Targeting Excellence:

The Missouri Beef Cattle Performance Testing Program

University of Missouri-Columbia
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Contents

Targeting Excellence: The Missouri Beef Cattle Performance Testing Program ..........1

Implementing The Program..............................2
  Preweaning
  Postweaning
  Performance Tested Bull Sales
  Computer Programs

Genetic Improvement Yields
  High Returns ..........................................................4
  South Central Missouri
  Southwest Missouri
  North Central Missouri
  Mid-Missouri
  Northeast Missouri
  Northwest Missouri
  Meramac Area
  Sale Price

Testing Stations Key to Missouri Program ..................................6

Extension, Research and Industry Interact ....7

Economic Impact of the Missouri Program ...8

Milestones in Performance Testing ..........9

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Cover photo, lower left: UMC’s Animal Science Research Center (large rectangular complex) and Trowbridge Livestock Center as seen from the air.
Targeting Excellence: The Missouri Beef Cattle Performance Testing Program

The Missouri Beef Cattle Performance Testing Program helps producers improve both quality and growth rate of their herds through breeding and selection.

The primary objective of the Missouri Program is to provide education and information to both purebred and commercial producers so they can increase their economic returns. Area and state livestock specialists direct major efforts toward creating awareness of research technology, demonstrating the value of records of performance and adopting improved selection procedures. Missouri beef cattle improvement programs are designed to change the genetic base or gene frequency of economic traits of beef cattle in order to yield a more desirable product for the consumer. This in turn yields producers a higher return which helps improve their standard of living and provides capital with which to upgrade their operation.

The need for the Missouri program is widespread. Approximately 95,000 of Missouri's 112,000 farms have beef cattle. The average size of cow herds in Missouri is 28 head, so the beef cattle enterprise is secondary on many farms. Still, the inclusion of beef cattle allows use of land and forage resources for which few or no alternatives exist.

Problems of greatest concern to the industry are:
- Light calf weaning weights.
- Low calving percentage.
- Dispersed calving season.
- Small herd size.

In response to the concerns of the industry, the Missouri program has developed outreach services to assist producers. Extension beef cattle programs are designed to raise the level of technology and management skills of Missouri beef cattle owners. Adoption of improved genetic selection programs, production practices, and sound management are all essential for producers to achieve the following production goals:

**Missouri Production Goals**

1. 500-pound calf per cow in breeding herd at weaning.
2. 90 to 95 percent calf crop weaned.
3. 90 days or less calving season.

One of Missouri's large frame polled Hereford cows.

The program is flexible, assisting both purebred and commercial cattlemen in their selection and breeding programs. The primary use of the program is in evaluating individual animals for comparison within a herd. Comparing results for one herd or one breed with another can be misleading because environmental conditions are not controlled.

Three phases of the Performance Testing Program are available to breeders for use in checking each animal's performance from birth until a decision is made to add the animal to the herd or slaughter it:

1. **Plan A**: The preweaning phase, which extends from birth to 205 days when the calf is weaned and evaluated.
2. **Plan B**: The postweaning phase, which extends a minimum of 140 to 160 days following weaning for bulls to 365 days of age and 160 or 335 days postweaning for heifers. Heifers may be evaluated at 365 or 540 days of age for postweaning growth.
3. **Missouri All-Breed Performance Tested Bull Sales**: Bulls that meet performance requirements may be sold through state and area performance-tested sales at 16-22 months of age.
Implementing The Program

Preweaning

The preweaning phase of beef cattle improvement is supervised by area extension livestock specialists. This within-herd, on the farm program evaluates reproductive traits, maternal traits, growth rate, frame, conformation, structural soundness and predisposition to waste or trimness.

During the last 10 years weaning weight has increased approximately 60 pounds, height at the shoulder increased about 2 inches, quality by 1/3 of one USDA grade for herds in the program. Calving percent for all beef cattle in the state has increased by one or two percent.

Postweaning

The postweaning phase of the Missouri beef improvement program was initiated in Missouri by Dr. Homer B. Sewell in 1958. The postweaning phase includes full-feeding superior bull calves from weaning to one year of age for a minimum of 140 to 160 days following the preweaning phase. Heifers may be evaluated at 365 or 540 days of age for postweaning growth. The postweaning phase can be conducted on the farm or at a beef cattle performance testing station. In addition, live animal evaluations for growth and composition can be conducted at 12 to 18 months of age using ultrasonics and potassium-40. During the postweaning phase, progeny testing of steers or heifers via carcass information is available in cooperation with the United States Department of Agriculture.

Performance Tested Bull Sales

In 1963, Missouri County Extension Agents stressed that commercial beef cow-calf producers needed performance-tested bulls of all breeds available at a central location for selection of superior sire replacements. In the spring of 1963, the Animal Science Department called a meeting of all purebred breeders who were performance-testing to discuss the possibility of supporting an all-breed performance-tested bull sale for the improvement of beef cattle in Missouri.

As a result of the meeting bull sales were begun that fall with 40 bulls consigned. Today, there are nine regional sales and two state sales yearly. Over 1500 people attend sales which are co-sponsored by the Missouri Beef Cattle Improvement Association, The Cooperative Extension Service and the College of Agriculture Animal Science Department annually on the University of Missouri campus. Since the beginning, over 6,000 bulls have been sold. Eighty percent go to commercial breeders, sixty percent of whom are repeat buyers. Central sales save energy and time by serving the beef industry of the entire state.

The number of bulls sold through performance tested sales is impressive, but most significant is the genetic progress that has been made. For the 10 year period ending in 1982, the 365 day adjusted weight of Angus and Polled Hereford bulls sold in Missouri Performance Tested Bull sales increased from 1058 to 1178 pounds—an increase of 12 pounds per year. During this same period, frame scores for the bulls increased from 3.5 to 5.1 reflecting an increased
Clockwise from left: Yearling bulls off test at 365 days. These two bulls show the extreme variation found in testing. Standing-room-only crowds are often found at performance tested bull sales. Missouri angus bull. At right: Missouri’s performance testing data is organized by computer.

shoulder height of over three inches.

Herd owners need the educational assistance provided by area livestock specialists early in the program to understand the use and value of records of performance. They then either continue efforts on their own or participate in other similar programs.

Every year, approximately one third of the participants in the program are newly enrolled herds. Therefore, many top-producing herds are not currently in the Missouri Beef Cattle Performance Testing Program and a large portion of Missouri’s records are from relatively new cooperators. Approximately one third of the herds are also enrolled in their respective breed association performance testing program. The average purebred herd participates in Missouri’s performance-testing program for seven years.

Computer Programs

Computer Programs are of vital importance in organizing data collected through Missouri’s performance testing program.

In the mid-1970’s, the Meramec Area received a federal grant to develop computer programs for evaluating various beef cow management systems. Software was developed at that time to do individual analysis for economic traits measured at preweaning and postweaning and for cow herd analysis for most profitable producing ability.

Since that time, records have been accumulated on the computer to evaluate growth curves. All records and programs were transferred to the Columbia Campus in 1981 for statewide use. The statewide program was funded as a pilot program jointly by the Associate Dean for Extension in the College of Agriculture and by Title V Rural Development funds.

Currently, over 120,000 individual preweaning records are held in the statewide data bank. About 20 percent of the records include postweaning information. These data allow area and state specialists to evaluate industry changes in beef cattle for reproduction and physiological traits. In addition, these analyses make it possible to more accurately and efficiently assist producers to solve problems with breeding programs and to make more accurate selection recommendations.

The combination of accurate measurement at test stations and computer evaluation of records is having important impact on the Missouri program. Continued efforts to apply analyses to breeding programs is expected to generate dramatic improvements in herds during the next decade.
The Missouri Beef Cattle Performance Testing Program does require more individual assistance than many other programs, but it also yields one of the highest dollar returns for breeders. Extension Specialists are working with the architects of the industry—seed stock producers—and the effort is multiplied through superior bulls utilized in the commercial industry. Area specialists evaluate over 10,000 potential herd sires selected from the top half of the herds annually at weaning time. If 25 percent of these bulls are eliminated because of poor performance or unsoundness, this program still identifies 7,500 top quality bulls to go into commercial herds. Research data indicates that 85 percent of genetic improvement comes through sire selection in commercial herds. So, with our limited area specialist manpower resources, our greatest economic contribution can be made through improving the genetic base of Missouri's number one industry—beef cattle. Examples of program effectiveness selected from reports of Extension Specialists throughout Missouri are included in the synopses which follow.

South Central Missouri

A report from the south central part of the Missouri Ozarks indicated that in 1968-69, bull calves from 33 herds averaged 446 pounds. Just 10 years later in 1978-79, the bull calves from 47 herds averaged 474 pounds—an increase of 28 pounds. In addition, 1978-79 data show that heifers averaged 440 pounds which was a 24-pound increase in the ten year period. The changes in herd enrollment in South Central Missouri are reasonably representative of the state for a 10-year period.

North Central Missouri

Performance Records from a North Central Missouri beef herd where calves were under the same management conditions for two consecutive years were compared. In just one year, the heifers from this herd showed an average frame score increase of .5 and yearling weight increased 104 pounds.

Ninety performance tested bulls in the area had an increased yearling weight of 50 pounds and a reduction of fat thickness indicated increased production of red meat. If each of these ninety bulls sires 30 calves annually, they have the potential of annually siring 2,700 calves with a total genetic increase in weight of 135,000 pounds at one year of age. At $.70 per pound, this would be a $94,500 increase in value for each calf crop sired by these bulls. Each bull, by genetic superiority, would add over $1,000 value annually to the calf crop he sires.

Northeast Missouri

Northeast Missouri reports summarized the pure-bred herds by breed in that area in 1979, and found that 44 percent of the bull calves were 2-frame; 37 percent, 3-frame; 17 percent, 4-frame; and 2 percent, 5-frame.

Northwest Missouri

Performance data for 1973 and 1978 from 367 bull calves in Northwest Missouri show an average 47 pounds increase in each animal's weaning weight for the five year period. Also during this time, shoulder height was increased by 1.8 inches, or almost one frame score.

More recently, 1980 weaning weights and frame scores from 779 weaning bull calves were analyzed. The correlation of frame scores and weaning weights is evident: 6.8 percent of the calves had number 2 frame scores and averaged weighing 411 pounds, 31.9 percent had number 3 frame scores and weighed 499
pounds, 44.7 percent had number 4 frame scores and weighed 549 pounds and 16.6 percent had frame scores of 5 or higher and had average weights of 595 pounds each.

Southwest Missouri
Reports from five counties in southwest Missouri, indicate that in 1980 1,696 calves from herds enrolled in performance testing were weighed averaging 470 pounds at 205 days of age. Some herds showed much more progress than others; however, for the five herds summarized, 205-day weights increased 52 pounds from 417 pounds in 1971 to 468 pounds in 1980.

Mid-Missouri
Most breeders agree that weight is most important and should be considered first, but height is also needed to describe cattle. Comparing weights and heights at a common age allows one to better estimate composition. The frame score developed by Missouri correlates shoulder height in inches required at certain months of age for the various frame scores. Frame scores are associated with 2 inch shoulder height intervals. For example, an animal at 12 months of age with 39 inch shoulder height would qualify for frame score 1 while a 51 inch shoulder height is required at that age for frame score 7.

Reports from the Mid-Missouri area show that performance tested cattle compare favorably with registered cattle not enrolled in the program. A producer who purchased a group of registered Angus cows to be used in an ova transplant program found that the heifer progeny from these cows were smaller in both weight and height than heifers from his performance tested herd. The three heifers which were a product of the untested herd averaged 400.3 pounds and 36.9 inches shoulder height while three heifers from his performance tested herd averaged 593 pounds and 43.2 inches shoulder height.

Meramec Area
A good example of the Missouri program's accomplishments was noted in a herd of Polled Hereford cattle in the Meramec area. In this herd, 205-day adjusted weaning weights have increased from 425 pounds in 1961 to 551 pounds in 1980, and heights at the shoulder from 39 inches in 1973 to 41.5 inches in 1980. Yearling weights have increased by 306 pounds—from 825 pounds to 1,131 pounds—during this same period. The yearling height at shoulder on these cattle has increased 3.7 inches to 47.7 inches in 1980. These gains were achieved through use of herd records as a basis for very rigid culling as evidenced by the herd average cow age of just over four years.

Similar examples of outstanding improvements can be noted in herds throughout Missouri. Adoption of improved genetic selection programs, systematic production practices and sound management are assisting producers in meeting their goals for herd improvement.

Sale Price
An increasing awareness of the value of performance testing caused demand for tested bulls to rise rapidly. During the 1963-1975 period sale prices increased significantly, in part due to inflation. However, sale price is significantly correlated with frame, sale day grade, sale day weight, 365-day weight, and yearling conformation grade. Adjusted shoulder height at sale day was by far the most important factor in sale price. Sale price is also greatly affected by the season of the year. Bulls sold in spring sales average approximately $150 more per head than those sold in fall sales.
Accurate measurement is essential to the success of performance testing in Missouri. Since 1960, three testing stations have been started to assist breeders working with the Missouri Beef Cattle Performance Testing Program.

In 1959, a group of breeders organized to request a special appropriation from the state legislature to construct a testing station on College of Agriculture property at Columbia, Missouri. Funding was granted and the facility erected on the University South Farm in 1960. The first test was initiated at this site in the fall of 1960. Since that time the station has operated nearly continuously with two tests per year.

In 1970, a second testing station was started in northwest Missouri at Spickard and has been used to feed progeny groups of bulls for breeders. It is in continuous use for fall testing of 8 to 12 bulls per pen, with 10 pens available.

In the fall of 1979, a third facility at French Village, Missouri, was made available for testing bulls through the College of Agriculture. This facility was sold in August of 1981, with bull tests continuing for one year at this site.

All bull test station facilities under University of Missouri supervision are designed to be self-supporting. The cost is pro-rated on a per head basis to consignors. This system has worked well for nearly 25 years.

Occasional assistance from breed associations has helped keep costs down. In 1976 and 1977, the Missouri Beef Cattle Improvement Association purchased two pinpointer 4,000 machines and located them at the Columbia facility. Each machine is capable of electronically obtaining individual feed consumption for 15 bulls. Feed efficiency can then be computed from this data.

Test averages at Missouri stations are impressive. Ninety bulls were fed at Columbia in the spring of 1980 with an average daily gain of 3.79 pounds per day; 365-day weight of 1,158 pounds; and 47.43 inches shoulder height adjusted to one year of age. At Spickard 108 bulls were on test with an average daily gain of 4.09 pounds per day; 365-day weight of 1,180 pounds; and 47.19 inches adjusted shoulder height. The French Village station had 89 bulls with an average daily gain of 3.44 pounds; 365-day weight of 1,086 pounds; and 47.64 inches adjusted shoulder height.

In comparison with other stations throughout the nation, cattle at the Missouri stations ranked first, second and sixth. However, considerable difference in daily gain occurred. Testing has shown that location and breed percentages both affect station average daily gain. Although cattle at the three Missouri stations were all fed the same ration of about 70 percent Total Digestible Nutrients and 13 percent protein with other nutrients based on national standards, uniformity in daily gain did not occur. A comparison of average daily gain at several stations throughout the United States is shown below.

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<tr>
<th>Test Location</th>
<th>Number of Bulls</th>
<th>Average Daily Gain</th>
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<td>Spickard, Missouri</td>
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<td>4.09</td>
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<tr>
<td>Columbia, Missouri</td>
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<td>French Village, Missouri</td>
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The beef cattle industry has changed drastically in the past two decades as a result of research technology developed through the research efforts of the land-grant universities, USDA, and the Extension Service. Research has supplied the information for State and area livestock specialists in Missouri to disseminate to producers. Progress in the industry through selection of genetically superior, objectively evaluated economic traits and crossbreeding in commercial beef cattle has been dependent on a sound base of research.

For instance, the performance testing idea, which was first discussed in the early 1930s is an excellent example of applied research. The first research on performance testing was initiated by the United States Department of Agriculture at the U.S. Range Livestock Research Station at Miles City, Montana, from 1930 to 1935. Research conducted from 1934 to 1945 on many growth and carcass traits found the traits to be highly heritable and to provide a sound basis for selection. Research programs during this period were expanded into New Mexico, Texas and California.

As a result of USDA research, several linebred herds of Hereford cattle were developed through selections based on economic traits. The closed herd Line 1 family developed by ARS at Miles City has become the industry's most prominent family in the last decade. For example, the average sale price of Line 1 bulls during the late 70's was $10,565 compared to only $1,911 per head for other lines of bulls.

The reason for this difference in sale price is clear. Line 1 Hereford cattle are sound with good conformation, excellent meat quality, and a fast rate of growth. Weaning weight of Line 1 cattle increases by 22 pounds and yearling weight by 35 pounds per generation (about every four years). This is approximately twice the national breed average.

Missouri cattle compare favorably with Line 1. Bulls from the top 50 percent of all Missouri breeds enrolled in the beef cattle on-farm-testing program have increased in yearling weight 1.3 percent compounded annually since 1963. This would be about 45.36 pounds per generation as compared to 35 pounds for Line 1 bulls.

Research findings are having enormous impact on Missouri's beef cattle industry. Livestock in Missouri now accounts for over 50 percent of the total farm income with beef cattle providing about 30 percent annually. Since 1973, Missouri has ranked second in the nation in beef cow numbers. Since 1974 over six percent of all cows in the United States were in Missouri. This means that an enormous market for improved cattle exists within the state.

Researchers in Missouri have seized the opportunity to help upgrade herds. Missouri currently leads all states in purebred production as the top state in numbers of cattle, breeds and breeders. Much of this success is due to excellent cooperative efforts between researchers and the Extension Service.

Programs implemented by Extension to create awareness and bring about change as a result of research technology have used mass media, educational meetings, result demonstrations, and one-on-one enterprise planning and problem solving. These programs have helped this country create a vast natural resource of agricultural products not only to feed our own people but to provide commodities that are competitive for world trade.

Due to the large number of cattle in the state, Missouri has a unique need and opportunity to continually improve the genetic base of animals for increased efficiency of production and carcass quality. The purebred breeder, who is the architect of the industry, must continue to engineer genetic change as it is the only permanent improvement the commercial producer can build on to increase his economic returns. Consumers rely on the food production ability of this industry which is based on genetic improvement.

In order to facilitate this change, Extension must continue to assist breeders in implementing new research findings and technology. Without this essential interface with research, most breeders would find progress difficult at best. By working together, researchers, breeders and extension specialists can help meet the ever-growing challenge of consumer demands.
Economic Impact of the Missouri Program

While determining the economic impact of the performance testing program in Missouri in absolute terms is difficult, it is possible to project an estimate using some realistic assumptions. A conservative estimate could be arrived at as follows:

**Economic impact on commercial breeders:**
The aggressive performance testing program carried out in Missouri has had a major impact on the pounds of feeder cattle sold in the state as well as on the weight of cattle fed out. Since genetically increasing weight at weaning is a slow process, the cumulative benefits of the program over many generations has been important in helping Missouri's cattlemen to maintain a competitive edge in producing beef calves.

For example, average genetic sire improvement over the last 10 years would be expected to add 12 pounds to the weaning weight of each calf produced. The 2,122,000 cows on Missouri farms January 1, 1984, produced approximately 1,761,260 calves. Twelve pounds increased weight per calf would generate a total of 21,135,120 pounds additional weaning weight attributable to genetic superiority gained through Missouri’s on-the-farm performance testing program.

If we assume a value of $70 per hundred weight for calves in the 400 to 500 pound weight range this year, $14,794,584 would be added to the annual income of commercial cattle producers and to the state's economy as a result of the program.

**Economic impact on consumers:** Increased weight from performance testing has kept the cost per pound of producing beef lower than it otherwise would have been. Also, the characteristics selected for in performance testing have led to the production of animals that are meatier, more nutritious and more appealing to today’s consumer. Thus, consumers have benefitted directly from much of the gains from performance testing.

**Economic impact on agribusiness:** In recent years, receipts from the sale of beef cattle in Missouri have totaled around two billion dollars annually. This income is used to purchase inputs and supplies for the farms and homes of rural Missourians, creating a significant portion of the economic activity of the state. Not only does the increased value as a result of performance testing add to economic impact, but the magnitude of economic activity is heavily dependent on Missouri producers maintaining a competitive edge with other parts of the country.

**Economic Impact on natural resources:** Missouri has a severe erosion problem and many soils of the state are too steep to be farmed in row crops without intolerable soil loss. Helping maintain productivity of beef cattle through performance testing has allowed producers to retain Missouri's position as a leading beef cow state, thus enabling them to realize a return while utilizing more sloping land for forage production.

Three-way cross calf, a product of Missouri's research program.
Milestones in Performance Testing

Some of the earliest efforts in what we now call performance testing began in Missouri in the late 1930's. Bill Ewing, then State Extension Specialist, established early performance testing goals and measurement based on the idea of a 500 pound calf at weaning. Throughout the country other such efforts were being made under various names.

Performance testing continued to grow as herd improvements were noted. The first central bull testing station was established at Balmorhea, Texas, in 1941. In 1955 the first state beef cattle improvement association was established in Virginia followed by associations in California, New Mexico and Montana. The Red Angus Association, formed in 1954, required performance data for registration and was the first breed association to adopt such records.

In 1955, the Performance Registry International was established in Texas and is still functioning today to promote performance testing and record keeping among all breeders. The first official effort to weigh and systematically record performance on both weaning and yearling beef cattle was initiated in Missouri by Dr. Homer B. Sewell in 1959. His work was instrumental in helping breeders obtain a special appropriation from the legislature to build a central testing station at Columbia in 1960.

Since that time nearly all the major breeds are represented in associations and provide computerized performance records for their breeders. Angus began in 1958, Hereford and Polled Hereford in 1964, and other breeds in the 60's and early 70's. The Simmental Association was the first national breed association to publish a national sire summary in 1972. Now, Angus, Hereford, Polled Hereford Limousin, Shorthorn, Maine Anjou, Charolais, and Red Angus breeds each publish national sire summaries.

Missouri remains a leader in promoting performance testing. The Performance Registry International Association headquartered in Joplin, Missouri was organized and chartered in 1955. The Missouri Beef Improvement Association was organized in 1967 and chartered in 1968.

For 25 years college of agriculture Extension Specialists and researchers, the national breed organizations and breeders have joined efforts as the National Beef Improvement Federation. Their goal is to develop uniform procedures for measuring, recording and evaluating important economic traits of beef cattle.

Missouri programs have made some significant contributions to improvements in the industry throughout the state and nation. The Missouri effort has caused the industry to change from a subjective system of evaluating breeding herds to selection based on objective records of performance for reproductive, physiological and morphological traits.

Some highlights of Missouri's program include:

- **The first systematic record of performance on weaning and yearling weight** of beef cattle in Missouri was begun by Dr. Homer B. Sewell in 1958, and has been further developed by Dr. John Massey. The American Hereford Association reports an increased weaning weight of 25.5 pounds since 1964—about 21 pounds less than weights reported for cattle on the Missouri Performance Testing Program.

- **Missouri Extension Specialists and researchers developed the present objective frame score system** which is used in Missouri as well as nationally.

- **Over 120,000 individual preweaning records have been computerized** on the Columbia campus. These records provide data for area and state livestock specialists to evaluate industry changes and help breeders solve problems and select appropriate herd replacements.

- **Thirty-seven sales of performance-tested bulls** have been held at the University of Missouri-Columbia. This activity brings over 1,500 people annually to the Columbia Campus.

- **From 1963 to 1984 sale prices of bulls have increased significantly.** Increased awareness of the value of performance testing has caused the demand for tested bulls to rise rapidly.
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