DR KEITH G. ZOELLNER
3104 PAYNE DRIVE
Manhattan, Kansas 66502

# PROCEEDINGS

## BEEF IMPROVEMENT FEDERATION

EASTERN REGIONAL CONFERENCE

November 19 & 20, 1972
Sheraton Inn
Montgomery, Alabama

Regional Beef Improvement Conference

Sheraton Inn, Montgomery, Alabama

November 19 & 20, 1972

Directors' Meeting -- November 19
General Meeting -- November 20

Welcome - John Besh, President, Alabama Beef Cattle Improvement Association

BIF--Its Origin & Objectives - Frank H. Baker, BIF Secretary & Chairman, Animal Science Department, University of Nebraska

The Significance of BIF Guidelines for Uniform Beef Improvement Programs - Will Butts, Investigations Leader, Beef Research, Southern Region, ARS, Knoxville, Tennessee

The Practical Utilization of Records in Breeding Herds - L. A. Maddox, Extension Beef Specialist, Texas A&M University

Development of Predicted Breeding Values - Richard Willham, Professor of Animal Science, Iowa State University

An Overview of State BCIA Programs - A. L. Eller, Jr., Extension Beef Specialist, Virginia Polytechnic Institute

Progress in Breed Association Programs - Jack Richey, Bovine International, Inc.

Progress in the PRI Program - Clarence Burch, Mill Creek, Oklahoma

Luncheon Address - John Trotman, President, American National Cattlemen's Assn.

BIF Committee Meetings

Beef Improvement Federation
Board of Directors Meeting
2:00 p.m. -- November 19, 1972

Present: Craig Ludwig, Fred Francis, Mack Maples, C. C. Mast, E. J. Warwick, Clarence Burch, Ray Meyer, Max Hammond, Dave Nichols, Dixon Hubbard, and Frank Baker.

A progress report on the participation in the Beef Carcass Data Service program was given by Frank Baker. The Board directed the Secretary to charge member organizations the same charge for eartags as BIF was charged by USDA. It was also indicated that additional attention needs to be given to getting facts about BCDS to all parts of the industry.

The report of the Symposium Program Committee was revised. The Symposium in 1973 will emphasize (1) research on live animal evaluation and grading in relation to performance testing and (2) research on beef production simulation programs. Participating speakers will receive complimentary registration at the Symposium but must bear their own travel and lodging costs. The President will contact the speakers' employers to establish the importance of the BIF Symposium.

The plan for the selection of the continuing service awardees was discussed. A motion by Ludwig, seconded by Hammond established the procedure as follows:

(1) A maximum of three Continuing Service Awards will be given in any year.
(2) Member organizations will nominate candidates by February 15, 1973.
(3) The Board members will review the nominees and vote by mail ballot as to whether to give 1, 2 or 3 awards that year.
(4) On the mail ballot, the Board members will rank the nominees for the Continuing Service Award.
(5) Awardees will be selected by tabulation of the composite rankings of the Board members voting.

A motion by Burch, seconded by Francis established that the BIF Board would add representatives to the National Sire Evaluation Committee to achieve representation needed in the active programs.

A motion by Ludwig, seconded by Hammond authorized appointment of a "new breed representative" to the National Sire Evaluation Committee.

The publication of a leaflet on bull selection using records was discussed and authorized.

Meeting adjourned 5:30 p.m.

Recorded by

Frank H. Baker, Secretary
Beef Improvement Federation

# "One Step at a Time"--BIF Maturation

by

Frank H. Baker
Animal Science Department
University of Nebraska

A preacher friend recently repeated a boyhood experience of Methodist notable Roy Smith. The setting was on a Kansas farm and the boy's father was ill. In late evening he called the boy to his bedside and outlined instructions for the evening chores. As the boy stepped out the back door, he became panicked by a fear of the dark. Returning to his father's bedside the boy said, "Father, I can't do the chores because I can't see the barn." With great patience the wise father said, "Son, light the lantern and take it in your hand and step out the back door. The light of the lantern will show you the beginning of the path to the barn. Take one step at a time along the path and the lantern light will show you the next step all the way to the barn."

'Tis my belief that BIF is the lantern and we the performance testing advocates are the small frightened boy on the beef improvement path leading to the future of the cattle industry that is not visible to us. Like the small frightened boy we are taking and must continue to take one step at a time.

A quick review of the "Beef Improvement Past" shows that performance testing itself for the industry and for individual producers has moved forward one step at a time; weaning weights--gain tests--yearling weights--lifetime performance--carcass evaluation--progeny tests--sire evaluation--performance pedigrees--calculated breeding values--selective registration!

Similarly, a review of the breeder's attitudes existing toward this type of beef improvement program shows that change has happened one step at a time; "Who needs scales"--"I'll weigh a few behind the barn"--"Weaning weights are o.k. for within herd improvement"--"Look at my herd average; it's better than Joe's"--"Buy this calf, he's 15% above the herd average."--Bull tests are not for me--well maybe--o.k. I'll try it--say, I like it!--Progeny tests are not for me--You say my bull would do o.k. based on his performance record--o.k. let's do it--Based on this progeny record, I got the best bull east of the Pecos River!" One step at a time, but attitude changes are slower than cattle improvement. Perhaps the generation interval for new ideas (about 25 years) is five times as long as the generation interval of cattle (about five years).

BIF is a federation of state and national organizations concerned and interested in speeding up the process of improvement of cattle through the use of performance records. BIF was planned, founded and is maturing--one step at a time!

Step 1--Standardization--This was that very first step on the path. Experience in the U.S. Beef Records Committee set the stage for development of the "BIF Guidelines for Uniform Beef Improvement Programs" which is now in the second edition. The usefulness of the "Guidelines" and needs in carcass evaluation opened the door for cooperation with the American Meat Science Association in development and publication of "The Recommended Procedure for Carcass Evaluation and Carcass Contests."

Step 2--Cooperation--Perhaps this should have been or was Step 1 because much cooperative effort did go into the development of the plans for BIF and the development of the "Guidelines." I consider cooperation as Step 2 because cooperation seldom, if ever, happens without there being reason for it. Need for standardization was the reason for cooperation. Ten years ago it was very difficult to arrange a meeting to bring together representatives of all state beef improvement associations, breed associations, PRI, NAAB, ANCA, etc. Today, we not only meet together but we attack problems with strength of cooperation and unity. The impact of this type of cooperative effort in the beef industry has been and will continue to be far-reaching. It came into being by approaching problems--one step at a time!

Step 3--Education--Using truths and understandings generated through research have been a challenge to individual beef producers and their organizations. One of BIF's objectives and certainly a key step in its maturation is assistance to its members in educational programs. Committee activities, committee reports, and publications have been oriented to speeding up the flow of information from the research herd or laboratory to the profit-making herd. The creation of the BIF Research Symposium as a part of BIF's annual meeting was another step forward in education. This symposium created a forum where key beef researchers and industry leaders could enter into face-to-face dialogue on current and relevant research data. This regional conference is another step forward in beef improvement education in which BIF has been involved. It is a giant step forward for beef improvement and we will take others, one step at a time!

Step 4--Confidence--The founders of BIF back in the 60's expressed great concern that the beef industry seemed to lack confidence in the performance concept and performance movement. Thus, those founding fathers set as one of BIF's objectives "increasing the confidence of the beef industry in performance recording and its use in cattle improvement." Today, we are just arriving in position to really take a big step or several big steps in further improving cattlemen's confidence in these concepts.

Will "Mr. Average Cowman" have confidence to buy his bull sight unseen over the telephone or by mail on the basis of performance information provided? Some evidence suggests that he will--at least some "Mr. Average Cowmen" have been buying beef semen from bulls and breeds of bulls they have not seen.

Will the beef industry really have confidence in sire-proving techniques of the National Sire Evaluation Program to utilize the full potential of the system? Experience with other new techniques shows that the industry will move forward with caution--but that's really what we are talking about, moving ahead--one step at a time--is it not?

Step 5--Future beef improvement--This is really the eternal stepping process in which BIF should always be. We can't fully visualize tomorrow's improvement programs. They may be anything from analysis of breed data through simulated production systems to use of combination weight and leanness recording devices, to recording and data analysis systems using voice inputs. We can only hope that BIF can contribute to program development and implementation. BIF owns no cattle, has no paid employees, rents no buildings, runs no computers, has no regulatory authority. A critic might say that in one sense of the word BIF is nothing. Some of us who were involved in performance testing activities before BIF was formed and are still involved, hold a belief that "Because BIF is nothing as the critic says, it will be everything in the future of beef cattle improvement." The reasons are:

**Because BIF owns no cattle it represents all cattle and it has no preferences as to breed, color, etc., and truly seeks improvement of cattle.

**Because BIF has no paid employees all people who are involved with BIF are special people sufficiently dedicated to principles of beef improvement to spend their time and money to work on BIF programs.

**Because BIF has no physical property it can be totally uninhibited in offering new concepts for consideration of the industry.

**Because BIF has no regulatory authority it can function totally in creative activity for the benefit of cattlemen and the cattle industry.

In the final analysis, encumbrances of cattle ownership, physical property, regulatory authority and personal employment sometimes create some blindness toward new concepts--darkness, if you please! As the wise founding fathers of BIF might have said, "Light the lantern to show the path toward the beef improvement future." I think they would tell us today to keep moving along that path "one step at a time."

# An Overview of State BCIA Programs

by

A. L. Eller, Jr.
Extension Specialist
Animal Science Department
Virginia Polytechnic Institute and State University

As we discuss this subject of state BCIA programs and their role and position in the scheme of performance records in the country, I think it is necessary that we look at their history, their reasons for growth, their strongpoints, their problems, and possible solutions. It is also important to assess the BCIA role in a contemporary situation where many organizations who are members of the Beef Improvement Federation are engaged in the business of keeping performance records for member breeder herds.

Let's quickly look at why state BCIA's were organized. About 20 years ago, research showed that performance testing might be a tool which would be valuable in improving the accuracy of selection. There was a tremendous amount of interest generated in a small number of breeders and the land grant universities of many states became interested from a standpoint of collecting field data for research uses in arriving at better genetic and environmental perameters. At this time there was no one else in the business of providing performance testing services to breeders. Thus the land grant universities through their research arm and Extension arm became involved. Out of this involvement grew state beef cattle improvement associations.

If we look at why state BCIA's have grown and flourished throughout the country, we might list these as reasons:

(1) Land grant universities through their Extension services were able to provide grassroot contact with breeders.
(2) Lots of services have been provided including consulting, grading of cattle and individual breeder attention.
(3) Scheduling and performing weighing and grading services.
(4) Quick data processing services.
(5) The educational arm, through local Extension units, was close to the breeder.
(6) State programs have all been unique and not exactly alike and have evolved so that state records were better understood by breeders than were PRI records or breed association records.

Next I think we should look at the way in which PRI and breed associations performance programs have evolved and what they have added. PRI came along about 20 years ago at approximately the same time that the first BCIA's were organized. They have provided a great service to breeders throughout the country who were already involved in state BCIA programs but more especially those that did not have a state BCIA program in which to participate. PRI has furnished some records and services as far as certifying performance that state BCIA's have never furnished. Basically, however, PRI has not furnished an overall service that was different than services offered by state BCIA's. Certainly they have not been able to give individual breeders the close attention that state BCIA's have been able to do. PRI, however, has done a great service to performance testing and cattle breeding by selling performance testing on a

nationwide scale that perhaps no other organization was in the position to do.

Breed associations were rather slow in getting into the performance testing program. Each breed association when they did set up a program, set it up slightly different than any other breed or state BCIA program. There was very little local interest or education or services furnished by the national breed associations. Breed association programs have however, gained momentum in the last five years with emphasis on performance records as a prerequisite to register in some instances and for use of performance pedigrees and/or performance certificates. Breed association programs have become strikingly alike through the efforts of participation in BIF. The cost has in general been very attractive to the breeder in most breed association programs. It would appear at this time that breeders of registered cattle should certainly consider recording the performance of their cattle with their national breed association just as they record geneology.

I have already alluded to the contribution of the Beef Improvement Federation in this whole evolution of the organizations who handle performance records for breeders. Certainly BIF has tended to standardize procedures for all breeds and all associations including state BCIA's. At this time, perhaps, state BCIA programs are still more different from these BIF recommendations than are breed association programs. This evolves from the fact that it is harder to change programming for computers on state level because of cost and personnel than it is in breed associations. BIF activity has certainly improved the understandability and credibility of performance records. On the other hand, BIF standardization procedures may have damped off efforts by some research groups and state BCIA's in looking for new and better answers. Certainly end points and certain adjustments are not and should not be the same for all breeds and all areas, but at this point all are using standard procedures since BIF has drawn associations together in this regard. The overall effect of BIF has certainly been a good one and was very necessary in pulling all associations together insofar as standardization of procedures and understanding one another is concerned.

Now let's look at the problems we face in state BCIA's and in the performance testing endeavor in all facets. There are two major problems that we all face: (1) not enough participation; and (2) not enough use of the records that are obtained. These problems are inherent to state BCIA's, breed association programs and all others.

In state BCIA's there are several problems facing individual associations. Many of these are common to practically all state BCIA's:

(1) Computer services in the land grant university. Many state BCIA performance testing programs are being forced out of the university computing centers either from a standpoint of cost, frequent change of equipment, lack of qualified programmer assistance, or a change in Extension or experiment station policy which may threaten the backing of performance programs, many of which have been paid for in total by Extension or experiment stations. At this time a number of state BCIA's are searching for a place outside their state land grant university to get computer services.

(2) Participation in the program. This is perennially a problem for many state BCIA's. Because of certain limitations, state BCIA's are unable in many instances to promote more participation then they now have.

(3) Weighing, grading, and scoring services are harder to render to large numbers by the state BCIA's and are being phased out in many instances. These type services tend to hold participation down.

(4) Viability of the state beef cattle improvement associations. In many instances state BCIA's are not strong organizations and have been highly subsidized by Extension and research from the land grant university. In many instances these organizations are not getting stronger but are, perhaps, getting weaker. In many cases a performance testing endeavor is strictly an Extension function. The breeders are not really active in the organization nor in the decision making.

(5) State BCIA's in many instances without financial support of Extension or research could not function. Practically no state BCIA is paying all costs.

When we assess problems with BCIA's, I think it is fair to look at some of the problems that breed associations face in their performance testing programs. In general one of their greatest problems is participation. Participation in the southeastern states particularly is poor in breed association programs from a standpoint of numbers, herds, and percent of cattle tested in these herds. Breeders in many instances are not completely performance testing their herds in national breed association programs. They are sending in a selected group of cattle for computation. Another problem, of course, is that the educational job for those breeders in breed association programs is not getting done as well as the breed associations would like. Again they do not have the personnel at the grassroots level to get this job done as well as would be desirable. Breed association performance programs have tended and will tend to get more and more sophisticated and this in itself, while being good, will necessarily require more educational thrust for breeder understanding and use.

When we look at the overall problems with state BCIA's, breed associations, PRI and others, we would have to say again that participation is not what it should be and that records utilization is not what it should be. The total educational job, while improving through standard procedures, is not really getting the job done. In the final point as far as overall problems are concerned, the beef industry and certainly the purebred breeder cannot afford the duplication of effort that he is required to do when he participates in both his state BCIA program and his national breed association program. This duplication really is unnecessary and should be corrected.

When we get down to the summary of the matter, I think we should ask ourselves what approaches shall we use for strengthening the entire beef cattle performance testing endeavor in the best interests of total beef cattle improvement. It appears to me there are two or three approaches that might be taken. One approach would be to plow greater effort into our state BCIA's and strengthen them and attempt to get a higher percentage of the purebred breeders in a state participating in the state BCIA program. If this approach is taken, folks in state BCIA's would more or less ignore the national breed association programs.

Another approach would be to strengthen the state BCIA's insofar as organization and decision making but work to bring about some marriage of the national breed associations and the state BCIA's so that breeders in a state would be BCIA members and be active and would receive some service from state BCIA's but their records would be processed in their national breed association. It appears to me that this approach is certainly one worth working on.

State BCIA's will continue, no doubt, to process a large number of performance records. Certainly they will be processing a lot of the records on commercial cattle and on certain BCIA herds where the breeder does not want to participate in his national breed association and with this load of work, it will become necessary to centralize much of the computing work that is now being done in state land grant university computing centers.

It appears now that we face a crossroads. We should not let petty jealousies between any of our programs stand in the way of greater participation and utilization by breeders. The breed associations and the state BCIA's need to sit down around the table and find the ways of most efficient operation. BIF provides the bargaining table.

# The PRI Report

by

Clarence Burch
Mill Creek, Oklahoma

As you know I represent PRI on the BIF Board; however, I would like to think I represent the practical beef breeders and producers of the United States.

With the computer age and world competition the cow production operation finds it necessary to keep complete records. Records make history. Records are recorded that we may study the past. Records direct the present. Records foresee the future.

PRI was the first official organization to recognize records as an important part of beef production operations. Further we recognize that the ultimate use of all beef cattle is meat which is purchased and sold by grade, quality and pound.

For us, the CMS program in PRI is one of the most practical ways for the average producer to test the progeny of a herd sire. CMS is also the carcass evaluation program of the progeny of sires to be checked for growth, gain, grade and the economic traits that will make profit for all segments of the beef industry and give the consumer a high quality protein beef.

Every purebred breeder should know the carcass evaluation of his herd sires that will transmit the economic traits to his progeny. The registered breeder's records, performance testing and carcass data puts him on common ground of direct interest with the commercial beef producer.

PRI is the working man's tool that has a practical application.

Mr. Glenn Butts, the Executive Secretary of PRI gave me this brief report. PRI has over 100,000 cows enrolled and 90% of those will have at least 2 performance weights certified. PRI has printed 20,000 performance pedigrees. PRI has received 67 certified meat sire nominations and 25 CMS award certificates have been issued in the past 6 months.

Most significant is the GENERATION II TEST & REGISTRY SYSTEM in operation. In this system:

Cards are used only for initial input. All data is stored internally in an index sequential electronic file for:

a. Retrieval of any data including cross industry (beyond across a breed) retrieval of sire performance.

b. Production of PERFORMANCE PEDIGREES from the only all breed genology and performance file in existence.

c. Cooperation with all breed associations.

d. Custom service to any breed association including accounting service.

e. Complete inventory control.

f. Maximum convenience (sorts on inventories and worksheets), minimum paper work, prompt service.

g. Convenient organized space for breeder management observations (breeding dates, DVM, etc.).

We were number 3 to sign a complete herd record in the Oklahoma BCIA. We were the first herd to have a complete computer record in PRI. We spent a lot of time, effort and money to continue this record system for the next few years without too much profit. Why? Because of this from the USDA Yearbook of 1937, "Animal Breeding at the Crossroads." I quote, "Too often, as already noted, pedigrees are not of the right type and thus have little or no practical value. The most valuable pedigree is one that gives the full performance record--bad points as well as good points. A desirable breeding animal is one that is directly descended from proved individuals on both sides of the pedigree."

I have found record keeping to be a challenge and like to see the progress we have made down in black and white. Records make it possible for us to analyze our herd. With records our management has improved. Therefore, genetic performance and carcass evaluation records made it possible for us to improve the Angus breed and add to the economics of the beef industry.

What did we do mechanical wise? Practical corrals and lot improvements to make scales part of the operation. We say certified records with 99% of the weights are weighed by the extension agent, agriculture department of Murray State College or a county Angus breeder. When we weigh a pasture all calves are weighed for 205 day weight and cows are weighed if calf is 160-220 day of age. If not, the calf will be weighed again between above ages. Therefore, we have two weights on most of our calves.

All bull calves have adjusted 205 day weights, 140 day gain test weights and 365 day weights. Any animal still on the place will have a 16 month adjusted weight to check the growth factor. All bulls not qualifying for a BAR brand in performance, weight, gain, growth factor, structural soundness and breed character (out of 140 day test) go direct to the packer. Heifer calves having adjusted 205 day weights go back to the pasture with only feed to keep them growing if necessary. Heifers still on the place will be weighed again for 365 day weights and 16 month adjusted weight.

Only records of total performance on all cattle can give you a true sire and dam analysis, ratio or index of inter-herd comparison. We need these as our calf crop will often have as many as 11 sires. The reason being we add 3 yearling sires a year to the bull battery.

Again I say every breeder should know the carcass evaluation of his herd sires and the CMS program of PRI will do that. I still insist that just a few records on some of the better cattle might be more misleading than no records at all. Why do I say records? We keep two sets of records--one in PRI and one in AHIR. Some of our breed associations were slow to recognize the value of performance records.

Performance records have made us a profit. Performance records have made us better managers. Performance records have made a contribution to the Angus breed and to the beef industry. Performance records have made us better Christians--it stopped us from lying!

And this to you gentlemen of the second generation and others: I would like to close with this story. There was once a very knowledgeable and wise professor whom students admired and to whom they went to seek counsel. One day a group of students plotted together in determining some means whereby they could discover the limitations of the professor's wisdom. Finally an idea was accepted. The students would take a live bird and place it behind their backs and see if the professor could identify what they had. In case he did--one would ask the professor if it were a dead bird or a live bird. If the professor said it was a dead bird, they would show it to him in a live state. If he said it were a live bird, they would kill it and then show him that it was a dead bird. They got the bird and went off to find the professor. As planned one of the students held the bird behind his back and another asked the professor, "Professor, what does he have behind his back?" The professor said, "I perceive by a feather on your shoulder that you possess a bird." They were all delighted and said, "Yes, professor you are right as usual." "Now, professor is it a dead bird or is it a live bird?" The professor slowly turned from one to the other, and in a quiet voice said, "IT IS IN THY HANDS."

# PRODUCTION AND QUALITY CONTROLS FOR LARGE RANCHES

L. A. Maddox, Jr. *

As ranchers get larger with some owners hiring professional managers and as owner-managers try to make their investments and management ability more productive, new record systems for large ranches must be developed.

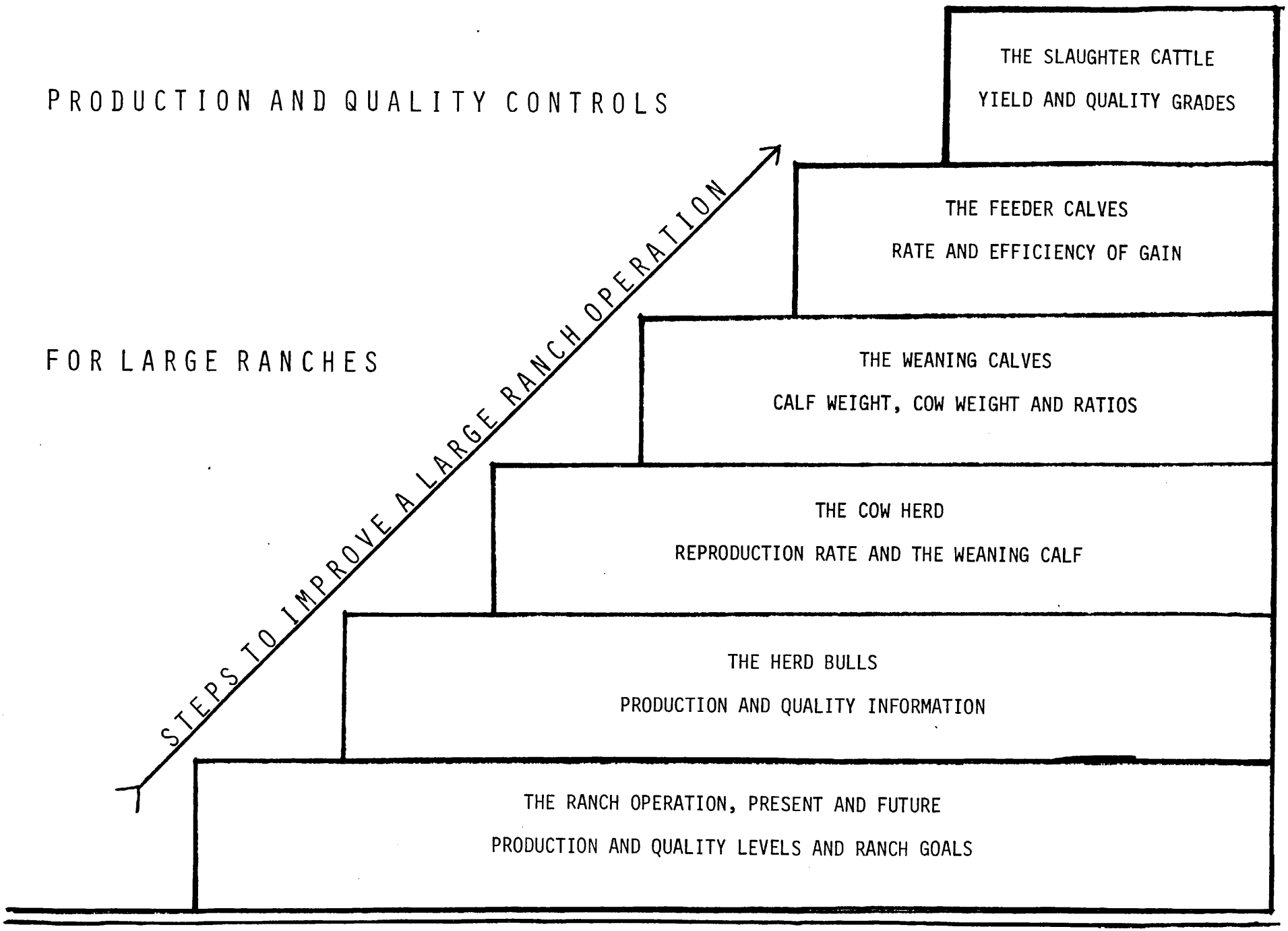
By combining records on production and quality of product into a management control system, a more modern and more scientific approach can be developed for these ranches. The control information - production and quality - measures in some degree, the biological processes that are typical in today's beef production. To direct these biological processes, management must have measurements taken from time to time to indicate if the processes are operating in a normal manner or deviating sufficiently to justify corrective action and then a study should be made to determine the cost of correcting the situation.

The Texas cattleman has been noted for his ability to keep records in his head or in his small black "tally book" carried in his shirt pocket. Ranchers had to improve their business records when government began requiring proof of income and expenses to establish proper tax contribution. As these laws became more complicated it became necessary for ranchers to establish annual income, deductible expenses, capital gain, what could be depreciated and a depreciation rate. All of these records, whether kept by the rancher or an accountant, gives the rancher a general profit and loss picture but gives little or no help identifying biological problems.

* Extension Beef Cattle Specialist, Texas A&M University

PRODUCTION AND QUALITY CONTROLS

FOR LARGE RANCHES



The greatest challenge to people working with beef cattle records is to develop measurements of the biological processes on ranch operations that can be used to identify breakdowns in these processes and suggest corrective measures to make them behave in the normal manner.

Owners and managers have always had to watch for problems in a ranch operation that could become serious. Now production and quality control records can be assembled to help owners and managers make decisions more accurately. Other problems still will have to rely on this "sixth sense" of the cow man until better measures of productivity and quality control have been developed.

Individuals, partnerships, estates and corporations with investments in ranching operations, as well as many in management, are looking for practical records and summaries that will help in making decisions affecting future ranching operations. The following records and summaries should be considered. Not all of them are necessary for a particular ranch operation. You may want to develop additional records and summaries that would be of particular help to your ranch.

The Ranch Operation, Present and Future

The three most important ingredients in a ranch operation is the piece of real estate called the ranch, a group of cows and bulls called the breeding herd and the individual controlling the land and cattle called the rancher. The ranch, the breeding herd and the rancher are each truly unique in that there is no other peice of real estate with exactly the same climatic conditions, soil type, soil conditions, native forage, undersirable range plants or ability to respond to pasture improvement or range management.

The breeding herd has a special uniqueness because of the characteristic of the original cow herd, how and why cattle were culled, the method of selecting replacement heifers and the kind of herd bulls the rancher has used.

The uniqueness of the rancher can be illustrated by the fact that no one else has exactly the same education and experiences to serve as a basis for making decisions. Each rancher has different goals for himself and his family and will react different on such things as the value of range and pasture improvement, the reasons for his selections of breeds or crosses of cattle to stock the ranch, the amounts of money he will invest in replacement bulls and his methods of marketing the cattle produced on the ranch.

Before a rancher embarks upon a continuing record of production and quality characteristics, it seems reasonable that his first step should document his present production and quality levels and set some goals for a period of 5 to 10 years in the future. The Form C-1 "Production and Quality Levels and Ranch Goals" furnishes an easy form to record such production characteristics as numbers of and percentages when applicable to, cows bred, calves born, calves weaned, acceptable calves weaned, average weaning weight, average cow weight, rate of replacements of bulls and rate of replacements of cows. To document the quality level of the young cattle produced on the ranch, there is a place to record such traits as age into feedlot, weight into feedlot, length feeding period, rate of gain in feedlot, weight of finished cattle, quality grade of finished cattle and yield grade of finished cattle for both steers and heifers.

The goals that you would establish for the size of the breeding herd, the production and quality characteristics will be unique because you are trying to put together the ranch, the breeding herd and the rancher which are each unique within themselves. The goals should reflect what appears to the rancher to be the necessary changes in production and quality to establish the most profitable ranch operation within his own personal preferences.

A completed Form C-1 "Production and Quality Levels in Annual Goals" on a ranch operation gives an accurate record of the year's activity. These records over a period of years will show changes or lack of changes in such things as cows bred, calves born, calves weaned, acceptable calves weaned, average weaning weight, average cow weight and rate of replacement of breeding animals.

On those years that you check the quality of your weaned calves, you should record such things as age in the feedlot, weight in the feedlot, age into feedlot, weight into feedlot, length feeding period, rate of gain in feedlot, finished weight, and yield and quality grades.

Desirable changes in production or quality characteristic should reflect improvement in management. Stable levels of production in problem areas indicates the need for management changes. The number and percentage of breeding animals that are replaced will indicate the possibility of genetic changes causing changes in production and/or quality.

Genetic change is slow on most large ranches. This is particularly true when the only addition of new genetic material is the addition of about 20 percent of the breeding bulls to replace the ones that must be discarded. When new bulls introduced at this rate are of the same breed, same breeding and same type, it is doubtful if one could identify any real change from these records in less than 5 years.

Major changes in breeding programs, such as purchases of 30 percent or more new bulls of a different breed with different production level or the purchase of 30 percent or more replacement heifers of a different breed or a cross, could result in an identifiable change in weaning weights, selling price, rate of gain, economy of gain, yield grades and quality grades in one generation.

The Herd Bulls

Probably the most overrated advice handed down from one cowman to another in the past 150 years is "buy a good bull." The idea of improving productivity and quality within a cow herd by introducing superior genetic material through the sire is sound because in one year he becomes one half of the genetic material of the calves being produced. The great problem to the cattlemen, at least within the last 40 years, has been what is a good bull and how can I recognize him. Research work on procedures to measure production and quality characteristics started at Miles City, Montanna in 1936. The first real attempt to develop testing procedures that could be used on a national basis resulted in a formation of Performance Registry International in 1955. The refinement of these testing procedures and the records programs developed by breed associations makes it possible at this time to buy bulls with performance and/or production information that will reliably predict their breeding value on many production and quality characteristics.

The use of performance and production tested sires with a natural or by artificial breeding has probably resulted in the greater improvement in productivity in the last 10 years and any similar 10 year period in the history of cattle breeding. There are many different kinds of records to indicate productivity and quality in young beef bulls. The suggested information on young commercial bulls outlined in Form C-2 "Production and Quality Information" suggests a 205 day weaning weight and the weaning weight ratio of all of the bulls purchased within a given year. Added to this information should be production information on paternal half sibs (calves sired by the same bull). If the registered breeder has good information on the productivity and quality of product of half brothers, then you can buy young bulls at weaning time based on these records with considerable confidence, without the extra expense and possibly some injury to breeding ability because of over feeding.

## The Cow Herd

Most large ranchers immediately loose interest when some kind of individual cow record is mentioned. The records can be maintained without large amounts of labor provided we leave out much of the details associated with good record programs for registered breeders. The detailed records are important and useful for registered breeders, but are too expensive for large commercial ranches.

Any individual cow record on large ranches will require some kind of number identification on each cow in the breeding herd. This should not be considered as an unusual task since other industries individually identify production machinery. This number can be a fire brand, an ear tag, a neck chain or a neck band.

### First Choice

An individual cow record for large ranches does not require each calf to be identified with its mother. A record showing only the identification number of each cow that did not calve and of each cow that produced a "reject" calf is all that is necessary to establish a useful individual cow record. This should be 30 percent of less of the total herd. Those cows that calve regularly and produce acceptable calves would be considered to be producing normally, and records would be so marked.

Palpation of cow to determine pregnancy will furnish additional information about the biological behavior of your cow herd. If percent calf crop is going to be low as indicated by the number of cows palpated open, you can begin corrective action and start making plans for the cows that will not calve.

With a lifetime record on a beef cow, recording on Form C-3 "Reproduction Rate and the Weaning Calf," it will be convenient to identify the age of the cow, the number of times she has calved and the kind of calf produced. If it is possible to palpate the cow, then you can have a record of non-pregnant cows before the calves are weaned.

Each line on the Form C-1 records should identify one calf crop year. This can be identified best by the year these calves are weaned. If cows are palpated, the month can be identified and recorded as pregnant or open. If this cow's number is not on the list of dry cows at the end of the calving season, the record should show that she has calved.

Identification of dams that have produced "reject" calves can be done by selecting these unacceptable calves at or near weaning time. Turn all cows and "Acceptable" calves out in the pasture leaving the "reject" calves in the pen. Record the identification numbers of the cows that are still around the pens 12 to 18 hours later.

Records showing that a cow failed to calve or raised a reject calf will give some indication of her lack of (1) genetic ability for reproduction (2) proper nutrition for rebreeding (3) genetic ability for acceptable conformation (4) genetic ability for milk production (5) proper nutrition for milk production and/or (6) freedom from diseases or parasites. When average production levels are good, the dry cows and dams of reject calves should be considered culls and sold for slaughter.

A comment made in the "remark" column may be useful later in evaluating a cow's record. Unusually circumstances affecting production of individual cows usually are not remembered accurately and should be recorded as soon as possible.

Second Choice

If individual identification of the breeding herd and individual record on each cow seems impossible then similar results can be obtained by making the cow be her own record system. If a cow is identified as a dry cow, she can be permanently marked by using a special ear mark, tipping a horn or some kind of a fire brand. A similar procedure can be used to identify all cows that produce "reject" calves. For example a cow that fails to conceive might have her left horn tipped, her left ear cropped or a zero branded on the left jaw. The cows that produce reject calves have the right horn tipped, the right ear cropped or a "R" branded on the left jaw. Systems similar to this have been used in many countries and allows a rancher to always have all of the information available on the production characteristics of a cow when he is looking at her and needs to make a decision about her future.

A Combination Of Both Systems

A rancher who would like detailed records on the productivity of the breeding herd in an office to study the effects of certain management systems and might find himself in a position of needing to make a decision on the future of an individual cow without the written records might want to use both systems.

The Weaning Calves

Calf and cow weights can indicate many things related to production efficiency. These weights can be recorded on an annual basis on Form C-4 "Calf Weights, Cow Weights And Ratios." These are not individual weights but group weights taken at the time the calves are weaned. If calves are weaned and sold at one time, the calf weights would be available. The weight of cows or the weight of the random sample of cows also would be excellent information. This information will have some meaning as annual weight records. The trend of the calf weight and cow weight over a period of years will reflect some changes in nutrition level, and possibly some genetic change. These two weights can be expressed as a weight ratio using weaning weight as a percentage of mature cow's weight. Both calf and cow weights will become the basis for many comparisons in subsequent records that will help answer questions about the overall efficiency and profitability of the ranch operation.

Correction factors for both calf and cow weights should be used if the groups are divided in such a manner to make the weights at different ages available.

Correction For Calf Weights, lb.

| | British and Small Dairy Breeds | Other Breeds |
|---|---|---|
| 2 year-old dams | + 15% | + 6% |
| 3 year-old dams | + 10% | + 3% |
| 4 year-old dams | + 5% | + 2% |

Correction For Dam Weights, lbs.

| | | |
|---|---|---|
| 2 year-old dams | + 20% | 4 year-old dams + 10% |
| 3 year-old dams | + 15% | 5 year-old dams + 5% |

The Feeder Calves

A record program for a cow and calf operation should record the kind of product that is being marketed. This product can best be measured by its performance through a feedlot and the carcass characteristics after the feeding period. A rancher's goals, as they relate to the quality of a product, may vary considerable. In all ranching operations the efficiency of production, while producing the calf, should be of primary consideration. The feeder and packer wants should be secondary. Many times we are more concerned with what the feeder and packer want and fail to make the cow and calf industry profitable first.

Using Form C-5 "Rate And Efficiency Of Gain," rate of gain is plotted because it relates to the time cattle must be in the feedlot and the cost of gain on that pen of cattle. Most commercial feedlots feeding cattle in one pen would be able to furnish this information. Rate of gain and the feed required per 100 pounds gain should be a better figure than cost of gain on long term records because of the changing feed prices.

This information is not hard to obtain on large ranches since the weaning calves are sold in large groups to one buyer and many groups retain their identity through the feedlot. Some large ranchers maintain ownership of their cattle through a commercial feedlot.

Rate and efficiency of gain can be measured every three or four years on most large ranches where breeding programs require at least this much time to change one-third of the genetic make up of the breeding herd. Large ranches may wish to use a random sample of the steer calves instead of feeding the entire calf crop.

The Slaughter Cattle

Even though cattle are efficient at weaning time and grow efficiently through the feedlot, characteristics have a large effect upon the total income and profit. To add this last dimension to ranch beef production Form C-6 "Yield and Quality Grades" was developed. Two measuring devices, yeild grades and quality grades, are used to indicate the quality of the product. Grading carcasses on yield and quality can be done by USDA graders. Their record will serve as documentary evidence of these data. If the cattle are sold to a small packing plant, it may be necessary for you or the feeder to make arrangements to have a government grader available at slaughter time.

A large percentage of the cattle on long feeding periods are expected to produce cattle with yeild grades between one and two in the low choice grade. Other fed cattle are expected to have the same yield grade with average or high good quality grades. You must set your own goals which may be for a market with different carcass characteristics. Design your overall ranching operation to be as efficient as possible. The most efficient ranching operation in you locality may or may not require cattle capable of grading choice when slaughtered.

Product quality does not have to be measured on the entire calf crop. but can be measured on a reasonable sample of feeder calves. This information does not have to be measured annually unless you have made radical changes in your breeding program.

THE RANCH, PRESENT AND FUTURE

Form C-1

PRODUCTION AND QUALITY LEVELS AND RANCH GOALS

| PRODUCTION | Number | Percentage | Number | Percentage |
|---|---|---|---|---|
| Cows bred | | XXX | | XXX |
| Calves born | | | | |
| Calves weaned | | | | |
| Acceptable calves weaned | | | | |
| Average weaning weights | | XXX | | XXX |
| Average cow weights | | XXX | | XXX |
| Rate of replacement of bulls | | | | |
| Rate of replacement of cows | | | | |

| QUALITY | Steers | Heifers | Steers | Heifers |
|---|---|---|---|---|
| Age into feedlot | | | | |
| Weight into feedlot | | | | |
| Length of feeding period | | | | |
| Rate of gain in feedlot | | | | |
| Weight of finished cattle | | | | |
| Quality grade of finished cattle | | | | |
| Yield grade of finished cattle | | | | |

THE HERD BULLS

Form C-2 PRODUCTION AND QUALITY INFORMATION

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | | | | | | | | |
| Individual Information | | | | | | | | |
| 205 day wt., lbs. | | | | | | | | |
| 205 day wt., ratio | | | | | | | | |
| Steer half sibs - Production | | | | | | | | |
| No. of half sibs | | | | | | | | |
| Day on feed | | | | | | | | |
| Feedlot gain, lbs./dry | | | | | | | | |
| Feed per lb. of gain | | | | | | | | |
| Steer half sibs - Product | | | | | | | | |
| No. of half sibs | | | | | | | | |
| Quality grade | | | | | | | | |
| Yield grade | | | | | | | | |

THE COW HERD

Form C-3

REPRODUCTION RATE AND THE WEANING CALF

Year of Birth _____ Cow No. _____

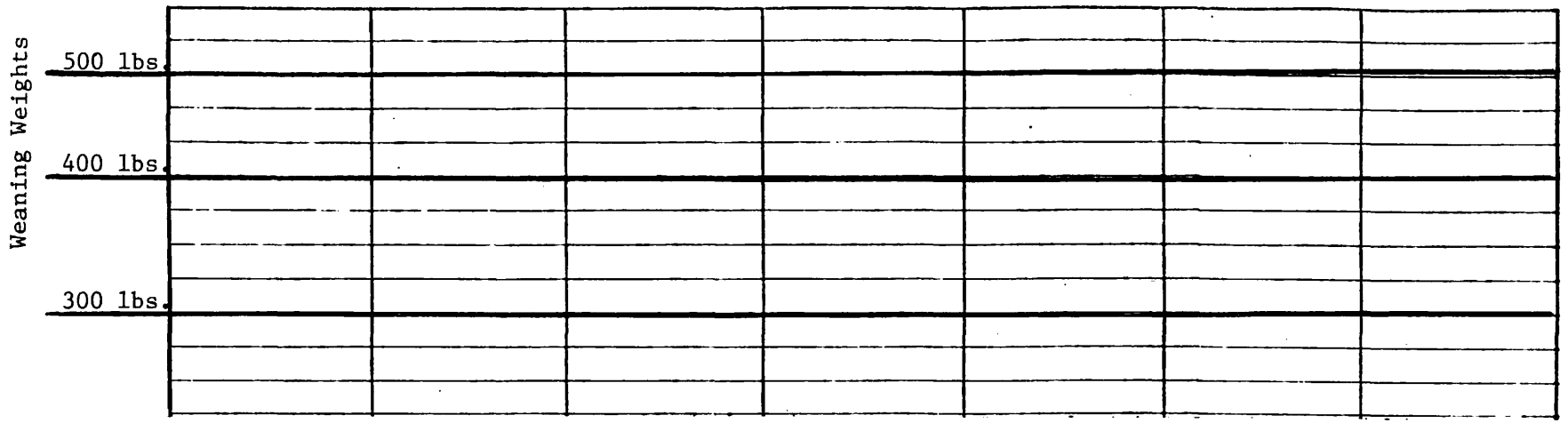
| Year | Palpated | | Calved | Remarks | Weaned Calf | |
|---|---|---|---|---|---|---|
| | Pregnant | Open | | | Acceptable | Reject |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

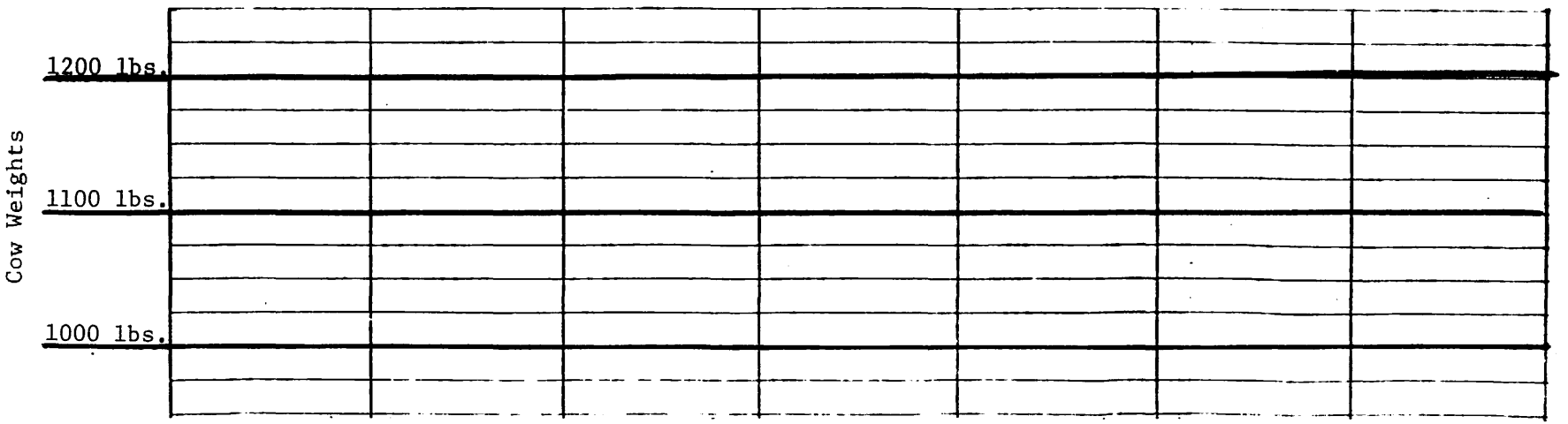
THE WEANING CALVES

Form C-4

CALF WEIGHT, COW WEIGHT AND RATIOS

Year ____ ____ ____ ____ ____ ____ ____ ____




Ratio ____ ____ ____ ____ ____ ____ ____ ____

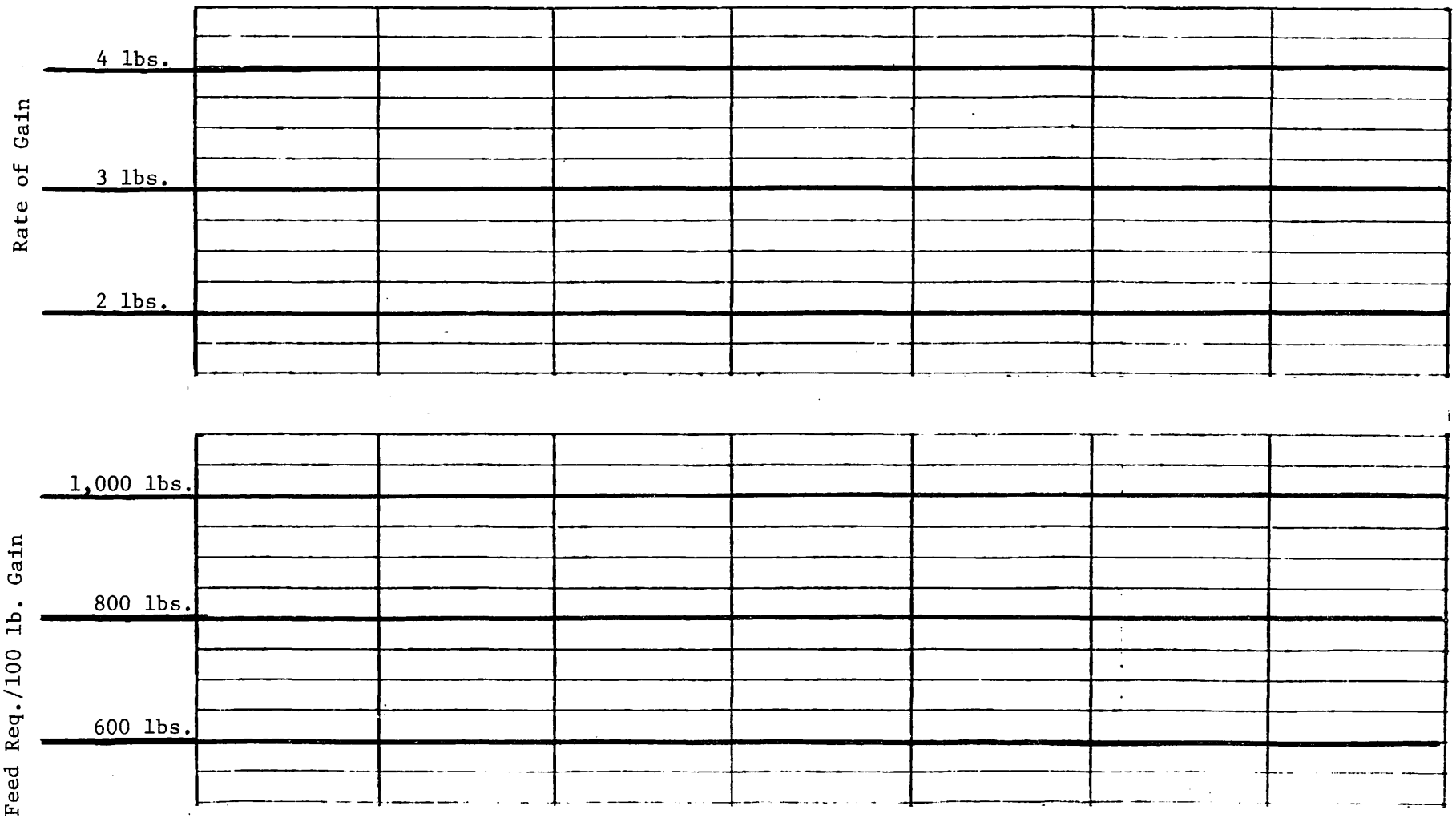
(Calf Weight as a Percentage of Cow Weight)

THE FEEDER CALVES

Form C-5

RATE AND EFFICIENCY OF GAIN

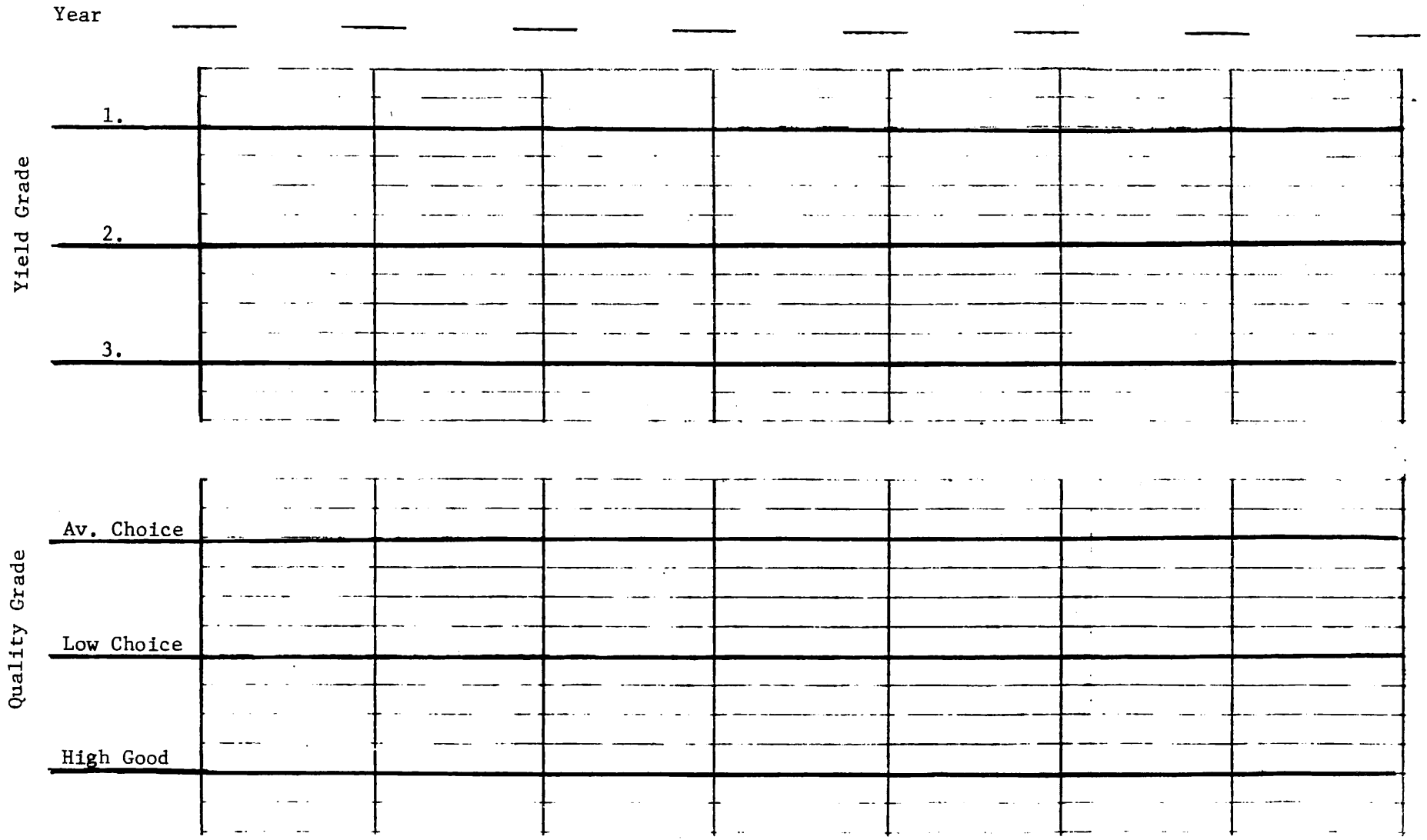
Year _____ _____ _____ _____ _____ _____ _____ _____



THE SLAUGHTER CATTLE

Form C-6

YIELD AND QUALITY GRADES



# CONCLUSION

The television and movie image of a cattleman being a lover of the outdoors, who goes about his ranch work riding a horse (or driving a pick-up) from daylight to dark, eating at a chuck wagon and sleeping outdoors did not fit the rancher in the middle one-third of the 20th century.

Large ranches have become big business and must be managed as such. Production and quality control records are one management tool that must be added to typical ranch management practices of the last 30 years to be able to compete between now and the year 2000.

Production and quality controls, when working with biological material and biological processes, are extremely difficult and complicated when compared with nonbiological ones. Problems with any kind of controls increase greatly for a ranch operation because of the dependence upon certain elements of nature that regulate the food supply, the environment and the health of the animals. Production management systems must constantly be improved. Production and quality controls used by manufacturing plants during World War II are crude and considerably less effective than those in use today. The systems suggested here are only a beginning and will probably be considered crude and ineffective when comparing systems in the late 1980's and 1990's.

This is the beginning of a scientific production management system for a ranch operation. No attempt has been made to make this a complete management system that takes in the many refinements that we find in a corporate structure.

The purpose is to consider a ranch operation as a manufacturing plant and to develop low cost records and summaries that will indicate the characteristics of the business and the trends of certain measurable traits over a period of years.

Production, cost and quality controls in a modern ranch operation and a group of planned observations and measurement designs based upon up-to-date principles and concepts of animal science, plant science and management. They are designed to guide the owner, manager or consultants in making decisions.

Advantages of a set of production, cost and quality control records are:

(1) Learning the characteristics of your business
(2) Planning changes and have some measure of how fast these changes are taking place
(3) Identifying undesirable changes in your business
(4) Planning corrective action for those undesirable changes
(5) Having reasonably accurate economic records or estimates of costs and returns of your decisions

The real purpose of a set of production, cost and quality control records is to help you as an investor and/or manager:

(1) To understand the past
(2) To predict the future
(3) To correct problems before they become serious

You probably are now concerned about the time it takes to maintain these records.

Numbering a cow herd is a routine procedure in many well-managed herds

Calf weights at weaning time are usually available and add little or no expense

Cow weights are good information but are optional in this kind of a program

Most well-managed ranches have an accounting system sufficient for cost records

With a 200 to 400 cow herd two hours weekly will be sufficient to develop all of the information suggested in this publication

# ESTIMATED BREEDING VALUES

R. L. Willham
Iowa State University

## INTRODUCTION

The issue in record utilization is selection. The central concept in selection is the notion of breeding value. Records can be utilized to estimate the breeding values of prospective parents. Selection on breeding values when properly estimated and used can enhance the effectiveness of selection. The purpose of this note is to consider the estimation of breeding values from performance records available in the beef industry and examine their use and value in beef breeding programs.

The three classes of traits having economic importance in the beef industry are reproduction, production, and product. Reproductive traits are notoriously low in heritability so fail to respond materially to selection pressure. The beef industry is lucky that real economic heterosis is produced by the crossing of existing breeds for the reproductive complex. This advantage can be exploited at the commercial level. The production and product traits have moderate to high heritability and do respond favorably to selection. Because of the high heritabilities, when the trait can be measured on the individual, selection based on own performance results in near maximum selection response. The maternal and carcass traits offer more of a problem since they either are sex limited or require slaughter for quantitative evaluation. Beef performance records are relatively expensive both in terms of money and time required to obtain them. Cattle have a long generation interval, a low reproductive rate, and are expensive per individual. These latter two problems result in a relatively low intensity of selection especially in the cows. If the existing

records can be utilized to increase the accuracy of selection even a bit without increasing the generation interval or reducing the intensity, this advantage should be capitalized upon in the performance programs serving the beef industry. Precisely this can be done for the beef industry by the performance programs serving it by estimating breeding values based on the available and useful relative and individual performance records.

## BREEDING PRINCIPLES

The basis of selection is the resemblance between parent and offspring. When this resemblance is high, selection of superior parents results in above average offspring. When low, selection of parents gives only average progeny. This resemblance results because a parent gives to each offspring a sample half of his genes, one or the other gene of each pair. The degree of resemblance depends on the influence of the gene effects on the performance. When resemblance is high the gene effects produce a large fraction of the differences among individuals. Doubling the parent-offspring correlation is one way to estimate the heritability of a trait. Heritability is defined as the fraction of the differences among individuals treated alike that is heritable. It measures, in a sense, the differences that can be transmitted or the percentage of variation that selection can use. Really what correlates the record of the parent and the record of the offspring is the fact that the breeding value of the parent as expressed in his record is related to half that same breeding value given to the offspring and expressed in its record. The breeding value is the sum of the gene effects possessed by an individual that influence his record.

The working definition of breeding value is twice the difference between

the average of a large number of progeny from an individual and the group average for a particular trait. It is doubled since a parent transmits, so to speak, half his breeding value. The other parent contributes the other half of his breeding value. Really if the breeding value of both parents were known, the breeding value of the offspring could be predicted. Actually this is the way selection response is predicted. Since heritability is the fraction of the differences due to breeding value variation, heritability times the superiority of parents over the average of the group from which they came predicts how much progress will be expected from using them as parents. The response per generation is

$$\text{selection response} = \tfrac{1}{2}\text{ breeding value of sires} + \tfrac{1}{2}\text{ breeding value of dams}$$

$$= \tfrac{1}{2}\text{ heritability x(sire superiority)} + \tfrac{1}{2}\text{ heritability x(dam superiority).}$$

Now to put it on a per year basis selection response per generation must be divided by generation interval (average age of parents when offspring destined to replace them are born). Thus

$$\text{response/year} = \frac{\tfrac{1}{2}\text{ H x Sire Superiority} + \tfrac{1}{2}\text{ H x Dam Superiority}}{\tfrac{1}{2}\text{ Sire Generation Interval} + \tfrac{1}{2}\text{ Dam Generation Interval}}$$

$$= \frac{\text{H x Sire Superiority} + \text{H x Dam Superiority}}{\text{Sire Generation Interval} + \text{Dam Generation Interval}}$$

since the halves cancel. This prediction equation is quite accurate since it involves the several parents. But the same logic can be used to estimate breeding values on individuals. Then when selection is predicted the heritability term is eliminated and only the superiority in breeding values used.

To calculate the breeding value of an individual based on his own record, the difference between his record and the contemporary average is multiplied by heritability. His superiority or inferiority is regressed toward the average by the fraction of the difference expected to be heritable on the average. If heritability is 40% and a bull is 100 pounds superior to his contemporaries in yearling weight, then his estimated breeding value is .40 x 100 = 40 pounds. On the average, 40 pounds of the 100 is expected to be heritable. Then this bull should transmit 20 pounds to his progeny if the cow herd were average.

Obviously progeny can also be used to estimate the breeding value of an individual. Any relative that has genes that are identical by descent (from a common ancestor) can aid in the estimation of breeding value. Actually the average performance of sibs is an excellent aid in breeding value estimation. To evaluate the various sources of relative information available in common beef records, the estimation of breeding value and selection response can be expressed as

heritability x Superiority = Accuracy x intensity x variation

where accuracy is the correlation between the "true" breeding value and the estimated breeding value used in selection. Intensity is a standardized form of the superiority of selected individuals, and variation is the amount of variation existing among breeding values for the trait. The breeder can do most to increase his effectiveness of selection by improving the accuracy of his selection since the reproductive ability of the species puts limits on the intensity and the variation is fairly standard over situations.

Table 1 presents for three levels of heritability the accuracies for relatives in estimating the breeding value of an individual. The accuracies

Table 1. The accuracy of records on relatives for estimating the breeding value of an individual.

| Relatives | Number | Relationship | Heritability 20% | 40% | 60% |
|---|---|---|---|---|---|
| Parent | 1 | 1/2 | .22 | .31 | .39 |
| Paternal half-sibs | 10 | 1/4 | .30 | .36 | .40 |
| | 40 | 1/4 | .41 | .45 | .47 |
| Maternal half-sibs | 2 | 1/4 | .15 | .22 | .26 |
| | 4 | 1/4 | .21 | .28 | .33 |
| Individual | 1 | 1 | .45 | .63 | .77 |
| Progeny | 10 | 1/2 | .59 | .72 | .80 |
| | 40 | 1/2 | .82 | .90 | .94 |

are higher the more highly heritable the trait. As the genetic relationship of an individual to the subject increases so does the accuracy. And as the numbers of relatives in an average increases so does the accuracy. The rate is faster for high heritability than low but diminishing returns set in faster for them compared to the low heritability. Accuracy is thus influenced by heritability, relationship, and numbers in the average.

Figure 1 shows the accuracy curves for three levels of heritability when the number of progeny are increased. Note how adding one more progeny is not worth as much as the previous one. Also for a trait that is 60% heritable that information on the individual herself is worth 10 progeny while for a 20% heritable trait only around 5 progeny. Selection based on own performance for highly heritable traits is primary since so many more can be tested than progeny tested thus increasing the intensity and the information is available early in life thus reducing the generation interval. The progeny test must have a considerably higher accuracy to make up for the other losses.

# PROGENY TEST

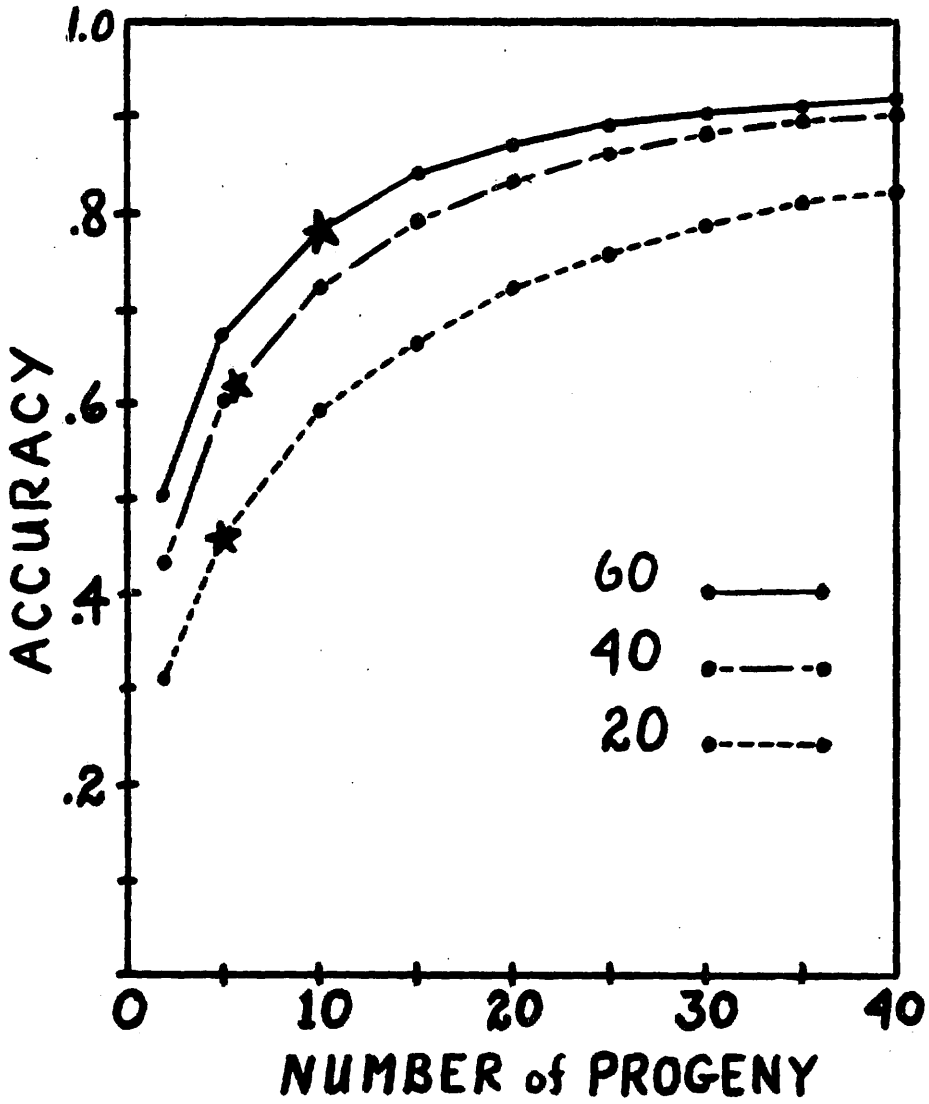



FIGURE 1

# RELATIVES

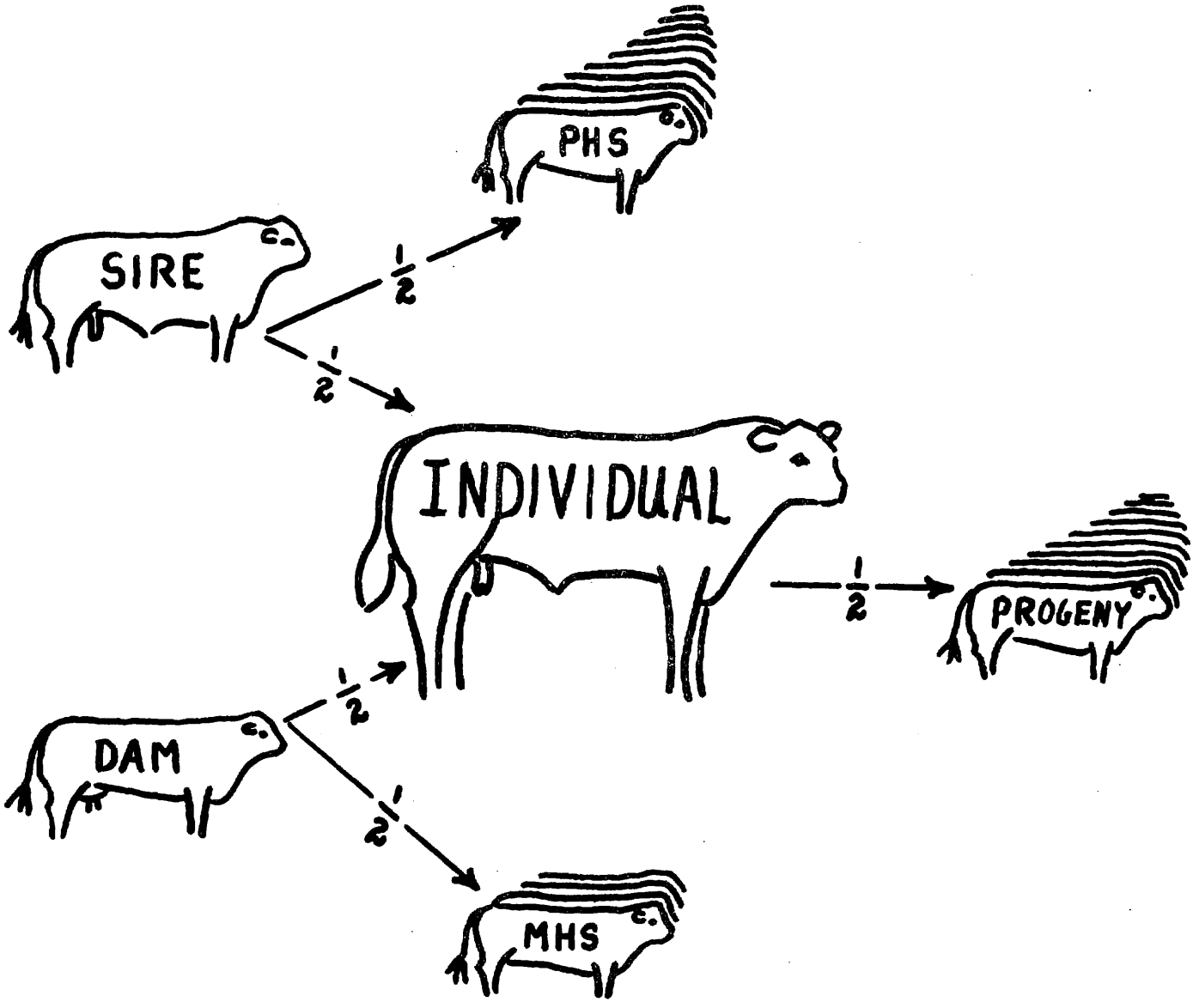



FIGURE 2

Figure 2 gives a diagram of the close relatives common in a beef records program. The primary relatives are the individual himself, his paternal and maternal half-sibs and his progeny. If sibs are available, the parent records add little. The first three bits of information are available at or before reproductive maturity while the progeny require an increased generation interval to obtain plus a lower intensity of selection since so many fewer can be progeny tested. Use of sib or progeny averages helps in breeding value estimation since the averaging of several records tends to cancel out the plus and minus environmental differences leaving more nearly a genetic value for the average.

It is possible to combine these sources of information into a single estimate of breeding value for each animal that is the subject of selection. This is done by using the numbers in the averages, the heritability, and the relationships to develop a set of linear equations that when solved give proper weighting factors to the particular pieces of information available on the individual. Then the weights times the records expressed as deviations gives an estimated breeding value. This breeding value estimate is for a particular trait using the available information. This multiple regression procedure has some desirable properties for the breeder using the values obtained in his selection. First, the available information is combined in such a way that the correlation between "true" and estimated breeding value is maximum. Second, the value obtained is regressed back toward the average depending on the amount of reliance that can be placed on it. If only a few records are available then the estimated breeding value will be close to average. When near complete data is available, then the value will be only regressed by heritability. Third, the second feature makes it possible for the

breeder to use these values to fairly rank individuals that differ in the amount of data available. Cows with one, two, or three calves can be fairly compared for example. Bull calves can be ranked fairly even though some have no sib information and others have a lot. The computation procedure to do this sort of breeding value estimation for a single or several traits separately is possible. This results because only linear equations with 4 or fewer unknowns need to be solved. Table 2 is presented to give some idea of the percentage attention paid to different pieces of information when the amount of information varies.

Table 2. The relative Amount of Attention that Should be Paid to Various Relative Groups in Estimating the Breeding Value of an Individual.

| Numbers | | | | Percentage Attention | | | |
|---|---|---|---|---|---|---|---|
| IND | PHS | MHS | PROG | IND | PHS | MHS | PROG |
| 1 | 10 | 2 | 0 | 44 | 42 | 14 | 0 |
| 1 | 20 | 4 | 9 | 33 | 46 | 21 | 0 |
| 1 | 10 | 2 | 10 | 18 | 17 | 6 | 59 |
| 1 | 20 | 4 | 20 | 10 | 14 | 6 | 69 |

The theory is available to combine the relative information for each of several traits together into an index such that selection could be based on an index breeding value. The additional information necessary to compute such an index is the relative economic values of the traits, the genetic and total correlations between the several traits, and a specification by the breeder of net merit. Just what traits should be involved and how they relate economically are individual breeder problems in his determination of goal and really cannot be set for him by his performance record program.

Two logical alternatives exist for the individual breeder. Suppose he

can obtain the estimated breeding values for the two or three traits of real importance to him. He can then weight these breeding values by appropriate economic values (net value of a unit change in this trait) and use this as his selection criterion. Or a breeder can use the independent culling level method to select. When the estimated breeding values for the trait first expressed and measured are available, he can select a fraction P of the individuals. Then when the second trait is measured he can select a fraction Q of those remaining from the first selection. The product $P \cdot Q$ must equal the number of replacements necessary so not too much selection can be done on the first trait if any room to select is to be left.

Appendix A gives the linear equations necessary to solve for the solution of estimated breeding values. Also information necessary to retrieve data from a herd file is given. This is included as an aid to performance organizations developing such a program. The nature of the procedure is such that it virtually defies hand calculation and really would not be worth the effort. Appendix B illustrates two of the forms in use now. One is for a selection worksheet and the other for a performance pedigree really.

## USE OF ESTIMATED BREEDING VALUES

There are essentially two ways these estimated breeding values can be presented for use by the breeder. The first is in the form of a selection worksheet and the second in the form of a performance pedigree. The selection worksheet, as its name implies, is just that. It is useful in making selections in the context of a creative breeding program. The performance pedigree has as its real purpose promotion of breeding stock.

The selection worksheet is a meaningful compilation of the available,

relevant records on a set of animals in a herd. The purpose of the selection worksheet is to make SELECTION of seedstock more accurate by using the available information in ranking. As the words "work sheet" imply, they are to be used in conjunction with common sense to select replacements and cull the herd. True the selection worksheets can be used as a powerful promotion tool, but that is not the primary role. Accurate selection is!

Animals listed on the selection worksheet are ranked from highest to lowest on their estimated breeding value. The breeding value is an estimate of what that individual is expected to transmit to his or her offspring for a particular trait. This breeding value concept is precisely what a seedstock breeder is selling. It is what a breeder's cattle do in the buyer's herd that counts. Records are used to estimate breeding values.

Each time a group of calves are weaned or weighed for yearling weights, the Performance program sends to the breeder selection worksheets that rank the male and female calves on either weaning or yearling weight and that rank the dams and sires of the calves. These are current documents and involve all the available information to this point that is on record at the organization. From such a ranking at weaning a breeder can select the bull calves to be fed for yearling performance, he can select the heifers to be reared as replacements, and he can, along with the pregnancy exam, cull his cow herd. When yearling information is available, the breeder can select his sire prospects, develop his sale bull offering, and make decisions concerning his herd bull battery all before he has to lot his sires for breeding. The selection work sheet is one way of really using record information in a creative breeding program.

To make the selection worksheet a meaningful document, the records going

into the calculations must be correct. One of the most important aspects is to have enough calves produced under like management within a two to three month calving season, so that their records can be fairly compared. For most efficient production testing a seedstock herd should calve once a year or at most twice yearly (spring and fall). Then the groups will be large and the cow and bull rankings more meaningful. To be successful in a breeding program designed to improve traits of economic importance that are objectively measured; requires attention to details of production, record keeping, and having the records available to use in selection at the appropriate times. This latter aspect is what the performance program does in the selection work sheets.

One can look at the selection worksheet as the compilation of the relevant information contained in a performance pedigree. It is put together into one value (estimated breeding value) that gives proper attention to own performance and the average performance of relative groups. Overemphasis on good records and ignoring relatives with poor performance does not happen when the computer is used to combine this information.

As an example, suppose spring calves are produced in February and March of each year. The weaning weights are sent in the first of October. The breeder then receives four rankings based on estimated breeding value for weaning weight. The first two are rankings of the bull calves and of the heifer calves. The calves will be ranked using their own weight ratio and the average ratio of their paternal and maternal half sibs which are the other progeny of their sire and dam. The second two lists are rankings of the dams and sires. The parental ranking will be based on own and sib ratios plus progeny average ratios.

Now the breeder can put these selection work sheets on a clip board and

go out to the cattle and exercise judgment in his selection program knowing that all of the recorded information on the individuals is available to him in the rankings. The tail end bull calves can be culled at weaning using this procedure. Heifers to keep as prospective replacements can be selected and wintered appropriately. The cows are ranked according to their breeding value for weaning weight. Also the number of calves (for reproductive efficiency) is available on the work sheet. This information coupled with appraisal for unsoundness and the pregnancy exam can be used together to cull the cow herd before going into the winter. The sire work sheet can be used to eliminate those young bulls being tested that have calves poor in weaning weight, provided one gave them a random sample of cows. If the young bulls were bred to poor cows then the records are of no value in comparing sires.

At the conclusion of the feedlot test of the bulls in March, the yearling weights are sent in. The breeder then receives three rankings based on estimated breeding value for yearling weight. The first is the ranking of bull calves. The other two are dam and sire rankings. This supposes that the heifers are not weighed until they are long yearlings. If they were measured at a year then a fourth ranking would be sent. These rankings are available at the time selection decisions are being made concerning breeding for the next calf crop. And this involves herd bull selection! Which of the herd sires are doing the job? This can be answered from the sire ranking. How are the yearlings of two years ago performing as sires? Which should be eliminated? How did the young bulls purchased perform in the herd? Which of the young bulls should become herd sires? All these questions can be answered from the herd sire ranking if the cows have been assigned to the sires such that the

bulls have a comparable group of cows. Which yearling bulls should be used as herd bull prospects? What group of yearling bulls meet the standards of excellence to be sold as seedstock? What group of yearlings along with their dams need to be culled or removed from the herd? These questions can be answered from the yearling bull ranking. Then appropriate breeding plans can be made for the upcoming breeding season.

Whenever the heifers are weighed for yearling data, the selection work sheet can be used to select herd replacements. If more heifers are retained at weaning than necessary and are bred, then 18 month yearling weights along with the pregnancy exam can be used to make final selection of heifers in the fall.

Lots more than the selection work sheet is involved in developing and conducting a sound, creative breeding program. But the work sheets do put at the breeder's disposal a compilation of the available performance information when the breeder needs to make his selections. It lets the breeder concentrate on the actual conduct of a breeding program, while the records are sorted and compiled without bias by the computer into meaningful predictions.

The purpose of performance pedigrees is promotion primarily, especially if selection work sheets are being used. Problems arise with performance pedigrees when breeding stock is transferred from one owner to another. Also, the relevant information contained in a pedigree should be combined using multiple regression techniques into estimated breeding values. This helps eliminate undue emphasis to remote ancestors with superior records. In general performance pedigrees should contain only individual performance data of the ancestors. Estimated breeding values should be shown for relevant traits. These should be based on the progeny tests of the sire and dam (paternal and

maternal half-sibs to the individual), the individuals' own record to date, and his progeny, if any. When an individual is sold the buyer gets a performance pedigree having the current information available in the herd of the seller. When the buyer requests an updated pedigree, the individual performance data of those in the pedigree and only the new data generated in the herd of the buyer will be used to recompute the estimated breeding values. This is the breeding value of importance anyway.

## SUMMARY

Consider a commercial producer and a breeder leaning on the bull lot fence carefully observing prospective yearling bulls. The seller, the breeder, has his performance records in hand while the commercial producer, the potential buyer, is asking the questions. What is the average yearling weight of this contemporary set of bulls? Is this better than your average over years? How many sires are represented in this group of bulls? Take bull 2071, what is his performance to a year of age? Is he in the high sire group for yearling weight? What was his weaning weight? Do you have the average ratio of weaning weight for his dam? Do you think daughters of this bull will milk? Have any carcass information of the sire of the bull 2071? How many progeny were slaughtered? Is this an adequate sib test for the bull? Was the sire compared with many other sires in the progeny test? Is this data a part of the breed national sire evaluation program? Why isn't the performance of bull 2071 as high as that pen of five you had in the central bull test?

There are not many commercial producers armed with such relevant questions about prospective commercial bulls and it is lucky because there are few breeders of breeding stock who could answer these questions especially out on the

bull lot fence. But a creative breeder should be able to answer such questions and even more important ones concerning expected breeding values for the traits of major economic importance to commercial producers. As the era of specification production proceeds more and more breeders should be able to provide specification germ plasm. And a breeder sells breeding values not performance records. It is how the stock performs in the producer's herd that is at issue. Using selection work sheets with estimated breeding values is a step in this direction.

## APPENDIX A

The statistical and computational details of combining relative information into an estimated breeding value is of concern to BIF organizations contemplating developing a program to compute these on a routine basis. The problem is one of multiple linear regression. That is regression coefficients are calculated for each piece of information such that these times the particular deviations or ratio deviations gives the estimated breeding values.

First the program should have parameter cards that give the values of heritability and repeatability when necessary for the various traits being considered. This makes the program adaptable to change when necessary. These could carry the economic values for the traits being considered if such index breeding values are to be calculated.

Second the program must use the best procedures available to look up the data for each individual to be calculated. This procedure differs for computer system. The information needed for each individual is as follows:

1. His own performance as a deviation or a ratio deviation from his contemporary group.

2. The average performance of his paternal half sibs (progeny of his sire) as the average of the individual deviations or ratio deviations and the number of them. The individuals own record should be excluded from the average.
3. The average performance of his maternal half sibs (progeny of his dam) as the average of the individual deviations or ratio deviations and the number of them. Again the individual's own record is excluded.
4. The average performance of his progeny as the average of the individual deviations or ratio deviations and the number of them.

This data must be collected for each individual. Some consideration needs to be given the master record. It should contain the individual identification plus that of the sires and dam followed by the trait data on individual performance. The look-up is speeded if the progeny average of the individual is kept in the master record but this is not necessary. If it is then the computer needs to look up the individual to find both individual and progeny data. Then the sire and dam are looked up for the paternal and maternal half sibs. They are the progeny averages of the sire and dam. The look up procedure can be done on a master record that has only individual performance. Then the progeny and sib averages must be calculated new each run. Sire progeny groups can be looked up as needed and saved for use again since sires have several progeny in a calf crop. The result of the look up procedure will be the one individual deviated record and three averages (deviations) with the numbers involved.

Then this data is moved to the calculation routine. When the trait of concern is measured once on the individual such as weaning and yearling weight, the following system of linear equations must be solved for the B values.

$$1/H \cdot B_1 + 1/4 \cdot B_2 + 1/4 \cdot B_3 + 1/2 \cdot B_4 = 1$$

$$1/4 \cdot B_1 + \frac{4+(N_1-1)H}{4N_1H} \cdot B_2 + 0 \cdot B_3 + 1/8 \cdot B_4 = 1/4$$

$$1/4 \cdot B_1 + 0 \cdot B_2 + \frac{4+(N_2-1)H}{4N_2H} \cdot B_3 + 1/8 \cdot B_4 = 1/4$$

$$1/2 \cdot B_1 + 1/8 \cdot B_2 + 1/8 \cdot B_3 + \frac{4+(N_3-1)H}{4N_3H} \cdot B_4 = 1/2$$

Only the numbers of sibs and progeny are used in the solution of this set of equations.

$N_1$ = number of paternal half sibs

$N_2$ = number of maternal half sibs

$N_3$ = number of progeny

$H$ = heritability of the trait

These equations with the particular numbers need to be solved for each animal and for each trait. Note that the diagonal from left to right contains the numbers for the relatives. The off diagonal elements contain only the genetic relationships among the relatives on the left hand side of the equal signs and the relationships of each relative group to the individual on the right hand side of the equal sign.

If a particular individual has only a part of the information, then the row and column where no data is available must be eliminated and the equations moved up and to the left. If only individual and maternal half sib data were available, then the equations to solve would be

$$1/H \cdot B_1 + 1/4 \cdot B_3 = 1$$

$$1/4 \cdot B_1 + \frac{4+(N_2-1)H}{4N_2H} \cdot B_3 = 1/4$$

The paternal half sib and progeny equation are eliminated. The solution to these equations is best obtained by matrix inversion of the matrix of coefficients of the B values on the left hand side of the equal signs. In matrix algebra notation the problem is as follows:

$$\begin{bmatrix} 1/H & 1/4 & 1/4 & 1/2 \\ 1/4 & \frac{4+(N_1-1)H}{4N_1H} & 0 & 1/8 \\ 1/4 & 0 & \frac{4+(N_2-1)H}{4N_2H} & 1/8 \\ 1/2 & 1/8 & 1/8 & \frac{4+(N_3-1)H}{4N_3H} \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix} = \begin{bmatrix} 1 \\ 1/4 \\ 1/4 \\ 1/2 \end{bmatrix}$$

$$[C]\ [B] = [R]$$

Then $$[B] = [C^{-1}]\ [R]$$

where $C^{-1}$ is the inverse of C which is the matrix of coefficients of the B values. Many fast inverse routines are available to use.

Now after solution a set of weights of regression coefficients are available. These are multiplied by their respective relative average and summed as

$B_1$·Individual deviation + $B_2$·Paternal half sib average deviation

+ $B_3$·Maternal half sib average deviation + $B_4$·Progeny average deviation.

This equals the estimated breeding value using all the available data. The value is numbers adjusted such that the values as calculated are directly comparable one to another. Thus, the program could then rank each sex from top to bottom based on breeding value estimate for a selection work sheet.

One other value is possible to calculate and this is the accuracy of the particular estimated breeding value. The accuracy is as follows

$$\text{Accuracy} = \sqrt{B_1 \cdot 1 + B_2 \cdot 1/4 + B_3 \cdot 1/4 + B_4 \cdot 1/2}$$

This accuracy value tells the breeder how much confidence to place in the estimated breeding value, but this has already been considered in the estimation procedure by regressing the breeding value back toward the average depending on the amount of data available and the heritability. Thus, the accuracy may result in more confusion than it is worth.

In dealing with a trait that can have repeated measures such as weaning weight, when considered as a trait of the cow rather than the calf, the diagonal elements are more complicated. They are

$$((1 + (M_1-1)R)/M_1H$$
$$[(1 + (M_2-1)R)/N_1M_2H] + [(N_1-1)/4N_1]$$
$$[(1 + (M_3-1)R)/N_2M_3H] + [(N_2-1)/4N_2]$$
$$[(1 + (M_4-1)R)/N_3M_4H] + [(N_3-1)/4N_3]$$

where $N_1$, $N_2$, and $N_3$ are the number of paternal sibs, maternal sibs and progeny, respectively. The M values are

$M_1$ = number of records on the individual,

$M_2$ = average number of records per paternal half sib,

$M_3$ = average number of records per maternal half sib,

and $M_4$ = average number of records per progeny.

The R equals repeatability and the H equals heritability, as before.

To produce an index of breeding values the estimated breeding values need to be multiplied by their economic value and the product summed. This procedure ignores any correlation between the several traits. If these correlations were to be considered, a large matrix would need to be inverted for a solution. Solution requires much more effort for a large matrix than for several small ones (4x4 or smaller).

# APPENDIX B

Figure 1 of Appendix B shows an example of a selection work sheet for yearling weight of a set of bulls. The actual adjusted yearling weight appears along with the weight ratio. Then the number and average ratio of the paternal and the maternal half sibs appear. The progeny columns are empty because these are yearlings. The estimated breeding value ratio appears in the rank column. The bulls are ranked on their breeding value. The worksheet is set up to use in making selection decisions.

Figure 2 of Appendix B shows an example of a breeding value analysis for a cow that involves using relative information on several traits. Note that calving ease and weaning weight are used once as a trait of the calf and then as a trait of the cow that can be repeated. One measures growth and the other maternal ability for weaning weight. The traits are combined into a breeding value index in the upper right hand of the sheet. The average index is 500. The "last calf breeding values" are computed by adding 1/2 the breeding value of the sire and 1/2 the breeding value of the dam. The multi-herd commercial section involves data obtained from "out of herd" progeny tests on sires. A copy of this sheet on several bull prospects (actually the dam of the bulls) gives nearly all the data necessary for performance selection. Absolute values of the traits appear, but the calculations were all made on the deviations and a mean added on. Data on the calf and cow are recorded right on the sheet in the lower section.

DATE: 03/22/72
CODE:

# ANGUS HERD IMPROVEMENT RECORD

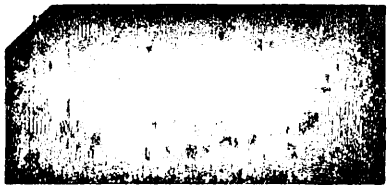
## PRODUCTION MEASURE
## SELECTION WORK SHEET

YEARLING

| ANIMAL INFORMATION | | | | | | | | | | AVAILABLE INFORMATION | | | | | | | | RANK | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALF IDENTIFICATION NUMBER | SEX | TATTOO | | BIRTH DATE | | | SIRE REGISTRATION NUMBER | DAM CHAIN NO. | DAM REGISTRATION NUMBER | ADJ WEIGHT | WEIGHT RATIO | PAT HALF SIBS | | MAT HALF SIBS | | PROGENY | | BREEDING VALUE RATIO | SELECTION DECISIONS |
| | | LEFT EAR | RIGHT EAR | MO | DAY | YR. | | | | | | NO. | AVERAGE RATIO | NO. | AVERAGE RATIO | NO. | AVERAGE RATIO | | |
| 6823836 | B | 29P0 | 29P0 | 3 | 24 | 70 | 3508548 | 50 | 4041654 | 811 | 112 | 40 | 100 | 1 | 103 | | | 105 | |
| 6823846 | B | 14P0 | 14P0 | 3 | 2 | 70 | 4201787 | 149 | 5117399 | 800 | 111 | 20 | 97 | 1 | 99 | | | 104 | |
| 6823834 | B | 9P0 | 9P0 | 2 | 25 | 70 | 4201787 | 42 | 4299155 | 799 | 111 | 20 | 97 | 1 | 98 | | | 103 | |
| 6823844 | B | 13P0 | 13P0 | 3 | 2 | 70 | 3508548 | 100 | 4922796 | 785 | 109 | 40 | 100 | 1 | 92 | | | 103 | |
| 6823848 | B | 6P0 | 6P0 | 2 | 15 | 70 | 4201787 | 151 | 5117403 | 779 | 108 | 20 | 98 | 1 | 104 | | | 103 | |
| 6892422 | B | 43P0 | 43P0 | 4 | 12 | 70 | 3508548 | 140 | 5109777 | 756 | 105 | 40 | 100 | 1 | 105 | | | 103 | |
| 6892423 | B | 48P0 | 48P0 | 4 | 22 | 70 | 6132326 | 142 | 5180802 | 773 | 107 | 6 | 100 | | | | | 103 | |
| 6823832 | B | 2P0 | 2P0 | 2 | 23 | 70 | 3508548 | 31 | 3738918 | 746 | 103 | 40 | 100 | 1 | 111 | | | 102 | |
| 6823833 | B | 10P0 | 10P0 | 2 | 25 | 70 | 3508548 | 34 | 3738922 | 754 | 104 | 40 | 100 | 1 | 97 | | | 102 | |
| 6706261 | B | 53P0 | 53P0 | 4 | 15 | 70 | 5141286 | 192 | 4831405 | 745 | 103 | 5 | 96 | | | | | 101 | |
| 6823835 | B | 5P0 | 5P0 | 2 | 14 | 70 | 4201787 | 47 | 4299160 | 769 | 107 | 20 | 98 | 1 | 87 | | | 101 | |
| 6892419 | B | 45P0 | 45P0 | 4 | 14 | 70 | 5812743 | 81 | 4781799 | 737 | 102 | 2 | 104 | 1 | 90 | | | 101 | |
| 6823842 | B | 32P0 | 32P0 | 3 | 28 | 70 | 3508548 | 97 | 4794749 | 720 | 100 | 40 | 100 | | | | | 100 | |
| 6823843 | B | 8P0 | 8P0 | 2 | 23 | 70 | 3508548 | 98 | 4794760 | 722 | 100 | 40 | 100 | 1 | 97 | | | 100 | |
| 6892421 | B | 36P0 | 36P0 | 4 | 3 | 70 | 3508548 | 135 | 5109792 | 735 | 102 | 40 | 100 | 1 | 92 | | | 100 | |
| 6823837 | B | 16P0 | 16P0 | 3 | 5 | 70 | 3508548 | 54 | 4041646 | 721 | 100 | 40 | 100 | 1 | 92 | | | 99 | |
| 6823847 | B | 11P0 | 11P0 | 2 | 28 | 70 | 4201787 | 150 | 5081324 | 717 | 99 | 20 | 98 | 1 | 100 | | | 99 | |
| 6892425 | B | 40P0 | 40P0 | 4 | 7 | 70 | 6132326 | 148 | 5081328 | 699 | 97 | 6 | 102 | | | | | 99 | |

The SELECTION WORK SHEET is a CURRENT RANKING of calves, their sires and dams. The ranking is based on BREEDING VALUE RATIOS for either WEANING or YEARLING weight. These breeding value ratios are estimates of how these animals should TRANSMIT their superiority or inferiority to their offspring. A ratio of 100 is average. The breeding value ratio of an individual is computed using its own record, those of its paternal half sibs, maternal half sibs, and progeny. The breeding value ratio of any two animals can be fairly compared, since the ratios are adjusted for differing numbers of records. The SELECTION WORK SHEET is to be USED in making SELECTION DECISIONS.

Figure 2 B
21



# BREEDING VALUE ANALYSIS

| | | |
|---|---|---|
| BREEDING VALUE INDEX | IN HERD | 507 |
| | COMMERCIAL | |
| INDEX ACCURACY | IN HERD | .83 |
| | COMMERCIAL | |
| HERD RANK | IN HERD | 48 |

HERD NO.: 012836 RANCH NAME NO. IN HERD 228

SIRE: 105-60
NO.: 183-65
SEX: Female
DAM: 206-60

| | | HERD PERFORMANCE | | | | | | | | MULTI-HERD COMMERCIAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DIRECT | | | | | MATERNAL | | | WEIGHT | | CARCASS | |
| | | CALVING EASE | WEIGHT WEANING | WEIGHT YEARLING | LOIN EYE | PELVIC MEASURE | WEANING WEIGHT | COW EFFICIENCY | CALVING EASE | WEANING | YEARLING | RETAIL VALUE | QUALITY GRADE |
| BREEDING VALUES | | 11 | 692 | 1034 | 13.3 | 14.2 | 690 | 3- | 9 | | | | |
| ACCURACY | | .52 | .73 | .85 | .69 | .64 | .71 | .57 | .61 | | | | |
| HERD RANK | | 168 | 31 | 22 | 144 | 75 | 45 | 144 | 71 | | | | |
| INDIVIDUAL RECORDS | NUMBER | | | | | | 3 | 2 | 4 | | | | |
| | VALUE | 10 | 706 | 1053 | | 15.0 | 703 | 0 | 9 | | | | |
| SIB RECORDS HALF SIBS | NUMBER | 151 | 373 | 299 | 188 | 113 | 80<br>214 | 80<br>149 | 80<br>201 | | | | |
| PATERNAL | AVERAGE | 12.0 | 672 | 984 | 13.5 | 14.09 | 675 | 4.5- | 8.8 | | | | |
| QUARTER SIBS | NUMBER | | | | | | | | | | | | |
| | AVERAGE | | | | | | | | | | | | |
| HALF SIBS | NUMBER | 2 | 7 | 7 | 5 | 1 | 2<br>6 | 2<br>4 | 2<br>6 | | | | |
| MATERNAL | AVERAGE | 11.0 | 687 | 987 | 13.72 | 14.20 | 680 | 2.2 | 6.5 | | | | |
| QUARTER SIBS | NUMBER | | | | | | | | | | | | |
| | AVERAGE | | | | | | | | | | | | |
| PROGENY RECORDS SONS | NUMBER | 2 | 1 | 1 | 1 | | | | | | | | |
| | AVERAGE | 20.0 | 876 | 1394 | 14.20 | | | | | | | | |
| G/SONS | NUMBER | | | | | | | | | | | | |
| | AVERAGE | | | | | | | | | | | | |
| DAUGHTERS | NUMBER | 2 | 2 | 2 | 2 | 1 | | | | | | | |
| | AVERAGE | 4.7 | 683 | 1015 | 12.35 | 12.80 | | | | | | | |

| SIRE OF LAST CALF NUMBER: 801-63 | BV INDEX 500 | | | HERD RANK 3 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CE | WW | YW | LE | PM | WW | CEF | CE | WW | YW | RV | QG |
| BREEDING VALUES | 10 | 802 | 1300 | 13.6 | 13.8 | 790 | 4 | 14 | | | | |
| ACCURACY | .72 | .96 | .98 | .97 | .90 | .70 | .64 | .69 | | | | |
| HERD RANK | 2 | 2 | 2 | 3 | 5 | 3 | 1 | 5 | | | | |

| LAST CALF BREEDING VALUES | | DIRECT | | | | | MATERNAL | | | COMMERCIAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CE | WW | YW | LE | PM | WW | CEF | CE | WW | YW | RV | QG |
| PEDIGREE | VALUE | 10 | 805 | 1312 | 13.6 | 14.0 | 735 | 0 | 10 | | | | |
| | ACCURACY | .44 | .60 | .65 | .59 | .55 | .49 | .43 | .46 | | | | |

| | NUMBER | BIRTH DATE | SEX | COW WEIGHT | CALVING EASE | BIRTH WEIGHT | WEANING DATE | WEANING WEIGHT | YEARLING DATE | YEARLING WEIGHT | LOIN EYE | PELVIC MEASURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAST CALF | 906 | 1 / 12 / 71 | M | 1730 | 10 | | 7 / 15 / 71 | 720 | | | | |
| NEW CALF | | | | | | | | | | | | |

SIRE OF NEW CALF: _____

☐ ALL PERFORMANCE INFORMATION ON THE LAST CALF HAS BEEN REPORTED.

☐ THIS CALF IS BEING RETAINED FOR BREEDING PURPOSES. PRINT BVA AND RANK WITH HERD.

☐ THIS ANIMAL IS BEING SOLD. PRINT BVA AND RANK WITH HERD.

☐ THIS ANIMAL IS BEING SOLD. PRINT BVA AND DO NOT RANK.

COMPILED BY LCR-BVA

# The Bull Selection Problem

by

R. L. Willham
Animal Science Department
Iowa State University

## Justification

Cattlemen spend hours and drive miles visiting first one herd and then another, they observe numerous shows, and they sit on hard bleachers around sale rings all in search of that illusive quantity, the herd bull. Such effort besides being fun is justifiable since the selection of a herd sire is the major genetic decision made by purebred and commercial breeder alike. This importance results from the differential reproductive rate between bulls and cows and the more intense selection possible among males. The bull is half the calf crop and in subsequent years his daughters remain as a constant reminder.

Sire selection can improve both immediate profit through his calves and be a capital improvement by way of his daughters. Net profit realized from using a superior sire is the product of

the number of calves produced per year,

the average pounds sold per calf,

the net value obtained per pound and

the number of years used less this same product for an ordinary sire. When a sire improves net value either by increasing selling price or reducing costs, net profit is improved most quickly. Improving any of the four factors the same percentage results in equal increase in net return.

Capital improvement through the daughters can be evaluated as the product of

the number of daughters saved,

the average pounds sold per calf (maternal plus growth),

the net value obtained per pound, and

the average number of calves produced per daughter less the same product for daughters out of ordinary sires.

If a sire produces 100 calves that weigh 50 pounds more at 10 cents net per pound, that is 500 dollars more profit than from a sire giving 50 pound lighter calves. If 20 daughters are saved that produce 25 pounds more calf because of improved maternal ability and the 25 pounds more expected in growth and they average 5 calves, that is another 500 dollars profit. When ordinary bulls cost 500 dollars, commercial breeders can well afford to pay 1000 dollars and more for a bull that will add 50 pounds per calf. Bulls that increase net value per pound one cent on a 1000 pound steer return 1000 dollars per 100 calves. The breeding stock producer has even more to gain by securing a top sire since the worth is multiplied through their sons and daughters.

## Purpose

The purpose of this BIF pamphlet is to define the bull selection problem and to develop some procedures, based on the concept of BREEDING VALUE, that can attack the problem. Today the problem and the procedures to solve it involve the utilization of performance records.

## Problem

The bull selection problem of a breeder is to find a bull or a set of bulls that when mated to his cow herd will produce offspring that are superior in value compared to those now being produced. What a breeder can do about this problem is circumscribed by the bulls known to be available. Knowledge of availability denotes promotion, advertisement and reputation. The traits contributing to value must be specified by the breeder. Some logical way to use the available records to discriminate among the available bulls as to which may produce offspring superior in value must be found.

## Breeding Principles

First, let us consider the concept of BREEDING VALUE. One solution to the bull selection problem would be to buy bulls, mate them to a sample of cows in the herd, and compare their calves with those of the current service sires. This procedure is a way to estimate breeding value. A BREEDING VALUE of an individual can be defined as twice the difference between the average performance of an indefinitely large number of progeny, when the individual is mated to a sample of the opposite sex, and the average performance of the whole herd or breed. This difference is clearly a measure of what a bull will transmit relative to some group average. The concept of breeding value, as defined, is at the heart of the bull selection problem and central to the whole matter of selection.

The basis of selection is the resemblance between parent and offspring. If high for a trait, selection of superior parents results in above average offspring. If low, selection of parents is ineffective. Their superiority was not transmittable. The cause of the resemblance is that a parent gives to each offspring a sample half of his genes, one gene at random from each pair. The degree of this resemblance for a particular trait depends on the influence of the gene effects or breeding value on the variability of the trait. When the breeding value differences account for a large fraction of the variation, then the trait is said to be highly heritable. HERITABILITY is defined as the fraction of variation in a trait that is due to differences among breeding values. Doubling the parent-offspring correlation estimates the heritability of a trait. What causes the correlation between parent and offspring is the relating of the breeding value of the parent expressed in his record with the half of his breeding value expressed in the record of his offspring.

Thus, the breeding value of an individual is expressed not only in his progeny, as we have carefully defined it, but also in his own or any other individual or group of individuals performance records. The requirement is that they have genes which are identical by descent. The individual himself, his paternal and maternal sibs, as well as his progeny all have fractions of their breeding values in common. Since heritability represents the fraction of the variation due to differences in breeding value, it is useful in estimating breeding values from the records. Suppose a bull is 50 pounds superior to his contemporaries and that heritability is 40%. The estimated breeding value of this bull is 20 pounds since on the average we expect 40% of the superiority to be heritable.

The prediction of selection response involves adding half the average breeding value of the sires and half the average breeding values of the dams. To put the response on a per year basis division by the average generation interval, age of parents when offspring destined to replace them are born, is necessary. In the design of optimum selection schemes using the prediction of selection response, expressing the two breeding values as the product of

1. the ACCURACY of selection
2. the INTENSITY of selection
3. the VARIATION available for selection

helps lay bare the factors influencing selection response. Accuracy is the correlation between the "true" breeding value and the estimate made of it using the available records. Values of the correlation go from zero to one for perfect. Table 1 presents the accuracy of records on relatives for estimating the breeding value of an individual for low, medium, and high heritability. The relatives are listed in order of their availability for use from the parent to the progeny. Accuracy depends on the following:

Table 1. The accuracy of records on relatives for estimating the breeding value of an individual.

| Relative | Number of Records in Average | Relationship of Relative to Individual | Heritability 20% | 40% | 60% |
|---|---|---|---|---|---|
| Parent | 1 | 1/2 | .22 | .31 | .39 |
| Paternal Half Sibs | 10 | 1/4 | .30 | .36 | .40 |
| | 40 | 1/4 | .41 | .45 | .47 |
| Maternal Half Sibs | 2 | 1/4 | .15 | .22 | .26 |
| | 4 | 1/4 | .21 | .28 | .33 |
| Individual | 1 | 1 | .45 | .63 | .77 |
| Progeny | 10 | 1/2 | .59 | .72 | .80 |
| | 40 | 1/2 | .82 | .90 | .94 |

1. the HERITABILITY of the trait
2. the RELATIONSHIP of the relatives to the individual
3. the NUMBERS of relatives in the averages.

Breeders can do most to increase the effectiveness of selection by manipulating accuracy. The accuracy can be increased by using relative groups with larger numbers and a higher relationship to the individual, but often such increase in accuracy comes at the expense of another factor.

The intensity of selection is a standardized measure of how much selection was practiced. It is a measure of the superiority of the parents relative to the average of group from which they came expressed in units of variation in the particular trait. The intensity depends on the fraction saved for breeding. The variation available for selection is the variation in breeding values. All three factors in the prediction of selection response must be greater than zero for there to be any response.

From these deliberations it is plain that to bring in each prospective bull and estimate his breeding value by the progeny test is not necessary nor is it

desirable in terms of cost both in money and time. Breeding value can be estimated using other records. For moderate to highly heritable traits the record of the individual is an accurate measure of his breeding value when properly evaluated. Paternal half sibs in adequate numbers are useful both to evaluate traits requiring slaughter and to aid in evaluating traits measured on the individual. The sibs really constitute the progeny test of the sire. But used as a sib test, the generation interval is not increased. The maternal half sibs of a prospective bull are useful in evaluating his breeding value for the maternal performance of his daughters. Armed with these concepts, we can venture back to the real world and see how they can be used to attack the bull selection problem.

## Breeding Programs

Again, the bull selection problem of the breeder is to find a bull or set of bulls that when mated to his cow herd will produce offspring that are superior in value compared to those now being produced. Value must be defined and this leads us to a consideration of the specific breeding program of the breeder. Bull selection is an important facet of any breeding plan but not all. Essentially two types of programs exist in the beef industry. The commercial type sells a genetic product that is utilized as is. This is opposed to the breeding stock program that sells a genetic product that must undergo segregation in its use. Thus, breeding stock programs sell breeding value and can utilize only variation among breeding values in their breeding programs once they have chosen their germ plasm source, usually a breed. The commercial type program can use all available genetic variation such as the differences among breeds which by crossing can produce economic heterosis and by using particular breeds introduce complimentarity into the program. And besides this for the moderate to highly heritable traits, within breed selection on breeding value

can further enhance the program for commercial production.

The most important decision in the design of either type program is that of goal choice. This involves specifying the traits concerned in defining value. Genetic and economic considerations with an eye to the future are critical. The specification of a goal for a particular herd depends on a careful analysis of many factors by the good breeder.

Next the production and record system must be chosen. Measurement in objective tests of the traits contributing to the goal for each production cycle is a must today. Regardless of whether the breeder is a commercial or breeding stock breeder, he must have some idea of where he is in relation to the prospective germ plasm available and his goal. This requires measurement and records even if it is the result of the performance of a sample of calves or the product he offers for sale. There is no excuse for the sound breeding stock breeder not keeping at least a minimum set of performance records and using them.

The particulars of the utilization of the records in selection toward the goal must next be considered. For the commercial type program germ plasm choice and the mating system to follow with this choice is critical. For the breeding stock program, after the initial germ plasm choice of breed is made the selection scheme to be followed in constructive improvement becomes paramount.

The real issue in this discussion is bull selection today. Effort has been made to make the discussion relevant to both commercial and breeding stock programs since many of the problems are the same.

Suppose for the sake of argument, we assume that the breeder after careful study of his and the industry position has concluded that the major trait in his bull selection is adjusted yearling weight. This trait was chosen because it measures growth over the relevant commercial period which is actually primary in

his definition of value. Adjusted yearling weight combines meaningfully both age of dam adjusted weaning weight and feedlot gain. Today, adjusted yearling weight is available on a reasonable number of bull prospects of the breed chosen by the breeder for his program. Further, soundness will be considered along with any available information on maternal performance and carcass desirability. Such assumptions give us a base from which to continue. They are not intended to be the suggested goal for every breeder! For some breeds selection for yearling weight is not the issue.

Adjusted yearling weight is the major trait in sire selection of this breeder. The trait is recorded in most of the performance programs offered by member organizations of BIF. But, by definition of our problem, we are really not concerned about yearling weights of the bulls or their relatives at all! We have asked that their offspring in the herd of the breeder be superior to those calves now raised. What is important is what they will transmit, the best estimate of their BREEDING VALUE.

Although most reports of the heritability for yearling weight are around 60%, let us consider it to be about 40% since the breeder will be dealing with field data under less controlled situations. The striking thing in Table 1 under the 40% heritability column is just how accurate the yearling weight of the bull actually is. A breeding value of a bull based on his own record is worth 6 progeny on a progeny test and over 40 paternal half sibs and almost as accurate as complete knowledge of both sire and dam which is really never possible. Needless to say, use of the individual performance of a bull in selection for yearling weight is the criterion. Because of the increased generation interval and reduced numbers from which to select, progeny testing to select for yearling weight is justifiable only when progeny testing is used sequentially with first selection based on own performance followed by selection among those remaining on the results of the progeny test. Own performance will be the primary criteria of the breeder in his search for bulls with breeding

value for yearling weight.

## Real Records

Problems are encountered with records in the real world. Let us destruct a performance record of an Angus bull for yearling weight and see what is its conceptual composition. Suppose the record is 1100 pounds. If we know the average yearling weight made by all Angus bulls during the period we could express the record relative to it. Suppose the average is 900 pounds.

Then 1100 - 900 = +200 or the particular record is 200 pounds superior to all Angus bulls. If we also knew the average yearling weight made by all Angus bulls in the same particular test we could express the record relative to the contemporary bull average and it in turn to the all bull average. Suppose the 50 contemporary bulls averaged 950 pounds. Then our record of 1100 pounds could be expressed as

$$1100 = 900 + (950 - 900) + (1100 - 950)$$
$$= 900 + 50 + 150.$$

Thus, we see that the 1100 pounds can be divided into parts attributable to three factors. The first is the all bull average, the second is the deviation of the contemporary bull average from the all bull average, and the third is the deviation of the record of the particular bull from his contemporary average. Now, what do these three factors represent? The all Angus average represents the average genetic level of Angus bulls tested under many different specific environmental situations. The deviation of the contemporary bull average from the all bull average represents the difference between the average genetic level of the contemporary bulls and the average genetic level of all Angus bulls plus the difference between the particular environmental situation under which the contemporary bulls were tested and the average environmental situation under which all Angus bulls were tested. The second difference has two causes; one is genetic and the other is environmental. The last difference, that between

the record of the bull and the average of his contemporaries has two causes also even though they were tested under exactly the same test situation. The first cause of difference is genetic in that the bulls differ in their genetic ability to grow and the second cause is due to intangible environmental differences that occur among bulls tested in the same environment.

Given this information from a record, what can be done with it to get an evaluation of the breeding value of the particular bull that weighed 1100 pounds. Heritability can be used to estimate the breeding value of individual bulls within a contemporary group. On the average 40% of the superiority or inferiority of a bull from the average of his contemporaries is the best estimate of his breeding value. Thus .40 x 150 or 60 pounds is the estimated breeding value of the bull. This bull would be expected to produce progeny that average 30 pounds more than the average of all contemporary bulls if they were all mated to a comparable set of cows. This 60 pounds is subject to considerable sampling variation. The whole 150 pound deviation could be heritable or none of it might be, but on the average 40% of it is due to breeding value differences. The average of the breeding values of 10 such bulls is relatively more accurate since much of the sampling variation is removed by the averaging. The problem is not so much the sampling variation but the fact that a buyer wants to relate the breeding value of a bull to all bulls that he could purchase and to his own cow herd potential.

To evaluate the particular bull relative to all available Angus bulls is not as easy as comparing him to his contemporaries. One needs to evaluate what fraction of the differences among contemporary group averages and the all bull average are really genetic differences and which are due to the environmental differences among the tests separated both in space and time and by management differences. Until enough data on multi-herd use of sires is available, this fraction is not known. Likely the differences that are genetic are

small relative to the environmental variation. Thus, if there are at least 50 contemporary bulls evaluated in the same contemporary test and they are sired by 5 or more bulls then the contemporary average can be used to evaluate the all Angus bull average when all bulls are assumed subject to the same treatment. The 60 pound breeding value does a reasonable job of estimating the superiority of this bull relative to all Angus bulls when tested under the same conditions. Buyers can compensate a bit for known differences among blood lines and families of Angus that are tested in specific tests. That is buyers can select the breeder herd or the test station from which they wish to buy bulls.

Will such a bull really improve the herd of the buyer? This depends on the real genetic level of the herd of the buyer. On the average, a bull that has a breeding value above his herd average will improve the level of the majority of herds because the breeding value is relative to available Angus bulls. Only high producing breeding stock herds will need to tentatively introduce such bulls. Commercial herds should have little problem since their genetic level is that of previously available Angus bulls or those of another breed.

The issue, then, is the use of the record as a deviation or a ratio from the contemporary average. A real minimum number of contemporaries is 10 other bulls. Ten reduces the sampling variation of the average enough to make it reasonably good; however, it does not give the amount of genetic variation necessary to estimate the all bull average. Thus, bulls so evaluated may by chance be tested with very superior bulls or with average bulls which would make a difference in how to interpret the breeding value estimate.

## Selection Levels

With this background in the use of real records we see that breeders of today have several options open to them in the choice of male germ plasm to go into a specific breeding program. They are outlined as follows:

1. The selection of the breed or breeds to be used in the program.
2. The selection of the source from which individuals of the breeds will come.
3. The selection of the individuals within the particular source chosen.

## Breeds

The commercial producer today has a wide germ plasm choice available to him. This is especially true if he can effectively use artificial insemination. Over 30 breeds are available along with all combinations of crosses among them. Particular combines are out because of only semen being available. The basic problem in commercial germ plasm choice is that available data must be interpreted and inferences made by the producer to his own management. Experiment station, USDA, and even field trial data are difficult to interpret in this way. Some trial and error will be necessary on the part of the producer. It is the adaptation of the new breeds to specific systems that will present the problems. This will come in the form of reduced reproduction generally. This really can not be tolerated. If replacement females are to be retained care must be taken to evaluate the reproductive and maternal potentials of the breeds.

Breeders wishing to become breeders of a newly imported breed have some excellent opportunities starting from almost any domestic stock. A breeder contemplating such a move should investigate every scrap of evidence thoroughly about the particular breed. The important issue is just how well is this breed likely to fit into beef production in the U.S. Will the breed have a terminal sire market only or will it also be a maternal breed? The breeder must plan carefully his breeding program. Grading up takes a long time in years and the "fast buck" is not here. Also half of the heterosis will be lost each successive back cross which may result in disappointment although it evidently did not with the Shorthorn and Hereford on the longhorn of the Southwest.

Sound commercial breeders willing to utilize A.I. have some really exciting opportunities to become custom progeny testing operations for the several breed-wide sire evaluation programs now in operation. Actually they might progeny test for a large breeding stock herd or several smaller herds working together. The opportunity to utilize the germ plasm of a breed deemed worthy of being progeny tested in the sire evaluation program would make quite a commercial herd in time. This is one way for a commercial breeder to pay for his complete testing program.

## Sources within Breeds

The really difficult problem is selection of source once the breed is chosen. The extent that herd or source differences are genetic is not known. Thus, all available information needs to be used in selecting the source. Most breed magazines carry adds that promote herds. Careful reading of these is sometimes helpful. Really few breeders know what is the important performance information and how to put it into convincing copy. The ad copy that follows gives some points worth considering whether reading the ad or writing it:

> "We have just concluded our annual performance test for our bull crop. This year the average weaning weight (205 days) was 500 pounds and 980 pounds for the adjusted yearling weight (365 days) for the 50 bulls. We are offering the top 50% of these bulls which average 560 pounds at weaning and 1000 pounds at a year. The majority are sired by our herd sire who now has a progeny test of 75 calves with an average weaning weight of 520 pounds and of 35 bull calves with an adjusted yearling weight of 990 pounds. Thirty commercial calves by this sire had a retail product percentage of 51%. All graded choice. Also we have some bulls from two sons we now have on test in the breed national sire evaluation program. Several of these calves weigh over 1050 pounds, and are from some of our best cows. These calves will be in our annual sale on such and such a date. All the records will be in the sale catalogue. Write for your copy today. Although we

have only been testing for five years we have made impressive progress with a sound breeding program. Come share in the development of a performance reputation."

Such copy fronted with pictures can sell cattle. Isolated performance results in stations or single sire progeny tests of selected animals adds little except to back up the breeders work at home. It is "what's going on back at the ranch that counts anymore." Adjectives of big, rugged, scale, stretch, substance, and quality when undefined by comparative figures will no longer suffice for today's educated buyer. Some breeds allow their breeders on the performance program of the breed to use a specific logo to identify them. At least some records are being kept.

Besides the breed magazines there exist beef performance magazines that carry ads. The whole livestock press needs to be studied for notes of events such as sales, shows, and field days where contact with sound breeders might be made.

Sound judgments need to be made by both the breeding stock and commercial breeder in evaluating breeding stock sources once contact has been made. The important issue concerns their breeding program. What follows are some notes on idealized programs that exist in the breeding stock industry today.

Several years back the typical program of a breeding stock herd consisted of selecting from the calf crop as early as possible individuals chosen to be as near ideal in conformation as were available. These were then brought into the show barn, given preferential treatment and since "fat sure enough is a beautiful color" the breeder gave himself a pat on the back because his selection was so very accurate. Sure enough his show string contained the best cattle he owned thanks to the big black and white nurse and TLC. Then this show string was dragged all over the circuit as being representative of the

breeding herd. Promotion and advertisement, the system gave! But such a program offers little to todays market for specification germ plasm.

Riding the coattail of a breeder that promotes highly by buying a son of THE bull was once in vogue. Cattlemen doing this were multipliers. They did not have the expense of developing the show reputation, neither did they get the same price for their bulls. Now we have the same situation. Multipliers are buying really good performance tested bulls out of top performance evaluated herd sires. Without further effort, attempt is being made to merchandise their produce with no more performance evaluation. It simply doesn't cost that much to record the performance on a standard program. You have to feed them to sale weight anyway! As valuable as own performance is for yearling weight in breeding value estimation, few bulls should be marketed without being so specified.

Interestingly enough a number of reputation performance breeders have allowed their stock to be exhibited at shows and fairs over the states. These products of performance testing and a sound selection program are winning at the major shows. The show still appears to be an excellent means of promotion--- these bulls are indeed popular. As long as new show stock comes up to be evaluated, that itself has been performance tested, the system simply adds frosting to an already adequately decorated cake. But if two or three generations of guess work separate the show ring winners from the real specified thing---we have problems again!

A problem exists today with breeding stock herds that have tried to move toward the "modern type" by acquiring the biggest mature weight sire that money could buy. Sure mature size is heritable and they will get mature size and a bit of early growth rate to boot. The point is--- SIZE is not the issue--- rapid early growth rate of high quality lean tissue is! This can

be measured rather accurately by standard gain tests and with a bit of visual appraisal after being treated alike. Breeders that talk about size and correct structure, that incidently have in a way been derived by looking at the cattle that perform, yet do no testing of their own and know very little about it are a real problem for their breed. They have very little to offer that is constructive to any buyer. In fact they do not know what they have. Actually breeders and cattlemen can rant and rave about size, substance, muscle, etc. but the real gut issue in the breeding stock industry is specification by performance recording of what is offered for sale.

Seeking germ plasm from sound central bull testing stations has numerous advantages. It acquaints the buyers with the performance breeders of a breed that are willing to really compete with one another based on the performance of their breeding stock when placed in a comparable environment. One would expect these breeders to send their best performance prospects to central test for the promotional benefit that can be derived especially when with the test is a promoted bull sale. Just visiting a central bull test or one of its sales is worthwhile just to hear performance talked by cattlemen to each other. As with the shows, there are "sharp" breeders consigning to testing stations. Long age bulls, shrunk bulls, etc. can still be found. They are becoming fewer in the reputable test stations. Careful consideration of all the data presented on a bull in the catalog can help to spot the counterfeits. A good weaning weight and yearling weight are a must. If there is discrepancy in the weight per day of age figure and the average daily gain on official test there can be problems. Sound judgment is necessary. Those stations who follow the BIF guidelines should be trustworthy. Breeders that send a few bulls to the stations but do not have at least a sound weaning weight program at home are worthy of less consideration. The

opportunity to select breeder herds from their results at testing stations exists. It is not perfect, but it can start the buyer in the right direction.

Today the ideal program of a breeding stock herd would be one in which all calves were born within as short a calving season as possible, the entire calf crop was treated as nearly alike as is physically possible, and each calf was measured and records kept on all the standard traits such as weaning and yearling weight and also traits of particular concern to the breed were being studied and data recorded. The management would be as nearly commercial as possible; the only artificial management would be that necessary to make the data from the seasons and calf crops as compatible as possible. Heifers would be developed for mother cows and all bull calves would be fed out in a comparative test designed to allow the bulls to express their tendency to fatten yet not long enough to produce fertility problems. All the calf crop would complete each test, however calves could be contracted earlier to get the better choices. The top individuals, based on comparative evaluations from a particular BIF member organizations performance program, were retained for breeding by the herd. Interest in bulls might sell. The average age of the cow herd and bull battery would be low; 2 to 3 years for bulls and 4 to 6 for cows. Upon visiting the herd, the breeder has at his fingertips the really important data and averages on each animal and is willing to share with his customers the really critical points of his herd and his creative breeding program.

Such herds will be involved in testing several of their young bulls on their breeds breed-wide sire evaluation program. A commercial buyer may have the opportunity to help such a breeder conduct his progeny test. Ask. You could get to use superior sires first and get the heifers! The best bull buys should be yearling sons of sires having completed the sire evaluation with superior expected progeny differences. The progeny test of carcass

traits can be used as a sib test of these sons.

Usually such herds will be involved in linebreeding to a particularly superior sire, concentrating or consolidating their selection gains. An inbred bull that has good yearling performance is superior to the outbred bull with similar performance. He will be more prepotent; sire a more uniform set of calves.

One of the important directions of the breeding stock business is toward more centralization. Bigger units, A.I. studs, corporate groups of independent breeders, and large corporations with histories of successful breeding in other species are all part of the times. Most of these operations have sound performance programs and offer superior breeding stock. Evaluate all the programs and then make your decision as to the source of your next bull or set of bulls.

Important questions to ask a prospective seller of breeding stock are as follows:

1. How many years has this herd been selected for performance?
2. What is your breeding program?
3. What is the average level of performance in your herd for the relevant traits?
4. What is the management system used in production?

Good answers to these questions usually indicate a sound breeder. Inspection of both the records and the cattle is helpful. A look at page after page of most impressive computer output is both frustrating and hopelessly confusing. The seller who has averaged the important figures and has them right at hand, not at the house, is a real joy to visit!

## Individuals Within Herd

The important figures would be the prospects own weight records, the average performance of his paternal and maternal half sibs and any progeny aver-

ages if any. These pieces of information combined in an estimated breeding value for yearling weight and weaning weight would help. The nearer the breeder can stick to one primary trait in his goal the faster will be the progress for that trait. But some other traits must be at least considered in bull selection. Little information will be available on the reproductive performance both maternal and paternal of a yearling bull prospect even from his close relatives. The low heritability makes selection difficult. The parent's mature size and those of older sibs can be used effectively in judging this. Milk production being sex limited offers problems. The weaning weight of the bull himself has an accuracy for maternal performance of about .3. The maternal half sibs will help. Even the progeny test of a bull tells the breeder nothing about maternal performance unless the daughters are evaluated. And using the progeny test of a sire as a sib test on the sons is useful.

If a breeder is making substantial genetic progress in his herd, a buyer should try for bulls out of young sires and young dams even though there is not as much data on which to make a decision.

The pedigree of a bull is not as important as it once was believed to be. When verbal descriptions were in vogue, names and numbers were sufficient. Today selection pressure is being directed toward improving highly heritable traits---for which own performance is a good indicator of breeding value. The pedigree is simply less important. The performance pedigree is useful in promotion and in determining how many generations of testing have gone into this animal. Problems arise in evaluating them since chance at segregation each generation quickly reduces the importance of data on much more than the parents. This is especially true when own performance is evaluated.

Records of performance cost money. A buyer should consider the level of accuracy in breeding value estimation he is willing to pay for. Really the

use to be made of the breeding stock by the buyer determines the performance testing level required. When the price of being wrong about the breeding value of a bull spells economic disaster, then a thorough test is in order. This situation occurs when large numbers of progeny are to be produced by the selected bull and whether being wrong destroys an otherwise substantial performance reputation. Bull studs offering semen from sires to all breeders have quite a stake in the sire being as reported. A sequential testing scheme where prospective stud bulls are performance tested and only the best are adequately progeny tested over several herds and possibly even for maternal traits using their daughters can be justified. A commercial producer, on the other hand, who is routinely buying ten range bulls each year and replacing them in his herd every two years needs to be concerned only with bulls having a good performance test and possibly some sib information on carcass traits. The average performance of progeny from the ten bulls will usually come close to what can be predicted. But just which bull was the best will forever remain hidden.

Today the opportunity exists to use any number of bulls by artificial insemination. In those breeds with open A.I., breeders can use superior sires that have been thoroughly tested. The issue in whether to use artificial insemination is whether the sires that can be used are superior enough to at least pay for the extra cost involved in an A.I. program. Several of the studs have sound beef breeding programs that are designed to put superior sires in A.I. service.

Now if after evaluating and studying the industry over for just the bull and you do not find one or are disappointed, do as you should have done in the first place---look your own bull crop over for prospects. Often breeders miss the golden opportunity at home. It is not as much fun as going all over,

but it may be more rewarding. Chances are if you have secured the right bulls in the past, you have superior sons at home just waiting to be used, even on their half sisters. Incidentally if you do not have a superior son you missed the definition of BREEDING VALUE.

Chance

Even after doing everything right in solving the bull selection problem and you come up with a dud do not blame yourself. Chance at Mendelian segregation got you and that is what makes the business of cattle breeding so exciting. Good Luck!

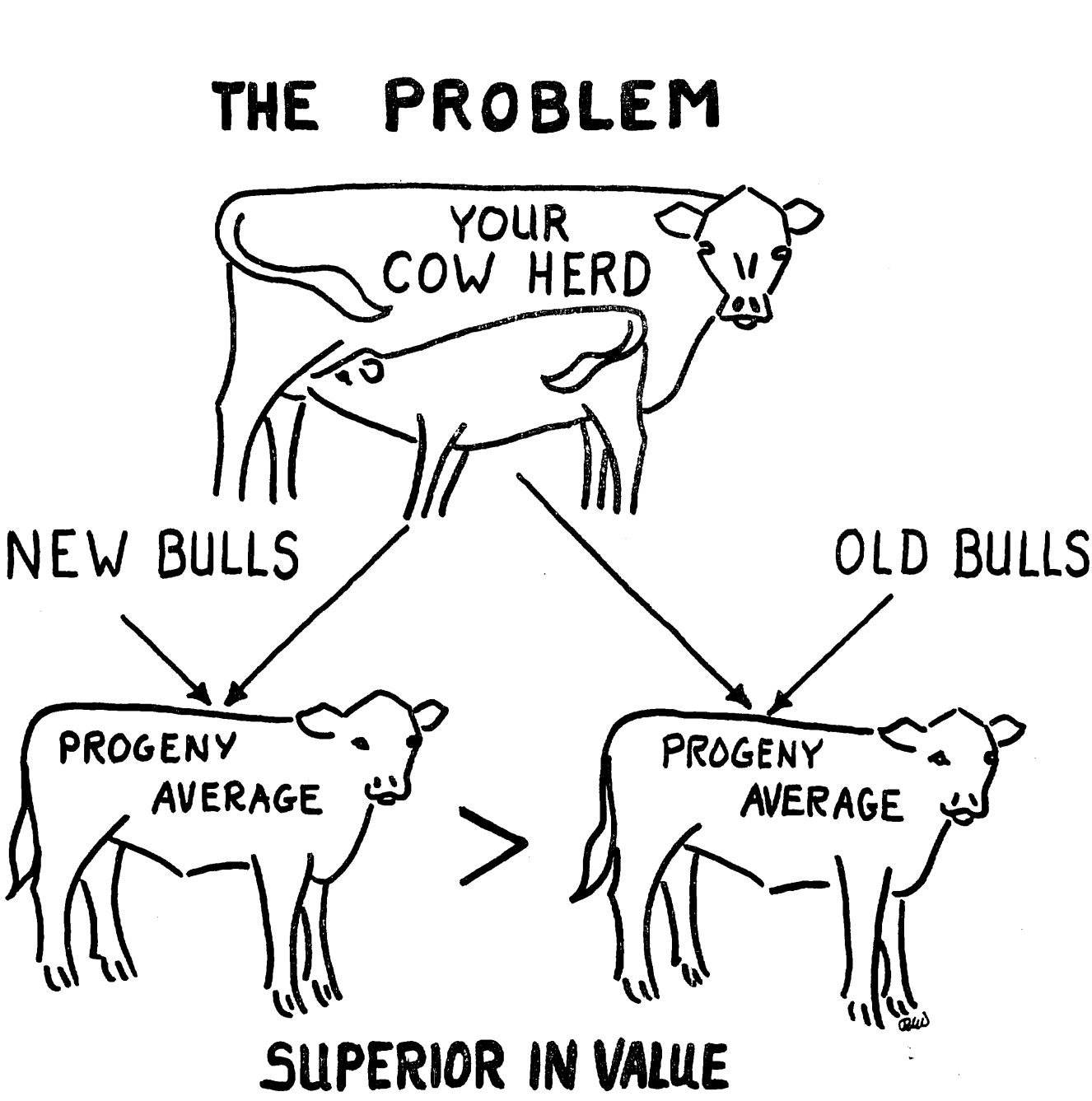



Figure 1. This figure states the bull selection problem in pictures. The problem is to find a bull or a set of bulls that when mated to the cow herd of the breeder will produce offspring that are superior in value compared to those now being produced.

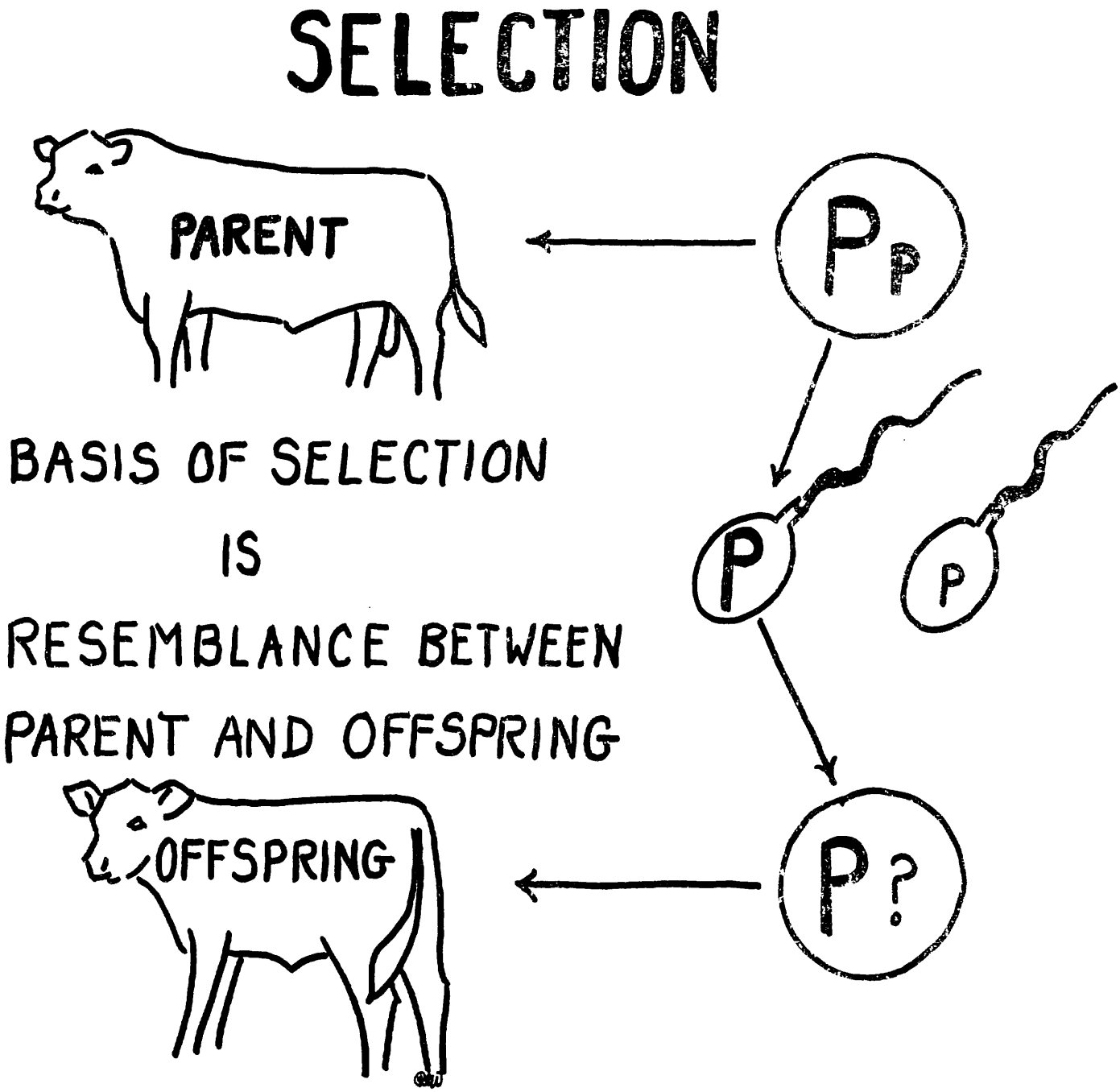



Figure 2. The basis of selection is the resemblance between parent and offspring. The cause of the resemblance is that a parent gives to each offspring a sample half of his genes, one gene at random from each pair. The degree of this resemblance depends on the influence of gene effects or breeding value on the variability of the trait. When the resemblance is high, selection will be effective for the trait.

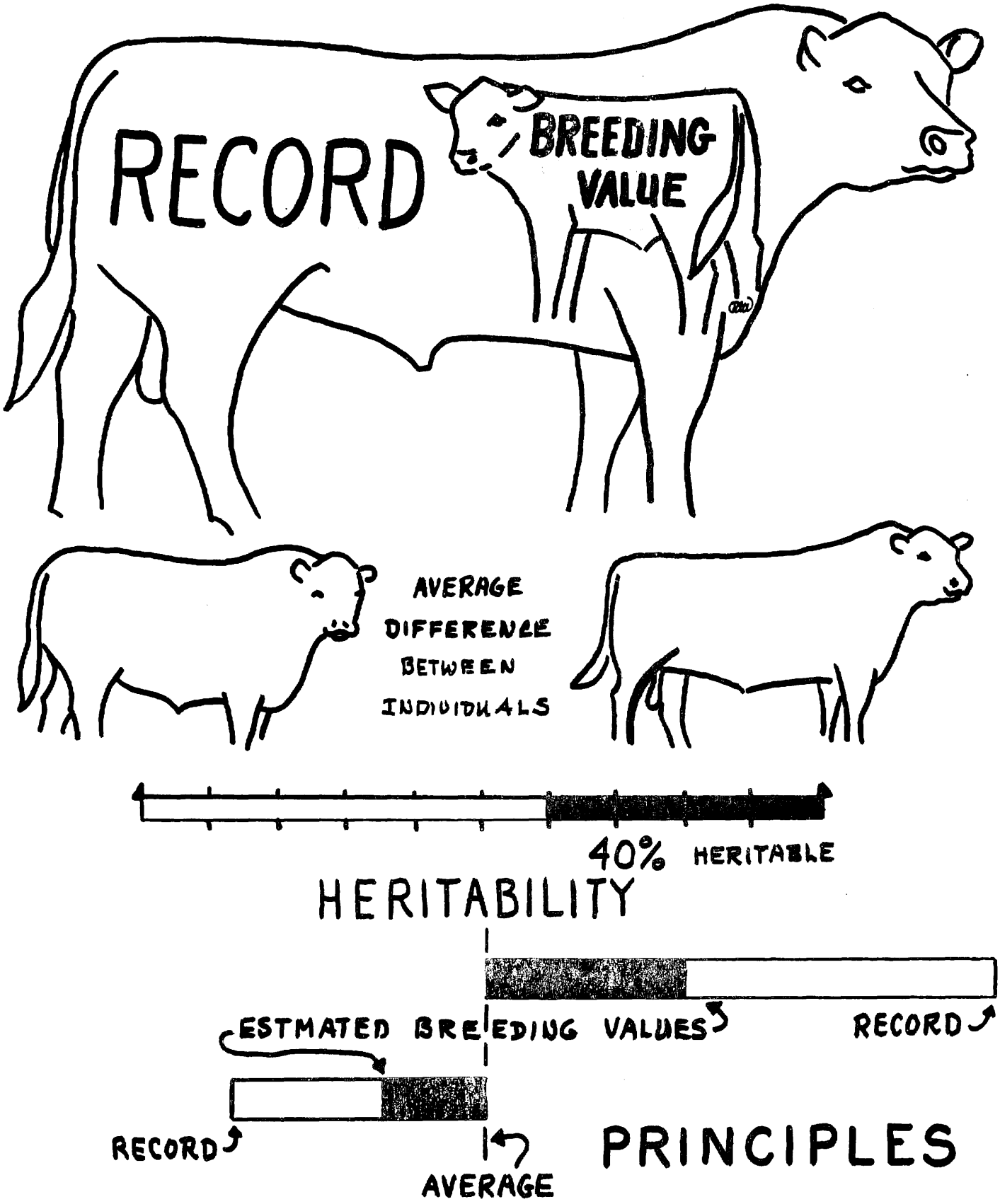



Figure 3. The breeding value of an individual is expressed not only in his progeny but also in his own record. Heritability is the fraction of the variation (average squared difference between individuals) that is due to differences among breeding values. The actual superiority or inferiority of a record from the average times heritability is an estimate of breeding value for the individual. That is, the heritable fraction of the superiority or inferiority is expected to be transmitted.

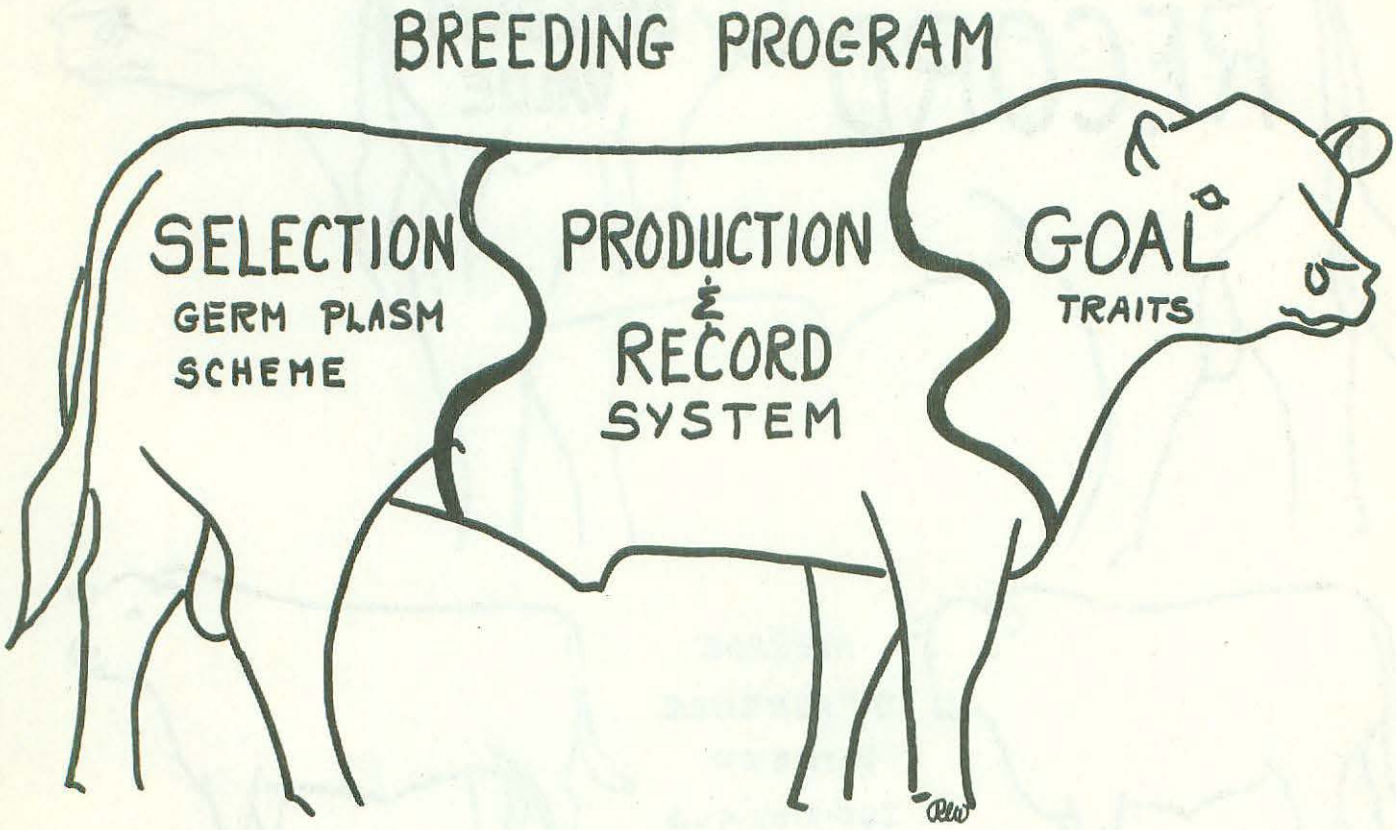



Figure 4. The important decisions in the design of a breeding program are as follows: 1) The first, the nervous system -- the goal choice. 2) The second, the gut issues -- the choice of production and record system to measure traits of the goal. 3) The third, the meat of the system -- the choice of selection procedure to use the records to accomplish the goal.

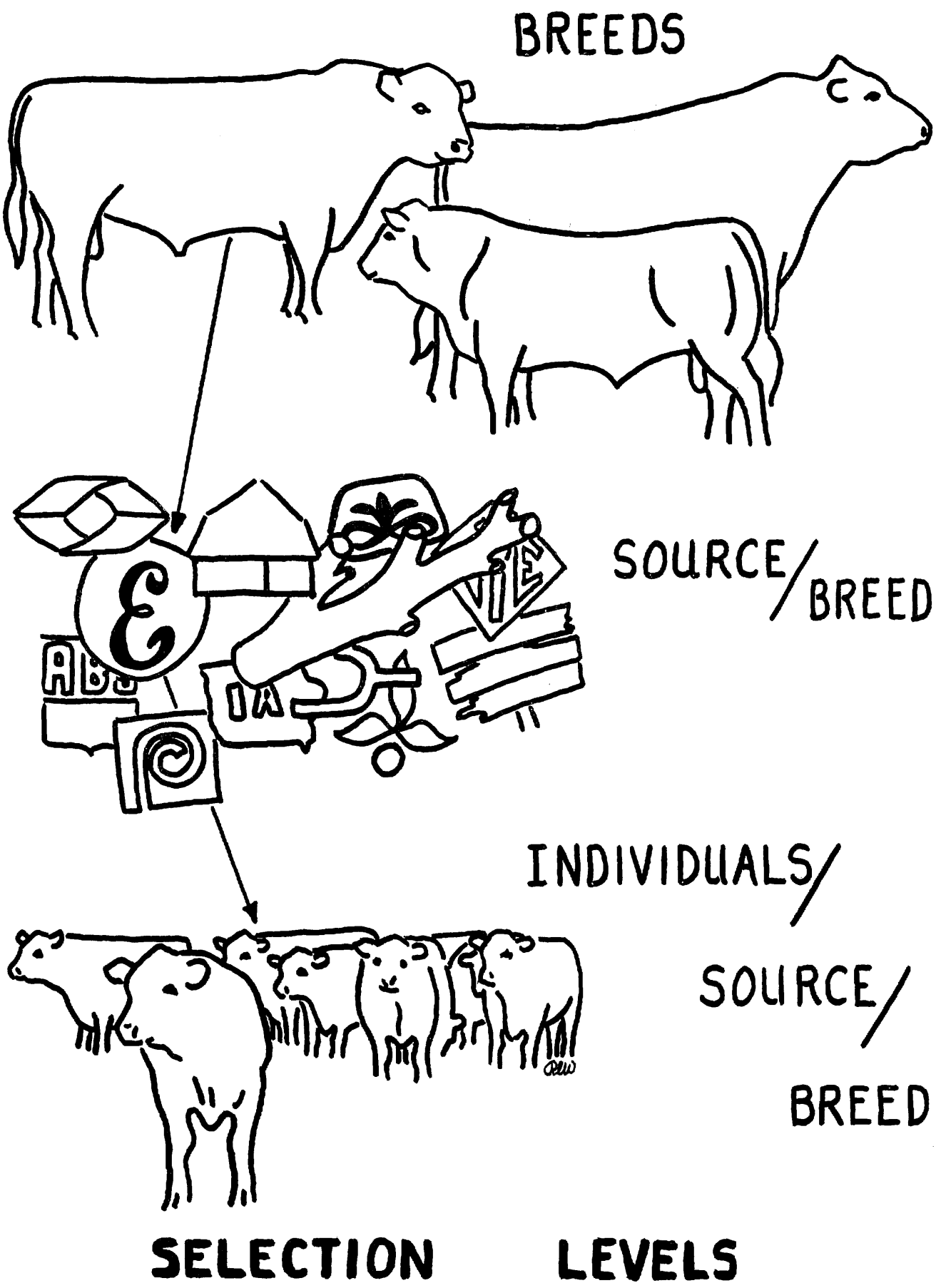



Figure 5. The selection levels are as follows: 1) The breed or breeds to use in the breeding program. 2) The sources of bulls within the breeds. 3) The choice of individuals within source and breed.

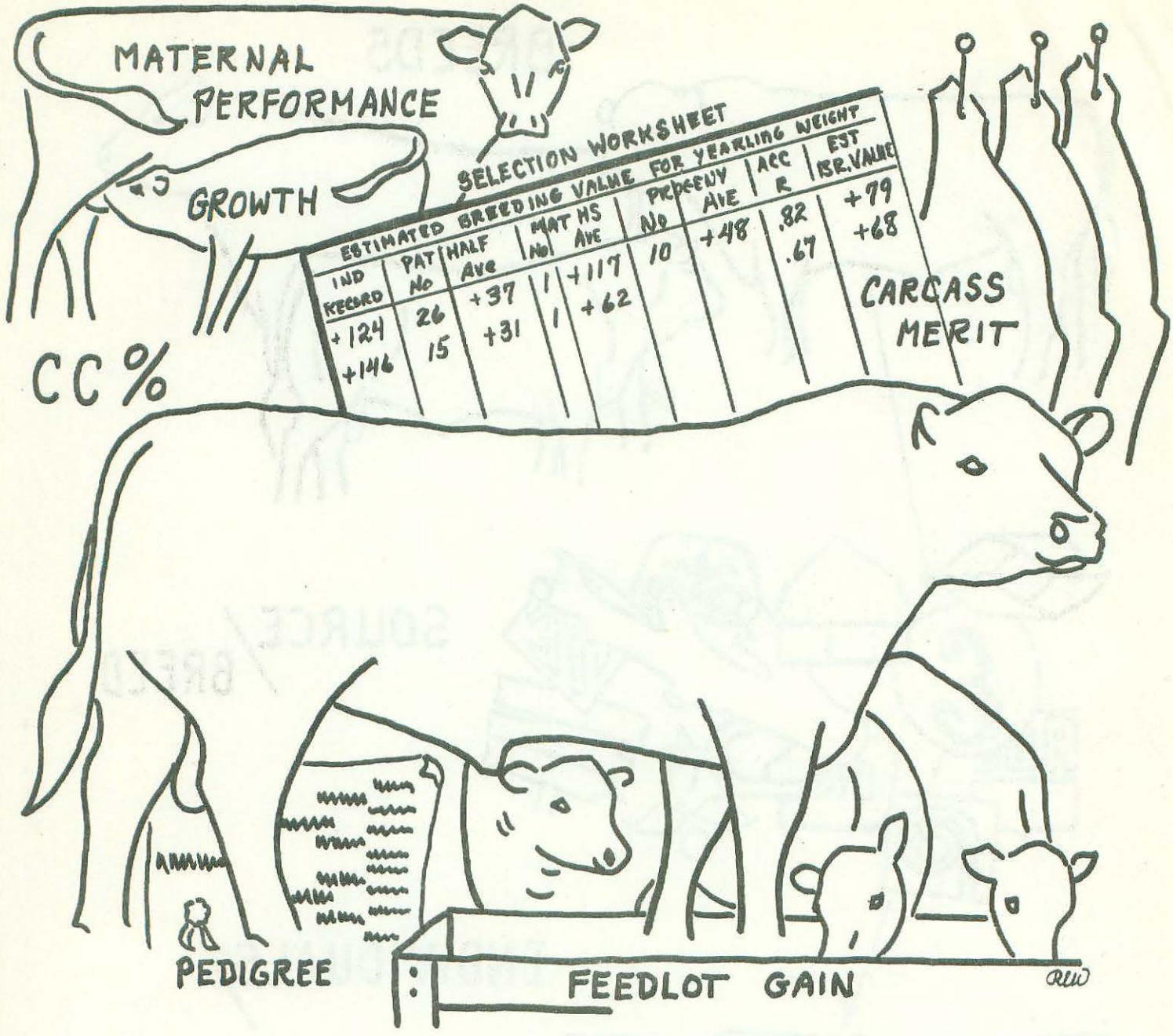



Figure 6. The individual, selected on performance records that measure the economic traits of importance in the goal of the breeder.