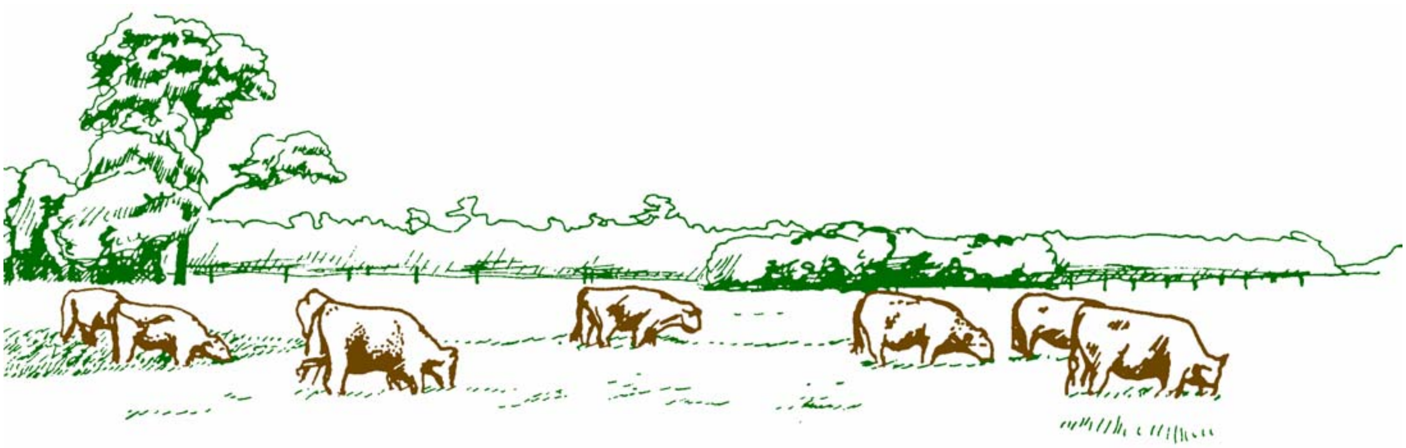
Celebrating the Fifty-third Annual

Beef Cattle Short Course

PROCEEDINGS

"Management Issues and Industry Challenges in Defining Times"



Gainesville, Florida
May 5-7, 2004

UNIVERSITY OF FLORIDA

Department of Animal Sciences
Cooperative Extension Service

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Beef Cattle Short Course

May 5-7, 2004

Sponsored by

Department of Animal Sciences
Cooperative Extension Service
Institute of Food and Agricultural Sciences
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53rd Annual Beef Cattle Short Course

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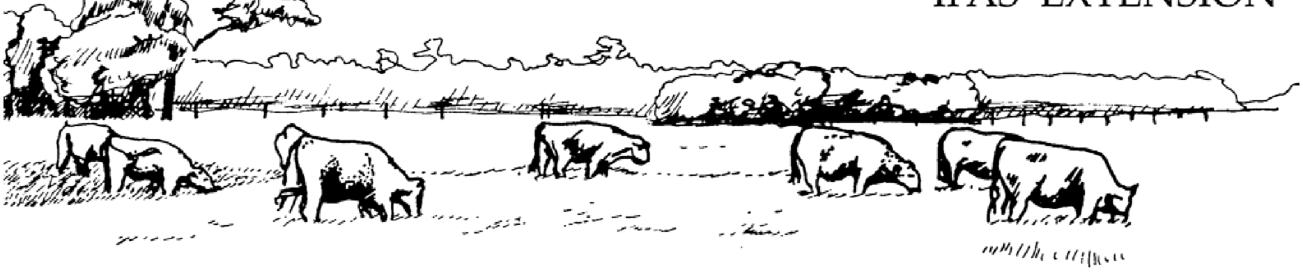

Beef Cattle Short Course

Program Schedule

“Management Issues and Industry Challenges in Defining Times”

Wednesday, May 5, 2004

AM

11:00 Registration *(Hilton UF Conference Center)*

PM

Presiding: *F. Glen Hembry*, Department of Animal Sciences, UF/IFAS, Gainesville, FL

1:00 **Welcome**

1:15 **Remarks**
- *Roger West*, President, Florida Cattlemen’s Association, Gainesville, FL

1:35 **Market Outlook for 2004 and Beyond**
- *Randy Blach*, Cattle-Fax, Englewood, CO

2:25 **Refreshment Break**

Presiding: *Todd Thrift*, Department of Animal Sciences, UF/IFAS, Gainesville, FL

2:45 **Under Construction: National Animal Identification System**
- *Glen Smith*, Ag Infolink, Macon, GA

3:30 **Political Climate of BSE and COOL: How Does it Affect You on the Ranch?**
- *Bryan Dierlam*, NCBA, Washington D.C.

4:00 **Have Marketing Plans Changed Given the Ramifications of BSE and the Resulting Market Conditions?**
- *Randy Blach*, Cattle-Fax

4:45 **Adjourn**

5:00 **Allied Industry Trade Show and Reception**
- Several companies will have exhibits and representatives to answer your questions. Hors d’oeuvres provided compliments of the exhibitors. A cash bar is available for your enjoyment.

Thursday, May 6, 2004

AM

7:00 **The Importance of Selenium Nutrition in Today's Beef Production**
- *Breakfast Sponsored by* ***Lakeland Animal Nutrition*** *and* ***Alltech,Inc.***

"Genetics, Breeds, and Breeding Programs for Profitable Beef Production in Florida - Sponsored by the American Breeds Coalition - Braford, Brahman, Beefmaster, Brangus, Red Brangus, Santa Gertrudis, and Simbrah"

Presiding: *David Riley*, STARS, USDA, Brooksville, FL

8:15 **Genetic Selection Using Genetic Markers**
- *Gary Hansen*, North Florida REC, UF/IFAS, Marianna, FL

8:45 **Implications of Breed Type Evaluations**
- *Larry Cundiff*, Meat Animal Research Center, USDA, Clay Center, NE

9:30 **Connecting the Cowherd to the Carcass: Balancing Production, Environment and the Market Place**
- *Bill Turner*, Texas A&M, College Station, TX

10:15 **Refreshment Break**

Presiding: *Bill Turner*, Texas A&M, College Station, TX

10:30 **Panel Response to Questions Concerning the Use of Bos indicus Genetics for Beef Production**
- *Larry Cundiff*, MARC, USDA, Clay Center, NE; Breeds Research
- *Tim Olson*, Department of Animal Sciences, UF/IFAS, Gainesville, FL; Breeds Research
- *Dan Dorn*, Decatur County Feed Yards, Oberlin, KS; Feeder in Northern Plains
- *Doug Husfeld*, Hondo Creek Cattle Co., Edroy, TX; Feeder in Southern Plains
- *Glen Dolezal*, Excel Corp.,Wichita, KS; Major Packer
- *Dwain Johnson*, Department of Animal Sciences, UF/IFAS, Gainesville, FL; Meats Research
- *Joe Jordon*, Publix, Lakeland, FL; Retail
- *Charlie Bradburry*, Nolan Ryan's All Natural Tender Aged Beef, Huntsville, TX; CEO
- *Chip Ramsay*, Deseret Cattle & Citrus, St. Cloud, FL; Cow/Calf and Current FL Beef Council Chairman
- *Don Quincy*, Quincy Cattle Co., Chiefland, FL; Stocker

12:00 **Leave for Lunch at UF/IFAS Beef Teaching Unit** *(Sponsored by* ***Farm Credit of North Florida*** *- Directions to be provided)*

PM

Presiding: *Tim Marshall* and *Bob Sand*, Department of Animal Sciences, UF/IFAS, Gainesville, FL

2:00 **Demonstrations and Discussions -** The U.S. Animal Identification Plan calls for a madatory system of ID, using radio-frequency identification technology to allow traceback on any animal within 48 hours of a disease outbreak. Some of the companies involved with EID tags, readers, scale heads, software, and other data management systems will demonstrate their products.
- Micro Beef Technologies/Decatur County Feedyard
- AgInfo Link USA
- Emerge Interactive
- Alflex USA
- Temple Tag
- Y-TEX Corporation

3:00 **Break -** *Sponsored by* ***Helena Chemical Company***

4:30 **Adjourn**

6:00 **Cattlemen's Steak-Out** (Horse Teaching Unit Arena) - Transportation on your own

Friday, May 7, 2004

"Profitable Cow Supplementation for Florida Management Systems"

AM

Presiding: *F. Glen Hembry*, Department of Animal Sciences, UF/IFAS, Gainesville, FL

8:30 **Principles of Supplementing the Grazing Beef Cow** - *Matt Hersom*, Department of Animal Sciences, UF/IFAS, Gainesville, FL

9:15 **Breakout Session -** Each session will have a program designed to meet the needs of cattlemen in the designated areas. Specific cow supplementation systems will be presented and discussed by extension professionals located in these areas.

1. Large South Florida Ranches
Topics will include: Stockpiled Limpo Grass, Molasses, and Citrus Pulp

2. Central Florida (Gainesville to Orlando)
Topics will include: Current Producer Supplementation Perspectives, Supplement Nutrition and Economic Evaluation, and Animal Management to Optimize Supplementation

3. Northwest Florida
Topics will include: Methods of Harvesting and Utilizing Forage Options and Supplementing the North Florida Beef Cow

10:15 **Refreshment Break**

11:45 **Adjourn**

Program Participants

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Under Construction: National Animal Identification System

Glenn Smith
USA Country Manager
AgInfoLink
Longmont, CO

The livestock industry in the USA appears to be rapidly moving toward the adoption and implementation of a national animal identification plan. The purpose of such a system is to improve the ability of the industry and state/federal regulatory officials to provide satisfactory animal herd health surveillance and respond to outbreaks of significant disease threats. These disease threats may be a result of naturally occurring disease outbreaks or a result of intentional terrorist introduction of disease to the nation's herds. The goal of the proposed national animal identification program is to enable 48-hour traceback or faster of all animals involved in a foreign animal disease outbreak.

The ability of state and federal regulatory officials to monitor the health of the nation's livestock herds has been greatly diminished in recent years. National surveillance has traditionally been reliant upon state/federal testing for brucellosis and tuberculosis. With these diseases nearly eradicated and annual herd testing having been greatly curtailed, sufficient sampling is no longer available to regulatory officials.

The need for increased herd surveillance is growing. Animal disease threats (Bovine Spongiform Encephalopathy (BSE), Foot-and-Mouth Disease (FMD), etc.) are very real in today's world. In addition to the animal health impact of such a disease outbreak, industry is also faced with significant economic impacts through loss of market opportunities. This was vividly illustrated in the recent BSE cases in North America. The diagnosis of a single case of BSE in Alberta, in May, was a strong wake-up call for USA producers. The "other shoe dropped" on December 23, 2003, when a single BSE case was diagnosed in Washington. The resulting loss of key export markets (including Japan, Korea, and Mexico) fueled remarkable price drops and price volatility. This market disruption underscores the economic risk that industries face without traceability that enables identification and containment of product or categories of product. As a result of these incidents, the USA livestock industry now appears to be more supportive of implementing a national livestock identification program.

The USA is not the only country in the world implementing national animal identification. In fact, the USA is behind many of the other major beef producing nations by putting in place traceability systems. Canada began implementation of a national animal tagging program in the late 1990s. This program became mandatory in 2001, and now requires that all cattle be tagged with an approved Canadian Cattle Identification Agency (CCIA) tag before leaving the farm of origin. Beginning in January 2005, the approved tags will all be radio frequency ear tags (RFID). The European Union (EU) has in place a passport system required for the movement of any livestock. Australia has implemented the National Livestock Identification System (NLIS) and is working toward its' mandatory national adoption. The South American nations of Brazil, Uruguay, and Paraguay are also in varying stages of implementing national identification systems. Mexico is developing a national system as well, and there is a desire to make the CAN-USA-MEX system as harmonious as possible. Japan identifies all animals as well. The key message in the global picture is that mandatory national individual animal identification systems are quickly becoming the *de minimus* standard. The USA will need an animal identification system to compete effectively in the global marketplace.

United States Animal Identification Plan (USAIP)

The framework for this national identification effort has already been developed and is known as the United States Animal Identification Plan (USAIP). USAIP was developed as a public-private collaboration. USDA is now reviewing this plan and formulating an implementation plan for national animal identification. It is anticipated that USDA, in its final implementation plan, will utilize much of the work outlined in USAIP.

USAIP Executive Summary

The following is the executive summary from the USAIP plan:

"Protecting American animal agriculture by safeguarding animal health is vital to the wellbeing of all U. S. citizens. It promotes human health; provides wholesome, reliable, and secure food resources; mitigates national economic threats; and enhances a sustainable environment. Essential to achieving this goal is an efficient and effective animal identification program. Building upon previously established and successful animal health and animal identification programs involving many animal industries, an industry-state-federal partnership, aided by the National Institute for Animal Agriculture (NIAA), was formed in 2002 to more uniformly coordinate a national animal identification plan. This resulting plan, requested by the United States Animal Health Association (USAHA) and facilitated by USDA's Animal and Plant Health Inspection Service (APHIS), was formulated in 2003 for presentation at the October, 2003 annual meeting of the USAHA. More than 100 animal industry and state-federal government professionals representing more than 70 allied associations/organizations collectively assessed and suggested workable improvements to the plan to meet future U. S. animal identification needs.

"Fundamental to controlling any disease threat, foreign or domestic, to the nation's animal resources is to have a system that can identify individual animals or groups, the premises where they are located, and the date of entry to that premises. Further, in order to achieve optimal success in controlling or eradicating an animal health threat, the ability to retrieve that information within 48 hours of confirmation of a disease outbreak and to implement intervention strategies is necessary. The USAIP is focused on utilizing state-of-the-art national and international standards with the best available and practical technologies. It is dynamic and flexible, and will incorporate new and proven technologies as they become available. States' needs in implementing animal identification will receive priority within the uniformity provided by federal oversight.

"The USAIP currently supports the following species and/or industries: bison, beef cattle, dairy cattle, swine, sheep, goats, camelids (alpacas and llamas), horses, cervids (deer and elk), poultry (eight species including game birds), and aquaculture (eleven species). Implementation will be in three phases: Phase I involves premises identification; Phase II involves individual or group/lot identification for interstate and intrastate commerce; and Phase III involves retrofitting remaining processing plants and markets and other industry segments with appropriate technology that will enhance our ability to track animals throughout the livestock marketing chain to protect and improve the health of the national herd. Initial implementation will focus on the cattle, swine, and small ruminant industries. In transition, the USAIP recommends that: all states have a premises identification system in place by July 2004; unique, individual or group/lot numbers be available for issuance by February 2005; all cattle, swine, and small ruminants possess individual or group/lot identification for interstate movement by July 2005; all animals of the remaining species/industries identified above be in similar compliance by July 2006.

"These standards will apply to all animals within the represented industries regardless of their intended use as seedstock, commercial, pets or other personal uses.

"It is well acknowledged that costs associated with the USAIP will be substantial and that a public/private funding plan is justified. Significant state and federal costs will be incurred in overseeing, maintaining, updating, and improving necessary infrastructure. Continued efforts will be required to seek federal and state financial support for this integral component of safeguarding animal health in protecting American animal agriculture."

USDA Direction

In comments presented at House and Senate oversight committee hearings in March, USDA indicated that a comprehensive national animal identification program in the USA should meet these goals:

1) Producer flexibility to utilize existing systems and adoption of new systems. Producers should not be burdened with having multiple identification numbers, systems, or requirements.

2) System should be technology neutral so that all existing technologies and emerging new technologies can be utilized.

3) Build upon the data standards developed by USAIP. Provisions to ensure data confidentiality are an essential part of this objective.

4) System must not preclude producers from being able to use the framework with production management systems that respond to market incentives.

5) The system must not unduly increase the role and size of the government.

USDA is proceeding with implementation plans for a national livestock identification program under the existing statutory authority of the Animal Health Protection Act. However, concerns over confidentiality of private business information and accessibility of this information by other agencies or the general public are issues that will likely spur USDA and industry to ask Congress for additional protection.

USDA is proceeding with a phased implementation plan. A national Premises Identification "allocator" is to be completed in 2004. This system will enable state veterinarians, through cooperative agreements with USDA, to issue unique uniform premises identifications to producers. USDA's next focus would be on setting of standards for data collection and sharing into a national database. USDA would likely attempt to fund some additional infrastructure needs such as reader systems in strategic locations. USDA has said they do not envision use of significant federal funding for purchase of electronic ear tags. Starting in fiscal year 2004, USDA would also focus on identifying and qualifying third parities, such as private industry and trade associations, that have identification products or programs, so they could be integrated into the national system. In early fiscal year 2005, USDA would then be in a position to issue premise and animal identification numbers to third parties and to begin receiving information from third parties into the system.

Industry Solutions

A number of commercial firms today offer various components needed for a national animal identification program. Utilization of these existing pieces in a national plan is essential in order to reduce the burden on producers, quickly put a workable system in place, and to limit the role and size of government. Many of these technologies are already being utilized by producers for improved management and for participation in value driven programs. One challenge that exists today with private systems is a lack of interchange between systems.

In response to that need, the Beef Information Exchange (BIE) has been created as a platform for exchange of information across private, proprietary systems. The founding partners of the BIE (AgInfoLink, APEIS, eMerge, IMI Global, and MicroBeef Technologies) are demonstrating how private firms can cooperate to share information for the benefit of the regulatory community and producers. The BIE offers to their customers a method of data management that meets the requirements of national animal identification for limited information sharing with government while maintaining the confidentiality and privacy of the participating producers. BIE membership will grow.

The private sector should be a significant partner with government in designing and implementing a national identification program. The critical role of government in this process is in establishing standards for data to be collected and shared. Private industry will provide the solutions for meeting those standards.

Conclusion

The USA is likely to implement a mandatory, national animal identification program over the next several years. Such a program will support improved animal herd health surveillance and improve the industry's ability to access global markets where traceability is a requirement. National animal identification and traceability will not prevent the outbreak of a foreign animal disease. It will, however, enable rapid identification and containment of that disease, with a goal of minimizing animal health impacts and reestablishing trade to limit economic impacts.

Producers have the opportunity to take advantage of the framework enabled under a national animal identification program. Individual animal identification and traceability can create new opportunities for the livestock industry. Identification enabled "individual animal management" coupled with "value traceability" will enable the creation and capture of new values for the food industry. Animal identification solely for the purpose of regulatory compliance will add costs to the industry. When such an identification program is also utilized by industry for improved management, producers can realize a positive return on the investments made in animal identification.

References

US Animal Identification Plan
http://www.usaip.info

USDA-APHIS-Veterinary Services
http://www.aphis.usda.gov

Beef Information Exchange (BIE)
http://www.beefinformationexchange.com

AgInfoLink
http://www.aginfolink.com

National Institute for Animal Agriculture
http://www.animalagriculture.org

US Animal Health Association
http://www.usaha.org

Notes:

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Genetic Selection Using Genetic Markers

Gary R. Hansen
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With recent advancements in biotechnology, genetic selection of beef cattle has entered the 21st century. Cattle producers now have the ability to assess the genetic makeup of an individual animal through the use of genetic markers. Using a tissue sample (hair, blood, muscle, etc.), cattle can be tested to see if they carry certain genes and whether the allelic combinations within the gene will have a net positive or negative influence when the gene is expressed in the animal. This type of technology will have widespread economic impact on the cattle industry. Using genetic markers will help to speed up selection of animals for traits that are difficult to measure due to expensive data collection as well as traits that are measured only in one sex or measured late in the life of an animal. Basic genetic principles must be understood to have an understanding of the use of genetic markers.

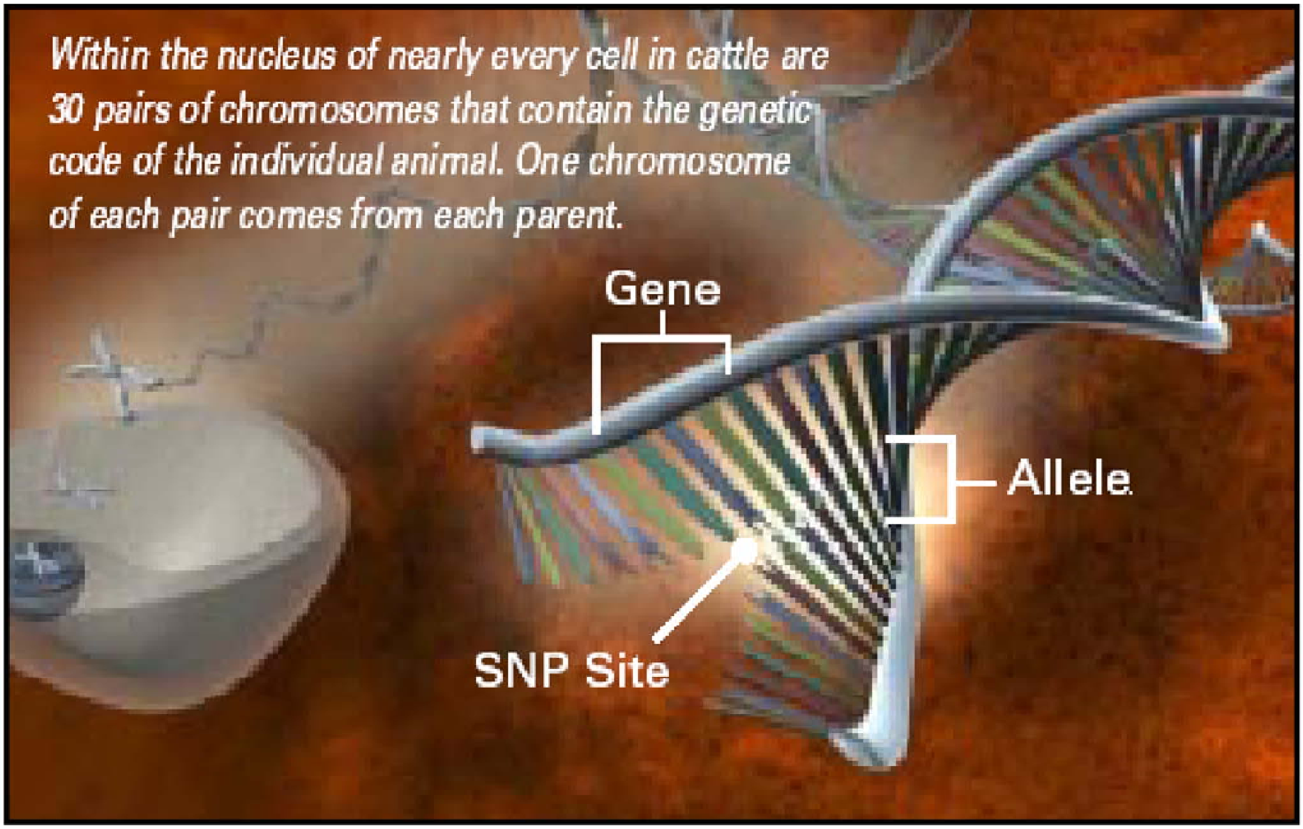
Chromosomes are long thread-like strands of DNA located in the nucleus that contain the code to make proteins, enzymes, hormones, etc**.** Genes are a discrete segment of a chromosome. The unique nucleotide sequence within a gene determines its specific biological role. Many genes code for protein products while others are involved in metabolic and developmental events. Others genes regulate when different genes will be expressed or not expressed depending upon different metabolic pathways synthesized in the animal. Alleles are alternate forms of genes. Animals that have the same allele at a given locus are homozygotes (BB, bb) while animals with different alleles at the same locus are heterozygotes (Bb). Mutations of a single nucleotide, called a single nucleotide polymorphism (SNP) can affect the expression of a gene, especially if the mutation takes place in a coding region. These types of mutations lead to a specific nucleotide sequence that give rise to easily detectable gene markers that can be used to differentiate between alleles at a locus. Figure 1 illustrates the basic organization of the genetic code for cattle.

Several genes have been identified that account for sufficient variation in specific traits of economic interest to cattle breeders. Traits of economic importance to cattle producers can be classified into two basic classes; qualitative and quantitative traits. Qualitative traits involve the expression of single gene with variation determined by various alleles (black or red coat color, horn versus polled, double muscling) while quantitative traits involve the interaction of several genes (polygenes) and multiple allelic combinations (carcass, growth, production). It appears that almost all economically important beef cattle traits are polygenic traits with 3 to 6 major genes affecting the expression of the trait with each gene having a small effect. This complicates genetic selection for these traits as it difficult to determine how much of the variation can be assigned to a single gene. This is complicated further by the fact that genes affecting the same trait can be antagonist to each other. Genes located close to each other on a chromosome are linked meaning that these genes are almost always passed on from one generation to the next generation together.

Progeny tests have been the traditional method to select for economic traits in beef cattle. Animals are evaluated using phenotypic trait comparisons within a contemporary group, followed by statistical analysis to determine genetic differences between individual animals. Recently, the National Cattle Evaluation has used the best linear unbiased prediction (BLUP) model to improve selection by generating expected progeny differences (EPDs).

EPDs have improved the ability of livestock

Figure 1. The basic genetic structure of chromosomes and genes found in beef cattle.



From Merial. Available at: http://us.igenity.com/pdfs/IGN-03-3003-FUNC-GEN_US.pdf, Accessed March 12, 2004.

producers to affect change in their herds; however, caution must be exercised to insure properly balanced trait selection is taking place. Under these types of selection systems, progress is limited due to expense of data collection, time between identification and subsequent gene introduction in the breeding population, and generation interval. This is complicated further in traits that are lowly heritable (fertility, disease resistance), classified only in one sex (milk production, scrotal circumference), measured late in an individual's life (stayability), or evaluated postmortem (carcass traits) (Bourdon, 1988; Hohenboken, 1988). Gene markers allow for identification of animals at birth with the right combination of alleles for traits where selection is difficult. Selection using genetic markers would decrease the time needed to introgress desired genes into a herd of selected animals. Marker assisted selection is used to identify specific regions of chromosomes where genes affecting quantitative traits are located (Davis and DeNise, 1998). Markers closely associate with a gene (indirect test) or within the gene (direct test) have been identified. Several have become commercially available for cattle producers to use in their genetic selection programs.

Molecular Genetics

Research in molecular genetics has led to techniques that allow for identification and direct manipulation of genes that influence economic traits. Most of the knowledge about gene structure and function has been obtained through recombinant DNA technologies (Snustad and Simmons, 1999). Recombinant DNA approaches begin with cloning the gene through insertion of a DNA sequence into a cloning vector. This allows for multiple copies of the gene to be replicated and allows for other molecular techniques that can determine gene structure and function. Collins (1992) defined two methods to clone genes of interest: functional cloning and positional cloning. Functional cloning identifies a gene through its role

Table 1. Current DNA markers commercially available for use in genetic selection in beef cattle.

Company Name	Available Markers	Gene Identity/ Location	Trait	Cost[a]	Website
Genetic Solutions	GeneSTAR Tenderness	Calpastatin-BTA 7	Meat Tenderness	N/A	www.geneticsolutions.com.au
	GeneSTAR Tenderness 2	Calpastatin-BTA 7 +Calpain 1- BTA29	Meat Tenderness	$75.00	
	GeneSTAR Marbling	Thryroglobin-TG5	Meat Quality	$55.00	
Frontier Beef Systems	TenderGENE	Calpain 1-BTA29	Meat Tenderness	$35.00	www.frontierbeefsystems.com
	DoubleBLACK	N/A	Black Coat Color	$38.00	
Genmark	Coat Color	N/A	Black Coat Color	$39.00	www.genmarkag.com
	Myostatin-Peidmontese	Myostatin-BTA2	Retail Yield/ Meat Tenderness	$25.00	
Merial	Igenity-L	Leptin-BTA4	Appetite Regulation/ Energy Utilization	$60.00	www.igenity.com

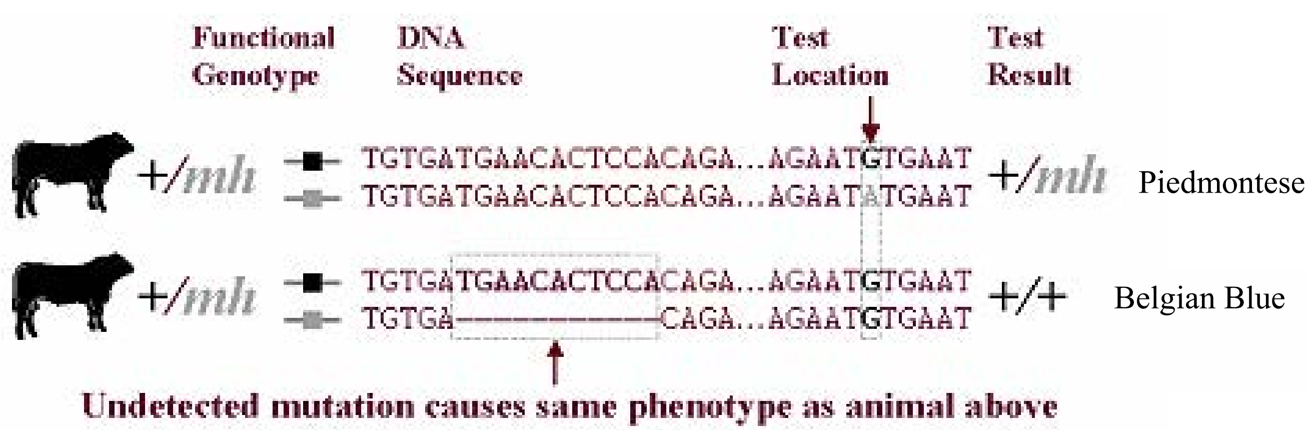
[a]Costs at time of publication and are subject to change. Contact company for current prices and volume discounts.
[b]GeneSTAR® is a registered trademark of Genetic Solutions.
[c]TenderGENE® and DoubleBLACK® are registered trademarks of Frontier Beef Systems.
[d]Igenity-L® is a registered trademark of Merial.

in the biochemical pathways of the organism of interest without regard to chromosomal map position. Positional cloning identifies genes solely by chromosomal map position without knowing gene function (Wicking and Williamson, 1991; Paterson and Wing 1993). Positional cloning makes use of evenly distributed polymorphic markers in the genetic map. Markers are used to locate gene position in a chromosomal region. As new markers are added, map resolution is refined revealing the exact location of the gene. This has lead to the discovery of genetic markers to aid in the selection of genes of economic importance.

Currently there are several companies that market gene tests to determine the genotype for specific traits in beef cattle. Listed in Table 1 are companies that have genetic tests and the specific genes they are able to test for.

Genetic markers are only tools that can help improve the accuracy of genetic selection. Genetic markers can be used to fix genes within a cow herd, however single trait selection should be avoided as this leads to non-functional cattle. Caution should be exercised when using markers in genetic selection as relationships with other economically important genes is usually unknown.

Figure 2. Mutations in Belgium Blue and Piedmontese cattle resulting in the muscle hypertrophy phenotype.



Source: Pollak, 2004.

Genes Associated with Carcass Traits

Myostatin

Myostatin (Growth-Differentiation-Factor-8 (GDF8)) is a member of the transforming growth β superfamily of secreted growth and differentiation factors that is essential for proper regulation of skeletal muscle mass. GDF8 is a negative regulator of muscle growth allowing for the development of normal muscle size. Mutations in this gene have lead to the muscle hypertrophy phenotype found in mice and cattle. Muscle hypertrophy phenotype (double muscling) has been documented in Belgian Blue, Piedmontese, and to a lesser extent in Limousin, Charolais, and Maine-Anjou (Grobet et al.,1998; Kambadur et al., 1997; McPherron and Lee, 1997). In Belgian Blue cattle, a deletion of an 11 nucleotide sequence in the third exon of the myostatin gene causes a frameshift that virtually eliminates all of the mature, active region of the molecule (McPherron and Lee, 1997; Figure 2). In Piedmontese cattle, a single nucleotide polymorphism (SNP) in which adenine is substituted for guanine in the coding region of the myostatin gene causes the muscle hypertrophy phenotype (McPherron and Lee, 1997; Figure 2). This demonstrates the fact that two different mutations resulted in the same phenotype. Casas et al. (2000), showed an interaction between myostatin and chromosome 5 in a Piedmontese X Angus family for meat tenderness measured by Warner-Bratzler shear force at 14 days postmortem. Animals inheriting the inactive myostatin allele from the Angus had higher shear force measurements (less tender) than animals inheriting the Piedmontese allele. Animals with a single copy of the inactivated myostatin gene have greater muscle mass and less fat than normal animals (Casas et al., 2001; Casas, et al., 1998). Tests are currently available to identify those animals segregating the Piedmontese inactive myostatin allele (Genmark).

Calpain and Calpastatin

A chilled carcass should be aged at least 7 days following slaughter to allow for the proteolytic enzymes to break down the myofibrillar structure of the muscle and connective tissue. Most research indicates that the calpain enzymes coupled with their interaction with the calpastatin enzyme are responsible for the increase in meat tenderness during aging (Koohmaraie, 1996). The calcium dependent proteases (calpains) in conjunction with calcium dependent protease inhibitors (calpastatin) appear to have the greatest effects on meat tenderness. The calpains cause degradation of the proteins that maintain myofibrillar structure (Koohmaraie, 1988, 1992, 1996). Calpastatin inhibits calpain activity which reduces the amount of protein degraded in the myofibrillar structure, which leads to less tender meat. *Bos indicus* breeds have more calpastatin activity than *Bos taurus* breeds, which helps to explain some of the differences in meat tenderness between these breed types (Whipple et al., 1990; O'Conner et al., 1997). Studies have shown calpastatin level to be a highly heritable trait which would allow for the selection of animals with low levels of calpastatin activity to increase meat tenderness (Shackelford et al., 1994). Recently, a commercial DNA marker test based on variants of the calpastatin gene located on BTA7 has become available to help predict meat tenderness (GeneNOTE 4, 2003). The test detects different forms of the gene with one form associated with an increase in tenderness and the other form leading to increased toughness (GeneNOTE 4, 2003). However, there is no published quantitative trait locus (QTL) that coincides with the position of calpastatin, so it is unknown how much genetic variation in meat tenderness could be explained by the mutation in calpastatin.

Calpain (CAPN1) has been mapped to a QTL region for WBSF on BTA29, possibly explaining part of the variation in meat tenderness (Smith et al., 2000). Two variant SNP's (SNP316 and SNP530) have been identified to increase meat tenderness (Page et al., 2002). Warner-Bratzler Shear Force (WBSF) was reduced 1.11 lb (greater tenderness) in a set of Simmental and Angus calf-feds when the CC genotype was present at SNP316 when compared to the GG genotype at the same location. The CG genotype was intermediate indicating that the genotypes are additive. At the same time, WBSF was increased 0.68 lbs when the AA genotype was present at SNP530 when compared to the GG genotype. Animals with the CC genotype for SNP316 and GG genotype for SNP530 had WBSF values that were approximately 1.8 lbs less than animals with the GG genotype for SNP316 and AA genotype for SNP530 (Pollack, 2004). Genetic tests have been developed that identify various variants of calpain (GeneSTAR Tenderness2, *Tender*GENE) and calpastatin (GeneSTAR Tenderness) genes.

Leptin

The leptin protein has been implicated in the regulation of appetite, energy utilization, and fat partitioning in cattle. Leptin is an important part of a negative feedback system that regulates insulin, glucocorticoids, and the sympathetic nervous system.

Variants (alleles) of a SNP in exon 2 of the leptin gene appear to be associated with variation in carcass traits in beef cattle. One SNP (cc at base pair 130) leads to higher levels of carcass fat while another (tt at base pair 73 and 57) is associated with lean tissue growth. A single nucleotide switch (cytosine versus thymine) leads to an amino acid switch (arginine versus cysteine) which code for different leptin proteins in the animal. When cystosine (cc) is present at a critical point on the DNA of both chromosomes, the leptin protein produced is recognized by specific receptors in the hypothalamus which signals the body to suppress appetite and modify fat metabolism. If thymine (tt) is present at the critical point on the DNA then the leptin protein is structurally different and is largely unrecognized by the normal receptors in the brain. The negative feedback is silenced leading to reduced efficiency in appetite and energy regulation (Merial®, 2004).

Animals with the cc genotype tend to have higher lean tissue growth where as animals with the tt genotype tend to have higher marbling scores. The frequency of the variant alleles in various beef cattle breeds are listed in Table 2. Notice that British breeds (higher levels of marbling and carcass fat) have a higher frequency of the t allele while Continental breeds (higher levels of lean tissue growth) have a higher frequency of the c allele. The frequency of homozygous animals for the t allele in the British breeds was considerably higher than in the Continental breeds. This would be expected since British breeds tend to have higher marbling scores and higher yield grades than Continental breeds.

Table 2. Frequency of the c and t alleles at the leptin SNP locus in beef breeds.

Breed	t Allele frequency	C Allele frequency	Lepin-tt proportion
Angus	58%	42%	30%
Hereford	55%	45%	32%
Charolais	34%	66%	10%
Simmental	32%	68%	10%

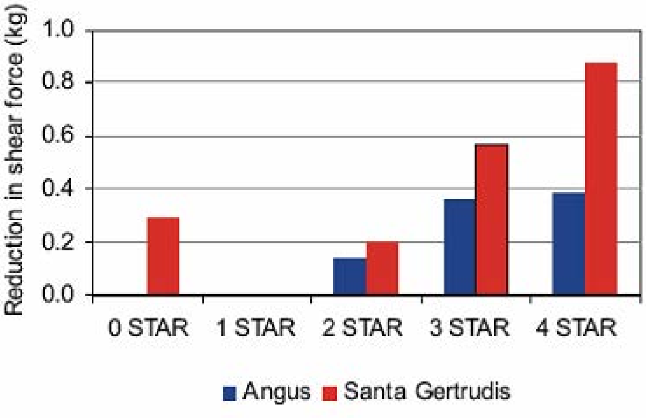
Source: http://sask.usask.ca/~schmutz/meat.html, 2004.

Commercially available genetic markers will be briefly discussed. Many of the markers have only recently become available so validation is still an ongoing process. Producers should realize that environment also plays an important role on how genes are expressed. Different genes are expressed at different times in the production environment. Production environment can also affect to what extent a gene is expressed. Producers should also consider which animals to test. Animals that will have a large genetic contribution to the herd (herd sires, donor cows, artificial insemination sires, etc.) should be considered as candidates for genetic testing. Caution should be exercised before culling animals based solely on a single genetic test.

GeneSTAR® Marbling

The GeneSTAR® Marbling test for variants of the thryoglobin TG5 gene. Animals are classified as 0, 1, or 2 STAR animals depending on which alleles are present at the locus. Studies show that animals with 2 versus 0 STAR increased marbling score 9 to 14 points with an accompanying 16-19% increase in animals grading choice. Animals classified as 1 STAR animal were intermediate. Use

Figure 3. Expected reduction in WBSF in Angus and Santa Gertrudis cattle with various levels of favorable alleles.



Source: GeneNOTE 7.

of GeneSTAR® Marbling is dependent on finish end point with the greatest improvement in cattle that are in the Select/Choice transition. Use of this marker would be most beneficial to cattle producers working to supply cattle that will be sold in alliances or on grids that place high premiums on quality grade and it appears to work best in cattle that are fed for a longer duration. Since the genetic component of marbling is controlled by several genes, 0 STAR animals need to be evaluated using other parameters (marbling EPD, %IMF EPD, leptin, etc.) to determine which individuals should be selected as breeding stock. In some instances, bulls with high EPD's for marbling have genotyped as 0 STAR with the GeneSTAR® Marbling test.

GeneSTAR® Tenderness

GeneStar® Tenderness is commercial DNA marker test marketed by Genetic Solutions and is based on variants of the calpastatin gene located on chromosome 7. The test detects different forms of the gene with one form associated with an increase in tenderness and the other form leading to increased toughness (GeneNOTE 4, 2003). Calpastatin is a naturally occurring enzyme that inhibits calpain, another naturally occurring enzyme involved with meat tenderization as it ages postmortem. GeneSTAR® Tenderness is now marketed in combination with CAPN1 (calpain SNP316) as GeneSTAR® Tenderness2.

GeneSTAR® Tenderness2

GeneSTAR® Tenderness2 is a second generation DNA marker test that is marketed by Genetic Solution which is a combination of the GeneStar® Tenderness (calpastatin) and a recent test developed by Meat and Animal Research Center (MARC) for CAPN 1 (calpain SNP316). The test measures whether an animal has alleles for the two genes associated with tender or tough muscle. Figure 3 shows that animals with four favorable alleles (4 STAR) for the two genes, will have reduced WBSF when compared to animals with less favorable alleles. Animals with 0 favorable alleles had lower WBSF than animal with 1 or 2 favorable alleles. This could be due to the small sample size of this treatment group as well as other genes with favorable alleles, for WBSF could be being expressed in these animals.

Only two trials, one in straightbred Angus and one in straightbred Santa Gertrudis, have looked at the combined effects of the calpastatin and calpain DNA markers. Further research will be

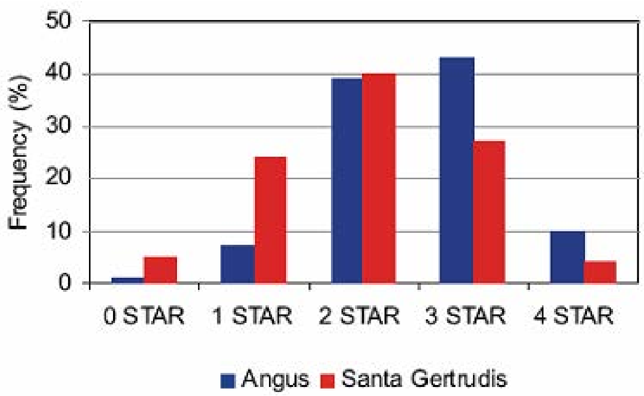
Table 3. Reduction in WBSF in Santa Gertrudis with various levels of favorable alleles.

	GeneSTAR® Tenderness 2 effects				
	0	★	★★	★★★	★★★★
Shear force (lb)[3]	-0.64[1]	0	-0.43	-1.24	-1.92[2]
% tough (WBS > 12lb)[4]	24	33	26	20	8

[1] N=17
[2] N=12
[3] Av = -0.62
[4] Av = 25%

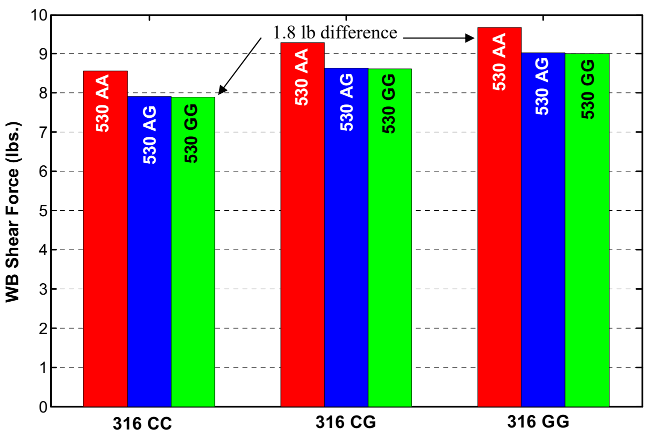
Source: Bovigen Solutions, LLC.

Figure 4. Frequency of Angus and Santa Gertrudis cattle with various levels of favorable alleles (GeneSTAR Tenderness2).



Source: GeneNOTE 7.

Figure 5. Two additive genotypes in Simmental and Angus calf-fed feeder calves.



Source: Pollak, 2004.

needed to validate the combined effects of these markers. The results of the Santa Gertrudis trial are summarized in Table 3.

The Santa Gertrudis trial showed that 4 STAR animals had reduced WBSF by up to 1.92 lbs and also reduced the percentage of tough animals by as much as 25% which translated into three times fewer tough carcasses (BOVIGEN Solutions, LLC). In the Angus trial, less than 2% of the 4 STAR carcasses were classified as tough (> 11 lbs WBSF) compared to 12 % of the 1 STAR and 2 STAR carcasses (BOVIGEN Solutions. LLC). Figure 4 shows the frequency of animals with one, two, three, or four favorable alleles with the Angus and Santa Gertrudis trials. Assuming that animals within these trials are representative of the population as a whole, one would expect similar results in Angus and Santa Gertrudis herds.

Selection for 4 STAR animals would be possible in both populations, however single trait selection should be avoided.

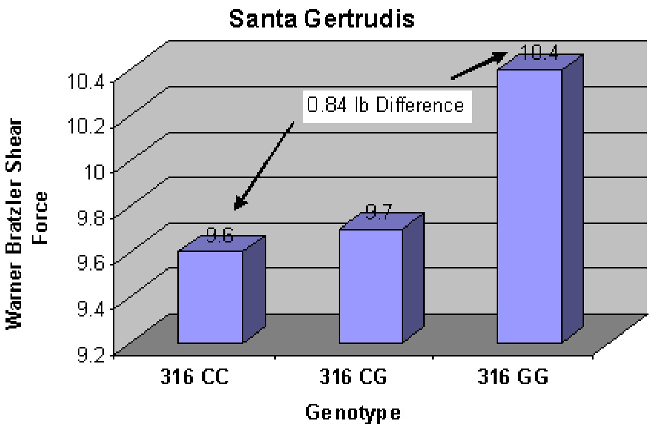
TenderGENE™

*Tender*GENE™ is a DNA marker test that is marketed by Frontier Beef Systems which test for two variants (SNP316 and SNP530) of the CAPN1 gene. Figure 5 summarizes the effect that each SNP has on WBSF in Simmental/Angus cross cattle. Preliminary results showed reduced WBSF scores in animals with all favorable alleles from CAPN1. Warner-Bratzler Shear Force (WBSF) was reduced 1.11 lb (greater tenderness) in a set of Simmental and Angus calf-feds when the CC genotype was present at SNP316 when compared to the GG genotype at the same location. The CG genotype was intermediate indicating that the genotypes are additive. At the same time, WBSF was increased 0.68 lbs when the AA genotype was present at SNP530 compared to the GG genotype. Animals with the CC genotype for SNP316 and GG genotype for SNP530 had WBSF values that were approximately 1.8 lbs less than animals with the GG genotype for SNP316 and AA genotype for SNP530 (Pollak, 2004).

Currently only the SNP316 variant is used in predicting increased tenderness in *Bos indicus* influenced cattle. In a trial with Santa Gertrudis cattle (Figure 6), WBSF was reduced 0.84 lbs when the CC genotype was present versus the GG genotype.

Animals with different genotypic combinations for the SNP316 and SNP530 are ranked according to the desirability of genotype, 5 being more tender in comparison to 1 (Table 4). Animal rank should indicate which animals would be expected to be more tender due to allelic combinations between the two SNP's.

Figure 6. Difference in WBSF Santa Gertrudis cattle with different genotypes at SNP316.



Source: *Tender*Gene Fact Sheet, 2004.

*Double*BLACK™

*Double*BLACK™ is a DNA marker for coat color marketed by Frontier Beef Systems®, to determine if an animal is homozygous black. The marker tests for three possible alleles: black, red, and wild type. With the advent of value based programs that are based on black coat color, several breeders are interested in producing animals homozygous for the black coat color. Since the black gene is dominant over red, black animals may carry one or two copies of the black gene. However, homozygous black animals carry two copies of the black gene. The wild type color gene is rare and animals that carry the wild type gene will possess the coat color of the opposite gene the animal is carrying. Therefore, a black animal that carries one copy of the black gene and one copy of the wild type gene is heterozygous even if is not carrying the red gene. Likewise, red animals may possess just one red gene if the other gene is wild type. Again, this is rare, but possible. Almost all red animals will have two copies of the red gene (Frontier Beef Systems, 2004). As with all of the traits previously discussed, caution should be exercised in selecting animal purely on coat color. Production environment should be considered as animals with black coat color can experience considerably more stress in hot, humid environments compared to animals with lighter coat colors.

Igenity™-L

Igenity™-L, marketed by Merial®, is a DNA marker of variant alleles of the leptin protein. Animals homozygous for the L-tt™ genotype have higher marbling scores as well as higher KPH and subcutaneous carcass fat. Animals homozygous for the L-cc™ produce carcasses with higher lean meat yield. Knowing this information would allow producers to sort animals according to what type of grid (quality versus yield grade) the animals will be marketed on prior to entering the production system. Research has proven that, if all other factors are equal, leptin genotype has a significant impact on carcass quality. In a Texas trial of Charolais/Angus steers, only 11% of cattle identified as L-cc™ graded choice, while 62% of L-tt™ cattle earned that grade. In a trial involving Hereford steers, no L-cc™ cattle graded choice, while 48% of L-tt™ cattle achieved that grade. In a trial at the University of Saskatchewan involving Charolais steers, the percent grading choice were 38% and 58%, respectively for L-cc™ and L-tt™ cattle. Cattle with the L-ct™ genotype graded intermediate between the L-cc™ and L-tt™ genotypes (Table 5; Merial®, 2003).

More cattle can grade choice or better if fed long enough. However, producers can unlock increased profit by grouping cattle of similar genotype into properly managed groups. Increased consistency and uniformity of finish will improve precision and reduce discounts for grade and fat (Merial®, 2004).

Table 4. Tenderness rank for different genotype combinations for SNP316 and SNP530.

Rank	SNP316	SNP530	Genotype score
1	CC	GG	5
1	CC	GA	4
3	CC	AA	3
3	GC	GG	3
5	GC	GA	3
5	GG	GG	3
8	GG	GA	2
8	GC	AA	1
9	GG	AA	1

Source: *Tender*GENE Fact Sheet, 2004.

Table 5. Effect of leptin genotype on carcass quality.

	Genotype			
	L-cc™	L-ct™	L-tt™	P-value
Trial 1[a] - % Choice	11	29	62	0.03
Trial 2[b] - % Choice	0	19	48	0.01
Trial 3[c] - % Choice	38	45	58	0.07

[a]AzTx Feeders (Charolais/Angus steers).
[b]Doerksen Feedlot (Hereford steers).
[c]University of Saskatchewan (Charolais steers).

Parentage Verification and Identification

DNA technology is commonly used for parentage verification and identification of beef cattle. Parentage of calves from multiple sired herds can be determined and inferior sires eliminated. National Cattle Evaluation records have shown that in some instances, misidentification of parentage is as high as 25% of the animals. Using DNA markers to verify parentage allows for a more accurate evaluation. There are several companies that provide DNA technologies for parent verification, but will not be discussed in this paper. DNA markers are also being used to track animals throughout the production chain. This allows producers to track data on an animal from birth to slaughter.

Summary

Several DNA markers are commercially available to assist cattle producers in making genetic selections within their herd. Genetic markers allow for selection of animals early in life. Caution needs to be exercised to properly use these tools with a selection program. Producers need to realize that all of the economically important traits in beef cattle production have a genetic and environmental portion of variance that affects how a gene is expressed. Although an animal may be homozygous for a specific trait, it may not be expressed within the animal due to environmental constraints. All of the economical traits are controlled by several genes, so no one marker will account for all of the genetic variation.

Genetic progress using genetic markers will be faster in the first generations than in succeeding generations. Phenotypic as well as genotypic correlations of a DNA marker with other genes should be considered before a genetic marker (gene) is fixed within a herd. Genetic selection for one gene could lead to an undesirable correlated response in another gene.

Glossary of Terms

Adapted from BIF Guidelines 1

Alleles - Alternate forms of genes. Because genes occur in pairs in body cells, one gene of a pair may have one effect and another gene of that same pair (allele) may have different effect on the same trait.

Base pair - The complementary bases found within a DNA molecule. There are four different bases: adenine (A), thymine (T), cytosine (C) and guanine (G). A always pairs with T, and C always pairs with G. The base sequence ultimately determines the effect of the gene.

Chromosomes - Chromosomes are paired strands of DNA, with accompanying structural proteins, on which genes are located. Domestic cattle have 30 pairs of chromosomes; one chromosome from of each pair having been inherited form each parent. One random chromosome of each pair is transmitted to each egg or sperm cell produced by a parent.

Codon - A specific three-base sequence in DNA that ultimately codes for a specific amino acid used in the building of a protein.

cM (centimorgan) - The unit of length used to express location of genes on chromosomes. One cM is approximately one million nucleotides long. The length of the DNA within a cattle cell is approximately 3,000 cM. A gene ranges from 0.001-0.005cM in length. A cM corresponds to 1 % recombination between loci.

Correlation - A numerical measure, ranging between -1.00 and +1.00, describing how tow traits are related. A high positive correlation means that as one trait increases, the other one usually does as well. For example, cattle with higher than average yearling weight generally will have larger mature size as well. When traits are negatively correlated, if one is above average, the other is likely to be below the average. For example, as birth weight of a calf increases, calving ease is likely to decrease. A near zero correlation between traits means there is no particular relationship between them.

DNA - Deoxyribonucleic acid a long double-stranded nucleic acid molecule arranged as a double helix: the main constituent of the chromosome, it carries genes as segments along its strands.

Exon - Those regions of a gene in which the nucleotide sequence actually codes for a biological relevant product.

Gene - A gene is a discrete segment of the DNA molecule, located at a specific site (its locus) on a specific chromosome pair. It is the basic physical unit of heredity, a linear sequence of nucleotides along a segment of DNA that provides the coded instructions for synthesis of RNA. Which, when translated into protein, leads to the expression of hereditary character. Two copies of each gene exist in each nucleated diploid cell in an animal. Only one gene of each pair is randomly transmitted to the offspring through the gamete. The unique nucleotide sequence of each gene determines its specific biological role. Many genes specify the amino acid sequence of a protein product. Others produce gene products that are involved in controlling metabolic and developmental events.

Gene Marker - A specific sequence of nucleotides that is easily detectable and can be used to differentiate among alleles at a locus. A small unique sequence of DNA whose specific location on a chromosome is known.

Genetic Antagonism - A genetic correlation in which desirable genetic change in one of the traits is accompanied by an undesirable change in the other. For example, because of the positive genetic correlation between milk yield potential and cow maintenance requirement, selection for increased milk would also lead to increased feed cost for maintenance.

Genetic Correlations - Correlations between breeding values for two traits that arise because some of the same genes affect both of them. When two traits (weaning and yearling weight for example) are positively genetically correlated, successful selection for one trait will result in an increase in the other trait as well. When two traits are negatively genetically correlated (birth weight and calving ease for example) successful selection for one trait will result in a decrease in the other. This is sometimes referred to as a genetic antagonism between traits.

Genetic Map - The order of DNA markers on a chromosome and distance between them.

Genome - The entire complement of DNA characteristic to individuals of a species.

Genotype - The two alleles present at a locus in an individual, for a locus with only two alleles, three genotypes are possible. For example, at the polled/horned locus in cattle, two common alleles are P (the dominant allele preventing growth of horns) and p (the recessive allele allowing horn growth). The three possible genotypes are PP (homozygous dominant), Pp (heterozygous or carrier) and pp (homozygous recessive).

Heritability - The proportion of the differences among cattle, measured or observed, that is transmitted, on average, to their offspring. Heritability of different traits may vary from zero to one. The higher the heritability of a trait, the more accurately individual performance predicts breeding value and the more rapid should be the response to selection of that trait.

Heritability estimate - An estimate of the proportion of the total phenotypic variation between individuals for a certain trait that is due to transmissible genetic merit. It is the proportion of total variation for a trait caused by differences among individuals in breeding value.

Indicator trait - Traits that do not have direct economic importance, but aid in the prediction of economically important traits.

Intron - DNA whose nucleotide sequence does not code for a product. An intron is transcribed but is excised and not translated. Therefore, it does not affect the sequence of sub-units in the gene product.

Linkage - The occurrence of two or more loci of interest on the same chromosome within 50 cM linkage distance of one another.

Locus - The specific location of a gene on a chromosome.

Marker Assisted Selection (MAS) - The use of genetic markers to select for specific alleles at linked QTL's and therefore specific traits.

Microsatellite - A type of genetic marker. It is composed of repeating nucleotide sequences with DNA that are locus specific and variable in the number of times the sequence is repeated.

Nucleotide - The subunit of DNA composed of a five carbon sugar, one of four nitrogenous bases (adenine, thymine, cytosine, or guanine) and a phosphate group.

Phenotype - The visible or measurable expression of a character; weaning weight, postweaning gain, or reproduction for example. For most traits, phenotype is influenced by both genotype and environment. The relative degree to which phenotypic variation among individuals is caused by transmissible genetic effects is the heritability of a trait.

Phenotypic Correlation - The net correlation between two traits caused both by genetic factors and environmental factors simultaneously influencing both traits.

Qualitative Traits - Those traits in which there is sharp distinction between phenotypes, such as black versus red or polled versus horned. Only one or a few pairs of genes are involved in the expression of many qualitative traits.

Quantitative Traits - Those traits, such as weaning weight, in which there is no sharp distinction in the range of phenotype, with a gradual variation form one extreme to the other. Usually, many gene pairs are involved as well as environmental influences affect variation in such traits.

Quantitative Trait Loci (QTL) - A gene locus that has an effect on a quantitative trait. Often the actual nucleotide sequence is unknown, so selection is based upon genotype at a linked gene marker.

Transcription - The process by which an RNA copy is made from a gene.

Translation - The process by which ribosomes use the nucleotide sequence in RNA to synthesize protein.

Variance - Variance is a statistic that numerically describes the differences among individuals for a trait in a population. Without variation, no genetic progress would be possible, since genetically superior animals would not be distinguishable from genetically inferior ones.

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Notes:

Implications of Breed Type Evaluations

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Introduction

Quality, quantity, and cost of feed resources available for beef production vary from one region of the country to another and within regions, depending upon climatic factors and natural resources available in specific production situations. Diversity among breeds can be exploited by crossbreeding to optimize performance levels and to match genetic resources with the climatic environment, feed resources, and consumer preferences for lean and tender beef products. Crossbreeding also provides for significant benefits of heterosis on components of production efficiency. In this presentation, research results will be reviewed focusing on effects and utilization of heterosis and breed differences, and on the importance of matching genetic potential with consumer preferences and the climatic environment.

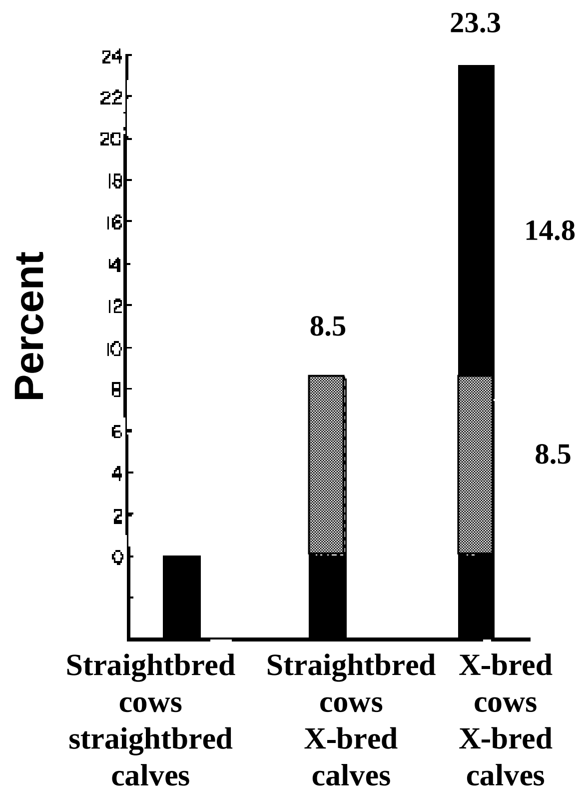


Figure 1. Cumulative effects of heterosis for weight of calf weaned per cow exposed to breeding in crosses of Hereford, Angus, and Shorthorns (Cundiff et al., 1974).

Heterosis

A crossbreeding experiment involving Herefords, Angus, and Shorthorns demonstrated that weaning weight per cow was increased by about 23% (Cundiff et al., 1974) due to beneficial effects of heterosis on survival and growth of crossbred calves and on reproduction rate and weaning weight of calves from crossbred dams (Figure 1). More than half of this advantage was due to use of crossbred cows. Effects of heterosis are greatest for longevity (Nunez et al., 1991) and lifetime production (Cundiff et al., 1992) of cows (Table 1). For comprehensive traits such as lifetime production, cumulative effects of heterosis are rather large and the performance of each specific cross usually exceeds that of either parent breed. For example, longevity and lifetime production of Hereford X Angus and Angus X Hereford cows was significantly greater than that of either straightbred Angus or Herefords (Nunez et al., 1991; Cundiff et al., 1992). Crossing of *Bos indicus* and *Bos taurus* breeds yields even higher levels of heterosis, averaging about twice as large as estimates reported for corresponding traits in crosses among *Bos taurus* breeds (Cartwright et al., 1964; Turner et al., 1968; Koger et al., 1975).

Rotational Crossbreeding

In the experiment involving Herefords, Angus, and Shorthorns conducted at the U.S. Meat Animal Research Center (MARC), it was demonstrated that

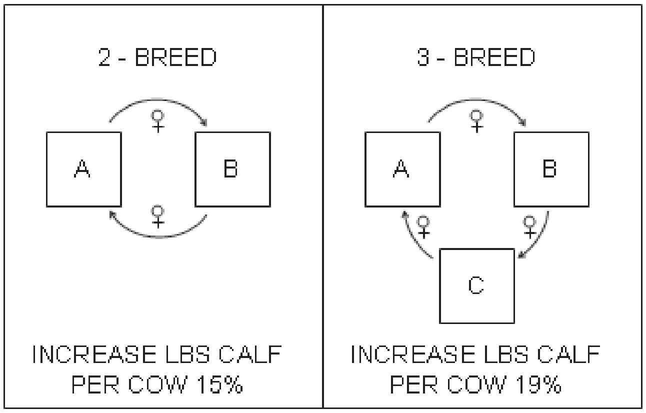


Figure 2. Rotational crossbreeding systems.

significant levels of heterosis were maintained from generation to generation by rotational crossbreeding of Herefords, Angus, and Shorthorns (Figure 2). The level of heterosis retained was proportional to expected heterozygosity (Gregory and Cundiff, 1980). It is important to use breeds that are reasonably comparable in rotational crossbreeding systems to provide for uniformity in traits such as birth weight to minimize calving difficulty, size, and milk production to stabilize feed requirements in cow herds, and carcass and meat characteristics. Breed composition fluctuates widely from one generation to the next with rotational crossbreeding. For example in two-breed rotation after the sixth generation and on the average over all generations, 67% of the genes of the cows are of the breed of their sire and 33% are of the breed of their grandsire, the latter being the same as the breed to which they are to be mated.

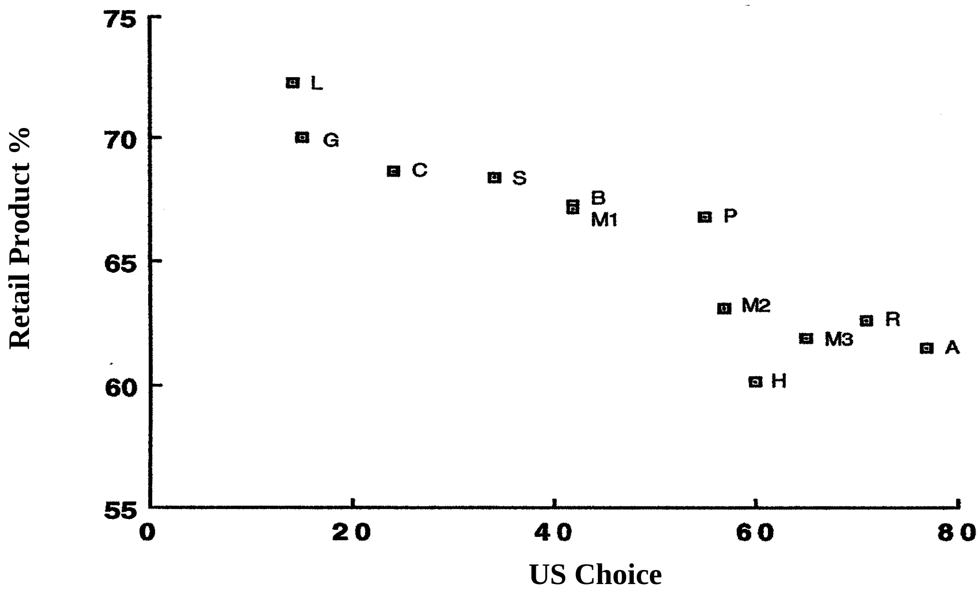
Composite Populations

Composite populations, developed by *inter se* mating of animals resulting from crossing of two or more breeds, have management requirements that are comparable to straight-breeding. Results of a comprehensive experiment involving four generations of *inter se* mating in three composite populations demonstrated that significant levels of heterosis are retained in composite populations (Gregory et al., 1999). In this experiment performance of each composite population (Composite MARC I was $^1/_4$ Charolais, $^1/_4$ Braunvieh, $^1/_4$ Limousin, $^1/_8$ Hereford, and $^1/_8$ Angus; Composite MARC II was $^1/_4$ each Simmental, Gelbvieh, Angus, and Hereford; and Composite MARC III was $^1/_4$ each Pinzgauer, Angus, Hereford, and Red Poll) was compared to performance of the purebreds that contributed to the foundation of each composite population. Effects of heterosis (F_1 minus Purebreds) and retained heterosis in advanced generations ($F_2 = F_1$ X F_1 matings, $F_3 = F_2$ X F_2 matings, and $F_4 = F_3$ X F_3 matings) are summarized in Table 2. Heterosis was maintained proportional to heterozygosity in composite populations. Since heterosis is retained proportional to heterozygosity, significant levels of heterosis can be maintained by rotational crossing of F_1 seedstock (e.g., F_1 cross Gelbvieh X Angus, or Simmental X Hereford) or by rotational crossing of composite populations (e.g., Brangus, Beefmaster) as well.

Uniformity of cattle and greater consistency of end product can be provided for with greater precision by use of F_1 seedstock or composite populations than by use of rotational crossing of purebreds. For example, with current pricing systems, cattle with 50:50 ratios of Continental to British breed inheritance have more optimal carcass characteristics, and experienced fewer discounts for excessive fatness (yield grade 4 or more) or for low levels of marbling (USDA Standard quality grades or less) than cattle with lower or higher ratios of Continental to British inheritance. This is caused by a strong genetic antagonism between USDA quality grade and percentage retail product (Figure 3). Retail product is closely trimmed (0.0 inches) boneless steaks, roasts, and lean trim (ground beef containing 20% fat). In the Germplasm Utilization Program at MARC, steers representing Continental European breeds (Charolais, Simmental, Braunvieh, Gelbvieh, Pinzgauer) excelled in retail product percentage but had difficulty grading USDA Choice because of lower levels of marbling. British breeds (e.g., Angus, Hereford, Red Poll) excelled in USDA quality grade because of higher levels of marbling but had reduced retail product yield due to excessive fat thickness and fat trim.

Breed Differences

Table 3 shows the mating plan for the first



Limousin (L), Gelbvieh (G), Charolais (C), Simmental (S), Braunvieh (B), Pinzgauer (P), Hereford (H), Red Poll (R), Angus (A), and composites MARC I (M1, ¼ Charolais, ¼ Braunvieh, ¼ Limousin, 1/8 Angus, 1/8 Hereford), MARC II (M2, ¼ Angus, ¼ Hereford, ¼ Simmental, and ¼ Gelbvieh), and MARC III (M3 = ¼ Angus, ¼ Hereford, ¼ Red Poll, and ¼ Pinzgauer).

Figure 3. Retail product versus percent USDA Choice in purebreds and composite populations (Gregory et al., 1999).

eight cycles of the Germplasm Evaluation (GPE) Program at MARC. Each Cycle is an experiment conducted over a time span of about 10 years. Topcross performance of 34 sire breeds has been evaluated in F_1 calves out of Hereford, Angus, or Composite MARC III (starting with Cycle V) dams. Hereford and Angus sires have been used in each Cycle of the program to provide ties for analysis of data pooled over cycles. Some of the Hereford and Angus sires used in Cycle I were repeated in Cycles II, III, and IV (60 to 70s sires). Later, many of the Hereford and Angus sires used for the first time in Cycle IV were repeated in Cycle V (80s sires). Similarly, many of the Brahman sires used in Cycle III (70s sires) were repeated in Cycle V and compared to a new sample of Brahman sires born in the 1980s (80s sires). As a general rule in each cycle, about 200 progeny per sire breed were produced from artificial insemination (AI) to 20 to 25 sires per breed. Sires were sampled representing young herd sire prospects (non-progeny tested sires) for each breed. Starting with Cycle VII, about half of the sires sampled were chosen from lists of the 50 most widely used bulls in each breed according to registrations.

Calves were born in the spring and weaned in the fall at about 7 months of age. Male calves were castrated within 24 hours of birth. Following weaning, steers were fed a diet containing about 2.8 Mcal metabolizable energy per kg dry matter. Data will be presented for steers that were slaughtered in three to four slaughter groups spaced 21 to 28 days apart. All F_1 females were retained to evaluate growth, age at puberty, reproduction, and maternal performance in three-way cross progeny produced at 2 through 7 or 8 years of age.

Prominent *Bos taurus* breeds. In Cycle VII of the GPE Program (Cundiff et al., 2004), the seven most prominent beef breeds in the U.S., according to registrations in breed associations (National Pedigreed Livestock Council, 2002), were evaluated (Table 4). Angus, Hereford, Limousin, Simmental, Charolais, and Gelbvieh had been characterized in Cycle I or Cycle II of the GPE

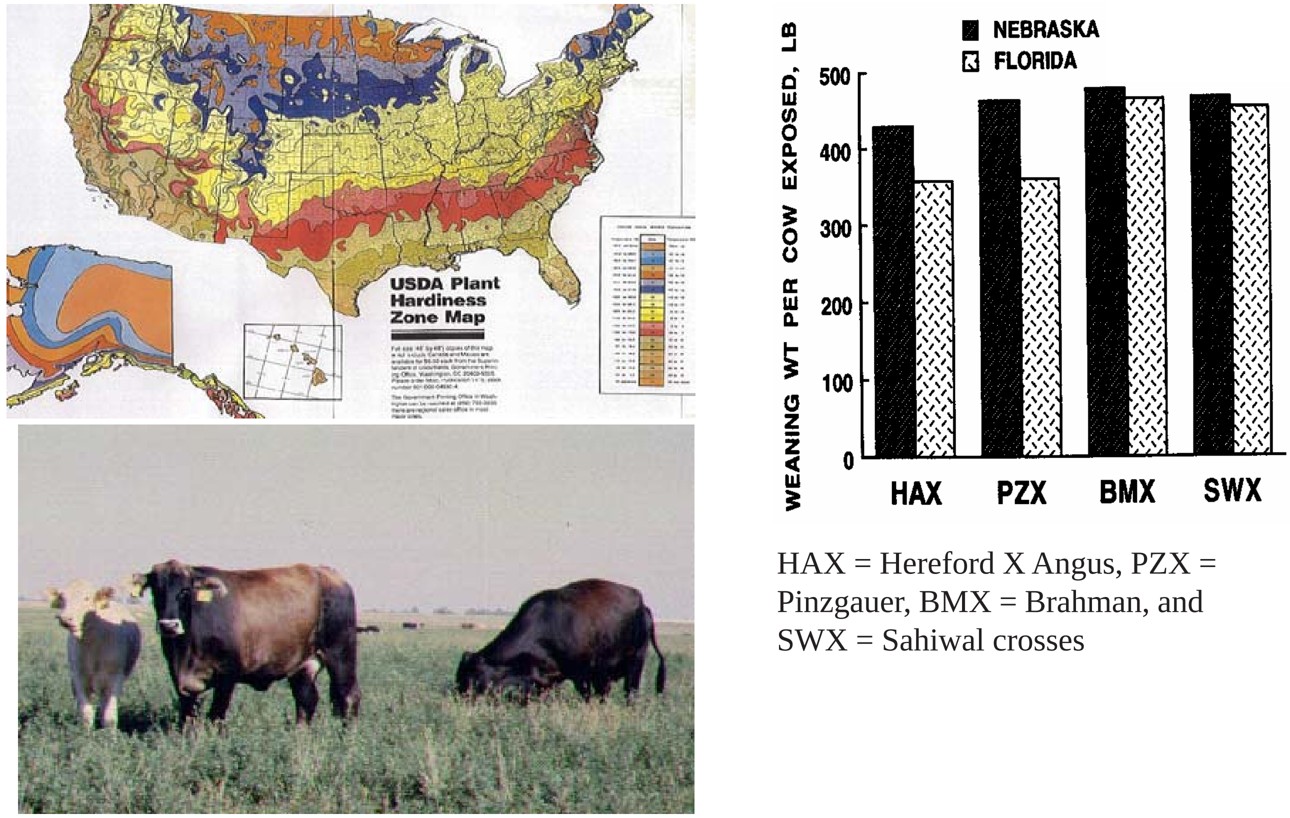
Program (Table 3). Red Angus cattle were evaluated for the first time in Cycle VII.

Sire breed means for final slaughter weight (445 days) and certain carcass and meat traits are shown in Table 5. The differences for slaughter weight (445 days) between progeny of Continental sire breeds compared to British sire breeds were considerably less than when they were evaluated 25 to 30 years earlier. However, differences between Continental and British breeds in retail product percentage, marbling score, and percentage grading USDA Choice were about the same as they were in Cycle I and Cycle II of the program. Carcasses from progeny of Limousin, Gelbvieh, Charolais, and Simmental sires had significantly higher retail product percentages and yield grades than carcasses from progeny of Hereford, Angus, and Red Angus sires. However, marbling was significantly greater in progeny of Red Angus and Angus sires than in progeny of Charolais, Hereford, Gelbvieh, and Limousin sires. Rib steaks from Angus sired progeny were significantly more tender than those from Gelbvieh sired progeny according to shear force evaluations. British breed crosses (Table 6) had a higher percentage of yield grade 4 carcasses than Continental European breed crosses (Table 7). Results in Cycle VII are consistent with earlier results indicating that cattle with 50:50 contributions of Continental to British inheritance are more optimal for current market grids than cattle with lower or higher ratios of Continental to British inheritance.

Post-weaning growth and puberty traits are shown in Table 8. Sire breed differences between British and Continental sire breeds for body weights at 400 days or 18 months of age in progeny of sires born in Cycle VII (born in 1999-2000) were not as great as they were in Cycle I and II (1970-1974) of the GPE Program and reflected considerable re-ranking among breeds. These results are consistent with estimates of expected progeny differences published by breed associations which also indicate that genetic trends have been greater for yearling weights in British breeds than in Continental European breeds. However, hip heights and frame scores were significantly greater for heifers with Simmental, Charolais, and Limousin sires than for those with Angus and Red Angus sires. Age at puberty was greater in Limousin sired heifers than all other sire breeds and younger in Gelbvieh sired heifers than in Hereford, Angus, and Red Angus sired heifers. Breeds that have had a history of selection for milk production (e.g., Simmental and Gelbvieh) reached puberty earlier than breeds that have not been selected for milk production (all other breeds).

Data reported for reproduction and maternal performance are especially preliminary, representing only the first of seven calf crops to be produced by the F_1 females (Table 9) exposed to MARC III bulls and calving at 2 years of age. Breed of sire of the F_1 dams calving at 2 years of age was not a significant source of variation for any of the traits summarized, except 200-day weaning weight per calf weaned. Weaning weights of progeny raised by F_1 females with Gelbvieh and Simmental sires were significantly heavier than those with Charolais, Limousin, and Angus sires. Weaning weights of progeny raised by F_1 females with Hereford sires were significantly lighter that those by any other sire breed, except Red Angus. Contrasts between British and Continental European breeds are less than half as great for direct and maternal weaning weight today as they were 25 to 30 years ago.

Tropically adapted breeds. Use of *Bos indicus X Bos taurus* crosses (e.g., Brahman X Hereford) is greatly favored in the subtropical regions of the U.S. In a cooperative effort between the Subtropical Agricultural Research Station (STARS), Brooksville, Florida, ARS, USDA, the University of Florida, and MARC, weaning weight per cow exposed was significantly greater for the *Bos indicus* X *Bos taurus* F_1 crosses (Brahman X Hereford, Brahman X Angus, Sahiwal X Hereford, Sahiwal X Angus) than for the *Bos taurus* X *Bos taurus* F_1 crosses (Hereford X Angus, Angus X Hereford, Pinzgauer X Hereford, Pinzgauer X Angus) at both locations, but the advantage was especially large in Florida (Figure 4) (Olson et al., 1991). Results at MARC also indicated that cow efficiency (pounds of calf gain per unit of feed



HAX = Hereford X Angus, PZX = Pinzgauer, BMX = Brahman, and SWX = Sahiwal crosses

Figure 4. Matching genetic potential to the climatic environment (Olson et al., 1991).

consumed by the cow and calf), estimated during lactation in summer months, was exceptional for *Bos indicus* X *Bos taurus* relative to Hereford-Angus crosses (Table10) (Green et al., 1991), which were in turn relatively efficient compared to other *Bos taurus* X *Bos taurus* crosses (Table 11) (Jenkins et al, 1991). Reproduction rate, weaning weight per cow exposed, and cow efficiency is outstanding in *Bos indicus* X *Bos taurus* F_1 crosses, especially in subtropical climatic environments, but their advantages are tempered by older age at puberty and reduced meat tenderness as the proportion of *Bos indicus* increases (Crouse et al., 1989). Concerns about meat quality and reproduction rate at young ages have prompted introduction and evaluation of other tropically adapted germplasm in cooperative research efforts involving MARC and research stations in subtropical regions of the U.S. (i.e., Texas, Oklahoma, Florida, Georgia, and Louisiana) with contributing projects to Regional Project S-277.

In Cycle V of the Germplasm Evaluation Program at MARC (Table 12), tropically adapted Tuli, Boran, and Brahman sire breeds were evaluated relative to Hereford and Angus crosses (Cundiff et al., 2000). The Tuli, a Sanga type of cattle (nonhumped), originates from Africa. Semen from nine Tuli bulls was imported from Australia for use in the experiment. Tuli were introduced into Australia from Zimbabwe in 1990 by embryo transfer. Borans are a pure Zebu breed (*Bos indicus*, humped) that evolved in southern Ethiopia and are believed to have been developed for milk and meat production under stressful tropical conditions. Boran cattle were also introduced into Australia from East Africa (Zambia) by embryo transfer at the same time as the Tuli. Semen from eight Boran bulls was imported from Australia for use in the experiment.

Performance of Nellore crosses, also shown in Table 12, were estimated by adding the deviation of Nellore crosses from Hereford and Angus crosses produced in Cycle IV (Wheeler et al., 1996; Wheeler et al., 1997; Cundiff et al., 1998) to the mean of Hereford and Angus crosses produced in Cycle V (The least significant differences between

Nellore crosses and other breeds can be approximated by multiplying 1.5 times the least significant difference shown in Tables 12 and 13 for Cycle V contrasts).

Results indicate that Tuli cattle produce crossbred progeny with carcass and meat characteristics more similar to progeny sired by British *Bos taurus* breeds (i.e., Hereford and Angus) than to progeny sired by *Bos indicus* breeds (i.e., Brahman or Boran) (Table 12). However, Tuli crosses had relatively low average daily gains. Performance of Nellore crosses was comparable to that of current Brahman crosses for preweaning and postweaning growth rate, weight, and percentage of retail product. Tuli and Boran crosses were significantly younger at puberty and had larger percentages of calf crop weaned as 2-year-olds than Brahman crosses (Table 13). However, at 3 years of age or older, percentages of calf crop weaned did not differ among Nellore, Brahman, Boran, and Tuli sired females. At all ages, maternal weaning weight (200 day weight per calf) was greater for Nellore and Brahman than Boran sired F_1 cross females which were in turn greater than Tuli sired F_1 cross females. Tuli germplasm may be useful to replace a portion of *Bos indicus* breeding and maintain tropical adaptation without detrimental effects on meat tenderness, provided they are crossed with other breeds that optimize size and growth rate. Cooperative research efforts have been completed recently to evaluate reproduction and maternal performance of F_1 cows by Tuli, Boran, and Brahman sires at research stations located in subtropical regions of the U.S. (i.e., Florida, Georgia, Texas, Louisiana, and Oklahoma). However, data have not yet been pooled and analyzed over all locations to assess the importance of genotype-environment interactions for these traits.

In Cycle VIII of the GPE Program Brangus, Beefmaster, Bonsmara, and Romosinuano are being evaluated relative to Hereford and Angus crosses. Beefmaster and Brangus were included in Cycle VIII because they are prominent breeds used extensively in subtropical regions of the U.S. ranking 8^{th} and 9^{th} in registrations among U.S. beef breeds (Table 4). Bonsmara are a composite breed that was developed in South Africa from approximately 50% Africaner (an African Sanga breed), 25% Hereford, and 25% Shorthorn foundation matings. Semen was used from 19 Bonsmara bulls purchased from Mr. George Chapman, Amarillo, TX who imported the breed into the United States. Semen from 20 Romosinuano bulls was used. The Romosinuano breed was developed primarily in Colombia and introduced into the U.S. from Venezuela at the STARS, ARS, USDA and the University of Florida. The Romosinuano is a Criollo (domestic) breed of Central America that traces back to *Bos taurus* cattle introduced from Europe about 400 to 500 years ago.

Estimates of sire breed means averaged over Angus and MARC III dams are shown in Table 14 for preweaning traits. Breed of sire effects were significant ($P < 0.01$) for birth weight, and 205-day weaning weight, but not for percentage unassisted births or calving difficulty score. Birth weights of Romosinuano sired progeny were significantly lighter than those of any other breed except Angus. Angus sired progeny were lighter at birth than those with Bonsmara, Brangus, or Hereford sires. Birth weight did not differ significantly among progeny of Bonsmara, Brangus, and Hereford sires. Progeny of Beefmaster sires were significantly heavier at birth than those of any other sire breed. Weaning weight at 205 days was significantly heavier for progeny of Beefmaster sires than for any other sire breed, followed by Brangus and Angus, which did not differ significantly. Brangus sired progeny were significantly heavier at weaning than Hereford sired progeny. Angus, Hereford, and Bonsmara sire breeds did not differ significantly in weaning weight. Romosinuano sired progeny were significantly lighter at weaning than those of any other sire breed.

Breed of sire means for postweaning growth rate and final weight of steers and carcass traits adjusted to 426 days of age are provided in Table 15. Breed of sire means differed significantly ($P < 0.01$) for postweaning average daily gain, final weight, percentage, and weight of retail product, marbling score, and percentage grading USDA Choice or higher. Postweaning average daily gains were significantly greater for Angus than all other breeds except Beefmaster. Beefmaster, Hereford, and Brangus sired steers had significantly greater postweaning average daily gains than Bonsmara and Romosinuano sired steers. Beefmaster sired steers had significantly heavier final weights than all other breeds except Angus. Angus, Brangus, and Hereford sired steers were significantly heavier than Bonsmara sired steers at 426 days, which were in turn significantly heavier than Romosinuano sired steers. Romosinuano and Bonsmara sired steer carcasses had significantly higher percentages of retail product than Brangus, Hereford, Beefmaster, and Angus sired steer carcasses. Angus sired steer carcasses had significantly lower percentages of retail product than those by any other sire breed. Estimates of weight of totally trimmed boneless retail product at 426 days of age were very similar for Beefmaster and Brangus sired steer carcasses and were significantly greater than estimates for the other four sire breeds - Angus, Hereford, Bonsmara, and Romosinuano. Hereford, Angus, and Bonsmara did not differ significantly for weight of retail product. Steer progeny of Romosinuano sires had significantly lower weights of retail product than those of all other sire breeds except Bonsmara. Marbling score and percentage grading USDA Choice or higher were significantly greater for Angus than for any other sire breed. Carcasses from Hereford sired steers ranked second and had significantly greater marbling scores and a greater percentage grading USDA Choice or higher than those from Romosinuano, Bonsmara, and Beefmaster sired steers. Brangus ranked third in marbling and percentage grading USDA Choice or higher, but did not differ significantly from Hereford or from Romosinuano, Bonsmara, or Beefmasters.

Half of the Brangus, Beefmaster, Bonsmara, and Romsinuano females being produced at MARC were transferred at about 8 months of age from MARC to Louisiana State University to evaluate genotype-environment interactions. Data summarizing growth and puberty characteristics of females in Tables 16 and 17, are for only the heifers produced which remained at MARC. The Brangus, Beefmaster, Brangus, and Romosinuano sired progeny represent only about 50% of the females being evaluated in the cooperative experiment. Results for growth of heifers are generally consistent with that of steers indicating that Beefmaster and Angus sired females had the greater growth rates to 400 days than all other sire breeds except Brangus. By 400 days, Brangus and Herefords did not differ significantly in body weight, but both were heavier than Bonsmara or Romosinuano sired females. By 18 months of age, after the summer gazing season, Beefmaster were significantly heavier than all other breeds except Brangus. Brangus sired heifers were significantly heavier at 18 months of age than Romosinuano sired females, but did not differ significantly from Hereford, Bonsmara, or Angus sired females, which had similar 18 month weights. Brangus and Beefmaster sired heifers had significantly greater hip heights and frame scores at 18 months of age than Hereford, Bonsmara, Angus, or Romosinuano sired heifers. Hereford sired heifers ranked third in hip height and frame score and were significantly taller than Romsinuano sired heifers. Bonsmara, Angus, and Romosinuano sired heifers did not differ in hip height or frame score at 18 months of age. Analysis of variance indicated that effects of sire breed were significant for age at puberty ($P < 0.05$) but not for pregnancy rate (Table 17). Females by Angus sires reached puberty at a significantly younger age than those by any other sire breed. Hereford sired females ranked second and were significantly younger at puberty than Brangus, Beefmaster, and Bonsmara sired females which did not differ significantly. Females by Romosinuano sires reached puberty at significantly older ages than females by any other sire breed except Bonsmara.

Implications

The beef industry is challenged to 1) reduce costs of production to remain competitive in global markets, 2) match genetic potential with the climate and feed resources available in diverse environments, 3) reduce fat and increase leanness of products to gain greater acceptance of consumers, and 4) improve palatability, tenderness, and consistency of beef products. Use of heterosis and breed differences through use of crossbreeding or composite populations, and selection of breeding stock to exploit genetic variation within breeds can all be used to help meet these challenges.

Effects of heterosis increase production per cow about 20% to 25% in *Bos taurus* crosses (e.g., Angus X Hereford) and at least 50% in *Bos indicus* X *Bos taurus* breed crosses (e.g., Brahman X Shorthorn). Significant levels of heterosis are maintained by rotational systems of crossbreeding and in composite populations. Rotational systems of crossbreeding provide for more effective use of heterosis than composite populations for any specific number of breeds. However, uniformity of cattle and greater consistency of end product can be provided for with greater precision by use of F_1 seedstock or composite populations than by use of rotational crossing of pure breeds.

No one breed excels in all traits of importance to beef production. Thus, crossing of two or more breeds can be used to optimize performance levels. In temperate environments, genetic potential for retail product and marbling are more nearly optimized in cattle with 50:50 ratios than in cattle with higher or lower ratios of Continental to British inheritance.

A strong influence of tropically adapted germplasm is needed in subtropical regions of the U.S. to limit costs and improve efficiency of production. In the hotter and more humid climates of the Gulf Coast, about 50:50 ratios of *Bos indicus* to *Bos taurus* inheritance may be optimal. A little further north (e.g., southeastern Oklahoma, central Arkansas, Tennessee, and parts of North Carolina), 25:75 ratios of *Bos indicus*: *Bos taurus* inheritance may be optimal in cowherds. In temperate climates (e.g., Nebraska), crosses with 50% or more *Bos indicus* inheritance suffer increased mortality when calves are born in colder seasons and reduced average daily gains in feedlots during winter months. Use of F_1 Brahman cross cows, Nellore, or Boran F_1 cross cows or rotational crossing of composite breeds such as Beefmaster, Brangus, Bonsmara, or Santa Gertrudis are especially appropriate in subtropical environments. If replacement requirements for suitably adapted females are met and terminal crossing is feasible, then a *Bos taurus* breed can be used to optimize carcass and meat characteristics and increase market value of terminal cross slaughter progeny.

In developing composite populations with an overall level of 50% tropical adaptation, it may be appropriate to substitute a portion (e.g., 25%) of non *Bos indicus* germplasm for *Bos indicus* germplasm from such breeds as the Tuli, Romosinuano, or Senepole to maintain tropical adaptation and improve meat tenderness, provided they are crossed with other breeds that optimize size and growth rate. However, additional research is needed to determine optimum contributions of *Bos indicus*, British *Bos taurus*, Continental *Bos taurus*, tropically adapted Sanga breeds, and tropically adapted Criollo breeds from Central and South America in beef production in subtropical environments of the U.S.

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Table 1. Longevity and lifetime production of straightbred Hereford (H), Angus (A), Hereford X Angus (HA), and Angus X Hereford (AH) cows.

	Breed group				
Trait	H	A	HA	AH	Heterosis
Longevity, yrs	8.4	9.4	11.0	10.6	1.9*
Lifetime production					
No. calves	5.9	6.6	7.6	7.6	1.3*
Wt of calves weaned, lb	2,045	2,837	3,518	3,514	766*

*P < .05

Table 2. Heterosis effects and retained heterosis in composite populations versus contributing purebreds (Gregory et al., 1999).

	Composites minus purebreds		
Trait	F_1	F_2	$F_{3\&4}$
Birth wt, lb	3.6	5.0	5.1
200 d wn wt, lb	42.4	33.4	33.7
365 d wt, females, lb	57.3	51.4	52.0
365 d wt, males, lb	63.5	58.6	59.8
Age at puberty, females, d	-21	-18	-17
Scrotal circumference, in	0.51	0.35	0.43
200 d weaning wt (mat), lb	33	36	
Calf crop born (mat), %	5.4	1.7	
Calf crop wnd (mat), %	6.3	2.1	
200 d wn wt/cow exp (mat), lb	55	37	

Table 3. Sire breeds used to produce F_1 crosses with Angus and Hereford dams in the germplasm evaluation program at MARC.[a]

Cycle I 70-72	Cycle II 73-74	Cycle III 75-76	Cycle IV 86-90	Cycle V 92-94	Cycle VI 97-98	Cycle VII 99-00	Cycle VIII 01-02
Hereford	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
Angus	Angus	Angus	Angus	Angus	Angus	Angus	Angus
Jersey	Red Poll	Brahman	Longhorn	Tuli	Wagyu	Red Angus	Beefmaster
S. Devon	Braunvieh	Sahiwal	Salers	Boran	Norweg Red	Limousin	Brangus
Limousin	Gelbvieh	Pinzgauer	Galloway	Belg Blue	Sw Red&Wh	Charolais	Bonsmara
Simmental	Maine Anj	Tarentaise	Nellore	Brahman	Friesian	Simmental	Romosinuano
Charolais	Chianina		Shorthorn	Piedmontese		Gelbvieh	
			Piedmontese				
			Charolais				
			Gelbvieh				
			Pinzgauer				

[a]Sire breeds mated to Angus and Hereford females. Composite MARC III (¼ Angus, Hereford, Red Poll, and Pinzgauer) females were also included in Cycles V, VI, and VII. In cycle VIII, sire breeds were mated to Angus and MARC III females.

Table 4. Beef breed registrations (National Pedigreed Livestock Council, 2002).

Breed	Registrations	%	Breed	Registrations	%
Angus	271,222	37.9	Maine Anjou	12,267	1.7
Hereford	80,976	11.3	Santa Gertrudis	11,500	1.6
Limousin	49,036	6.9	Salers	10,286	1.4
Simmental	44,159	6.2	Longhorn	6,200	0.9
Charolais	45,354	6.3	Chianina	6,679	0.9
Red Angus	41,900	5.9	Braunvieh	6,235	0.9
Gelbvieh	32,323	4.5	Tarentaise	1,900	0.3
Beefmaster	30,416	4.3	Highland	1,500	0.2
Brangus	25,500	3.6	Pinzgauer	664	0.1
Shorthorn	21,608	3.0	Bl d'Aquitaine	625	0.1
Brahman	15,000	2.1	Total	715,350	100

Table 5. Sire breed means for final weight and carcass traits of F_1 steers (445 days).

			Retail product			
Sire breed	N	Final wt, lb	%	lb	USDA Choice, %	WB shear, lb
Hereford	97	1,322	60.7	480	70	9.1
Angus	98	1,365	59.2	488	95	8.9
Red Angus	93	1,333	59.1	474	93	9.2
Simmental	92	1,363	63.0	522	61	9.5
Gelbvieh	90	1,312	63.8	509	56	9.9
Limousin	84	1,286	63.7	504	46	9.5
Charolais	95	1,349	63.7	523	69	9.6
LSD < 0.05		40	1.3	16	17	0.7

Table 6. USDA quality grade x yield grade for Hereford, Angus, and Red Angus (N=288).

	USDA yield grade, %				
Quality grade	1	2	3	4	Total
Low Prime	0.0	0.0	1.7	0.4	2.1
High Choice	0.0	0.7	2.1	1.7	4.5
Average Choice	0.0	1.7	7.3	2.8	11.8
Low Choice	2.8	18.4	29.5	17.0	67.7
Select	1.7	8.3	2.8	1.0	13.9
Standard	0.0	0.0	0.0	0.0	0.0
Total	4.5	29.2	43.4	22.9	100.0

Table 7. USDA quality grade x yield grade for steers with Simmental, Gelbvieh, Limousin, and Charolais sires (N=361).

	USDA yield grade, %				
Quality grade	1	2	3	4	Total
Low Prime	0.0	0.0	0.0	0.3	0.3
High Choice	0.0	0.0	0.3	0.0	0.3
Average Choice	0.3	1.9	3.1	0.3	5.5
Low Choice	8.3	27.2	14.4	1.7	51.5
Select	13.6	18.3	9.1	1.1	42.1
Standard	0.3	0.0	0.0	0.0	0.3
Total	22.4	47.4	26.9	3.3	100.0

Table 8. Sire breed least squares means for growth and puberty traits of heifers in Cycle VII of the GPE program (1999-2000 calf crops).

Sire breed of female	No.	400-d wt, lb	18 month wt, lb	18 month ht, cm	Frame score, sc	Pub exp, %	Pub wt, lb	Age at pub	Preg rate, %
Hereford	81	841	950	128.4	5.5	79.2	733	342	94
Angus	85	869	936	127.2	5.3	97.2	750	340	88
Red Angus	106	868	953	126.9	5.2	88.2	744	339	91
Simmental	103	849	961	130.2	5.9	91.6	757	335	90
Gelbvieh	111	807	922	128.8	5.6	91.5	711	322	83
Limousin	109	824	933	129.9	5.8	80.4	785	363	87
Charolais	103	828	950	129.5	5.8	88.5	758	348	91
LSD < 0.05		31	32	1.6	0.5	9.9	35	16	13

Table 9. Sire breed means for reproduction and maternal traits of F_1 females mated to produce their first calves at 2 years of age (2001 & 2002 calf crops).

Sire breed of female	No.	Calf crop Born, %	Calf crop Wnd, %	Calving diff score	Unassist births, %	Birth wt, lb	Surv to wn, %	200-d wt per Calf, lb	200-d wt per Cow exp, lb
Hereford	80	92	70	1.9	74	81.5	78	413	292
Angus	84	83	76	2.0	72	79.8	93	424	325
Red Angus	104	86	76	2.2	68	78.2	88	415	317
Simmental	98	86	69	1.5	86	79.6	82	442	309
Gelbvieh	109	79	68	2.2	64	83.6	86	447	307
Limousin	109	85	73	2.0	68	80.3	85	429	313
Charolais	97	87	73	2.1	69	81.6	83	430	315
LSD < 0.05		14	15	0.6	19	4.4	14	21	68

Table 10. Output/input differences among *Bos indicus* X *Box taurus* and *Bos taurus* x *Bos taurus* F_1 cows (Green et al., 1991).

Item	Overall mean	Breed group[a] (ratio) HAx	Pzx	Bmx	Swx
Progeny (126 days)					
Weight gain, lb	284	91	98	109	102
Energy consumed, Mcal ME	596	112	102	91	93
Dams (126 days)					
Milk production, lb/day	14.6	93	113	99	94
Cow weight, lb	1,229	98	100	105	96
Fat probe, in	0.46	89	92	104	115
Energy consumed, Mcal ME	3,305	94	105	104	97
Efficiency (138.5 days)					
Progeny gain, lb/Mcal ME calf + dam	0.07	94	95	105	97

[a]HAx = Hereford or Angus, Pzx = Pinzgauer, Bmx = Brahman, and Swx = Sahiwal.

Table 11. Output/input differences among *Bos taurus* X *Bos taurus* F_1 cows (Jenkins et al., 1991).

Item	Overall mean	Breed group[a] (ratio) HAx	Rx	Bx	Gx	Mx	Cix
Progeny (138.5 days)							
Weight gain, lb	346	97	99	103	100	103	98
Energy consumed, Mcal ME	744	106	102	99	96	98	99
Dams (138.5 days)							
Milk production, lb/day	8.8	85	101	118	111	104	82
Cow weight, lb	1,138	98	91	97	100	107	107
Fat probe, in	0.25	124	101	91	93	90	101
Energy consumed, Mcal ME	3,787	91	96	105	105	100	104
Efficiency (138.5 days)							
Progeny gain, lb/Mcal ME calf + dam	0.08	103	103	99	97	103	95

[a]HAx = Hereford or Angus, Rx = Red Poll, Bx = Brown Swiss, Gx = Gelbvieh, Mx = Maine Anjou, Cix = Chianina sired F_1 crosses.

Table 12. Sire breed means for final weight and carcass traits of F_1 steers (447 days).

Sire breed	No.	Final wt, lb	Retail product %	Retail product lb	USDA Choice, %	14-d Shear, lb
Hereford	106	1,270	61.9	449	70.3	10.6
Angus	101	1,278	62.2	454	84.6	8.9
Brahman	76	1,199	63.8	449	30.4	12.9
Boran	138	1,116	62.6	400	47.2	11.3
Tuli	158	1,110	63.4	405	63.8	10.1
Nellore	97	1,224	65.0	465	51.4	----
LSD < 0.05		48	1.7	18	22.2	1.3

Table 13. Breed group means for reproduction and maternal traits.

Sire breed of female	Age at puberty No.	Age at puberty Days	2 years of age: Calf crop wnd, %	2 years: 200-day wt Per calf, lb	2 years: 200-day wt Per cow exp, lb	3 to 7 years of age: Calf crop wnd, %	3 to 7 years: 200-day wt Per calf, lb	3 to 7 years: 200-day wt Per cow exp, lb
Hereford	152	355	73.8	419	300	88.7	474	422
Angus	130	351	74.4	437	313	86.3	493	426
Average	282	353	74.1	428	307	87.5	483	424
Brahman								
Original	82	429	54.3	456	238	85.9	511	440
Current	208	423	69.6	476	319	82.7	521	430
Average	244	426	62.0	466	279	83.2	516	435
Boran	206	396	83.3	444	357	86.2	488	421
Tuli	244	371	74.6	413	296	84.1	471	397
Nellore	82	406	75.1	463	324	91.6	514	461
LSD < 0.05		13	13.9	18	62	6.7	14	36

Table 14. Breed group means for preweaning traits of calves produced in Cycle VIII of the GPE program (2001 & 2002 calf crops).

Sire breed of calf	No. calves born	Calvings unassist, %	Calvings diff score	Birth wt, lb	200-d wn wt, lb
Hereford	212	94.4	1.33	91.1	534
Angus	208	97.2	1.19	87.1	541
Brangus	214	96.9	1.19	90.5	549
Beefmaster	222	95.6	1.23	95.5	560
Bonsmara	207	97.7	1.10	90.4	533
Romosinuano	207	99.2	1.05	84.7	507
LSD < 0.05		3.4	0.20	3.0	11

Table 15. Sire breed means for final weight and carcass traits of F_1 steers produced in Cycle VIII of the GPE program (426 days, 2001 & 2002 calf crops).

Sire breed	N	ADG, lb/d	Final wt, lb	Retail product		Marb score	USDA Choice, %
				%	lb		
Hereford	102	3.02	1,245	61.8	466	515	52
Angus	103	3.15	1,283	60.0	469	548	71
Brangus	107	2.99	1,256	62.1	481	497	42
Beefmaster	103	3.10	1,296	61.2	482	483	35
Bonsmara	104	2.80	1,183	63.4	464	487	37
Romosinuano	102	2.71	1,150	64.4	452	488	37
LSD < 0.05		0.09	29	1.1	13	24	13

Table 16. Sire breed means for growth traits of heifers produced in Cycle VIII of the GPE program (2001 & 2002 calf crops).

Sire breed of female	No.	400-d wt, lb	18 months		Frame score, sc
			wt, lb	ht, cm	
Hereford	102	854	889	127.7	5.41
Angus	107	881	880	126.3	5.12
Brangus	47	870	904	129.3	5.74
Beefmaster	53	884	923	129.1	5.69
Bonsmara	51	832	889	126.7	5.20
Romosinuano	50	766	821	126.1	5.09
LSD < 0.05		26	25	1.2	0.24

Table 17. Sire breed means for puberty traits of heifers produced in Cycle VIII of the GPE program (2001 & 2002 calf crops).

Sire breed	No.	Age at puberty, days	Pregnancy rate, %
Hereford	102	325	86
Angus	107	312	83
Brangus	47	339	92
Beefmaster	53	343	97
Bonsmara	51	353	85
Romosinuano	50	359	90
LSD < 0.05		14	11

Notes:

Connecting the Cowherd to the Carcass: Balancing Production, Environment, and the Market Place

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The commercial cow-calf operation is now facing greater challenges and economic uncertainty as the beef industry continues to consolidate into production segments with profit centers that focus on an increasing number of traits and issues that impact herd management and breeding decisions. The economic importance of marketing and producer accountability has changed so dramatically that integrated beef production has become a near requirement in some cases for market access. At a minimum, cow-calf producers must consider the acceptability of their cow herd production and too often have little or no knowledge of the true value of their calves to others in the industry. It is realistic to assume that marketing power (value) will drive production concepts. However, market value is too often confused and misrepresented in our segmented industry. This has led to the concept of value-based marketing and the need for integrated production systems that consider all traits and issues affecting value perception in a fair and honest manner for all industry participants. With most beef industry participants this means a loss of independence in management in some cases and to dictated control by others in other cases. This makes it hard to accept for those with a truly independent attitude about their enterprise. Most often, it is viewed as profitability competition among the segments with a material distrust resulting within the industry. It will be no easy task to develop efficient industry operation with many cow-calf herds owned and operated by part-time cattlemen and with the cattle enterprise a largely secondary aspect to many landowners and agricultural businesses.

Basic Concepts

Beef production and the industry cannot succeed without the basic cow-calf operation as the viable foundation. The cow herd is the renewable resource and the most important segment in capital investment. Low returns (profitability) are accepted by many based on land appreciation and alternative land use. However, future industry emphasis must address the need for survivability of cow-calf enterprises. Essentially every educational effort dictates the need for brood cows to be genetically matched to the production environment. Ritchie (2002) prepared the following table based on BIF guidelines as an illustration.

Table 1. Examples of matching genotype to production Environment.[a]

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

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

The problem is many industry leaders in other segments beyond the cow herd ignore the production environment of the cow as an industry concern. I would like to point out that the really important factor is that in every environment crossbred cows are universally needed. Research has consistently identified reproductive, maternal, and growth trait heterosis that cannot be ignored in brood cows. I submit that British X *Bos indicus* cows are advantageous in arid climates with restricted or medium feed resources. Any type of crossbred cow is functional in an environment with abundant feed resources and adequate rainfall. Extreme cold climate disadvantages in winter may limit British X *Bos indicus* cow acceptance. Sub-tropical climates truly require *Bos indicus* inheritance in the crossbred cow.

Beef Traits

Balancing the relative importance or emphasis to place on beef production traits has been widely discussed and evaluated. On a broad classification, reproductive traits are most economically important but only limited opportunity exists for direct selection in breeding cattle. Fertility is best managed in any herd by pregnancy testing cows annually and the best genetic predictor is to select crossbred replacement females. Culling open and non-functional cows and maintaining a sound heifer development program insures herd reproductive performance. Bulls should be fertility tested yearly and scrotal circumference used as a threshold trait to ensure early sexual maturity in yearling bulls. Use 34 cm at 12 months of age as a reference.

Production traits, maternal and growth, are the most widely available for use in direct selection. However, they are environmentally influenced and we need to rely upon EPD values when available. For cow-calf operations weaning weight is the major trait correlated with economic return. It is not maximum weaning weight but that performance level that is economically viable. Most cow herd efficiency evaluations reflect realistically that the calf weaning weight to mature cow weight at weaning ratio should be about 0.47. Stated differently, a 1,150-pound mature cow at weaning should produce a calf weighing 540 pounds (1,150 X 0.47) at 7 months of age. Heavier cows should produce more calf weight while smaller cows produce proportionally less calf weaning weight. Producers must decide if their herd weaning weight average is adequate and economically viable in the environment. Weaning weight is an important cow trait and should be evaluated with percentage calf crop weaned of cows exposed. Cundiff (1987) defined the product value (average weaning weight X percentage calf crop weaned) as a maternal index. I used it in early research reporting it as a herd productivity value which measured the actual average calf weight weaned per cow exposed to breeding. It is a true herd efficiency measure but has no application to an individual animal. The actual weaning weight of a calf has some merit in selection for growth but is a dual trait (milk and growth) and other growth traits expressed later in life are most capably used for individual growth selection.

Individual growth evaluation in cattle beyond weaning should rely upon yearling weight or a defined postweaning average daily gain. Cundiff (1987) recommended a lean growth index (yearling weight - 3.2 X birth weight) in young beef bulls which stresses heavy yearling weight and credits value to low birth weight. This really stresses early growth and technically aids cowherd management to avoid calving difficulties. Interestingly, the lean growth index also added a negative emphasis on fat thickness at yearling weight or stressed selecting low fatness bulls. This was not widely applied or used. Today we see many cattlemen using an implied lean growth index when high yearling weight and low birth weight bulls are selected via EPD values. Such “spread” bulls are valued as industry acceptable. Most commercial cow-calf producers are not aware of postweaning growth performance of their calves since most calves are sold after weaning. It is safe to recommend that crossbred calves be recognized as superior due to growth heterosis. Most industry participants use expected breed differences to predict growth potential. Frame score and muscling score are reported in marketing description as aids to predicted growth. However, there are other factors relative to weight, age, sex, and fat condition that greatly influence growth. Cattle buyers use all aspects in value determination but most feel breed composition is the best predictor. It is the easy descriptive terminology accepted. I disagree with judged breed composition as a safe growth predictor because many cannot see or correctly identify the inheritance. What really creates problems are the discrimination aspects of a breed that become major price deductions in value assessment. It is simply not color, shape, muscling, or a quality measure that guarantees success. Buyers will use any aspect to discount price paid whether factual or an implied problem. Unknown genetics and beef breed limitations are still largely used by most to establish price. This appears acceptable to many in the industry since breed differences are recognized for product traits like tenderness and marbling and associated with feedlot growth and feed efficiency. Extremely large and small frame cattle are discounted relative to expected slaughter weight. Reduced marbling and tenderness expectations by breed inheritance are too often used. Yield grade is not so much a genetic trait to consider, but is a feeding management problem. With mixed breeding load-lots being fed, it is easy to blame breed inheritance as the problem. Maybe the buyers and feeders should sort and feed more by breeding potential to acceptable fatness (0.35 inches of fatness) and let slaughter weight vary according to cattle breeding merit. Feeders have too often extended feeding time to increase fatness in order to increase marbling and thus destroy yield grade. Also, cattle have been fed to heavier weights by increasing fatness which is improper feeding management. Again in mixed load-lots, the lot feeding concept creates more "out" carcasses when cattle have not been sorted or packaged properly before feeding. Variation within a breed is large enough that even purebred cattle will not fit with improper feeding management in load-lot feeding without proper sorting and grouping prior to feeding. Because marbling ability and tenderness are highly heritable traits, many consider genetic control as the major emphasis. I strongly recommend the industry needs to review the USDA beef quality grading system. It is too subjective and does not address maturity in truly youthful cattle. I support research and development of objective and mechanical systems like the CVS BeefCam® that attempts to sort beef carcasses at chain speed for tenderness and yield grade component traits. Those carcasses sorted into less desirable groups for tenderness can then be further processed and treated to enhance eating quality. Major emphasis in feeding management must be to minimal fatness for eating quality and optimum lean tissue yield. Feedlot energy efficiency for the beef industry has predicted a 100-day feedlot period as optimum.

With breed differences clearly identified for tenderness and marbling, it is acceptable to many in the industry to justify breeding discrimination as economically accurate. It is not always justified nor accurate but widely used. Without carcass data and progeny records, selection of young breeding animals in any breed for product traits is difficult. Most commercial cattlemen rely upon breed of bull to predict quality grade, yield, and eating quality (tenderness). Ritchie (2002) identified three market targets for the beef industry and defined acceptable breed composition to meet each as:

1. Upscale restaurants and export trade, Mid-Choice and higher grade.

British X British
¼ Continental X ¾ British

2. Retail supermarkets and midscale restaurants, High Select to Low Choice.

½ Continental X ½ British
¼ *Bos indicus* X ¾ British

3. Young, extremely lean market.

Continental X Continental
¾ Continental X ¼ British
¾ Continental X ¼ *Bos indicus*

I would recommend that Market 1 should specify ≥ ½ British crossbred. Market 2 cattle should include all crosses except avoid ≥ 75% any specialty breeds inheritance. Market 3 cattle will require cattle of higher growth potential and larger mature size breeds.

I support the notion that the consuming public mainly fits into the Market 2 classification. With about 50% of all beef consumed as ground beef with reduced fat content preferred, it seems logical to rank Market 3 as next in priority. With young cattle being more widely used in feeding operations, beef carcass maturity is largely A or A- in the industry, so young cattle are expected in all markets. Certified Angus Beef (CAB)® is represented by Market 1. This very successful program is an excellent example of quality control. However, of all breed qualified (black hide) cattle presented for CAB®, only about 15 to 20% qualifies. This means the majority of all cattle fed and prepared for this market fails and must be assimilated into the other markets, which means more inefficient fat content to address.

The industry carcass target of 70% Choice or above, 70% Yield Grade 1 or 2, and 0 % “outs” is an unrealistic goal. Some individual sets of crossbred cattle may meet the target but the normal association between marbling ability (grade) and yield grade make it unrealistic. A well-known genetic antagonism is at play here and selection within a breed cannot guarantee high grade and high lean yield. Fatness management is deemed a more important need and to seek an optimum marbling level. This is certainly more economically important to the industry.

Ritchie (2002) prepared the following, Table 2, which illustrates the breeding problem for any one-breed type composition:

Table 2. Quality grade and yield grade of various biotypes of fed cattle.[a]

Biotype	% Choice	%YG1 & 2
100% Continental	30	89
¾ Continental X ¼ British	43	83
½ Continental X ½ British	56	56
¼ Continental X ¾ British	66	52
100% British	70	38

[a]Adapted from U.S. Meat Animal Research Center (MARC) data.

The U.S. Meat Animal Research Center (MARC) and Gelbvieh Alliance general recommendations imply that ideal feedlot cattle should be 50% Continental and 50% British. My early research of feedlot mating type comparisons show that three-breed and backcross cattle are heavier than F-1 and purebred cattle at slaughter due to maternal and growth heterosis advantages carried over from hybrid cows. F-1 cattle were faster gaining in the feedlot but did not compensate for the early weight advantage of calves from crossbred cows.

Historical Industry Management Concepts

The commercial beef industry has been breed oriented since improvement was deemed necessary over native cattle of natural indigenous origin. Selection emphasis has been stressed for heritable traits that are easily measured in life through performance testing. With limited breeds and differences to make rapid industry change, the industry adopted breed importations and creation. Crossbreeding became well documented as advantageous for the cow herd and identified advantages for breed diversity. Management of the cow herd with predictable heterosis over generations then surfaced as an important need. The movement to product marketing and beef product quality and consistency has lead to the renewed emphasis on selection for product traits that are difficult and expensive to measure. It is safe to assume that the commercial cattlemen will demand the purebred breeders to perform this task and commercial cattlemen will use breed selection to address beef product merit through bull purchases. It appears we will not abandon crossbreeding at the commercial herd level. Some propose a single dominant beef breed will become the breed of all commercial cattlemen. This is very doubtful as no evidence to date identifies a straight bred system as comparable in economic efficiency to controlled crossbreeding for the commercial cattleman. The extensive climate and environmental differences across our nation clearly identify the need to address crossbreeding as required for most commercial beef herds. Certainly evidence exists to stress the need to address beef product quality and consistency but this must be done in holistic management concepts. There is a need to address low-cost production on a brood cow basis in our commercial herds.

Conclusions

It seems important that commercial producers must stress meeting market demands but must select the market that best fits their cow herd genetic potential. Selecting a breed of bull for the market specifications is most important to compliment the cow breeding to produce a suitable calf of breeding that can compete. Optimum calf genotype will vary over the different cow herd environments. Neither one breed nor one breed of bull will be an industry standard that meets all needs. It can work in egg laying chickens and dairy cattle where the production environment is essentially controlled. Swine breeds are essentially similar for most production traits except for maternal breed aspects, which demand crossbred genotypes. Because cattle are creatures of forage and climatic environments, the beef industry must balance traits and enhance management to control production limitations without destroying breed diversity and/or limiting the known use of crossbreeding and controlled heterosis in the industry. The need for uniformity and consistency does not imply only purebred cattle. Crossbred cattle can be equally uniform or actually have less variation in traits influenced by heterosis. Crossbred cattle are intermediates.

Selection and management emphasis must be prioritized in rank order as reproduction, production, and product traits for the beef industry. Functional breeding cattle and management ease in the herd will drive acceptance along with low-cost production.

The crossbred cow that produces a breed composition calf with heterosis in growth traits and sufficient additive inheritance in product traits must be used. Who will make these decisions? Who is responsible for industry accountability to the consumer? How will the industry progress to a more profitable position for all participants? The producer, who selects the crossbred cows, chooses the breed of bull and individual breeding cattle based on optimum trait performance for the industry and controls the mating system and management to ensure effective heterosis usage is the responsible person. The consumer, packer, feedlot manager, nor order buyer individually can correctly dictate the needed balance of traits for the industry to survive. Each can specify acceptable production and product trait values or what is clearly unacceptable performance that impacts them. We need to think in threshold values and reduce the simplistic breed or breeding answers for the complex industry problems. Source verified, reputation hybrid cattle that combine beef production attributes are the answer. They must be manageable on a herd basis in a defined production environment as a renewable resource. The brood cow is the required base for a profitable beef industry.

Acknowledgement

This presentation was formatted to comply with an original paper prepared by Harlan Ritchie cited as Animal Science Staff Paper 433, File No. 19.162, July, 2002. Prepared for 2001 KOMA Beef Cattle Conference, Fayetteville, AR and Ft. Scott, KS. I was originally asked to address this topic in reference to this paper and I did, but I take responsibility for any errors and omissions in my preparation and presentation of his concepts. My presentation and recommendations are believed to be consistent with his conclusions. However, I am totally responsible for the presentation and conclusions and use his citations to verify a consensus.

Notes:

Principles of Supplementing the Grazing Beef Cow

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Introduction

Feeding the cow herd is the largest cost in the cow-calf enterprise. The cow herd's feed requirements amount to 54 - 75% of the annual maintenance costs for the herd (Houghton et al., 1990). Grazed forages comprise the largest and most important feedstuff for the cow. Utilization of forage through grazing is the most economical feed that is available to the cow herd. Grazed forages provide the majority of the nutrients for maintaining the cow during gestation, lactation, and breeding. However, during certain times of the production cycle beef cows require additional nutrients beyond those supplied by grazed forage. Supplemental feedstuffs are utilized to meet cow nutrient requirements when they exceed the nutrients supplied by grazed forage because of an increase in cow requirements, decrease in forage quality or quantity, or a combination of all factors.

Determining and implementing the optimal supplementation program is imperative to maintaining a healthy bottom line in the cow-calf business. You will notice that I used the term optimal rather than maximal. Optimal is defined as the best or most favorable condition or degree, or the amount for a particular situation. This is an important distinction because often maximal production or supplementation is not economical. The idea of optimal supplementation is important because stored/supplemental feeds constitute the largest, potentially most variable, and costliest feedstuff for the cow herd.

Considerations for Starting Supplementation

To implement a supplementation program you as a producer must first define your situation. Defining the situation requires several steps. The first step is to decide what is the overall objective of the supplementation program. Considerations for implementing a supplementation program include extending the forage base in situations where the forage quantity is lacking because of overstocking, seasonal transitions, or drought. A second reason to implement a supplementation program is to alter the level of production of the cows. Changing production levels in the cow herd might include additional feeding of first calf heifers or thin cows, or feeding a supplement with special ingredients. A final reason to start supplemental feeding is to meet nutritional deficiencies. These nutritional deficiencies can include vitamins, minerals, protein, or energy. The important thing to remember is that in order to implement a plan you need to identify what is the goal of the supplementation program and then what will you do to accomplish the stated goal. In addition to implementing the supplementation program, determining a method to measure the effectiveness of the supplementation program is important. Otherwise, how will you know if you ever reach your goal, how soon you got there, and what it costs.

An important consideration to implementing a supplementation program is knowledge of what you have to work with and that starts with the forage base. Effective management of grazing requires determining the quantity, quality, composition, and overall forage utilization rate. Determining pasture yield can be as easy as relying on experience or as complicated as taking forage samples to calculate estimated forage available. Determining quality and composition can be more difficult, but knowledge of the predominated grass species in the pasture and knowledge of the level of maturity are valuable for determining quality of grazed forage. Finally, decide from a management standpoint how much

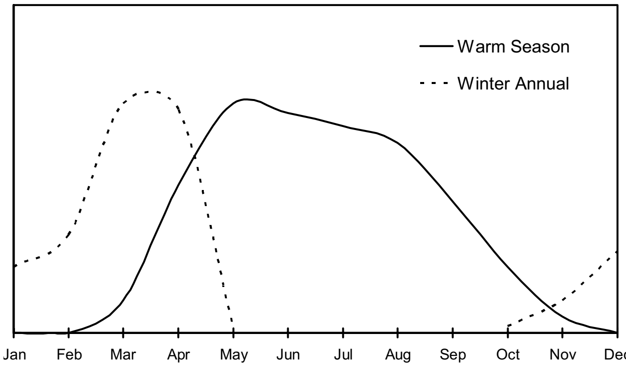

Figure 1. Florida forage/pasture growth.

of the available forage will I make the cows utilize. An important consideration is that increasing the level of forage utilization has two results; the first is that increasing utilization generally decreases the quality of forage consumed as the grazing season progresses, especially during winter grazing. The second result is that by increasing the utilization rate, the cattle remove a greater amount of forage from the pasture. A utilization rate that is too high can compromise subsequent plant growth and can negatively affect future pasture productivity.

The need for supplementation for the grazing cow occurs because of multiple forage factors. The supply of forage for grazing animals is seasonal and dependent on the forage species available for grazing. Figure 1 demonstrates the relative forage availability of warm season and winter annuals. Easily identifiable times of supplementation are apparent when warm season grass production declines and before winter annual growth occurs. Other times include when forage energy and crude protein concentrations fall below the requirement of the grazing cow. Forage deficiency of energy and protein relative to cow requirements occurs during forage dormancy in the fall, winter, and early spring, and during the height of the summer when accelerated forage growth results in lower quality forage. A complication in successfully balancing supplemental feed and grazed forage is the selectivity of grazing cattle. Grazing cattle have the ability to graze through a sward of grass and select a diet that can be 5 - 50% greater in digestibility and protein than what is available (Hitz and Russell, 1998; Hersom unpublished data). Therefore the exact composition of the forage diet is often poorly known when we rely on pasture samples because of the cow's selective ability.

Cow Factors Affecting Need for Supplementation

Equally important to forage issues is the cow herself. The cow introduces as much variation as the forage or the environment. Differences in the amount and type of forage consumed by the cow vary. This variation in forage consumption results in differences in nutrient intake by cows. Differences in supplement consumption also occur among cows regardless of our attempt to feed the desired amounts of supplement. Cow nutrient requirements are affected by numerous variables. Many of the issues concerning the cow haven't changed from 20 years ago. In 1984, Dr. W. E. Kunkle put together a Beef Cattle Short Course talk, "A Winter Supplementation Program for the Cow Herd." The proceedings contained many of the same items I am discussing in these proceedings. Particularly, I will review his discussion of the cow factors that influence the nutrient requirements and their effect on supplementation.

Age. Heifers definitely and older cows possibly require a higher level of supplementation than mature cows. Heifers, if bred to calve at a younger age, still have growth requirements to meet in addition to the demand that pregnancy and/or lactation put on their nutritional status. The heifer generally does not have the body stores, principally fat, on which to draw during times of higher nutritional demands. Additionally, heifers generally are smaller than their mature counter parts and thus have less ability to consume large amounts of high roughage diets.

Level of Production. It is well established that different stages of the production cycle result in different nutrient requirements. Milk production, fetal development, and body weight gain all require additional energy and protein above maintenance. Additionally, higher producing animals have increased nutrient requirements compared with the average of the herd. Requirements for energy

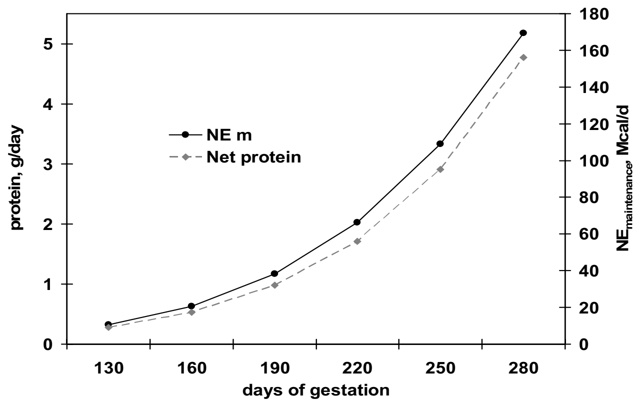

Figure 2. Estimates of energy and protein requirements for pregnancy.

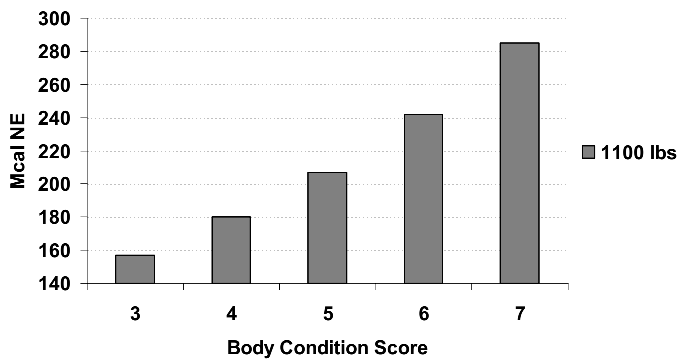

Figure 3. Energy reserve/required to change body condition score.

change by nearly 2.0 Mcal/d and net protein by 0.22 lb/d from week 3 to peak lactation at 9 weeks (NRC, 1996). Differences between low and high milk producers at peak lactation are even more pronounced (2.15 Mcal/d of NE_m, and 0.22 lb/d of net protein; NRC, 1996). During gestation the requirements for energy and protein increase dramatically as the products of conception: fetus and placental tissues grow. The increases in energy and protein for gestation are demonstrated in Figure 2. You can see how closely energy and protein track together during gestation because of the simultaneous need for energy and amino acids for metabolism of the uterus, placenta, and fetus.

Cow Body Condition. Cow body condition score (BCS) in my estimation is one of the easiest and best tools for evaluating nutrition and management decisions. Consistent and timely evaluation of cow BCS allows you to determine if and when supplementation is indicated. Once a supplementation program has been initiated, continued observation of cow BCS will allow you to evaluate the effectiveness of the supplementation program. Without a benchmark like cow BCS how will you ever know when you've reached the goals that you set out at the initiation of supplementation? There are several critical times that cow BCS should be evaluated in the cow herd. Times to evaluate cow BCS also coincide with other management periods essential to profitable cattle production. The logical times to evaluate cow BCS are:

1) 60 days before calving
2) Calving
3) Beginning of breeding season
4) Mid-summer
5) Weaning

These time points are important because they allow you to make decisions regarding the future nutritional program for cows needing additional BCS. Remember BCS at calving and breeding season are important to the reproductive efficiency and success of the cow, and there are few economical ways to increase BCS on dormant forage alone during the winter. Ample evidence exists for the importance of adequate cow body condition for return to estrus, improved pregnancy rate, and adequate weaning weights (Houghton et al., 1990; Sinclair et al., 1998; Wiltbank et al., 1962). Sufficient evidence in the literature recommends that cows be a minimum BCS of 5 on a 9 point scale at calving. The BCS 5 provides adequate body reserves of fat and protein for mobilization during early lactation. Moreover, cows that are thin prior to calving (BCS < 5) but on an increasing plane of nutrition can reap the same benefits, improved time to estrus, improved conception rates, and improved pregnancy rates, that cows in adequate BCS (≥ 5) exhibit. Additional research demonstrates that cows in adequate BCS are capable of withstanding stress associated with cold and wet better than thin cows. In addition, the cost associated with achieving adequate body condition are much cheaper to achieve during early and mid-gestation, when cow requirements are lowest compared with late gestation, lactation, and the breeding season. This becomes particularly important when one considers that 1 Mcal of body energy reserves is utilized at 80% of what dietary energy is utilized to supply maintenance energy. Figure 3 demonstrates the NRC (1996) determined energy required or supplied beyond the current dietary supply for a 1,100 lb cow to move to different BCS. For that cow to move from a BCS of 3 to a 5 requires an extra 387 Mcal above her maintenance requirements which equates to about 177 lb of bahiagrass hay, 103 lb of molasses, or 90 lb of soybean hulls. If you have to do that with very many cows it can start to get expensive. In contrast letting a BCS 6 cow return to a 5 would save 75 lb of hay, 44 lb of molasses, or 39 lb of soybean hulls.

Breed. There are reasons for the amount of research that goes on concerning breed differences and breed adjustment factors in the NRC. Breed of cattle can have a large impact on the nutritional management and accompanying supplementation program. The importance of *Bos indicus* cattle to Florida cattle production goes without saying. Research has demonstrated that *Bos indicus* cattle have a 2 to 3% increase in dry matter digestibility and 3 to 4% increase in protein digestibility. The NRC acknowledges the maintenance difference between *Bos indicus* and *Bos taurus* by assigning a 5 to 10% decrease in net energy for maintenance to *Bos indicus* cattle. This increase in energy efficiency is especially important in forage-based production systems. Breed effects are also indicated in milk production and composition. Increases in milk production and increases in milk fat and protein content increase the net energy for lactation of cows. Milk potential can be especially important during grazing and supplementation periods.

Environment. The key concept is adaptation. The genetic-environmental interaction can have profound effects on cattle production and enterprise profitability. The wrong cow in an environment is a recipe for disaster through increased feed cost, disease and parasite susceptibility, and the effect of weather. Cattle bred and selected for production on improved pastures with abundant supplement will not be economically successful in range-minimal supplementation management programs. Each producer must evaluate their own overall environment: nutritional, weather, and pest to decide on the optimal cow to utilize.

Supplementation Priorities

Vitamins – Minerals. Supplementation of minerals should constitute the first supplementation priority in the cow-calf herd regardless of the time of year. Vitamin and mineral deficiencies cause performance and production problems regardless of any other nutritional or supplementation programs that you have in place. For the effect on animal performance and production, adequate supplementation of minerals and vitamins produces the largest return on investment. Forages in Florida, especially during the dormant cycle of production, can be deficient of several minerals and vitamin A. Winter annuals also incur mineral deficiencies that can result in metabolic disorders of grazing cattle. Cattle grazing wheat, rye, and ryegrass are particularly susceptible to grass tetany. These forages are often high in N, K, organic acids, and have a high K/(Ca + Mg) ratio, and low in Mg and/or Ca (Grunes et al., 1983). The imbalance of minerals occurs during periods of rapid growth during favorable growing conditions in conjunction with N-fertilization.

The addition of other supplement feedstuff may alter the mineral availability of the forage. There are numerous commercial mineral and vitamin sources. Types of supplement include loose, block, or incorporation into molasses supplements. Adequate management practices including storage, feeding, and placement need to be in place for successful utilization of mineral and vitamin supplements. The efficacy of all other supplementation programs depends on the adequate mineral and vitamin status of the animals.

Protein. Protein supplementation is likely the next in the list of priorities for supplementation. Protein supplementation has consistently been shown to increase forage dry matter intake and forage digestibility. The positive effect of protein on intake and digestibility is most apparent in cattle consuming low quality forages. Protein

Table 1. Nutrient composition of selected feedstuff.[a]

Feed	TDN, %	NE_m, Mcal/lb	NE_g, Mcal/lb	CP, %	DIP, % of CP	UIP, % of CP
Bahiagrass hay	51	0.50	0.25	8.2	63	37
Bermudagrass hay	49	0.42	0.18	7.8	85	15
Wheat pasture	69	0.70	0.43	28	95	5
Alfalfa pellets	59	0.58	0.32	17	54	46
Soybean hulls	80	0.88	0.59	12	58	42
Wheat middlings	83	0.92	0.62	18	77	23
Citrus pulp,dehydr.	33	0.91	0.61	9.8	43	57
Corn grain	88	0.96	0.64	9.8	45	55
Corn gluten meal	84	0.94	0.64	47	38	62
Dry distiller grains	88	0.99	0.68	30	26	74
Whole cottonseed	95	1.08	0.76	23	70	30
Cottonseed meal	78	0.85	0.56	44	57	43
Peanut meal	77	0.84	0.64	34	69	31
Soybean meal	87	0.98	0.67	49	65	35
Feather meal	68	0.71	0.44	86	30	70
Molasses, cane	72	0.77	0.49	5.8	100	0
Urea	65	0.67	0.40	291	100	0

[a]Tabular values from NRC, 1996.

supplementation has been associated with decreased loss of cow body weight and BCS during gestation and lactation and increased body weight gain in growing animals. Moore et al. (1999) summarized numerous research trials and concluded that the critical level for additional protein to be effective in affecting animal performance was forage CP less than 7% or TDN:CP greater than 7. In each case, nitrogen for microbial protein synthesis is deficient or out of balance relative to the amount of energy available from the forage. This is the case for much of the mature forages (8 weeks or more regrowth) in Florida.

There are considerations to make when selecting protein supplements. The main consideration is the differences between non-protein nitrogen (NPN) and natural protein containing supplements. The issue of NPN versus natural protein also introduces the concept of degradable intake protein (DIP) and undegradable intake protein (UIP). NPN is a DIP source that supplies nitrogen to meet the ruminal microbial requirement for nitrogen. Generally, NPN is supplied in supplements as urea. Exclusive use of NPN for supplemental protein has demonstrated improved animal performance compared with no supplemental nitrogen. However, the success of NPN utilization is contingent on adequate ruminal energy for the microbes to utilize the nitrogen. The use of NPN exclusively has generally met with the most success in medium- and high-energy diets that contain adequate TDN. A consideration with NPN is that it provides no other nutrients such as energy, vitamins, or minerals. Several other considerations exist for the use of NPN. The use of NPN generally is advised for older rather than young or growing cattle because of the issues regarding energy supply and lack of additional nutrients in NPN that younger animals still require. NPN requires a carrier because of the potential toxicity when directly fed. The need for a carrier substance is met when NPN is incorporated into liquid, particularly molasses supplements. Molasses works well because of the solubility of urea and molasses supplies carbohydrates for microbial energy to utilize the nitrogen from urea. Urea can also be incorporated into pelleted supplements that contain energy sources such as corn or wheat middlings.

Natural protein comes from plant and animal (fish or feather meal) sources. Natural protein presents a combination of DIP and UIP for the animal. The relative proportions of DIP and UIP vary according to the feedstuff. This combination of DIP and UIP is advantageous and allows for tailoring of supplements to meet both the ruminal microbe N requirements and the animal requirements for amino acids. Performance of animals, in general, is greater with natural protein sources compared with NPN sources, but exceptions are common. Utilization of natural protein is similar among different classes of animal, but is favored for use with young and growing cattle because of their additional requirements of growth. Natural protein sources can be fed in dry forms including meals and pellets, or incorporated into liquid supplements. Table 1 presents energy and protein values of several common feedstuffs utilized as supplements.

Utilization of either NPN or natural protein in supplementation programs involves several decisions. First, can NPN be utilized and is there enough energy in the diet to allow the incorporation of NPN? Secondly, is the supplemental protein requirement for only DIP or is UIP also needed to improve cattle performance? Then consider price per pound of crude protein supplied; price may also dictate the need for UIP addition in the diet. Remember supplementation is about optimizing performance and profitability; those two can not be mutually exclusive. Finally consider consumption patterns, over-consumption of protein supplements may improve animal performance. However the additional supplement consumed above the protein requirement must be valued at the cost of energy supplementation only if there is a positive economic benefit, otherwise it is unnecessary expense.

Winter annuals can offer an excellent source of protein, often exceeding 20% CP, and are a highly digestible roughage source. However, because of economic cost of establishment, limited acres for planting, fencing requirements, and high nutritive value of winter annuals as a cow supplement, they can be overlooked. In order to realize any cost savings compared with commodity supplementation, a producer must design and implement some system to regulate the cow's intake of the high quality winter annual forage (Altom and Schmedt, 1983). Research has demonstrated that a grazing frequency of one day per two days up to one day per week can be utilized as a supplement for mature cows grazing dormant forage. In as few as two hours a cow can consume nearly 12 lb of DM of small grain forage containing up to three lb of CP (Altom and Schmedt, 1983). The use of small grain winter annuals and ryegrass as a supplement is dependent on successful establishment, yield, and availability and quality of the base forage supply.

Energy. If there is adequate forage for grazing, then supplementation of additional energy is the last consideration for the grazing cow. Energy supplementation is generally the most expensive because it has the lowest performance return to dollar spent for supplement. Molasses is likely the lone exception because of the low cost in Florida. However, use of traditional energy supplementation may be warranted when a reduction in overall forage consumption is required to stretch the forage supply, cattle have increased energy demands, or diet selection of a low amount of high quality forage is possible. There are a number of considerations associated with utilizing energy supplements for the grazing beef cow. Energy supplements usually contain less than 20% CP, and energy supplements should not be fed when a high CP supplement will improve performance to the desired level. High starch supplements work best with moderate and high quality forage, not low quality dormant forage. Energy supplements, particularly grain, substitutes for forage consumption even at low levels of supplementation. Low levels of energy (without natural protein) supplementation will decrease overall energy intake of cows. This occurs because high starch feedstuffs decrease fiber digestibility (negative associative effect). Inclusion of adequate supplemental DIP in grain based supplements has been shown to overcome the negative associative effects that high-energy grain supplements impart on low-quality forage diets (Bodine et al., 2000). The decrease in negative associative effects on forage utilization is reduced or eliminated by balancing total diet DIP in relation to total diet TDN (Bodine and Purvis, 2003). Balancing of the dietary DIP and TDN still decreased total forage intake, but fixed the total digestibility problem caused by high-starch supplements. Managing the DIP:TDN ratio allowed the incorporation of corn into a supplementation program and thereby increasing the ADG, supplement efficiency, and reducing the cost.

By-product feeds offer alternatives to traditional feedstuffs for energy supplements. Many of the available by-product feedstuffs are low starch with moderate levels of fiber. These by-products include soybean hulls, wheat middlings, citrus pulp, corn gluten feed, or brewers' grains. The by-product feeds have less impact on forage fiber digestion because the energy supplied is in the form of highly digestible fiber. Many by-products provide a 15-30% increase in performance per unit of TDN. This increase in performance can offset some of the potential increased cost of the by-product feed. An increasing amount of research has examined the incorporation of by-product feedstuffs into supplements for cattle. Like all supplemental feed sources the effectiveness of by-products depends on their cost. One caution is that by-product feeds are still variable in nutrient composition between loads and this needs to be considered when formulating supplement plans.

Things to Consider about Supplementation. Supplementation programs need to be planned. Historical data and experience can help to determine when, what, and to what extent nutrient deficiencies will occur, and what supplementation programs are successful. An important part of supplementation success is to start feeding the cows before it is too late. It is much easier and cheaper to keep BCS on cows than it is to have to re-feed her so she can gain BCS. As Figure 3 demonstrates it can take considerable energy above the current level of feeding to move up the BCS scale. When a cow utilizes body condition to make up for a deficiency in dietary energy she does so at a reduced efficiency. One Mcal of energy from body tissue will only replace 0.8 Mcal of dietary energy, a 20% loss of efficiency. The reduction is efficiency generally is not compensated for when the cow gets adequate nutrition.

Pay considerable attention to the type of supplement the cow actually needs; don't feed an energy supplement when a high protein supplement is all that is needed to stimulate intake of lower quality forages and thus supply adequate energy. Supplementation frequency is a flexible matter. Plenty of research has demonstrated that high protein supplements do not need to be fed on a daily basis. Frequencies as low as 2-3 times per week have been shown to be adequate to support both cow and growing animal performance. Less frequent feeding results in greater amounts of feed at each feeding, reduced disruption of grazing time, and allows for more timid cows access to the supplement. Higher energy supplements require more management and more frequent feeding. Consider the time of day that supplements are fed. Feeding supplements first thing in the morning or in the evening is generally better than midday to minimize the disruption of grazing times. If the supplements are being fed in conjunction with hay, make sure the cows have hay to eat and are not hungry. Allow the cows to be "full" of hay or forage before feeding expensive supplement.

Supplementation decisions are financial decisions and therefore the cost of the supplemental protein or energy must be considered. Calculating the cost of protein or energy is straight forward. The cost ($/lb) is calculated by dividing the unit cost of feed by the protein or energy fraction (% CP or TDN/100). For example wheat middlings cost $90/ton = $0.045/lb ($90/2,000 lb), 1 lb of wheat midds contains 18% CP, and therefore a pound of protein cost $0.25 (0.0455/0.18). The cost/lb of CP can then be multiplied by the pounds needed for daily supplementation to achieve the cost per day (0.25 x 1.75 lb = $0.44/d).

If your feed costs are high it may be an indicator of production/management problems. The first and obvious problem is that the forage nutrient supply and cow nutrient requirements do not match. If a lack of nutrient synchrony between the cow and available forage is the problem then altering the production calendar may need to be considered. Adjusting the calving time and subsequent lactation period by as little as two weeks could coordinate forage supply and cow requirements to reduce supplement needs. A second question is does the cow match the nutritional environment that you are providing. If the cow's nutrient requirements are greater than what the forage supplies regardless of your management inputs, then she may not be the right cow for the production resources available.

Summary

Supplementing the grazing cow is about striking the balance of input cost with output return. The cow has basic requirements that are often not met by the forage she is grazing and supplemental nutrients are required. Vitamins and minerals are the most important because of their extensive effect on the rest of production. Protein is likely the next limiting nutrient. Protein sources vary in quality, composition, and price. The best protein supplement is one that meets the cow's requirements at the lowest cost. Energy supplementation is the highest cost supplement with the greatest potential negative effect on forage intake. Remember maximal production does not equal optimal production from the cow herd. Keeping the beef production factory which is the cow working and producing at the desired level of output will require diligence and sufficient maintenance to her needs.

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Market Outlook for 2004 and Beyond

Prepared for:

University of Florida

May 5th, 2004

Presented by:

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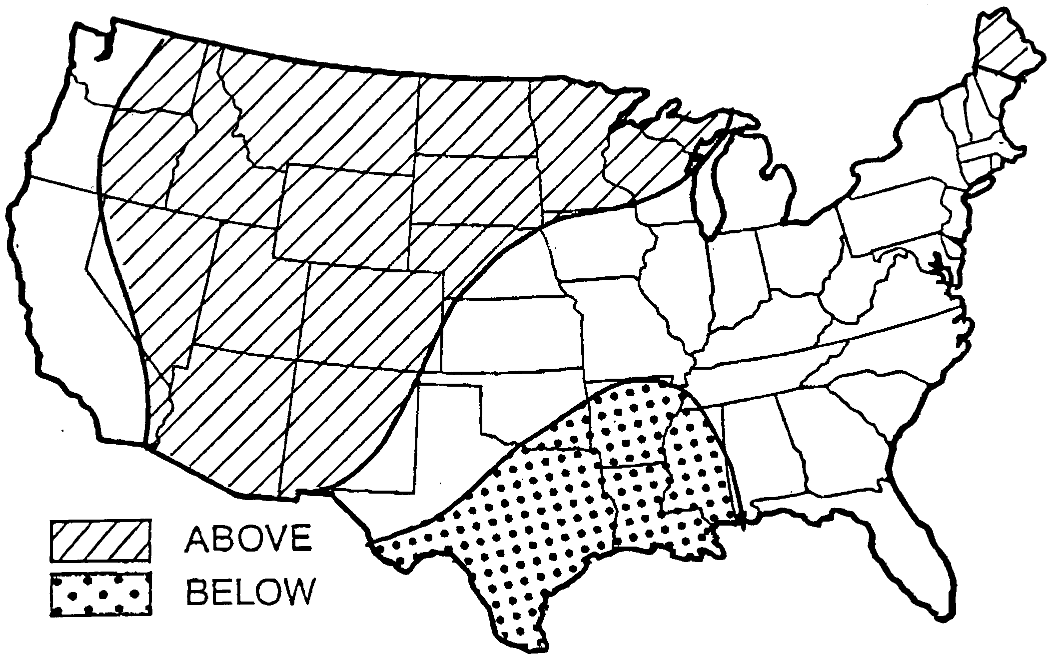
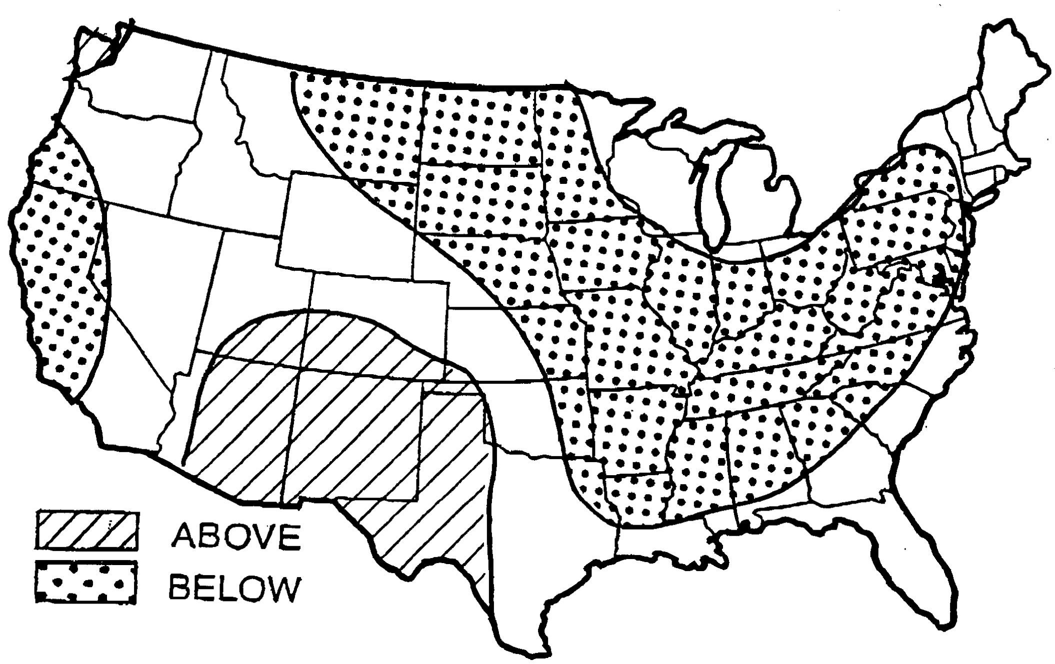
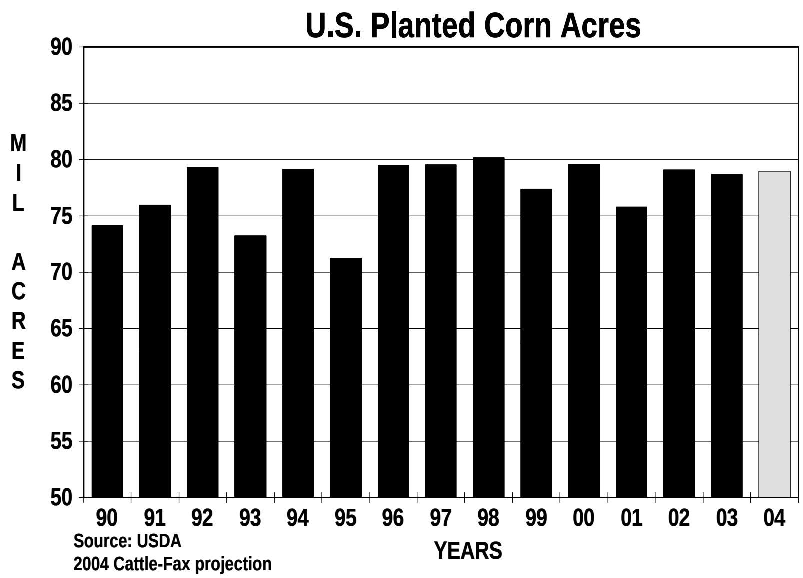
Feed Grains

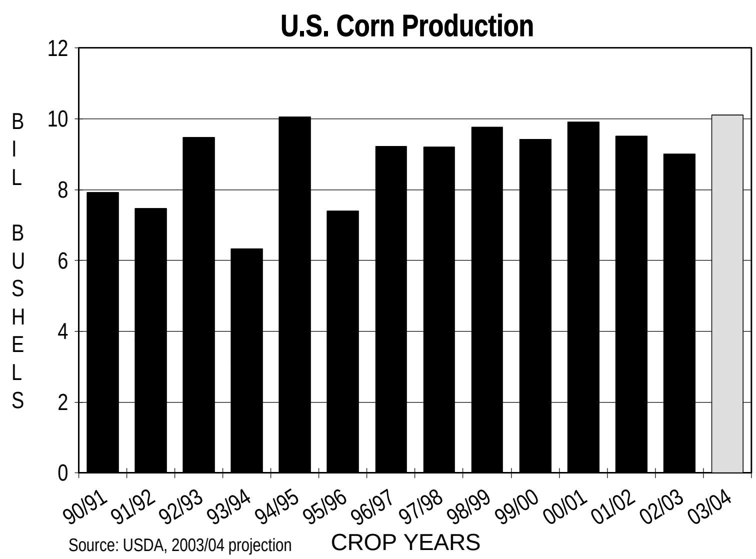
Temperature Outlook
April through June 2004

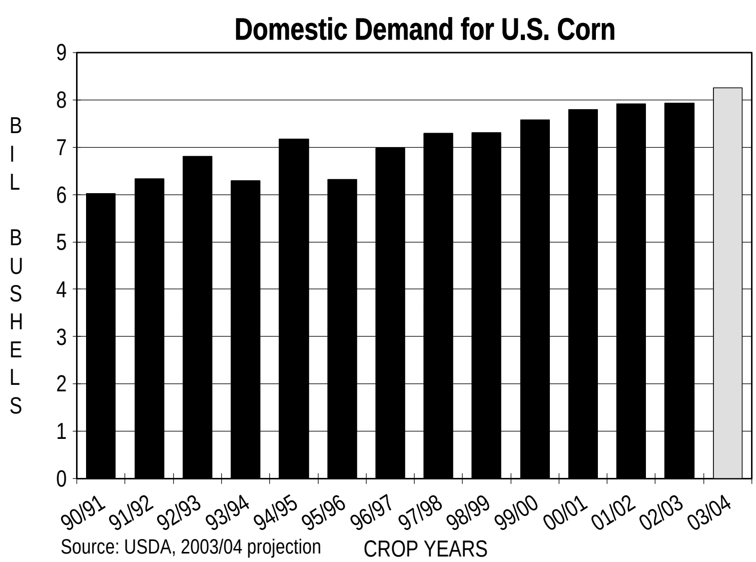


Precipitation Outlook
April through June 2004

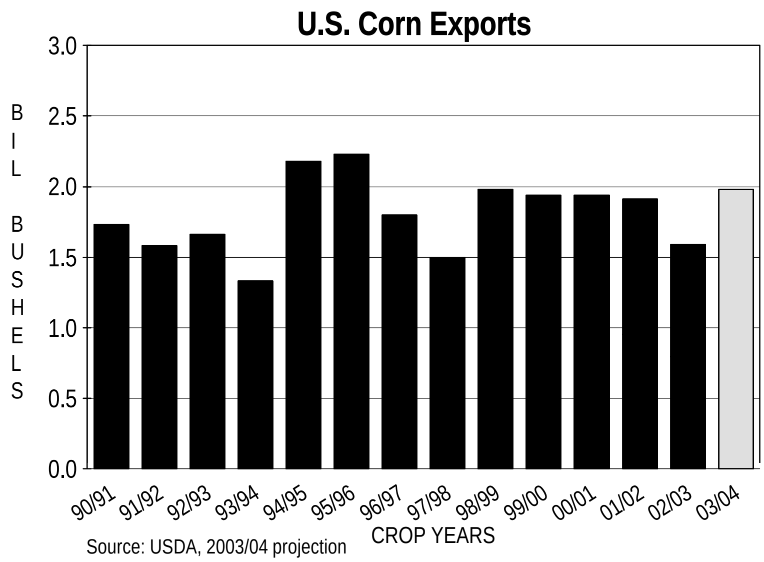



U.S. Planted Corn Acres
MIL ACRES
90
85
80
75
70
65
60
55
50
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source: USDA
2004 Cattle-Fax projection
YEARS

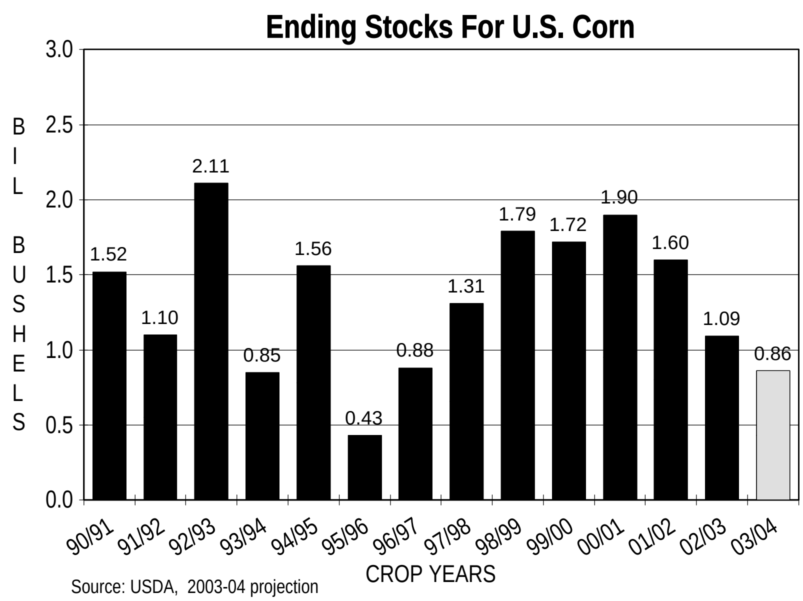

U.S. Corn Production
BIL BUSHELS
12
10
8
6
4
2
0
90/91 91/92 92/93 93/94 94/95 95/96 96/97 97/98 98/99 99/00 00/01 01/02 02/03 03/04
Source: USDA, 2003/04 projection
CROP YEARS


Domestic Demand for U.S. Corn
BIL BUSHELS
9
8
7
6
5
4
3
2
1
0
90/91 91/92 92/93 93/94 94/95 95/96 96/97 97/98 98/99 99/00 00/01 01/02 02/03 03/04
Source: USDA, 2003/04 projection
CROP YEARS

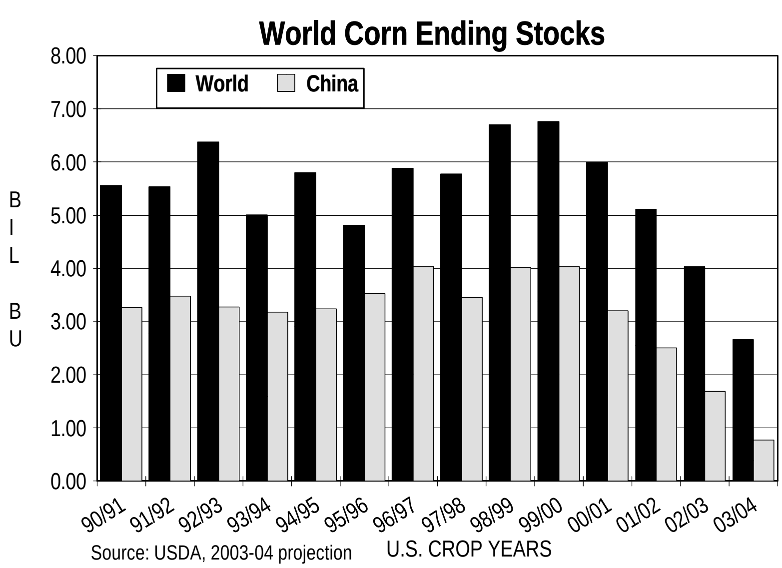
Notes



U.S. Corn Exports
BIL BUSHELS
3.0
2.5
2.0
1.5
1.0
0.5
0.0
90/91 91/92 92/93 93/94 94/95 95/96 96/97 97/98 98/99 99/00 00/01 01/02 02/03 03/04
CROP YEARS
Source: USDA, 2003/04 projection

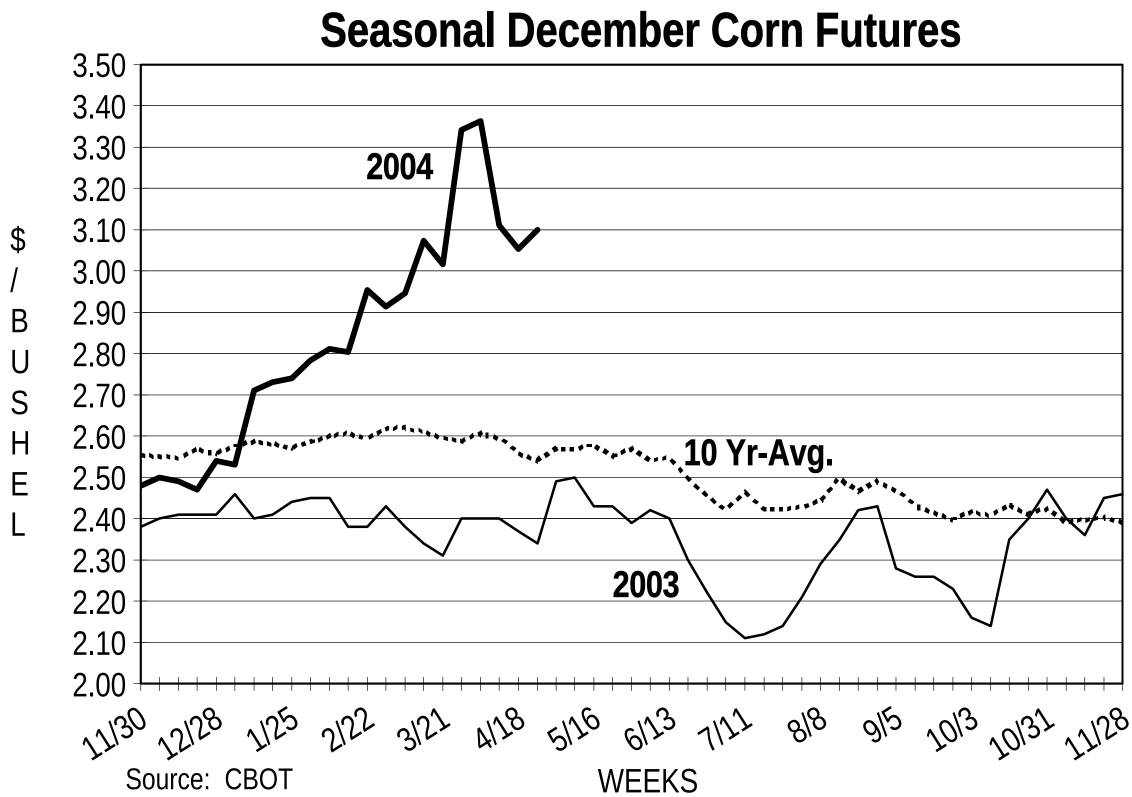


Ending Stocks For U.S. Corn
BIL BUSHELS
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.52
1.10
2.11
0.85
1.56
0.43
0.88
1.31
1.79
1.72
1.90
1.60
1.09
0.86
90/91 91/92 92/93 93/94 94/95 95/96 96/97 97/98 98/99 99/00 00/01 01/02 02/03 03/04
CROP YEARS
Source: USDA, 2003-04 projection



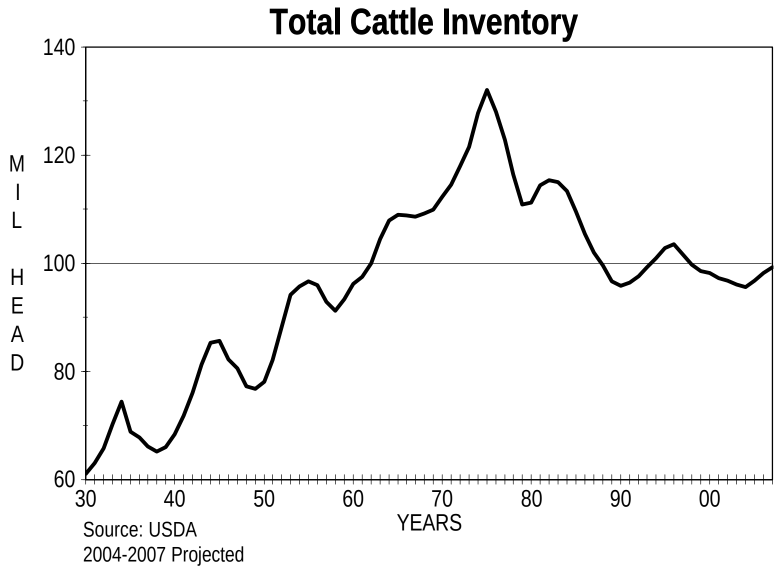
World Corn Ending Stocks
World
China
BIL BU
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
90/91 91/92 92/93 93/94 94/95 95/96 96/97 97/98 98/99 99/00 00/01 01/02 02/03 03/04
U.S. CROP YEARS
Source: USDA, 2003-04 projection

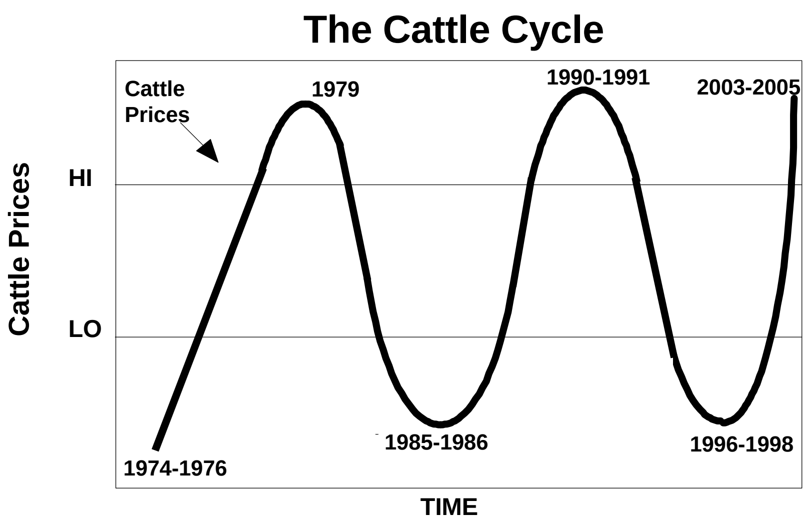
Notes

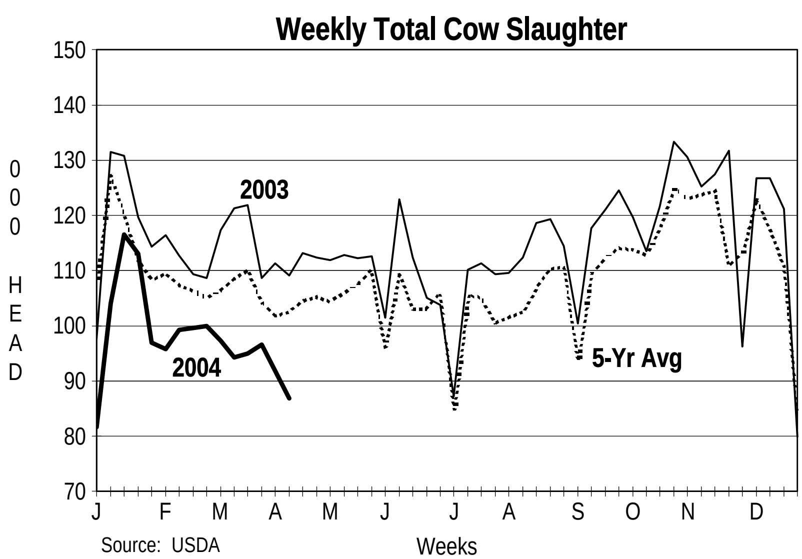


December 2004 corn futures are already building a weather premium into this summer's corn market. With the need for such a large corn crop, volatility will be significant during the planting and growing season. Higher corn prices are very possible this spring and summer. If so they will have a negative impact on fed cattle profitability and thus could have a significant impact on feeder cattle prices and to a lesser extent, calf prices in 2004.

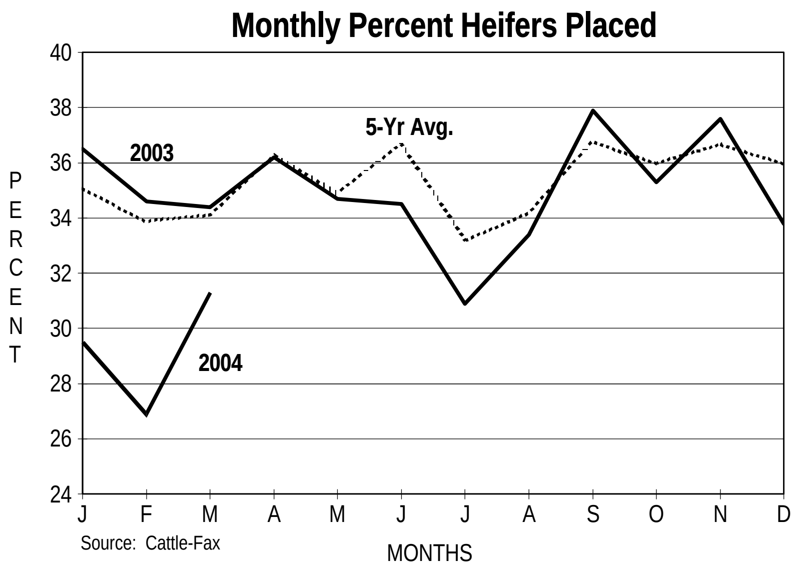
Cattle Numbers
&
Beef Supply


Total Cattle Inventory
140
120
100
80
60
MIL HEAD
30
40
50
60
70
80
90
00
YEARS
Source: USDA
2004-2007 Projected

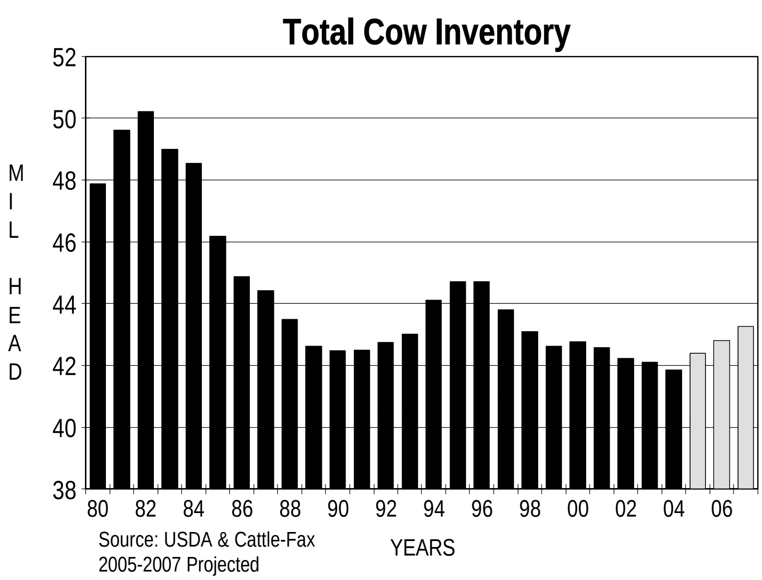

The Cattle Cycle
Cattle Prices
HI
LO
Cattle Prices
1979
1990-1991
2003-2005
1974-1976
1985-1986
1996-1998
TIME

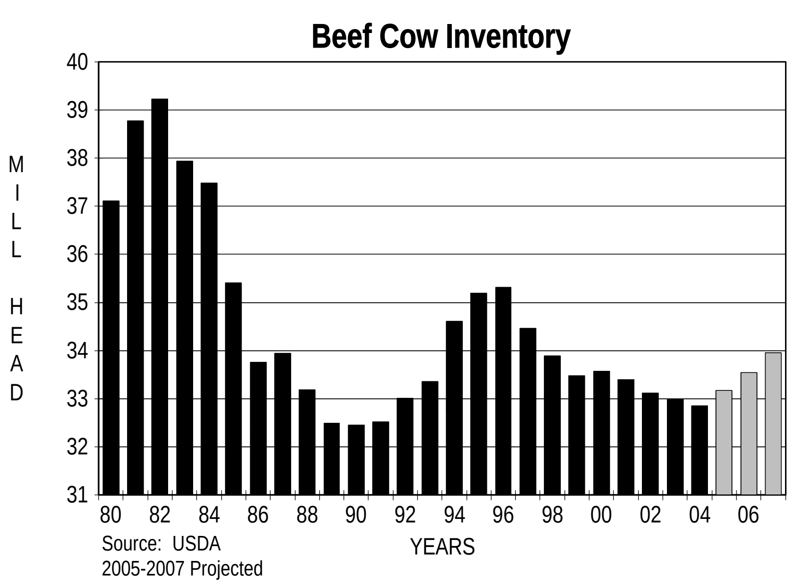

Weekly Total Cow Slaughter
150
140
130
120
110
100
90
80
70
000 HEAD
2003
2004
5-Yr Avg
J
F
M
A
M
J
J
A
S
O
N
D
Source: USDA
Weeks

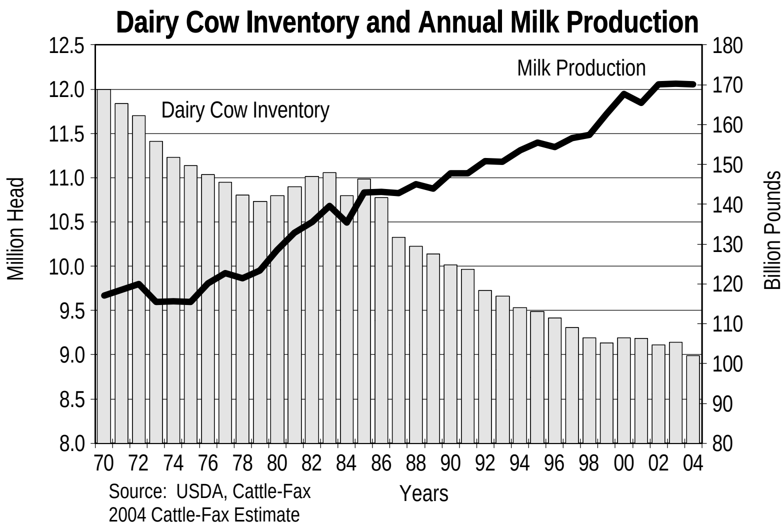
Notes


Monthly Percent Heifers Placed
40
38
36
34
32
30
28
26
24
PERCENT
5-Yr Avg.
2003
2004
J F M A M J J A S O N D
Source: Cattle-Fax
MONTHS

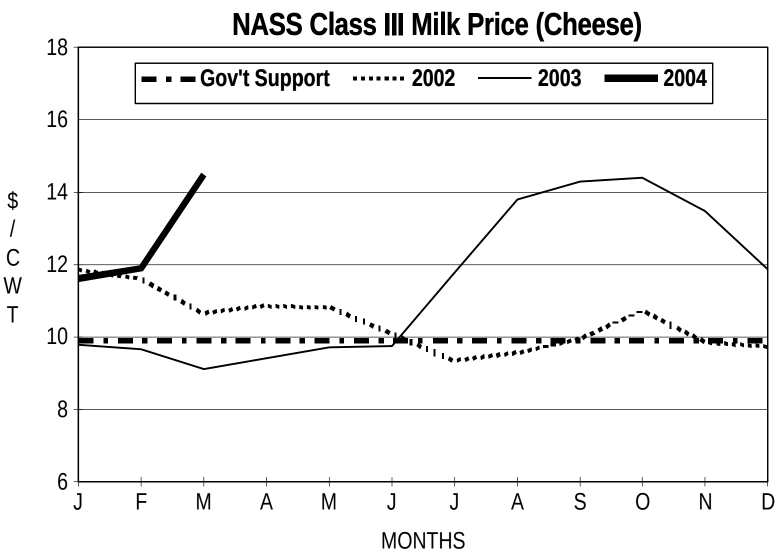
Notes


Total Cow Inventory
52
50
48
46
44
42
40
38
MIL HEAD
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: USDA & Cattle-Fax
2005-2007 Projected
YEARS

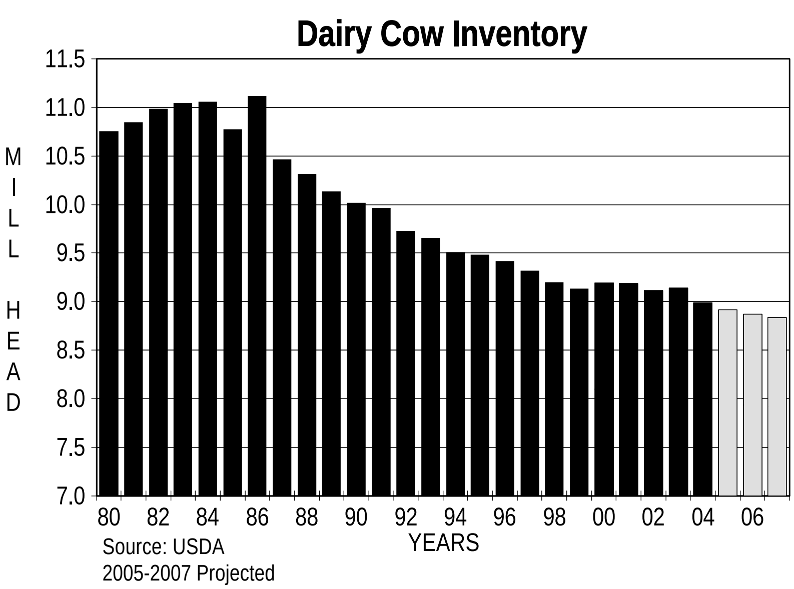

Beef Cow Inventory
40
39
38
37
36
35
34
33
32
31
MILL HEAD
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: USDA
2005-2007 Projected
YEARS



Dairy Cow Inventory and Annual Milk Production
Milk Production
Dairy Cow Inventory
Million Head
Billion Pounds
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
180
170
160
150
140
130
120
110
100
90
80
70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04
Years
Source: USDA, Cattle-Fax
2004 Cattle-Fax Estimate

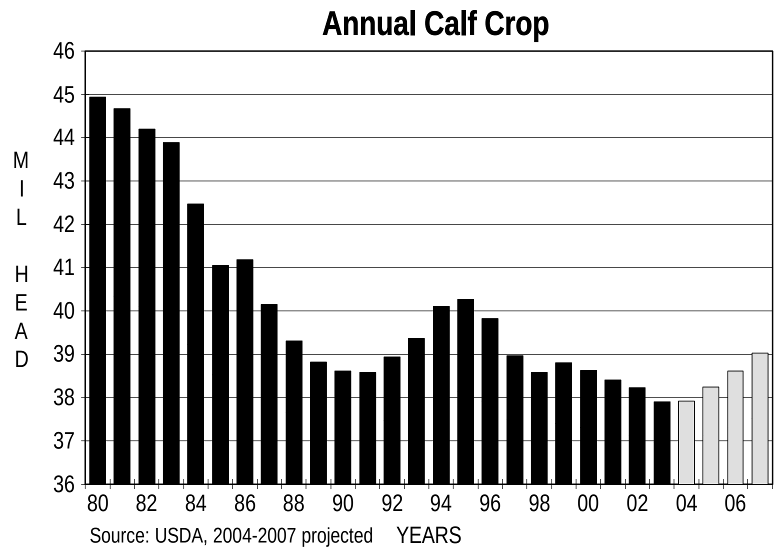


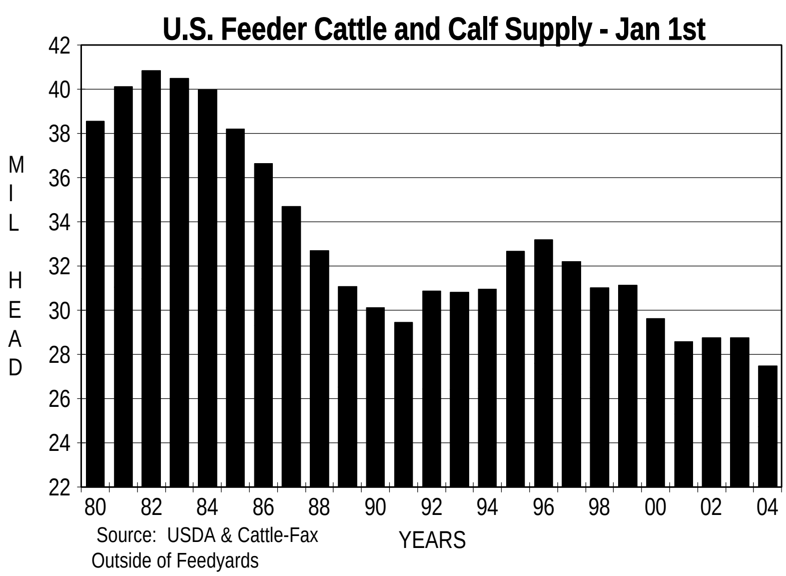
NASS Class III Milk Price (Cheese)
Gov't Support
2002
2003
2004
$/CWT
18
16
14
12
10
8
6
J F M A M J J A S O N D
MONTHS



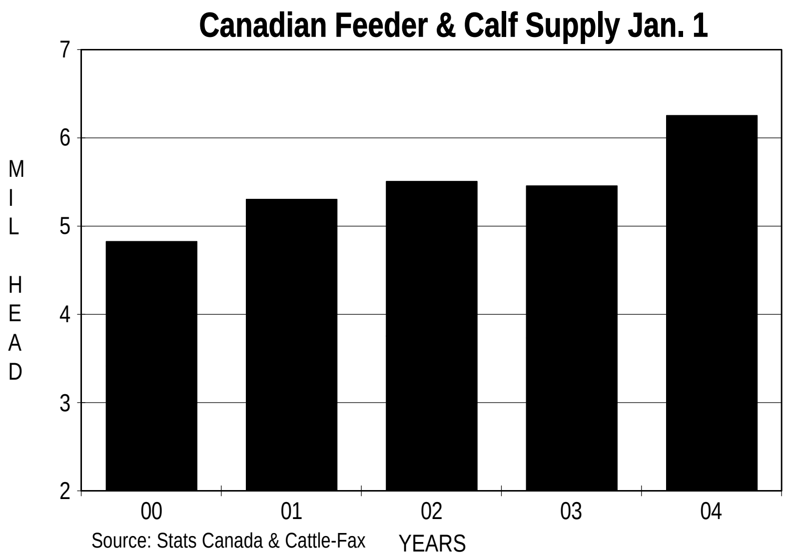
Dairy Cow Inventory
MILL HEAD
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
80 82 84 86 88 90 92 94 96 98 00 02 04 06
YEARS
Source: USDA
2005-2007 Projected

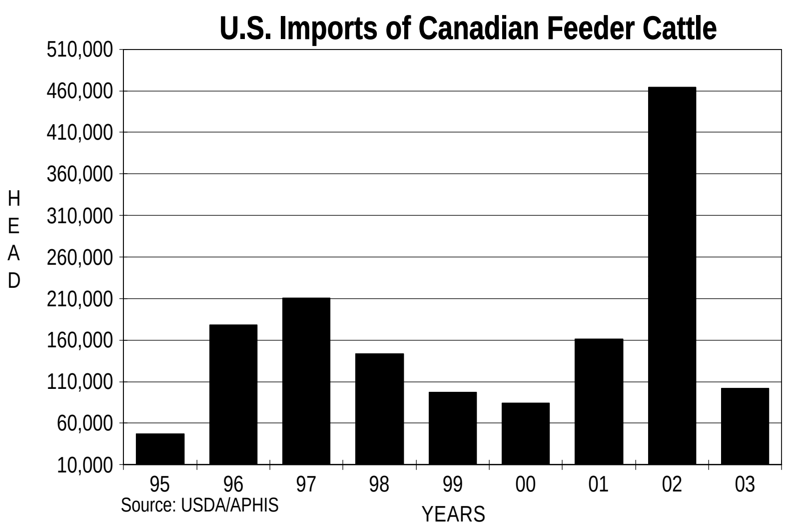
Notes

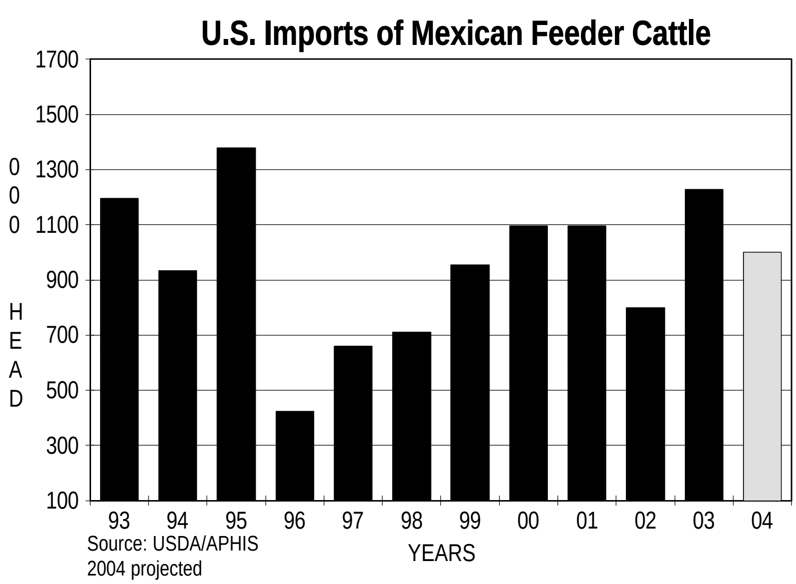

Annual Calf Crop
MIL HEAD
46
45
44
43
42
41
40
39
38
37
36
80
82
84
86
88
90
92
94
96
98
00
02
04
06
Source: USDA, 2004-2007 projected
YEARS


U.S. Feeder Cattle and Calf Supply - Jan 1st
MIL HEAD
42
40
38
36
34
32
30
28
26
24
22
80
82
84
86
88
90
92
94
96
98
00
02
04
Source: USDA & Cattle-Fax
Outside of Feedyards
YEARS

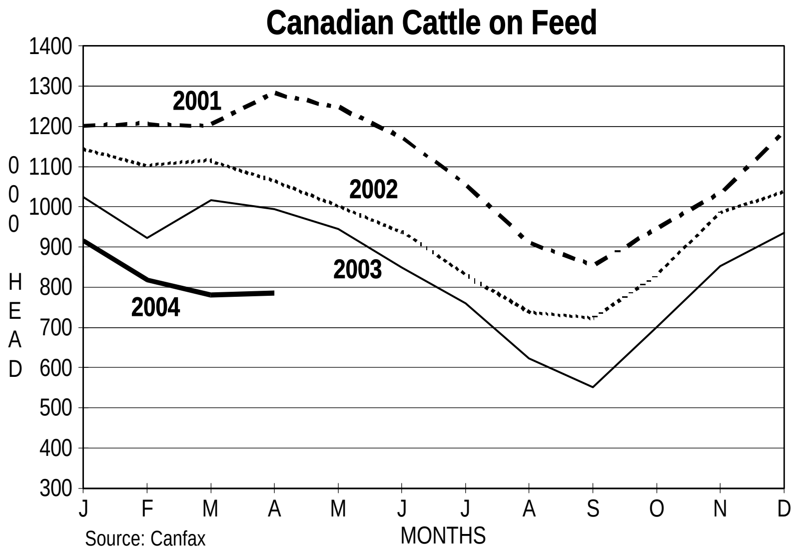
Notes

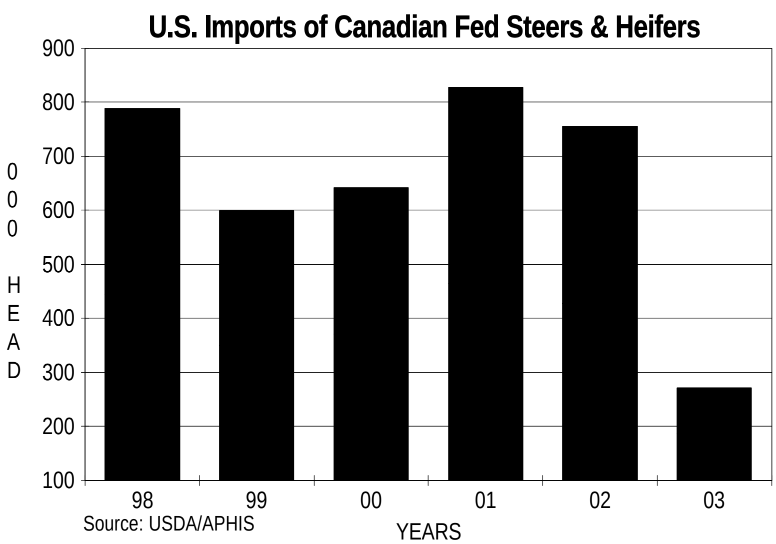

Canadian Feeder & Calf Supply Jan. 1
MIL HEAD
7
6
5
4
3
2
00
01
02
03
04
Source: Stats Canada & Cattle-Fax
YEARS

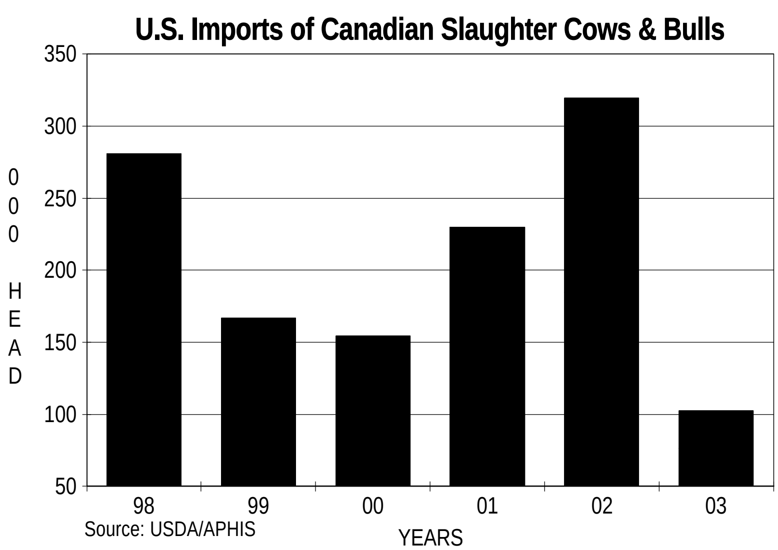

U.S. Imports of Canadian Feeder Cattle
HEAD
510,000
460,000
410,000
360,000
310,000
260,000
210,000
160,000
110,000
60,000
10,000
95
96
97
98
99
00
01
02
03
Source: USDA/APHIS
YEARS


U.S. Imports of Mexican Feeder Cattle
000 HEAD
1700
1500
1300
1100
900
700
500
300
100
93
94
95
96
97
98
99
00
01
02
03
04
Source: USDA/APHIS
2004 projected
YEARS

Notes

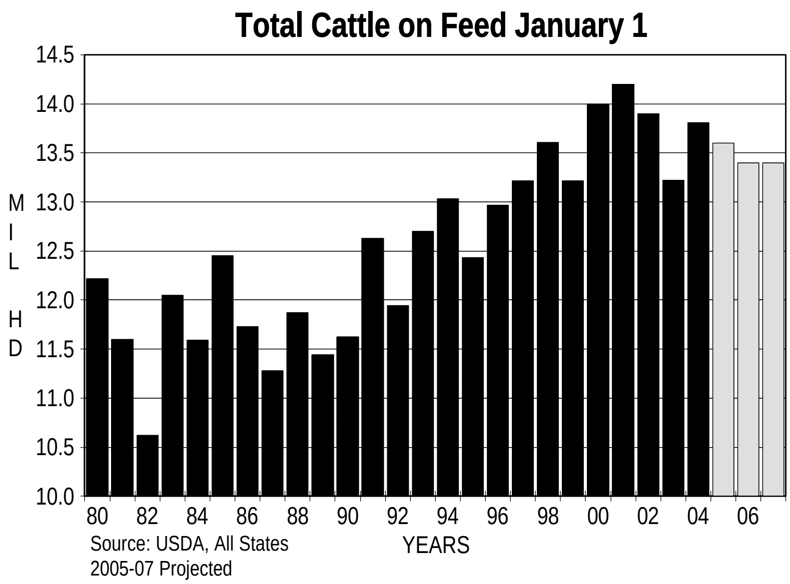

Canadian Cattle on Feed
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
000 HEAD
2001
2002
2003
2004
J F M A M J J A S O N D
MONTHS
Source: Canfax


U.S. Imports of Canadian Fed Steers & Heifers
900
800
700
600
500
400
300
200
100
000 HEAD
98 99 00 01 02 03
YEARS
Source: USDA/APHIS

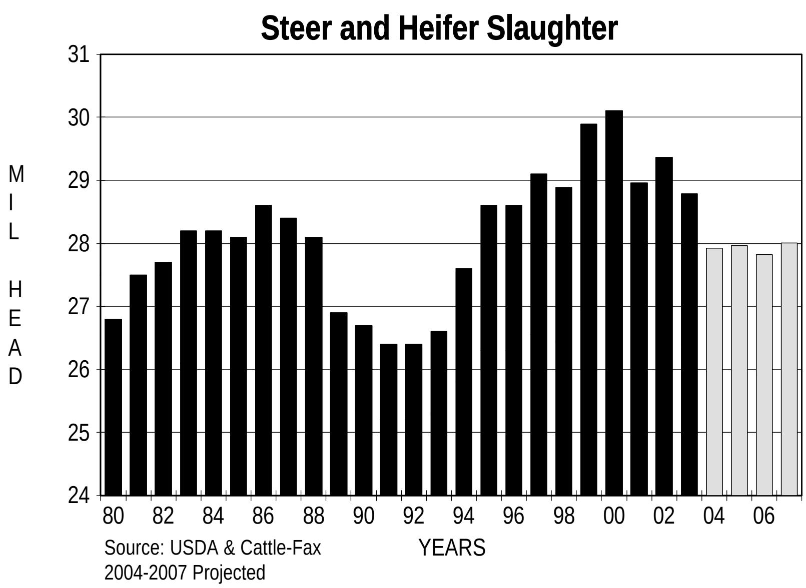

U.S. Imports of Canadian Slaughter Cows & Bulls
350
300
250
200
150
100
50
000 HEAD
98 99 00 01 02 03
YEARS
Source: USDA/APHIS

Notes

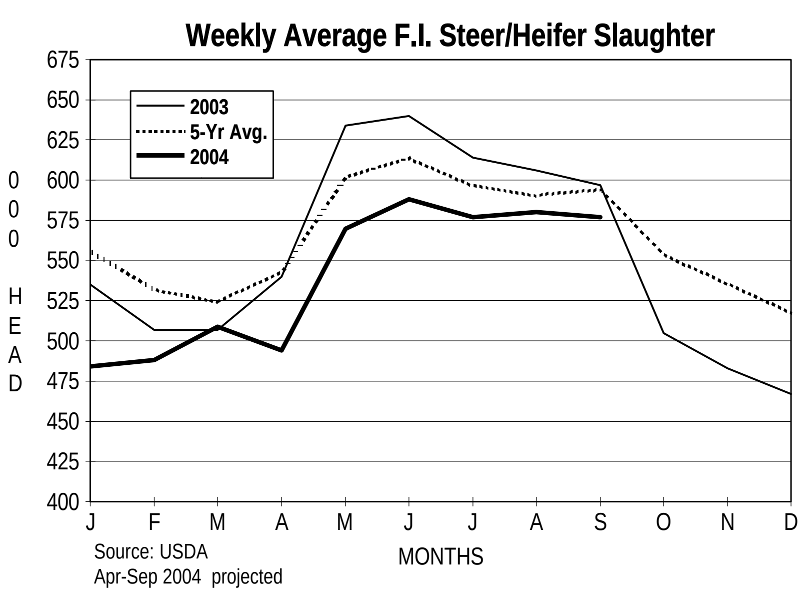
Notes



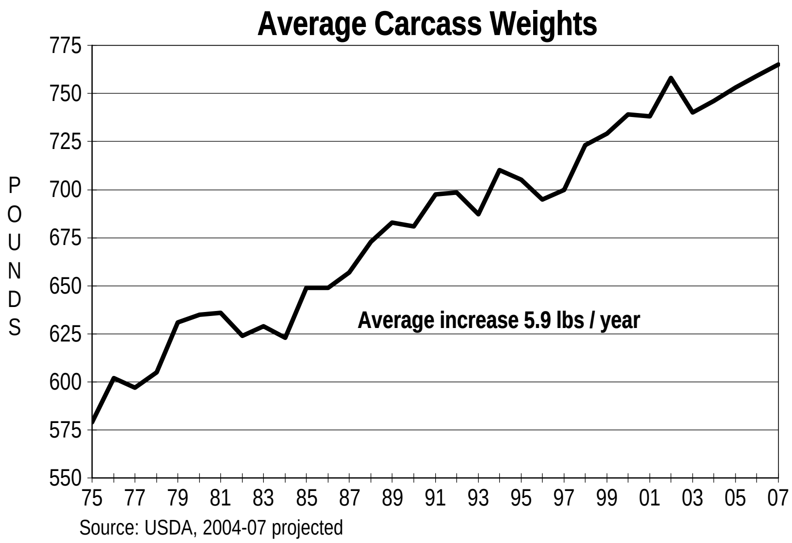
Total Cattle on Feed January 1
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
MIL HD
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: USDA, All States
2005-07 Projected
YEARS

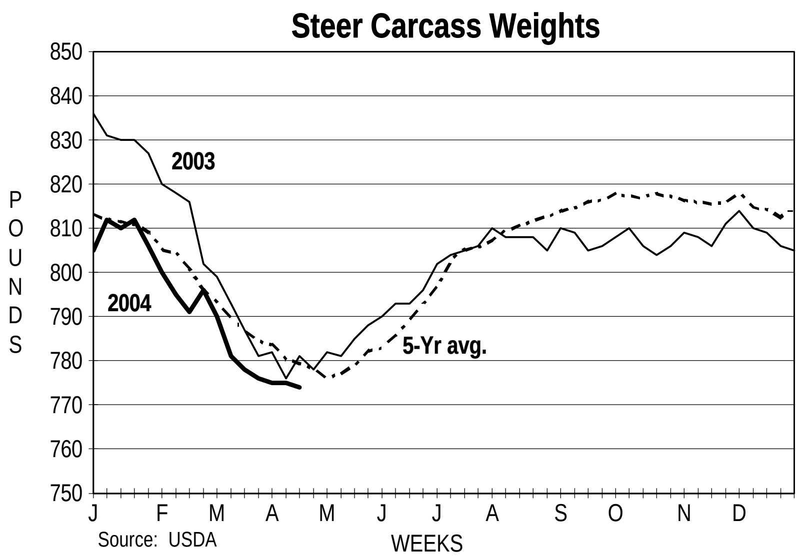


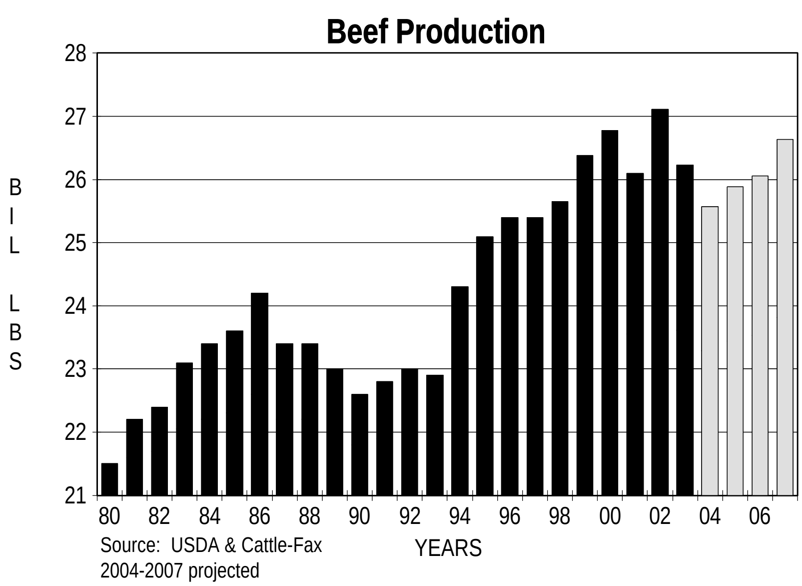
Steer and Heifer Slaughter
31
30
29
28
27
26
25
24
MIL HEAD
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: USDA & Cattle-Fax
2004-2007 Projected
YEARS



Weekly Average F.I. Steer/Heifer Slaughter
2003
5-Yr Avg.
2004
675
650
625
600
575
550
525
500
475
450
425
400
000 HEAD
J F M A M J J A S O N D
Source: USDA
Apr-Sep 2004 projected
MONTHS


Average Carcass Weights
P O U N D S
775
750
725
700
675
650
625
600
575
550
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07
Average increase 5.9 lbs / year
Source: USDA, 2004-07 projected

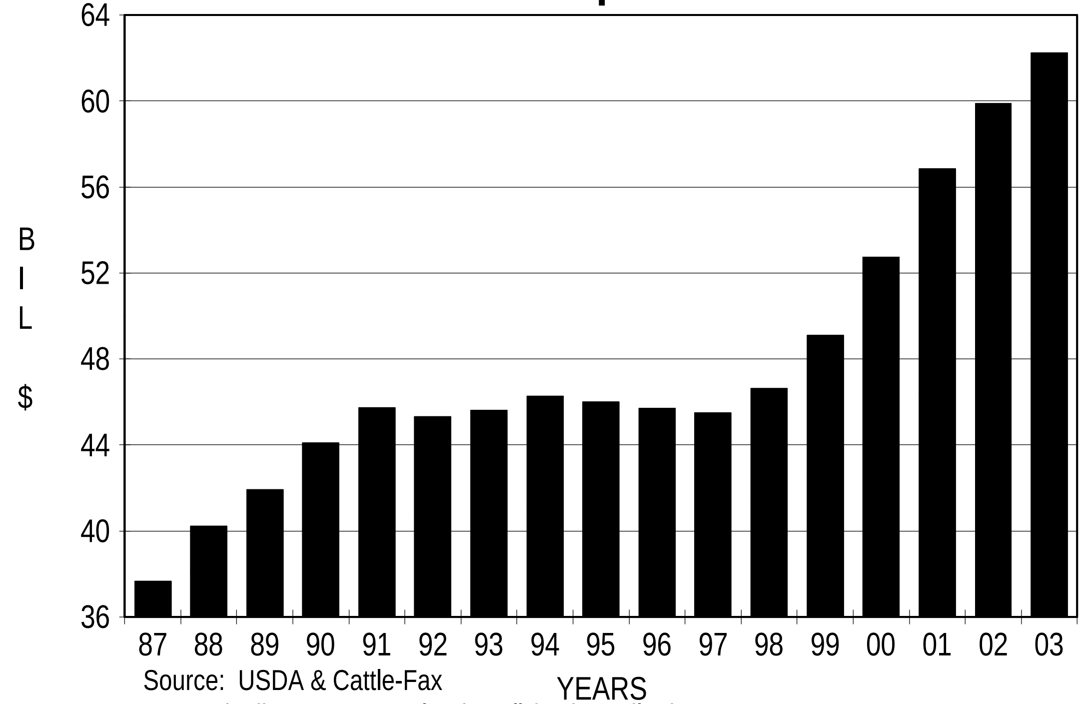

Steer Carcass Weights
P O U N D S
850
840
830
820
810
800
790
780
770
760
750
2003
2004
5-Yr avg.
J F M A M J J A S O N D
Source: USDA
WEEKS


Beef Production
B I L
L B S
28
27
26
25
24
23
22
21
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: USDA & Cattle-Fax
2004-2007 projected
YEARS

Notes

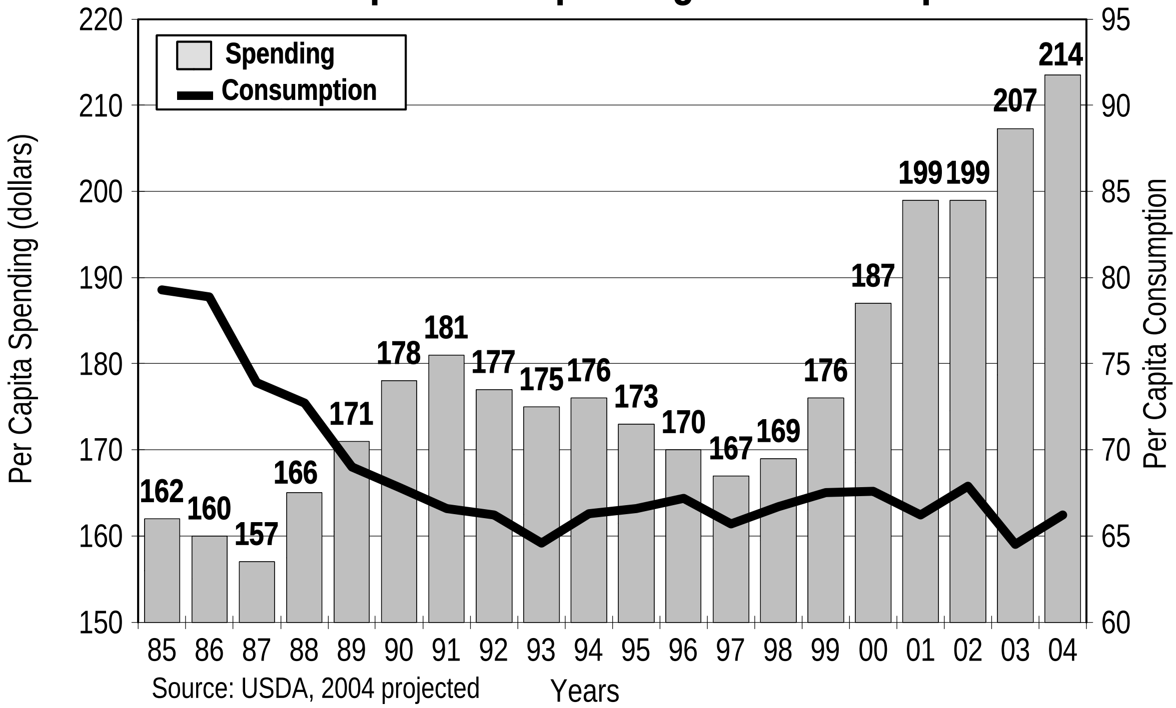
Demand
&
Trade

U.S. Consumer Expenditures on Beef

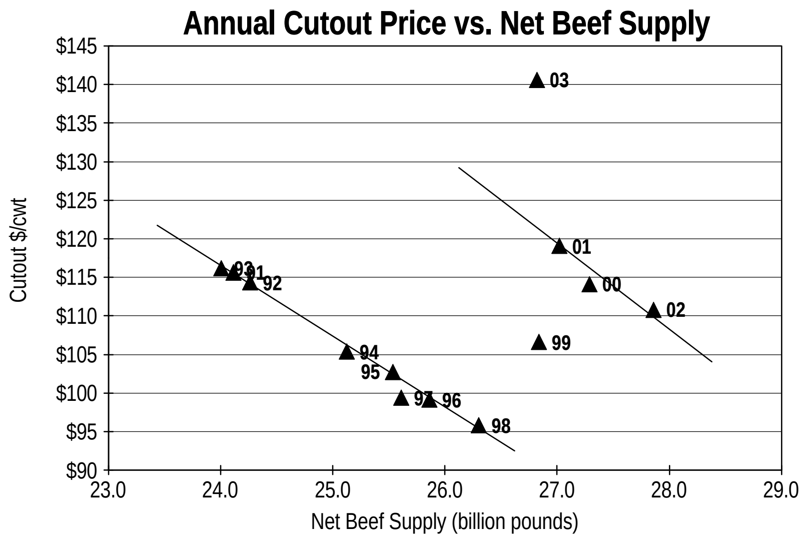


Source: USDA & Cattle-Fax
Domestic disapperance valued at all-fresh retail price

Per Capita Beef Spending and Consumption



Source: USDA, 2004 projected

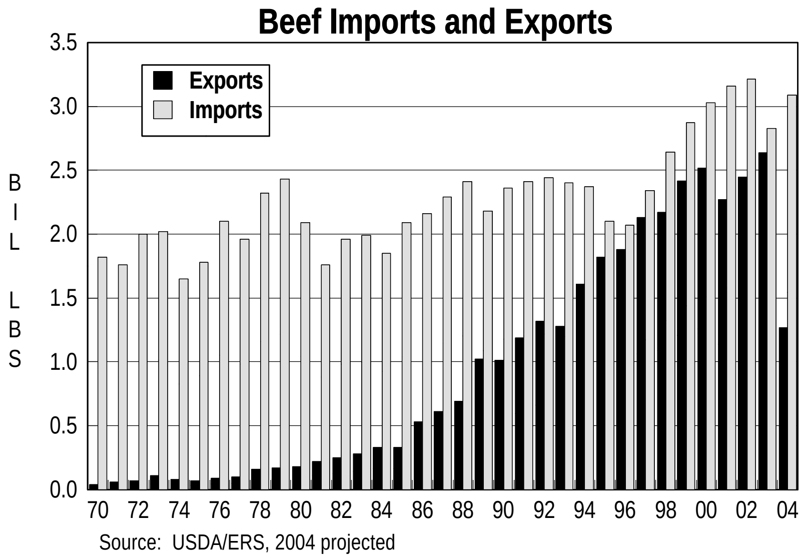


Beef Primal Values

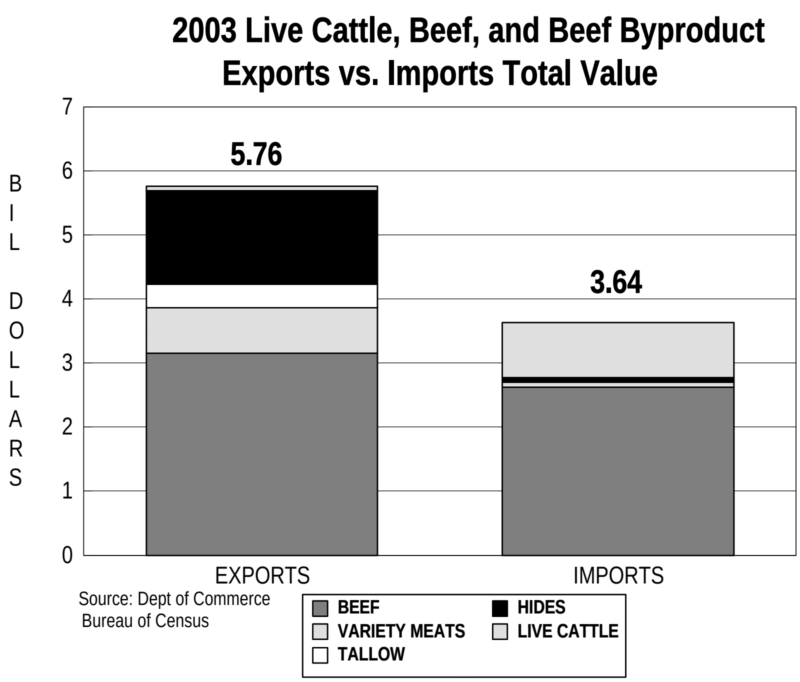
	1992	1998	
Rib	1.58	1.59	1%
Chuck	.93	.68	27%
Round	1.20	.88	26%
Loin	1.54	1.58	3%

Beef Primal Values

	1998	2003	
Rib	1.59	2.37	49%
Chuck	.68	1.08	59%
Round	.88	1.16	32%
Loin	1.58	2.15	36%

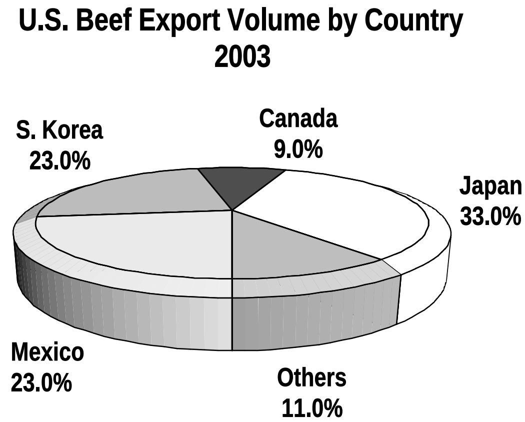


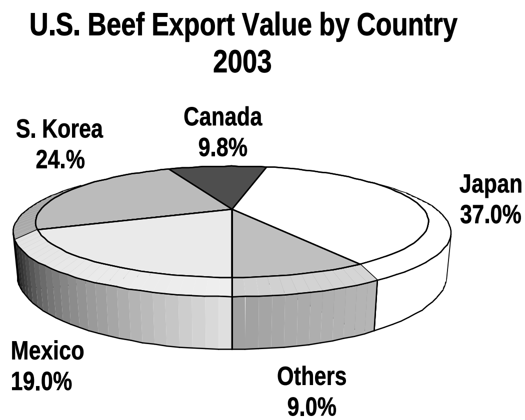
Beef Imports and Exports
Exports
Imports
BIL LBS
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04
Source: USDA/ERS, 2004 projected

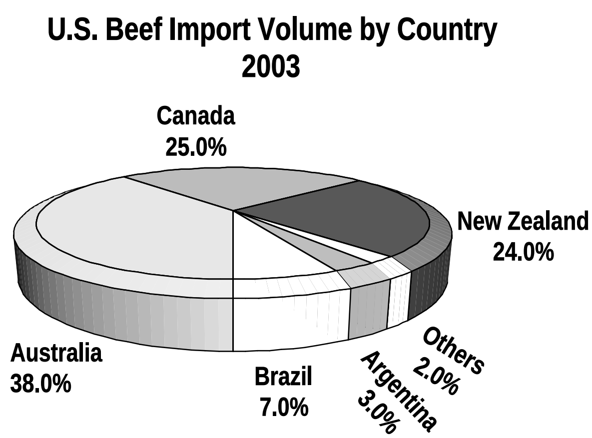


2003 Live Cattle, Beef, and Beef Byproduct Exports vs. Imports Total Value
BIL DOLLARS
7
6
5
4
3
2
1
0
5.76
3.64
EXPORTS
IMPORTS
Source: Dept of Commerce Bureau of Census
BEEF
HIDES
VARIETY MEATS
LIVE CATTLE
TALLOW

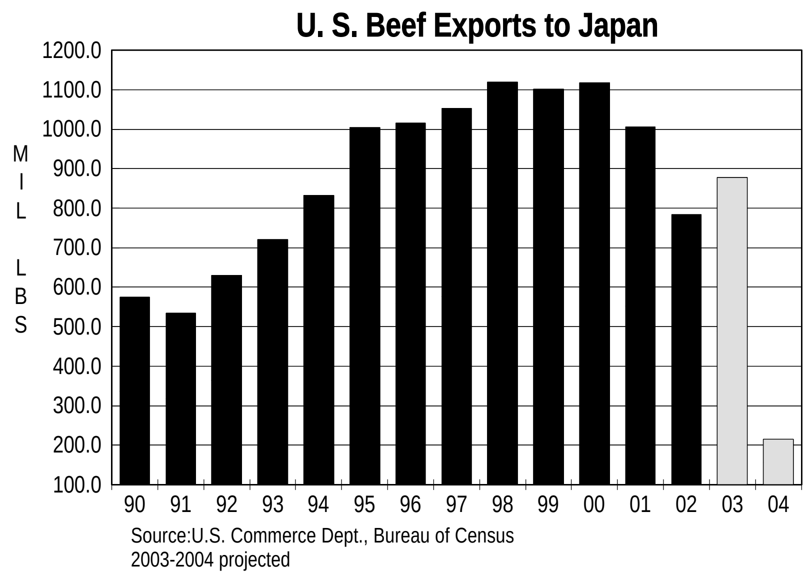
Notes

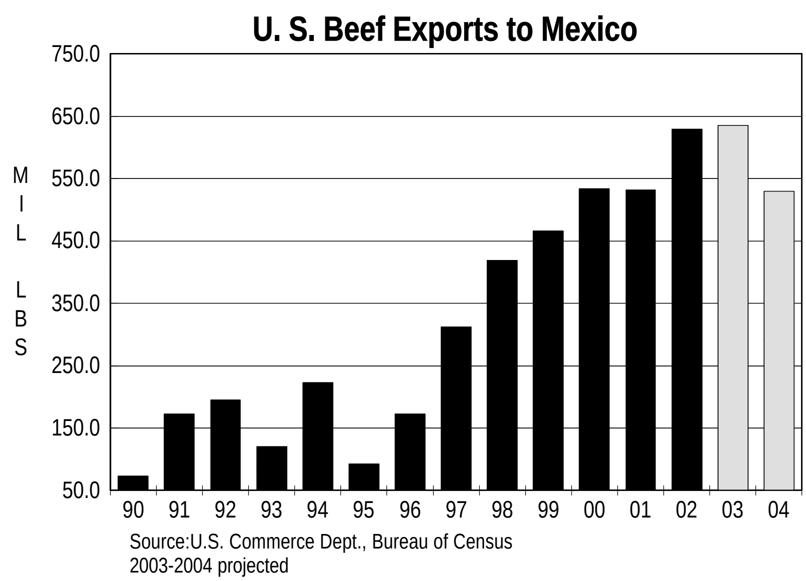

U.S. Beef Export Volume by Country
2003
S. Korea
23.0%
Canada
9.0%
Japan
33.0%
Mexico
23.0%
Others
11.0%

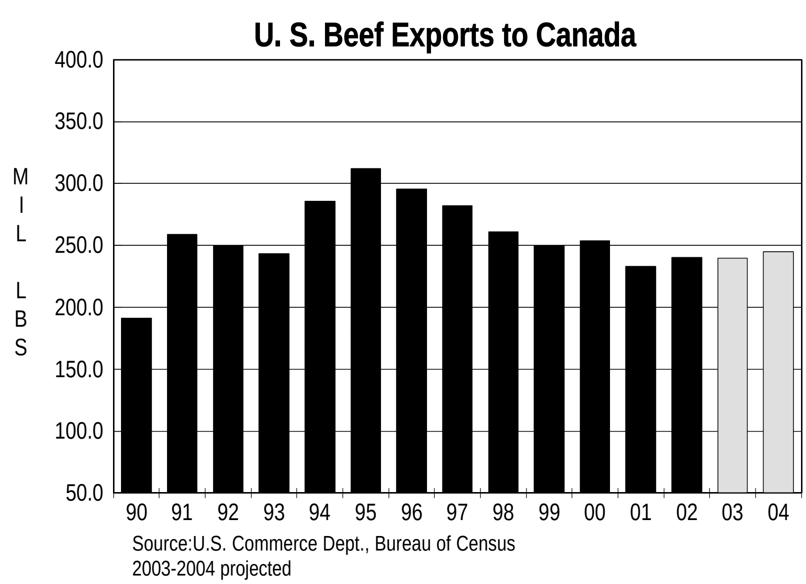

U.S. Beef Export Value by Country
2003
S. Korea
24.%
Canada
9.8%
Japan
37.0%
Mexico
19.0%
Others
9.0%


U.S. Beef Import Volume by Country
2003
Canada
25.0%
New Zealand
24.0%
Australia
38.0%
Brazil
7.0%
Argentina
3.0%
Others
2.0%

Notes


U. S. Beef Exports to Japan
M
I
L
L
B
S
1200.0
1100.0
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

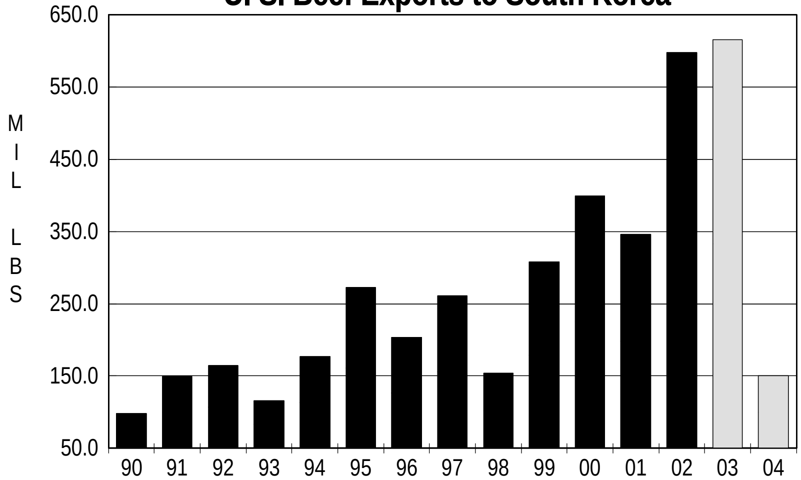

U. S. Beef Exports to Mexico
M
I
L
L
B
S
750.0
650.0
550.0
450.0
350.0
250.0
150.0
50.0
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected


U. S. Beef Exports to Canada
M
I
L
L
B
S
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

Notes

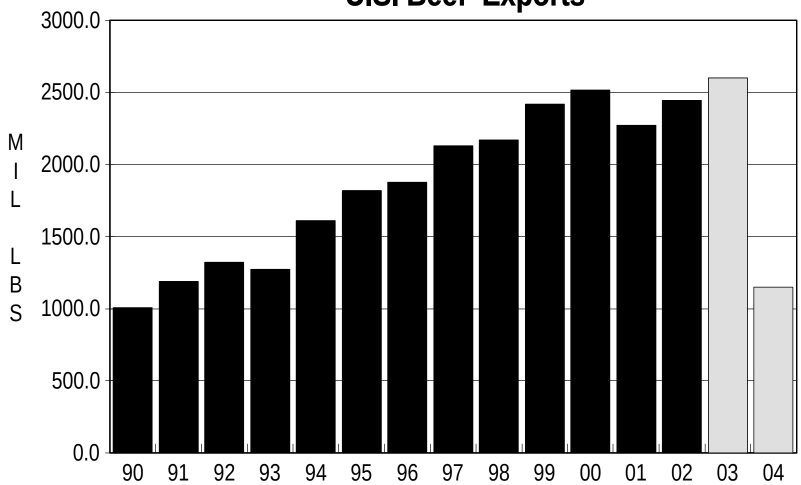
Notes

U. S. Beef Exports to South Korea



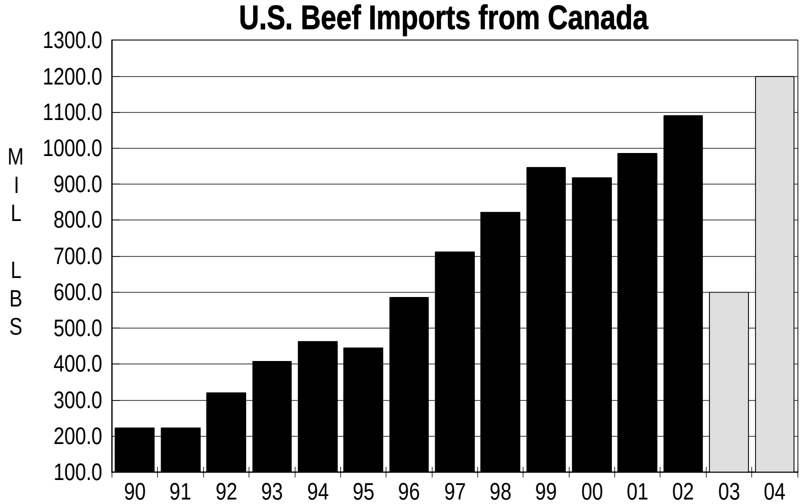
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

U.S. Beef Exports



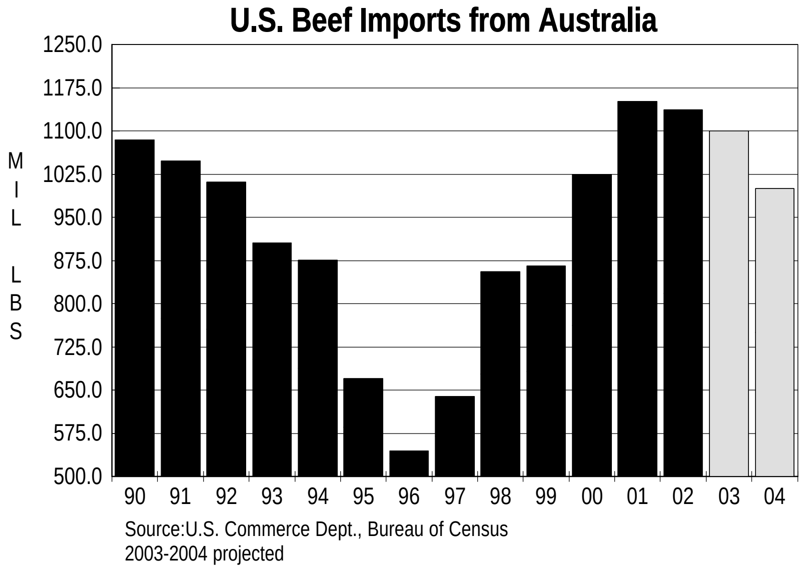
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

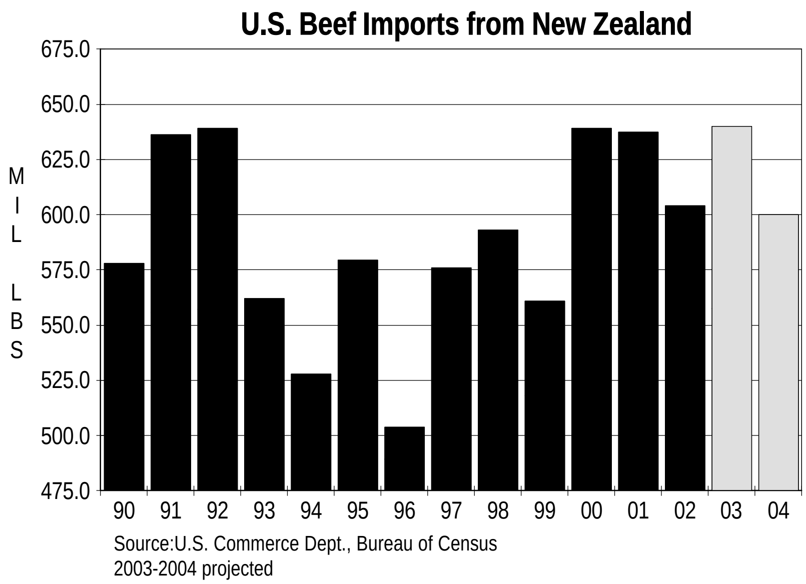
U.S. Beef Imports from Canada

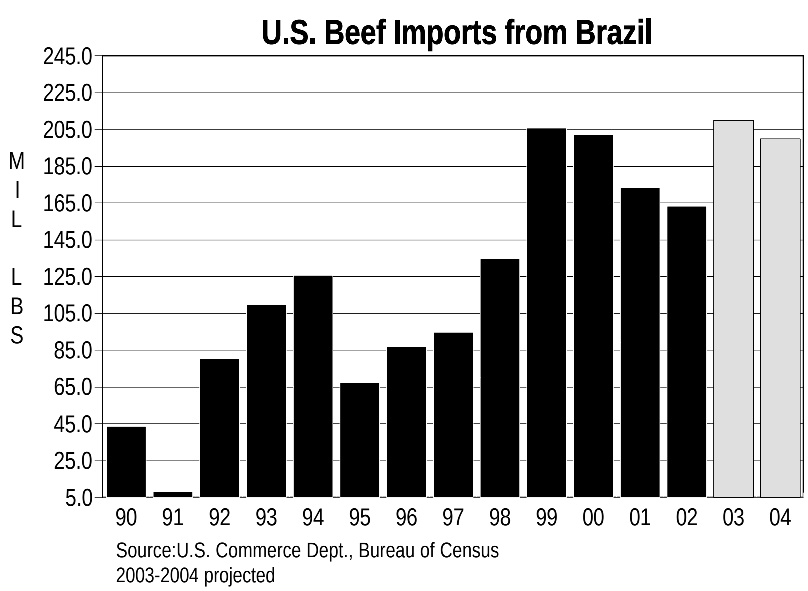


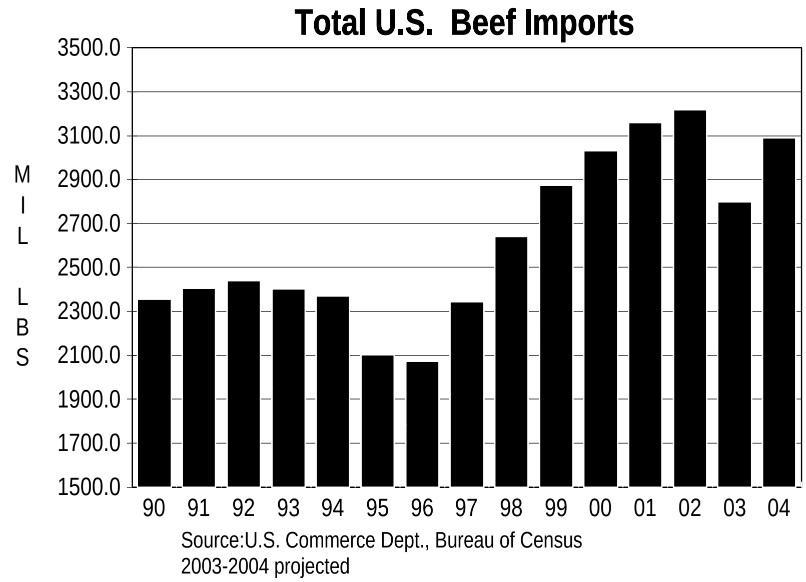
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

Notes

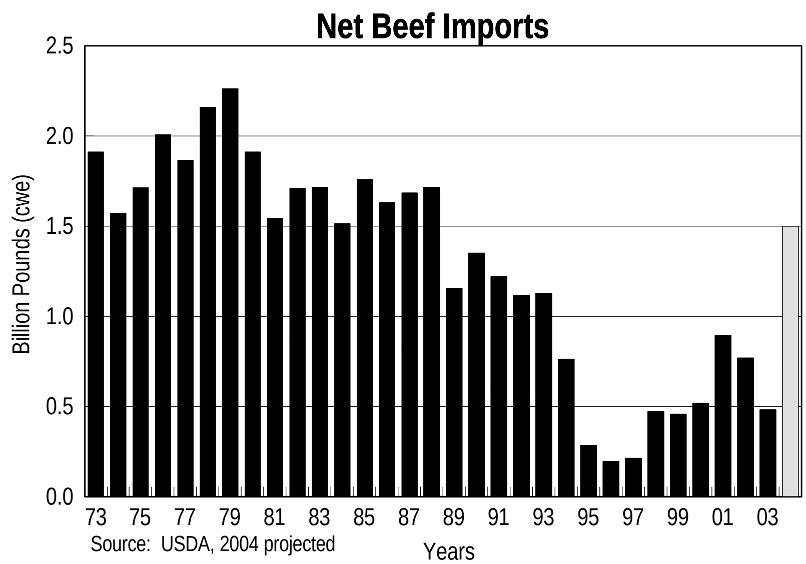

U.S. Beef Imports from Australia
1250.0
1175.0
1100.0
1025.0
950.0
875.0
800.0
725.0
650.0
575.0
500.0
M I L L B S
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected


U.S. Beef Imports from New Zealand
675.0
650.0
625.0
600.0
575.0
550.0
525.0
500.0
475.0
M I L L B S
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected

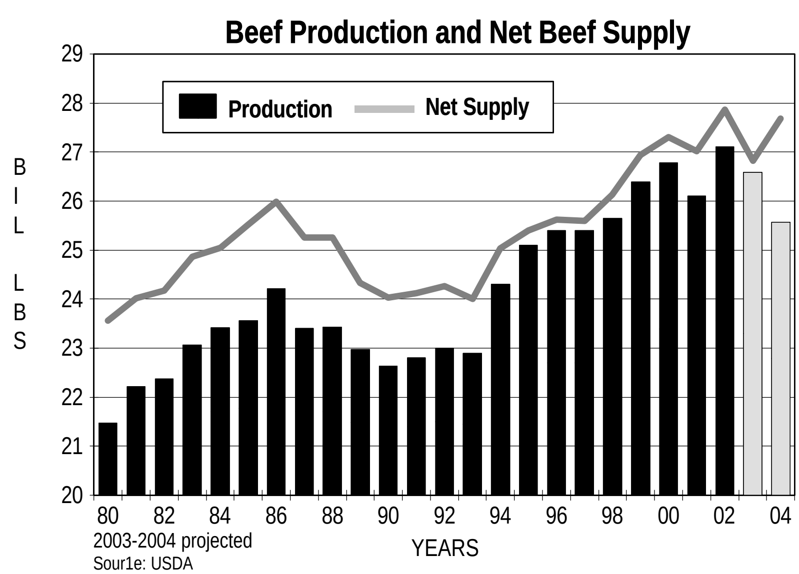

U.S. Beef Imports from Brazil
245.0
225.0
205.0
185.0
165.0
145.0
125.0
105.0
85.0
65.0
45.0
25.0
5.0
M I L L B S
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected



Total U.S. Beef Imports
MIL LBS
3500.0
3300.0
3100.0
2900.0
2700.0
2500.0
2300.0
2100.0
1900.0
1700.0
1500.0
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source:U.S. Commerce Dept., Bureau of Census
2003-2004 projected



Net Beef Imports
Billion Pounds (cwe)
2.5
2.0
1.5
1.0
0.5
0.0
73 75 77 79 81 83 85 87 89 91 93 95 97 99 01 03
Source: USDA, 2004 projected
Years

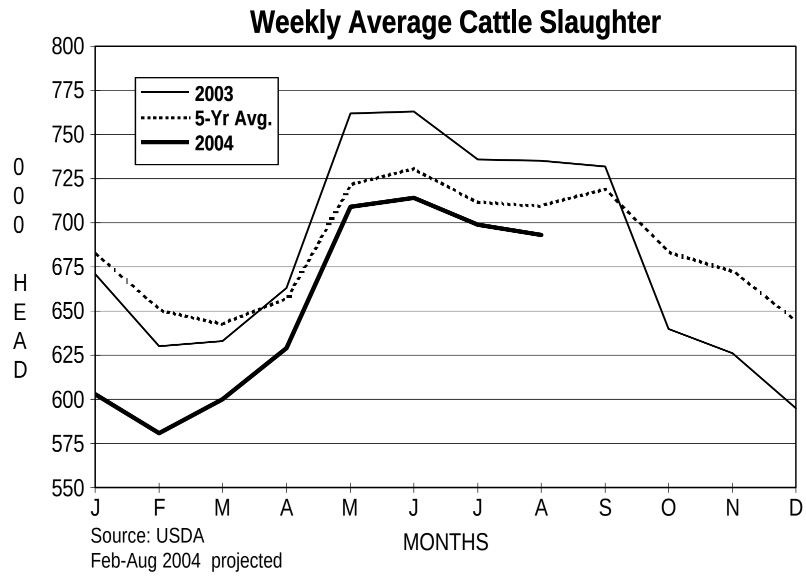


Beef Production and Net Beef Supply
Production
Net Supply
BIL LBS
29
28
27
26
25
24
23
22
21
20
80 82 84 86 88 90 92 94 96 98 00 02 04
2003-2004 projected
Sour1e: USDA
YEARS

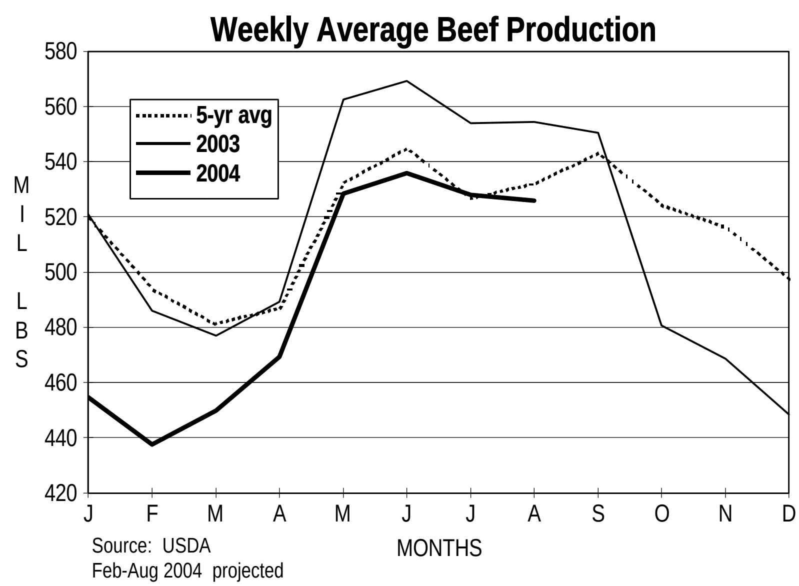
Notes

2004 Outlook

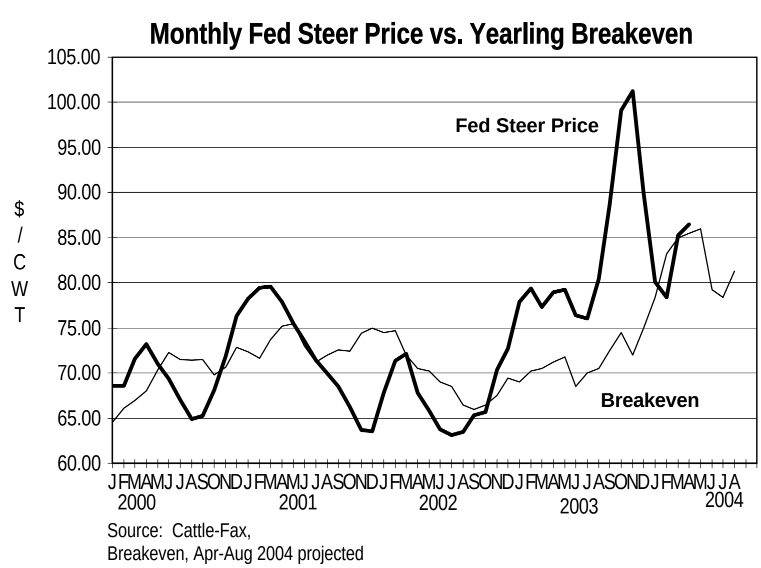
Notes



Weekly Average Cattle Slaughter
000 HEAD
800
775
750
725
700
675
650
625
600
575
550
2003
5-Yr Avg.
2004
J F M A M J J A S O N D
MONTHS
Source: USDA
Feb-Aug 2004 projected

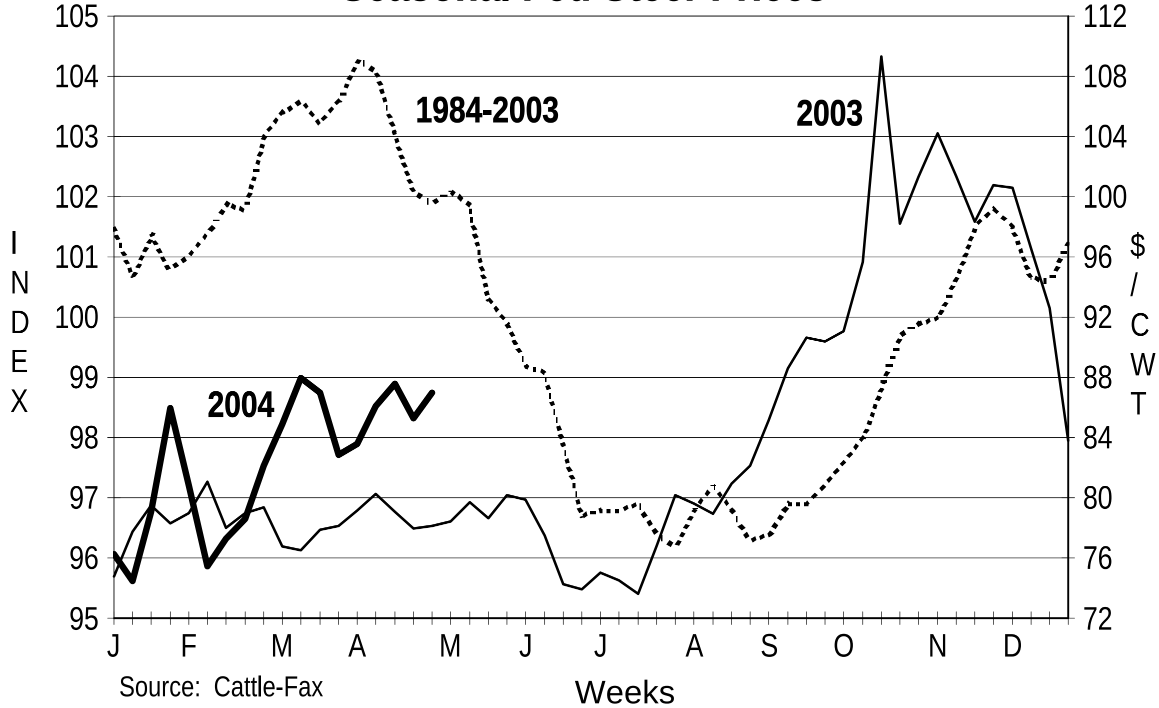


Weekly Average Beef Production
MIL LBS
580
560
540
520
500
480
460
440
420
5-yr avg
2003
2004
J F M A M J J A S O N D
MONTHS
Source: USDA
Feb-Aug 2004 projected

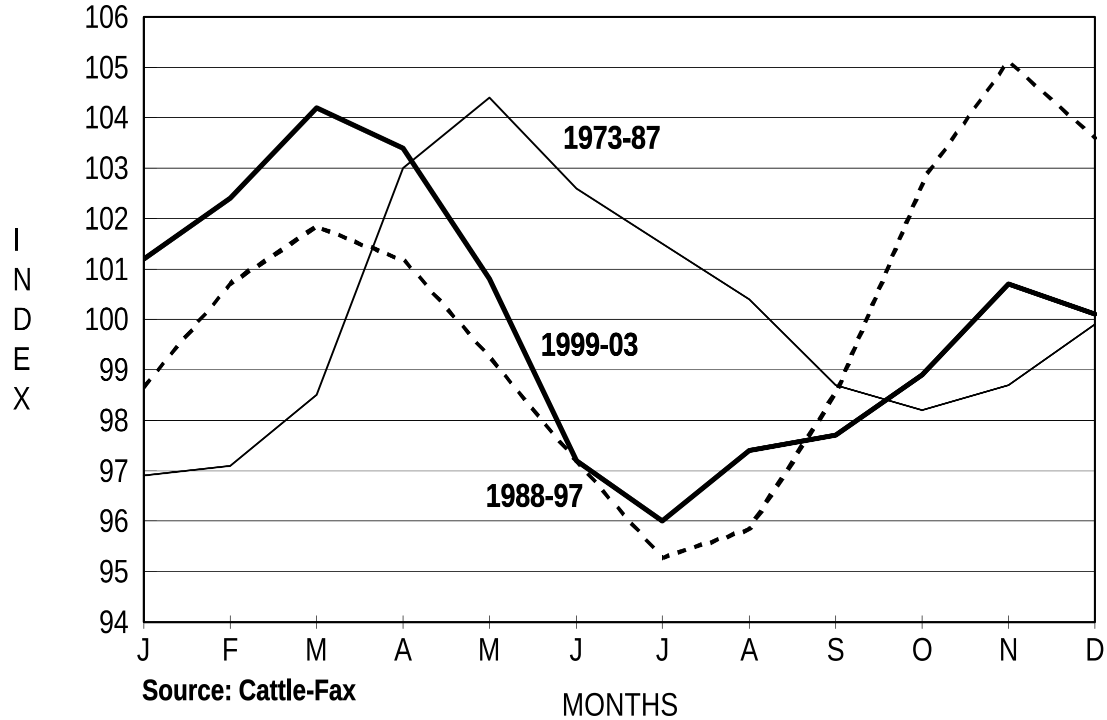


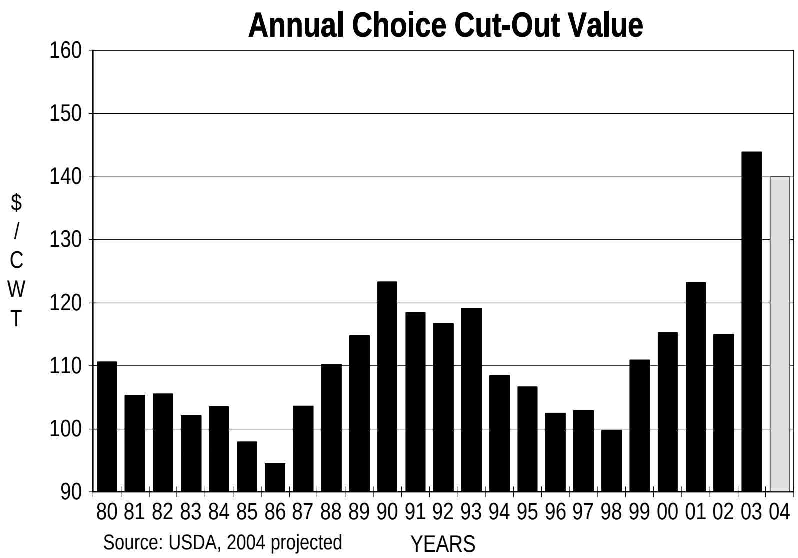
Monthly Fed Steer Price vs. Yearling Breakeven
$/CWT
105.00
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
Fed Steer Price
Breakeven
2000
2001
2002
2003
2004
Source: Cattle-Fax,
Breakeven, Apr-Aug 2004 projected

Seasonal Fed Steer Prices

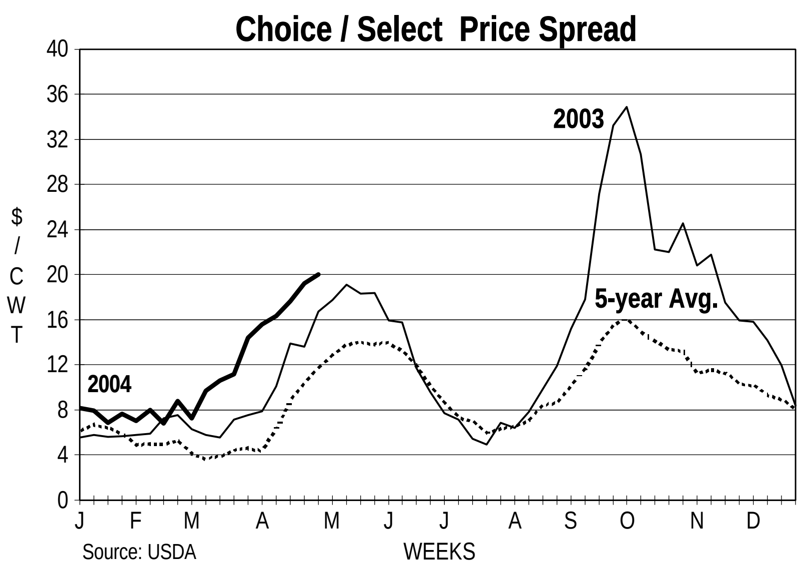


Seasonal Fed Cattle Prices

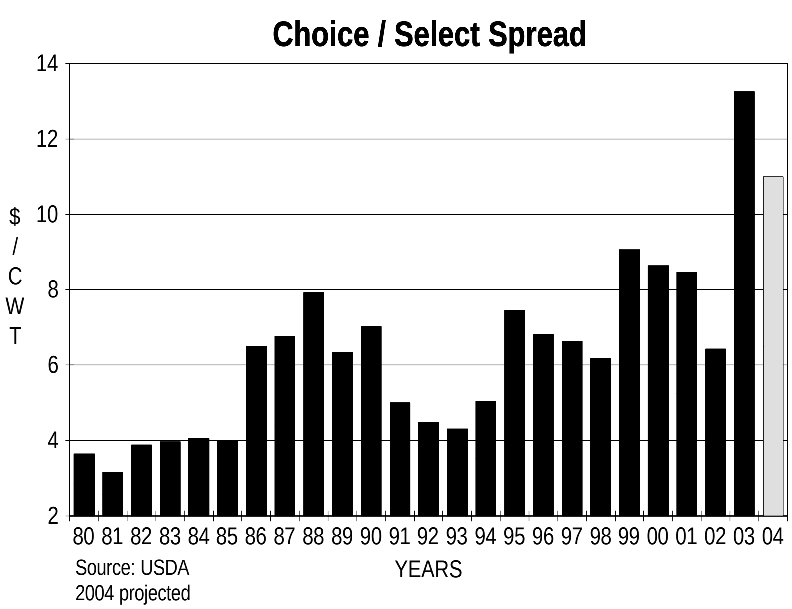




Annual Choice Cut-Out Value
160
150
140
130
120
110
100
90
$/CWT
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source: USDA, 2004 projected
YEARS

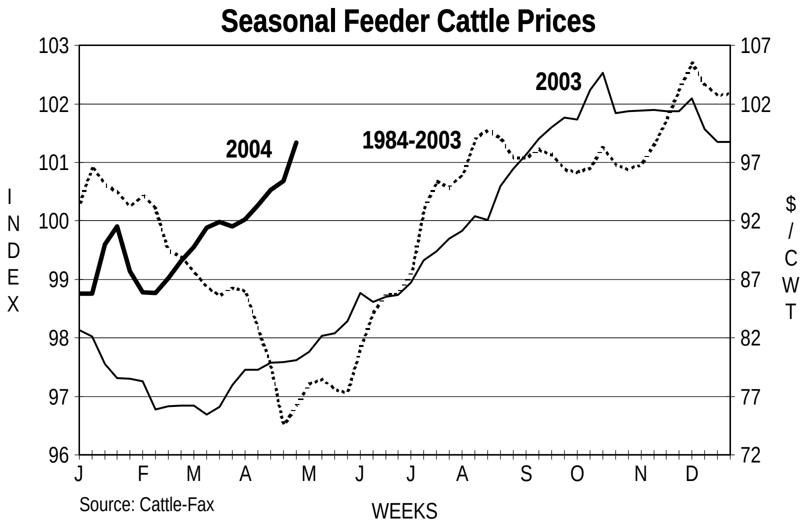


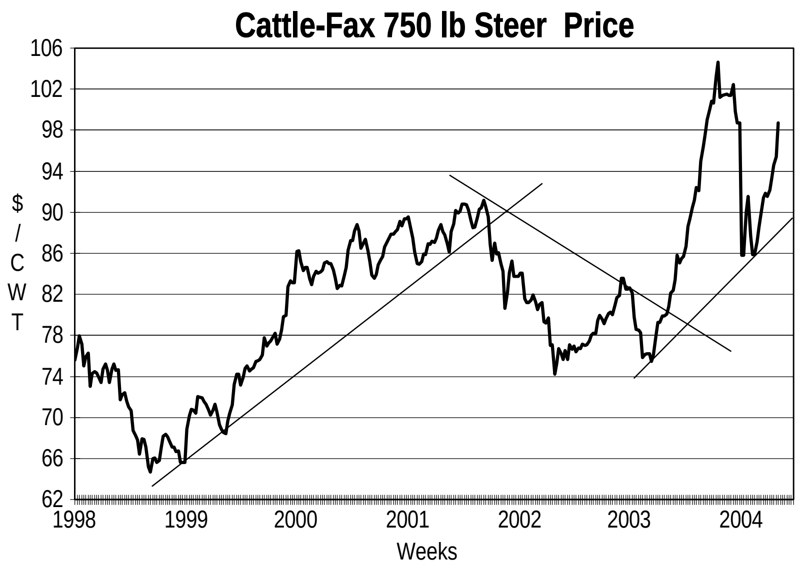
Choice / Select Price Spread
40
36
32
28
24
20
16
12
8
4
0
$/CWT
2003
5-year Avg.
2004
J F M A M J J A S O N D
Source: USDA
WEEKS

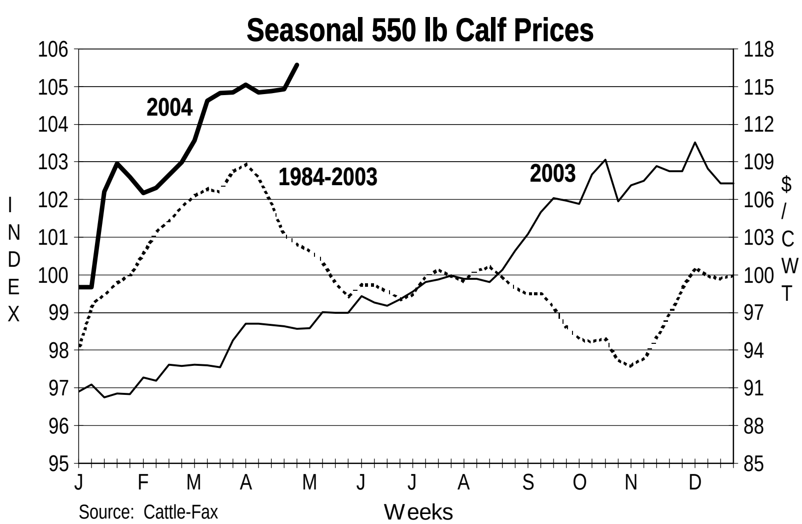


Choice / Select Spread
14
12
10
8
6
4
2
$/CWT
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source: USDA
2004 projected
YEARS

Notes


Seasonal Feeder Cattle Prices
INDEX
$/CWT
2004
1984-2003
2003
J F M A M J J A S O N D
Source: Cattle-Fax
WEEKS


Cattle-Fax 750 lb Steer Price
$/CWT
1998 1999 2000 2001 2002 2003 2004
Weeks


Seasonal 550 lb Calf Prices
INDEX
$/CWT
2004
1984-2003
2003
J F M A M J J A S O N D
Source: Cattle-Fax
Weeks

Notes

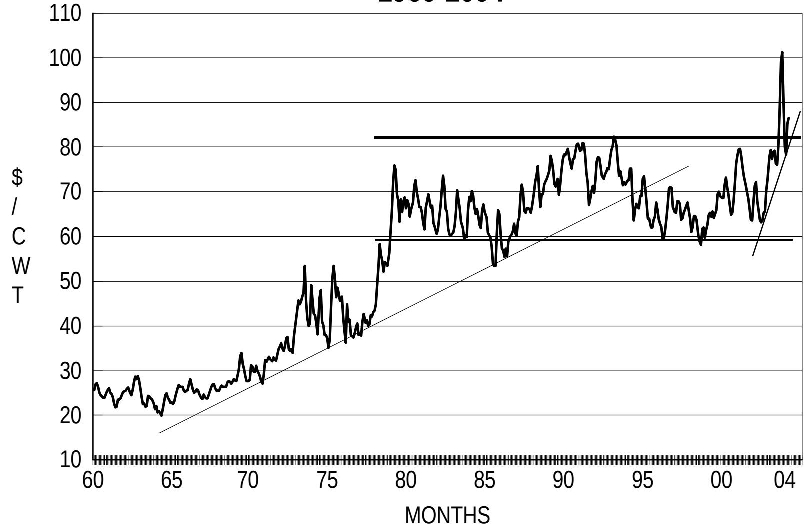
Breakeven Purchase Price
550 lb Steer

Fed Price	Corn Price $/bu 2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
60.00	70.25	67.23	64.21	61.19	58.17	55.15	52.13	49.11
62.00	74.00	70.98	67.96	64.94	61.92	58.90	55.88	52.86
64.00	77.75	74.73	71.71	68.69	65.67	62.65	59.63	56.61
66.00	81.50	78.48	75.46	72.44	69.42	66.40	63.38	60.36
68.00	85.25	82.23	79.21	76.19	73.17	70.15	67.13	64.11
70.00	89.00	85.98	82.96	79.94	76.92	73.90	70.88	67.86
72.00	92.75	89.73	86.71	83.69	80.67	77.65	74.63	71.61
74.00	96.50	93.48	90.46	87.44	84.42	81.40	78.38	75.36
76.00	100.25	97.23	94.21	91.19	88.17	85.15	82.13	79.11
78.00	104.00	100.98	97.96	94.94	91.92	88.90	85.88	82.86
80.00	107.75	104.73	101.71	98.69	95.67	92.65	89.63	86.61
82.00	111.50	108.48	105.46	102.44	99.42	96.40	93.38	90.36
84.00	115.25	112.23	109.21	106.19	103.17	100.15	97.13	94.11
86.00	119.00	115.98	112.96	109.94	106.92	103.90	100.88	97.86
88.00	122.75	119.73	116.71	113.69	110.67	107.65	104.63	101.61
90.00	126.50	123.48	120.46	117.44	114.42	111.40	108.38	105.36
92.00	130.25	127.23	124.21	121.19	118.17	115.15	112.13	109.11
94.00	134.00	130.98	127.96	124.94	121.92	118.90	115.88	112.86
96.00	137.75	134.73	131.71	128.69	125.67	122.65	119.63	116.61
98.00	141.50	138.48	135.46	132.44	129.42	126.40	123.38	120.36

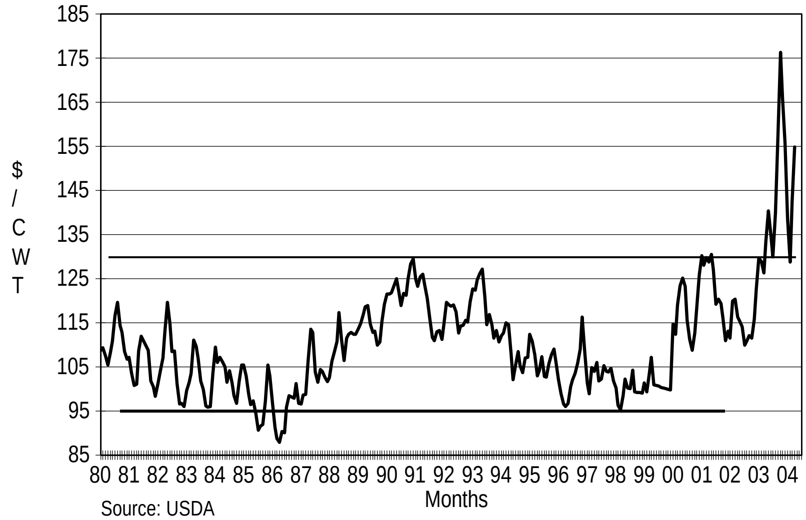
Breakeven Purchase Price
750 lb Steer

	Corn Price $/bu							
Fed Price	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
60.00	64.68	63.03	61.38	59.73	58.08	56.43	54.78	53.13
62.00	67.63	65.98	64.33	62.68	61.03	59.38	57.73	56.08
64.00	70.58	68.93	67.28	65.63	63.98	62.33	60.68	59.03
66.00	73.53	71.88	70.23	68.58	66.93	65.28	63.63	61.98
68.00	76.48	74.83	73.18	71.53	69.88	68.23	66.58	64.93
70.00	79.43	77.78	76.13	74.48	72.83	71.18	69.53	67.88
72.00	82.38	80.73	79.08	77.43	75.78	74.13	72.48	70.83
74.00	85.33	83.68	82.03	80.38	78.73	77.08	75.43	73.78
76.00	88.28	86.63	84.98	83.33	81.68	80.03	78.38	76.73
78.00	91.23	89.58	87.93	86.28	84.63	82.98	81.33	79.68
80.00	94.18	92.53	90.88	89.23	87.58	85.93	84.28	82.63
82.00	97.13	95.48	93.83	92.18	90.53	88.88	87.23	85.58
84.00	100.08	98.43	96.78	95.13	93.48	91.83	90.18	88.53
86.00	103.03	101.38	99.73	98.08	96.43	94.78	93.13	91.48
88.00	105.98	104.33	102.68	101.03	99.38	97.73	96.08	94.43
90.00	108.93	107.28	105.63	103.98	102.33	100.68	99.03	97.38
92.00	111.88	110.23	108.58	106.93	105.28	103.63	101.98	100.33
94.00	114.83	113.18	111.53	109.88	108.23	106.58	104.93	103.28
96.00	117.78	116.13	114.48	112.83	111.18	109.53	107.88	106.23
98.00	120.73	119.08	117.43	115.78	114.13	112.48	110.83	109.18

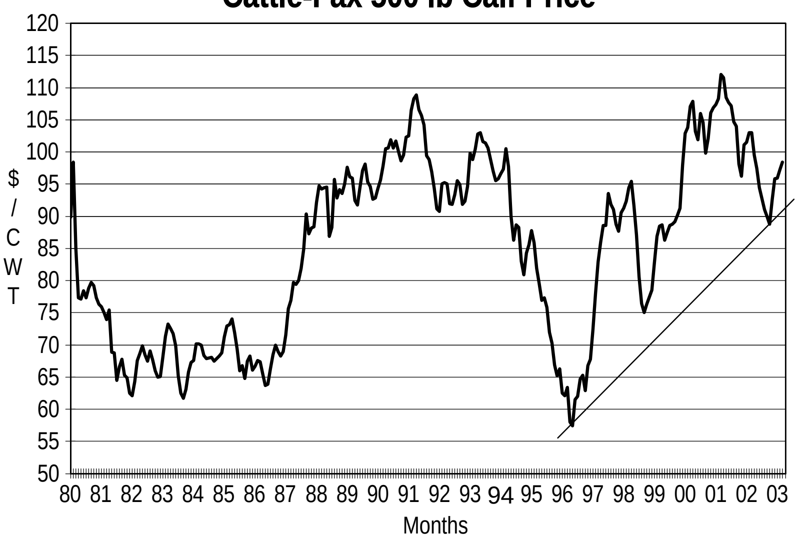
U.S. Average Choice Fed Steer Price 1960-2004



Choice Cut-Out 550-700 lb



Cattle-Fax 500 lb Calf Price



Notes

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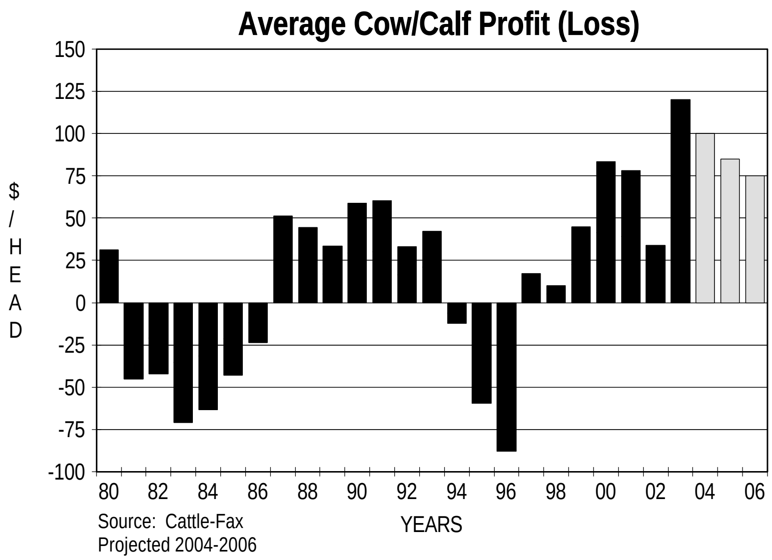
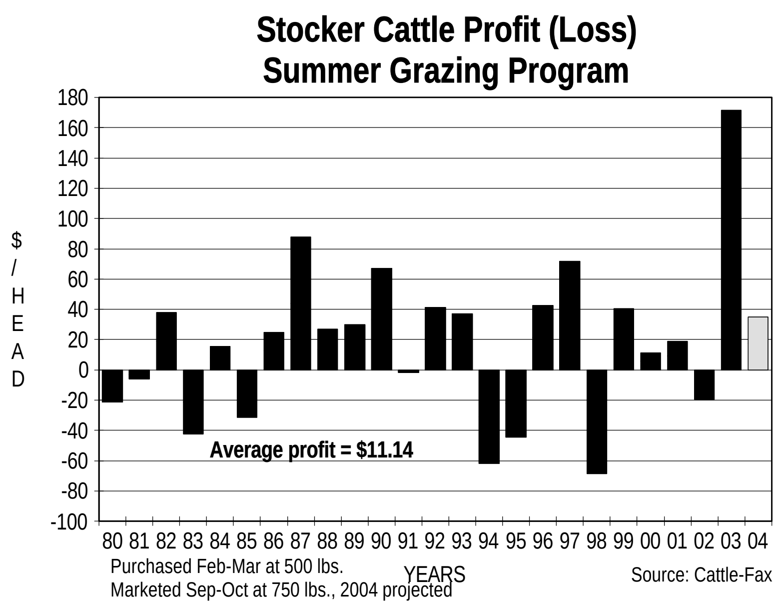
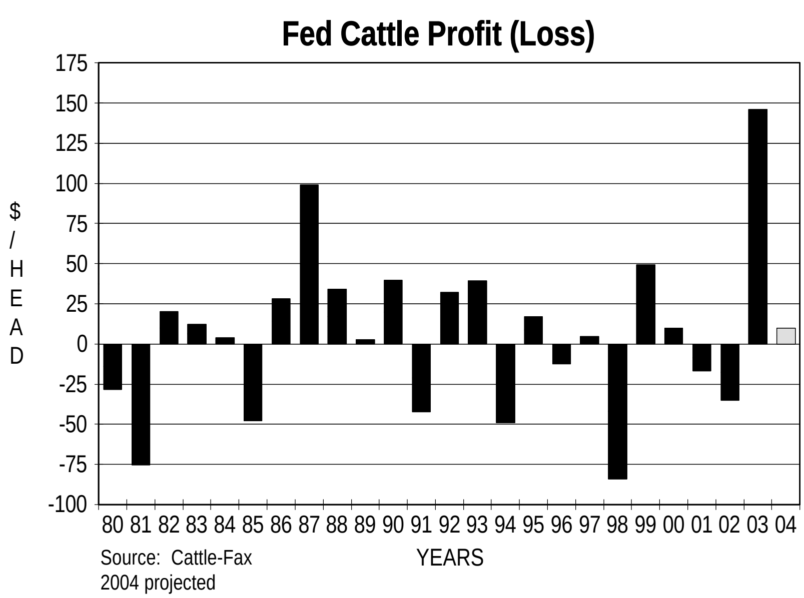


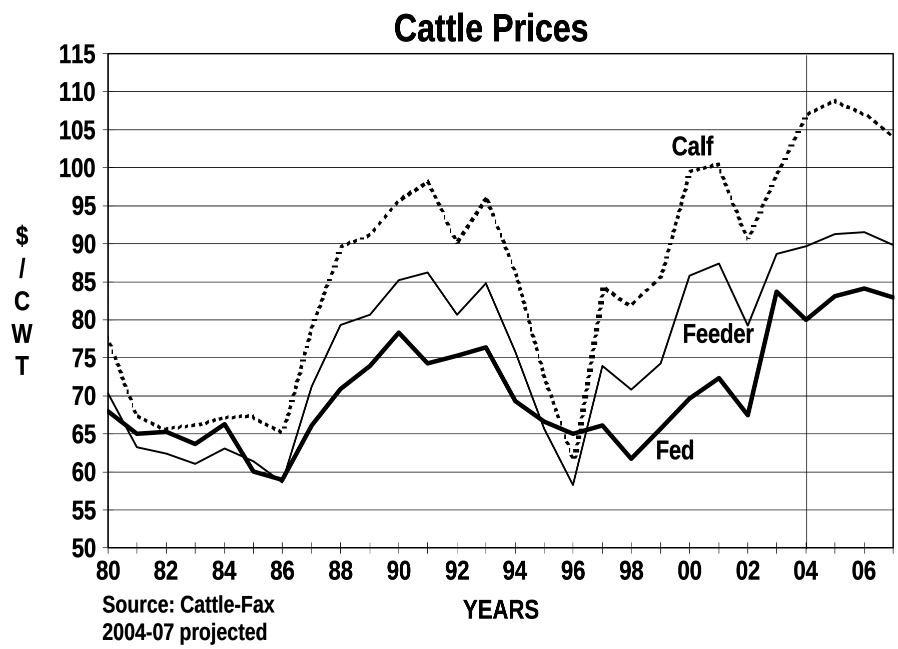
Average Cow/Calf Profit (Loss)
$/HEAD
150
125
100
75
50
25
0
-25
-50
-75
-100
80 82 84 86 88 90 92 94 96 98 00 02 04 06
Source: Cattle-Fax
Projected 2004-2006
YEARS



Stocker Cattle Profit (Loss)
Summer Grazing Program
$/HEAD
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
Average profit = $11.14
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Purchased Feb-Mar at 500 lbs.
Marketed Sep-Oct at 750 lbs., 2004 projected
YEARS
Source: Cattle-Fax



Fed Cattle Profit (Loss)
$/HEAD
175
150
125
100
75
50
25
0
-25
-50
-75
-100
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Source: Cattle-Fax
2004 projected
YEARS



Things to Watch

1) Slaughter levels

2) Front-end supplies/carryover

3) Carcass weights

4) Corn Prices

5) Export markets reopening – Timing/Impact

6) Border reopening to Canadian live and feeder cattle

7) Domestic demand

All have a Major Impact on Market Situation and Outlook during 2004

Animal Identification & Country of Origin Labeling

Bryan Dierlam
Director, Legislative Affairs
National Cattlemen's Beef Association

University of Florida
Annual Beef Cattle Short Course
Gainesville, Florida
May 5th, 2004

Introduction to Animal ID What is it? Different Things to Different People

- **Animal Management**
- **Regulatory Compliance**
- **Disease Control and Prevention**
- **Meeting Customer Needs**
- **Electronic ID**
- **Trade Obligations**
- **National Identification System**
- **Identifying Bad Actors**
- **Trace back**
- **Carcass Data and Feedback**
- **All The Above**

Animal Identification

- Regulatory Component
- Management Information Component

Animal Identification: Regulatory

- Legitimate needs of government to help protect our industry and the consuming public
- Animal Health System
  - Disease Control
    - BSE
    - FMD
    - Tuberculosis
    - Brucellosis
- Food Safety Inspection System
  - Residues

Animal Identification: Management Information

- Information needed to improve profitability, animal genetics, carcass quality, and eating consistency
- Genetics
  - Sire and Dam
- Performance
  - Average Daily Gains
  - Feed Conversion
- Carcass Data
  - Quality Grade
  - Yield Grade
  - Ribeye Area

Focus on Regulatory Component

- Brucellosis tags are the current regulatory ID
- Used for traceback if there are residue or disease problems
- In 1990, 9 million cattle were tagged
- In 1999, less than 4 million cattle were tagged
- Near end of eradication, fewer ccinations

NCBA and Animal Identification

- ID has been an issue for more than 10 years
- 1999—2001 Animal ID Subcommittee
  - Established standards through NCBA policy process
- 2002—U.S. Animal Identification Plan
  - NCBA and state cattle associations represented
- December 30, 2003--USDA announced ID initiative
- April 27, 2004—USDA made ID announcement

USDA Announcement of National Animal Identification System (NAIS)

- "designed to identify any agricultural premise exposed to a foreign animal disease so that it can be more quickly contained and eradicated"
- $18.8 million in funding for FY 04 approved
- $33 million requested from Congress for FY 05

USDA Announcement of National Animal Identification System (NAIS)

- Phase I

  USDA would evaluate current federally funded animal identification systems and determine which system(s) should be used for a NAIS, further the dialogue with producers and other stakeholders on the operation of a NAIS, identify staffing needs, and develop any regulatory and legislative proposals needed for implementing the system.

USDA Announcement of National Animal Identification System (NAIS)

- Phase II

  "would involve the implementation of the selected animal identification system at regional levels for one or more selected species, continuation of the communication and education effort, addressing regulatory needs and working with Congress on any needed legislation."

USDA Announcement of National Animal Identification System (NAIS)

- Phase III

  "the selected animal identification system(s) would be scaled up to the national level."

Animal Identification Summary

- Producers questions must be answered
  - Confidentiality
  - How will it work
  - Flexibility to deal with diverse industry
  - Cost—What will it cost and who will pay it?
- USDA must put in place a process that resolves these and other issues

Country of Origin Labeling

Past, Present and Future of Country of Origin Labeling

- 1997—NCBA supported Mandatory Country of Origin Labeling
- 1997—Task force to facilitate legislation development and implementation
- 1998—Task force report became text of legislation that passed US Senate
- 1998—Legislation was stripped from bill during Conference on ag appropriations bill and a study on labeling was ordered

Past, Present and Future of Country of Origin Labeling

- 1999—House Agriculture Committee hearing held to “explore the matter more fully” and “know more about the methods and cost of compliance.”

Comments made by Chairman Pombo

- “Explore this matter more fully”
- To “understand the philosophies, the costs, the benefits, and the alternatives.”
- “Whether or not country of origin labeling is a tool for producers to earn more in the marketplace”
- “Know more about the methods and cost of compliance and enforcement”

Caren Wilcox, Deputy Under Secretary for Food Safety testified:

- “There are a variety of regulatory regimes for country of origin labeling that could be adopted.”
- These include:
  - “Enforcement by USDA at retail”
  - “Enforcement at wholesale establishments”
  - “Enforcement by states or other Federal agencies”
  - “Monitoring through private, third party certifiers”
  - “Whistleblower or competitor complaint system”
- “We believe there would probably have to be some kind of paperwork trace-back system.”

Robert Robertson with the General Accounting Office testified:

- “There is going to be significant costs associated with compliance and enforcement.”

Producers told to work this thing out

- Peterson to Pombo

  "You and I should round up all the suspects and get them in a room and see if we can have a good discussion and come up with a resolution that would be good for everybody."

FY 2000 Ag Appropriations Bill: Report Language

- "The conferees believe that there is an absence of clarity concerning the definition of U.S. cattle and U.S. fresh beef products. This limitation hinders the ability of producers to promote their products as `Product of the U.S.A.' The conferees direct the Secretary of Agriculture, in consultation with the affected industries, to promulgate regulations defining which cattle and fresh beef products are `Products of the U.S.A.' This will facilitate the development of voluntary, value-added promotion programs that will benefit U.S. producers, business, industry, [illegible]mers, and commerce." [House Report 106- [illegible]R 1906]

USDA Report Released January 2000

"[C]ountry or origin labeling is certain to impose at least some costs on an industry which will either be passed back to producers in the form of lower prices or forward to consumers via higher prices. There would also be compliance and enforcement cost to the government. The extent of these costs would vary depending on the nature of the regulatory scheme and the amount of enforcement and compliance [illegible]."

GAO Report Released January 2000

- Mandatory country of origin labeling for meat "would necessitate change in the meat industry's current practices." "Creat[ing] compliance costs across all sectors of the industry."
- "U.S. Packers, processors, and grocers would, to the extent possible, pass their compliance costs back to their suppliers—U.S. cattle and sheep ranchers—in the form of lower prices or forward to consumers in the form of higher retail prices."

GAO Report Released January 2000

- "To comply with [country of origin labeling] U.S. producers could be required to track and maintain detailed records of the movements of their livestock and have controls in place to ensure the accuracy of this information."

GAO Report Released January 2000

- "Enforcement cost for country of origin labeling would be incurred because government regulators would have to adequately oversee all sectors of the meat industry affected by the legislative requirements. The enforcing agency would have to implement a monitoring system to ensure the identity of meat is maintained at the producer, packer, processor, distributor, and retail levels…Because inspectors would generally be unable to determine the country of origin of livestock for meat from visual inspection, they might need to periodically review the entire industry's internal [illegible]s, practices, and records."

NCBA: Negotiating a workable program 2000

- Negotiated with:
  - Food Marketing Institute
  - American Meat Institute
  - American Farm Bureau Federation
  - National Farmers Union
  - National Meat Association
- Submitted to USDA in September 2000

Petition to USDA

- Submitted to USDA September 2000
- House Agriculture Subcommittee Hearing September 26, 2000 to review studies and progress on proposal to USDA
- Clinton administration acknowledged receipt of proposal in Federal Register, January 19, 2001
- Follow up letter to Secretary Veneman, February 9, 2001
- Meeting with Under Secretary Bill Hawks, July 11, 2001
- Response from Mr. Hawks, July 2001

Letter from Under Secretary Hawks

- "I have asked AMS to begin action on the petition requesting a USDA voluntary, user-fee funded certification program that will enable a label for beef products"
- "I have directed AMS to conduct an expeditious review to ensure that all segments of the industry are aware of this action"

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- House Farm Bill Markup Transcript
  - 12,463 lines of text
  - 3167 on Country of Origin Labeling
  - 25% of markup record is Country of Origin Labeling

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- Chairman Combest:

  "I think it is very important that we lay out the full ramifications of what this amendment may potentially do, and try to get the answers to the unanswered questions before it is put into passage rather than after the fact."

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- USDA personnel were asked how the program would be implemented?
  - "Records intensive"
  - "Maintained at all levels"
  - "Trace records back to level of production"
  - "Complex"
  - "a lot of on-the-ground visits to a whole variety of entities to be checking records"
  - "making sure that identity truly does trace back to origin as is represented at the retail level"

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- Mr. Pombo recapped his concerns:
- We have worked through all that "was necessary to develop legislation"
- "We began to realize that there were a lot of problems with proceeding with legislation like this"
- We "began to realize that it was nearly impossible to put together a bill that answered all of the questions."
- "If you put a higher cost on our producers, the only way to recoup that higher cost is through lower prices."
- "I have a feedlot…Everyone of those cattle…would have to be tattooed at birth so we could track those cattle…I would have [illegible] records of exactly where that animal came from."

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- The Committee had extensive debate about:
  - How processed foods will be dealt with
  - Foodservice exemption
  - Grocery store delis
  - Blended products
  - Products of mixed origins
  - Wild-caught fish, farm-raised fish
  - Labeling progeny of imported semen or embryos

House Agriculture Committee Farm Bill Markup—July 26 & 27, 2001

- At one point, the Committee consented to exempting retailers in the following states from the mandatory labeling law:
  - Texas
  - Minnesota
  - Ohio
  - North Carolina
  - Virginia
  - Alabama
  - Florida
- The mandatory country of origin labeling amendment failed in the House Agriculture Committee on a voice vote after 6 hours of debate.

NCBA Affiliate Meeting

- The meeting convened in Denver on September 24, 2001
- Working group statement:
  - NCBA will serve as a catalyst to facilitate and endorse voluntary USA beef labeling in the private sector for "born, raised & processed" USA beef.
  - Voluntary labeling of USA beef will be market-driven in private sector retail and foodservice channels.
- Working group statement approved by Executive Committee on October 16, 2001
- Approved at 2002 Convention

Farm Bill Developments

- House Floor
  - October 4, 2001—Adoption of mandatory fruit and vegetable labeling amendment (296-121, 107th Roll Call #370)
- Senate
  - November 13, 2001—Senate Agriculture Committee approved Title X of Senate Farm Bill containing mandatory country of origin labeling
  - February 13, 2002—Farm Bill passed Senate

Farm Bill Conference

Conferences held March 13-April 21, 2002

- Republican and Democratic members of the House conference posed questions to Senate supporters about tracking, tracing, labeling, auditing, verifiable audit trails, certification, blended product, and product of multiple origins, the answers included:
  - "at some point we have to ask USDA to write regulations"
  - "we are saying to USDA, you by regulation have the authority and the responsibility to cross all the T's and dot all the I's"
  - "I guess we leave it to the Secretary to determine that."

Farm Bill Conference
Conferences held March 13-April 21, 2002

- Mr. Pombo said:

  This bill would have a "record keeping requirement…." The Senate bill contains a paragraph "that the secretary may require that…That they keep the recordkeeping to trace back exactly where that animal came from. That is a record keeping requirement that would be unavoidable for every cow, every pig and everything that would come under the bill….Mr. Peterson and I spent 4 years working on this…I think this is not a very workable program format. It is very cumbersome and very confusing. And quite frankly, I do not know if you can enforce it if you were to adopt it. It would be nearly impossible for our producers in any way to comply with this. Without a recordkeeping requirement that would just be unbelievable.

Farm Bill Conference
Conferences held March 13-April 21, 2002

- Mr. Pombo said, "I cannot afford to sit here and say, we'll let somebody figure that out. I have to figure out for myself how you expect this to be implemented. Because for the life of me, I cannot figure out how you would do this."
- A Senate supporter, responded "I am not the author."
- To which Mr. Pombo replied "…That is what this is about. We are sitting here at the conference working out the differences between you and us and if we do not figure this out right now, when is it going to happen…?"

Country of Origin Labeling Law

- Guidelines Issued October 11, 2002
- Listening Sessions in 2003
  - Orlando, Florida on May 14, 2003
- Bonilla Provision in House (208-193)
- Proposed Rule Issued October 30, 2003

Country of Origin Labeling Law

- Implementation date delayed two years

  H.R. 2673, The Consolidated Appropriations Act of 2004—Sec. 749:
  - Section 285 of the Agricultural Marketing Act of 1946 (16 U.S.C. 1638d et seq.) is amended by striking `2004' and inserting `2006, except for `farm-raised fish' and `wild fish' which shall be September 30, 2004'.

Present Status

- Two year delay in place
- Bono-Hooley Bill
  - 2004 Implementation
- Daschle amendment
  - 2004 Implementation

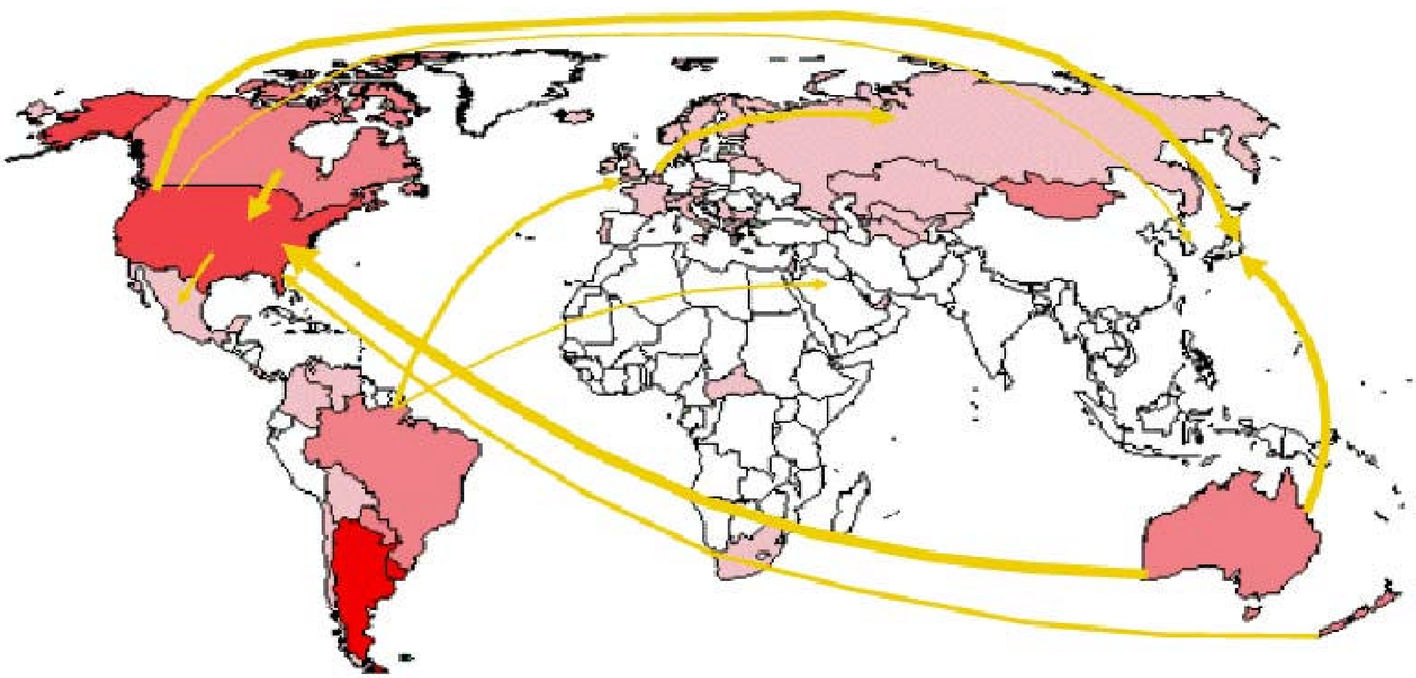
Current Status

- NCBA Continues to work to develop legislation that would implement policy established by producers
  - Voluntary, producer driven effort
- Anticipate legislation at some point to modify the law

Future of Country of Origin Labeling?

- NCBA will work to implement policy so program works better for producers
- The future of country of origin labeling is in your hands

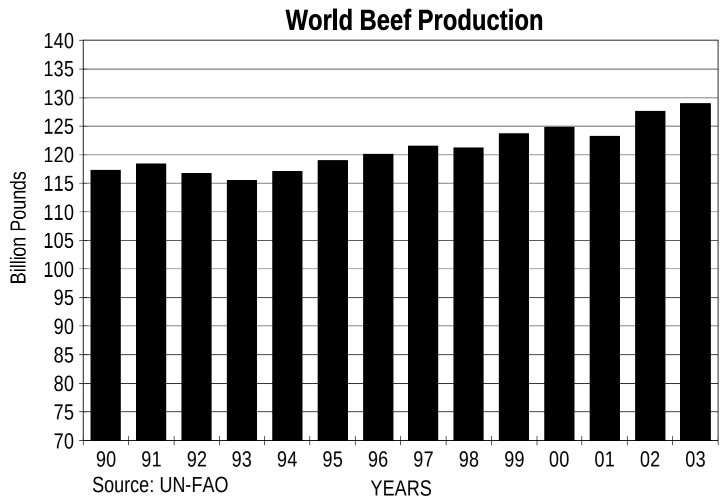
Economic Impact of BSE on the U.S. Beef Industry

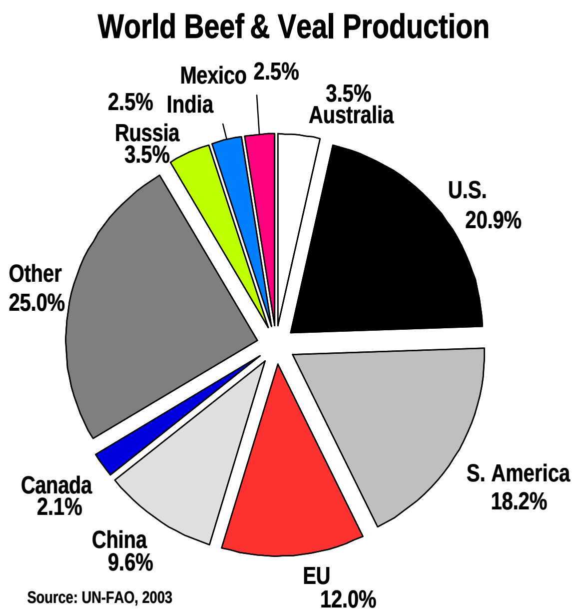


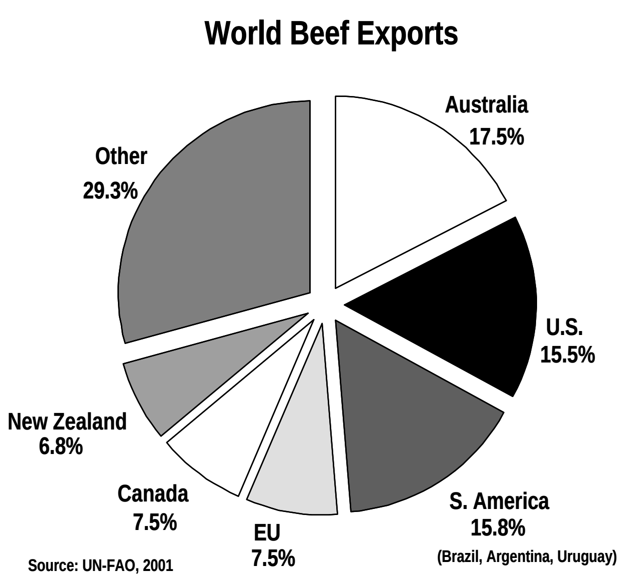
Presented by:

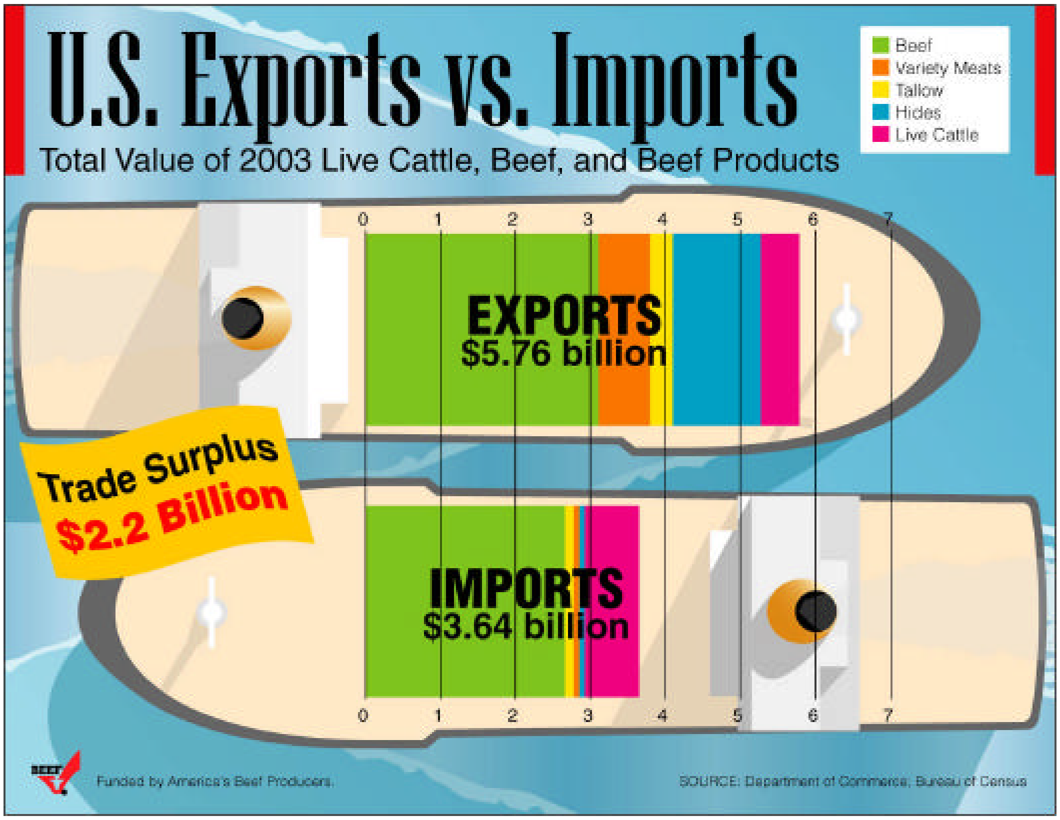
CATTLE-FAX®

Randy Blach
9110 East Nichols Ave
Centennial, CO 80112
1-800-825-7525
www.cattle-fax.com


World Beef Production
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
Billion Pounds
90 91 92 93 94 95 96 97 98 99 00 01 02 03
Source: UN-FAO
YEARS


World Beef & Veal Production
Mexico 2.5%
2.5% India
3.5% Australia
Russia 3.5%
U.S. 20.9%
Other 25.0%
Canada 2.1%
China 9.6%
EU 12.0%
S. America 18.2%
Source: UN-FAO, 2003


World Beef Exports
Australia 17.5%
Other 29.3%
U.S. 15.5%
New Zealand 6.8%
Canada 7.5%
EU 7.5%
S. America 15.8%
(Brazil, Argentina, Uruguay)
Source: UN-FAO, 2001

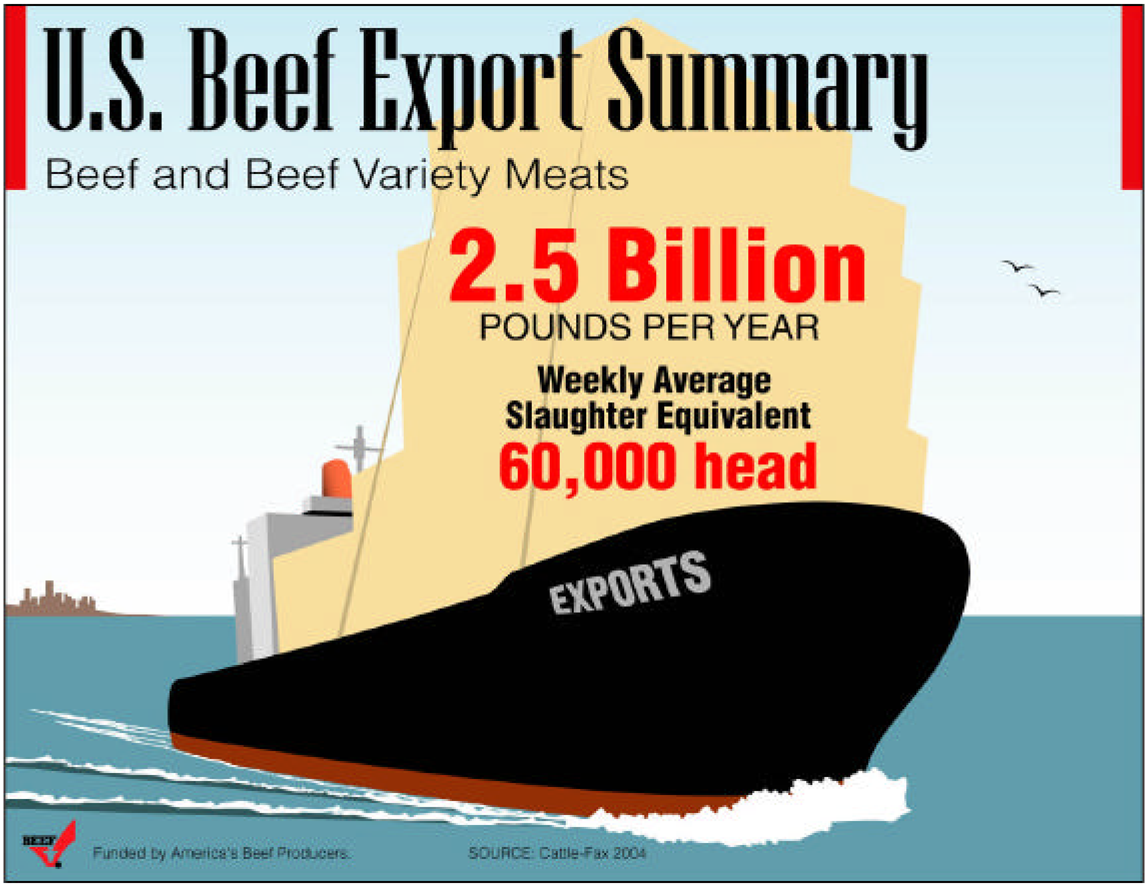


US Beef Export vs. Import Summary

2002 Beef & BVM Exports	**$3.2 billion**
2002 Beef Imports	**$2.8 billion**
2003 Beef & BVM Exports	**$3.9 billion**
2003 Beef Imports	**$2.6 billion**

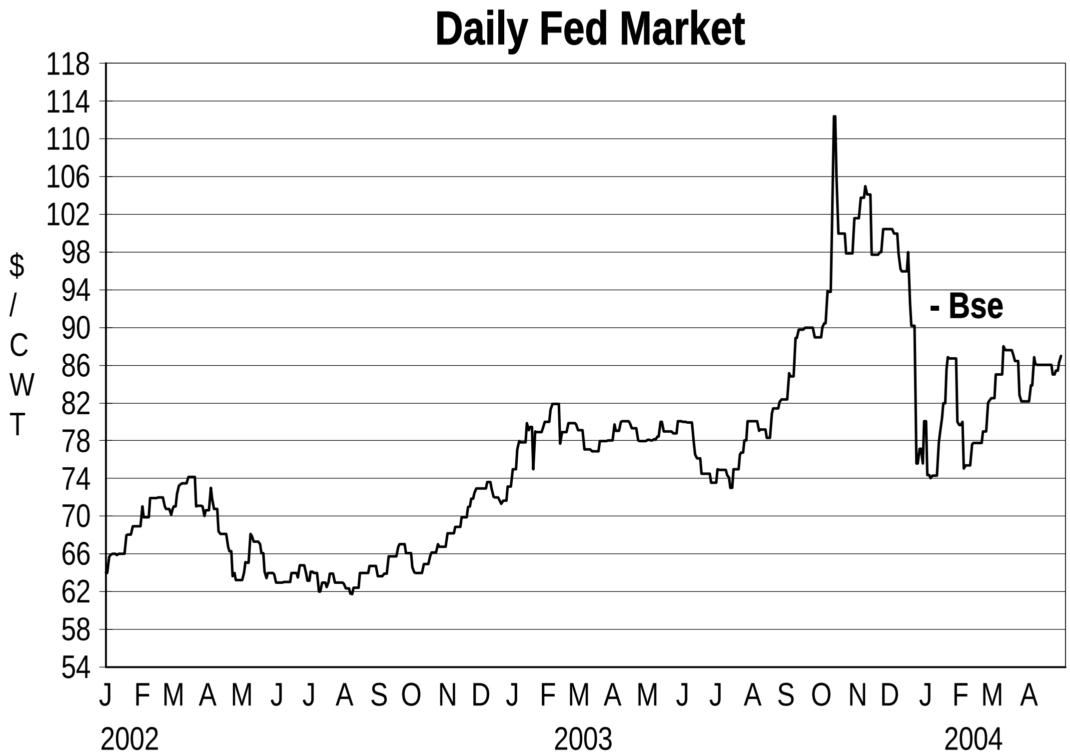
Net

2002 Exports-Imports ($1.38-$1.13/lb)	**$0.25/lb**
2003 Exports-Imports ($1.66-$1.21/lb)	**$0.45/lb**

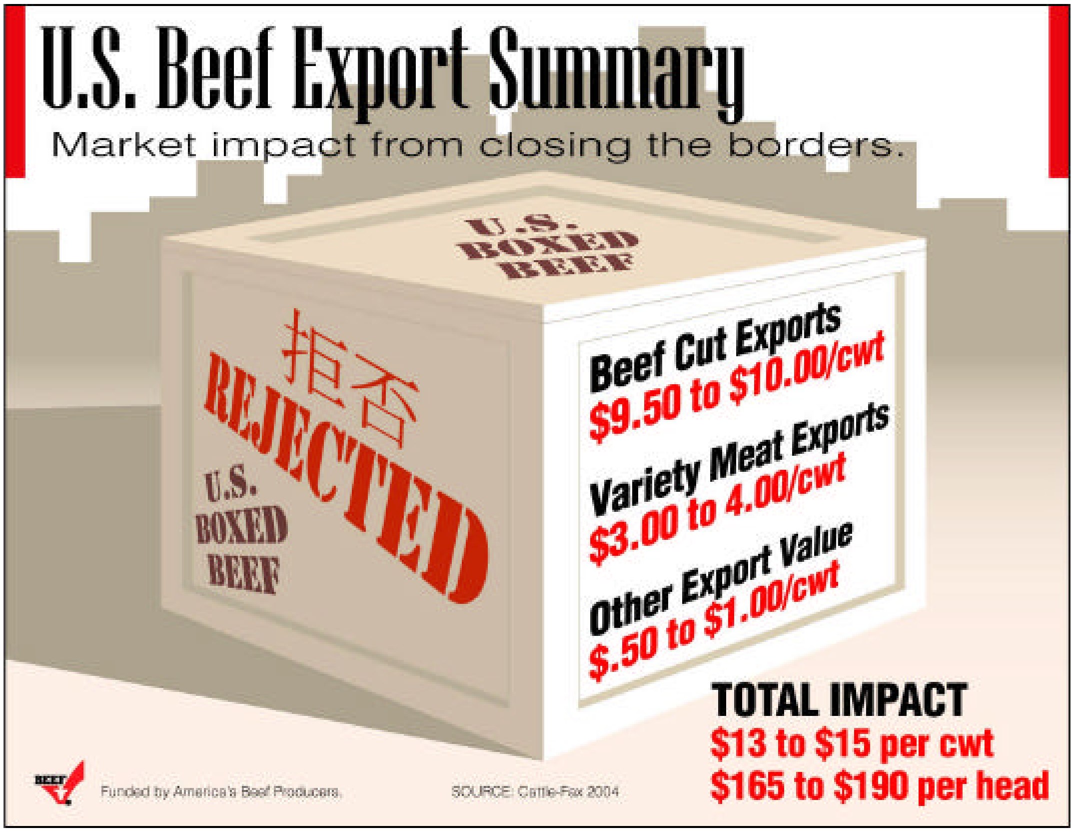


Value of Beef, Variety Meat and Tallow Exports
($ billion)

	Beef	Variety Meat	Tallow	Total
1999	2.724	0.557	0.372	3.653
2000	2.987	0.628	0.261	3.876
2001	2.633	0.772	0.237	3.642
2002	2.586	0.619	0.343	3.548
2003	3.150	0.712	0.374	4.236



Source: Cattle-Fax



Hide and Offal Value	12/22/03 $/head	4/20/04 $/head
Steer Hide, butt brand	66.94	60.95
Tallow, edible	4.34	3.32
Tallow, packer bleachable	13.64	11.86
Tongues, Swiss #1 white	12.50	2.17
Cheek meat, trmd	5.36	3.95
Head meat	1.40	1.15
Oxtail, selected	5.48	2.68
Hearts, reg, bone out	1.53	1.79
Lips, unscalded	1.66	1.28
Livers, selected, gall off	4.34	2.81
Tripe, scalded, edible	4.59	2.42
Tripe, honeycomb bleached	2.93	2.42
Lungs, inedible	0.13	0.13
Melts	0.00	0.00
Meat and bone meal 50% blk/ton	6.12	6.38
Blood meal, 85% blk/ton	2.81	1.91
Total	$133.75	$105.19

New FDA Feed Rules

Ban all mammalian blood and blood products from ruminant feeds

Ban poultry litter

Ban plate waste

Requires dedicated facilities or lines for feed mills and renderers that handle prohibited ruminant materials and ruminant feed

Increases feed mill and plant inspections in FY 2004.

Downer Cow Rule Industry Impact

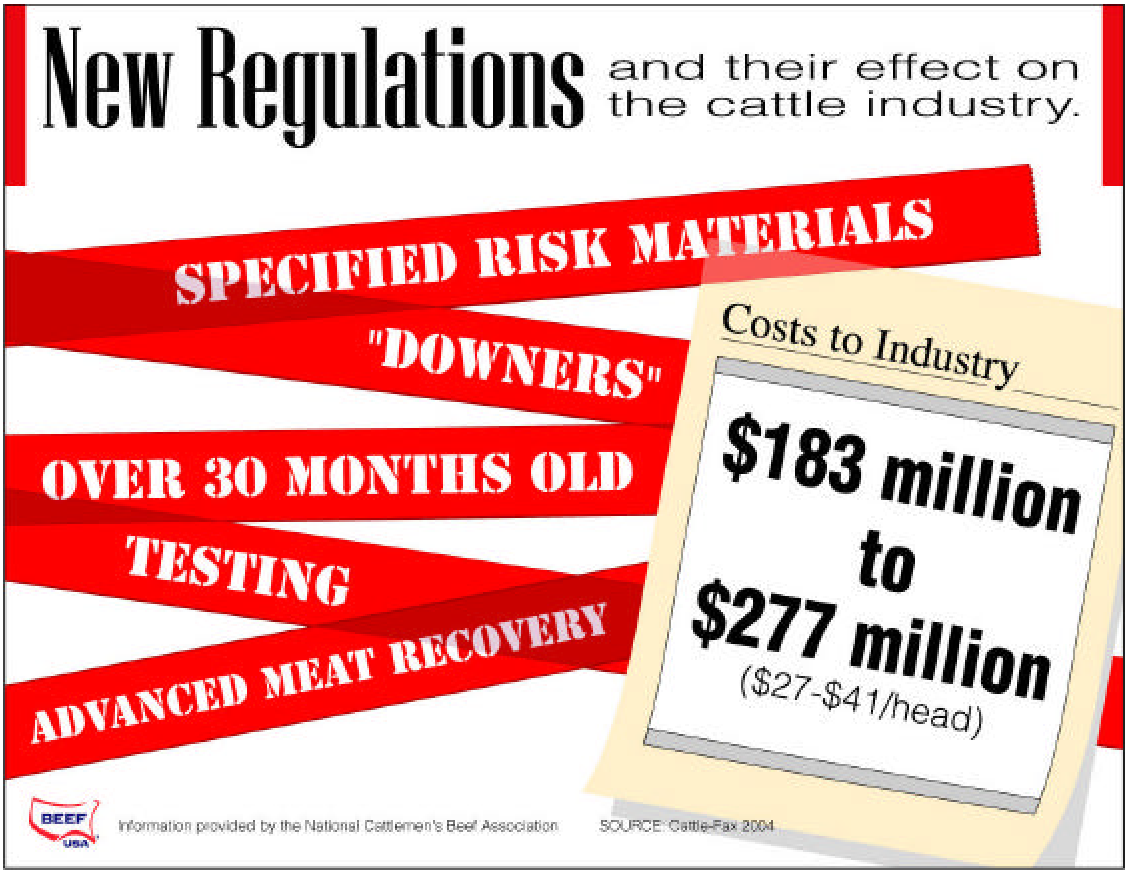
USDA estimate	195,000 hd
Condemnation of 50,000 head	195,000 hd - 50,000 hd = 145,000 hd
Average canner cow price 2001-2003	$36.35 per cwt.
Average cow live weight	1020 lbs
Average value	1020 lbs * $0.3635 per lb = $371 per hd
Industry impact	145,000 hd * $371 per hd = $53.8 mi
Cost to Industry	$50 to $70 million

Specified Risk Materials (SRMs)

Skull
Brain
Trigeminal ganglia
Eyes
Tonsils
Spinal column
Dorsal root ganglia
Distal ileum

Cost Summary

New Regulation	1/25/04 Cattle-Fax Cost Estimate	4/7/2004 FSIS Cost Estimate
	$100 million	$63-64 million
SRMs	$50-70 million	$36-71 million
"Downers"	$17-73 million	$
Over 30 months	$15 million	$14-16 million
AMR	$1.2 million	$70 million
Testing		
Total	$183-277 million ($27-41/head)	$183-221 million ($27-33/head)



Impact on Production Programs

Grid pricing variables to change

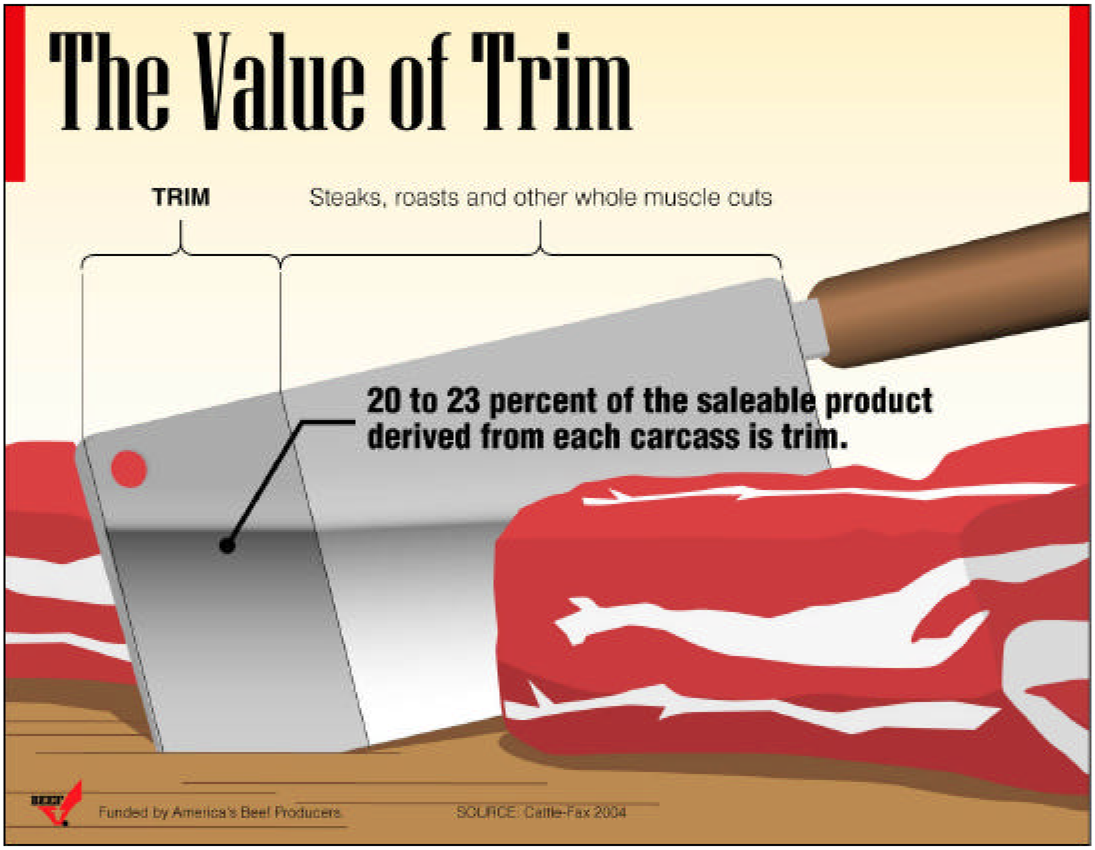
Heiferette feeders expect major discounts

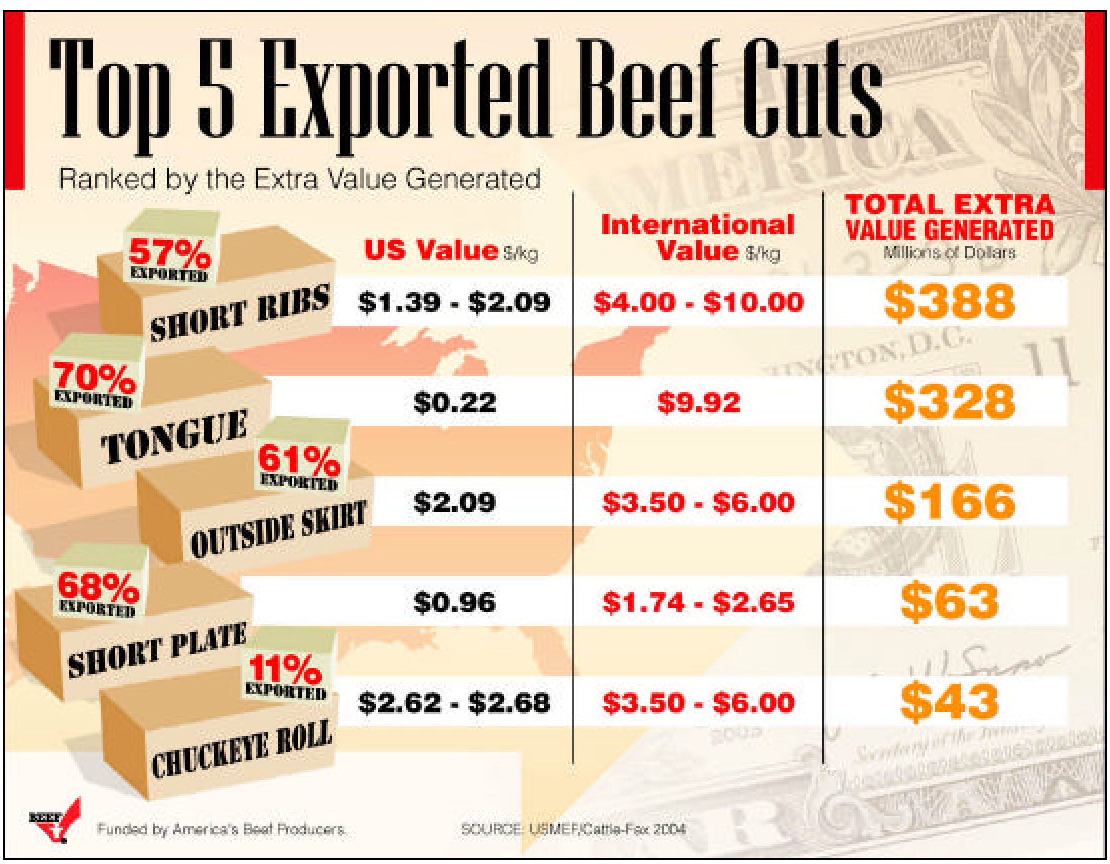
Grazing programs may need to be modified

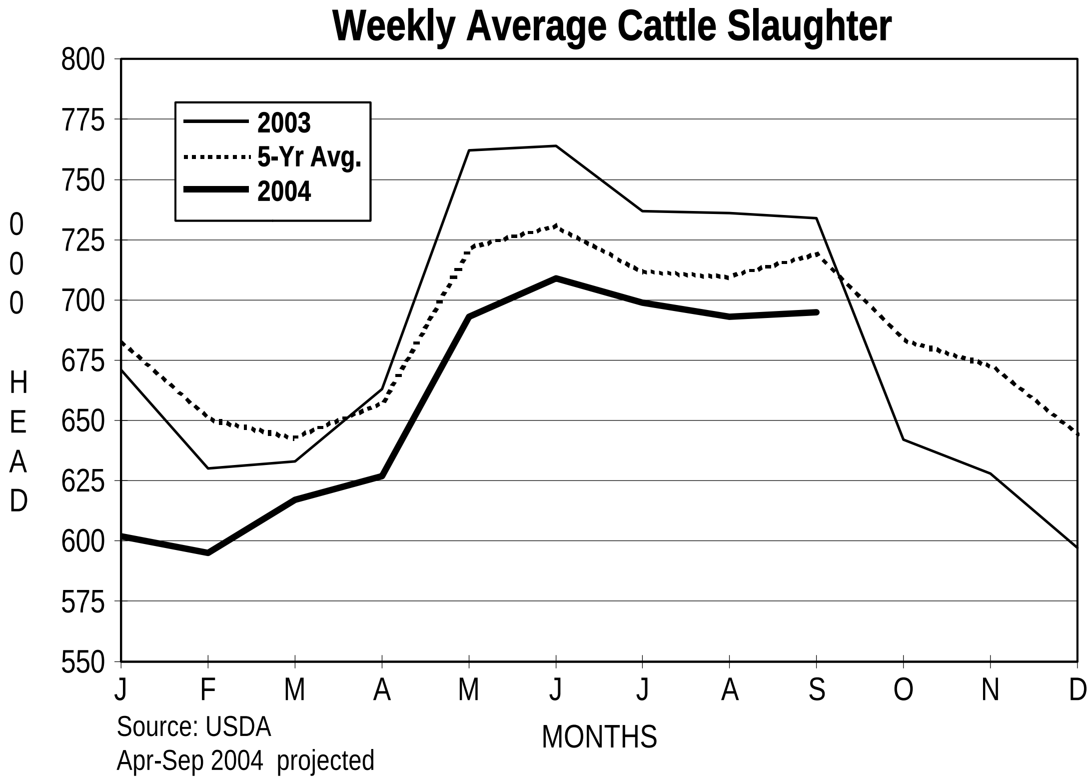
Long term loss in variety meat value

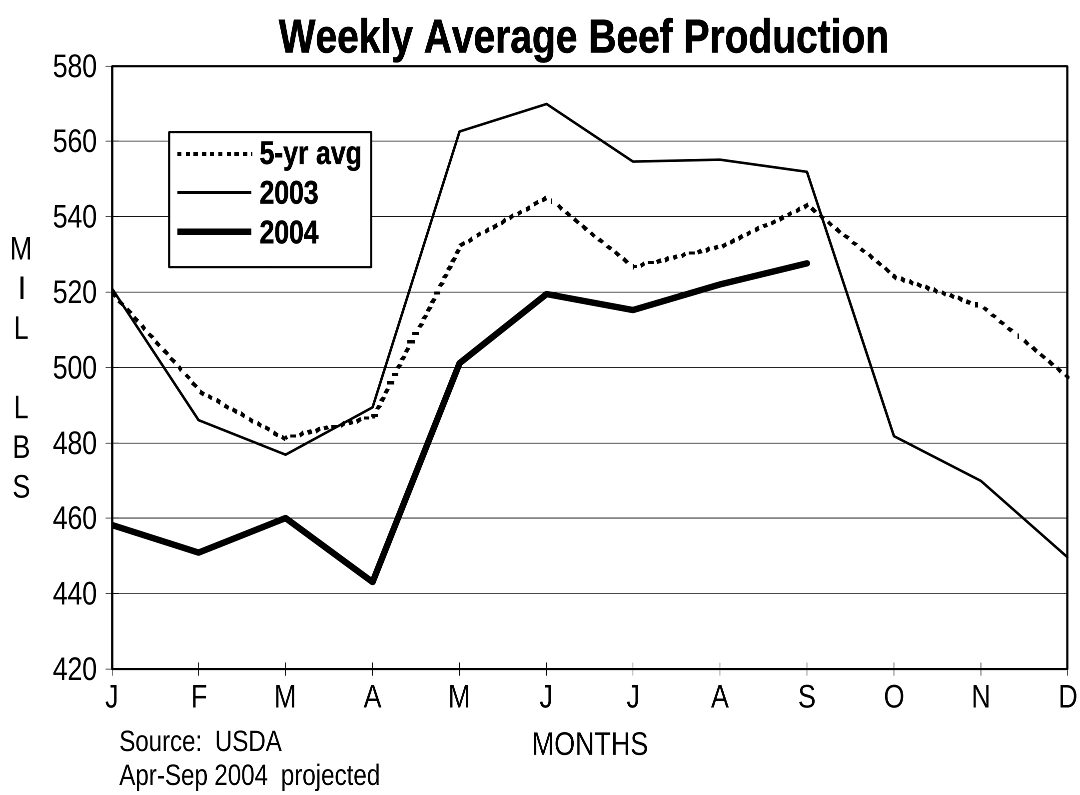
Improved consistency of beef supply

Increased cost of doing business for the industry


The Value of Trim
TRIM
Steaks, roasts and other whole muscle cuts
20 to 23 percent of the saleable product derived from each carcass is trim.
Funded by America's Beef Producers.
SOURCE: Cattle-Fax 2004


Top 5 Exported Beef Cuts
Ranked by the Extra Value Generated
US Value $/kg
International Value $/kg
TOTAL EXTRA VALUE GENERATED
Millions of Dollars
57% EXPORTED
SHORT RIBS
$1.39 - $2.09
$4.00 - $10.00
$388
70% EXPORTED
TONGUE
$0.22
$9.92
$328
61% EXPORTED
OUTSIDE SKIRT
$2.09
$3.50 - $6.00
$166
68% EXPORTED
SHORT PLATE
$0.96
$1.74 - $2.65
$63
11% EXPORTED
CHUCKEYE ROLL
$2.62 - $2.68
$3.50 - $6.00
$43
Funded by America's Beef Producers.
SOURCE: USMEF/Cattle-Fax 2004


Weekly Average Cattle Slaughter
000 HEAD
800
775
750
725
700
675
650
625
600
575
550
2003
5-Yr Avg.
2004
J F M A M J J A S O N D
MONTHS
Source: USDA
Apr-Sep 2004 projected


Weekly Average Beef Production
MIL LBS
580
560
540
520
500
480
460
440
420
5-yr avg
2003
2004
J F M A M J J A S O N D
MONTHS
Source: USDA
Apr-Sep 2004 projected

Summary

- Export markets add $14/cwt. to the value of fed cattle. Re-opening these markets is critically important.

- New regulations will increase cost or decrease revenues by an estimated $27 to $41/hd.

- Uncertain how domestic market will absorb larger slaughter levels (especially chuck & trim).

- The changes to the industry are permanent. Added uncertainty and extreme volatility will be common.