Beef Cattle Improvement Association for a job well done.

PLANS FOR THE 1996 CONVENTION - Vice President Brinkman recognized Lisa Kriese, Beef Extension Specialist, Animal Science Dept., Auburn University, co-host of the 1996 convention along with the Alabama Beef Cattle Improvement Association. Kriese announced that the 1996 BIF Convention would be held at the Sheraton Convention Civic Center Complex in Birmingham, Alabama on May 16 - 18, 1996. Kriese provided further details regarding accommodations and potential tour attractions. Kriese and/or Dave Maples from the Alabama Beef Cattle Improvement Association will attend the Midyear Board Meeting in Estes Park for 1996 convention program development.

PROPOSAL FOR THE 1997 CONVENTION - Vice President Brinkman recognized Kris Ringwall, Livestock Extension Specialist, Animal Science Department, North Dakota State University, Co-Host of the 1997 convention along with the North Dakota Beef Cattle Improvement Association. Ringwall presented a formal proposal inviting BIF to hold their 1997 convention in Dickinson, North Dakota. Ringwall then introduced Michelle Weber from the Dickinson Convention and Visitors Bureau who presented hotel accommodations, air service and additional benefits of holding the convention in Dickinson. After further discussion, Healey moved and Crouch seconded that we accept the North Dakota proposal. Motion carried. Specific dates were tabled until Midyear Board Meeting with strong suggestion from numerous Board members to return to an early to mid-May time frame.

LONG RANGE TASK FORCE PROPOSAL - Vice President Brinkman called on Healey to provide current status of the approved merger of NCA, BIC, CBB and MEF. Healey distributed a "Process of Transition" schematic which outlined the current merger thought process. Healey reported that the MEF preferred to remain outside the merger and function as an independent contractor. At their respective conventions, the NCA, CBB and State Beef

Council affiliates of the BIC had voted to merge. However, later legal counsel advised that the CBB could not legally merge according to statutes outlined in The Cattlemens Beef Promotion and Research Act which implemented the beef check-off system. Healey indicated that a series of stake holder congresses would be scheduled for future producer input.

GUIDELINES REVISION PROCESS - Vice President Glenn Brinkman recognized Curt Bailey, Editor of the Guidelines revision process. Bailey distributed a draft of the Guidelines and briefly discussed currently submitted sections. Sections yet to be submitted included the Introduction, Growth and Efficiency and the remainder of the Appendix and Index. With two revisions completed, standardization of format, clarity and accuracy of statements would receive attention. Bailey offered additional suggestions including, however not limited to the presence of inconsistencies, concentration of Table of Contents, removal of subheadings, introductory synopsis of the United States Purebred Beef Cattle Industry, ultrasonography, biotechnologies including embryo transfer, splitting and cloning plus an appendix listing breed association and allied industries telephone/Fax numbers and mailing addresses. Silcox indicated the Appendix was complete for currently paid dues members. Willham questioned incorporation of an historical account of the purebred industry. Kniffen questioned the incorporation of artificial insemination/embryo transfer within the Biotechnology section. Healey proposed that current revisions be presented to convention committee meeting participants for review. Crouch suggested minimal committee input to expedite the review process. Vincel proposed that section authors address suggestions rather than the entire Board. Silcox suggested that section authors meet with Bailey during the convention. Crouch, Silcox, Healey, Hough, Boggs and Willham agreed to meet with Bailey immediately after dinner. Healey suggested and Bailey agreed that committee suggestions be incorporated into the revision process by September 1, 1995. Bailey agreed to report back when the Board reconvened Saturday morning.

STANDING COMMITTEE REPORTS- PLANS FOR THE CONVENTION

a. Biotechnology - Burke Healey
Healey reported that Jerry Taylor would present the current status and recent breakthroughs in the discovery of gene markers for the bovine genome. In addition, the committee will review and discuss the Biotechnology section for the Guidelines revision process.

b. Central Test and Growth - Ronnie Silcox
Silcox reported that Dave Patterson would report on a University of Kentucky sponsored heifer development program. Darrh Bullock, also from the University of Kentucky would present data involving relationships between pelvic area and puberty in developing heifers. John Hough would review the directory of state sponsored feed-out programs. Roger McCraw would lead a discussion of types of carcass data to be collected in steer feed-out programs. In addition, the committee would review and discuss the Central Test and growth section for the Guidelines review process.

c. Genetic Prediction - Larry Cundiff

In the absence of Cundiff, Willham reported that updated breed means and adjustment factors for across breed EPD's would be presented. Reports on the genetic evaluation of stayability and genetic resistance to nematodes would be presented. In addition, the committee would review and discuss revision of the BIF Guidelines for Genetic Evaluation. Willham proposed that a Genetic Prediction workshop involving ultrasonography applications be scheduled for December 8-9, 1995 at the Kansas City Airport Embassy Suites.

d. Integrated Genetic Systems - John Hough

Hough reported that he, Kniffen, Comerford and Bullock would present Guidelines revision utilization sections for committee review. There would also be a round table discussion concerning the relationships between genetics, production and economics in the beef cattle business involving Larry Benyshek, Troy Marshall and Bryan Melton. In addition, discussion would focus on breed association implementation of generating Standardized Performance Analysis (SPA) for seedstock producers.

e. Live Animal and Carcass Evaluation - John Crouch

Crouch reported that Gene Rouse, Iowa State, would present alternative methods in determining carcass merit in live cattle. Kurt Steinkamp, Iowa State, would present validations data of real time ultrasound measurements to predict body composition traits. William Herring, University of Missouri, would present the guidelines and adjustment factors utilized in the ultrasound certification process. In addition, Crouch would lead a discussion concerning the need for an ultrasonic hardware and software equipment evaluation session.

FRANK BAKER MEMORIAL SCHOLARSHIP AWARDS - Willham, reporting for the committee also including Cundiff, Hubbard and Silcox, stated that two individuals would be recognized as recipients of the Frank Baker Memorial Scholarship Award. Recipients included Dan Moser, University of Georgia and Denny Crews, Jr., Louisiana State University. The awards consisting of $500. checks plus plaques would be presented at the Friday evening awards banquet. Recipients papers would be published in the Proceedings.

ELECTION OF NEW OFFICERS - Altenburg, Chairman of the Nominating Committee also including Anderson, Boggs, Hunsley and McPhee, presented the following nominations: Glenn Brinkman for President and Burke Healey for Vice President. Healey's first three year term ended in 1995, however, he was eligible for re-election to a second three year term. Therefore, Altenburg amended that vice presidential nomination making it pending Healey's re-election the following day during the caucus for election of directors. There being no further nominations, Crouch moved the nominations cease and the two be elected by acclamation pending Healey's re-election. Dillard seconded and the motion carried.

AWARDS COMMITTEE - Vincel, Chairman of the Awards committee consisting of Johnson, Husfeld, Healey and Dillard presented the following recipients of awards:

Pioneer Award:
Robert Taylor and Jim Brinks
Continuing Service Award:
Brian Pogue, Paul Bennett and Pat Goggins
Ambassador Award:
Nita Effertz
Outstanding Seedstock Producer Award:
Dalebank Angus, Tom and Carolyn Perrier
Outstanding Commercial Producer Award:
Thielen Beef, Joe and Susan Thielen

Vincel indicated that a different format involving 4-5 slides per seedstock/commercial nominee would be employed for greater recognition and to reduce luncheon time requirement. Bolze indicated that this would take place immediately after the Friday general session.

CAUCUS FOR THE ELECTION OF DIRECTORS - Vincel distributed copies outlining necessary caucus action for the election of directors according to the BIF by-laws. In the Eastern region, Bennett's second term expires in 1996 and Dillard was eligible for re-election to a second term. In the central region, Johnson's second term expires in 1997 and Brinkman's second term expires in 1996. In the Western region, Altenburg's first term expires in 1996 and McPhee was eligible for re-election to a second term. In the at-large category, Leachman's first term expires in 1997 and Healey was eligible for re-election to a second term. In the breed associations, the first terms of Husfeld and Anderson expire in 1997; the first terms of Ludwig and Hough expire in 1996; Crouch was eligible for re-election to a second term; Hunsley, fulfilling the unexpired term of Steve McGill was eligible for re-election to two 3 year terms. Vice President Brinkman appointed Silcox, Boggs, Hixon and Hough to chair the Eastern, Central, Western and breed association caucuses, respectively. Boggs questioned if one breed association could have more than one director on the Board given the proposed merger of Polled and Horned Hereford Associations.

MIDYEAR BOARD MEETING - Bolze indicated that a non-refundable $250 deposit had been made to reserve the Barclay Lodge, YMCA of the Rockies, Estes Park, Colorado for Friday through Sunday, October 27-29, 1995 and that 25% of the estimated total rental expenses was due shortly. Leachman moved and Altenburg seconded to hold the Midyear Board meeting as proposed and motion carried. Tentative plans are for the program committee to meet Friday afternoon, October 27 with the Board meeting beginning after dinner and continuing through Saturday.

WESTERN REGION SECRETARY REPLACEMENT - Hixon indicated that hosting the 1995 convention would be his last significant involvement with BIF and requested that the Board pursue a replacement. Numerous potential replacements were discussed. Brinkman suggested that the Western regional directors including Hixon, Altenburg and Leachmen identify and contact an individual at the convention and table the discussion until Saturday morning.

There being no further business, Vice President Brinkman adjourned the meeting at 6:15 P.M. to be reconvened Saturday morning.

President Brinkman reconvened the Board of Directors meeting at 6:30 A.M. Saturday, June 3, 1995. Anderson, Bennett and Cundiff were in attendance. All directors eligible for re-election to a second term were re-elected during the caucuses including Dillard, McPhee, Healey, Crouch and Hunsley. Therefore, Board content did not change.

STANDING COMMITTEE REPORTS:

a. Integrated Genetic Systems - John Hough

Based on committee discussion, Hough moved and Crouch seconded that breed associations take a more active role in recording and reporting Standardized Performance Analysis (SPA) data for seedstock producers. Healey moved to amend motion to expand proposed Genetic Prediction workshop by one day to include a program targeted at breed association staff outlining methods for implementing SPA procedures. Crouch seconded and the amended motion carried. Hough and Kniffen agreed to provide leadership for this one day session.

b. Central Test and Growth - Ronnie Silcox

Silcox indicated that an updated steer feedout list would be available for inclusion in the proceedings. A subcommittee will compile recommendations for carcass collection from steer feedouts compatible with structured sire evaluation methods to generate data useful for carcass trait Expected Progeny Difference (EPD). No Board action required.

c. Reproduction - Bruce Cunningham

Cunningham reported that Lisa Kriese had presented data showing little advantage in sire pelvic area selection to reduce calving difficulty in daughters. Jim Gibb had presented the fee structures associated with whole herd, inventory based record keeping programs. Cunningham suggested standardization of cow disposal codes. No Board action required.

d. Genetic Prediction - Larry Cundiff

Cundiff indicated that the Genetic Evaluation section for Guidelines revision was nearly complete. Breed means and adjustment factors for across breed EPD comparison were presented in committee. Based on Darrh Bullock research, Cundiff indicated that Polled and Horn Hereford cattle were evaluated as being more similar in pure milk EPD in the combined North American evaluations and more divergent in pure milk EPD based on MARC data. Gasbarre from the USDA Helmintic Diseases Laboratory presented evidence for genetic resistance to GI tract nematodes. Warren Snelling presented research on the genetics of stayability involving cows remaining productive in the herd beyond their sixth birthdate and the requirement of whole herd, inventory based recording programs. Willham moved and Vincel seconded that BIF provide $1000 of financial support to a Genetic Prediction workshop focusing on ultrasonography and the development of EPD for body composition. Sessions would include current research, future research needs and producer guidelines. Workshop would be held December 8-9, 1995 at the Kansas City Airport Embassy Suites. Motion carried. Crouch indicated that attendance may need to be limited.

e. Biotechnology - Burke Healey

Healey indicated that Jerry Taylor presented the latest research findings in the discovery of Gene Markers for the bovine genome. The committee suggested that the Biotechnology section for Guidelines revision be rewritten with less caution and greater emphasis on short and long term industry application. Healey indicated that committee discussion strongly suggested that new findings were challenging current theories of inheritance. Many, particularly qualitative traits, may be controlled by as few as 3-5 genes. No Board action required.

f. Live Animal and Carcass Evaluation - John Crouch

Crouch expressed the need for an evaluation process for ultrasonic hardware and software given the diversity within the current five major research institutions (Iowa State, Cornell, Canada, Tennessee and Kansas State). Hough indicated that certification of equipment was just as important as certification of individuals. Discussion followed involving BIF role in development of standards for certification. Brinkman suggested the need for legal counsel. Crouch indicated that the University of Georgia and Auburn University may host an equipment evaluation session late summer, 1995. Crouch moved that BIF be involved in an ultrasound equipment evaluation session for determining % intramuscular fat in cattle. Leachman seconded and motion carried. Crouch moved and Hough seconded that BIF provide $1000 of financial support to the host institution(s) if needed. Motion carried.

GUIDELINES REVISION UPDATE - Curt Bailey updated the Board on results of discussion provided by authors of various sections. Crouch will address the use of ultrasonography for carcass composition prediction. The Biotechnology section will be written more positively by Healey. Names and addresses of BIF paid members will appear in the Appendix. Bailey will provide the Index. Copies of the most current revisions will be sent to Brinkman, Healey, Bolze, Willham, Cunningham, Cundiff, Crouch, Silcox, Boggs, Vincel and Hough by August 1, 1995. Advanced revisions will be available to the entire Board by Midyear Board Meeting. Bailey requested an acknowledgement statement to include list of writers. Appreciation was expressed to Bailey for his perseverance and dedication to staying on schedule.

WESTERN REGIONAL SECRETARY REPLACEMENT - Hixon, Leachman and Altenburg presented the name of Ronnie Green, Colorado State University as a logical replacement for Hixon. Green was recognized as a regular BIF convention attendee, convention speaker and nationally recognized beef cattle geneticist. Green had expressed interest in the position and had received clearance and support from his administrator. Leachman moved and Bennett seconded that Green replace Hixon as Western Regional Secretary. Motion carried. Appreciation was express to Hixon for his years of service to BIF and particularly for hosting the highly successful 1995 convention.

1996 CONVENTION PROGRAM COMMITTEE - President Brinkman appointed a 1996 Convention Program committee consisting of Healey, Chairman; Kriese, Maples, Silcox, Dillard, Green, Schutz and Bolze. The program committee planned to meet a half day early at the Midyear Board Meeting in Estes Park.

GENETIC EVALUATION IN CANADA - President Brinkman recognized Mike Schutz from Canadian Beef Improvement to provide an update on Canadian beef cattle evaluation. Schutz indicated that historically, the Canadian government had subsidized the collection and dissemination of performance data. More recently, beef cattle genetic evaluations have become privatized and are now producer funded. Schutz expressed his anticipation of involvement in BIF activities.

There being no further business, President Brinkman adjourned the meeting at 7:55, Saturday, June 3, 1995.

Respectively Submitted,
Ron Bolze
Executive Director

BEEF IMPROVEMENT FEDERATION

STATEMENT OF ASSETS, LIABILITIES AND FUND BALANCE
CASH BASIS
December 31, 1994

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BEEF IMPROVEMENT FEDERATION

STATEMENT OF REVENUES AND EXPENSES
CASH BASIS
For The Twelve Months Ending December 31, 1994

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Beef Improvement Federation
Ron Bolze, Executive Director
Colby, Kansas

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Respectfully Submitted,

Roger D. Kough

Roger D. Kough

Paid BIF Member Organizations and Amount of Dues for 1995 (as of May 31, 1995)

State BCIA's	Dues		Dues
Alabama	$100	Virginia	$100
California	100	Washington	100
Colorado	100	West Virginia	100
Florida	100	Wisconsin	100
Georgia	100	Wyoming	100
Hawaii	100	**Breed Associations**	
Idaho	100	American Angus	600
Illinois	100	American Beefalo	100
Indiana	100	American Blonde D'Aquitaine	100
Iowa	100	American Brahman	200
Kansas	100	American Chianina	200
Kentucky	100	American Gelbvieh	300
Minnesota	100	American Hereford	300
Mississippi	100	American Int. Charolais	300
Missouri	100	American Murray Grey	100
New York	100	American Polled Hereford	300
New Mexico	100	American Red Brangus	100
North Carolina	100	American Red Poll	100
North Dakota	100	American Salers	300
Ohio	100	American Shorthorn	200
Oklahoma	100	American Simmental	500
Oregon	100	American Tarentaise	100
Pennsylvania	100	Barzona Breeders	100
South Carolina	100	Beef Booster Cattle LTD.	100
South Dakota	100	Beefmaster Breeders	300
Tennessee	100	Canadian Angus	100
Texas	100	Canadian Charolais	200
Utah	100	Canadian Hays Converter	100

Paid BIF Member Organizations (Continued)

Breed Associations (Continued)	Dues		Dues
Canadian Hereford	$100	Integrated Genetic Management	$100
Canadian Simmental	100	King Ranch	50
International Brangus	300	Manitoba Agriculture	100
North American S. Devon	100	National Assoc of Ani Breeders	100
Red Angus Assoc. of America	200	National Cattlemen's Assoc.	100
Salers Assoc. of Canada	100	NOBA, Inc.	100
Santa Gertudis Breeders	200	Rancho Arboleda	50
Senepol Cattle Breeders	100	Ronald Schlegal	50
United Braford Breeders	200	Select Sires	100
Others		Taylors Black Simmental	50
Agricultue Canada	100	Tri-State Breeders	100
American Breeders Service	100	Turner Brothers Farms	50
Beef Improvement Ontario	100	Joe VanZandt	50
Canadian Beef Improvement	100	21st Century Genetics	100
Connor State College	100	John Yardley	50
Great Western Beef Expo	50	John Lillicrop	50
		Saskatchewan Livestock Assoc.	100

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

John Crowe	CA	1972
Dale H. Davis	MT	1972
Elliot Humphrey	AZ	1972
Jerry Moore	OH	1972
James D. Bennett	VA	1972
Harold A. Demorest	OH	1972
Marshall A. Mohler	IN	1972
Billy L. Easley	KY	1972
Messersmith Herefords	NE	1973
Robert Miller	MN	1973
James D. Hemmingsen	IA	1973
Clyde Barks	ND	1973
C. Scott Holden	MT	1973
William F. Borror	CA	1973
Raymond Meyer	SD	1973
Heathman Herefords	WA	1973
Albert West III	TX	1973
Mrs. R.W. Jones, Jr.	GA	1973
Carlton Corbin	OK	1973
Wilfred Dugan	MO	1974
Bert Sackman	ND	1974
Dover Sindelar	MT	1974
Jorgensen Brothers	SD	1974
J. David Nichols	IA	1974
Bobby Lawrence	GA	1974
Marvin Bohmont	NE	1974
Charles Descheemacker	MT	1974
Bert Crame	CA	1974
Burwell M. Bates	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chesnut	WA	1975
George Chiga	OK	1975
Howard Collins	MO	1975
Jack Cooper	MT	1975
Joseph P. Dittmer	IA	1975
Dale Engler	KS	1975
Leslie J. Holden	MT	1975
Robert D. Keefer	MT	1975
Frank Kubik, Jr.	ND	1975
Licking Angus Ranch	NE	1975
Walter S. Markham	CA	1975
Gerhard Mittnes	KS	1976
Ancel Armstrong	VA	1976
Jackie Davis	CA	1976
Sam Friend	MO	1976
Healey Brothers	OK	1976
Stan Lund	MT	1976
Jay Pearson	ID	1976
L. Dale Porter	IA	1976
Robert Sallstrom	MN	1976
M.D. Shepherd	ND	1976
Lowellyn Tewksbury	ND	1976
Harold Anderson	SD	1977
William Borror	CA	1977
Robert Brown, Simmental	TX	1977
Glen Burrows, PRI	NM	1977

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

Henry, Jeanette Chitty	NM	1977
Tom Dashiell, Hereford	WA	1977
Lloyd DeBruycker	MT	1977
Wayne Eshelman	WA	1977
Hubert R. Freise	ND	1977
Floyd Hawkins	MO	1977
Marshall A. Mohler	IN	1977
Clair Percel	KS	1977
Frank Ramackers, Jr.	NE	1977
Loren Schlipf	IL	1977
Tom & Mary Shaw	ID	1977
Bob Sitz	MT	1977
Bill Wolfe	OR	1977
James Volz	MN	1977
A.L. Frau		1978
George Becker	ND	1978
Jack Delaney	MN	1978
L.C. Chestnut	WA	1978
James D. 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 Willson	SD	1979
Donald Barton	UT	1980
Frank Feltonn	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

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

Dwight Houff	VA	1981	Harvey Lemmon	GA	1983
G.W. Cronwell	IA	1981	Frank Myatt	IA	1983
Bob & Gloria Thomas	OR	1981	Stanley Nesemeier	IL	1983
Roy Beeby	OK	1981	Russ Pepper	MT	1983
Herman Schaefer	IL	1981	Robert H. Schafer	MN	1983
Myron Aultfathr	MN	1981	Alex Stauffer	WI	1983
Jack Ragsdale	KY	1981	D. John & Lebert Shultz	MO	1983
W.B. Williams	IL	1982	Phillip A. Abrahamson	MN	1984
Garold Parks	IA	1982	Rob Bieber	SD	1984
David A. Breiner	KS	1982	Jerry Chappel	VA	1984
Joseph S. Bray	KY	1982	Charles W. Druin	KY	1984
Clare Geddes	CAN	1982	Jack Farmer	CA	1984
Howard Krog	MN	1982	John B. Green	LA	1984
Harlin Hecht	MN	1982	Ric Hoyt	OR	1984
William Kottwitz	MO	1982	Fred H. Johnson	OH	1984
Larry Leonhardt	MT	1982	Earl Kindig	VA	1984
Frankie Flint	NM	1982	Glen Klippenstein	MO	1984
Gary & Gerald Carlson	ND	1982	A. Harvey Lemmon	GA	1984
Bob Thomas	OR	1982	Lawrence Meyer	IL	1984
Orville Stangl	SD	1982	Donn & Sylvia Mitchell	CAN	1984
C. Ancel Armstrong	KS	1983	Lee Nichols	IA	1984
Bill Borror	CA	1983	Clair K. Parcel	KS	1984
Charles E. Boyd	KY	1983	Joe C. Powell	NC	1984
John Bruner	SD	1983	Floyd Richard	ND	1984
Leness Hall	WA	1983	Robert L. Sitz	MT	1984
Ric Hoyt	OR	1983	Ric Hoyt	OR	1984
E.A. Keithley	MO	1983	J. Newbill Miller	VA	1985
J. Earl Kindig	MO	1983	George B. Halterman	WV	1985
Jake Larson	ND	1983	David McGehee	KY	1985

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

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 & Family	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 Van Dyke	MT	1986
John H. Wood	SC	1986
Evin & Verne Dunn	CAN	1986
Glenn L. Brinkman	KS	1986
Jack & Gini Chase	WY	1986
Henry & Jeanette Chitty	FL	1986
Lawrence H. Graham	KY	1986
A. Lloyd Grau	NM	1986
Matthew Warren Hall	AL	1986
Richard J. Putnam	NC	1986
Robert J. Steward & Patrick C. Morrissey	PR	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
Robert J. Steward & Patrick 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

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

Glynn Debter	AL	1988	Paul E. Keffaber	IN	1990
William Glanz	WY	1988	John & Chris Oltman	WI	1990
Jay P. Book	IL	1988	John Ragsdale	KY	1990
David Luhman	MN	1988	Otto & Otis Rincker	IL	1990
Scott Burtner	VA	1988	Charles & Rudy Simpson	CAN	1990
Robert E. Walton	WS	1988	T.D. & Roger Steele	VAN	1990
Harry Airey	CAN	1989	Bob Thomas Family	OR	1990
Ed Albaugh	CA	1989	Ann Upchurch	AL	1991
Jack & Nancy Baker	MO	1989	Nicholas Wehrmann & Richard McClung	VA	1991
Ron Bowman	ND	1989	John Bruner	SD	1991
Jerry Allen Burner	VA	1989	Ralph Bridges	GA	1991
Glynn Debter	AL	1989	Dave & Carol Guilford	CAN	1991
Sherm & Charlie Ewing	CAN	1989	Richard & Sharon Beitelspacher	SD	1991
Donald Fawcett	SD	1989	Tom Sonderup	NE	1991
Orrin Hart	CAN	1989	Steve & Bill Florschuetz	IL	1991
Leonard A. Lorenzen	OR	1989	R.A. Brown	TX	1991
Kenneth D. Lowe	KY	1989	Jim Taylor	KS	1991
Tom Mercer	WY	1989	R.M. Felts & Son Farm	TN	1991
Lynn Pelton	KS	1989	Jack Cowley	CA	1991
Lester H. Schafer	MN	1989	Rob & Gloria Thomas	OR	1991
Bob R. Whitmire	GA	1989	James Burns & Sons	WI	1991
Dr. Burleigh Anderson	PA	1990	Jack & Gini Chase	WY	1991
Boyd Broyles	KY	1990	Summitcrest Farms	OH	1991
Larry Earhart	WY	1990	Larry Wakefield	MN	1991
Steven Forrester	MI	1990	James R. O'Neill	IA	1991
Doug Fraser	CAN	1990	Francis & Karol Bormann	IA	1992
Gerhard Gueggenberger	CA	1990	Glenn Brinkman	KS	1992
Douglas & Molly Hoff	SD	1990	Bob Buchanan Family	OR	1992
Richard Janssen	KS	1990	Tom & Ruth Clark	VA	1992

SEEDSTOCK BREEDER HONOR ROLL OF EXCELLENCE

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
Dan Eldridge & Yates 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	SK	1993
Harrell Watts	AL	1993
Bob Zarn	MB	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 diZerega	VA	1995
Maurice Grogan	MN	1995
Donald J. Hargrave	ONT	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

SEEDSTOCK BREEDER OF THE YEAR

John Crowe	CA	1972	Lee Nichols	CA	1984
Mrs. R.W. Jones	GA	1973	Ric Hoyt	OR	1985
Carlton Corbin	OK	1974	Leonard Lodoen	ND	1986
Leslie J. Holden	MT	1975	Henry Gardiner	KS	1987
Jack Cooper	MT	1975	W.T. "Bill" Bennett	WA	1988
Jorgensen Brothers	SD	1976	Glynn Debter	AL	1989
Glenn Burrows	NM	1977	Doug & Molly Hoff	SD	1990
James D. Bennett	VA	1978	Summitcrest Farms	OH	1991
Jim Wolfe	NE	1979	Leonard Wolf & Sons	MN	1992
Bill Wolfe	OR	1980	R.A. "Rob" Brown	TX	1993
Bob Dickinson	KS	1981	J. David Nichols	IA	1993
A.F. "Frankie" Flint	NM	1982	Richard Janssen	KS	1994
Bill Borror	CA	1983	Tom & Carolyn Perrier	KS	1995

Tom and Carolyn Perrier
Dalebank Angus Ranch
1995 Seedstock Producer of the Year .
Paul Bennett, President; Tom and Carolyn Perrier, Ron Bolze, Executive Director.

1995 BIF
SEEDSTOCK NOMINEES

Bobby Aldridge
Oak View Farm
Yanceyville, North Carolina

Mr. Aldridge has worked with cattle all his life, with his father, sons and now a grandson.

Mr. Aldridge grew up in the Anderson, North Carolina, community and has worked hard to improve his cattle herd for many years. He does not have the best quality land in Caswell County but strives to provide the best quality forage he can with the environment that he works in.

Over the last 23 years, 205 day weights have improved from 444 pounds to 553 pounds with a 100 percent calf crop and average calving intervals of 12 months. Average adjusted 365 day weight on bulls and heifers have increased to 997 and 758 pounds, respectively. This represents a long period of intensive selection and breeding with continued improvement throughout this period. Bobby has incorporated progressive management techniques such as Estrovs Synchronization and artificial insemination to enhance genetic progress.

Mr. Aldridge has been very cooperative in all aspects of his cattle operation and has worked hard to accomplish his goals in the cattle industry.

Gene Bedwell
Bedwell Charolais Farm
Osceola, Iowa

Gene Bedwell has been a seedstock Charolais producer for 28 years. He has utilized performance records for 21 years with 16 years of involvement with the American International Charolais Association Performance Program. As an example of foresight, Gene has 14 years of carcass data from progeny sire by his bulls used in commercial herds. Gene merchandises most of his bulls by private treaty because this provides the opportunity to evaluate potential buyers needs and the opportunity for potential buyers to evaluate his program. Gene has incorporated the use of current technology through the use of embryo transfer of genetically superior females.

Gene's goals include keeping up with the changes and demands in the cattle industry, and continuing to produce the quality of cattle that will work for commercial producers, packers and consumers. Gene maximizes the use of his rolling terrain as pasture and minimizes expenses through manual labor. Gene believes quality feed yields quality beef and he constantly strives for improved performance.

Gordon and Mary Ann Booth
Booth's Cherry Creek Ranch, Inc.
Veteran, Wyoming

"Progress through Performance" has been the direction taken by Booth's of Cherry Creek for over 40 years. Every living thing, man or animal is expected to perform and perform well at Cherry Creek. Challenge has never been feared, only confronted! HONEST FACTS FROM HONEST PEOPLE MAKE HONEST CATTLE.....DISCRIMINATING CATTLEMEN CAN DEPEND ON CATTLE FROM CHERRY CREEK...these are not slogans used lightly but with conviction.

"A hardworking and busy family who manage and operate the ranch and farm", describes Gordon and Mary Ann and their three sons and their respective families. This philosophy was set by the example of Gordon's parents, Henry and Helen, who still live at the ranch's headquarters.

Four generations of Booth's work cattle and farm near Veteran, WY, a small community in southeastern Wyoming located in the fertile North Platte Valley. Work is interrupted only occasionally by church, civic duty, 4-H or a ballgame. All energy is directed at trying to raise the finest performance Angus and Charolais cattle in the West.

Ward Burroughs
Vista Livestock Company
Denair, California

Ward Burroughs, along with his father Ernest and brother Bruce, operates Vista Livestock Company, which includes a dairy, almonds, field crops, and a 350 cow beef operation, in the rolling foothills of northern Merced County, California. Today, Ward sells bulls from their Gelbvieh and Beefmaster herds.

During the fall and winter, the cows are pastured on annual clover-improved native pasture. The cows and their calves are moved to irrigated pasture in the spring, where they stay until late summer. The cow herd is artificially inseminated, followed by a short exposure to cleanup bulls.

Performance records and performance testing have been a way of life for Vista Livestock Company. They utilized hand records until CowBoss became available. Ward Burroughs was one of the first producers in California to purchase CowBoss and put it into use in order to make management decisions. Ward has been conducting on-ranch bull testing in cooperation with Cooperative Extension since 1989. The data provided to potential bull buyers includes performance in a 105 day gain test, semen evaluation, pelvic measurements, and sonogram information of fat thickness and ribeye area.

Ward is currently a Director i n the Merced-Mariposa Cattlemen's Association. He and his wife, Rose, are the club leaders of their 4-H Club. Ward and Rose, along with the entire Burroughs Family, have established Valley Oak School in Turlock; a school specializing in the education of children with learning disabilities. They have four children. The Burroughs name is synonymous with innovative approaches to agricultural production; Ward is no exception.

Chris & John Christensen
Christensen Brothers Simmental
Wessington Springs, South Dakota

Christensen Brothers Simmental is a family partnership producing Simmental and Red Angus seedstock. Their goal is to produce cattle that meet the needs of both purebred and commercial operations. Calving ease, maternal, growth, and carcass traits are important tools in their business and to their customers.

The Christensen Brothers strive to raise cattle that require less care and management. With easier calving, they have less labor in calving and also higher fertility. With polled cattle, less labor is needed in dehorning. With more performance, cattle finish faster in the feedlot, requiring less time and labor to finish.

The Christensen Brothers incorporate pregnancy testing through the use of Ultra-Sound. They have found the results of this test to be very accurate both in the predicted sex of the calf and in the number of days bred. Ultrasonography has also been utilized for the prediction
of carcass characteristics.

Attendance at the last five BIF Research Symposium and Annual Meetings has increased their awareness for the need to continually improve their work in genetics, accurate record keeping, and using the tools already available in the beef industry.

Mary Howe DiZerega
Oakdale Farm
Upperville, Virginia

Mary Howe DiZerega is the recipient of the 1995 American-International Charolais Association Seedstock Producer of the Year Award. She grew up on the family farm in Fauquier County, Virginia, and at an early age developed a love of the land and cattle that have been the livelihood of her forbears since the 1600's. Becoming the owner of Oakdale Farm in 1964, she has brought the cattle operation from a 100 cow commercial herd to 250 registered Charolais cows and some 500-700 total head of purebred Charolais.

The purebred Charolais herd has been developed since 1970 and has moved from the use of only natural service bulls to the use of artificial insemination and embryo transfer in the performance selection program. The primary goal of the Oakdale Farm program is to service the commercial producer with functionally sound, optimum performance level bulls. Many purebred Charolais herds now consider Oakdale genetics when selecting a herd sire or replacement females. Oakdale Farm has developed an increasingly popular annual bull sale which has become very successful. Over the years Oakdale has tested bulls in the Virginia BCIA and West Virginia central test stations annually and has received a number of awards.

In addition to being very successful as a Charolais Breeder, Mary Howe DiZerega has emerged as a real leader in the Virginia Beef Industry, having served as treasurer and president of the Virginia Charolais Association. She is currently serving as Director of the Virginia Cattlemen's Association, as President of the Virginia Beef Expo, as a member of the American-International Charolais Association Breed Improvement Committee, and as a Beef Advisor Board Member for the Atlantic Rural Exposition. She served as a member for the Virginia Tech Board of Visitors and currently serves as a member of the Virginia Tech Animal Science Advisory Committee. She has been active locally and currently serves on the Fauquier County Farm Bureau Board of Directors.

Maurice Grogan
Kelley Land & Cattle Company
Marine-On-St. Croix, Minnesota

Maurice Grogan has been the manager of Kelley Land & Cattle Company at Marine-On-St. Croix, Minnesota for 36 years. The Ranch consists of approximately 2800 acres of which 1100 acres is open pasture, 500 acres has been in cropland and the balance is woods and lakes and wet land areas.

The operation has been changed from grass and cropland to all roughage. This has allowed the ranch to increase production through more efficient use of farm assets and resources and to reduce overhead and direct costs.

An intensive rotational grazing system has been installed over all of the pastures and former cropland areas creating 55 pastures. This allows for a much heavier stocking rate than was previously possible. In 1994 nearly 1000 head of cattle and 500 sheep were grazed on the ranch. Beef, lamb and wool production has drastically increased over the last 10 years.

Historically, using high accuracy EPD bulls has helped to make genetic improvement in the herd.

Maurice has been an officer and director of several livestock organizations. He has received many honors, including the first R.E. Jacobs Award for Contributions to the Minnesota Livestock Industry. He received the 1994 Seedstock Producer award, Minnesota Beef Cattle Improvement Association, and was inducted into the Minnesota Livestock Hall of Fame in 1995.

Donald J. Hargrave
Harprey Farms
Maxwell, Ontario

Don Hargrave operates a cow calf and farrow to finish swine operation in Grey County, Ontario. His herd consists of purebred Angus and Angus cross cows. The herd consists of approximately 100 head of breeding age females.

Don has participated in the Bull Evaluation program since 1978 and has recorded his cow herd in the Beef Herd Improvement Program since the program's inception in 1984. Don has found information from both programs valuable and uses the information gained from both to improve his herd.

Don has established performance goals for his herd which is to achieve an average adjusted weaning weight of 650 pounds and an average adjusted yearling weight of 900 pounds. However, while striving to reach these growth goals there are several traits that must be maintained including low birth weights, easy fleshing ability, high fertility, mothering ability and a reasonable mature size. Don utilizes artificial insemination and selects bulls which have a high weaning gain EPD and yearling gain EPD. The bull must also be in the top 15% of the breed for their traits, to be of interest to the Hargrave operation. Don places equal emphasis on phenotypic traits including conformation and muscling. Don plans to emphasize carcass traits in the near future.

The Hargrave operation is quickly reaching it's herd performance goals.

Howard and JoAnne Hillman
Bon View Farms
Canova, South Dakota

Bon View Farms at Canova, South Dakota, has been a family operation in southeastern South Dakota since 1882, being homesteaded by Howard's grandfather. The present diversified operation consists of 3000 acres, with a 350 cow registered Angus herd and a rotational, no-till cropping system. 1100 acres are in cultivation and the remainder is in grass, hayland, shelterbelts and facilities.

Registered Angus have been the basis for the operation since 1918. Bon View cattle have been marketed throughout the United States, Canada, South America, South Africa and Japan.

Artificial insemination has been used extensively for over thirty years to take advantage of the genetics available. EPD's have been an important selection tool in predictable genetic progress. The cattle have been tested using the AHIR of the Angus Association since 1968. Pelvic measuring and ultrasound represent adoption of new technology.

Bon View Farms has focused breeding programs on the commercial industry's needs and wants. The Hillmans strongly believe in conservation of resources and care to land and livestock. They are dedicated to the production of functional, problem free cattle that will be profitable to all segments of the industry.

Love of land, livestock, and the people associated with the cattle industry have been incentives for the accomplishments attained. Integrity and the satisfaction of customers are of the utmost importance.

Mack, Billy, and Tommy Maples
Maples Stock Farm
Elkmont, Alabama

Despite many changes and land divisions at each generation, the Maples farm at Elkmont, Alabama has been in continuous operation on the same land by the same family since February 11, 1818.

Today, Maples Stock Farm is a 1,500 acre farm located along Elk River in North Alabama and is comprised of Registered Angus cattle, poultry, cotton and corn.

It is a true family farm spanning four generations. Mack Maples started the Angus herd in 1937 when he bought four heifers for $50.00 each. The next year he added six more. His son, Bill Maples, and his grandson, Tommy Maples, now conduct all the daily activities on the farm.

The Angus herd is the focal point of the operation and is composed of 160 mature cows, 50 replacement heifers and several bulls. Yearling bulls are sold privately and through central bull test sales. Today, several cow families are still in the herd descended from the original heifers.

The primary forage available for cattle use is fescue and clover. A soybean and milo mixture is ensiled to provide supplemental feed during the winter months.

With a basic belief in honesty, hard work and thriftiness the Maples family has developed a cattle herd that has withstood the test of time.

Mike McDowell
Locust Level Farms
Vernon Hill, Virginia

Mike McDowell owns and operates Locust Level Farms in Halifax County, VA, with his father, Thomas McDowell, Sr. Mike and his wife, Wanda, have three children, Angela, Bridget, and West. Mike is responsible for the management, breeding and marketing of the purebred cattle. Mike is a 1978 graduate of VPI and SU in Animal Science and Agronomy. He has been developing the purebred herd since prior to graduation. Currently there are 130 head of Angus and 20 head of Polled Herefords in the breeding herd. The cattle programs are driven by performance utilizing EPD's in selection. Seedstock is sold both to commercial and other purebred breeders.

The total farming operation includes numerous acres of grasslands and small grains. These, along with corn acreage, are all used within the cattle operation.

Mike has also been involved in the commercial cattle industry as a feeder calf producer and backgrounder. He is active in his local cattle association as well as having served in offices and as a board member of BCIA, Virginia Angus Association and Virginia Polled Hereford Association.

Mike currently is a deacon and Sunday School teacher at his local church. He serves on the Virginia 4-H Board of Trustees and the Mecklenburg Electric Cooperative Board of Directors.

Tom Perrier
Dalebanks Angus
Eureka, Kansas

Tom Perrier, along with his wife Carolyn, is the manager and owner of Dalebanks Angus. The Angus cow operation is located in the heart of the Flint Hills near Eureka, Kansas. The cows graze 4,300 acres of native tallgrass pastures and 700 acres of farm ground are used to raise feed for cattle.

The Dalebanks herd was started in 1904 by Tom's grandfather with almost all of the present herd tracing to cows purchased before 1920. Tom and Carolyn's children, Matt, Michele and Mark, represent the fourth generation involved in the herd.

The objective of this herd has always been to provide quality bulls for the commercial cowman. Annually, 100 bulls are sold in their production sale the Saturday before Thanksgiving and 30 are sold in the spring at private treaty. The emphasis has been on selection for rapid early growth while avoiding excessive birthweight or mature size. Cows must calve, milk well, and breed back under range conditions. The herd produces two different products for use by commercial cowmen. They are:

Calving ease bulls - Birth EPDs of -2.0 to +2.0; weaning EPDs of +20 to +30; milk EPDs of +10 to +20; yearling EPDs of +40 to +50 and scrotal EPDs of 0 to +1.2.

Rapid early growth bulls - Birth EPDs of +1.5 to +5.0; weaning EPDs of +25 to +40; milk EPDs of +5 to +20; yearling EPDs of +45 to +65; scrotal EPDs of 0 to +1.2.

Tom believes that expected progeny differences (EPDs) are a set of specifications that can be used to meet the needs of any herd and he promotes their use to his customers. His herd was one of the very first herds (1985) to provide EPDs on sale cattle for use by their customers. This reliance on EPDs continues today as they are utilized heavily in the selection program.

John Robbins
Double Fork Ranch
Dillon, Montana

Building on eight years in a commercial cow/calf program, John Robbins entered the seedstock industry in the late 1970s. Double Fork Ranch maintains an outlook with the commercial cattle industry in mind. Fulfilling the needs of their customers and the beef cattle industry is their number one concern. Success is measured by success of their customers. This unique perspective provides guidance for the breeding program. By running the herd as if they were commercial cattle, Double Fork Ranch is able to produce cattle that work in the real world.

Double Fork Ranch has been using performance records since 1974. Currently, there are 450 cows in the seedstock breeding herd. The cattle meet and perform to high standards. Every registered calf born on the ranch is weighed, tested and reported. Performance records provide a general trend of the EPD's within the herd and provide prospective buyers with performance data. Every trait is important and the selection process is geared toward serving the needs of their customers.

Thomas Simmons
Glenfield Farm
Franklin, West Virginia

Tom Simmons was named "Cattleman of the Year" at the West Virginia Cattlemen's Association Annual Convention. Tom is a purebred Angus breeder from Franklin, WV.

The Simmons family manages a herd of 70 purebred and 40 commercial cows under the Glenfield Farm name.

Tom has remained on the leading edge of technology and management philosophy, beginning 33 years ago when he began keeping performance records. This progress has continued through the intense use of artificial insemination and introduction of embryo transplant.

Approximately 30 bulls are marketed under the Glenfield Farm name annually. Most of which are sold private treaty, with 70% being sold to repeat customers.

The Simmons family supports youth activities, both on a county and state level.

Tom has served as President and director of the West Virginia Angus Association, Director of the 4-H/FFA Livestock Roundup, Tri-County Fair and a member of the County Extension Service Committee.

For Immediate Release

Tom and Carolyn Perrier receive the "1995 Outstanding Seedstock Producer Award"

Sheridan, Wyoming - Tom and Carolyn Perrier, owner and operators of Dalebank Angus Ranch, Eureka, Kansas, have been selected as the Beef Improvement Federations (BIF) 1995 Outstanding Seedstock Producer at the convention held at the Holiday Inn in Sheridan, Wyoming.

Tom Perrier, along with his wife Carolyn, is the manager and owner of Dalebanks Angus. The Angus cow operation is located in the heart of the Flint Hills near Eureka, Kansas. The cows graze 4,300 acres of native tallgrass pastures and 700 acres of farm ground are used to raise feed for cattle.

The Dalebanks herd was started in 1904 by Tom's grandfather with almost all of the present herd tracing to cows purchased before 1920. Tom and Carolyn's children, Matt, Michele and Mark, represent the fourth generation involved in the herd.

The objective of this herd has always been to provide quality bulls for the commercial cowman. Annually, 100 bulls are sold in their production sale the Saturday before Thanksgiving and 30 are sold in the spring at private treaty. The emphasis has been on selection for rapid early growth while avoiding excessive birthweight or mature size. Cows must calve, milk well, and breed back under range conditions. The herd producers two different products for use by commercial cowmen. They are:
Calving ease bulls - Birth EPDs of -2.0 to +2.0; weaning EPDs of +20 to +30; milk EPDs of +10 to +20; yearling EPDs of +40 to +50; scrotal EPDs of 0 to +1.2.
Rapid early growth bulls - Birth EPDs of +1.5 to +5.0; weaning EPDs of +25 to +40; milk EPDs of +5 to +20; yearling EPDs of +45 to +65; scrotal EPDs of 0 to +1.2.

Tom believes that expected progeny differences (EPDs) are a set of specifications that can be used to meet the needs of any herd and he promotes their use to his customers. His herd was one of the very first herds (1985) to provide EPDs on sale cattle for use by their customers. This reliance on EPDs continues today as they are utilized heavily in the selection program.

Tom currently provides insight into Angus breed policy by serving on the American Angus Association Board of Directors.

Tom and Carolyn Perrier were nominated by the Kansas Livestock Association.

BIF is pleased to recognize this excellent production system with their 1995 Outstanding Seedstock Producer Award.

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
Odd 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

COMMERCIAL PRODUCER HONOR ROLL OF EXCELLENCE

Norman, Denton & Calvin Thompson	SD	1979	Clarence Reutter	SD	1982
Jess Kilgore	MR	1980	Leonard Bergen	CAN	1982
Robert & Lloyd Simon	IL	1980	Kent Brunner	KS	1983
Lee Eaton	MR	1980	Tom Chrystal	IA	1983
Leo & Eddie Grubl	SD	1980	John Freitag	WI	1983
Roger Winn, Jr.	VA	1980	Eddie Hamilton	KY	1983
Gordon McLean	ND	1980	Bill Jones	MT	1983
Ed Disterhaupt	MN	1980	Harry & Rick Kline	IL	1983
Thad Snow	CAN	1980	Charlie Kopp	OR	1983
Oren & Jerry Raburn	OR	1980	Duwayne Olson	SD	1983
Bill Lee	KS	1980	Ralph Pederson	SD	1983
Paul Moyer	MO	1980	Ernest & Helen Schaller	MO	1983
G.W. Campbell	IL	1981	Al Smith	VA	1983
J.J. Feldmann	IA	1981	John Spencer	CA	1983
Henry Gardiner	KS	1981	Bud Wishard	MN	1983
Dan L. Weppler	MT	1981	Bob & Sharon Beck	OR	1984
Harvey P. Wehri	ND	1981	Leonard Fawcett	SD	1984
Dannie O'Connell	SDN	1981	Fred & Lee Kummerfeld	WY	1984
Wesley & Harold Arnold	SD	1981	Norman Coyner & Sons	VA	1984
Jim Russell & Rick Turner	MO	1981	Franklyn Esser	MO	1984
Oren & Jerry Raburn	OR	1981	Edgar Lewis	MT	1984
Orin Lamport	SD	1981	Boyd Mahrt	CA	1984
Leonard Wulf	MN	1981	Don Moch	ND	1984
Wm. H. Romersberger	IL	1982	Neil Moffat	CAN	1984
Milton Krueger	MO	1982	William H. Moss, Jr.	GA	1984
Carl Odegard	MT	1982	Dennis P. Solvie	MN	1984
Marvin & Donald Stoker	IA	1982	Robert P. Stewart	KS	1984
Sam Hands	KS	1982	Charlie Stokes	NC	1984
Larry Campbell	KY	1982	Milton Wendland	AL	1985
Lloyd Atchison	CAN	1982	Bob & Sheri Schmidt	MN	1985
Earl Schmidt	MN	1982	Delmer & Joyce Nelson	IL	1985
Raymond Josephson	ND	1982	Harley Brockel	SD	1985

COMMERCIAL PRODUCER HONOR ROLL OF EXCELLENCE

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	NEN	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
Federick M. Mallory	CA	1988
Stevenson Family	ORN	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	NEN	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	KSN	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
Rober A. Nixon & Son	VA	1991

COMMERCIAL PRODUCER HONOR ROLL OF EXCELLENCE

Murray A. Greaves	CAN	1991	Jed Dillard	FL	1993
James Hauff	ND	1991	Art Farley	IL	1993
J.R. Anderson	WI	1991	Jon Ferguson	KS	1993
Ed & Rich Blair	SD	1991	Walter Hunsuker	CA	1993
Reuben & Connee Quinn	SD	1991	Nola & Steve Kleiboeker	MO	1993
Dave & sandy Umbarger	OR	1991	Jim Maier	SD	1993
James A. Theeck	TX	1991	Bill & Jim Martin	WV	1993
Ken Stielow	KS	1991	Ian & Alan McKillop	ON	1993
John E. Hanson, Jr.	CA	1991	George & Robert Pingetzer	WY	1993
Charles & Clyde Henderson	MO	1991	Timothy D. Sutphin	VA	1993
Russ Green	WY	1991	James A. Theeck	TX	1993
Bollman Farms	IL	1991	Gene Thiry	MB	1993
Craig Utesch	IA	1991	Fran & Beth Dobitz	SD	1994
Mark Barenthsen	ND	1992	Bruce Hall	SD	1994
Rary Boyd	Al	1992	Lamar Ivey	AL	1994
Charles Daniel	MO	1992	Gordon Mau	IA	1994
Jed Dillard	FL	1992	Randy Mills	KS	1994
John & Ingrid Fairhead	NE	1992	W.W. Oliver, V	VA	1994
Dale J. Fischer	IA	1992	Clint Reed	WY	1994
E. Allen Grimes Family	ND	1992	Stan Sears	CA	1994
Kopp Family	OR	1992	Walter Carleee	AL	1995
Harold, Barbara & Jeff Marshall	PA	1992	Nicholas Lee Carter	KY	1995
Clinton E. Martin & Sons	VA	1992	Charles C. Clark, Jr.	VA	1995
Lloyd & Pat Mitchell	CAN	1992	Greg & Mary Cunningham	WY	1995
William VanTassel	CAN	1992	Robert & Cindy Hine	SD	1995
James A. Theeck	TX	1992	Walter Jr. & Evidean Major	KY	1995
Aquilla M. Ward	WV	1992	Delhert Ohnemus	IA	1995
Albert Wiggins	KS	1992	Olafson Brothers	ND	1995
Ron Wiltshire	CAN	1992	Henry Stone	CA	1995
Andy Bailey	WY	1993	Joe Thielen	KS	1995
Leroy Beitelspacher	SD	1993	Jack Turnell	WY	1995
Glenn Calbaugh	WY	1993	Tom Woodard	TX	1995
Oscho Deal	NC	1993			

COMMERCIAL PRODUCER OF THE YEAR

Chan Cooper	MT	1972
Pat Wilson	FL	1973
Lloyd Nygard	ND	1974
Gene Gates	KS	1975
Ron Blake	OR	1976
Steve & Mary Garst	IA	1977
Mose Tucker	AL	1978
Bert Hawkins	OR	1979
Jeff Kilgore	MT	1980
Henry Gardiner	KS	1981
Sam Hands	KS	1982
Al Smith	VA	1983
Bob & Sharon Beck	OR	1984
Glenn Harvey	OR	1985
Charles Fariss	VA	1986
Rodney G. Oliphant	KS	1987
Gary Johnson	KS	1988
Jerry Adamson	NE	1989
Mike & Diana Hopper	OR	1990
Dave & Sandy Umbarger	OR	1991
Kopp Family	OR	1992
Jon Ferguson	KS	1993
Fran & Beth Dobitz	SD	1994
Joe & Susan Thielen	KS	1995

Joe and Susan Thielen, Thielen Beef
1995 Commercial Producer of the Year
(left to right): Paul Bennett, President, Kevin, Joe, Susan and Matt Thielen,
Ron Bolze, Executive Director.
(Not Pictured, Joey Thielen)

1995 BIF
COMMERCIAL NOMINEES

Walter Carlee
Carlee Farms
Lawley, Alabama

Carlee Farms is a family farm located near Lawley, Alabama in Central Alabama. The farm consists of 340 owned acres and 90 rented acres. Walter Carlee, his wife Nancy and daughter Jami provide the labor force to manage a 150 commercial cow-calf operation. The Carlee's have been in the cattle business for 20 years along with operating a timber harvesting business. They expanded their herd over the years and began keeping performance records in 1989. Their numbers and production reached a point that they sold the timber harvesting operation in 1992 and the cattle are now the only income producing enterprise on the farm.

The Carlee Farm has increased their weaning weights from 528 pounds in 1989 to 637 pounds in 1994. The actual pay weight on their steers at weaning in August of 1994 was 748 pounds per steer. They use Angus and Simmental bulls on Simmental-Angus cross cows. Their heifers are sold at a premium for replacement heifers through organized sales and private treaty based on their performance records. The Carlee herd has been ranked in the top three herds of 100 plus cows on the Alabama BCIA Program since 1992. Mr. Carlee serves as a director of the Chilton County Cattlemen's Association which has over 500 members.

Nicholas Lee Carter
Berle Clay Farm
Paris, Kentucky

Nicholas Lee Carter is manager of the Berle Clay Farm located in Paris, Kentucky. A 1,200 acre commercial beef cattle farm consisting of 180 commercial cows, 225 Elite Replacement heifers, 175 Elite feeder heifers and 100 head of backgrounding steers. Other enterprises include 250 acres corn, 120 acres soybeans, 50 acres alfalfa and 20 acres of tobacco.

Nicholas strives to maintain a balance between production, reproduction and the environment, and is always seeking new information that will enhance his total operation. His forage/rotational grazing program has allowed him to increase his carrying capacity, while at the same time improve efficiency of his entire beef operation.

Nicholas graduated in 1982 from Eastern Kentucky University with a degree in Farm Management. He is married to Lois Ann Ferrill and they have two children

Nicholas is active in the Kentucky Cattlemen's Association and serves as Co-Chairman of the Elite Heifer Program for the Bourbon County Livestock Improvement Association.

Charles C. Clark, Jr.
Clark Farms
Saltville, Virginia

The Clark family has been a mainstay in agriculture in the Smyth County area for many generations. Charlie Clark, his wife Jane, and their three boys, Champ, Will and Ben, live on the farm that his great grandfather bought in 1854. They live in the house that he built after returning from the Civil War. Charlie's father, recently deceased, Champ Clark, took over management of the operation in 1950. The family farm is approximately 3,900 acres of which 3,300 is owned and 600 is rented. The farm supports 500 cows and several hundred grazing yearling cattle. Nearly all crops produced on the farm go into the beef operation, including 135 acres of corn, 100 acres of wheat and 180 acres of mixed hay. The only exception is 8 acres of burley tobacco which is produced annually.

Charlie Clark and his family have been exceptional leaders in agriculture and the cattle industry in Virginia and their part of the state. Average weaning weights in their herd have increased from 650 pounds in 1993 to 740 pounds in 1994. They buy all replacement females and utilize terminal crossbreeding in the program. A strong aspect of the Clark program is the marketing program through a long standing arrangement with Ohio farmer feeders.

Greg and Mary Cunningham
Cunningham Cattle Company
Buffalo, Wyoming

Greg Cunningham, his wife Mary and their three children are carrying on the cattle business his great-grandfather started years ago when he came west from Missouri. The Cunninghams moved to Wyoming four years ago from eastern Utah. Leaving a large public lands ranch, the Cunninghams brought with them a predominantly Hereford cow herd and high hopes for operating on a privately owned ranch. Utilization of crossbreeding with Red Angus bulls that exhibit moderate birth weights, ample milk and growth plus carcass traits has helped improve conception rates, weaning weights and overall productivity of the herd. The Cunninghams are strong believers in financial and production records and find them an integral tool in making management decisions. Use of a management intensive grazing system has greatly improved the productivity of the ranch as well as insured that the resources are not over-utilized. Their goals are to create a diverse ranching operation utilizing livestock and range management techniques that benefit the cattle, the natural resources and wildlife. They believe and hope that this approach to ranching will insure the passing on of the operation to another generation.

Robert and Cindy Hine
Wessington Springs,
South Dakota

Robert Hine was born and raised in the Gann Valley and Wessington Springs, South Dakota area, and graduated from Wessington Spring High School in 1974. He worked at various jobs while starting his own farming-ranching operation, which now includes 3600 acres and 300 head of stock cows utilizing production records, several management tools, and a three breed Angus, Gelbvieh, Simmental rotational crossbreeding system. Robert has made significant progress increasing weaning weights and in producing productive replacement heifers. In addition he backgrounds about 500 head of calves yearly. Crops raised include corn, wheat, sunflowers and alfalfa. He is a past member of the Jerauld County Extension Board. He is currently serving as secretary of the Ankota Coop Board of Directors in Wessington Springs. He and his wife, Cindy, have two children' Jason, age 15 and Jacki, age 12.

Walter Jr. and Evidean Major
Major Farms
Lawrenceburg, Kentucky

The ideal commercial cow must deliver a live healthy calf every 12 months and breed back in a timely manner while raising her calf to an acceptable weaning weight in 240 days. This is the basic philosophy that Major Farms, owned and operated by Walter Jr. and Evidean Major, of Lawrenceburg, Kentucky are following in their commercial cow/calf operation. The 100 year old family farm acreage has remained unchanged while there has been an increase in production and efficiency. While developing a commercial herd of 200 + cows, consisting of a 3-breed Charolais, Angus and Hereford cross breeding system, emphasis has been placed on cow quality, bull selection, increased feeder cattle weights and quality forage production. The farm constantly strives to keep a balance between reproduction, production and the environment.

Operational enhancements include a replacement heifer management program that was researched, developed and put in place in 1991. This program has provided the cowherd with quality replacement heifers of the desired breed and genetic composition. A spin-off of this program is the yearly consignment of residual heifers in the Bourbon County Livestock Improvement Association Elite Bred Heifer sale which has drawn national recognition. Full use of an on-farm backgrounding program, utilizing farm produced forage, has allowed for the retention and development of their weaned calves into yearlings.

The Major's have been rewarded for the cattle they have raised in their commercial cow/calf operation and sincerely believe that quality cattle will favorably influence the market price of all cattle in the future.

Delhert Ohnemus
Ohnemus Farms, Inc.
Milo, Iowa

Delhert Ohnemus originally started with dairy cattle 62 years ago. Beef cattle experience through the years has included cow/calf production involving commercial Herefords, crossbreds and later seedstock Angus production. The Ohnemus operation involved 1250 acres of row crops, hay and pasture acreage currently supporting 130 cows. Delhert has utilized performance records for 17 years to select herd sires and cull the cow herd. Delhert exerts selection pressure for disposition, udder quality, fleshing ability, milking ability and reproduction.

Expected progeny differences have been effectively utilized for artificial insemination sire selection with emphasis on light birth weight, high growth and moderate milk combinations. Percent calf crop consistently averages 95% and weaning weights have increased 245 pounds from 1975 to 1991.

Delhert has been one of the first to adopt new production and management principles including estrous synchronization and intensive grazing management.

Olafson Brothers
Edinburg, North Dakota

Olafson Brothers, Edinburg, North Dakota, operate a highly diversified operation involving a 180-200 head commercial cow herd, a 2800 tillable acre farming operation producing Durum and Hard Red spring wheat, barley, and dry edible beans, and a construction business involved in earthmoving, land clearing, and road construction. Three brothers, Dean, Roger, and Curtis, are involved in the partnership, with each one having primary management responsibilities for one of the three segments of the operation. A fourth brother, Robert, recently retired from the business. The partnership was formed in 1969, and is headquartered on the original quarter-section homesteaded by the partners' grandparents, who immigrated to the US from Iceland in 1883, settling on the western edge of the Red River Valley.

Cattle have been an integral part of the operation from the very beginning and for many years a herd of straight bred Angus cows was maintained. In 1976, crossbreeding was begun with the introduction of Amerifax bulls, and in recent years, Gelbvieh and Black Simmental have been added to the program. This breeding strategy, together with the performance information utilized, has resulted in a dramatic increase in herd performance. A short calving season is also one of the strengths of the herd. NCA-IRM-SPA production measures over the last three years show 85% of the females calving during the first 21 days, and 99% calving in the first 42 days. Coupling these reproductive qualities with performance has always been a challenge, but the cow herd has averaged 546 pounds weaned per cow exposed the past three years which is 43 pounds above the state average. In recent years, they have been feeding out steers on an accelerated finishing program, which takes advantage of the genetic potential of the cattle and the seasonal tendencies of the market, and have developed a market for bred heifers at premium prices.

Henry Stone
Yolo Land and Cattle Company
Woodland, California

Henry H. "Hank" Stone's Yolo Land and Cattle Company, Woodland, California, is a partnership with his two sons. The 600 cow ranch operates in three northern California counties. He is the director and vice president of the California Beef Cattle Improvement Association and past president of the Yolo County Cattlemen's Association and actively participates in the California Cattlemen's Association and the California Farm Bureau.

He began in 1973 in Yolo County running "just a bunch of commercial cows bought on the open market" and 900 stockers, using Hereford and Simmental bulls to build his cow base. Since 1982, he's used Angus bulls. The "engine" for dynamic performance has been bull selection and cow retention records. He was an early adopter of EPD evaluations and "all the measurements I can get".

Mr. Stone's emphasis on heifers allows for rapid genetic improvement. They are weighed at birth and weaning with recorded birth dates. Heifers are all synchronized and artificially inseminated. The marketability of his high-valued heifers for replacements and the feedlot performance of his steers prove his program. Accent on calving ease means that only 1-2 calves are pulled each season.

Though proud of his herd, he is proudest of his sons. They are CalPoly/San Luis Obispo and Chico State University graduates and are integrated into daily ranch management. This provides Yolo Land and Cattle Company with continuity, good cattle sense and management with a scientific flavor well into the next century. Any ranch family would be proud of these accomplishments.

Joe Thielen
Thielen Beef
Dorrance, Kansas

Joe Thielen of Dorrance believes the beef industry is facing many challenges. He is committed to confronting these challenges by being creative, innovative and resourceful. One of the biggest problems facing today's beef industry is producing a consistent quality beef carcass at the lowest possible price. Determined to produce a desirable beef product, new technology and ideas such as Quality Assurance Program, EPDs, AI, computerized record keeping and management skills have been incorporated into his program. Joe practices and improves with Integrated Resource Management (IRM) in his diversified operation consisting of cattle, winter wheat and grain sorghums.

Joe progresses with the IRM concept in all aspect of his operation. In the area of beef production management, some of these aspects have included ammoniating wheat straw, utilizing crop residues and wheat midds, rotational grazing and Quality Assurance programs aimed at improving herd health and nutrition and reducing production costs. Including EPDs in sire selection, utilizing AI, developing performance testing with the aid of computerized records and a chute scale have helped to increase herd production and profitability. These measure have added to improved cowherd fertility, a reduced calving season, increased weaning and yearling weights and a slaughter animal that is desirable from a carcass standpoint.

Grassroots involvement is vital to the health of the beef industry and is one of Joe's reasons for being active in the Kansas Livestock Association and a member of the National Cattlemen's Association. He has served as chairman of the Cow-Calf/Stocker Council of KLA, commercial producer representative on the Kansas Bull Test Committee and executive KLA committee member. Finally, Joe was a founding member and current president of the statewide IRM group for Kansas beef producers formed in 1991.

Joe and Susan Thielen have three boys including Joey, Matt and Kevin who all play intregal roles in the beef production enterprise.

Jack Turnell
Pitchfork Ranch
Meeteetse, Wyoming

As owner and manager of the historic Pitchfork Ranch near Meeteetse, Wyoming, Jack Turnell believes in the business of cattle. That business means producing a product that meets the feeder, packer and ultimately the consumer's demand for a consistent product. To achieve that goal, Turnell has put his environment, as well as his cattle, to work for him.

An innovative cattleman with the desire to learn, Turnell has utilized what he calls a "self rotational grazing system." Adding that "Salers cattle distribute themselves away from riparian and other environmentally sensitive areas, thus alleviating many of the Pitchfork overgrazing problems experienced in the past".

Using Salers cattle, from a business standpoint, Turnell now sells 543,000 pounds more beef using the same number of cows as in past years and has increased weaning and yearling weights by over 100 pounds.

Successful cattle businessman, Turnell is active in rural Wyoming activities, as well as involved with the National Cattlemen's Association (NCA), American Salers Association and International Salers Federation. He heads many environmental committees and is involved with several economic and educational programs. He has received several outstanding leadership awards: the NCA Environmental Stewardship Award, the "Take Pride in America" award presented by Barbara Bush and Manual Lujan and a Certificate of Excellence from Secretary of Agriculture Clayton Yuetter and the University of Wyoming College of Agriculture Distinguished Alumni Award to name a few.

Cattleman, businessman, environmentalist: Turnell believes being involved and learning are all just a part of being a cattleman.

Tom Woodward
Broseco Ranches
Decatur, Texas

Broseco Ranch began operation in 1961 in Northeast Texas as a cow/calf operation and has expanded its operations to the stocker and feeding segments of the industry. The operation has grown from a 4000- to a 7500-cow operation and uses both purchased and leased land. The operation has capacity for running 12,000 yearling cattle and custom feeds at several lots.

Broseco produces all of their replacement females and purchases Simbrah, Red Angus and Beefmaster bulls to use in a three-breed rotational crossbreeding program. The ranch retains all of their heifer calves for use as replacements and retains ownership of most of their steer calves. All replacement heifers are bred to calve at two and are bred to calving ease Red Angus bulls.

Pounds of calf weaned per acre is a key production number for the ranching operation. Grazing management is an essential element in continuing to increase the production per acre. The goal is to integrate the management of all resources into a system that will generate an annual profit and at the same time improve the ranch.

For Immediate Release

Joe and Susan Thielen receive the "1995 Outstanding Commercial Producer Award"

Sheridan, Wyoming - Joe and Susan Thielen, owner and operators of Thielen Beef, Dorrance Kansas, have been selected as the Beef Improvement Federations (BIF) 1995 Outstanding Commercial Producer at their convention held at the Holiday Inn in Sheridan, Wyoming.

Joe Thielen of Dorrance believes the beef industry is facing many challenges. He is committed to confronting these challenges by being creative, innovative and resourceful. One of the biggest problems facing today's beef industry is producing a consistent quality beef carcass at the lowest possible price. Determined to produce a desirable beef product, new technology and ideas such as quality assurance program, EPDs, AI, computerized recordkeeping and management skills have been incorporated into his program. Joe practices and improves with Integrated Resource Management (IRM) in his diversified operation consisting of cattle, winter wheat and grain sorghum.

Joe progresses with the IRM concept in all aspect of his operation. In the area of beef production management, some of these aspects have included ammoniating wheat straw, utilizing crop residues and wheat midds, rotational grazing and quality assurance programs aimed at improving herd health and nutrition and reducing production costs. Including EPDs in sire selection, utilizing AI, developing performance testing with the aid of computerized records and a chute scale have helped to increase herd production and profitability. These measure have added to improved cowherd fertility, reduced calving season, increased weaning and yearling weights and a slaughter animal that is desirable from a carcass standpoint.

Grassroots involvement is vital to the health of the beef industry and is one of Joe's reasons for being active in the Kansas Livestock Association and a member of the National Cattlemen's Association. He has served as chairman of the Cow-Calf/Stocker Council of KLA, commercial producer representative on the Kansas Bull Test Committee and executive KLA committee member. Finally, Joe was a founding member and current president of the statewide IRM group for Kansas beef producers formed in 1991.

Joe and Susan are the proud parents of three sons, Joey, Matt and Kevin that are deeply involved in the cattle operation. Joe and Susan Thielen were nominated by the Kansas Livestock Association.

BIF is pleased to recognize this excellent production system with their 1995 Outstanding Commercial Producer Award.

For Immediate Release

Nita Effertz, Associate Editor, Beef Today, is awarded the 1995 Beef Improvement Federation Ambassador Award.

Sheridan, Wyoming - Nita Effertz was named the recipient of the 1995 BIF Ambassador Award at the BIF convention held at the Holiday Inn in Sheridan, Wyoming. Effertz is currently the associate editor of BEEF TODAY, the nation's largest circulated beef publication which is devoted to keeping producers abreast with the industry's latest in management and performance information.

Nita has performance in her pedigree! She was one of 13 children of Gerald (Pat) and Loretta Effertz so when the Effertz' family talks performance they know what they're talking about!

Seriously, the Effertz family runs one of the largest purebred operations in the country featuring Charolais and Salers cattle near Velva, North Dakota. Today they continue to improve and innovate in part because of the advice and information Nita gives them from her travels and research for BEEF TODAY articles. That communication is two-way as her family acts as a sounding board for many of the issues she writes about. Several times a year they still get a chance to put her feet and mind back on solid ground when she stops by home to help with turn out, weaning and sale time chores.

Nita started her college education at North Dakota State University before transferring to Colorado State University where she earned a degree in journalism. While in college she recorded livestock performance records and wrote for the Colorado Rancher and Farmer.

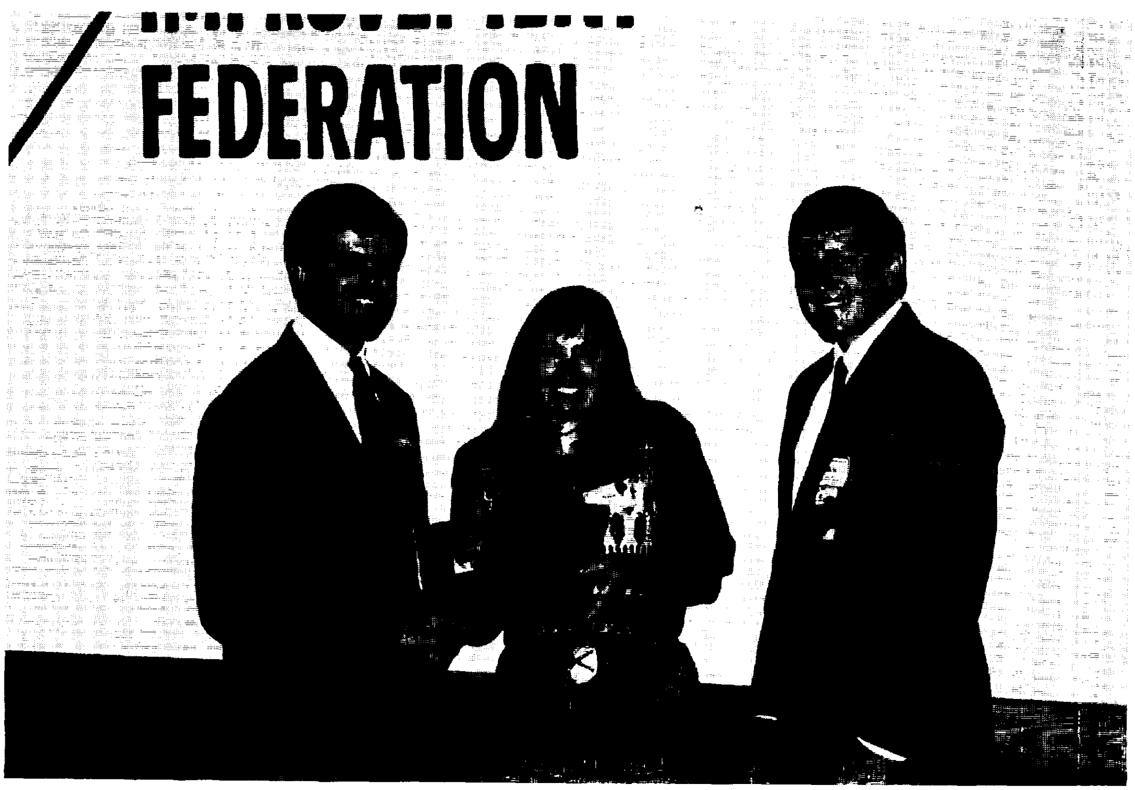
The importance of performance carried over to her journalism career where she has won her share of awards--many for articles that dealt with performance issues. Most recently her work on across-breed EPD's caught the attention of most BIF members.

Nita worked for the Nebraska Farmer as associate beef editor and the Maine-Anjou Mark as editor before joining up with Farm Journal 17 years ago where she helped start BEEF TODAY, the nation's largest circulated beef publication. If there's a uniqueness to Nita's career, it is that she never dodged the tough story and, in fact, still looks for the cutting edge ideas that will help beef producers become more efficient and profitable. It's that commitment and dedication that causes many of her peers in the beef ag journalism circles to label her the best at her profession in the business today.

BIF is pleased to recognize the many contributions of Nita Effertz and the BEEF TODAY publication by presenting her with the BIF Ambassador Award.

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. de Baca	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



Nita Effertz
Beef Today Magazine, receives the
1995 BIF Ambassador Award
(left to right): Paul Bennett, President
Nita Effertz
Ron Bolze, Exectutive Director

For Immediate Release

James S. Brinks receives a "1995 BIF Pioneer Award"

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored James S. Brinks with a Pioneer Award at the convention held at the Holiday Inn in Sheridan, Wyoming.

James S. Brinks was born in South Haven, Michigan in 1934. He earned the B.S. and M.S. degrees from Michigan State University in 1956 and 1957, respectively, and the Ph.D. degree from Iowa State University in 1960. From 1960-1964, he was an USDA Agricultural Research Service Animal Geneticist with the Animal Husbandry Research Division in Denver, Colorado. From 1964-1967 he was the investigations leader for the USDA-ARS W-1 Western Regional Beef Cattle Breeding Project. Joining the Animal Science staff at Colorado State University in 1967, Dr. Brinks has been a Professor since 1971, involved in teaching and research activities primarily in beef cattle animal breeding.

Dr. Brinks has excelled in student teaching and advising having been the major professor for 42 M.S. and 24 Ph.D. candidates. Many advisees have progressed to assuming leadership roles within the beef cattle industry.

Dr. Brinks has contributed greatly to worldwide knowledge of performance beef cattle concepts as he has lectured throughout the United States and in Canada, Australia, New Zealand, Argentina and Brazil. He has also authored or co-authored close to 200 general publications, 69 western section articles and 66 referred publications.

Dr. Brink's professional memberships include the American Society of Animal Science, The American Genetics Association, Gamma Sigma Delta, Alpha Gamma Rho, Sigma Xi and Alpha Zeta.

Dr. Brinks has been the recipient of numerous national, regional and university awards for teaching, advising and service to the beef cattle industry.

Dr. Brinks is recognized as the facilitator who, along with the support of his colleagues, implemented the genetic evaluation methodology which generates genetic information such as Expected Progeny Differences through National Cattle Evaluation for numerous national level breed association performance programs.

Dr. Brinks is married to Rose and they have nine children.

BIF is pleased and honored to recognize the many contributions of Dr. James Brinks by presenting him with the BIF Pioneer Award.

For Immediate Release

Robert E. Taylor receives a "1995 BIF Pioneer Award"

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored Robert E. Taylor with a Pioneer Award at the convention held at the Holiday Inn in Sheridan, Wyoming.

Robert E. Taylor was born in 1934 and reared on a ranch in Almo, Idaho. He earned the B.S. and M.S. degrees from Utah State University in 1956 and 1957, respectively, and the Ph.D. degree from Oklahoma State University in 1959. From 1959-1968, he was an Assistant and Associate professor at Iowa State University. He has been a Professor of Animal sciences at Colorado State University since 1968, involved in teaching, coordinating the departmental teaching program and research activities primarily in beef cattle management systems.

Dr. Taylor's professional memberships include Phi kappa Phi, Gamma Sigma Delta, Council for Agricultural Science and Technology, Sigma Xi, and the American Society of Animal Science. He has served several times on the ASAS beef and teaching committees. He presented the Invitational Diamond Jubilee paper on "Teaching Animal Science: Changes and Challenges" at the 1983 ASAS annual meeting.

Dr. Taylor has been elected as a Fellow in ASAS on the basis of his outstanding teaching achievements. In addition to his effective classroom teaching, he has made more than 100 presentations at international, national, regional, and state beef cattle meetings, conferences, seminars, and symposia. He also has contributed 110 scientific and popular publications primarily in teaching and beef cattle management. His frozen cattle and cross-section demonstrations and slides have made a significant contribution to understanding body composition and yield grades in live slaughter cattle. His two textbooks, Scientific Farm Animal Production and Beef Production and Management Decisions are widely used.

Dr. Taylor was among the earliest initiators of the undergraduate internship program in Animal Sciences. More than 1,500 animal science interns from Colorado State have obtained formalized educational experiences throughout the United States and several foreign countries.

Dr. Taylor has distinguished himself as a teacher, academic advisor, and personal counselor to more than 5,000 students. He has made innovative changes in curriculum and advising and he has been a leader in the objective evaluation of teaching and advising.

Dr. Taylor has received several national, regional, and university awards for teaching and advising. Numerous students credit Dr. Taylor with being one of the first to recognize and teach the importance of matching genotype to environment and thereby, optimizing beef cattle performance in an attempt to minimize annual cow costs.

Dr. Taylor is married to Carole; is the father of 5 children, and the grandfather of seven grandchildren.

BIF is pleased to recognize the many contributions of Robert Taylor by presenting him with this BIF Pioneer Award.

PIONEER AWARDS

Jay L. Lush	Iowa State University	Research	1973
John H. Knox	New Mexico State Univ	Research	1974
Ray Woodward	American Breeders Service	Research	1974
Fred Wilson	Montana State University	Research	1974
Charles E. Bell, Jr.	USDA-FES	Education	1974
Reuben Albaugh	Univ of California	Education	1974
Paul Pattengale	Colorado State Univ.	Education	1974
Glenn Butts	Performance Registry Int'l	Service	1975
Keith Gregory	RLHUSMARC	Research	1975
Bradford Knapp, Jr.	USDA	Research	1975
Forrest Bassford	Western Livestock Journal	Journalism	1976
Doyle Chambers	Louisiana State University	Research	1976
Mrs. Waldo Emerson Forbes	Wyoming Breeder	Breeder	1976
C. Curtis Mast	Virginia BCIA	Education	1976
Dr. H. H. Stonaker	Colorado State University	Research	1977
Ralph Bogart	Oregon State University	Research	1977
Henry Holsman	South Dakota State Univ.	Education	1977
Marvin Koger	University of Florida	Research	1977
John Lasley	University of Florida	Researach	1977
W.L. McCormick	Tifton, Georgia Test Station	Research	1977
Paul Orcutt	Montana Beef Performance Assoc.	Education	1977
J. P. Smith	Performance Registry Int'l	Education	1977
James B. Lingle	Wye Plantation	Breeder	1978
R. Henry Mathiessen	Virginia Breeder	Breeder	1978
Bob Priode	VPI & SU	Research	1978
Robert Koch	RLHUSMARC	Research	1979
Mr. & Mrs. Carl Roubicek	University of Arizona	Research	1979
Joseph J. Urick	US Range Livestock Experiment Station	Research	1979
Bryon L. Southwell	Georgia	Research	1980
Richard T. "Scotty" Clark	USDA	Research	1980

PIONEER AWARDS

F. R. "Ferry" Carpenter	Colorado	Breeder	1981
Clyde Reed	Oklahoma State University		1981
Milton England	Panhandle A & M College		1981
L. A. Moddox	Texas A & M College		1981
Charles Pratt	Oklahoma		1981
Otha Grimes	Oklahoma		1981
Mr. & Mrs. Percy Powers	Texas		1982
Gordon Dickerson	Nebraska		1982
Jim Elings	California		1983
Jim Sanders	Nevada		1983
Ben Kettle	Colorado		1983
Carroll O.Schoonover	University of Wyoming		1983
W. Dean Frischknecht	Oregon State University		1983
Bill Graham	Georgia		1984
Max Hammond	Florida		1984
Thomas J. Marlowe	VPI & SU		1984
Mick Crandell	South Dakota State University		1985
Mel Kirkiede	North Dakota State University		1985
Charles R. Henderson	Cornell University (Retired)		1986
Everett J. Warwick	USDA-ARS (Retired)		1986
Glenn Burrows	New Mexico		1987
Carlton Corbin	Oklahoma		1987
Murray Corbin	Oklahoma		1987
Max Deets	Kansas		1987
George F. & Mattie Ellis	New Mexico		1988
A. F. "Frankie" Flint	New Mexico		1988
Christian A. Dinkel	South Dakota State University (Retired)		1988
Roy Beeby	Oklahoma		1989
Will Butts	Tennessee		1989
John W. Massey	Missouri		1989

PIONEER AWARDS

Donn & Sylvia Mitchell	Manitoba, Canada	1990
Hoon Song	Agriculture Canada	1990
Jim Wilton	Univ. of Guelph, Canada	1990
Bob Long	Texas Tech	1991
Bill Turner	Texas A & M	1991
Frank Baker	Arkansas	1992
Ron Baker	Oregon	1992
Bill Borror	California	1992
Walter Rowden	Arkansas	1992
James W. "Pete" Patterson	North Carolina State Univ. (Retired)	1993
Hayes Gregory	North Carolina State Univ. (Retired)	1993
James D. Bennett	Virginia	1993
O'Dell G. Daniel	University of Georgia (Retired)	1993
M. K. "Curly" Cook	University of Georgia (Retired)	1993
Dixon Hubbard	USDA-Extension	1993
Richard Willham	Iowa State University	1993
Dr. Robert C. deBaca	Iowa State University	1994
Tom Chrystal	Iowa Bull Test System	1994
Roy A. Wallace	Select Sires, Inc.	1994
James S. Brinks	Colorado State University	1995
Robert E. Taylor	Colorado State University	1995

James Brinks receives the 1995 BIF Pioneer Award.
(Left to Right): Paul Bennett, President; James Brinks; Ron Bolze, Executive Director

For Immediate Release

Paul S. Bennett receives a "1995 BIF Continuing Service Award"

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored Paul Bennett with a Continuing Service Award at the convention held at the Holiday Inn in Sheridan, Wyoming.

Paul Bennett was born in 1961 to James and Barbara Bennett of Knoll Crest Farms of Red House, Virginia. Paul's interest in beef cattle was noticed when he was four years old. He started showing heifers when he was six and has maintained all Knoll Crest cattle records since he was ten. Paul graduated from Randolph Henry High School and VPI and SU in 1979 and 1983, respectively. While in college, Paul was a member of the livestock judging team and was the first recipient of the George Litton Award. He was an active Block and Bridle Club and AGR Fraternity member and officer. Paul returned to Knoll Crest Farms which today has a national reputation of producing performance oriented Polled Hereford, Gelbvieh and Angus cattle. Paul is one of the most outstanding breeders of purebred cattle in America today producing both bulls and females that have been in demand by both the purebred and commercial cattle industries. Knoll Crest Farms have placed in excess of 10 bulls of the Polled Hereford, Gelbvieh and Angus breeds in A.I. studs that have been used extensively throughout the United States and foreign countries. Polled Hereford seedstock cattle have been exported to Australia.

Paul is a demonstrated leader at the local, state and national levels. He has served unselfishly and has made noteworthy contributions in several important organizations. He is the former President of the Virginia BCIA and Virginia Cattlemen's Association. Paul continues to serve on the BIF Board of Directors as former Vice President and now Immediate Past President. James and Paul represent the only father/son team that have served in this capacity in BIF's 27 year history. Paul serves as Deacon and Sunday School teacher at the Union Hill Baptist Church and is a director of the Southside Electric Cooperative. Paul and his wife Tracy have two children, Scott and Sarah.

BIF is pleased and honored to recognize the many contributions of Paul Bennett by presenting him with the BIF Continuing Service Award.

For Immediate Release

Patrick K.Goggins receives a "1995 BIF Continuing Service Award"

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored Pat Goggins with a Continuing Service Award at the convention held at the Holiday Inn in Sheridan, Wyoming.

Pat Goggins was born May 28, 1930, in Orland, California. When he was four years old, his family moved to Montana where his family primarily dairy farmed in the Bridger and Belgrade areas. He attended Western Montana College in Dillon and later graduated from Montana State University with a degree in Animal Husbandry.

Patrick Goggins is the President of Western Livestock Reporter, Inc., Billings, MT. This corporation includes Western Livestock Reporter, Agri-News, Public Auction Yards, Western Sale Management, Vermillion Ranch, Skymont Charolais, Pryor Creek Ranch, Diamond Ring Ranch, a farm and ranch real estate company and numerous commercial real estate interests.

Goggins started his professional career in the newspaper business when he worked for the Montana Farmer Stockman, Western Livestock Journal and finally the Western Livestock Reporter. Goggins bought Western Livestock Reporter from publisher-founder, Norman Warsinske.

Western Livestock Reporter is a respected livestock publication which covers the 12 Northwestern states. Also, Goggins started Agri-News, now a growing general agriculture publication which covers Montana and Northern Wyoming agriculture news. He is publisher of both newspapers and writes a weekly column for each.

While working as an advertising salesman, Goggins taught himself to be an auctioneer. He practiced the auctioneer's chant by selling telephone poles as he drove down the road to sell advertising. Today, he is recognized as one of the best livestock auctioneers in the Western United States - and he never did go to an auctioneer school.

In 1968, Goggins purchased Public Auction Yards and is proud of the fact it soon became the largest stockyard facility in the Northwest.

Goggins is an innovator, having put livestock auction selling on the map in a big way in the Northwest. He is the originator of Video Livestock Auctions - a sales tool which uses video equipment to sell cattle. His organization, PAYS Video Feeder Cattle Contract Auction Association, conducted nine successful video feeder cattle sales in Montana, Wyoming and Nebraska, before this form of feeder cattle sales became widespread.

In 1965, Goggins purchased the Vermillion Ranch east of Billings and under his direction and the management of son-in-law Bob Cook, the ranch has become a nationally recognized quality registered Angus operation. His other ranching interests include Skymont Charolais, a purebred polled Charolais operation, managed by son-in-law, Jeff Mosher, as well as other ranches in the area for the commercial cattle.

Goggins is an energetic entrepreneur with a spirited mind. A born business man, he was raised in a meager environment but has built an empire through drive, ambition and a sense of humor. What he does - he does well. He enjoys a well-earned reputation as a spokesman and authority of livestock matters throughout the United States.

Among his recognitions are awards for Family of the Year and Auctioneer of the Year from the National Auctioneers Association.

His newspapers - Western Livestock Reporter & Agri News have received separate, national recognition for news coverage.

Pat is a founder of the Northern International Livestock Exposition and was the organizations' first president and a board member for 15 years.

He was honored by his livestock marketing peers as Marketeer of the Year in 1977 and in 1992 was U.S. Man of the Year in Livestock at the National Western Stock Show in Denver.

Pat Goggins career has had a widespread positive influence on cattle industry affairs. One need only attend an annual Montana Agriculture Political Action Committee fundraising luncheon at the Montana Stock Growers Convention to see the respect and esteem in which he is held.

Goggins support promotion and communications about BIF principles through his weekly columns, widespread travels, auctioneering activities and industry involvement have strengthened the performance beef cattle movement throughout the Northwest.

Through family member involvement, Pat has built a legacy that will transcend his career. Pat and his wife Babe have three daughters, three sons and thirteen grandchildren.

BIF is pleased to recognize the many contributions of Pat Goggins by presenting him with this BIF Continuing Service Award.

For Immediate Release

Brian Pogue receives a "1995 BIF Continuing Service Award"

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored Brian Pogue with a Continuing Service Award at the convention held at the Holiday Inn in Sheridan, Wyoming.

A native of Belmont, Ontario, Brian dedicated his formal studies and career to the science of beef cattle genetic improvement. Following his undergraduate and graduate studies in beef cattle genetics, Brian commenced a fourteen year career with the Ontario Ministry of Agriculture and Food. Brian held various positions directly related to the genetic improvement of beef cattle, and continued to serve the province as the Beef Cattle Genetics Specialist.

Being responsible for the genetic improvement policy and program delivery from 1980 to 1989, Brian was able to make a substantial impact on program development and utilization. His early involvement was with the Ontario Bull Test Program, which is widely considered a model for bull testing programs elsewhere. Under Brian's leadership, the program expanded from testing 1,000 bulls annually, to testing over 4,000. Government stations were built and private stations contracted. New traits were measured and evaluation procedures improved.

Brian played an influential role, directly and indirectly, in the growth of herd testing in Ontario. The number of recorded weaning weights rose from 4,000 to 130,000 per year during Brian's time with the program. The average adjusted weaning weight in enrolled herds increased by 92 pounds over 10 years.

Brian took the lead role in three major initiatives designed to enhance genetic improvement in the Ontario beef herd. The first was the design and delivery of bull merchandising clinics, where consignors and buyers developed a better understanding of the use of genetic information in bull marketing and selection. Brian was also responsible for the development of heifer selection clinics, and more recently has initiated the creation of heifer development centers around the province.

For many years, Brian was involved with Canada's National Advisory Board for Beef Cattle Improvement (NABBCI) and its various committees. He continues to be involved with provincial organizations such as the Cattlemen's Association and the Beef Cattle Performance Board.

Brian has been in attendance at BIF conferences for many years, and was instrumental in raising Canadian awareness of BIF and its activities. He was also responsible for bringing BIF to Canada in 1990.

Brian's understanding of genetic improvement principles, his initiative and industriousness, have had a significant impact on the Ontario beef industry. Through his various positions in program delivery and extension, Brian has truly broken new ground for the province, and pioneered many developments in support of breeding better beef cattle.

Brian currently serves as the director of Beef Programs for Ontario Animal Breeders, a Guelph, Ontario based artificial insemination firm which markets superior, progeny proven beef semen worldwide.

BIF is pleased and honored to be able to recognize the many contributions of Brian Pogue with their 1995 Continuing Service Award.

CONTINUING SERVICE AWARD RECIPIENTS

Clarence Burch	OK	1972
F.R. Carpenter	CO	1973
E.J. Warwick	DC	1973
Robert De Baca	IA	1973
Frank H. Baker	OK	1974
D.D. Bennett	OR	1974
Richard Willham	IA	1974
Larry V. Cundiff	NE	1975
Dixon D. Hubbard	DC	1975
J.David Nichols	IA	1975
A.L. Eller, Jr.	VA	1976
Ray Meyer	SD	1976
Don Vaniman	MT	1977
Lloyd Schmitt	MT	1977
Martin Jorgensen	SD	1978
James S. Brinks	CO	1978
Paul D. Miller	WI	1978
C.K. Allen	MO	1979
William Durfey	NAAB	1979
Glenn Butts	PRI	1980
Jim Gosey	NE	1980
Mark Keffeler	SD	1981
J.D. Mankin	ID	1982
Art Linton	MT	1983
James Bennett	VA	1984
M.K. Cook	GA	1984
Craig Ludwig	MO	1984
Jim Glenn	IBIA	1985
Dick Spader	MO	1985
Roy Wallace	OH	1985
Larry Benyshek	GA	1986
Ken W. Ellis	CA	1986
Earl Peterson	MT	1986
Bill Borror	CA	1987
Daryl Strohbehn	IA	1987
Jim Gibb	MO	1987
Bruce Howard	CAN	1988
Roger McCraw	NC	1989
Robert Dickinson	KS	1990
John Crouch	MO	1991
Jack Chase	WY	1992
Leonard Wulf	MN	1992
Henry W. Webster	SC	1993
Robert McGuire	AL	1993
Charles McPeake	GA	1993
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

For Immediate Release

Sally Forbes, Beckton Red Angus receives Beef Improvement Federation recognition

Sheridan, Wyoming - The Beef Improvement Federation (BIF) honored a true pioneer in the genetic improvement of beef cattle when they presented a leather bound 25 Year BIF History entitled "Ideas Into Action" to Sally Forbes of Beckton Red Angus at their convention held at the Holiday Inn in Sheridan, Wyoming.

Sally and her husband, Waldo Emerson Forbes, were married in 1939 and moved to the Wyoming Ranch near Sheridan where they began accumulating Red Angus cattle in 1945. They bred and developed Red Angus cattle for nine years prior to the development of a Red Angus cattle breed association. In 1954, the American Red Angus Association was formed with Waldo Emerson Forbes as the first President and Sally as Executive Secretary. Waldo passed away in 1955 and Sally assumed sole responsibility for raising seven children along with ranch management.

Sally thrived with the constraints imposed by working in an area composed of three minorities- A new unaccepted breed at the time, being a woman and involvement in the then unpopular performance movement. She overcame numerous obstacles in her numerous attempts to publicize the superiority of her Red Angus cattle. She initiated the first performance show at a significant beef cattle event complete with individual weights, full performance records and early ultrasonic fat cover evaluation. In Denver, she spearheaded a crossbred association with the purpose of putting crossbreds before the public and in carcass contests. Sally was one of the early believers and promoters of beef carcass evaluation and, as a result, Beckton Red Angus was very active in Performance Registry International with six certified meat sires. Sally recognized early on that effective beef cattle selection principles needed to include a thorough understanding of multiple trait selection. As a result, she avoided single trait selection for the everchanging fads and kept her focus on the total animal and on the end product - beef. In the '50's and 60's, she emphasized biological and functional efficiency which have only recently been recognized by the industry in an attempt to match genotype to environment and, thereby, optimize beef cattle performance and minimize annual cow costs. Sally never pampered her cow herd in order to obtain better measures of fertility, longevity and reproductive traits under practical range conditions. The past few years have seen the Beckton operation inspired by and gradually involved in a program of holistic resource management.

In more recent years, sons Spike and Cam have assumed responsibility for ranch management. Sally moved rapidly into the critical surface coal mining and environmental war and spent a great deal of time in Washington helping get the Federal Surface Mining law passed.

Performance beef cattle historian Robert C. deBaca writes in his book entitled Courageous Cattlemen, change is caused by people who dare be different. Waldo Emerson Forbes developed a moral philosophy based on optimism and individualism and gave praise to non-conformity. Throughout a very productive life, Sally Forbes has looked at alternative approaches - many not of the current popularity. She has left a powerful impact, not only on the American cattle industry and world cattle breeding, but on almost every endeavor she undertook. Her Beckton cowherd is a lovely sight to behold - a tribute to her husband's foresight and inspiration and monument to practical efficiency in times of "image extremes".

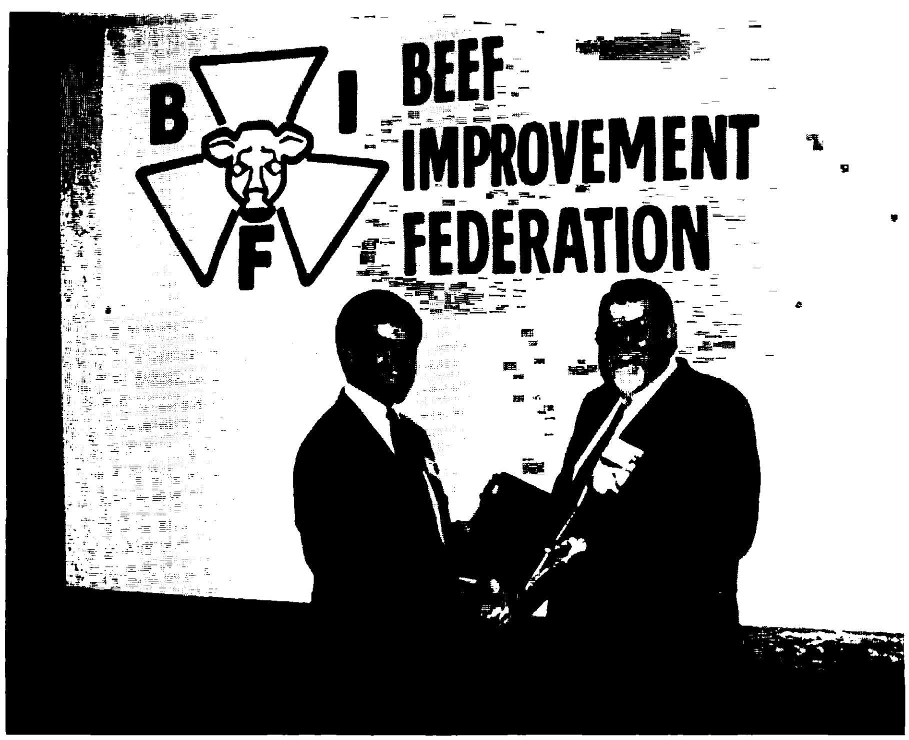
In appreciation for her pioneering efforts in the establishment of the Beef Improvement Federation, Sally Forbes' career of dedication to the breeding and promotion of performance beef cattle is recognized by the Beef Improvement Federation.

Sally Forbes, Becton Stock Farms, receiving special Recognition as one of the BIF Founders 27 Years ago. (Left to right) Sally Forbes, Jack and Gini Chase

1995 Beef Improvement Federation Board of Directors
Front Row: Richard Willham, Ron Bolze, Burke Healey, Glenn Brinkman Jed Dillard, John Hough
Back Row: Mike Schutz, Don Boggs, Doug Husfeld, John Crouch, Lee Leachman
Paul Bennett, Norm Vincel, Larry Cundiff, Roger Hunsley, Ronnie Silcox, Gary Johnson
Not Pictured: Willie Altenburg, Kent Anderson, Ronnie Green, Dan Kniffen, Craig Ludwig, Roy McPhee

Wyoming Beef Cattle Improvement Assoc. President, Robert Pingetzer, Welcomes BIF Convention Attendees to Sheridan, Wyoming

Convention host, Doug Hixon, University of Wyoming Beef Extension Specialist, did a Masterful job of planning, Coordinating and implementing What proved to be one of the best BIF Conventions ever



New BIF President, Glenn Brinkman, expressing appreciation to former President Paul Bennett, for contributions to BIF over the past year.

Out-Going President, Paul Bennett, expressing a few thoughts to banquet attendees relative to the impact of BIF through the years.

New BIF President, Glenn Brinkman, taking over the helm of BIF with great anticipation.

Who better to emcee The awards banquet than Wyoming's very own Jack Chase, Buffalo Creek Red Angus.

1995 Frank Baker Memorial Scholarship recipients. (left to right): Larry Cundiff, Committee Chairman, Dan Moser, University of Georgia; Danny Crews, Louisiana State University and Ron Bolze, Executive Director.

Brian Pogue receives a 1995 BIF Continuing Service Award. (left to right): Paul Bennett, President, Brian Pogue, and Ron Bolze, Executive Director.

Paul Bennett receives a 1995 BIF Continuing Service Award. (left to right): Paul Bennett, President, Ron Bolze, Executive Director.

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