PROCEEDINGS

BEEF IMPROVEMENT FEDERATION

RESEARCH SYMPOSIUM & ANNUAL MEETING

B I F

MAY 17-19, 1976

PLAZA INN INTERNATIONAL

KANSAS CITY INTERNATIONAL AIRPORT

KANSAS CITY, MISSOURI

SYMPOSIUM

A look at Some Genetic Decisions
Richard Willham, Moderator

CANADIAN CONSULATE

8:30 a.m. to 9:00 a.m.	LINEBREEDING ... WHAT IT WILL AND WON'T DO FOR YOU - Dr. Jim Brinks, Colorado State University
9:00 a.m. to 9:15 a.m.	Question and Answer Period
9:15 a.m. to 9:45 a.m.	CURRENT GENETIC BEEF CATTLE RESEARCH IN CANADA - Dr. Gunther Rahnefeld, Canadian Department of Agriculture
9:45 a.m. 10:00 a.m.	Question and Answer Period
10:00 a.m. to 10:15 a.m.	Coffee Break (courtesy of American Breeders Service)
10:15 a.m. to 10:45 a.m.	POSSIBLE EFFECTS ON GROWTH WITH SELECTION FOR BIRTH WEIGHTS (U.S. data) - Dr. Peter J. Burfening, Montana State University
10:45 a.m. to 11:15 a.m.	BREEDING VALUES FOR CALVING DIFFICULTIES AND THEIR RELATIONSHIP TO PERFORMANCE PROGRAMS (French data) - Dr. Tom Sutherland, Colorado State University
11:15 a.m. to 11:30 a.m.	Question and Answer Period
11:30 a.m. to 12:00 noon	WHAT PERFORMANCE RECORDS CAN DO FOR THE COWMAN - Jim Glenn, Iowa Beef Improvement Association, Ames, Iowa
12:00 noon	Awards Luncheon - AMERICANA NORTH Don Vaniman, presiding Pioneer recognitions - Dwight Stephens Seedstock breeder recognitions - John Massey Commercial breeders recognitions - Glenn Butts SPORTS SNAFUS
1:30 p.m.	Committee Meetings - Dixon Hubbard in charge
3:00 p.m.	Coffee Break (courtesy of Missouri Beef Performance Association)
3:10 p.m.	General Session, committee reports CANADIAN CONSULATE

Beef Improvement Federation
Symposia and Annual Meeting
May 17-18-19, 1976
Kansas City International Airport
Kansas City, Missouri

MAY 17 - Monday

9:00 a.m. to 9:00 p.m	Registration	
10:00 a.m. to 3:45 p.m.	Committee Meetings, Dixon Hubbard in charge	
10:00 a.m.	National Sire Evaluation	AMERICANA NORTH
1:00 p.m.	Farm & Ranch Testing	AMERICANA NORTH
	Merchandizing	CANADIAN CONSULATE
	Carcass Evaluation	MEXICAN CONSULATE
3:45 p.m. to 4:00 p.m.	Coffee Break (courtesy of Ralston Purina Co.)	
4:00 p.m.	Caucus for Election of Directors Breed Associations, C. K. Allen, Presiding AMERICANA NORTH Eastern States BCIA's, James Bennett, Presiding MEXICAN CONSULATE Central and Western States BCIA's, J. David Nichols, presiding - CANADIAN CONSULATE	
6:30 p.m.	Buffet - JAPANESE CONSULATE	
7:30 p.m.	UNIQUE ANIMAL IDENTIFICATION, Dr. J. Coleman Hensley, USDA/APHIS L. A. Maddox, presiding	
8:30 p.m.	Committee meetings (cont'd.) Central Testing - MEXICAN CONSULATE Record Utilization - CANADIAN CONSULATE Reproduction - SCANDINAVIAN CONSULATE	

May 18 - Tuesday

6:30 a.m.	Breakfast Meeting; Board of Directors (retiring and new directors) MEXICAN CONSULATE

5:30 p.m.	Social hour - CANADIAN CONSULATE
7:00 p.m.	Awards Banquet - AMERICANA NORTH Master of Ceremonies - Lou Chestnut President's Address - Ray Meyer National BIF Awards - Frank H. Baker Beef Cattle Improvement Association of the Year Breed Association of the Year Commercial Producer of the Year Seedstock Breeder of the Year A WEE BIT OF SCOTCH - Dr. and Mrs. Tom Sutherland

May 19 - Wednesday - Glenn Richardson, presiding

6:30 a.m.	Breakfast Meeting; Board of Directors (retiring and new directors) - MEXICAN CONSULATE

CONTINUATION OF SYMPOSIUM
Glenn Richardson, Moderator

9:00 a.m.	Panel on Beef Cow Efficiency
9:00 a.m. to 9:30 a.m.	Dr. Ed Hauser, University of Wisconsin
9:30 a.m. to 10:00 a.m.	Dr. Earle Klosterman, Ohio State University
10:00 a.m. to 10:30 a.m.	Dr. Tom Cartwright, Texas A&M
10:30 a.m. to 10:45 a.m.	Question and Answer Period
10:45 a.m. to 11:00 a.m.	Coffee Break (courtesy American Hereford Association)
11:00 a.m.	Panel on Beef from Producer to Consumer
11:00 a.m. to 11:30 a.m.	Lloyd Schmitt, Stanford, Montana
11:30 a.m. to 12:00 noon	James H. Bell, Jr., Bountiful, Utah
12:00 noon	Lunch - AMERICANA NORTH

Proceedings of Beef Improvement Federation
Research Symposium and Annual Meeting

Compiled and Edited by Robert C. de Baca
with assistance from Mrs. Joane Cole

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LA-UR

TITLE: ELECTRONIC MANAGEMENT FOR THE LIVESTOCK INDUSTRY

AUTHOR(S): J. C. Hensley, D. M. Holm, and W. Mort Sanders

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ELECTRONIC MANAGEMENT FOR THE LIVESTOCK INDUSTRY*

by

J. C. Hensley**, D. M. Holm, and W. Mort Sanders

Presented at Beef Improvement Federation

Kansas City

May 17, 1976

*This work was supported by the United States Department of Agriculture and the Energy Research and Development Administration under USDA/ERDA interagency agreement. The work was performed at the Los Alamos Scientific Laboratory.

**USDA, Office of Scientific Liaison

ELECTRONIC MANAGEMENT FOR THE LIVESTOCK INDUSTRY

by

J. C. Hensley, D. M. Holm, and W. Mort Sanders

INTRODUCTION

As the world demands more optimum use of energy in food production, the application of present day scientific technology to solving agricultural problems will be necessary. With optimum use of the world's energy resources as a prime concern, the conservation of energy in food production is paramount. Efficient food production will be measured not only in optimizing protein for animal and human consumption, but will also be measured in terms of decreased energy requirements.[1] One area of conservation that can be improved is that of disease control in animals. New methods for disease prediction, detection, and forecast need to be developed.

After a diseased animal is detected, its herd of origin and the source of the disease must be determined so that corrective disease control and eradication procedures may be initiated. To determine their herds of origin, animal populations must be identified. Computer technologies must be applied to manage the extensive records that will be necessary for traceback through commerce to herd of origin. Electronic technology offers long-sought solutions for disease detection and epidemiology problems. Developmental work at present has shown that a subdermally-implanted, electronic transponder (having no batteries) can be remotely activated and transmit temperature and identification information back to a receiver in a few tenths of a second. If this electronic identification and temperature monitoring system is developed into a commercially available product line, and is widely accepted by the cattle industry, it will enable them to carry out more extensive management practices. Better management can result in greater efficiency and productivity. The system will also enable regulatory agencies to trace the movements of diseased animals through commerce, and thus assist in disease control measures.

THE USDA/ERDA IDENTIFICATION PROJECT

The inadequacy of present-day methods for animal identification are well recognized by those in the livestock industry and regulatory veterinary medicine. A cooperative activity between the USDA, Animal and Plant Health Inspection Service (APHIS) and the ERDA, Los Alamos Scientific Laboratory (LASL) has been underway for three years to seek a satisfactory solution by developing a system for effective animal identification.

Several alternative methods of identifying animals were considered. It was concluded that most nonelectronic methods could not satisfy a preponderance of the desired characteristics from the list below.

1. Passive (no batteries)
2. Remote sensing (do not have to hold the animal)
3. Capable of identifying individual animals
4. Error free
5. Suitable for direct input to a computer
6. Long life
7. Low cost

In the winter of 1972, LASL scientists were asked to consider the possibility of passively monitoring the temperature of animals during ante mortem inspection at slaughterhouses. In considering this problem, a remote temperature monitoring system was envisioned using encoded microwave backscatter from a fixed frequency interrogator. It soon became apparent that identification numbers could also be encoded on the temperature signal, and that the resulting concept incorporated most, and perhaps all, of the desired properties on the above list. Thus, a combination of animal identification and temperature monitoring seemed possible, and work was started to determine the technical feasibility of the concept. Since the electronic development was at the forefront of electronics technology, many concepts used in the design had not been proven, and thus, considerable risk was involved in extrapolating existing technology to a practical system. To minimize the cost associated with the risks, the technical development was divided into five stages.

Stage I.

The first stage was to demonstrate the feasibility of a passive, remote transponder having both identification and temperature. Once the concept had been demonstrated as feasibile, it was determined that a subdermally-implanted transponder with 15-decimal digits of identification and 3-decimal digits of temperature was desired by a large segment of the livestock industry and the APHIS.

Stage II.

The next stage of development was the demonstration of a subdermally-implanted transponder which would work under the skin without the use of batteries. This was accomplished with a temperature-only indicating unit in September 1975.

Stage III.

With the successful operation of the equipment in Stage II, it appeared that there were no unsolved fundamental problems which would prevent the development of a practical electronic identification and temperature monitoring system. Although the feasibility of the concept had been demonstrated, considerably more electronic development was necessary before a practical system could be realized.

It was recognized early that it would be necessary to use integrated circuit (IC) chip manufacturing techniques to reduce the size and cost of the transponders to acceptable values. Since a substantial investment is required (up to $100,000) to develop and produce IC chips, it was decided to develop the final circuits with hand-wired and hybrid circuit electronic components. Considerable circuit development was required, and modifications were necessary as a result of field testing. It was also necessary to keep the size of the working models close to that of the final unit. Therefore, a compromise was necessary for Stage III, and it was decided to incorporate only three decimal digits of identification with the temperature measurements; but to incorporate all of the other essential features of the final system. Stage III is currently underway, and a demonstration is expected in the summer of 1976. At the completion of Stage III, it is expected that the major technical problems will be solved, and it will be time to initiate transfer of the technology to industry.

Stage IV.

Stage IV involves the completion of the electronics development and the successful transfer of that technology to industry. Specific inputs from the livestock industries and regulatory agencies will be required to develop specifications for the system developed in Stage IV.

Stage V.

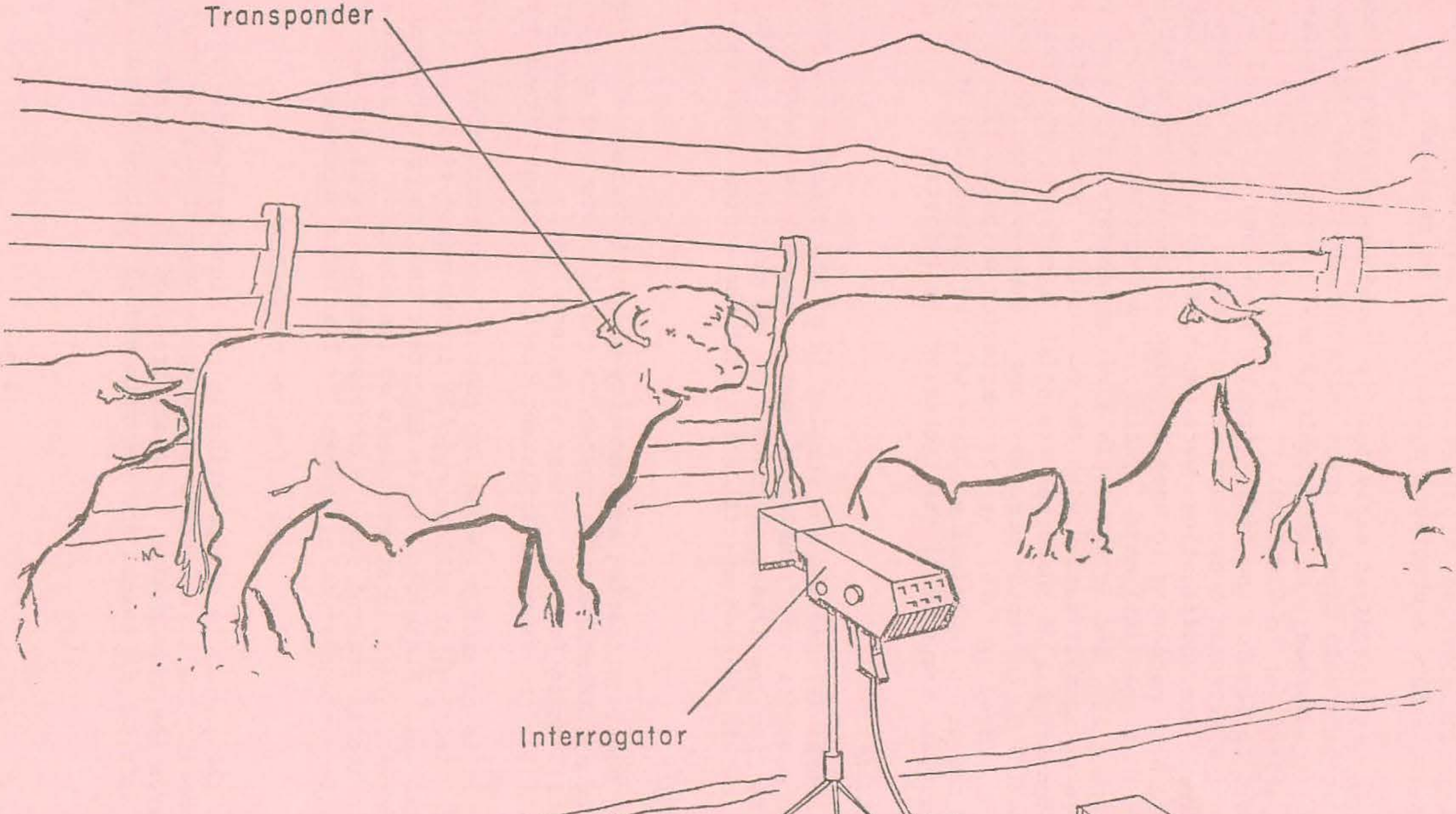
Commercialization and industry-wide utilization of a practical electronic identification system is the ultimate goal of the Electronic Identification Project. Stage V is intended to encompass all of the activities necessary to implement Electronic Identification of Animals.

It is generally recognized that if electronic identification is cost effective, it will be quickly incorporated into the livestock industries. Therefore, it is important that the development of the commercial system meet the needs of the specific industries so that incentive is present for its incorporation. As it becomes widely accepted, the cost effectiveness is likely to increase.

PRINCIPLE OF OPERATION

The principle of operation in the final system is illustrated in Figure 1. The interrogator sends out a beam of 915 MHz radio waves towards the transponder. A small fraction of the microwaves penetrate the skin of the animal and generate enough voltage (about 1-1/2 volts)

Fig. 1



to power the transponder circuitry. The internal circuitry of the transponder is used to change the reflection of the transponder antenna with a frequency (approximately 20 kHz) that is proportional to the temperature of the animal. This relatively low frequency reflection is detected with the same antenna that sent out the interrogating beam. Signal mixing and suitable filters isolate the return signal from the powering beam, and the signal is subsequently decoded into identification and temperature. The digital identification number uses a binary-coded decimal format in which the "zeros" and the "ones" are further encoded into a pattern of 10 kHz and 20 kHz frequency "packets."[2] The receiver circuitry requires that the identical coded signal be received two successive times before it is accepted as a correct signal. This requirement eliminates essentially all erroneous readings. Each reading of the 15-decimal digits takes place in less than one-tenth of a second.

The antenna constitutes the largest item in the transponder package (see Fig. 2). When operated near resonance, its length is proportional to the amount of voltage which can be generated to power the electronics. The present length of 10 cm was chosen to be compatible with present day circuit elements, biological radiation standards, and the frequency of the interrogating beam.

INTERROGATOR UNITS

The identification and temperature monitoring systems may eventually be developed into two basic configurations: 1) a shoulder-harness or back pack model, and 2) permanently mounted models. The back pack models would be used by individuals to identify animals while the permanently mounted models would be interfaced to a computer and be capable of directly transmitting data to a large computer center.

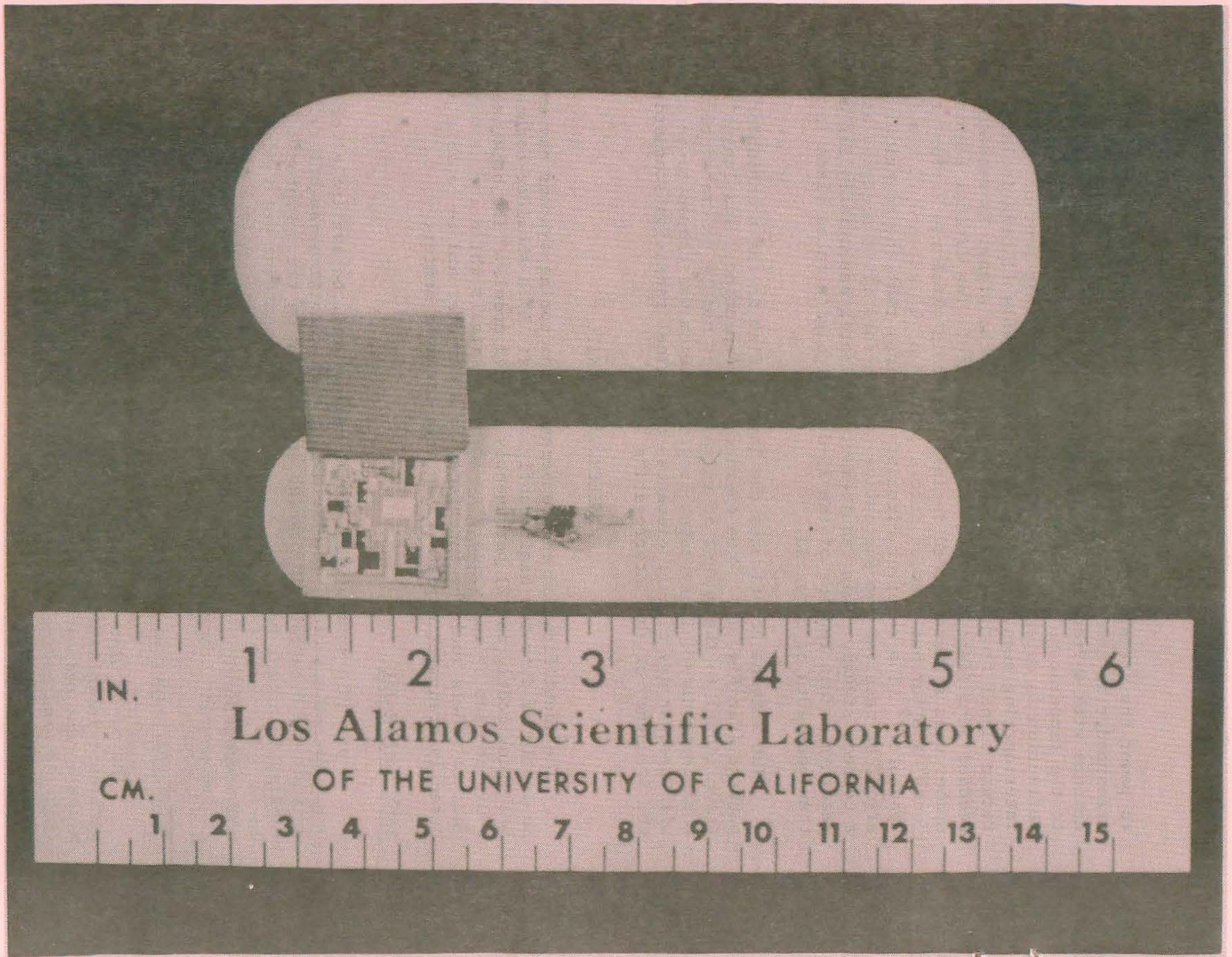
Back Pack Model

A portable system with visual readout will be available for field use. Variations could have permanent data recording capability. The systems would be battery powered and carried on the operator's back, similar to a back pack, but with a hand-held antenna and readout. These units would be used for recording individual animal temperature and identification. The data could be recorded on a magnetic tape for subsequent transmission to a computer for analysis.

Permanently-mounted Model

The major uses for electronic identification will be found in permanent installations. These systems can be used to control feed mixutres and medication to individual animals, open and close gates (Fig. 3), and assign weight and performance information to the proper animal.

Fig. 2 - This photo shows the implantable temperature monitoring transponder before and after encapsulation.



These systems can be used to monitor animals as they enter a slaughter plant. The animal identification number will allow traceback to the herd of origin. This information is extremely important if the animal is found to be diseased and disease control procedures are initiated.

APPLICATION OF REMOTE ELECTRONIC IDENTIFICATION AND TEMPERATURE MONITORING

To define uses of the remote, passive electronic identification and temperature monitoring system, we must assume completion of current developmental activity,[3] acceptance by the livestock industry of the need for implanted identifiers, and their subsequent use in domestic animals. We have also assumed that a network of large computers can be developed to manage the large amount of data that will be generated.

Disease Detection and Eradication

Animal diseases cause reductions in production efficiency. Since elevated body temperature is frequently associated with disease, the measurement of temperature offers an early disease detection capability. Therefore, frequent monitoring of animal temperature and detection of variations from normal temperature patterns can have significant impact on the economic losses associated with disease.[4] This is particularly true in disease eradication programs where it is important to detect the disease early in an outbreak and initiate appropriate control measures. Small changes in the average temperature of a large animal population may give an indication of a physiological change associated with disease.

Continuous temperature monitoring of individual animals is currently underway to show the effects of environmental conditions and infectious agents on the body temperature.[5,6,7,8] Many animal diseases cause specific perturbations in temperature histories. These perturbations are related to the multiplication of the infectious organism, and in some instances can be used for determining the type of organism. Initial temperature profile research at the USDA's Plum Island Animal Disease Center (PIADC) in Long Island, NY,[5] showed the potential of using animal temperature histories in remote detection of foot-and-mouth disease in deer and cattle.

Continuous temperature measurements show that there are considerable temperature variations in animals under normal conditions. Thus, it appears that it will be necessary to develop methods for cancelling out the normal fluctuations due to the environment, so that abnormalities can be identified. It is expected that computer codes will be developed to assist in the identification of temperature abnormalities.

Metabolism

In cattle and swine, adequate intake of nutrients provides for physiological stability in the absence of disease. Prudent use of plant protein in producing meat and dairy products will become more and more critical, and genetically efficient production animals must be fed exactingly to produce the end product with optimum consumption of plant protein. Electronic identification and temperature monitoring coupled with computer controlled feeding stations and weighing stations, will make it possible to monitor changes in conversion efficiences associated with changes in metabolism. Computer programming will allow the producer to become aware of animals going off their feed, or off their milk production. Since altered metabolic or physiological activity is associated with ovulation, parturition, and other disturbances, it is expected that these will be detectable by frequent temperature measurements.

Markets

Individual animal identification will make it possible to institute considerably more automation in business transactions.[9] In the livestock markets, an animal can be immediately identified upon reaching the facility. The animal's identification number could be transmitted to a large computer center and verification of ownership could be quickly obtained. If the animal was removed from an infected herd, proper disease control procedures could be initiated. If the animal is determined to be disease free, its sale could proceed normally. Animals with certain diseases could be consigned to slaughter-only status.

A small computer would necessarily be a part of this system. This computer could be used to automate many of the market operations. Sales transactions, animal weight, seller information, market commissions, and buyer information could all be handled by this computer for rapid and efficient operation. The resulting market data could be transmitted to a large computer facility. There it would be summarized and indexed to provide information to agencies and individuals in need of, and qualified to receive, the information. These data could be used to forecast world food supplies.

CONCLUSION

Passive electronic identification with temperature monitoring of animals appears to be technically feasible and offers the potential for practical individual animal management. While there are additional developments and experiments which must be done, there is good reason to expect that a practical system will evolve in the next few years.

The development and widespread use of an accurate passive livestock identification and temperature monitoring system is the key to the control and subsequent eradication of animal diseases (Fig. 4). This will lead to more efficient food production. With the systems that we have discussed, the livestock industry will be able to better optimize the production of animal protein.

Fig. 3 - The passive identification system is being used to automatically sort cattle.

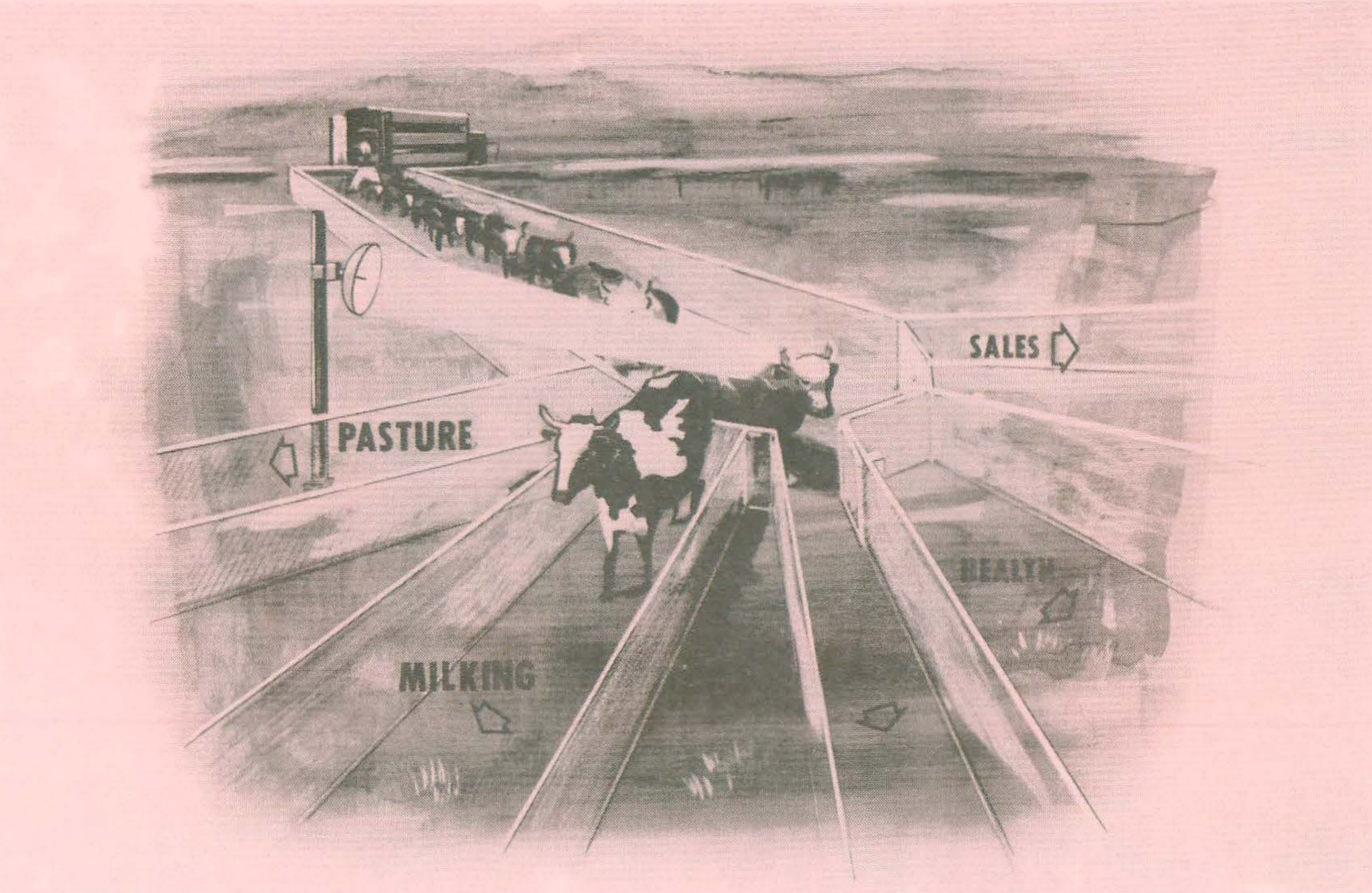


Fig. 4 - The animal identification and disease detection systems are shown as they may be used in disease control programs.

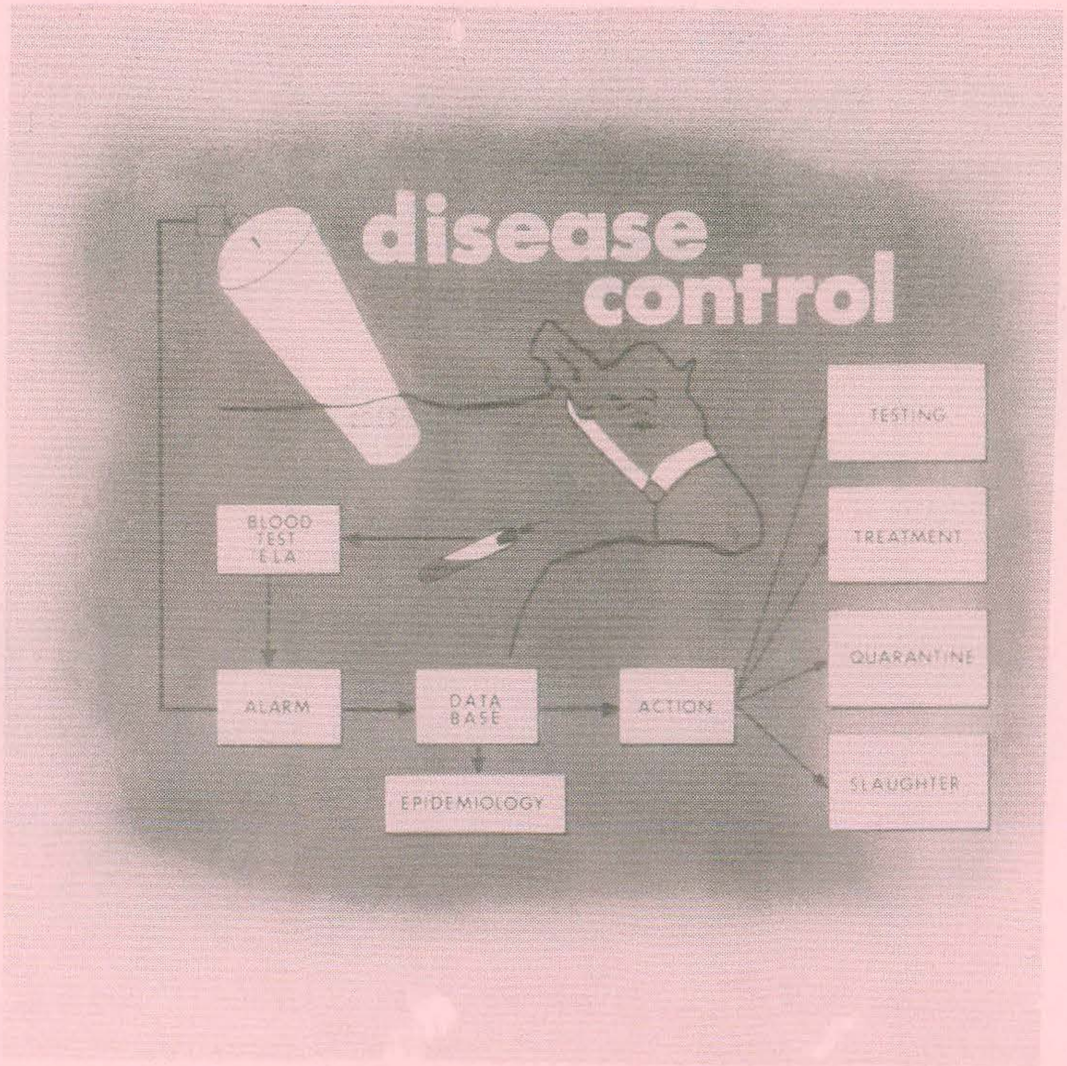
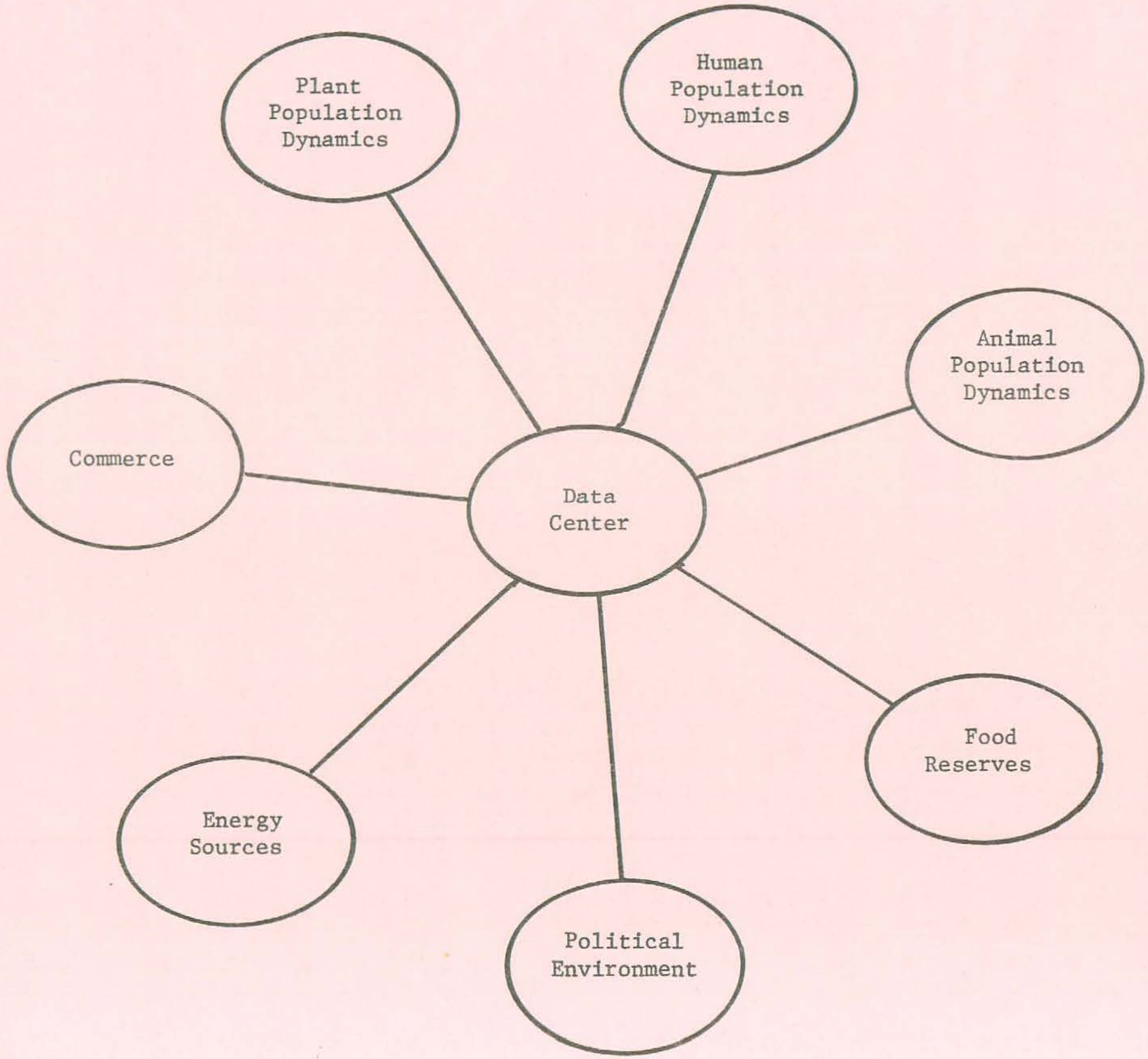


Fig. 5 - The interaction of food and energy supplies are shown.



There is an important balance between plant foods for animal and human consumption, animal products and by-products, world human population dynamics, and political and international economic considerations (Fig. 5). All available technology should be used to maintain this delicate balance. New disease detection methods, remote electronic identification and temperature monitoring, and space-age plant-crop assessment, offers the means for maintaining this delicate balance. Further application of scientific technology to agricultural problems is needed.

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LINEBREEDING[1]

J. S. Brinks

Colorado State University

My topic this morning is linebreeding. I plan to make the discussion somewhat broader than simply linebreeding and will touch on the overall subject of mating systems, concentrating on how linebreeding relates to the seed stock industry.

I plan to throw in a touch of theory, a few principles, some research results along with some observational experience and try to come up where this breeding system fits into the beef breeding enterprize.

Definition of Terms

The term mating system refers to how animals are mated after selection of replacements. They can be 1) randomly mated or 2) nonrandomly mated on the basis of pedigree relationship (inbreeding and outbreeding) or on the basis of phenotypic resemblence (positive or negative assortive mating). This discussion is on inbreeding and outbreeding only.

Inbreeding is the mating of animals more closely related to each other than the average of the breed. When mates are related through common ancestors, the resulting offspring are inbred. Table 1 presents information for a few of the common matings of related animals.

Table 1. RELATIONSHIP AND INBREEDING VALUES

Mating	Relationship of mates	Inbreeding of offspring
	%	%
Parent-offspring	50	25
Full-sib	50	25
Grandparent-grandchild	25	12.5
Half-sib	25	12.5
First-cousin	12.5	6.2
Double first-cousin	25	12.5
Uncle-niece	25	12.5

Cattle have many thousands of gene pairs. An offspring from a sire X daughter mating would be 25% inbred indicating that he is expected to have 25% fewer heterozygous gene pairs than an animal that is not inbred.

Linebreeding is keeping the relationship to a superior animal high in

[1]Presented at the Beef Improvement Federation meeting, Kansas City, Missouri, May 18, 1976.

the descendants pedigrees. A breeder uses an outstanding individual, usually a sire, and he wishes his entire herd to become genetically identical to that superior individual. This breeding system results in some inbreeding even though the breeder's aim is to achieve the high genetic relationship rather than to intentionally inbred.

Linecrossing is the crossing of inbred lines within a breed and it results in restoration of inbreeding depression or heterosis.

Topcrossing is the use of inbred bulls on unrelated outbred cows.

Outcrossing is the mating of animals which are less related than average within a breed and is used to prevent inbreeding depression or obtain hybrid vigor.

Heterosis is simply the opposite side of the coin of inbreeding depression. It is usually defined as the amount or percent the average of the two reciprocal crosses exceeds the average of the two parental lines.

A Few Principles

Differences among animals are due to two major causes - genetic and environmental. Likewise, the observed performance (phenotype) of a specific animal is due to the genes it receives from its parents and the environment in which it is raised. The genetic makeup of an animal (genotype) is determined by the sample one-half of the genes from the sire and the sample one-half from the dam and how those genes are combined in the animal.

The genotype of an animal can be divided into two portions, 1) the additive genetic value (breeding value) and 2) the nonadditive portion of the genotype. The breeding value is that portion of the total genotype which is transmitted from parent to offspring and is determined by the additive effects of the genes affecting a particular trait. Additive gene effects are comparable to adding block upon block as in construction of a building (gene effect upon gene effect). The sum of the additive gene effects totaled over all pairs of genes affecting a particular trait determine an individual's breeding value for that trait. The nonadditive portion of the genotype is determined by the way the genes are combined in an individual. This effect is caused by two genes at the same position on a pair of chromosomes interacting (dominance or recessiveness) or by genes at different positions on the same or different chromosomes interacting with each other (epistasis) to produce an additional effect contributing to the phenotype.

A theoretical example of partitioning the overall genotype into the two components for an outbred, a crossbred, an inbred and a selected inbred animal is shown in Figure 1.

Figure 1. Theoretical Example of Partitioning the Genotype Into the Breeding Value and Nonadditive Value.

Let the Dominant Gene (capital letter) = + 1
Let the recessive gene (small letter) = 0
Let the heterozygous condition = + 1
Let the homozygous recessive condition = - 1

	Crossbred	Outbred	Inbred	Selected inbred
	A B C D	A b C D	A b C d	A B C d
	a b c d	A b c d	A b C d	A B C d
Breeding value =	4	4	4	6
Nonadditive value =	4	2-1= 1	-2	-1
Genotypic value =	8	5	2	5

The above example is for a trait where both the additive and non-additive effects on performance is important. If all individuals were subjected to exactly the same environment, the crossbred would be expected to have the best performance followed by the outbred and selected inbred and lastly the inbred. However, if used as breeding animals, the selected inbred would be the superior breeding animal with the other three being equal. The superior performance of the crossbred cannot be passed on to his offspring because his superior combination of genes is not transmitted to his offspring but only a sample half of his genes. Systematic crossing schemes must be used to produce this kind of genotype to maximize performance for certain traits.

Results from Inbreeding Studies

A study was recently completed on the effects of inbreeding involving cattle from experiment stations in the Western States. The purpose of this cooperative study was to determine the effects of increased inbreeding on various fitness and growth traits. Both pooled analyses over all lines and separate analyses by line were used to study both linear and curvilinear effects of inbreeding of calf and of dam.

Data were from 48 inbred lines from ten experiment stations located in eight Western States participating in the W-1 Regional Beef Cattle Breeding Project. The lines averaged 305 matings, 94 dams, and 11 sires per line and were in existence an average of 13 years. The average inbreeding values per line were 13.9 percent for sires, 12.2 percent for dams and 18.5 percent for matings (calves). However, there was considerable variation around these average values.

The traits studied were divided into the two categories of fitness traits associated with reproduction and survival and growth traits from birth through yearling ages.

The following summary of results and conclusions are drawn from the study:

Fitness Traits

1. The least squares mean from the pooled analyses for percent open was 16.3. This result indicates that 83.7 percent of all matings resulted in pregnancy. Of matings resulting in pregnancy, 0.5 percent resulted in abortions, 3.7 percent died at birth, 5.2 percent died from birth to weaning and 90.7 percent of calves born were weaned.

2. There were large differences in means for fitness traits among stations and lines associated with differences in rate and degree of inbreeding. More rapid and higher levels of inbreeding were associated with lower performance for all fitness traits.

3. Increased inbreeding of calf and of dam had a detrimental effect on all fitness traits studied. Inbreeding of calf was slightly more important than inbreeding of dam for all traits except percent open. The partial regressions of traits on inbreeding of calf were: percent open, .1287; percent aborted, .0045; percent dead at birth, .0775; percent dead birth to weaning, .0825; and percent weaned, -.1645. Corresponding regressions on inbreeding of dam were: .2094, .0081, .0255, .0734 and -.1070.

4. The response to inbreeding of calf and of dam by line varied greatly as evidenced by both the sign and magnitude of the partial regression coefficients both within and among stations. The percent of the partial regressions by line that were unfavorable was about 60 percent for all traits except percent abortions for inbreeding of both calf and of dam.

Growth Traits

1. The least squares means from the pooled analyses for males in pounds were: birth weight, 76.9; preweaning daily gain, 1.71; weaning weight, 406; initial weight at test, 451; test daily gain, 2.09; and final weight, 795. Corresponding values for females were: 73.1, 1.62, 389, 431, 1.54, and 660. Males were more variable than females in preweaning daily gain and weaning weight, as evidenced by their larger standard deviations and coefficients of variation.

2. Increased inbreeding of calf had a detrimental effect for

all growth traits studied when only the linear effect of inbreeding was considered. Partial regression coefficients of traits on inbreeding in pounds per percent inbreeding were: birth weight, -.0934; preweaning daily gain, -.002735; weaning weight, -.6370; initial test weight, -.4574; test daily gain, -.003482; and final weight, -.9687. Corresponding values for females were -.0661, -.003147, -.6715, -.1283, -.003259, and -.5548.

3. Increased inbreeding of dam had a detrimental effect for all traits in males, and in all but birth weight and post-weaning growth in females. The largest detrimental effect was found for preweaning daily gain in both sexes as determined by standard partial regression coefficients. This effect is presumably due to decreased milk production associated with increased inbreeding of dam. The partial regression coefficients for males corresponding to traits listed above were: -.170, -.004865, -.8808, -.4173, -.002050, and -.6777. For females the coefficients were .0016, -.002492, -.5288, -.0123, .001279 and .2946.

4. Increased inbreeding of dam had about twice the detrimental effect on preweaning daily gain of male as for female calves. It is postulated that male calves, having more growth potential, are handicapped more than females by decreased milk production associated with increased inbreeding of dam. Thus, the magnitude of effects of inbreeding may depend on the level of environment provided the inbred population.

5. When both the linear and quadratic effects of inbreeding of calf and of dam were considered, the quadratic term for inbreeding of dam was significant for preweaning daily gain, weaning weight, test daily gain and final weight of bulls, but was nonsignificant for growth traits in females. The quadratic term for inbreeding of calf was nonsignificant for all growth traits in both sexes.

6. A differential response to increased inbreeding of calf and of dam by line was again evident when only the linear effects of inbreeding were considered. For inbreeding of calf, 72 to 80 percent of the individual line regression coefficients were unfavorable for all growth traits except birth weight. The effects were less severe for inbreeding of dam; 62 to 72 percent of the regressions were unfavorable for preweaning daily gain and weaning weight. This detrimental preweaning effect was compensated for in post-weaning paily gain in which 64 percent (males) and 70 percent (females) of the regressions were favorable.

7. There was no strong evidence for a quadratic growth response to inbreeding of calf or of dam. The largest proportion of significant quadratic effects (16.9 percent) was for the

effect of inbreeding of dam on weaning weight.

The results of this study corroborates previous reports that, in general, increased inbreeding is detrimental to performance in fitness and growth traits. The results also document the magnitude of the inbreeding effects. More important, however, the results indicate that the response to increased inbreeding varies with the individual lines; some lines show little or no detrimental effects in certain traits, whereas, other lines are affected greatly. The differential response is probably due to different initial gene frequencies in the lines and to the combination of the inbreeding plus concurrent selection processes operating with different degrees of success in the individual lines.

From an observational standpoint, relatively small inbred lines apparently can be developed and maintained without their loss due to highly detrimental effects of inbreeding in fitness traits. Although some cost through lower performance is associated with the maintenance of these lines, the cost does not appear to be prohibitive if the use of inbred lines is warranted in the production of seed stock in beef cattle.

Some Nonrandom Thoughts

I believe the main goal of seed stock producers should be to improve breeding values for important traits as rapidly as possible. I do not believe that inbred lines of beef cattle will be developed or selected for specific nicking ability. The commercial man can then obtain individuals with superior breeding values and then combine them in systematic crossing schemes to take advantage of both selection and heterosis. Also, some lines will be used in linecrossing or crossbreeding in a complementary fashion, i.e., utilize the lines strengths where they fit into a total program as in specialized lines (breeds) of sire and dam. Since members of the same line have many genes in common (some strengths and weaknesses), there is some advantage in consistency or repeatability for using individuals from the same line.

Now, to improve breeding values as rapidly as possible, one must change gene frequencies rapidly - increase the frequency of desirable genes and vice versa. The main method used is selection of animals with superior breeding values.

What does inbreeding do? Inbreeding speeds up changes in gene frequency but by itself is random in direction, i.e., inbreeding speeds up changes in gene frequency for undesirable genes as rapidly as for desirable genes. This phenomen is called random drift. Inbreeding plus selection (both between and within line) may speed up changes in gene frequency over straight selection especially for low to moderately heritable traits. Possibly, a new term called directed drift could be coined for this process.

Let's take a look at what this process has done in the Colorado Experiment Station herd.

Observations on Nonrandom Mating

The development of inbred lines of Hereford cattle coupled with intense selection for performance traits and subsequent crossing of these inbred lines has been a major portion of the beef cattle breeding work being conducted at the San Juan Basin Experiment Station, Hesperus, since 1946.

The objective of this study was to evaluate the genetic progress in weaning weights in both the inbred and linecross populations over a 26-year period. In addition, estimates of genetic progress in individual line and linecross groups are evaluated. The inbreds showed a genetic increase of 2.587 lbs per year for a total of 67 lbs over the 26-year period. The linecrosses had a genetic increase of 4.617 lbs per year or a total of 120 lbs over the entire period. The inbreds would be expected to show less genetic improvement than linecrosses since inbreeding intensity was increasing over the years and a decline in calf growth and milk production of the dam is generally associated with increased inbreeding. Figures 2 and 3 also show the phenotypic, environmental and genetic changes per year for the inbred and linecross populations.

Inspection of yearly genetic changes indicates a slight genetic decline from initiation of the project to about 1955 in both populations after which time, there was steady genetic improvement. Prior to 1955, selection of inbred bulls was based on weaning weight, feed efficiency, and yearling conformation score. In 1955 and in subsequent years, selection was based on weaning weight and postweaning daily gain, thus giving more emphasis to growth. Also, several of the poorer inbred lines based on performance were culled from the herd in the mid and late 1950's which also would contribute to the estimate of genetic progress made over the period.

Of primary concern in this study is how much genetic progress has been made in the linecross population. The increase of 4.617 lbs per year in adjusted weaning weight is about what breeders might expect from intense selection for growth in an outbred herd. Thus, the overall system of developing inbred lines with subsequent crossing among them has yielded about the same result as selection only. However, more progress has been made since 1955 and also certain lines and linecross groups have improved much more than the 4.617 lbs per year average. Thus, the inbred line approach appears to sort out at least some superior lines more rapidly than selection and outbreeding.

Other Observations

Inbreds are more susceptable to environmental stresses and, therefore, there is some cost involved in terms of better management and probably somewhat more losses -- death and lowered performance.

When a highly inbred bull is outstanding in performance, he is a good bet for superior breeding values for those performance traits. When a highly inbred bull has lower performance, one is not so sure whether

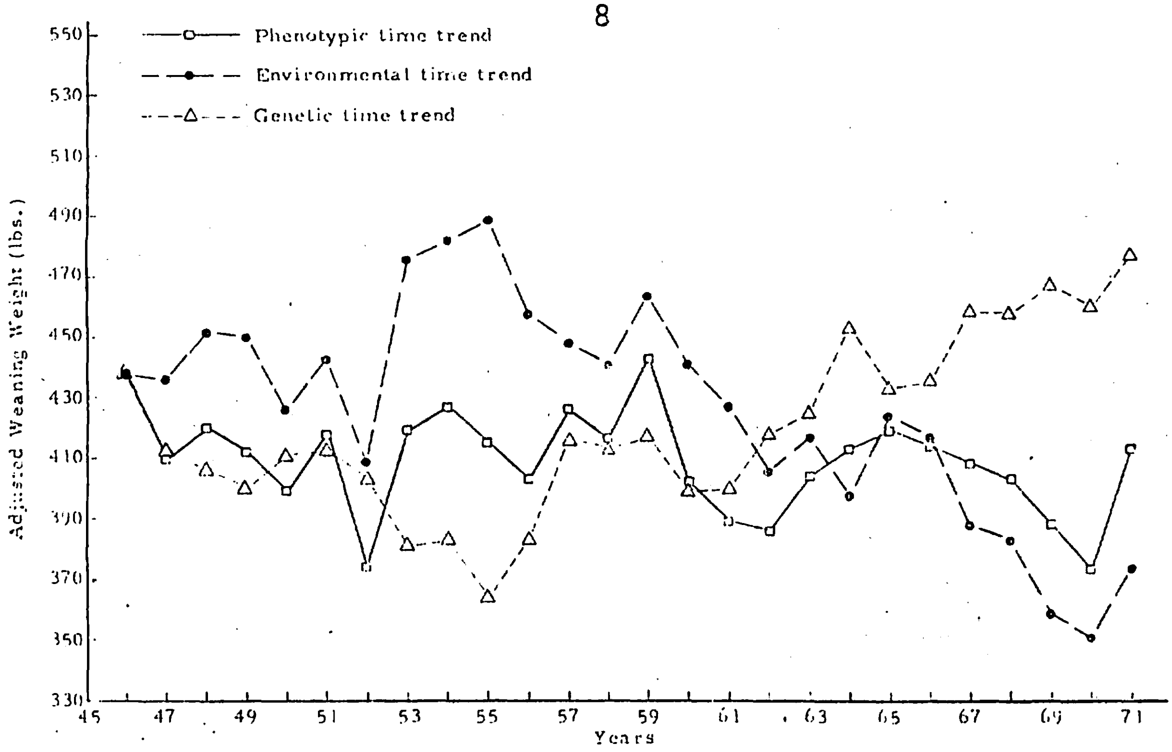

Figure 2. Phenotypic, environmental, and genetic time trends in performance for adjusted weaning weight of the inbred population.

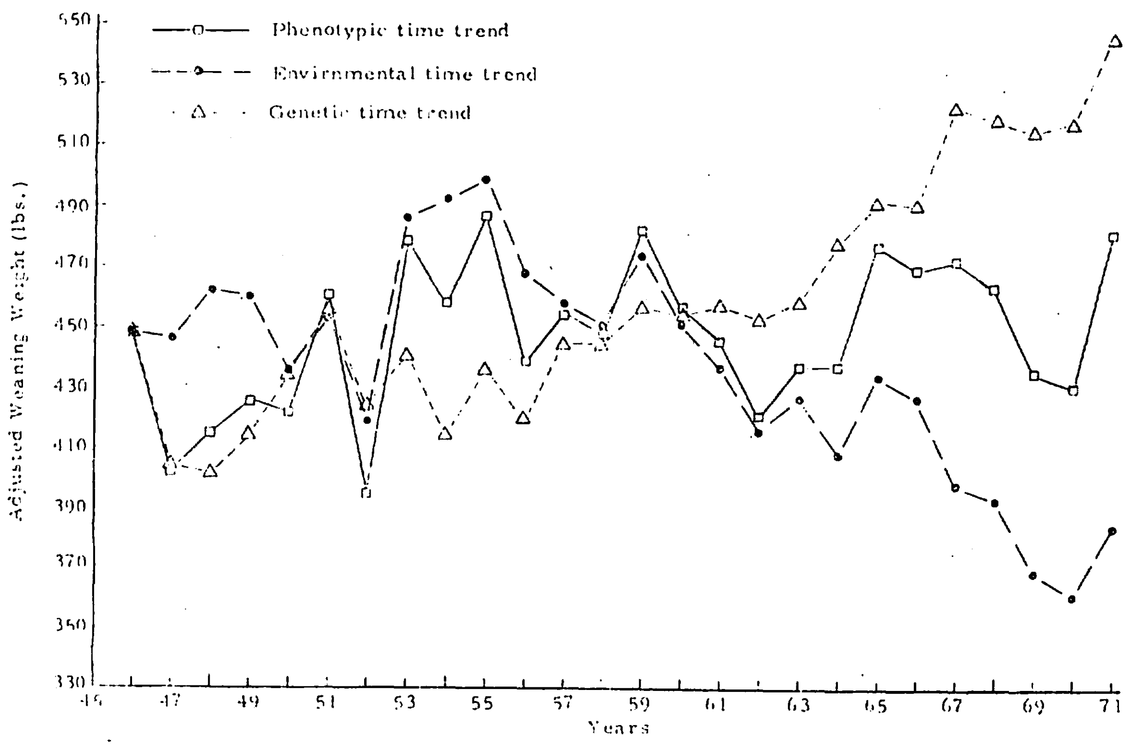

Figure 3. Phenotypic, environmental, and genetic time trends in performance for adjusted weaning weight of the linecross population.

it is due to lowered genotypic value or environmental stress and one should rely more on information from relatives (sire, dam, half-sibs, etc.).

Small inbred lines (10-15 females) can be maintained for long periods of time providing some attention is placed on fertility and one uses the best available bull rather than using a new, young bull each year. Does the extra cost merit such a program?

Inbred lines really differ in their response to inbreeding and in different traits. The lines remaining in the CSU herd are outstanding in some measure of performance -- semen production, calving ease, growth, maternal aspects, carcass cutability and quality. However, no one line ranks first in all important traits just like no one bull is on top for all traits.

There have been fewer deleterious recessive abnormalities occur than I would have expected. Possibly, this is due to the inbreeding bottlenecks that individuals went through in breed formation.

Some people are oversold on the use of inbred bulls. I consider our linecross cattle at the Station to be the result of the same inbreeding process as the inbreds since they are by inbred bulls and out of dams by inbred bulls of different lines. One should prefer using an inbred bull of a particular line only if that line is superior in a majority of the traits the breeder wants and if the estimated breeding values of the inbred are superior to a linecross bull.

Application and Summary

I believe a limited amount of linebreeding or inbreeding is good for any breed. However, not all seed stock producers should use this mating system.

Let's go back to the goal of improving breeding values for important traits as rapidly as possible. I would begin with a truly superior sire that matches your goals. This indicates he has a high frequency of the desired genes for the traits you consider important. I would then mate him to relatives and grade up the females to his superior breeding values. Rather than practice mild inbreeding through linebreeding, which I consider a compromise, I would inbred rapidly through sire X daughter matings. Intense selection on resulting offspring should be combined with the inbreeding process. Only superior offspring would be saved with poorer offspring being culled which should reduce the frequency of genes that are undesirable in the homozygous recessive condition. Remember there is some cost involved.

There is no reason to keep a line closed forever. At Colorado State we are forming some new lines from the linecross foundations. Breeders using linebreeding should at the same time be introducing genes from other superior lines that fit their goals in a portion of their herd. Breeders may wish to keep a line closed until a new sub-line is superior. Also, when introducing new genes, one might consider bringing in cattle that have recently been through an inbreeding bottleneck.

To put some of these concepts into better perspective, let's consider two seed stock producers over a ten year period -- one practicing outbreeding and selection and one inbreeding plus selection. The breeder practicing outbreeding will most likely have higher overall herd performance while the one practicing inbreeding will sustain some cost due to inbreeding depression. The average breeding values for the two herds will probably not differ much. However, the one practicing inbreeding plus intense selection may have a few individuals in a sub-line with higher breeding values that he can then capitalize on. One also might consider a third breeder who is utilizing superior inbred lines developed by other breeders. By judicial selection of lines and individuals within those lines, rapid improvement in breeding values should be possible.

The above discussion relates to how seed stock producers can improve the breeding values of their cattle rapidly. The commercial producer is concerned with using bulls with superior breeding values and then also utilizing heterosis. Don't get oversold on linebreeding or inbreeding by itself. It is simply another tool that can be used to manipulate the existing gene pool and possibly sort out the desirable and undesirable genes more rapidly.

CANADIAN BEEF CATTLE RESEARCH PROGRAM[1]

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Beef Cattle Research Programs of the Canada Department of Agriculture are primarily carried out in Western Canada at the Agriculture Canada Research Stations at Brandon, Manitoba; Lacombe, Alberta and Lethbridge, Alberta.

Results from early and present efforts have contributed greatly to the development of Record of Performance programs and selection procedures being utilized increasingly in herd and breed improvement programs.

The programs at these three Research Stations are designed to improve the economics of production in beef cattle by quantifying selection response for lean growth, by identifying correlated responses, by evaluating the relative productive efficiency of new beef breeds in straight and crossbred combinations and by extending knowledge to the industry.

The largest single program is the Foreign Cattle Breed Evaluation experiment which is cooperatively conducted at the Brandon, Lacombe and Lethbridge stations. Research effort at Lacombe is also directed toward evaluating the consequences of selecting for yearling weight and performance evaluation of purebred Simmental, Limousin and Chianina cattle. At Lethbridge experiments are in progress which are designed to evaluate the effects of selection for postweaning gain using high and low planes of nutrition, to compare the effectiveness of selection in closed populations of cattle from straightbred and crossbred foundations and a cow size and efficiency of feed utilization study.

In the limited time available, I regret that I must pass over many important results, exceptions and details. My objective will be to present a brief overview of the major studies and to review the practical observations.

Selection for Yearling Weight in Beef Cattle

The objective of this program is to evaluate the consequences of selecting herd replacement animals that are heaviest at 1 year of age. The experiment is designed to determine the

[1] Presented at BIF Research Symposium and Annual Meeting. May 18, 1976.

genetic gain made in the trait under selection (yearling weight) and to measure correlated responses in other traits that contributed to net economic merit.

The study was initiated in 1958 with the 2 main centres of activity being Brandon and Lacombe. During the period of 1958 to 1971 approximately 540 straight bred Shorthorns were involved with 180 in a selected line and 90 in a control line at each centre. In 1971 the Brandon herd was transferred to Lacombe and the herd presently numbers 350 cows. The program is under the direction of Dr. J. A. Newman at the Lacombe Research Station.

In the select line all bulls and 20 to 25 percent of the females are replaced annually with the heaviest select-line yearlings available. No selection is practiced in the control line. Every effort is made to minimize genetic change in the unselected control line.

Cows are pasture bred during a 42 day breeding season. Calves are weaned at 6 months of age and placed on a 180-day performance test.

Yearling weights of select line cattle after 10 years of selection averaged approximately 200 lbs. heavier than the first year of selection. In the absence of a "control" this dramatic change would make an impressive story of genetic gain. However, only half of this was genetic gain as shown by the fact that the control line increased by 100 lbs. over this 10 year period. The average genetic change of approximately 10 lbs. per year represented 45% of the selection applied. Estimated genetic and environmental change per generation for birth weight, weaning weight and yearling weight are given in Table 1.

The results of this research support several conclusions of importance to the beef industry.

(1) Yearling weight is highly heritable (about 45%) and will show material improvement if consistent selection is practiced over time.
(2) Virtually all the selection for this trait will be achieved by choosing replacement sires but the results of selection will not become apparent until foundation cows have been replaced with daughters of selected bulls.
(3) Genetic advances in any year may be entirely masked by changes in feeding, management or other environmental factors.
(4) Selection must be viewed as a long term investment. Annual genetic changes may seem small but these changes are permanent and, over a period of time, will have substantial economic value.

(5) The potential problem of increasing calving difficulty as a result of selection for yearling weight should be recognized.
(6) There is a favorable correlated response in weaning weight as a result of direct selection for yearling weight.
(7) There were no measurable indirect effects on percent bone, percent external fat, percent internal fat, percent total fat, percent lean and lean to bone ratio of the round, short loin, sirloin butt, rib and chuck.

Selection for postweaning gain using high and low planes of nutrition.

This study was initiated in 1963, at the Manyberries Station, a substation of the Lethbridge Research Station, to determine the long-term effect of selection for 168-day postweaning gain under two widely different levels of nutrition. The program is under the direction of Mr. J. E. Lawson of the Lethbridge Station.

Two hundred straightbred Herford and 200 straightbred Angus are involved in the study with 100 in a high plane line and 100 in a low plane line within each breed.

The high plane ration consists of 80% concentrate and 20% chopped hay by weight and the low plane ration consists entirely of chopped hay. The rations are fed free choice during a 168 postweaning feedlot performance test.

In all lines the only basis of selection is superior gain during the test period. Select heifers replace twenty percent of the cows annually within each line and breed. Cows are removed from the project at 7 years of age. Selected bulls are used at 1 and 2 years of age.

A control population is not utilized in this study but a repeat mating system, by which half of the sires each year are mated to the same cows as the previous year allows for the identification of between-year variation. Semen from foundation sires has been placed in storage to facilitate a test to provide supplementary evidence on the effectiveness of selection.

Among the 894 base-generation progeny of the foundation bulls and cows, Angus calves were lighter at birth by 12 lbs., but heavier at weaning by 7 lbs. than Hereford calves (Table 2). Hereford calves outgained the Angus by 16 lbs. on the high plane ration, but the breeds did not differ in gains made on the low plane ration. At the conclusion of the 168-day feedlot test the weight-per-day-of-age (total weight/age in days) was identical for the two breeds on the high plane and low plane.

Practical observations from the study:

(1) Most of the digestive disturbances and deaths, and all of the founders, during the feedlot test occur among the calves on the high plane ration.
(2) Bull and heifer calves from both lines exhibit good fertility and can be bred successfully at about 14 months of age.
(3) Cows in the low plane lines tend to produce more milk than cows from the high plane line.
(4) Cows in the low plane line are lighter than cows in the high plane line at comparable ages.
(5) Calves in the low plane line tend to gain faster from birth to weaning than calves in the high plane line.
(6) Mature cows must be replaced sooner in the high plane line. This indicates that stress induced by the high plane ration causes cows to "break down" when younger than those in the low plane line.

Why do some of these differences occur? One reason may be that in the high plane line we are selecting calves that have a large appetite while, in the low plane line, we are selecting those that are efficient in feed utilization.

Most breeders of replacements for beef cattle herds use a high grain ration to maximize gains during the feedlot portion of their performance test. The results of this study suggest that the practice is not only unnecessary but also unwise.

First-Calf Performance of Foreign X Domestic Hybrid Heifers.

As part of its foreign breed evaluation program the Department is assessing the maternal performance of the nine possible crossbreds derived from Charolais, Simmental or Limousin sires mated to Hereford, Angus, or Shorthorn dams. Groups of these crossbred heifers are being compared with Hereford X Angus cross heifers managed under the same conditions. The project involves three stations with one-half the cows (500) and their calves kept at the Brandon, Manitoba, Research Station, and the remaining cows (500) managed under range conditions in southern Alberta (Manyberries Station) by the Lethbridge Station, with their calves fed out at the Lacombe Station. The work at the Manyberries Station is under the direction of Mr. John Lawson and at Lacombe the work is under the direction of Dr. H. T. Fredeen and Dr. J. A. Newman.

Results have been summarized for the first-calf production of these 10 types of hybrid dams when mated to Red Angus and Beefmaster bulls in a 9-wk A.I. period with no clean-up bulls. The results are based upon 87 to 150 heifers exposed to breeding (over a 3-yr. period) per breed cross of dam. The results are presented in Tables 3 and 4.

The conception percentage ranged between 77.8% and 87.6% for the various crosses. The Limousin X Hereford heifers had the lowest conception rate and the Simmental X Shorthorn the highest.

Birth weights of calves (average for males and females) ranged from 71 to 82 lbs. for the foreign x domestic cross groups of dams, with progeny of Limousin-sired dams at about 75 lbs., averaging 4 to 5 lbs. lighter than the progeny of Charolais-sired and Simmental-sired dams. The progeny of Hereford X Angus dams averaged 71 lbs.

Percent unassisted births of Charolais-sired, Simmental-sired, and Limousin-sired dams was 64,70 and 68%, respectively. The percent unassisted births of Hereford X Angus dams averaged 75%.

The calf crop weaned (Table4) as a percentage of heifers exposed to breeding was 80% for Hereford X Angus dams and ranged between 65% and 80% for the various foreign x domestic crosses. The Limousin X Hereford heifers had the lowest weaned calf production due to a combination of reduced estrus detection and reduced conception. This tends to confirm other reports of late sexual maturity in this cross.

The weight at calving of Hereford X Angus dams at 749 lbs. was lower than any of the foreign-cross groups which ranged from 781 to 884 lbs. The Charolais-sired dams were heaviest, averaged 861 lbs. while Simmental-sired and Limousin-sired dams averaged 842 lbs. and 793 lbs., respectively.

The 200-day adjusted weaning weight of progeny (average for males and females) ranged from 389 to 435 lbs. for the foreign x domestic cross dams - all exceeding the weight of calves from Hereford X Angus dams which averaged 368 lbs.

The gross productivity of a cow herd is best measured as the weight of calf weaned per cow exposed to breeding. In these terms Simmental x Shorthorn and Simmental X Angus dams performed best at 336 and 334 lbs. respectively. The Hereford X Angus group at 297 lbs. fell short of these figures but exceeded the gross performance of the Limousin X Hereford dams (255 lbs.), the Limousin X Angus dams (274 lbs.) and the Charolais X Hereford dams (279 lbs.).

The ratio of weaned calf weight to calving weight of the dam is of interest to many people as a rough measure of production efficiency. The highest calf weight to cow weight ratio was 52% achieved by the Simmental X Shorthorn dams. The Charolais-Hereford dams at 46% had the lowest ratio and the Hereford X Angus dams were intermediate with a ratio of 49%.

These results do not take into account the possible effect of high productivity on rebreeding performance, but this factor is presently being assessed.

<u>Efficiency of feed utilization by hybrid cows during growth, pregnancy and lactation as influenced by body size.</u>

This study was initiated in 1970, at the Lethbridge Research Station and is under the direction of Dr. D. M. Bowden.

Simmental X Angus, Charolais X Angus, Hereford X Angus and Jersey X Angus heifers were obtained from the U.S.D.A Meat Animal Research Center for this study. Approximately 30 heifers of each breed type are being utilized in the study. The heifers were obtained over a three year period of time 1970, 1971 and 1972. Simmental X Angus were selected for large size and high milk production; Charolais X Angus for large size but lower milk production; Hereford X Angus for intermediate size; and Jersey X Angus for small size and high milk production.

All animals started on feed at Lethbridge at an average age of 270 days. Each is fed in an individual pen and her daily feed intake is recorded. The calves received a pelleted creep feed free-choice from 60 days of age until weaning. The diets are high in grain rather than roughage to permit more accurate weighing of feed and to minimize wastage. For the first two calvings a Red Poll bull was used and for the third and fourth calvings a Brown Swiss bull will be used.

<u>Observations from the study to-date:</u>

(1) Jersey X Angus heifers weaned calves that weighed 498 lbs. at weaning (200 days of age). The Hereford X Angus calves weighed 452 lbs.; Simmental X Angus calves weighed 512 lbs. and Charolais X Angus 503 lbs.

(2) Feed intake for the 4 types of crossbred females from 270 days of age until the calves were weaned at 200 days was - Jersey X Angus 3.9 tons of feed; Hereford X Angus 3.8 tons; Charolais X Angus 4.3 tons, and Simmental X Angus 4.3 tons.

(3) Jersey X Angus heifers needed 6 percent more digestable energy per pound of metabolic weight than the other three types.

(4) Milk production was measured at 6, 14 and 22 weeks after calving. Average milk production for the three milkings was 15 lbs. for the Jersey X Angus, 14 lbs. for the Simmental X Angus, 13 lbs. for the Hereford X Angus, and 12 lbs. for the Charolais X Angus. Jersey X Angus heifers had the most fat in their milk, 4.3%, while the Charolais X Angus had the least, 3.9%. With the combination of high milk production and high fat content, the calves of the Jersey X Angus heifers received the greatest amount of energy from milk. Those of Charolais X Angus heifers received the least energy in the milk.

(5) The amount of milk affected the amount of creep feed consumed by her calf to weaning. Calves receiving less energy from milk needed more creep feed. For each pound of gain, calves of Jersey X Angus heifers consumed an average of 1.2 pounds of creep feed from birth to weaning. Calves of Hereford X Angus and of Charolais X Angus, 1.6 lbs.; and calves of Simmental X Angus, 1.5 lbs.

(6) Milk production was influenced by the level of feeding. Heifers that received 10 percent extra energy in their feed produced 9 percent more energy in their milk.

(7) The work strongly suggests that the size of cow and her milk production do influence the efficiency of feed utilization during the preweaning period. Feedlot production and carcass data are collected on all calves.

Future Work

In 1977, major emphasis will be directed towards evaluating the maintenance costs of the 10 hybrid female types under two environments - semi-intensive, Brandon, Man. - range environment, Manyberries, Alberta. Data will be collected during the winter gestation period and the summer nursing period. At the Lacombe Research Station a similar evaluation program will be undertaken with the 2 Shorthorn lines and the three purebred exotic breeds (Simmental, Limousin and Chianina).

TABLE 1. ESTIMATED GENETIC (G) AND ENVIRONMENTAL (E) CHANGE PER GENERATION[1]

TRAIT	G (LB)	E (LB)	G + E (LB)
BIRTH WEIGHT	2.1	2.6	4.7
WEANING WEIGHT	12	5.0	17
YEARLING WEIGHT	35	35	70

(1) GENERATION INTERVAL 3 1/2 YEARS.

TABLE 2. BASE GENERATION PERFORMANCE - 1964, 1965, 1966, 1967 [1] CALVES

BREED	N	BIRTH WT. (LBS)		WEANING WT. (LBS)
HEREFORD	427	76A		387 B
ANGUS	467	64A		394 B
	TOTAL FEEDLOT GAIN (LBS)			
	N	HIGH PLANE RATION	N	LOW PLANE RATION
HEREFORD	224	283 (1.68)[2] A	203	124 (.74)[2]
ANGUS	225	267 (1.59)[2] A	242	123 (.73)[2]
	WEIGHT PER DAY OF AGE (LBS)			
HEREFORD		1.86		1.43
ANGUS		1.86		1.42

A → $P < 0.01$

B → $P < 0.05$

1 ONE HALF OF THE 1967 CALVES SIRED BY FOUNDATION BULLS - BY SELECTED BULLS. ONLY CALVES FROM FOUNDATION BULLS PRESENTED IN RESULTS.

2 AVERAGE DAILY GAIN.

TABLE 3. FIRST CALF PERFORMANCE OF FOREIGN X DOMESTIC HYBRID HEIFERS - NUMBERS. % CONCEPTION, BIRTH WEIGHT. % UNASSISTED AND % DIFFICULT PULL

BREED OF DAM'S SIRE	DAM	NO. OF HEIFERS	CONCEPTION (%)	BIRTH WT. M + F (LB)	UNASSISTED (%)	DIFFICULT PULLED (%)
CHAROLAIS	HEREFORD	107	81.9	80	65	11
	ANGUS	102	83.2	78	63	10
	SHORTHORN	87	82.6	80	63	15
SIMMENTAL	HEREFORD	124	85.1	78	73	13
	ANGUS	118	82.2	79	72	7
	SHORTHORN	124	87.6	82	65	8
LIMOUSIN	HEREFORD	97	77.8	74	62	10
	ANGUS	101	87.0	71	77	8
	SHORTHORN	140	83.3	78	64	9
HEREFORD	ANGUS	150	86.5	71	75	5

TABLE 4. FIRST CALF PERFORMANCE OF FOREIGN X DOMESTIC HYBRID HEIFERS - CALF CROP WEANED, HEIFER WEIGHT AT CALVING. 200-DAY ADJUSTED WEANING WEIGHT. CALF WEIGHT WEANED PER COW EXPOSED AND CALF WEIGHT PER COW WEIGHT RATIO.

BREED OF DAM'S SIRE	DAM	CALF CROP WEANED (%)	HEIFER WT. AT CALVING (LB)	200-DAY ADJ. WEANING WT. M + F AVE. (LB)	CALF WT. WEANED PER COW EXPOSED (LB)	CALF WT. PER COW WT. RATIO %
CHAROLAIS	HEREFORD	71	855	392	272	46
	ANGUS	76	845	399	303	47
	SHORTHORN	78	884	423	329	48
SIMMENTAL	HEREFORD	75	839	422	315	50
	ANGUS	80	845	417	334	49
	SHORTHORN	77	843	435	336	52
LIMOUSIN	HEREFORD	65	782	389	255	50
	ANGUS	70	781	390	274	50
	SHORTHORN	75	807	408	304	50
HEREFORD	ANGUS	80	749	368	297	49

Possible Effects on Growth with Selection for Lighter Birth Weights[1]

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The Beef Improvement Federation (BIF) and state beef cattle improvement associations (BCIA) have recommended for many years that cattle be selected on the basis of their own performance records (ROP selection). This selection, usually based on 365 day adjusted weight (yearling weight), has resulted in significant increases in the performance (increased weaning and yearling weights) of herds where rigorous selection was practiced. This in turn has resulted in significant increases in the sale prices of bulls from these performance tested herds. At the same time in many of these herds birth weight has also increased to the point that calving difficulty has now become a major problem. This is particularly true in herds that are using top performance tested bulls from the ROP seedstock producer and in which cow size has not increased to accommodate the greater birth weights. Changes in birth weight in Hereford herds at Fort Robinson, Nebraska, Wyoming and Miles City, Montana experimentally selected for increased yearling weights are shown in table 1 and in purebred producer herds (members of the Montana Beef Performance Association) who have been selecting for rapid growth rates there has also been a significant increase in birth weights over time (table 2).

Birth weight has been shown to be the single most important factor of those factors identified affecting calving difficulty (Bellows et al., 1971 and Laster et al., 1973). Data from 20,949 half and three quarter blood Simmental calves (Burfening, unpublished data) indicated that as birth weight increases the percent of cows requiring assistance at birth also increases (Figure 1). In 2 year old cows for example, for every pound increase in birth weight the percent of the cows requiring assistance increased by approximately 2%. In all of the older age groups as birth weights became quite large (above 90-95 pounds) the percent of the cows requiring assistance increased fairly rapidly.

The problem of increased birth weights due to selection for high yearling weights is the result of two factors: 1) yearling weight may be viewed as a simple form of a selection index combining the traits birth weight, gain from birth to weaning and gain from weaning to yearling; and 2) the relatively high genetic correlation between birth weight and other growth traits (table 3). Note that the genetic correlations between birth weight and final feedlot weight and mature weight are somewhat higher than with weights earlier in life even though there is less of a part-whole relationship. These correla-

[1]The author wishes to thank Dr. Ray Woodward, Superintendent, U.S. Range Livestock Experiment Station, Miles City, MT and Mr. Don Vaniman, Executive Secretary, American Simmental Association, Bozeman, MT for supplying part of the data used in this paper. Contributions from Montana Agricultural Experiment Station, Journal Series No. 693.

tions then indicate that selection for increased final or mature weights will also cause an increase in birth weights.

Increases in birth weight are not all bad. Birth weight is also related to weaning weight. The results of this are evident in figure 1. Remember, weaning weight is equal to birth weight plus gain from birth to weaning. Theoretically if two calves are born and one is 20 pounds heavier at birth than the other and they both grow at the same rate from birth to weaning, then the calf that was 20 pounds heavier at birth will be 20 pounds heavier at weaning. Birth weight is positively correlated with gain from birth to weaning. From figure 1 we find that a one pound increase in birth weight returned approximately 1½ to 2 pounds at weaning. Further, Brinks (1965) reported that in the Miles City line 1 herd where selection was primarily practiced for increased yearling weight. There was a 30 pound increase in weaning weight, but there was also a 9 pound increase in birth weight. Increased birth weight due to selection for yearling weight accounted for almost 1/3 of the increase in weaning weight. Therefore, it appears that we need some compromise among the antagonistic factors-birth weight, rate of gain and calving difficulty in our selection programs. Continued improvement is needed in growth rate from birth to slaughter weight, but increases in birth weight need to be minimized in order to reduce problems associated with calving difficulty. The question is how can this be done. I don't think there are any easy solutions to this problem but let's examine some possible alternatives.

First let's look at some records (table 4). These data are from the Miles City line 1 herd. This herd has been closed since 1934 and selection has been primarily for end of test weight or yearling weight. The bulls that were selected for use each year were divided into a heavy and a light birth weight group on the basis of their own birth weight adjusted for age of dam. The difference in the individual birth weights between the two groups of bulls was 8.3 pounds, but the two groups had the same average yearling weight ratio. The calves sired by the heavy birth weight bulls bred an average birth weight of 82.9 pounds compared to 80.0 pounds from the low birth weight group, a difference of 2.9 pounds at birth ($P<.01$). However, the calves from the heavy birth weight group were also 14 pounds heavier ($P<.05$) at weaning (180 days of age). The bull calf progeny from the heavy birth weight group fed from weaning to yearling age were 4.2 pounds lighter than the bull calf progeny from the light birth weight bulls. This indicates that the use of bulls with low birth weights would result in decreased birth weights of their progeny but approximately the same rate of growth from birth to yearling age.

Koch et al. (1974) reported that in the Fort Robinson selection study (table 1) the expected increase in birth weight could have been reduced by 30% if all emphasis on growth was directed toward selection for postnatal growth rather than weaning or yearling weight. This would significantly slow the rate of increase that we are presently seeing in birth weight.

Avoiding the use of bulls with excessively large birth weights should have a significant impact on slowing the rate of increase in birth weight within a herd. But, placing negative emphasis on birth weight should result in an even greater reduction in the rate of increase in birth weight. Dickerson et al. (1974) in their paper "Selection criteria for efficient beef production" developed a selection index which places negative emphasis on birth weight while still selecting for rapid growth rate. The index is: Yearling Weight - 3.2 X Birth Weight = Index. This index should reduce the expected increase in birth weight by 55 percent, reduce the expected increase in mature cow size by 25 percent while only reducing the expected increase in yearling weight by 10 percent.

In table 5 is shown the results of selecting the top 10 percent of the bulls in Hereford and Angus breeders who were members of the Montana Beef Performance Associated and Simmental herd from throughout the U.S. on the basis of yearling weight and the previously proposed index. In all three breeds the index resulted in bulls being selected that had a lower birth weight and yearling weight. We would expect the off-spring of the bulls selected by the index to have birth weights 0.6, 1.3 and 1.5 pounds lighter than those selected for yearling weight for the Angus, Hereford and Simmental breeds respectively. Their yearling weights would be 1.4, 3.2 and 2.9 pounds lighter than those selected for yearling weight for the Angus, Hereford and Simmental breeds respectively. Again, we are talking about a trade off. To reduce the rate of increase in birth weight we will have to accept bulls that will sire calves with slightly lower yearling weights but the percent change in birth weight is much greater than the percent change in yearling weight.

In table 6 is shown the top 5 bulls (8%) based on 365 day weight of a group of bulls offered for sale this spring from a performance tested Angus herd. First note the large variation in birth weight in this group of bulls (29 pounds). Secondly, note the changes in rank of the bull if they were to be selected on the basis of 365 day weight, gain from birth to 365 day weight or index.

Up until now we have been talking about selecting bulls based on their own individual performance. Now let's talk for a bit about selecting AI sires for use in a herd.

National sire summaries provide a very valuable tool to use in selections and when breeding by AI it is very easy to breed heifers to a different sire than the cows are being bred to. If one is breeding yearlings to calve first as 2 year olds it has generally been recommended that a bull be used whose expected progeny difference (EPD) for birth weight is below average. His calves should have a below average birth weight thus decreasing the incidences of calving difficulty among his mates. Generally, based on the genetic correlation between birth weight and weaning weight (table 3) we would expect the progeny of these bulls to be below average not only for birth weight, but also for weaning weight. Now look at the following data (table 7) which is from the top 5 for birth weights (lowest expected progeny differences) of the 42 Simmental reference sires (1975 National Simmental Sire Summary Supplement). Just as we would expect from the genetic correlation, 4 of these bulls sired calves whose 205 day weight was also below breed average. However, bull no. 2 sired calves whose EPD for birth weight was well below breed averages, but whose progeny were breed average for 205 day weight. Such a bull seems to be the kind to use since his calves were smaller at birth but must have grown faster from birth to weaning. These calves should return more income to the rancher than calves from the no. 1, 2, 3 or 5 bull.

The next question is, what kind of bulls should be used on the mature cow herd? Again, the genetic correlations between birth weight and 205 day weight, birth weight and 365 day weight (table 3) indicate that bulls whose EPD's are above average for 205 day weight or 365 day weight should also have calves whose EPD's for birth weight are above average. The data in table 8 are from the top 5 of the 42 Simmental reference sires (1975 National Simmental Sire Summary Supplement) for 205 day weight and the data in table 9 is from the top 5 of the 44 Limousin sires (1976 National Limousin Sire Summary) for 365 day weight. Both tables show the same pattern. Some of the sires EPD's for birth weight were above average as expected. However, there are also some whose EPD's for birth weight were breed average or below. Also, of all buls that had EPD's for birth weight, 205 day weight and 365 day weight, 8 of 50 (16%) of the bulls in the 1975 National Simmental Sire Summary Supplement and 7 of 44 (16%) of the bulls in the 1976 National Limousin Sire Summary respectively had EPD's that were average or below for birth weight but above average for both 205 day and 365 day weight. The use of these bulls should result in calves being sired whose 205 day weight or 365 day weight is well above average, but calves whose birth weights are breed average or below. Obviously calves from these sires must grow faster from birth to 205 days of age or birth to 365 days of age. Although there are not many of these type of sires with these characteristics they should be very valuable because they would not be expected to increase birth weight but would be expected to continue to increase both 205 and 365 day weight.

Conclusions and Recommendations:

1. Birth weight data must be collected as a routine record along with weaning weight and yearling weight because without a valid birth weight record it is impossible to take birth weight into account at selection time. Further, it needs to be adjusted for age of dam.

2. Every effort should be made to slow down the rate of increase in birth weight without affecting growth rate by:

   a. avoiding the use of bulls with excessively large birth weights themselves.

   b. when two bulls are essentially equal in other growth traits always select the bull with the lightest birth weight or

   c. use an index which places negative emphasis oń birth weight rather than positive emphasis.

   d. use progeny data when available to evaluate bulls and try to select bulls with rapid growing calves, but average or below average birth weights.

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TABLE 1. PHENOTYPIC CHANGES IN BIRTH WEIGHTS OF HEREFORD CATTLE EXPERIMENTALLY SELECTED FOR GROWTH.

Location	No. of Years	Breed (line)	Average Birth Wt (lbs)	Change Per Year (lbs)	Reference
Ft. Robinson, Nebraska	8	Hereford (WWL)	81	0.88	Koch *et al.*, 1974
	8	Hereford (YWL)	82	0.88	
	8	Hereford (IXL)	83	1.10	
Wyoming	12	Hereford	72	0.63	Nelms and Stratton, 1967
Miles City, Montana	24	Hereford (01)	77	0.40	Brinks *et al.*, 1965
	13	Hereford (01)	82	0.45	Unpublished Data
	17	Hereford (12)	87	0.26	
	17	Hereford (14)	80	0.20	
	17	P. Hereford (9)	73	0.00	

TABLE 2. PHENOTYPIC CHANGES IN BIRTH WEIGHTS OF CATTLE FROM SOME MONTANA BEEF PERFORMANCE ASSOCIATION HERDS[1].

Location	No. of Years of Testing	Breed	Average Birth Wt (lbs)	Change Per Year (lbs)
MBPA - Montana	9	Angus	70	1.03
	8	Angus	64	0.22
	10	Angus	68	0.52
	12	Hereford	76	0.40
	9	Hereford	89	0.53
	7	Hereford	75	0.40

[1]Nelsen, (1976)

TABLE 3. HERITABILITIES OF GROWTH TRAITS AND THEIR GENETIC CORRELATIONS WITH BIRTH WEIGHT[1]

Trait	Heritability (%)	Genetic Correlation with Birth Weight
Birth Weight	44	----
Weaning Weight	32	0.58
Yearling Weight	58	0.61
18 Month Weight	50	0.60
Gain Birth to Weaning	31	0.38
Feedlot Gain	52	0.54
Mature Fall Weight	84[2]	0.68[2]

[1] Petty, R. R. and T. C. Cartwright (1966).

[2] Heritability of average mature weight, Brinks *et al.* (1962).

TABLE 4. HEAVY AND LIGHT BIRTH WEIGHT BULLS USED IN MILES CITY LINE 1 HERD AND THEIR PROGENYS PERFORMANCE.

Trait	Heavy Birth Wt. Bulls	Light Birth Wt. Bulls	Difference Heavy - Light
No. Bull	17	16	
Birth Weight (lbs)	91.7	83.4	+ 8.3**
Yearling Ratio	109.6	108.6	+ 1.0
No. Progeny	346	312	
Progeny Birth Wt. (lbs)	82.9	80.0	+ 2.9**
Progeny 180 Day Wt. (lbs)	393.2	379.0	+14.2*
No. Progeny	165	169	
Progeny 196 Day Gain (lbs)	524.1	533.0	- 8.9
Progeny 376 Day Wt. (lbs)	934.3	938.6	- 4.2

*(P<.05); **(P<.01)

TABLE 5. DIFFERENCE IN BIRTH WEIGHT AND YEARLING WEIGHT OF THE TOP 10% OF BULLS SELECTED FOR 365 DAY WEIGHT AND INDEX

	Selection Criteria		
	365 Day Wt	Index	Difference
Angus (755 bulls; 76 selected)			
Birth Wt. (lbs)	75	72	3*
Yearling Wt. (lbs)	954	949	5
Hereford (662 bulls; 66 selected)			
Birth Wt. (lbs)	86	80	6**
Yearling Wt. (lbs)	1001	990	11
Simmental (1630 bulls; 165 selected)			
Birth Wt. (lbs)	100	93	7**
Yearling Wt. (lbs)	1069	1059	10

*(P<.05); **(P<.01).

TABLE 6. VARIATION IN BIRTH WEIGHT, 365 DAY WEIGHT, GAIN BIRTH TO YEARLING AND SELECTION INDEX AMONG THE FIVE HEAVIEST BULLS FOR 365 DAY WEIGHT IN A PERFORMANCE TESTED ANGUS HERD.

Bull No.	Birth Weight[a]	Rank	365 Day Weight	Rank	Gain Birth to Yearling	Rank	Index[b]	Rank
1	92	3	1057	1	965	1	763	3
2	97	2	1037	2	940	4	727	4
3	75	4	1024	3	949	2	784	2
4	70	5	1018	4	948	3	794	1
5	99	1	1004	5	905	5	687	5

[a]Adjusted for age of dam.

[b]I=365 day wt. - 3.2 birth wt.

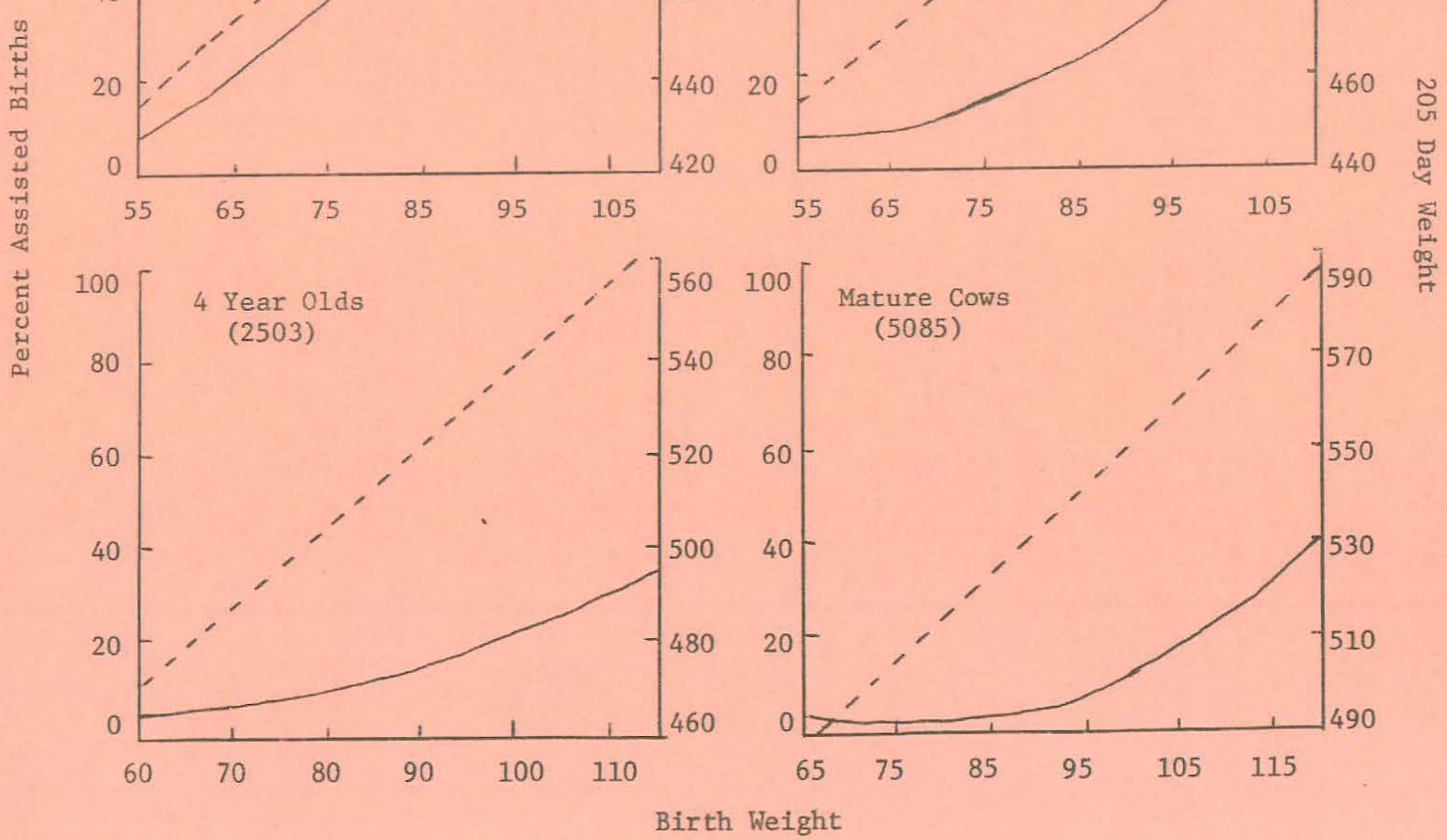

FIGURE 1. RELATIONSHIP BETWEEN BIRTH WEIGHT AND PERCENT ASSISTED BIRTHS (——) AND BIRTH WEIGHT AND 205 DAY WEIGHT (---) FOR 4 AGE OF DAM GROUPS

TABLE 7. PROGENY 205 DAY WEIGHT EPD'S FROM FIVE SIMMENTAL REFERENCE SIRES WITH THE LOWEST EPD'S FOR BIRTH WEIGHT[1]

	Birth Wt.		205 Day Wt.	
Bull No.	No. of Progeny	EPD	No. of Progeny	EPD
1	803	-8.62	1206	-14.29
2	579	-6.85	747	0.41
3	228	-4.01	1353	- 2.79
4	854	-3.71	1504	- 5.86
5	532	-2.63	819	-10.13

[1]1975 National Simmental Sire Summary Supplement.

TABLE 8. PROGENY BIRTH WEIGHT EPD'S FROM THE FIVE SIMMENTAL REFERENCE SIRES WITH THE HIGHEST EPD'S FOR 205 DAY WEIGHT[1]

	205 Day Wt.		Birth Wt.	
Bull No.	No. of Progeny	EPD	No. of Progeny	EPD
1	770	13.1	263	0.43
2	1230	13.0	915	2.20
3	1531	12.1	904	4.22
4	601	9.0	393	-2.37
5	990	8.7	547	0.52

[1]1975 National Simmental Sire Summary Supplement.

TABLE 9. PROGENY BIRTH WEIGHT EPD'S FROM THE FIVE LIMOUSIN SIRES WITH THE HIGHEST EPD'S FOR 365 DAY WEIGHT[1]

	365 Day Wt.		Birth Wt.	
Bull No.	No. of Progeny	EPD (lbs)	No. of Progeny	EPD
1	4992	23.8	5719	3.0
2	375	23.6	468	3.4
3	149	22.8	202	-2.6
4	2647	21.6	3215	1.4
5	89	18.2	105	-2.0

[1]1976 National Limousin Sire Summary.

CALVING ABILITY IN FRENCH BEEF BREEDS AND ITS GENETIC IMPROVEMENT

by

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INTRODUCTION

In all beef production systems, particularly in Western Europe, we are seeing a gradual increase in the frequency of calving difficulties. The level is already so high that calving ability is becoming one of the most important factors limiting efficiency of beef herds; this is especially the case with the Charolais breed.

We shall first discuss the economic influence of calving difficulties; thenwe shall analyze their causes and origin and try to find a way of testing or improving calving ability by genetic means, under Western European conditions and, more particularly, in the French system. The paper is organized into four major sections as follows:

- I. Influence of calving difficulties on the efficiency of beef herds and origin or evolution of their frequency.
- II. Causes and components of calving ability.
- III. Genetic variability of calving ability.
- IV. Genetic improvement of calving ability -
  - A. Choice of breeds or strains
  - B. Selection

I. Influence of Calving Difficulties on the Efficiency of Beef Herds and Origin or Evolution of their Frequency.

A. Economic Influence

Calving ability has a noticeable and definite impact on the efficiency of beef herds, being felt both in terms of the calving cost, and in terms of its consequences on getting the cows rebred.

1. Direct Consequences on Calving

Calving difficulties increase the cost of calving and risks of mortality of the calf and even the dam (even in systems where there is close surveillance of calving - Table 1). These two consequences are closely related; their importance depends on the technical level of the farmer for calving control. This level is variable according to the production system, but for a traditional herd, the relative cost of calving difficulty (workers, veterinary) can be estimated on the following basis:

Slight help---------------------------------------1

Difficult calving, without veterinary assistance--3-4

Difficult calving, with veterinary assistance-----15

Caesarian operation------------------------------90-100

In a production system such as that used in French beef breeds, these costs are only a small fraction of the cost of the weaned calf; for example if we estimate this cost according to Billiere's (1966) formula, the increase is only around 30 Francs per calf when the percentage of caesarians rises from 3% up to 10% in the herd. On the other hand, if the calf dies, the impact becomes very important; in the same example, reduction in the percentage of weaned calves from 80 to 70% leads to an increase of 220-250 Fr. of the cost of weaned calves.

2. Indirect Consequences on Production Traits of the Dam and on Breeding Efficiency.

Calving difficulties have repercussions on the subsequent production of dams:

i. Milk production decreases, chiefly in the case of caesarians. For heifers from French beef breeds, calving at 2 years old, we observed a drop of around 33% in the quantity of milk (Table 2), interestingly without any effect on the weaning weight. However, if we accept that calves born by caesarian or difficult calving have a higher growth potential, the fact that they have the same weaning weight as those born without any difficulty indicates that their growth rate has been limited by the milk production of the dam. This consequence of calving difficulties is far more important when milk production is already a limiting factor of growth rate of calves (i.e. for heifers calving when 2 years old).

ii. The subsequent fertility of heifers is disturbed by a caesarian; we observe a decrease in pregnancy rate of around 31% after caesarian on calving of heifers (2 years old) from French beef breeds (Table 3a,b). It also appears that the pregnancy rate also decreases after a difficult calving without caesarian. Calving difficulties not only affect the post partum interval but also the fertility of cows causing a reduction of as much as 5 to 8% of pregnancies (Laster, et al., 1973). This leads, depending on the length of breeding season to a more or less important increase of the calving interval (Brinks, et al., 1973; Laster, et al., 1973; Dreyer and Smidt, 1966; Hanset, 1966).

iii. A diminution in the selection pressure on other traits appears after calving difficulties; these involve, first a reduction in the number of calves, then, an increase in the number of traits to be selected with sometimes incompatible objectives.

The economic impact of calving difficulties in France depends on the rearing system of beef cows. In large and extensive operations, calving problems have more direct consequences than in small, well supervised herds. Finally, the impact of calving problems is a function of the ratio between the value of the weaned calf and the cost (or opportunity) of performing caesarians; for example, the value of a dairy calf is 2.3 times higher than the cost of veterinary assistance. On the other hand, in extensive systems where performing caesarians is impossible, calving difficulties lead to a loss of calves; their consequences on the efficiency of the herd are more important. This explains the variation in a farmer's reaction as regards to the level or risks of calving difficulties which are acceptable.

B. Origin and Trend

Three main reasons can be proposed to explain the increase in the frequency of calving difficulties in beef herds (mainly in Europe).

1. Increased Use of Commercial Crossing

The recent rapid development of terminal crossing with sires from large sized and heavy muscled European beef breeds (Charolais primarily, also Simmental, Chianina, Limousin, Maine-Anjou) is a primary reason for increased calving problems. These sires are generally bred to small dams in order to increase their beef potential; these cows generally belong to dairy or native breeds (no longer milked) and to British beef breeds.

Used in a purebreeding system, these cows usually exhibit good calving ability in their own environment; crossing with beef sires has increased birth weight of their calves and consequently, calving risks, however, this consequence is generally only serious when calving ability is already a limiting factor in purebreeding (Table 4).

2. Improvement of the Muscle Development and Growth Potential of Beef Breeds

The selection of beef breeds on muscle development and growth rate in the early life of animals has led to an increase in the birth weight. Two examples can be given for the Charolais breed; the breeding value of Charolais sires now used in S.W. France for terminal crossing concerning birth weight is higher (+4 kgs) than that of sires used in the purebreeding area (Vissac, et al., 1971,a). The second example concerns birth weights of Charolais calves born in 1971 and ranking highest at the Vichy show; these calves weighed 4 kg more than the average of calves born during the same year in recorded herds. The same result was observed in 1973 and in other breeds (Limousine for example - see Foulley and Menissier, 1976). Further, such selection to increase muscle development results in a relative decrease in the skeleton;

double muscling is an extreme type in this direction (Vissac, et al., 1973). So the more and more frequent use, in purebreeding, of double muscled sires has now multiplied by 10 the rate of caesarians on heifers and young cows of the White Blue Belgian breed (Hanset, 1967).

Finally, if replacement of embryotomy by caesarian leads to a decrease in the mortality rate related to calving difficulties, it has by the same token also eliminated the limit on selection in favor of large birth weights.

3. Intensification of Production Systems

Other than the different aspects of intensification of beef production, early calving certainly appears as one of the chief factors responsible for the increasing rate of calving difficulties. A first calving at two years old leads, chiefly in beef breeds where calving ability is already limited, to a rapid increase in the calving difficulties of heifers (Table 5a,b); the percentage of caesarians on heifers rises from 7 to 10% at 3 years to 20 to 30% at 2 years.

The nutritional level of these young pregnant cows then appears a very important factor for an early calving; however the safety margin is very small owing to the compromise which must be found between the positive effect of restricted feeding on calving ability and the negative one on fertility, milking ability and growing ability of the cow.

II. Causes and Components of Calving Ability

We shall now focus our attention on the improvement of calving ability through breeding methods. The majority of difficult calvings in beef herds comes from an anatomical incompatibility at calving between dam and foetus. Dystocia resulting from an abnormality in the position of the foetus are rare; in most cases they require only a little assistance at calving. They seem to appear somewhat more frequently when the overall percentage of difficult calvings is high (Table 6).

A. Causes of Calving Difficulties

The analysis of calving difficulties in crossbreeding experiments and Charolais beef herds has led us to classify the factors responsible into two groups; those caused by the calf and those caused by the dam.

1. The Calf

Birth weight is the most important factor in this group. Its variation explains around 50% of the variance of the calving score of heifers. For older dams and for dams with superior calving ability, the importance of the effect of birth weight on calving ability decreases (Table 7). The morphology of the calf expressed by its dimensions independently of weight is another important factor but with a minor role compared to birth weight, at fixed birth weight, the width at thurls and body length significantly influence the calving score (Table 7). However, measuring the morphology (length for a given birth weight for example) is difficult to achieve with any reasonable accuracy.

2. The Dams

Maternal behavior before calving (preparation for calving) which is evaluated subjectively (relaxation of ligaments, vulva and udder congestion) explains around 10% of the variance of calving score (Abdallah, 1971, b; Couteaudier, et al., 1971; Menissier, et al., 1973). Here also, we need an objective measurement of this component to operate efficiently.

The variation of pelvic opening, measured on the live animal by a caliper (Menissier and Vissac, 1971), explains likewise 10% of the variance of the calving score. As for birth weight the effect of this component decreases as the age of the dam increases (Table 7).

Size and external measurements of the dam are less correlated with calving score than is pelvic opening. In Charolais heifers calving at 2 years, the correlation coefficient is negative or close to 0 (Table 7); it is positive in cows. The influence of the size of the dam on calving difficulties is in fact more complicated than that of the previous factors; if the size of the dam increases, the pelvic opening but also the birth weight of the calf increases.

Several research workers have estimated calving ability using combinations of these components. These estimations usually take into account either the ratio of the weights: dam/calf (Monteiro, 1969) or ratios and linear combinations of the calf and the dam's measurements (Abdallah, 1971, a); Couteaudier, 1970; Bonnot, 1971; Seitz, 1972). In all cases, the most efficient estimation of calving ability is obtained by a combination of the dam's pelvic opening and the calf's birth weight (or width at thurls).

B. Components of Calving Difficulties and Its Relations

For beef breeds, where calving difficulty is a consequence of a lack of balance between the respective sizes of the calf and the dam's coxal bone, the above correlation coefficients reflect only general tendencies. In fact, calving difficulties are the result of an interaction between the two main factors; pelvic opening and birth weight; the extent of the variation in calving ability due to one of them depends on the other; further, their action will chiefly be by threshold effects (i.e. non linear effects).

1. Let us take a sample of Charolais cows of a given age reared under similar conditions; if the frequency of calving difficulties increases with birth weight, the value of this increase (by unit of birth weight) is of greater or lesser importance depending on the birth weight (under or above the upper limit which can fit with the pelvic opening of the dam). For example (Fig. 1,a) for pure Charolais heifers calving at 2 years this level lies between a birth weight of 30 to 35 kg. under this range we do not encounter any caesarians; above this range their frequency increases rapidly with the birth weight. The corresponding level would be close to 40-45 kg for heifers calving when 3 years old and 55 kg for cows of 4 years and over. This threshold or curve of frequency of

calving difficulties, expresses calving ability of the population. It varies in particular according to age (Charolais, Fig. 1,a) and genotype of the dams (3 breeds, Fig. 1,b). This threshold reflects again the interaction between the pelvic opening of the dam and the size of the calf.

2. If we consider the variation in the dam's pelvic opening, we again find similar threshold effects (Fig. 2).

3. When combining the distribution of calving difficulties with these two factors, we observe a "frequency area of difficult calvings" (Fig. 2). It is to be noticed that threshold values of birth weights tend to increase with increased pelvic opening of dams.

From a genetic point of view, if these factors do not act independently, the same thing, occurs for their genetic determination. We have tried, by a procedure similar to that used for pre-weaning growth, to analyze the effects of paternal and maternal genotypes according to their effects on calving ability (Fig. 4). In this way, calving ability depends on two genetic components:

PATERNAL COMPONENT: representing the effect of the paternal genotype (sire of calf) on the size of progeny calf, i.e. the "direct effect" of the sire (or of the paternal breed concerned) on birth weight. For instance, for veal production, we have found a high positive genetic correlation ($r_g \simeq + 1.$, Belic and Menissier, 1968) between this component and the direct effect of beef sires on the birth weight of their crossbred progeny.

MATERNAL COMPONENT: more complex and composite than the previous one, this component represents the effect of the maternal genotype on calving difficulties. It represents the "direct effect" of the dam (or of the breed concerned) on the size of calf at birth (as above) as well as the "indirect or uterine effect" of the latter on the calf weight and the "indirect effect" of the genotype of the dam by its own pelvic opening. The maternal component is the resultant of these three effects.

We are most interested in an analysis of these genetic effects for improvement of calving ability if crossbreeding is being practiced, or if animals have to be selected for crossbreeding. We shall apply it next to define:

*either the paternal or maternal value of a breed: this is the value of the breed according to its use as a paternal or maternal breed considering calves. On the other hand, the average level of calving difficulties of purebred cows in a purebreeding situation involves a combination of the paternal and maternal values; it would be a general value.

*either the paternal or maternal breeding value of a sire will be the value of its direct and indirect effects depending on whether we consider calving difficulties of its progeny at birth or that of its breeding heifers in the next generation.

Now, we shall analyze the genetic variability of this component for beef breeds and especially French beef breeds.

III. Genetic Variability of Calving Ability

We shall deal only with overall tendencies now observed and with some new results concerning the main European cattle breeds used or experimented with in beef production systems.

Three situations will be considered according to the use of breeds; purebreeding (general value) or crossbreeding as paternal (paternal value) or maternal breeds (maternal value). In each case, we shall analyze the genetic variability.

A. General Value (or purebreeding situation)

The frequency of calving difficulties increases from native to dairy and dual purpose breeds, largest rates being obtained with beef breeds. With dairy breeds, calving difficulty seems to occur more frequently in large sized breeds (Simmental, Pie-Rouge, European Brown Swiss for example) than in smaller ones (Jersey, Ayrshire). With specialized beef breeds, this tendency is also observed if one compares the calving ability of the main French and British breeds according to the results of numerous experiments done in the U.S.A. on these breeds; French and European Continental breeds of a large size give more calving problems than Aberdeen Angus and Hereford. Between these two breeds, in spite of its lesser weight, Aberdeen Angus exhibits a better calving ability. Within our French beef breeds we also find the same overall tendency with heifers and cows (Table 8); beef breeds with the largest mature weight and birth weight show more frequent calving difficulty. This phenomenon is a general tendency, including the "within breed" situation even, which we will discuss after analyzing the variability among the paternal and maternal effects.

B. Paternal Value (or paternal breed)

This component is mainly related to the "direct effect" of breed on birth weight of the progeny; the large sized breeds (European beef breeds) are those exhibiting the poorest paternal component. This is clearly shown by the results of the U.S. Meat Animal Research Center (Fig. 5,a,b); Charolais, Limousin, Simmental, Maine-Anjou and Chianina breeds produce heavier calves requiring major assistance at delivery; South Devon and Gelbvieh give approximately the same results.

In this trial, it is possible that the direct effect of the Charolais breed could have been underestimated, particularly compared to the Limousin breed; as a matter of fact, genetic values for birth weight are lower than those of the French Charolais type in the purebreed area (-3.7 kg) or in a strain selected for terminal crossing (-7.7 kg) - (Vissac, et al., 1972). This difference in genetic value between Charolais types is of the same magnitude as that existing now between Charolais and Limousin sires together selected for terminal crossing (-7.8 kg; estimates on Friesian cows, from progeny testing data, Foulley, et al., 1975) Blond d'Aquitaine sires are located just between the two former breeds (-3.8 kg as compared to Charolais). Our crossbreeding experiment between beef breeds confirms these differences in the genetic values between Charolais and Limousin, the Maine-Anjou breed being similar or even superior, to the Charolais (Table 9).

Within French beef breeds, we find slight variation among bulls for the direct effect on calving difficulty, the heritability being around 5% (Belic and Menissier, 1968, Foulley, et al., 1975a). These estimates are from bulls used in artificial breeding and progeny tested for veal calf production, by terminal crossing on-farm, with one progeny per farm. Under these conditions, birth weight (direct effect) is more highly heritable (h^2 = 15-20%) although these estimates are still somewhat lower than the values found by American authors. On the other hand we have found a very close genetic correlation among these direct effects ($r_g \approx .9$-1.0). This has led us to expect genetic improvement in the direct effects on calving ability by means of birth weight rather than through the frequency of calving difficulty.

C. Maternal Value (or maternal breed)

This component concerns calving ability of purebred or crossbred heifers from different breeds, so the results and analyses are more limited.

Using data on calving score from progeny recording of A.I. bulls used for veal production in France, we classified all maternal breeds according to their calving ability (Table 11) (Foulley, et al., 1975). It appears rather clearly that the local breeds, especially those of small size and small muscle development (Aubrac and Tarantaise) present a more favorable maternal component than others. For the latter, it is difficult to separate dairy breeds from dual purpose and beef breeds. Among dual purpose and dairy breeds, those with the highest carcass value exhibit the poorest calving ability (for instance "Tachetèe de l'Est", the beef type of French Simmental or the European Brown Swiss). This classification of cattle breeds is not entirely explained by the effect of their maternal component on the birth weight of their calves. This general trend between breeds is confirmed by first calvings at 2 years of crossbred Angus or Hereford heifers bred to several paternal breeds, (crossbreeding experiment; U.S. Meat Animal Research Center) (Fig. 6); crossbred Jersey heifers, even with lower weight, had only slightly difficult calvings as compared to all the other breeds; conversely, crossbred Charolais and especially crossbred Simmental and South Devon heifers had more difficult calvings in spite of their heavy weight. Crossbred Limousin heifers whose calves exhibit intermediate size and weight have a rather favorable maternal ability for calving. The ability of the Jersey breed may result from a very favorable effect on the maternal component on birth weight as well as from large pelvic opening; but the first analysis by Laster (1974) on the latter criterion, does not reveal any obvious superiority of this breed.

In comparison with purebred Charolais and Maine-Anjou heifers, we demonstrated the particular ability of Limousin heifers for early calving without too many difficulties (Table 12) (Menissier, et al., 1974,a). This ability seems to depend both on their relatively large pelvic opening and on the very favorable effect on their maternal component on size of calves(resulting from direct as well as from uterine effects on birth weight). On the other hand, the unfavorable maternal ability for calving in Maine-Anjou heifers seems to be more related to their effect on the weight of their progeny than to their pelvic opening. Conversely, the ability of Charolais heifers which is about as unfavorable as that of Maine-Anjou heifers, stems chiefly from the smaller pelvic opening; furthermore, as compared to the two other breeds Charolais heifers seem to exhibit more delayed development of their pelvic opening (Fig. 7).

All our observations (for example, Table 13) suggest that the maternal ability for calving in the Blond d'Aquitaine breed is intermediate between that of the Limousin and the Charolais. Its pelvic opening is more favorable than that of the Charolais (Abdallah, et al., 1971,a) but, as compared to Limousin, the larger size of the dams, and the higher calf birth weight as well as the greater gestation length represent unfavorable components of maternal calving ability. In both of these blond breeds (Limousin and Blond d'Aquitaine), we observed a better sacro-sciatic relaxation at delivery, but a poorer preparation of the vulva and of the udder than in the Charolais breed (Abdallah, et al., 1971,b); Menissier, et al., 1974,a). This may cause more frequent resistance to the expulsion of the foetus at the level of vulva.

The heritability of the maternal contribution of this criterion is relatively higher than that of the direct effect (Brinks, et al., 1973; Couteadier, et al., 1971; Hansen, 1975). In the Charolais breed we have obtained from 15 to 20% (Table 14). These values are higher than those generally estimated for direct effects (h^2 = 0.05, approximately - Menissier, 1974), but they are mostly obtained under conditions where the environmental variability is reduced (stations or experimental herds) and where the genetic variability is expressed to a maximum (calving of the heifers). This maternal ability is directly related to the size of the calf (r_g = +0.67 and r_p = +0.59) and much less to the gestation length (r_g = -0.07 and r_p = +0.21). Although these two traits have a maternal component as heritable as that of calving ability, they are more subjected to direct effects than to maternal effects (Philipson, 1975) and depend more on the genotype of the calf than on that of the mother. Furthermore, the genetic correlation of their direct and maternal effects is naught or negative (Table 15 - Koch, 1972; Philipson, 1972) which might be the expression of a competition between the mother and the foetus regarding their requirements in the case of animals with a high growth potential. The genetic antagonism is less evident in the case of calving ability (r_g = -0.19; Philipson, 1975), but let us recall with respect to this that a greater number of traits are involved (Menissier, 1975). The morphological traits of the mother at calving (weight and pelvic opening) are the most heritable criteria (Table 14 and Couteadier, et al., 1971). With respect to the weight at calving, there is no, or a slightly negative, phenotypic correlation with calving difficulties, whereas there is a very high positive genetic correlation (r_g = +0.5 to +0.8). The relationships with growth and the conformation of the heifers at 18 months confirm this genetic opposition (Table 15).

As a matter of fact, this decrease of calving ability in large beef breeds, is the result of two phenomena:

1. First, the increase in size of the mothers (weight) is connected with an increase in birth weight of the calves. Proportionally, this increase would be greater than that of the size of the mothers (Monteiro, 1969) or of their pelvic opening related with the larger size of the dams (Taylor, et al., 1975); consequently, there would be more calving difficulties in large-sized breeds. Increase in calf weight/mother weight ratio would signify a higher maturity of the calves at birth; there is an apparent discrepancy between this and the observations of Fitzhugh and Taylor (1971). In addition, we do not know the respective share of the direct effect and maternal effect in the increase of weight at birth.

2. Secondly, the improvement of muscle development has also played a role. We have noticed that muscle development causes more difficulties at calving (r_g = +0.51), independently of the increase in the weight of the calves (r_g = +0.01). The effect of muscle development consists probably more in changing the morphology of the calves and especially in reducing the pelvic opening of the mothers relative to their size. This phenomenon has been described in connection with studies on the double muscle trait (Vissac, et al., 1973; Menissier, 1974,a). This last tendency (reduction of pelvic opening) is illustrated by a comparison of the weight and pelvic opening of cattle with varying muscular development from dairy (Holstein)and native (Gascon, Salers) to beef (Charolais) around one year old (Table 17). The pelvic opening decreases relatively as the live weight increases. In beef breeds, calving difficulties might be a consequence of their size and/or of their muscle development (Menissier, et al., 1974,b). It would be necessary to examine more thoroughly the influence of their present selection on this ability.

IV. Genetic Improvement of Calving Ability: Application of the French System

Genetic improvement of calving ability can be uncertain at two different levels 1) choice of breeds or strains and 2) selection within these populations according to the time their means need to be changed.

A. Genetic Improvement of Calving Ability Through the Choice of Breeds or Strains

As pointed out by Menissier (1975), the choice of the optimum combination of parental breeds allowing production of the heaviest veal or yearling calves without exceeding the critical threshold of calving difficulties can certainly be planned more objectively.

The procedure developed by Menissier can be summed up as follows in Figure 8. Knowing for a given maternal breed the upper limit of permitted calving difficulties and the relationship between the frequency of calving difficulties and birth weight of calves, we can determine the maximum average weight these females should produce without exceeding the tolerable risk of difficulties. From this average weight and on account of the maternal component for birth weight (genetic and environmental, such as age) of the female strain, we can then deduce the maximum breeding value (direct effect) of the sire strains which could be used.

This reasoning has been applied by Menissier (1974, 1975) to Charolais, Limousin and Maine-Anjou females from Bourges experimental data. In the case of the Charolais breed, even when the sires to be used are very carefully selected, early first calving at 2 years will lead to at least 10% calvings by caesarian operation (Table 18); it is therefore necessary to practice crossing to very small sized paternal breeds to reduce this risk. In the case of Maine-Anjou heifers, although the passage of heavier calves is possible, the limits of choice are identical to those recorded in Charolais heifers on account of the strong effect of their maternal component on birth weight. Conversely, Limousin heifers, in which passage of calves as heavy as those of Maine-Anjou is possible, can be mated to sires of higher breeding value and particularly those of the same breed. For these beef heifers subjected to early calving, the choice of the paternal breed must be based on production of calves weighing 30-35 kg to a maximum in order not to exceed the limit of 5% caesarian operations. For that purpose, a comparative study is now in progress on these purebred and crossbred heifers of beef breeds; we are comparing the use of three very different paternal breeds, the genetic values of which are distributed around our determinations (Jersey, Angus and very small sized Limousin, Table 19). Primary results confirm rather well our predictions. Taken as a whole, the results are rather concordant. At the present time, we are trying to make these same determinations in both dairy and dual purpose breeds used in terminal crossing, on the basis of the analysis of their maternal component at calving (Menissier and Foulley, 1975).

B. Genetic Improvement of Calving Ability through Selection

In connection with the genetic analysis of calving ability and taking into account the main breeding systems of beef breeds in France, we have to consider selection for calving ability in the two following situations: 1) selection schemes in beef breeds for terminal crossing and 2) selection schemes in beef breeds within purebreeding or in crossbreeding for producing breeding females.

1. Selection for Calving Ability in Terminal Beef Breeds

(Indirect effect of selection on birth weight)

The main selection criteria for growth applied in this selection scheme, such as 75 day weight (field progeny test for veal production), or 400 day weight (performance test and a new set of progeny tests in-station for baby beef) are genetically very strongly correlated to birth weight (Foulley, 1976) so that selection for growth practiced at present tends to increase birth weight and consequently the direct paternal component of calving difficulties (Belic and Menissier, 1968; Foulley, et al., 1975).

These predictions are effectively very well confirmed by French field data. Under the conditions of field progeny testing of A.I. bulls for veal production, the genetic superiority in birth weight of selected bulls over contemporary tested bulls was estimated at 0.40; 0.54 and 0.61 kg in Limousin, Charolais and Blonde d'Aquitaine breeds (Foulley and Gaillard, 1975 unpublished; Poivey, 1973). In fact, genetic increase of birth weight will be higher as a result of improvement in the efficiency of the different stages of the selection scheme of A.I. terminal beef bulls (Gaillard, et al., 1974).

It thus becomes very important to be able to master the genetic change in birth weight. The setting up, since 1971, of a national sample of reference bulls in progeny-test programs of each beef breed (Blonde d'Aquitaine, Charolais and Limousin) will be very useful to evaluate more objectively the genetic trends for birth weight.

Different ways can be imagined in order to limit the deterioration of birth conditions and increase in birth weight in progeny of terminal sire breeds. We are now, in France, engaged in two directions:

a) using crossbred sires from breeds with complementary abilities; in particular, combining a more adapted morphology (Blond d'Aquitaine), a limited birth weight (Limousin) with a large growth potential (Charolais), constitutes the first approach. This selection program, started some years ago in the South-Western part of France, is now producing various types of crossbred animals, known under the general name of "COOPELSO-93" and "INRA-95".

b) designing a selection program in which we take into account the age of females by producing different sire lines to breed them; selection criteria, particularly for growth, might be very different for young versus mature cows. Such a scheme is now in progress in France for the Limousin breed with the selection of a sire line with limited birth weight ("minimum line") intended to be used in terminal crossing, particularly on heifers.

In this situation, we have to propose adequate selection criteria for growth and calving ability. In the present French progeny-test with 60 recorded progeny per bull, a direct selection on the rate of dystocic calvings would not be as efficient as an indirect one based on birth weight, unless a higher number of progeny are scored for birth conditions (Foulley, et al, 1975).

Different selection methods for growth can be suggested: selection can be based on the absolute growth rate, or better yet on relative growth rates as proposed by Fitzhugh (1975) rather than on the weaning or yearling weights, since the genetic correlation between these criteria of growth rate and birth weight also indirectly include the weights (Fitzhugh and Taylor, 1971).

We can select also independently on birth and final weight in such a way as to restrict the genetic response of birth weight. But, with this goal, selection on a restricted index on birth weight will be more effective (+22 to 61% for total selection rates on 75 day weight varying between 5 and 50% according to Foulley and Menissier, 1975). This selection procedure appears also the more interesting as the relation between the reduction of expected genetic change in birth weight and those in weaning or yearling weight is not linear (Fig. 9), Foulley and Menissier, 1975; Foulley, 1976.

For instance by selecting on yearling weight minus 2.4 times birth weight, we can expect to reduce by half the genetic response of birth weight with a corresponding loss of only 7.5% in genetic improvement of yearling weight versus 25% loss when the absolute restriction of no change in birth weight is applied (Fig. 9). These results are in good agreement with those of Dickerson, et al., (1975) independently established from somewhat different reasoning and parameters. Selecting on yearling weight minus 3.2 times birth weight to improve the economic efficiency of beef production from weaning to slaughter on a constant age basis, they found reductions of genetic improvement in birth and yearly weight of 56 and 9% respectively in comparison to the selection situation where no negative value was put on birth weight.

2. Selection for Calving Ability in Suckling Cow Herds

(Selection schemes of beef breeds used in purebreeding or crossbreeding for producing breeding females.)

In this case, the selection goals are numerous and complex (Menissier, 1975) and not limited to the direct effect.

Up to the present time, this selection was mainly in herds kept under rather extensive systems with natural mating. Mass selection of males and females on conformation and growth criteria (especially weaning weight) appeared to be sufficient, as the extensive conditions favored natural selection with respect to the fitness trait. The situation in Europe (and even more so in France) differs for two reasons:

- primarily, the selection concerns in particular muscle development in animals from small family farms (well supervised herds) and with more intensive systems (management and feeding). Under these conditions the natural selection on breeding qualities intervenes less and less. (For example, practice of caesarian sections in Charolais is one cause of increasing frequency of calving difficulty by genetic change).
- in addition, 20 to 60% of these herds according to cases, are subjected to artificial insemination. It therefore seems logical to use this technique, on the one hand, to optimize the choice of the selected animals on the basis of their breeding qualities (selection on progeny) and, on the other, to accelerate the diffusion of genetic change to all suckling herds.

For that purpose, integrated selection schemes using three French beef breeds for production of breeding females have been developed over the last few years (Vissac, 1970; Menissier, et al., 1974; Vissac and Menissier, 1974; Menissier, 1975; Boyazoglu, 1975) (Fig. 10, Table 20).

a) Choice of the breeding animals:

- The first step is the progeny testing of breeding qualities of daughters of A.I. sires. This testing was done on a sample of 20 purebred daughters/sire, kept for two years at the station, from weaning till the second gestation. Not only their growth, but their fertility, calving ability and maternal mothering ability at first calving when 2 years old, were estimated. Although it represents one of the selection objectives, this early first calving was retained in particular in order to reduce the duration of progeny testing and to permit a better expression of the genetic variability of the maternal abilities. This assumes a good repeatability of these abilities.

- The second step consists of a combined choice on both pedigree and individual value of the young bulls, resulting from planned matings on the nucleus of elite cows (or "sire mothers"). The choice of sire mothers distributed in a great number of herds, is made from performance recorded on the farm. At the level of overall controlled population, the performance is generally expressed in the form of a "female index" (or estimation of the "Most Probable Producing Ability" - Regis, 1974), thus leading to rather strong selection pressure. The young males produced are subjected to performance testing before they are chosen for the subsequent steps.

In this scheme, the efficiency of the choice of breeding animals depends on the quality of the estimations of their genotypic value at each stage. It might be improved by a better combination of the available information as well as by utilization of early selection criteria (e.g. chromoronal aberations, hormonal levels, pelvic opening of young bulls).

b) Utilization of breeding animals:

Lastly, the optimization of such selection schemes requires a rationalization of the utilization of breeding animals chosen at each step; with the aim of obtaining a rapid diffusion of genetic change to the overall population. In particular, the sires selected by this scheme, after progeny testing, should in priority be kept for planned matings (by A.I.) with the elite females, in order on the one hand to procreate the following generation with the best elite mothers and, on the other, to produce young males with the other elite cows for the natural services in the recorded or unrecorded commercial herds. Before being used, these young males should be performance tested. Such an integration of the selection schemes at the level of the population, is difficult at the present time because of the difficulty in the distribution of the costs (supported by the A.I.) and the returns (obtained by natural matings).

CONCLUSION:

Calving difficulties, resulting from increased protential for muscle growth, are evidence of the effectiveness of genetic improvement in beef production under conditions which have become more and more intensive and in which natural selection no longer plays its customary role.

Despite the antagonism between calving ease and muscular development, it is possible to make genetic progress, thanks not only to the existing genetic diversity in cattle, but especially to opportunities presented by the structure for genetic improvement developed in France of which important components are: the existance of very large A.I. centers for the production of semen; the extensive use of A.I. in beef breeds, the "Law on Breeding Stock" which made possible many developments in French breeding schemes, etc., etc. Specifically thanks to A.I., we should be able to assure a very precise effectiveness in selecting bulls for the diverse systems of production practiced.

Foreign countries, especially the U.S. are often unaware of the specialized genetic material we have produced, and which could well be used to produce bulls for use in natural service.

Table 1. Calving difficulties and calf mortality, for first calving at two years of age - Charolais breed. Unpublished data from the "Agonges" Progeny Tests Station; Charolais bulls used in A.I. to test maternal ability to their daughters.

Calving Difficulties	Age of Calf							
	At Birth Including Stillborn's		0-48 hours		48 hours-1 month		1-4 months	
Cesarians & Embryotomies	n=167	14.4%	n=143	2.4% (2.8)	n=139	6.6% (7.9)	n=128	3.6% (4.7)
Calf Puller Used	n=228	13.2%	n=198	6.6% (7.6)	n=183	5.3% (6.6)	n=171	0.9% (4.2)
Easy Pull	n=297	3.0%	n=288	1.7% (1.7)	n=283	4.7% (4.3)	n=269	0.7% (0.7)
No Assistance	n=130	3.1%	n=126	0.8% (0.8)	n=125	5.4% 95.6)	n=118	0.8% (0.8)

1st figure = % (calves dead/calves born)

2nd figure = % (calves dead/calves present at the beginning of the period)

Table 2. Effect of caesarian on calf's weaning weight and dam's milk production[1]

(BONNET, 1973; INRA - unpublished data)

Trait:	Number of[2] calvings:	Age of calf at recording: (month) 1 m	3.5 m	6 m	From calving to 210 days lactation:
Daily milk production (kg/day)[3]	96	-2.38* (-48%)	-1.18* (-23%)	-1.08* (-26%)	-1.41 (-32%) (-298 kg of milk for the whole lactation)
Weaning weight at 7 months: (kg)	96	+1.3(NS) (+3%)	-1.2(NS) (-1%)	-1.0(NS) (-0.6%)	

[1] Maine-Anjou, Charolais, Limousin and Hereford heifers, pure and crossbred, calving at 2 years old (INRA - experiment at BOURGES).

[2] 20 caesarians and 76 other calvings (without caesarian).

[3] Obtained by weighing calf before and after suckling.

(NS) = non significant.

* = significant to 5%.

TABLE 3: Effect of calving difficulties on subsequent fertility of beef cows

a) Charolais breed (% of pregnant cows after a 1st calving at 2 years old and A.I. in pure during 60 to 70 days of breeding season)

Calving conditions at 2 years old:	1969		1971		1972		1973		Overall		
	1st A.I.	All breeding season	1st AI	All breeding season	1st AI	All breeding season	1st AI	All breeding season	NB females	1st A.I. (deviation)	All breeding season
Easy	76	98	59	91	68	91	46	88	238	62.6 (0)	91.2 (0)
Very difficult	47	84	66	94	56	78	35	82	146	49.3 (-13.3)	79.5 (-11.7)
Caesarian	33	56	38	73	36	43	32	55	94	35.1 (-27.5)	60.6 (-30.5)
Not calving	61	89	65	86	41	53	57	69	152	56.6	74.3
Number	97		161		182		190		630		
Oestrus	Natural		Natural		Synchronised		Nat. + Synchr.		Natural + Synchronised		

(Data from the "station de testage de la race charolaise", unpublished)

b) French beef breeds (% of pregnant Maine-Anjou, Charolais, and Limousin heifers and cows, inseminated during 60 to 70 days, in pure and cross, on natural oestrus for more than 80%)

Calving condition:	1972		1973				Overall:	
	1st calving at 2 years		1st calving at 3 years		2nd calving at 3 years		Number	%
	Nb	%	Nb	%	Nb	%		
Without help	38	92	17	94	42	76	97	85.6 (0)
With help	69	75	15	80	46	78	130	76.9 (-8.7)
Caesarian	31	61	7	29	14	43	52	51.9 (-33.7)
Number	138		39		102		279	

[Data from the crossbreeding experiment between French beef breeds, BOURGES (I.N.R.A.)]

TABLE 4 : Increasing birth weight and rate of calving difficulties by commercial crossing with large beef sires.

Dam breed :		Native breed				Dairy breed				British beef breed			
		Salers		Aubrac		Normande				Aberdeen Angus		Hereford	
Age of dam :		Heifers-Cows		Cows		Heifers		Cows		Heifers (2 years), Cows (3-4-5 years)			
Reference :		PETIT (1972)		Field data (b)		COLLEAU, 1972				LASTER et al., (1973)			
Criteria :		Nb	Average (a) value	Nb	Average value	Nb	Average value	Nb	Average value	Nb	Average value	Nb	Average value
Birth weight: (kg)	Pure	173	36.6	2033	35.1	40	39.0	40	42.0	231	29.5	217	32.2
	Crosses: Charolais	99	+5.1	752	+5.5	18	+3.8	20	+2.8	190	+5.7	174	+5.5
	Limousin	-		581	+0.3	-		-		69	+5.6	79	+4.4
	Simmental	-		-		-		-		87	+5.5	78	+6.7
Calving ability: (%)	Pure	-		2033	0	-		-		231	8.5	217	18.6
	Crosses: Charolais	-		-		-		-		190	+18.6	174	+16.1
	Limousin	-		-		-		-		69	+17.7	79	+16.7
	Simmental	-		-		-		-		87	+14.8	78	+23.4

(a) crosses expressed by the deviation from the average for pure animal (dam breed);

(b) growth recording in farm for pure animals (1970) and for beef crosses in the same area : 1959-1971, (unpublished data).

Table 5a. Effect of early calving of heifers on calving difficulties.

Charolais in pure breeding (MENISSIER, 1974 and unpublished data).

	1st CALVING AT 2 YEARS: - in station and experimentation - heifers bred by very small sires (A.I.)	1st CALVING AT 3 YEARS: - in farm - heifers bred by small sires (A.I. + n.m.)	COWS 4 YEARS & OLDER: - in farm - cows bred by normal sires (A.I. + n.m.)
- Number of . . . calvings	829	2947	14953
- % requiring :::			
-- caesarian and . . embriotomy	20.5%	8.5%	1.3%
-- very difficult . extraction	27.5%	17.0%	5.4%

Table 5b. Effect of age at first calving and parity on calving difficulties.

French beef breeds in crossbreeding (MENISSIER et al., 1974a).

	AGE AT 1st CALVING (A)	PARITY (B)
	(calving at 3 years vs. calving at 2 years) =	(2nd calving at 3 years vs. 1st calving at 2 years) =
% caesarians . . .	- 6.2 ± 7.2% (n.s.)	-11.5 ± 11.0% (n.s.)
% caesarians and very difficult calvings	-15.7 ± 8.8% (n.s.)	-13.5 ± 13.5% (n.s.)
Birth weight of calves	- 2.1 ± 1.1 kg (n.s.)	- 0.4 ± 1.7 kg (n.s.)
Dam's weight after calving	+ 42 ± 9 kg (*)	- 15 ± 14 kg (n.s.)
Pelvic opening after calving .	+ 37 ± 6 cm^2 (*)	+ 19 ± 7 cm^2 (*)

(A) Both groups of heifers were mated to small bulls.

(B) The heifers were mated to bulls smaller than those for the (cow's 2nd calving).

Table 6. Frequency of abnormal positions of foetus at birth.

Heifers and young beef cows in crossing (MENISSIER et al., 1973) and in purebreeding (MENISSIER et al., 1975 - unpublished data).

Type of abnormal position (%)	1st calving at 2 years (1972): (n = 149)	1st calving (n = 43) & 2nd calving (n = 109) at 3 years, (1973):	TOTAL (n = 301 calvings)	1st calving at 2 years (7 yrs.) (n = 829)
Normal (or unknown)	95%	89%	92%	96.0%
Posterior presentation	3%	9%	6%	1.7%
Other abnormal presentation	-	-	-	2.1%
Torsion of uterus	2%	2%	2%	0.2%
	IN PURE AND CROSSBREEDING			IN PUREBREEDING

TABLE 7 : Correlation coefficients between the calving score and its components (French data):

Age of dam		1^{st} calving = 2 years (experiments)								1^{st} calving 3 years pedigree	2^{nd} calving and over herds	1st Calving at 2 years progeny test	
Reference		ABDALLAH (1971)				SEITZ (1972)		COUTEAUDIER et al. (1970)				unpublished	
Number of calvings		47		83		114		60	46	38	198 to 119	829	
Breeding type :	Calf :..........	Cross				Pure, cross		Pure				Pure	
	Dam :	Aubrac and beef crosses		Gascon and beef crosses		Pure : Maine-Anjou, Limousin Charolais (c)		Charolais				Charolais	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	Note	% vers difficile
Dimension of the calf :	Birth weight......	+0.65*	-	+0.43*	-	+0.79*	-	+0.73±0.07	-	+0.61±0.12	+0.24±0.07	+0.59	+0.60
	Girth, at shoulders	+0.52*	+0.17	+0.23*	-0.10	+0.72*	-	+0.56±0.10	+0.44±0.13	-	-	-	-
	at thurls...	+0.55*	+0.06	+0.44*	+0.21	+0.80*	+0.30	0.77±0.66	+0.47±0.13	-	-	-	-
	Width, at shoulders	-	-	+0.44*	+0.21	+0.66*	-	-	+0.31±0.14	-	-	-	-
	at thurls...	-	-	+0.44*	+0.25*	+0.79*	+0.44	-	+0.54±0.12	-	-	-	-
	Height, at shoulders	-	-	+0.17	+0.09	+0.54	-	-	+0.39±0.14	-	-	-	-
	at thurls..	-	-	+0.13	-0.12	+0.81*	+0.65	-	+0.56±0.11	-	-	-	-
	Body length.......	-	-	+0.06	-0.26*	+0.60	-0.42	-	-	-	-	-	-
Dimension of the dam :	Pelvic opening....	-0.10	-0.08	-0.17	-0.19	-	-	-0.30±0.12	-	-0.36±0.15	-0.18±0.07	-	-
	Width, at hips.....	-0.11	-0.09	+0.02	-0.05	-	-	-0.06±0.13	-	-0.05±0.17	+0.10±0.07	-	-
	at thurls...	+0.17	+0.32*	+0.21*	+0.22*	-	-	-	-	-0.05±0.17	+0.06±0.07	-	-
	Weight after calving (or heart girth)	-0.06	-	+0.03	-	-	-	-0.16±0.13	-	-0.13±0.17	+0.13±0.07	-0.08	-0.03
Preparation for calving	Duration..........	-	-	-	-	-	-	-	-	+0.46±0.14	+0.34±0.07	-	-
	Intensity.........	-	-	-	-	-	-	-0.44±0.11	-	-	-	-0.24	-0.23

(a) : Correlation coefficient ;

(b) : Partial correlation at fixed birth weight for the dimension of the calf and at fixed dam weight for the dimension of the dam ;

(c) : Correlation coefficients are calculated between breeding types = pure and crosses (9 types) ;

(*) : Significantly different from 0 at the 5% probability level.

Table 8. Calving ability of the French beef breeds (general value).

Breed	Number (a)		% of difficult calvings (a)		Birth weight (kg)(a)		Mature weight of sires (kg)(b)		Ratio= mature weight
	Heifer	Cow	Heifer	Cow	Heifer	Cow	No.	Mat. Wt.	Birth Weight
Maine-Anjou	531	3284	64	49	46.9	50.6	37	1275	25
Charolais	5216	38795	50	34	42.0	44.9	62	1225	27
Blond d'Aquitaine	295	2351	30	20	41.7	45.5	15	1125	24
Limousin	1012	6207	15	7	35.5	38.2	18	1090	29

(a) Data from the "National Growth Recording Scheme" (1970); - difficult calving = calving with any help.

(b) Data from the National Show of Paris = 1965 to 1970 (BOUGLER, 1972).

TABLE 9 : EFFECT OF PATERNAL BREED ON CALVING DIFFICULTIES AND ITS COMPONENTS.

(Crossbreeding Experiment with french beef breeds - INRA) - (MENISSIER et al., 1974. a), and unpublished data).

PARITY and YEARS of CALVING:	SIRE BREED: (a)	NUMBER	% VERY DIFFICULT CALVINGS: (with caesarians and large assistance: score : 5+4)	CALF BIRTH WEIGHT:	GESTATION LENGHT (days)	RATIO of WEIGHTS : DAM/CALF (b)	CALF MORPHOLOGY at constant birth weight : BODY LENGTH : (cm)	WIDTH at (cm) : SHOULDERS:	THURLS:
1ST CALVING AT 2 YEARS (1972)	MAINE-ANJOU	37	58.3 %	40.7	284	12.8	62.0	19.4	20.3
	CHAROLAIS	38	40.0 %	40.3	286	13.1	62.9	18.2	19.8
	LIMOUSIN	38	36.4 %	37.3	288	14.2	62.7	18.5	19.4
1st calving at 3 years (1973)	MAINE-ANJOU	14	47.2 %	44.1	-	13.0	50.1	19.1	21.7
	CHAROLAIS	8	24.3 %	40.0	-	14.0	51.4	19.5	20.8
	LIMOUSIN	17	17.1 %	39.2	-	14.6	50.4	19.1	20.7
2ND CALVING AT 3 YEARS (1973)	MAINE-ANJOU	37	27.4 %	44.2	285	12.6	50.8	19.5	21.5
	CHAROLAIS	31	33.0 %	44.6	287.5	12.4	49.4	18.4	20.6
	LIMOUSIN	31	21.5 %	42.6	290.5	13.2	49.7	18.4	20.5
CALVING AT 4 YEARS (1974)	MAINE-ANJOU	48	18.3 %	45.2	285	-	-	-	-
	CHAROLAIS	46	21.0 %	45.1	287.5	-	-	-	-
	LIMOUSIN	31	7.7 %	44.3	290	-	-	-	-
CALVING AT 5 YEARS (1975)	MAINE-ANJOU	36	5.5 %	46.1	no calculed	-	-	-	-
	CHAROLAIS	36	11.1 %	47.8		-	-	-	-
	LIMOUSIN	37	15.1 %	44.3		-	-	-	-

(a) 2 small sires for each breeds for 1st calving at 2 and 3 years of age ; 6 (2 small + 4 normal) sires for each breeds for 2nd and subsequent calvings.

(b) unweighted values.

Table 10. Heritabilities and correlation between direct effects of calving difficulties and birth weight. (FOULLEY, et al. 1975a)

(Data from progeny testing in the field; A.I. bulls for veal production through crossbreeding).

(1) BA = Blond d'Aquitaine bulls (94) - and 4,696 calves.
(2) LI = Limousin bulls (374) - and 16,765 calves.
(3) CH = Charolais bulls (256) - and 12,824 calves.

(r_p) (h^2) (r_g)		Calving difficulties: Score	Calving difficulties: % difficulties	Birth Weight
Calving Difficulties	Score	(1) 4.3% (2) 2.2% (3) 4.4%		+0.17 +0.11 +0.32
	% dif.		2.1% 2.0% 6.0%	
Birth Weight		+0.89 +0.91 +0.91		19.1% 8.6% 16.5%

Table 11. Effects of dam breeds on calving ability of females crossed with beef bulls.

Sire Breed	Limousin				Blonde d'Aquitaine				Charolais			
Variable	1	2	3	4	1	2	3	4	1	2	3	4
Dam Breeds												
~~*Laitières et mixtes*~~ *(dairy and dual-purpose)*												
Frisonne française	38,94	1,37	33,4	7,0	40,92	1,58	50,8	10,4	42,82	1,48	42,2	5,2
Montbéliarde	+1,63	−0,21	−18,2	−4,2	+5,58	−0,27	−24,9	−4,0	+1,87	−0,20	−21,6	−1,4
Pie-Rouge de l'Est	—	—	—	—	—	—	—	—	+3,26	+0,44	+28,5	+1,1
Normande	+0,97	−0,03	−3,2	−1,4	+0,92	−0,03	− 3,5	−0,1	+0,43	−0,14	−13,9	−0,2
Brune des Alpes	+1,91	−0,01	−1,8	−2,7	+2,47	−0,10	−10,2	−1,7	+2,49	−0,01	− 6,3	+2,4
Rustiques (local)												
Abondance	−0,52	−0,27	−24,7	−4,2	—	—	—	—	−0,14	−0,14	− 4,1	+1,0
Tarentaise	−1,38	−0,34	−29,6	−5,7	—	—	—	—	−3,62	−0,21	−27,0	+1,9
Aubrac	−3,09	−0,29	−26,6	−5,1	−1,37	−0,45	−38,4	−8,5	−3,33	−0,31	−30,5	−3,1
Salers	−0,22	−0,28	−24,5	−5,0	−0,25	−0,28	−24,9	−5,2	−2,04	−0,19	−20,0	−2,3
Gasconne	−0,84	−0,21	−11,4	−3,3	−0,58	−0,20	−17,9	−4,0	−0,72	−0,48	−26,5	−2,3
A viande (beef)												
Limousine	−0,71	−0,12	−7,2	−3,5	−0,67	+0,01	−0,9	+1,8	−0,23	−0,05	−10,5	+1,0
Blonde d'Aquitaine	−0,01	+0,01	+0,6	−1,8	+4,72	+0,00	+2,0	−1,3	—	—	—	—
Charolaise	+1,75	−0,07	−6,7	−0,1	+2,08	−0,05	−7,5	+2,2	+1,29	−0,12	−15,5	+1,6

1 - Birth weight (kg)
2 - Calving difficulty (score 1 to 4
3 - Frequency of difficult calvins (score 3 + 4)
4 - Frequency of very difficult calvings (score 4)

Data from on-the-farm progeny tests for veal production.

TABLE 12 : EFFECT OF MATERNAL BREED ON CALVING DIFFICULTIES AND ITS COMPONENTS.
(crossbreeding Experiment with French beef breeds - INRA) (MENISSIER et al., 1974. a), and unpublished data).

PARITY and YEARS of CALVING:	DAM BREED: (a)	NUMBER	% VERY DIFFICULT CALVINGS (with caesarians and large assistance. score: 5 + 4)	CALF BIRTH WEIGHT: (kg)	GESTATION LENGHT (days)	DAM'S WEIGHT AFTER CALVING:	RATIO of WEIGHTS: DAM/CALF. (b)	PELVIC OPENING AFTER CALVING: (cm^2) (b)
1ST CALVING AT 2 YEARS (1972)	MAINE-ANJOU	36	56.2 %	43.7	287	541	12.4	278
	CHAROLAIS	35	57.3 %	40.7	285	540	13.3	253
	LIMOUSIN	43	21.2 %	34.0	287	492	14.5	253
1st CALVING at 3 YEARS (1973)	MAINE-ANJOU	12	42.9 %	44.3	-	571	12.9	-
	CHAROLAIS	17	45.7 %	41.4	-	588	14.5	-
	LIMOUSIN	10	0.0 %	37.6	-	529	14.2	-
2ND CALVING AT 3 YEARS (1973)	MAINE-ANJOU	35	39.3 %	47.9	288	580	12.1	344
	CHAROLAIS	30	35.1 %	43.5	287	571	13.2	310
	LIMOUSIN	34	7.5 %	39.9	288	514	12.9	300
CALVING AT 4 YEARS (1974)	MAINE-ANJOU	39	30.4 %	49.1	288.5	625	12.9	376
	CHAROLAIS	37	17.7 %	45.8	287	653	14.5	358
	LIMOUSIN	49	4.2 %	40.9	287	570	14.0	333
CALVING AT 5 YEARS (1975)	MAINE-ANJOU	34	15.6 %	49.6	not calculated	653	12.9	411
	CHAROLAIS	34	5.4 %	46.2		687	15.1	403
	LIMOUSIN	41	10.4 %	43.0		598	14.2	359

(a) : bred by 2 small sires of each breeds for 1st calving at 2 and 3 years of age ; bred by 6 (2 small + 4 normal) sires of each breeds for 2nd and subsequent calvings.

(b) : unweighted values.

TABLE 13 : CALVING ABILITY OF HEIFERS IN PROGENY TESTING STATION FOR A.I. BEEF SIRES ON FERTILITY AND MATERNAL ABILITY (a) - (unpublished data).

STATION, BREED, and YEAR :	Number of calvings	CALVING ABILITY : AGE at calving : (days)	CALVING DIFFICUL-TIES : % of caesarians	CALVING DIFFICUL-TIES : % of large assistance (caesarians included)	CALF BIRTH WEIGHT : (KG)	GESTATION LENGTH : (days)	WEIGHT OF DAMS : (KG) : at 18 months of age	WEIGHT OF DAMS : (KG) : after calving	CALF MORTALITY : WITHIN 48 hr. of Birth	CALF MORTALITY : Later	CALF MORTALITY : FROM BIRTH TO WEANING
BLONDE D'AQUITAINE : (in South-West "CASTELJALOUX")											
• 1972-74-(6 Sires)...	64	763	18.8 %	30.5 %	40.7	292	420	532	11 %	5 %	16.7 %
• 1973-75 (6 Sires)	86	787	10,5 %	19,8 %	38,4	291	404	501	6 %	4 %	9,3 %
LIMOUSINE : (in Center "UZERCHES")											
• 1972-74-(10 Sires)...	157	839	2.2 %	7.1 %	36.4	287	368	480 (b)	13 %	7 %	19.8 %
CHAROLAISE : (in Center East : AGONGES)											
• A : 1967-69.........	70	(2years old)	14 %	41 %	38.9	285	477	554	-	-	4.2 %
• B : 1968-70-(9 Sires)	125	(2years old)	21 %	47 %	36.6	282	419	502	-	-	17.8 %
• C : 1969-71-(10Sires)	120	(2years old)	36 %	65 %	40.6	286	432	504	21 %	12 %	33.3 %
• D : 1970-72-(10Sires)	97	745	18 %	46 %	36.6	-	443	508	7 %	1 %	8.2 %
• E : 1971-73-(10Sires)	141	756	22 %	60 %	37.8	284	445	508	12 %	5 %	17.0 %
• F : 1972-74-(9 Sires)	115	755	11 %	34 %	34.9	283	425	456	-	-	22.7 %
• G : 1973-75 (7 Sires)	106	751	17 %	41 %	37,1	284	418	462	12 %	10 %	22,6 %

(a) sample of about 20 daughters of each sire, bought at weaning on farm.
heifers are inseminated for 1st calving at two years, with the same bull for all heifers of each station.

(b) aproximate estimation.

Table 14. Heritability estimates of maternal calving ability in Charolais breed.

Progeny testing results in station, for maternal abilities for A.I. bulls.
(1st calving at 2 years old - 55 sires).

	Number of Heifers		Mean Values		HERITABILITIES
CHARACTERS:	Total	Per sire	Average + Stand. dev.	c.v. (%)	(confid. limits for p = .05)
CALVING DIFFICULTIES[a]					
Score (increasing 1 to 4)	753	13.6	2.53 ± .03 points	39	18.2% (.6/42.3)
% of difficult calving	753	13.6	48.1 ± 1.7%	104	14.9% (-.0/38.3)
CALF[a]					
Birth weight	753	13.6	37.3 ± .2 kg	16	16.7% (-.7/40.5)
Gestation length	753	13.6	283.7 ± .2 days	2	18.6% (.9/42.8)
DAM					
Calving weight	405	8.8	494 ± 2 kg	11	47.0% (15.2/88.6)
Calving preparation (% good score)	719	13.0	78.7 ± 1.5%	52	13.7% (-3.9/37.6)

(a) = as maternal characters.

Menissier et al., 1975.

Table 15 : GENETIC (R_G) AND PHENOTYPIC (R_P) CORRELATIONS BETWEEN MATERNAL CALVING ABILITY AND GROWTH OR CONFORMATION SCORE IN CHAROLAIS BREEDS : progeny testing results in station, for maternal abilities for A.I. Bulls (1st calving at 2 years old - 753 heifers sired by 55 bulls).

(r_g and r_p)			GROWTH AND CONFORMATION SCORE (heifers at 18 months old)						
			WEIGHT at 18 months old	A.D.G. (9 to 18 months old)	MUSCLE (b) development	SKELETAL (b) development	BREED (b) qualities	TOTAL (b) SCORE	CALVING WEIGHT
HERITABILITIES:			33 %	21 %	48 %	31 %	14 %	25 %	47 %
CALVING ABILITY (a)	CALVING DIFFICULTIES: Score (increasing 1 to 4)	r_g	.09	.08	.33	−.12	.26	.24	.51
		r_p	−.01	.18	−.01	.09	.07	.08	−.08
	% difficult calvings	r_g	.21	.14	.51	.30	.37	.64	.75
		r_p	−.01	−.04	−.01	.26	−.10	.04	−.03
	CALF BIRTH WEIGHT (c)	r_g	.47	.61	.01	.32	.12	.23	.33
		r_p	.05	.03	−.05	.04	.06	.19	.26
	GESTATION LENGTH (d)	r_g	.15	.29	−.05	−.02	.13	−.00	.05
		r_p	.04	.01	.03	.29	.03	.04	−.08
	CALVING WEIGHT	r_g	.75	.47	1.33	−.11	.69	1.04	.
		r_p	.78	.23	.30	.54	.07	.48	.

(a) : as a maternal trait. (b) linear combination of score for various characters.

(c) : correlations with maternal calving ability are : $r_g = +0.67$ and $r_p = +0.59$;

(d) : " " " " " " : $r_g = -0.07$ and $r_p = +0.21$;

- MENISSIER et al., 1975 -

Table 15 : GENETIC VARIABILITY OF DIRECT AND MATERNAL EFFECTS ON THE PREWEANING GROWTH : Results of literature (according FOULLEY and MENISSIER, 1974).

CHARACTERS :	HERITABILITIES: (%) TOTAL (c) H^2_T	DIRECT EFFECT H^2_O	MATERNAL EFFECT H^2_M	GENETIC CORRELATIONS: P_G (O, M)	REFERENCE : Number and genetic type:	Authors:
BIRTH WEIGHT:	42	35	-	⩾ 0	4 553 Hereford	KOCH and CLARK, (1955).
	49	45	9	.00 (a)	4060 Hereford	KOCH, (1972).
	56	44	10	.14 (b)		
	48	72	-	- .56 TO - .89	1962 Hereford	VESELY and ROBISON, (1971).
	2	22	4 to 15	- .93	1064 Holstein	EVERETT and MAGEE, (1965).
	36	56	30	- .58	789 Hereford	BROWN and GALVEZ, (1969).
	17	14	25	- .39	932 Angus	
GROWTH : BIRTH TO WEANING.	12	21	-	- .65	4553 Hereford	KOCH and CLARK, (1955).
	32	20	28	- .05 (a)	4060 Hereford	KOCH, (1972).
	12	26	11	- .41 (b)		
	25	18	15	.00	725 Brahman	DEESE and KOGER, (1967).
	17	40	46	- .73	466 Brahman x Shorthorn	
WEANING WEIGHT:	32	44	40	- .32	717 Hereford	HILL, (1965).
	42	32	51	- .46		
	17	37	-	-.73 TO -1.07	1692 Hereford	VESELY and ROBISON (1967).
	28	23	34	- .28 (a)	2618 Hereford	HOHENBOKEN and BRINKS, (1971).
	8	23	54	- .79 (b)		
	32	14	34	- .07 (a)	228 Charolais	FOULLEY et MENISSIER, (1974).
	-	14	64	- 1.14 (b)		

(a) = without offspring - Dam relation ; (b) with offspring - Dam relation ; (c) estimation according WILLHAM (1973).

TABLE 17:

Live weight and pelvic opening of cattle according
to breeding type: French results. (MENISSIER, 1974).

Experiment:	Age of cattle:	Breeding type: (sire x dam)	Number:	Live weight: (kg)	Pelvic opening: (cm^2)	Ratio = Pelvic Op. / weight	Reference
crosses= native x beef,	♀ 13 months	Charolais x Charolais	15	344	155	0.45	ABDALLAH et al., (1971a)
		Blond d'Aq. x Blond d'Aq.	14	326	167	0.51	
		Charolais x Gascon	16	349	166	0.47	
		Blond d'Aq. x Gascon	15	345	171	0.49	
		Gascon x Gascon	26	324	161	0.49	
crosses= dairy x beef,	♂ 13 months	Charolais x Charolais	3	449	130	0.29	
		Charolais x Normand	6	444	143	0.32	
		Normand x Normand	20	417	150	0.36	
		Holstein x Normand	7	465	173	0.37	
		Holstein x Holstein	3	443	188	0.42	
Performance test stations (purebred animals)	♂ 12 to 13 months	Charolais	51	540	135	0.25	MOINE, (1967)
		Limousin	70	490	150	0.31	
		Salers	35	440	168	0.38	
		Charolais	52	500	160	0.32	REGIS, (1969)
		Limousin	64	500	190	0.38	
		Salers	17	445	200	0.45	
		Charolais= (1) hypert. type	12	466	152	0.326	MOINE, (1967)
		= beef type	28	525	173	0.330	
		= beef type	35	535	143	0.27	REGIS, (1969)
		= interm. type	17	438	177	0.40	

(1) Hypertrophied type = young bulls showing evidence of double muscling;
Beef type = young bulls selected for terminal crossing in A.I. schemes;
Intermediate type = young bulls selected by A.I. centers for use in the purebreeding area.

Table 18. Average upper limits of birth weight of progeny calves ($\bar{P}_o$) and breeding sires ($\hat{P}_o$) for an a priori level of calving difficulties. (MÉNISSIER, 1974).

dam breed: Upper limit of Birth weight (kg) (a)			MAINE-ANJOU $\bar{P}_o$	MAINE-ANJOU $\hat{P}_o$	CHAROLAIS $\bar{P}_o$	CHAROLAIS $\hat{P}_o$	LIMOUSIN $\bar{P}_o$	LIMOUSIN $\hat{P}_o$
1st calving at 2 years	Level of calving diff.	(b) 1%	29.0	9.0	25.5	7.5	30.5	30.5
		5%	34.0	24.0	31.0	23.5	34.0	40.5
		10%	37.0	32.0	34.0	32.0	36.5	47.5
2nd calving at 3 years		1%	36.5	31.0	33.0	20.0	38.0	42.0
		5%	42.0	35.5	38.0	33.5	41.5	52.5
		10%	44.5	36.5	40.5	40.5	44.0	58.0

(a) % fixed of caesarians.
(b) Data corrected for age of dam effect; heterosis effect not considered.

□ : impossible situation.

▤ : situation corresponding to the use of sires smaller than those of the maternal breed involved.

▦ : situation corresponding to the use of small sires from the maternal breed.

Table 19. Comparison of three paternal breeds for 1st calving at 2 years of beef heifers.

(Crossbreeding experiment with French beef breeds - 2nd generation - INRA, unpublished data).

Sire Breed of calves: (a)	Number of Calvings	% Calvings without any difficulty (score: 1+2)	CALVING DIFFICULTIES % very difficult extraction: (score: 4)	% caeserians (score: 5)	TOTAL (score: 4+5)	BIRTH WT. (kg)
Jersey	37	92%	0%	0%	0%	30.6 kg
Angus	38	66%	3%	5%	8%	32.5 kg
Limousin (b)	31	55%	19%	10%	29%	36.5 kg

(a) 3 bulls from each breeds, used for A.I. on Maine-Anjou.
Charolais and Limousin pure and half bred heifers for the 1st calving at 2 years.

(b) progeny tested bulls producing very small calves.

(c) unweighted results of 3 years (1974-76) data.

Table 19b. Comparison of various paternal breeds for 1^{st} calving at 2 years of two-way cross beef heifers.

(Germ plasm evaluation program, USDA - Clay Center, NB)-(Anonyme, 1975).

Sire Breeds of Calves:	Number of calvings (a)	% Calvings without difficulty	CALVING DIFFICULTIES			Birth weight (kg)	Early calf Mortality (b)
			% with calf puller	% caesarians	TOTAL		
Angus and Hereford	128	71.7%	23.2%	1.8%	25.0%	31.3	4.5%
Devon	138	67.3%	26.6%	3.1%	29.7%	31.8	1.8%
Holstein	144	51.2%	39.4%	3.4%	42.8%	33.5	9.2%
Brahman	149	34.1%	50.4%	6.0%	56.4%	40.0	15.3%

(a) results of 3 calf crops (1972-74).

(b) within 24 hr. of birth.

Table 20. Characteristics of progeny testing stations of A.I. beef sires on fertility and maternal abilities of their daughters.

- 20 daughters per sire purchased on farm at weaning and reared for 1st calving at 2 years.
- all heifers mated by the same bull for each station.

BREEDS :	Manager of program Localisation of station	TYPE OF SELECTION: Choice of bulls to be progeny tested:	Year of opening; number of sires; number of testing groups (1974)	Number of selected bulls
CHAROLAIS	"Union nationale de Testage de la Race Charolaise" - 03 AGONGES -	- partially performance tested, and progeny tested for calf production (direct effect in pure breeding	1968 7 to 10 bulls per year 5	4 to 5 bulls per year
LIMOUSIN	"Union Auvergne-Limousin et Charentes" - 19 UZERCHE -	- progeny tested for veal or baby beef production in cross and pure breeding	1972 10 bulls per 2 years 1	4 bulls per 2 years
BLOND D' AQUITAINE	"Midatest" - 47 CASTELJALOUX	- progeny tested for veal or baby beef production in crossbreeding	1972 6 bulls per year 1	2 bulls per year

FIGURE 1 → "THRESHOLD EFFECT" OF BIRTH WEIGHT ON THE FREQUENCY OF DIFFICULT CALVINGS ACCORDING TO AGE AND BREED OF DAMS, in purbreeding.

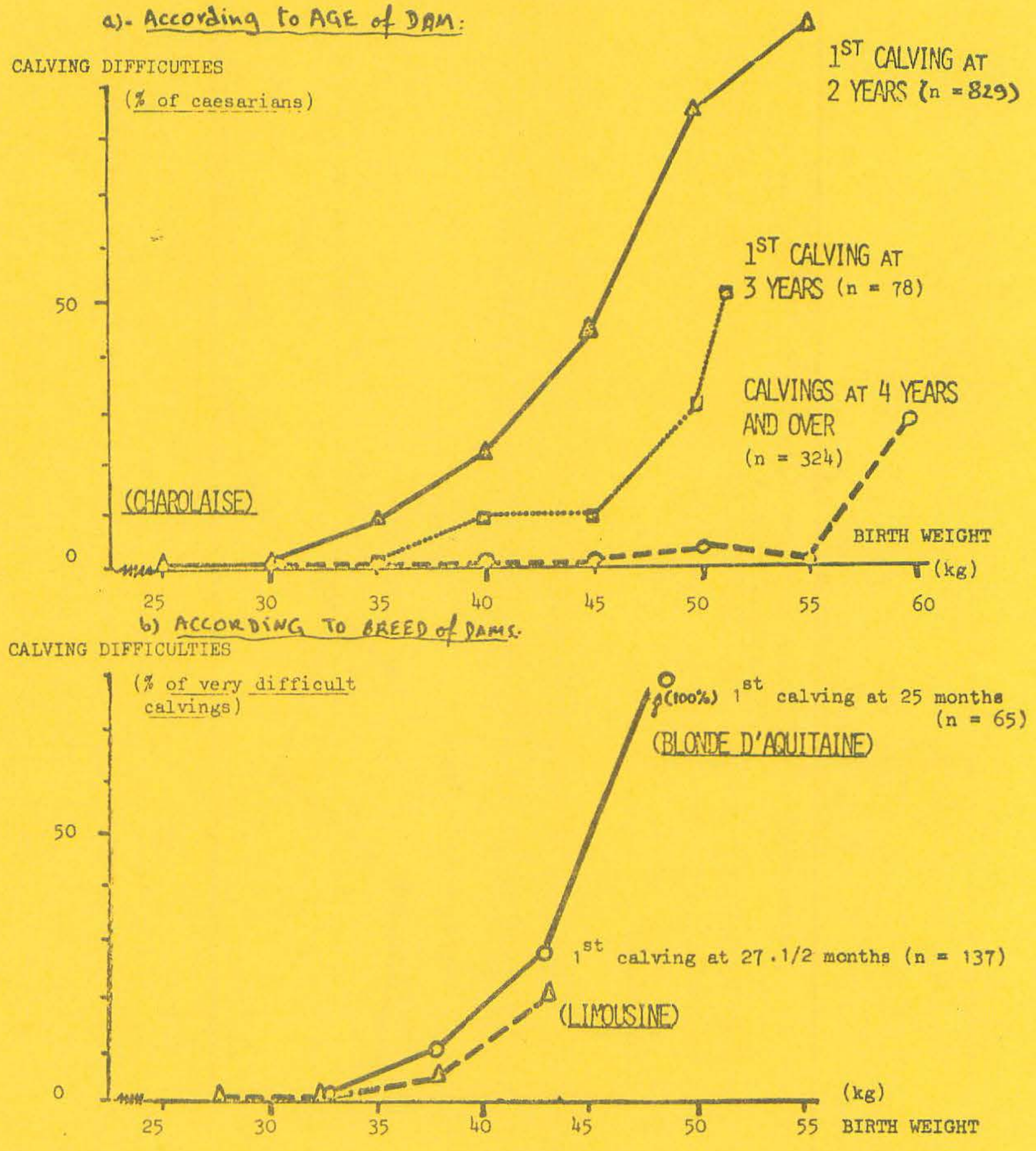


fig. 2 : Threshold effect of pelvic opening on the frequency of difficult calvings according to age of dams - (Charolais breed.)

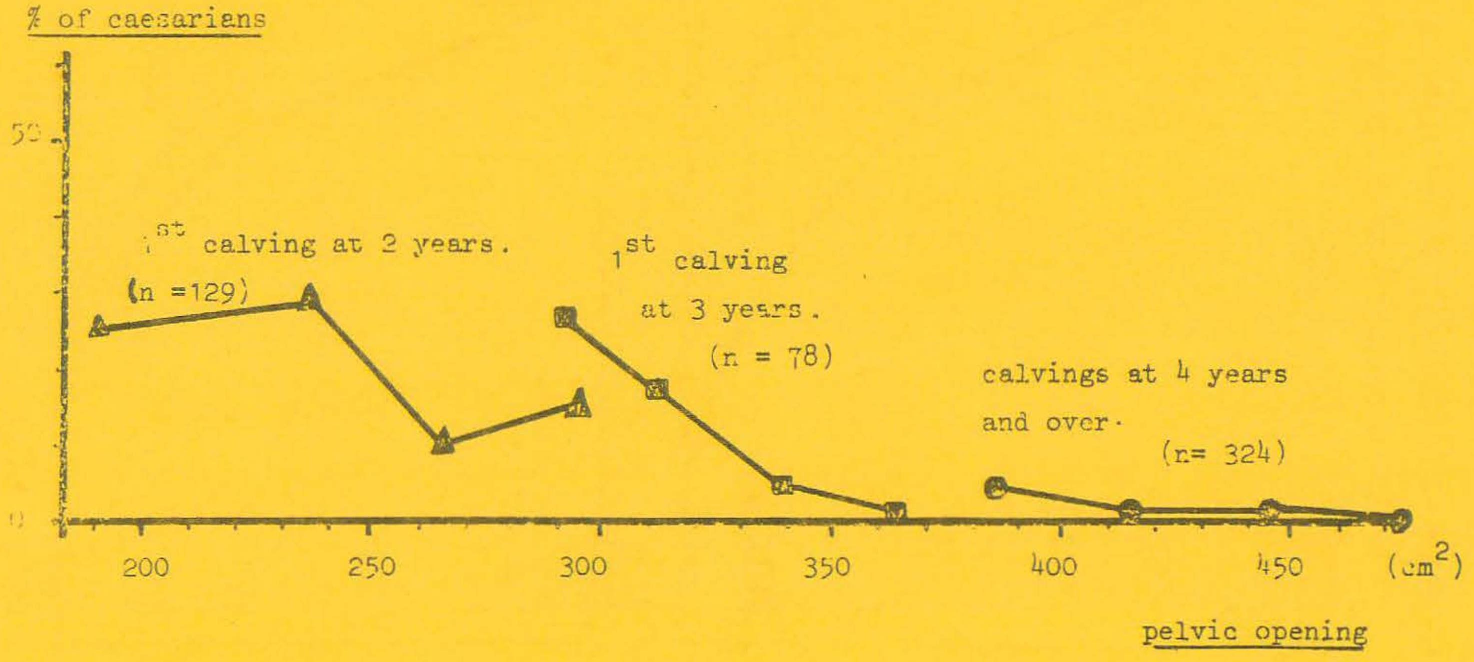


FIGURE 3 : FREQUENCY OF DIFFICULT CALVINGS (calf puller and caesarian) ACCORDING TO BIRTH WEIGHT OF CALF AND PELVIC OPENING OF DAM.

(Experimental results of crossbreeding experiment, concerning 262 calvings from 2 and 3 years old cows from Charolais, Limousin and Maine-Anjou breeds - MENISSIER, 1974).

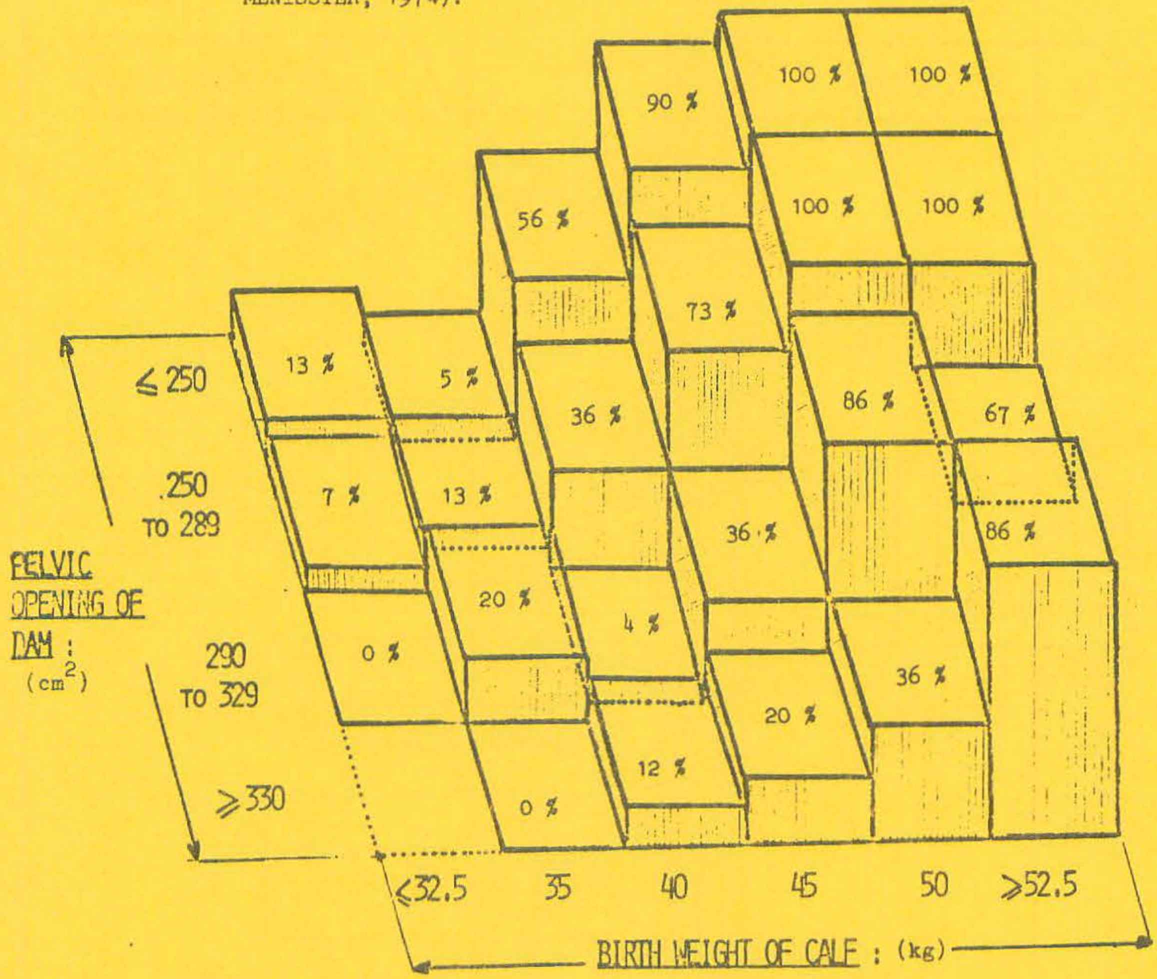
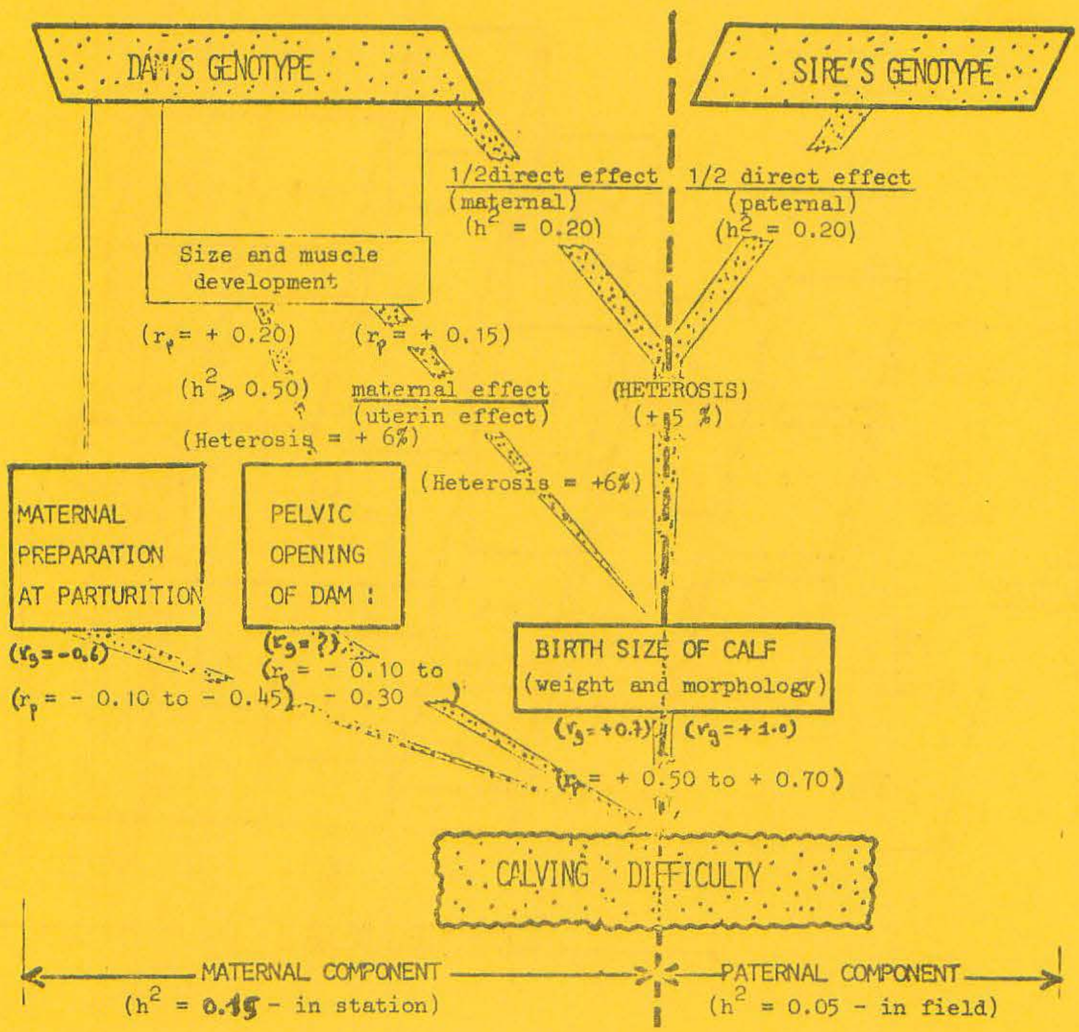


FIGURE 4: RELATIONSHIPS BETWEEN CALVING DIFFICULTIES AND COMPONENTS OF CALVING ABILITY.

(The values of heterosis, heritability and correlations referred to are those found in various french experiments).

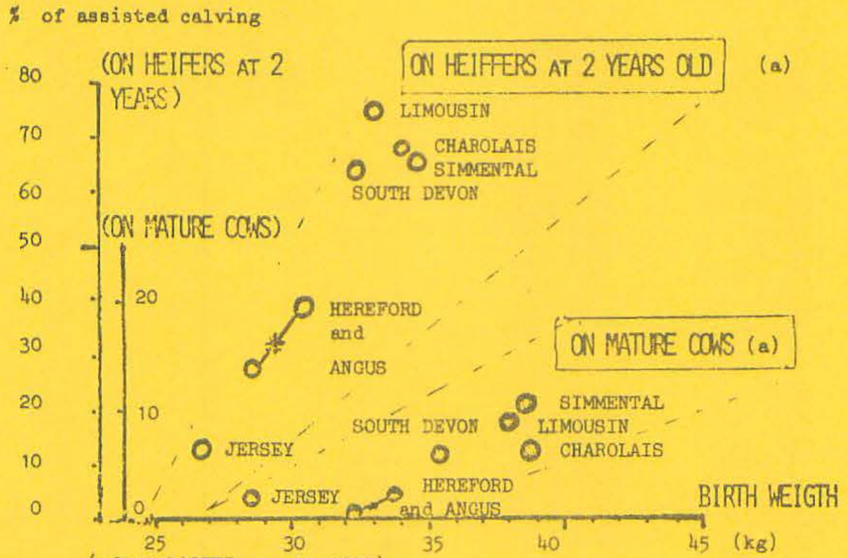


* Direct effect = Effect of the *genes transmitted to the calf* by its parents.

* Maternal (Indirect effect) = Effect of *dam genotype on its progeny*.

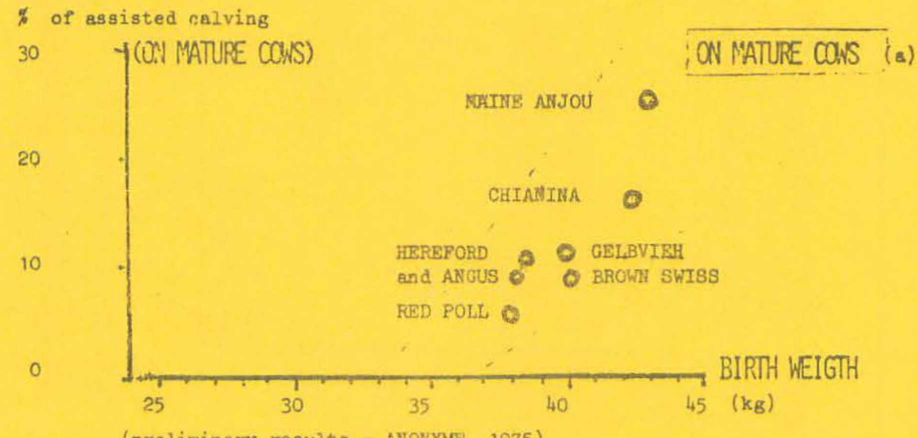
FIGURE 5 : COMPARISON OF CALVING DIFFICULTIES FOR VARIOUS PATERNAL BREEDS (paternal components): ("Germ Plasm Evaluation Program, U.S. Meat Animal Research Center, Clay-Center, NEBRASKA).

a)- 1st phase



(after LASTER et al., 1973)

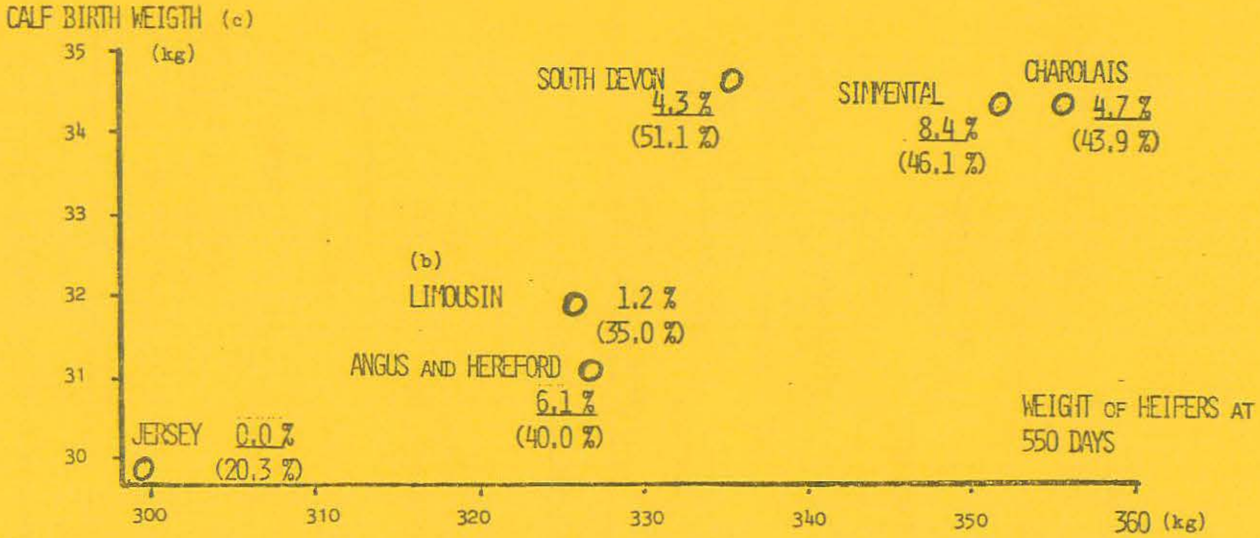
b)- 2nd phase.



(preliminary results - ANONYME, 1975)

(a) : Angus or Hereford Dams.

FIGURE 6 : COMPARAISON OF MATERNAL COMPONENTS OF CALVING ABILITY FOR VARIOUS BREEDS : Crossbred heifers (a) with first calving at 2 years (according to results of "Germ Plasm Evolution Program " - U.S. Meat Animal Research Center, Clay Center - NEBRASKA) - (ANONYME, 1975).



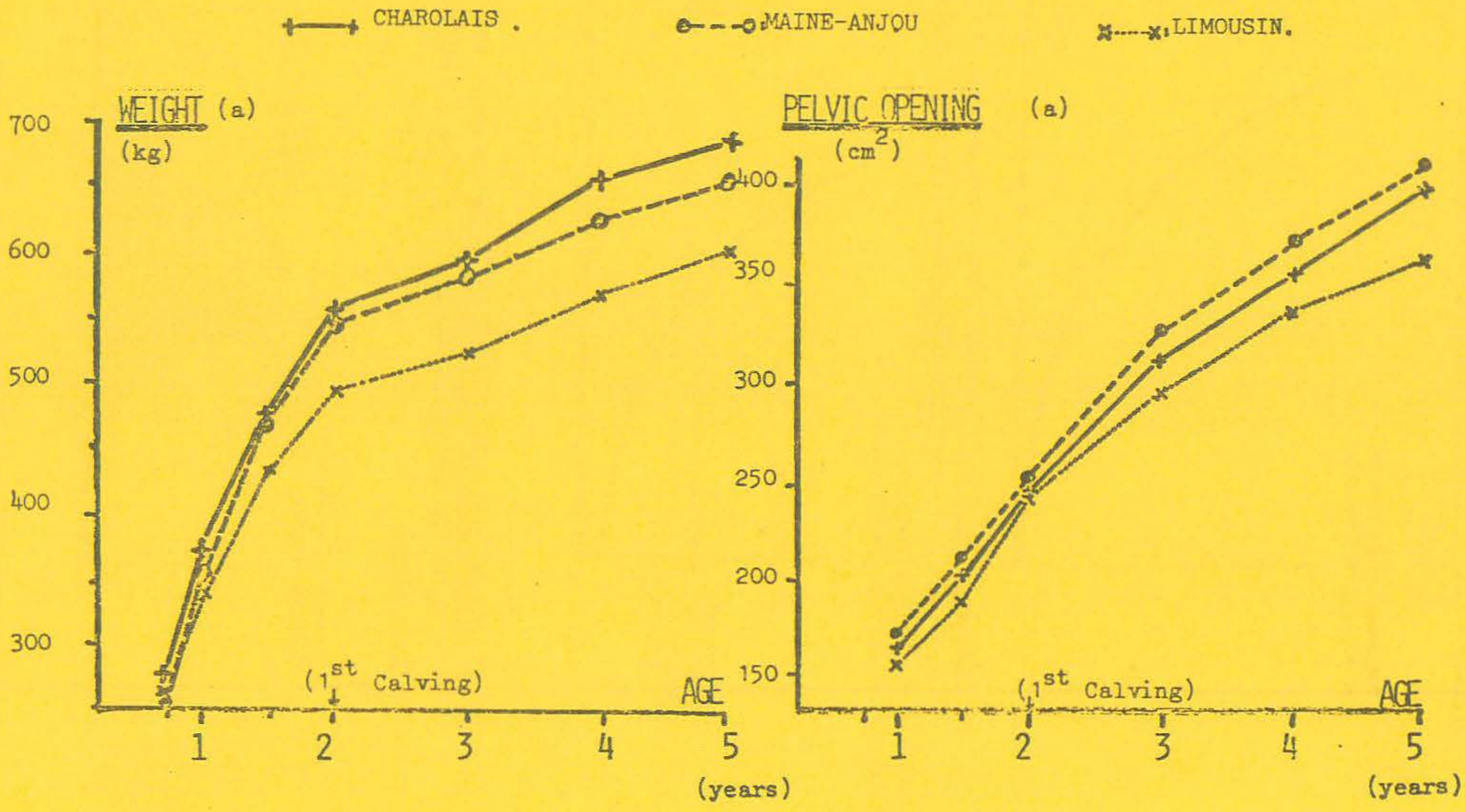
(a) : Angus or Hereford Dam Breed ;

(b) : Adjusted results of 3 calf crops (1972-74) : sire breed, 1st figure = % of calving requiring caesarian, 2nd figure = % of calving with difficulty.

(c): all calves are sired by Brahman, Devon or Holstein.

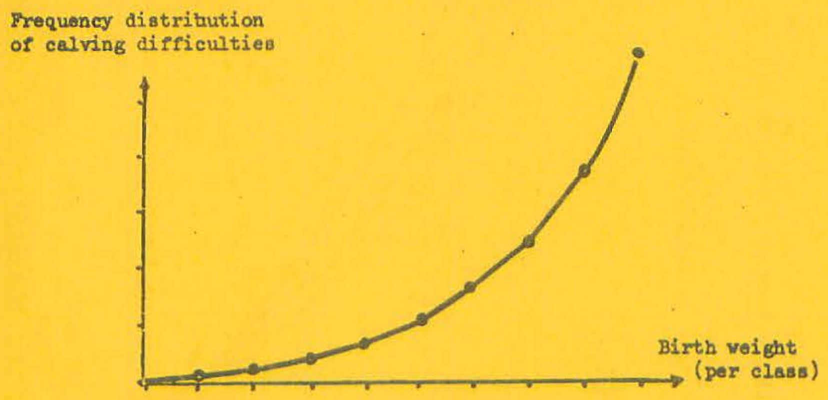
FIGURE 7 : WEIGHT AND PELVIC OPENING, ACCORDING TO AGE : FEMALES FROM THREE FRENCH BEEF BREEDS.

(Crossebreeding Experiment with french beef breeds - INRA) (unpublished data).

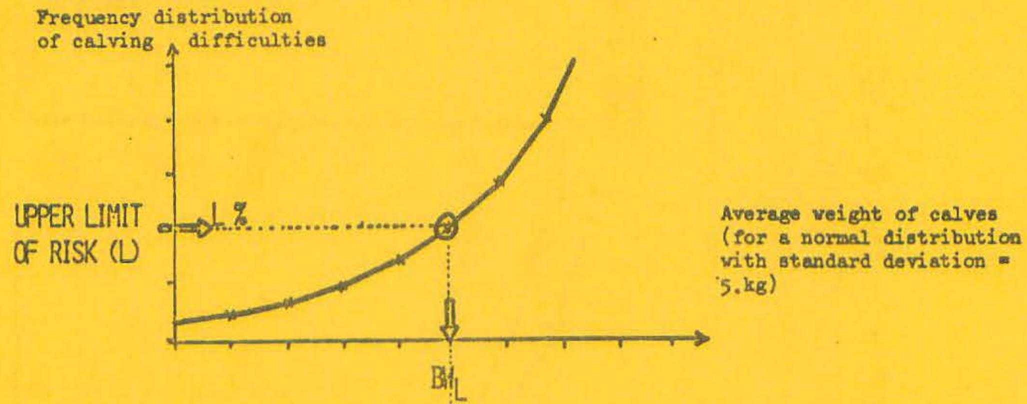


(a) : after calving, from two year old heifers.

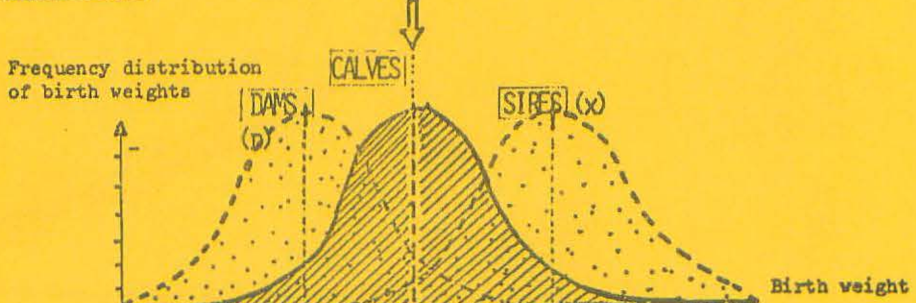
FIGURE 8 : FINDING A PATERNAL BREED IN ORDER TO OBTAIN A FIXED RATE OF CALVING DIFFICULTIES :



A - FINDING THE RELATIONSHIP between birth weight and rate of calving difficulties (probability of a difficult calving for a fixed individual birth weight).

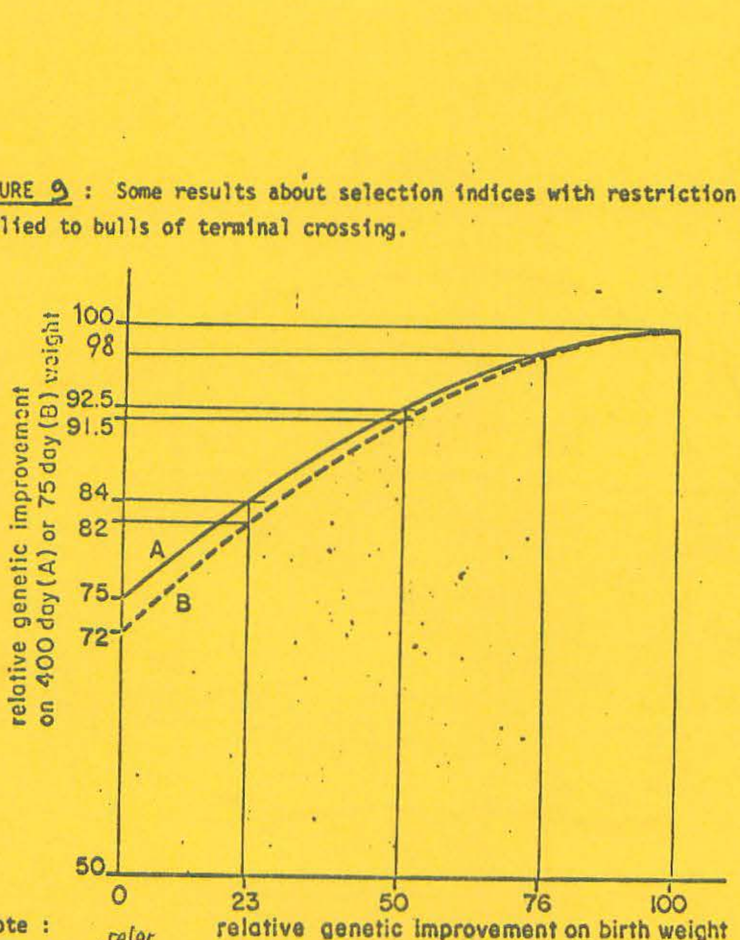


B - FINDING THE UPPER LIMIT OF BIRTH WEIGHT BW_L to remain under the acceptable level of calving difficulties (L) (probability of a calving difficulty for a fixed average birth weight)



C - FINDING THE PATERNAL BREED (X) OF average birth weight (BW_X), BW_X is such that :
$BW_L = (BW_X + BW_D) + (BW_D - BW_X) / 10.$

FIGURE 9 : Some results about selection indices with restriction on birth weight applied to bulls of terminal crossing.



Note :

-The curves refer to two situations of selection :

(A) selection for 400 day-weight after progeny-test in station with 20 progeny per bull;

(B) selection for 75 day-weight after field progeny-test with 60 progeny per bull (FOULLEY and MENISSIER, 1975).

-The absolute expected responses (value 100) are for one generation of selection of bulls with a standardized selection differential of one :

. 0.67 and 1.32kg for birth weight in (A) and (B) respectively ;
.15.84 and 5.14kg for 400 day-weight (A) and 75 day-weight (B) respectively.

-The coefficients (K) to apply to birth weight (BW) relatively to final weight (FW;400 or 75 day-weight) in selection indices (I=FW+K.BW) are in these two situations

.(A): -5.40 ; -3.95 ; -2.43 ; -0.83 and 0.88 for relative genetic improvement on birth weight of 0 ; 23 ; 50 ; 76 and 100p.100 respectively ;

.(B): -1.75 ; -1.37 ; -0.92 ; -0.36 and 0.35 respectively in the same conditions.

-Parameters used in (A)

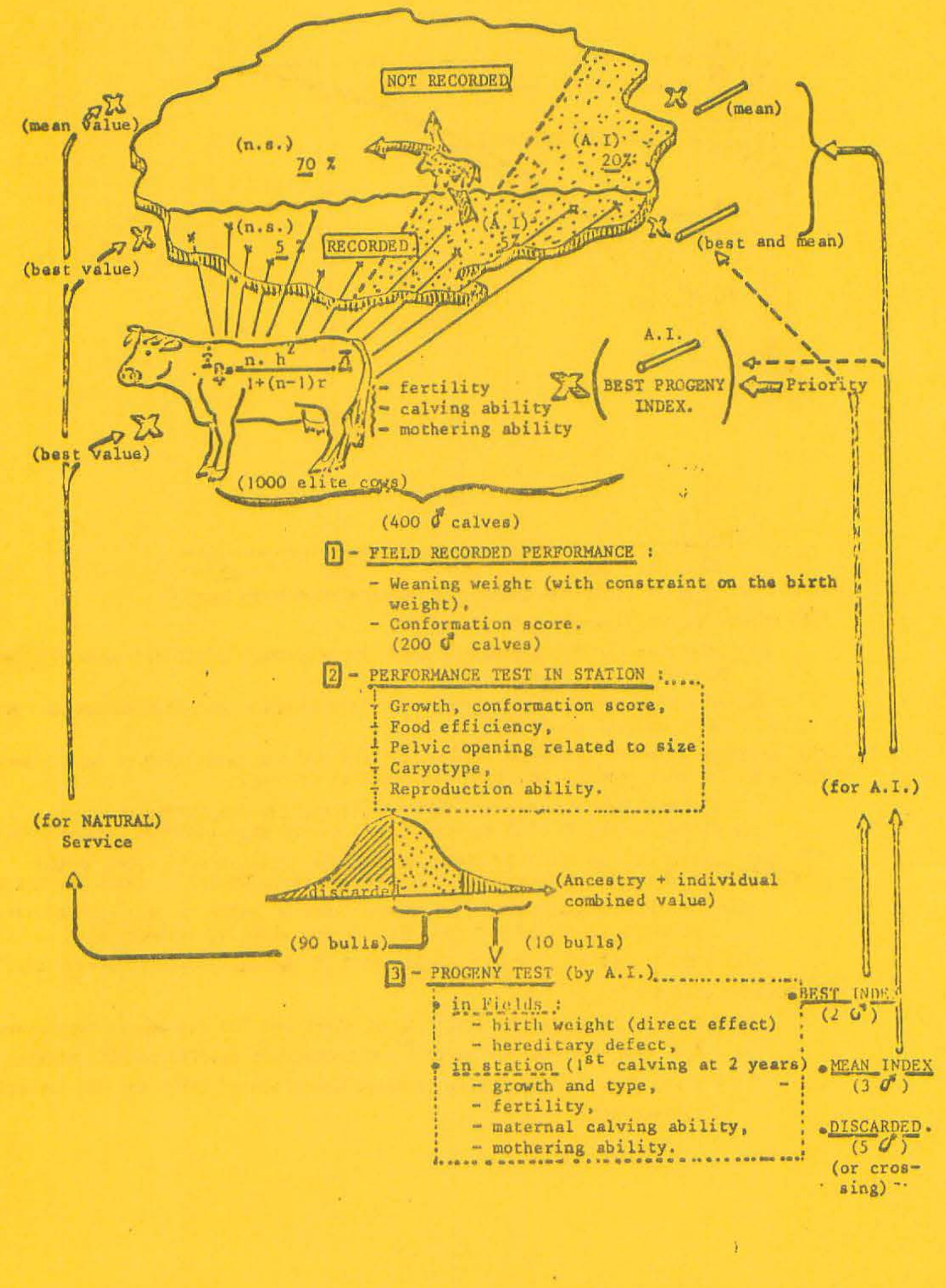
.h^2 = 0.10 and 0.40 for heritability of birth and 400 day-weight respectively;

.rg = 0.45 and rp= 0.09 for genetic and phenotypic coefficient of correlation;

.σp = 5 and 30kg for phenotypic standard deviation of birth and 400 day-weight respectively.

FIGURE 10

INTEGRATED SELECTION SCHEME FOR BEEF BREEDS IN BEEF HERDS : (as example)



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WHAT PERFORMANCE RECORDS CAN DO FOR THE COWMAN

Jim Glenn, Iowa Beef Improvement Association

Don't forget where you come from! Don't forget who you're going through the exercise for! I'll forever remember Clarence Burch at the first BIF organizational meeting when he stood up and said "Look at me, I'm the guy you're trying to save!"

I say look at me! I'm the commercial cow man you're all trying to save. And not doing a very damn good job I might add! I've earned the right to tell you what's what. I've paid my money and I've played the game.

Keep your program geared to the commercial man. If you can't produce a yearling bull for $500 at today's cost - you may want to consider another business. With the price of breeding animals established at or below production costs, we obviously have too many people in the business.

After listening to all these doctors I thought you were ready for the common touch. I felt we should have someone here representing the commercial end of business. Really the men who pay your bills! It seems to me that beef cattle genetic engineers too many times take their clientel for granted. I plan to tell you a little about performance testing beef cattle-especially as it has evolved in Iowa. Basically it comes back to the old adage: you don't get something for nothing.

In our case, successful performance testing started with promotion. When you talk about beef cattle performance testing and mention Iowa - the next word is de Baca. Bob de Baca with help from pioneering breeders and extension personnel promoted the concept, did the work and we are now measuring the results. de Baca built what is probably the strongest commercial bull market in America. I mean commercial cattle producers who believe in the program and are willing to pay for a top product. Bob did the job through extension meetings and promotion, personal visits to breeders and buyers and getting other extension people and breeders to carry the word. I happen to be one of these people who saw the light and became a believer. Bob started the IBIA Newsletter and built it into one of the most effective promotional devices in performance testing circles.

Let me talk about performance records and what they can do for you. I'll show you some examples of people who have advanced the performance in their beef herds and in their bank accounts.

1. First we have a typical Hereford operation in Montana. Analyzing the records we see that most of the progress has come in prices, second in weaning weights and little change in test gains.
2. Next let's look at a typical Angus operation in South Dakota. The trends parallel those in the Hereford herd.
3. Now let's look at performance over the years at test stations in Montana and Iowa.

It soon becomes apparent that measuring genetic trend over years is a very difficult procedure. In visiting with Garrold Parks, I was informed of a procedure that Pioneer is using to evaluate genetic improvement for yearling weights. Sons are compared with sires on a within year basis. I have an example showing two of the breeds Pioneer is working with. You'll notice that this procedure is not perfect but it does give some credibility to the rolling generations concept. Whereas looking at raw data across years usually proves futile in trying to draw conclusions concerning genetic progress.

We've seen two herds that have progressed genetically and advanced their prices through the auction method. I would like to show a couple of different types of pricing methods used by two herds in Iowa. First the Pioneer herd - where every bull is individually priced - based primarily on his yearling weight ratio. Bulls are sold by advance orders based on end point ratios. The second example is Nichols Farms - bulls are grouped at weaning time according to weaning weight and projected yearling weights. Bulls are sold individually when the first gain data is available.

Here's what you can do with performance records.

1. You can build a beautiful cow herd.
   a. They won't all look alike; there'll be big ones, tall ones and short ones, thin ones and fat ones. In a commercial herd they'll be all colors of the rainbow.
   b. Keeping in mind that economic considerations overshadow all the careful planning of breeding programs. (How many herds do you know that have been wiped out by cash flow problems?) With this in mind you can build a sound economic unit which will be the most competitive possible within the boundaries imposed by biological and national economic conditions.

2. For the purebred breeder - performance records

when combined with a suave nature, a bearing of cowboy aristocracy and a whole bunch of bullshit can make your cattle bring tears of happiness to the eyes of your banker. (Bucket of cow pies is the essential ingredient for success in the cattle business - breeding division.)

3. Let me show you how the sire effects the performance of the cow herd when you're really rolling generations. I got this chart out of a sheep book, but I suppose it works the same way for cattle. New performance is really added every generation so the procedure really starts all over with each new set of bulls.

4. Performance records will make you a better manager. They provide an additional tool to spot management mistakes.

Let's also consider what performance records will not do for you.

1. They will not make your cattle better! You must do that through selection based on the records available.

2. They will not guarantee better records every year. You may improve genotype but not phenotype. Negative environmental influences can hold measurable progress back - just as positive environmental influences can make progress seem to be faster than it really is.

3. Breeders should be careful not to oversell performance (especially environmental differences) and having buyers expecting more from their cattle than they can ever possibly realize. We in Iowa are just as guilty of this as anyone.

4. Commercial cow men are being conned into thinking they can get all the performance they want by straight breeding cattle. I am observing a straightbred revolution in cow country. I hope breeders are not under-cutting the economic necessity of heterosis to the cattle industry.

Don't forget who you're trying to save!

BEEF COW EFFICIENCY

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Efficiency is the ratio of input to output or vice versa. Animal scientists have most commonly used the ratio $\frac{\text{feed}}{\text{gain}}$ as it can be expressed as the amount of nutrients required per unit or hundred units of product. For example, one steer may require 800 units of feed per one hundred units of gain, while another may require 900. The former is the most efficient. The problem with this ratio is its negative association with rate of gain and some other desirable traits. The inverse ratio $\frac{\text{gain}}{\text{feed}}$ can also be used and is preferred by some because a high figure is desirable and this ratio is often positively associated with other desirable traits. In the example used earlier, the latter ratio would be expressed as the production 12.5 units of product per 100 units of feed and the steer requiring 900 units of feed per 100 units of product would produce 11.1 units of product per 100 units of feed. The merits of these ratios and other measures of efficiency have been discussed in various publications.

There are an infinite number of expressions of cow efficiency. What should be the product considered -- weaned calf or calves, slaughter steers, carcass beef, wholesale cuts, trimmed retail cuts, total edible nutrients or total product value? Should the cow as a salable product be included? What inputs should be included -- the feed intake of the cow from the time of her birth to the time of weaning one or more calves plus the feed consumed by one or more progeny from birth to weaning or slaughter? Various economic weightings could be applied to both input and output items.

In order to decide which traits to include in a selection program, information as to the following is needed:

(1) Is the trait measureable in the population of animals to be considered for selection?
(2) The variability of the trait and the proportion of the variation that is heritable.
(3) The genetic and phenotypic correlations between this trait and others.
(4) The value of the trait relative to others.

Individual animal feed intake is seldom measured under farm and ranch conditions; as a result, feed efficiency is not a measured trait. Measures of the trait have not often been made at experiment stations. Data on dry lot feeding of the cow-calf unit for long periods of time are not generally available.

Ohio, Oklahoma, Purdue, South Dakota, Texas A & M, Wisconsin, and a few other stations have measured feed intake and product production on relatively few cattle and for varying lengths of the cow's life time.

Because of the paucity of the data, heritability estimates are not available and the possibility of getting genetic correlations that are meaningful is extremely remote.

"Cow efficiency" is a valuable trait as it is a major component in the index for net merit. The value of efficiency relative to other traits can be determined but the relative value of traits is not static. In the recent past, econmic values concerned with the cow-calf enterprise have fluctuated widely, but more on that later.

The conclusion reached in regard to selection for cow efficiency must be that since it is not measured on individual females, selection for it directly is not possible. Since genetic correlations are not known, the traits associated with cow efficiency cannot be accurately incorporated into a selection index.

Repeatability estimates could be used instead of heritability estimates in establishing a selection index, but again, there is the problem of not having the measurement and not knowing the repeatability of the trait.

There is some rationality in selecting for traits that are phenotypically correlated with cow efficiency. One must be willing to assume that the sign and size of the phenotypic correlation is indicative of the sign and size of the genetic correlation. That may be a dangerous assumption.

Cow size, because of its relationship to rate of gain and the maintenance requirement, immediately comes to mind as a characteristic that must be related to efficiency. Milk production is another that could influence the weaning weight of the calf and therefore the denominator of the ratio $(\frac{feed}{wt.})$.

Considering the measures of size, it is most often measured by weight but it can also be measured in terms of height and length. Weight to the .60 to .75 power ($W^{.60}$, $W^{.75}$) is considered to be an expression of metabolic size. The maintenance requirement of the animal is related to metabolic size. Body weight is partially composed of fat which is not considered as metabolic tissue, but rather as a storage of energy.

Height at the withers of hooks seem to be fairly good measures of skeletal size and fat does not influence these measurements as much as it does weight.

Whichever measurements are chosen, the time of measurement will influence the degree of the relationship between the measure of cow size and efficiency.

Measures of efficiency can be related to cow size within breeds in determining whether large or small cows should be selected or the comparisons could be made between large and small breeds to determine the adaptability of the various breeds in differing environments.

There are some indications that optimal size may be influenced by climatic conditions and intensity of production so that answers obtained in one situation or part of the country may not be applicable in another. Large cows may have a thermodynamic advantage in a cold climate, whereas the opposite may be true in a warm climate. Large cows have less surface area per unit of weight and surface area is directly proportional to maintenance requirements.

In our experiments at the University of Wisconsin, we have used the feed consumption of the cow and calf from birth up to the weaning of 1, 2 and 3 calves. The weights of the calf or calves, plus the weight of the cow, multiplied by 4/7 (an economic weighting) were include in the numerator.

The data obtained from these individually ad lib fed Hereford and Holstein cows and their calves would warrant the following conclusions:

Reproductive performance influences efficiency more than any other factor associated with production. Within a breed, fast growing (larger) animals generally reach puberty at younger ages. Between breeds, the opposite may be true, although not always as the Holstein is an exception. In our data, Holsteins reach sexual maturity at about a year of age as compared to 15 months of age for the Hereford. Early sexual maturity could be exploited to increase efficiency since the feed consumption up to calving must be amortized over the calves produced.

When reproductive performance was excluded, there was little association between cow weight and efficiency. Heavier cows tended to wean larger calves than lighter weight cows, but they also consumed more feed. Fat cows were less efficient than thin cows. Cows that were taller at the withers were more efficient than shorter cows, although that association was not statistically significant.

Efficiency of gain of the heifer from weaning to 15 months of age positively related to her later efficiency as a cow in calf production. Be reminded, however, that this was a phenotypic correlation as were all of the others.

If selection is to be practiced for efficiency in the cow-calf system of production, the most effective, easily obtainable measure would be calf weight at weaning. It is estimated that 85 to 90% of differences in efficiency within a herd can be accounted for by the uncorrected weaning weight of the calf. The commercial producers profit is determined by the pounds of calf sold per cow. Differences between cows may be due to the calving date, the dam's milk production, and the calves' growth rate. Selecting the cows that have heavier calves will increase profit and cause some genetic improvement no matter what the cause of increased weaning weight.

The ratio of calf or calves weaning weight or cow weight to the .75 power ($CW^{.75}$) have been suggested as ratios to be used in selecting for efficiency. The assumption is that cow weight or $W^{.75}$ is related to her maintenance requirement.

Weight to the .75 power as compared to weight itself would favor heavier cows if the ratio is expressed as calf weight/cow weight. If selection to improve efficiency were to be practiced for any other trait, indications are that taller, thinner cows should be selected within the herd or breed under environmental conditions as they existed at the Wisconsin experiment station.

Post weaning gain would tend to favor the progeny from large cows since they grow faster and produce leaner beef at a given age or weight. If, however, the progeny were slaughtered at a constant grade or percentage of fat, there would be no difference in post weaning feed efficiency. There would be the additional efficiency accruing to the larger cattle in that more pounds of beef would be produced per cow per year and that part of economic input that is due to per head cost would be amortized over the larger amount of beef produced per progeny.

Comparisons of productive efficiency between breeds of differing sizes include at least two influences: those due to differences in size and those due to breed. The conclusions that are reached in the comparison between two breeds may not be valid in a comparison of two other breeds that are similar in size to the first two compared. In addition, the relationship that exists between size and efficiency within a breed may not apply between breeds. Breeds of similar mature size and growth rate may vary in the age at which they reach sexual maturity just as they may vary in the rate at which they approach maturity in any other measureable trait.

Feed efficiency was probably not a very significant factor in the decision to select for increased rate of gain. The demand for leaner meat and the rapid increase in per head costs (labor, taxes, vet bills, breeding costs, etc.) relative to feed costs were probably the two factors most responsible for present day selection for increased gain and size. The demand for leaner meat could result in marketing cattle of smaller size at lighter weights. This may not be economically sound when per head costs are increasing. The alternative would be producing larger cattle that will be leaner at heavier weights, and thereby amortizing the increasing per head costs over a greater amount of product. The per head costs, especially labor, are continuing to increase at all levels of the industry--on the farm, ranch, feed lot, at the packing plant. Per head costs per unit weight are less for the large than for the small animals.

In summary:

(1) Direct selection for efficiency is not possible because the trait is not measured.

(2) Because the genetic correlations between efficiency and other traits is not known, the traits to include in a selection index and their proper weighting is not known.

(3) Since efficiency is a ratio, it probably is advisable to select for one part of the ratio; for example, weaning weight or weaning weight over cow weight or cow weight $^{.75}$ since the other part of the ratio, feed consumption, is not known. Selection for increased weaning weight or increased rate of gain will probably not be detrimental to efficiency.

(4) Reproductive performance influences cow efficiency more than any other associated trait.

(5) Increase efficiency by breeding at a young age. Breeding at puberty under some management and crossbreeding systems may be recommended.

(6) Breeding as soon as possible postpartum, if year around calving is practical, would increase cow efficiency.

(7) The Wisconsin experiments indicate that there are genotype X environment interactions that could influence cow efficiency. This would mean that some breeds or crosses would be more efficient than others in differing environmental situations.

BEEF COW EFFICIENCY IS REPRODUCTION - OR ELSE!

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Any thrifty calf marketed is worh infinitely more than the best hoped-for calf which for some reason never materialized. With the high feed requirements of maintaining a breeding herd and a good price for cull cows, any mature cow which is neither carrying and/or nursing a calf should be marketed. The ratio of pounds of beef, including cow beef, sold to weight of beef maintained in the herd should be kept as high as possible.

A few good cows will produce a calf year after year. Unfortunately, reproduction is a lowly heritable trait and little progress can be expected through selection. What then is left for improvement where, at best, only limited selection is possible in the cow herd? Do individual cows differ in their maintenance requirements? What about size of cow, how much milk should she give? Experiments have been conducted at the Ohio Agricultural Research and Development Center (OARDC) to obtain information on these questions.

Maintenance

If cattle differ in their requirements for maintenance, this variation does not appear to be genetic. Per unit of metabolic weight ($W^{0.75}$), Hereford and Charolais cows did not differ significantly in amount of feed required to maintain constant weight. However, fat cows required less feed per unit of weight than thin cows. A beef cow may vary widely in weight depending upon her condition, a variation which may be greater than the actual variation in maintenance needs of that individual. If, for example, a 1,000 pound cow is fattened to 1,200 pounds and then fed as a 1,200 pound cow she is likely to continue to gain weight. If, however, she is starved to 800 pounds and then fed as an 800 pound animal, she is likely to continue to lose weight.

Does the so-called "easy-keeping" cow have a lower maintenance requirement or does she eat more than her share of feed? I suspect the latter may be true. Research with growing-finishing cattle at OARDC has shown that early maturing types of cattle eat more feed per unit of weight than later maturing types. This suggests that the early maturing type of cow, which tends to fatten on good quality forage, may have the appetite to comsume feed and remain thrifty on a lower quality forage than the later maturing type of cow.

Cow Size

An experiment was conducted at OARDC to measure the total feed efficiency of beef cows of different sizes and breeds. Individual feed consumption records of cows for a full year and their calves to choice slaughter condition were obtained during a 4-year period for 133 cow-calf pairs. Milk production of the cows and weights, gains, and carcass data of their calves were recorded. These included Hereford, Hereford x Angus, Hereford x Charolais and Charolais cows varying in size. One-half of the cows of each breed were bred to Hereford bulls and the other half to Charolais bulls.

The results obtained were studied according to three weight classes with the effects of breed removed and according to breed with effects of weight class removed. Some cows of all breeds were included in each of the weight classes which averaged 874, 1022 and 1210 pounds. The heavier cows had greater weight-to-height ratios (a measure of condition) and weaned significantly heavier calves. They required more total feed and their calves ate more feed prior to weaning. The differences among weight classes in total digestible nutrients (TDN) required per pound of weaning weight were small. Differences in post-weaning performance were not significant among weight classes, but calves from the larger cows produced carcasses which were significantly heavier. Hereford x Angus cross cows produced the most milk, weaned the heaviest calves and required the least TDN per pound of weaning weight. However, their calves were the least efficient on feed post-weaning.

Differences in carcass traits among calves out of the cow breeds were significant at the 5 percent level. Calves from the Hereford x Angus cross cows graded one-third grade higher than those from Charolais cows and were two weeks younger at slaughter. Net efficiency (total TDN consumed by the cow and calf divided by pounds of edible portion produced) tended to be similar for all sizes and breeds of cows as there were no significant differences among them in this trait. Irrespective of condition as it affects cow weight, calf production by cows of different sizes appears to be in proportion to the size of the cow. Thus, size of cow per se seems to be of minor importance in calf production.

In these experiments, only 13 percent of the metabolizable energy fed to the cow and calf was recovered as net energy in the calf at slaughter. Thus, 87 percent was required for maintenance and other non-productive functions. These data include only those cow-calf pairs which completed the experiment and hence are based on a 100 percent calf crop slaughtered. Actual efficiency of production is somewhat lower than this and emphasizes the importance of culling non-productive cows from the herd.

Maturing Rate

Rate of growth has been highly emphasized as an important production trait in beef cattle. However, the relationship between growth rate and efficiency of feed utilization among cattle of various types and sizes fed to similar carcass grade or degree of finish has not been significant. The important difference among individual cattle is not their rate of absolute gain but rather their rate of gain per unit of weight, relative gain. When fed to a constant grade, there is a highly significant relationship between relative gain and feed efficiency.

Feed-lot studies at OARDC and elsewhere have shown that earlier maturing types of cattle (small vs. large or heifers vs. bulls) eat more feed per unit of weight and finish at younger ages and lighter weights than later maturing types. The market generally prefers a certain degree of finish and discounts those cattle which are underfinished or overfinished. Excessive finish can easily be avoided by slaughtering when the cattle are ready, however, undermaturing becomes an important trait in beef cattle.

C. F. Parker at OARDC has derived a measure of maturing rate from an expression of relative gain as follows:

$$\frac{\text{Weight per day of age}}{\text{Slaughter weight}} \div \text{Slaughter weight}$$

which reduces to: $\frac{1}{\text{Age of slaughter}}$

This function measures rate of growth relative to the body weight at which time the desired degree of finish is attained.

Feed consumption data obtained in the cow-size experiment, where calves were fed to a constant low choice grade, were used to correlate the term 1/Age at slaughter with feed efficiency. The correlation between this term and total TDN consumed by the cow and calf was -0.52, indicating that animals with faster rates of maturity were more efficient. This relationship was highest with TDN required by the calf on feed following weaning ($r = -0.63$) and less ($r = -0.22$) with TDN required by the cow. This expression of maturing rate simply means that those cattle which produce the most carcass weight of the desired grade at the youngest age are the most efficient.

Weaning Weight Ratio

The ratio of a calf's weaning weight to the weight of its dam is often considered as a measure of cow efficiency. The relationship between this ratio and weaning weight was also studied using the cow-size data. A highly significant correlation of 0.48 was found suggesting that selection for this ratio would lead to heavier calves at weaning. However, when a ratio containing a certain trait, weaning wt./cow wt., is related to that same trait, weaning weight, there is an error in estimating the true relationship which may exist. When the effect of this error was removed, the correlation between this ratio, weaning weight/cow weight and weaning weight was found to be -0.20. This negative correlation indicates that selection for weaning weight ratio would lead to lighter calves by giving the advantage to the smaller cows in the herd. This advantage could be explained by the fact that the smaller cows in a herd are always being mated to a bull which is proportionately larger than they are as compared to the larger cows being mated to the same bull in that breeding unit.

Milk Production

With the selection for growth and introduction of new breeds of large size, the question has been raised as to how much milk a beef cow should give. Weaning weight of a calf is increased with increased milk production of its dam up to a rather high level.

However, extremely high levels of milk production may not be consistant with total feed costs if such milk yields produce thin cows which require special feed and management during the dry period in order to breed back the following year. Conversely, an overly fat cow at weaning time has not produced as much milk as she should. Therefore, a beef cow should give the amount of milk which, with a feed supply normal for the region, will leave her in strong, thrifty condition at weaning time. Year-to-year feed supplies vary widely from desert ranges to lush irrigated pastures or Corn Belt farms. Thus, the milk production expected from cow herds managed under these different conditions should also vary.

Reproduction

As implied by the title of this paper, reproduction may not be the only thing of importance to the cow-calf man but it is certainly way ahead of whatever is second. And, whatever is second is difficult to determine. Differences in maintenance requirements among individual cows appear to be small. Size of calf produced is in proportion to the size of cow, hence, size of cow in itself is of minor importance. Weaning weight ratio tends to favor the smaller cow and may lead to lighter, average weaning weights. Milk production may be overemphasized to the detriment of reproduction and should vary with local feed conditions. Unfortunately, little or no progress can be expected in reproductive rate through selection.

Keep Replacements!

Any mature cow which is neither carrying and/or nursing a thrifty calf should be marketed for beef. Any attempt to evaluate the individual cow may overemphasize her importance and lead to the temptation to keep her whether she is producing or not. As shown in Table 1, it would be a very unusual, open, mature cow that could catch up to a bred cow of the same age.

Table 1
Anticipated Average Future Annual Calf Weights from Bred Versus Open Cows*

		Expected Annual Production in Calf Weights	
Age in Fall	Calving Seasons Ahead	Bred Cows	Cows Open that Fall
1	9	352	318
2	8	357	315
3	7	360	308
4	6	360	298
5	5	358	282
6	4	352	258
7	3	344	218
8	2	327	154
9	1	307	0
10	0	0	0

* From Stonaker, 1958, Colo. Bull. 501-S

On the other hand, Table 1 indicates that an open, young, immature cow has a better chance of catching up with a bred, older cow. Also, she is still growing and producing cow beef. Once a cow is mature, all she can produce is a calf.

Heifers will reproduce prior to maturity and thus, through growth, add weight to their own body while producing a calf.

Therefore, feed costs of producing beef, cow beef and feeder calves, can be reduced by combining reproduction with the growth of immature cows.

As a heifer grows to maturity she increases in weight which increases her feed requirements for maintenance. Data in Table 2 were obtained from a Hereford-Charolais crossbreeding experiment in which heifers were bred first as yearlings and were kept on experiment for three calf-crops. One-half of the calves were creep-fed, hence, the creep feed requirements listed are averages of those which did and did not receive creep feed. As expected, weaning weight of calf increased with age. However, as the heifers weight increased their feed requirements increased at a faster rate such that TDN required per pound of calf weight increased with age of dam. At the same time, these immature cows were producing cow beef which is a merchantable product. These data question the importance of longevity as a measure of cow efficiency.

Another advantage of keeping a high proportion of replacement heifers is that it shortens the generation interval. If improvement is made through the sire, where selection is possible, a faster turn-over of the females will result in a more rapid improvement of the total herd.

It is true that keeping replacements and calving two-year olds will increase the quality of feed and management practices required. Unfortunately, most improvements in production demand a higher level of management.

Beef Cow Efficiency - Forget It!

With only limited selection possible at best and no clear-cut trait for selection, any female of breeding age which is not reproducing should be marketed for beef. The owner of a cow herd has two sources of income - the sale of calves and the sale of cull breeding animals. Keep the total pounds sold in proportion to the pounds maintained in the herd as high as possible.

Table 2

Total Digestible Nutrients Required Per Pound of Weaning Weight by Two, Three and Four Year Old Cows (Average of Approximately 50 Hereford and 50 Charolais)

	Age at calving, years		
	2	3	4
		Pounds	
TDN required per head to:			
Winter cow	1160	1508	1872
Pasture cow	1640	1896	2233
Pasture calf	872	964	1029
Creep feed	244	222	207
Total TDN	3916	4590	5341
Percent of 2 yr. old		117	136
Weaning weight	513	526	549
TDN/weaning weight	7.63	8.73	9.73
Percent of 2 yr. old		114	128
Avg. cow weight	904	1006	1087
Gain		102	81

RELATIONSHIPS OF SIZE, MATURING RATE, MILK PRODUCTION AND NET LIFETIME FERTILITY TO COW EFFICIENCY

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The cow is usually finally slaughtered for beef, but her primary function which relates to cow efficiency is her part in the production chain of producing weanling calves. This function is intimately tied up with the total production system and must be considered in relation to production efficiency. The efficiency of beef cattle production systems is very complex and involved and is usually best appreciated when stated in terms of income in relation to expenses or dollars; this is usually called profitability. Since the output of a production system is cattle and the major input is nutrition the following ratio, which I call Productivity, is closely related to profitability:

$$\text{PRODUCTIVITY} = \frac{\text{Liveweight Output}}{\text{Nutrient Input}} = \frac{\text{Cull Cows and Bulls, Steers and Excess Heifers}}{\text{Nutrients Consumed}}$$

The denomination of Productivity is in terms of nutrients whereas for profitability it is in dollars. Of course the liveweight of the steers and heifers is worth more per pound than of the cull cattle. Nutrient expenses include land (pasture or range), fencing, fertilizer, weed control, hay, protein supplement, and the equipment and labor used for feeding.

In order to examine the cause and effect relationships affecting the Productivity of cattle we must consider the characteristics of the cattle and the total production system. The genetic characters of cattle which have the predominant effect on Productivity are:

Size
Maturing Rate
Milk Production
Net Lifetime Fertility

These characters may best be thought of in terms of genetic potential (for example, the milking potential of Holstein vs. Hereford) as well as in terms of their correlations with other characters (for example, the correlation between yearling weight and mature size which is quite close).

Trends for size in cattle have changed with the times since Robert Bakewell demonstrated in England during the late 1700's that livestock could be changed by selection. Size is highly heritable; we can push it up or down relatively easily either by selection of breeds or selection within breeds. Of course, it is a lot faster to select a breed that is already formed and fits the desired size (thus, one reason for the exotics). It appears from a review of history that the reason for changes in size has been to control finish at desired weights more than for any other purpose. That is, much of the selection which has resulted in making cattle breeds larger or smaller has been indirect in that it has been directed toward controlling finishing qualities at various sizes. At last year's BIF meeting Fitzhugh (1975) explained the relationship between size and gaining ability as well as the effects of size on rearing costs, maintenance costs, age and weight at puberty, and optimal slaughter weight. The relationship of size and milk production and fertility will be discussed below. Size may be considered the single most important character in cattle.

Increased size brings increased growth rate but may have little if any effect, or even adverse effect, on Productivity. The rate at which mature size is approached must also be considered. Unlike shear size or weight, maturing rate is difficult to change genetically and the bounds or limits are narrow compared to weight. (Again, refer to the talk by Fitzhugh, 1975.)

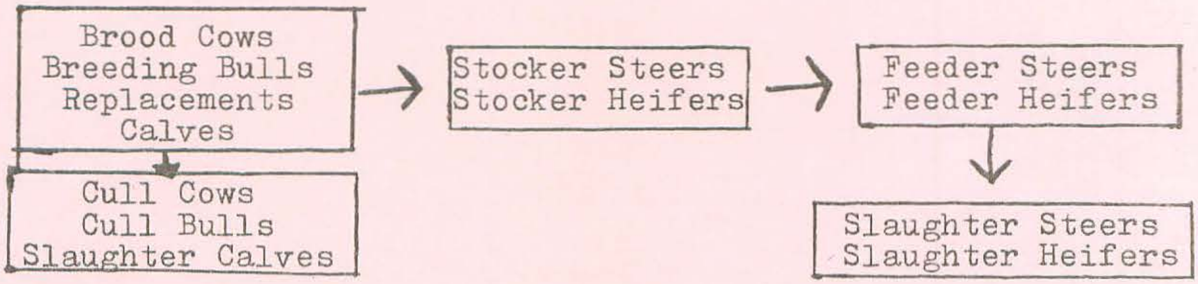
Milk production is another predominant genetic character and, like size, we can change it by selection to any reasonable level desired by beef cattle producers. Again, it is quicker to change it by selection of or crossing with a breed with the desired level, but it can be done by selection within breeds also. Our ideas of the best level for milk production have changed from time to time, like size, in response to the changing demands and ideas of different times.

Net lifetime fertility is used here to mean the number of weaning calves produced by a cow in relation to her lifetime in the herd (no. calves/age of cow when culled). This measure accounts for the time required to raise the heifer until she calves (which is usually expensive in terms of nutrients for two or more years), her annual conception rate, ability to carry to term and deliver a live calf, ability to suckle, and her productive longevity. Losing a calf is much more of an economic loss than failure to conceive. Fertility is so much affected by the health and physiological status of the cow and heifer that it is difficult to sort out a separate genetic component except that which is associated with nutrient requirements for growth, maintenance and milk production. Calving ability and longevity are probably the clearest genetic components but these are also complicated.

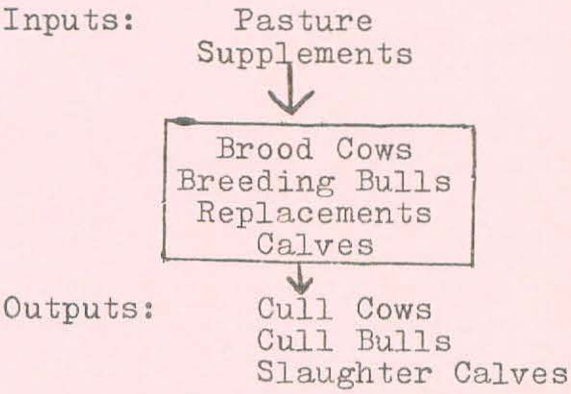
The Productivity of cattle is largely a function of these four genetic characters, but the level of each character (for example size, milk production) which is most productive must be determined in relation to the production conditions.

Changing one input component or genetic character affects other components. For example if the milk production potential of cattle is increased through selection for heavier weaning weight or by infusion of a dairy breed, then the nutrition, reproduction and composition of the offtake should be expected to change also.

These relationships require that Productivity be examined for the entire production process, not just the calf production or just the finishing phases. The phases of production may be conveniently divided as follows (the arrows indicate flow of cattle):



The first block represents the brood herd where all cattle are generated and is the most important component. The inputs and outputs and the traits that are most important to consider are given below:



Important Traits

Cow Size
Net Lifetime Fertility
Milk Production
Calf Size (Gainability)
Maturing Rates of
Heifers and Sale Calves

The stocker phase is generally much less complicated:

Inputs: Pasture
Supplements
↓
Stocker Steers
Stocker Heifers
↓
Outputs: Weight Gain
Condition Gain

Important Traits

Size (Gainability)
Maturing Rate

The finishing phase has been almost entirely in separate feedlots in recent years; however, there is current interest in greater utilization of pasture especially in the Southeast. This phase is shown below:

Inputs: Harvested Feeds
Pasture
↓
Feeder Steers
Feeder Heifers
↓
Outputs: Weight Gain
Increased Grade

Important Traits

Size (Gainability)
Maturing Rate (Grading Ability)

In order to examine the balance of the predominant characters which tend toward maximal Productivity for a given production situation we have resorted to systems analysis which takes into account relationships of these characters as well as the entire chain of the production process. This technique is a method of simulating actual production.

The best size cow has been a controversial issue as long as I can remember. One reason is because there is no one best size; it depends on a number of conditions some of which change with the market (cost of feed vs. price of cattle) such as we have seen demonstrated during 1973-74-75. Another reason is that the trade-offs related to size tend to balance out; as cow size increases feed costs required to raise heifers and maintain cows increase while the size and value (gainability) of their calves increases. Simulations of beef production systems utilizing small (950 lb. fully mature weight), medium (1100 lb.) and large (1325 lb.) straighbred cows yielded results which were almost identical in efficiency or profitability under one set of fixed conditions; under another set of conditions the larger cattle were more profitable but only slightly more so (Long, Cartwright and Fitzhugh, 1975). These results indicate that there is a broad range of sizes similar in Productivity.

Nonetheless, size is a most important character because it relates to other characters. Results of simulations which illustrate the relationships between fertility level, nutritional level and size are shown in tables 1 and 2 (Sanders and Cartwright, 1976).

These simulations are for specific sets of conditions and are presented to illustrate the relationships. Table 1 illustrates the effect of past level of nutritional (which is reflected by weight at about one year of age, 360 days) and present level of nutritional (which is reflected by daily gain) on conception rate; genetic potential for mature size is the same, 1058 lb. in good condition, for all weights. Table 2 illustrates the effect of the other variable, genetic potential for mature size, by holding weight and gain constant while the size potential is varied from 948 lb. up to 1169 lb. Even over this rather small range of size, conception rate is again greatly affected. This table does not imply that larger cattle have a lower fertility potential. These figures illustrate that the balance of characters which tend toward maximal Productivity must be considered in relation to the nutritional level and other production conditions. (Also, they illustrate the necessity of good husbandry; larger cattle at any stage of maturity need more feed.)

During the lactation or suckling period the nutrient requirements of cows increase substantially depending especially on level of milk production but also on size and stage of maturity. For a managed East or Central Texas operation, we found that an optimal or intermediate level of milk resulted in maximal Productivity and that this optimal level depended on size of cow. That is, when the tradeoffs of fertility level, calf weight, etc. are taken into account, too much or too little milk production potential for the size of cow lowered overall herd Productivity. The relationship between milk production potential and size of cow can vary depending on the exact conditions. For one set of conditions we examined, (Sanders, 1976) the optimal levels were approximately as follows:

Weight of fully mature cow in good condition, lb.	Optimal level of maximum daily milk production at peak production of fully mature cow, lb.
800	12 to 13
1000	15 to 16
1200	18 to 19

These estimates are presented to illustrate the relationship and not as general recommendations. Again the range of levels of milk production which are similar in Productivity is probably fairly broad.

The relationships of size, maturing rate, milk production and net fertility to Productivity also lead to an increased understanding of the value of hybrid vigor in cattle and the use of crossbreeding systems. A hybrid or crossbred is expected to be a blend or average of the characteristics of its sire and dam; however, the first cross (F_1) is usually a little above or better than average for most characters. The F_1 gains its advantage in Productivity, at least in part, from the fact that it tends to be more vigorous and matures more quickly. Crossbreeding systems can be planned so that the sire breed and dam breed can be matched so as to take as much advantage as possible of having the mix or blance of characters desired in the brood cow, the most important component of the production chain, and then getting the best mix of or balance of characters in the sale progeny through the sire; i.e. using complementarity or matching the characteristics of the dam breed with those of the sire breed so that they complement one another.

Summary and Conclusion

Size, maturing rate, milk production and net lifetime fertility are the predominant genetic characters which affect productivity of the cow. These characters are important themselves but are also important because of the effect, or relationship, each has with a number of other characters. There is no evidence to support the idea that continuous selection to increase any single character will continuously increase productivity. Instead, maximal productivity results from an optimal balance of traits. The best balance of traits depends on specific production and market conditions; these conditions may change from place to place and from time to time.

The quickest way to attain a desirable balance may be through crossbreeding. Also, crossbreeding may provide a method of maintaining the optimal (best) balance of traits in the cow herd and in the slaughter calves. Selection objectives for cattle to be used in straightbreeding may be different from those to be used in crossbreeding. The efficiency of a cow can not be evaluated without also considering her sire mate (or the breed type of her calf).

There is no single trait measured on cows which is a satisfactory indicator of efficiency. The most efficient cow is one which is fitted to both the specific conditions and mating system in such a way that her potential is best used; she must have the best balance of traits for this use.

References

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Sanders, J. O., G. E. Joandet and T. C. Cartwright. 1974. Simulation of female bovine fertility. J. Anim. Sci. 39:149 (Abstract).

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TABLE 1. SIMULATED CONCEPTION PERCENTAGES DURING AN 80 DAY BREEDING SEASON, BEGINNING AT 370 DAYS OF AGE, WHERE ALL GROUPS OF HEIFERS ARE OF THE SAME GENETIC POTENTIAL FOR MATURE WEIGHT, 1058 lb.

Daily weight gain during breeding season, lb.	Weight at 360 days of age, lb. 485	507	529	551	573	595
.0	11	26	45	65	78	87
.22	15	32	52	71	83	90
.44	20	39	59	77	87	92
.66	27	47	67	83	91	94
.88	35	56	74	88	93	95
1.10	45	65	81	91	94	95
1.32	55	74	87	92	94	95
1.54	65	80	89	92	94	95

TABLE 2. SIMULATED CONCEPTION PERCENTAGES DURING A 180 DAY BREEDING SEASON OF TWO AND SEVEN YEAR OLD COWS OF DIFFERENT GENETIC POTENTIAL FOR MATURE SIZE, BUT WITH THE SAME WEIGHTS AND WEIGHT GAINS (LOSS) FOR EACH AGE BEGINNING IMMEDIATELY AFTER CALVING.

Genetic potential for mature weight, lb.	Age years	Actual postpartum weight, lb.	Daily weight gain (loss) during breeding season, lb.	Conception Percentages First 90 days	180-day breeding season
948	2	807	0	87	100
	7	1003	-.44	88	100
1003	2	807	0	79	99
	7	1003	-.44	83	99
1058	2	807	0	68	96
	7	1003	-.44	70	97
1114	2	807	0	55	89
	7	1003	-.44	55	87
1169	2	807	0	42	75
	7	1003	-.44	36	67

Minutes of Board of Directors
Beef Improvement Federation
Plaza Inn
Kansas City International Airport
May 18, 1976

The meeting was called to order by President Ray Meyer. Directors present included Bennett, Nichols, Miller, Vaniman, Durfey, Rankin, Hubbard, Jorgensen, Ludwig, Allen, Butts, Cooper, Baker, Gillis, Berg, Stephens, Cook, Whaley, Meyer, Francis, Wolf, Vantrease, Chesnut, Warwick, Lilly, Nelson and de Baca.

Proof of notice was acknowledged.

The minutes of the October 21, 1975, meeting were approved without rereading on a motion by Chesnut, seconded by Bennett.

Canadian <u>Membership</u>

There was a report on the Canadian membership progress by the subcommittee which included C. K. Allen, Bill Durfey and Wayne Gillis. Their recommendation is to get the Canadian Breed Association and Provincial Beef Improvement Association to join Beef Improvement Federation as individual members. The Canadian Hereford Association has already indicated an interest in joining and in using some assistance from Beef Improvement Federation. Wayne Gillis will follow-up on instilling enthusiasm into Canada.

<u>Guidelines</u>

On a report by Dixon Hubbard, the new Beef Improvement Federation guidelines are to be available by June 1.

Annual Meet-<u>ing 1977</u>

Concerning the annual meeting for 1977, it was moved by Butts and seconded by Lilly that Bozeman, Montana, be the location. The topic for the conference according to suggestion is to be "Correlated Responses to Selections". The 1977 meeting will be May 16, 17 and 18.

Computer <u>Systems</u>

Concerning central computer systems for Beef Improvement Association, Bill Durfey had corresponded with one or two centers and we have indication from Bliss Crandall that he would like to make service available and similarly from Performance Registry International. At this point the enthusiasm from state associations has not warranted further communications. It is suggested that the next executive committee continue to pursue the topic.

Motivation (Baker)

The Board continues to express concern about the lack of strength and enthusiasm in the beef improvement associations throughout the country. Dr. Baker has offered to move in on the problem. He is going to contact deans and department heads to give his impressions concerning the status of BCIs. Dr. Baker indicated that we also need to get through to the other aspects of the industry, indicating the Beef Improvement Federation is the beef improvement arm of this industry.

The meeting was recessed until the morning of May 19.

Election of Officers

The first item of business on May 19 was election of officers. C. K. Allen nominated Martin Jorgensen. Jack Cooper seconded the nomination. Lou Chesnut moved unanimous ballot. Jim Bennett seconded the motion and Martin Jorgensen was named president unanimously.

David Nichols nominated Jim Bennett for vice-president. Don Vaniman nominated Dick Whaley. C. K. Allen moved nominations cease. Lou Chesnut seconded the motion which carried. Bennett was elected on secret ballot.

In the election of secretary-treasurer Jim Bennett nominated Robert de Baca. Glen Butts moved unanimous ballot, seconded by Vaniman carried.

Motion

Question arose whether the new directors, old directors or both groups of directors should elect the new officers. Consensus was that all old business should be transacted by the old board, election of new officers should be transacted by the new board. The term of office should be through the end of an annual meeting. To make more definite the above consensus, Chesnut moved and Don Vaniman seconded said procedure. The motion carried. For further clarification the new directors take over the duties of Beef Improvement Federation AFTER the annual meeting.

We moved into the discussion of the recommendations of the various committees. The Central Test Committee was the only one that evoked any controversy. Most of the controversy was relative to adjusted 365 day weight as described in the central test report herein attached.

Central Test Report

Hubbard moved that we accept the central test report as written with the exception of item 2 paragraph 2, which would be referred to a subcommittee appointed by a chairman and that item 3 paragraph 2 be stricken from the report (it is left here for purposes of history, but it is indicated to the left of the paragraph that this is acted upon in accordance with the Board request.) Motion was seconded by Jim Wolf and carried.

Subcommittee Motion

The subcommittee appointed to further study the 365 day adjusted weight recommendation includes Jim Bennett, Chairman, Dr. Bob Cook, Dr. Bob Rankin, Dr. Jim Brinks, Mr. Dave Nichols, Dr. John Massey and Mr. Dick Whaley. The committee is charged with coming up with technically sound alternatives in the calculation of adjusted yearling 365 day weight. The subcommittee was appointed on the motion by Vaniman, seconded by Nichols which carried.

Reproduction Committee

Report of the committee on reproduction. Dixon Hubbard moved and Don Vaniman seconded acceptance of this report. Motion carried.

National Sire Evaluation Committee

The National Sire Evaluation Committee report was considered. Fred Francis seconded Dixon Hubbard's motion that it be accepted. Motion carried.

<u>Record Utilization Committee</u>

The Records Utilization Committee report was considered. Hubbard moved and Cooper seconded adoption of this committee report (attached), motion carried.

<u>Farm and Ranch Committee</u>

The Farm and Ranch Test Committee report was considered. Hubbard moved and Chesnut seconded adoption of said committee report. Motion carried.

<u>Carcass Evaluation Committee</u>

Hubbard moved and Berg seconded the motion to accept the report of the Carcass Evaluation Committee. Motion carried. Note the change in the numbering system indicated in the report.

Discussion concerning the activities of committees in coming months led to the expression of the desire to keep the committees active throughout the year and spend less time at the time of the committee meetings hassling things that we have discussed and solved in years past. The intent is to have indepth presentations during the committee activities with some time devoted to new business--pre-planned through communication within the committees throughout the year.

<u>Merchandizing Committee</u>

It was moved by Hubbard and seconded by Meyer that the report of the Merchandizing Committee be approved with the exception of where they ask for endorsement of a new merchandizing scheme, BIF should support the <u>concept</u> rather than the <u>project</u> itself. Adopted.

de Baca and Hubbard were instructed to go ahead with the printing of the Central Test Brochure on a motion by Francis, seconded by Allen which carried.

<u>Age of Dam Factors</u>

The Secretary was asked to call for age of dam factors breed by breed so that they could be put into use.

<u>Ray Meyer</u>

On a motion by Wolf, seconded by Bennett, Ray Meyer was commended and the Board showed an expression of appreciation for his past efforts as a director and as president. The motion carried by applause.

Mid-Year Board Meet

Cooper moved and Nelson seconded motion to hold the mid-year directors meeting at Omaha on October 25 with October 26 as an alternate date. The meeting is to start at 7:30 at breakfast. Carried. de Baca and Berg are in charge of arrangements.

It was moved by Vaniman and seconded by Francis that the meeting adjourn. Carried.

Respectfully Submitted,

Robert C. de Baca, Secretary

Financial Status
Beef Improvement Federation
May 1, 1976

by Robert C. de Baca

	(May 1, 1976)	(May 1, 1975)
Savings Account	9,500.00	--
Interest on above	205.18	--
Cash on Deposit	4,087.39	9,170.47
Accounts Receivable	4,000.00*	--
Assets	$17,792.57	$ 9,170.47
Liabilities including bills outstanding	0.00**	

Itemized Disbursements
by Robert C. de Baca

Check					
101	Lincoln, Post Office	$ 30.00	112	Carcass Data	$ 74.10
102	Leaflets	VOID	113	Carcass Data	$ 10.40
103	Carcas Data	$140.40	114	Stamps	$ 65.00
104	de Baca itemized	$187.88	115	UPS	$ 27.06
105	Carcass Data	$ 24.70	116	Stamps	$ 74.92
106	Stauffer Inn	$280.07	117	Film (movie)	$ 75.00
	Deduct Bank Stamp		118	Carcass Data	$ 2.60
107	Carcass Data	$110.50	119	de Baca itemized	$344.67
108	Leaflets (March)	$108.16	120	Manuscript Typing	$ 5.40
109	Carcass Data	$ 6.50	121	Postmaster	$ 65.00
110	Filing Cabinets	$221.45	122	Colo. Sec. State	$ 5.00
111	de Baca itemized	$865.91			

* Treasurer unsure of association which will not pay or have not paid in previous years.

** April clerical, printing and telephone bills were not paid prior to this summary date.

Agenda Items
Beef Improvement Federation
May 18-19, 1976

- Proof of Notice
- Financial Report
- Minutes
- Canadian Membership Progress
- Guidelines
- Annual Symposium 1977 (Virginia)
- Central Computer System
- Motivation (Letter to Deans and Department Heads)
- Election of Officers
- Committee Activation Throughout Year
- Changes of October 21 (into Guidelines)
- Brochures--Camera Ready Copy
  - Birth Weights
  - Testing Stations
- National Sire Evaluation Committee Changes
- Action on Committee Reports

REPRODUCTION COMMITTEE REPORT

May 17, 1976 Kansas City, MO

Committee was called to order by Wayne Singleton at 8:30 p.m. Larry Rice presented the sub-committee report on conditions under which semen evaluation should be done. These recommendations are to be placed in BIF guidelines for use by central test stations and breeder owned bulls. The present guidelines were presented and explained by Rice.

The subcommittee composed of Larry Rice, Wayne Singleton, John Massey and Keith VanderVelde recommended the following guidelines for evaluation of young bulls:

MALE

The following are the guidelines for physical examinations and semen evaluation in screening yearling bulls. These recommendations are especially intended for bulls which have completed post-weaning gain test at either central test stations or on breeders' farms.

I. Physical Examination (very important)
   A. Palpation of scrotum and its contents---
      score 0 for unacceptable (abnormalities of scrotum and testes) and 1 for acceptable.
   B. Examine extended penis and prepuce for injury or abnormalities---
      score 0 for unacceptable and 1 for acceptable.
   C. Palpate internal glands rectally---
      score 0 for unacceptable and 1 for acceptable.

II. Conditions and equipment
   A. Bulls should be restrained in a chute providing
      1. firm footing
      2. means of support to prevent bull from collapsing during ejaculation, or manual massage.
   B. Bulls may be collected by artificial vagina and mount animal, electric ejaculation, or manual massage.
   C. Laboratory equipment - minimum
      1. binocular scope with 200 to 1000X magnification
      2. means of maintaining semen sample at 37 degrees C from collection through microscopic evaluation (insulated jacket for collection cone, water bath in lab or van, slide warmer and miscroscope stage warmer).
      3. morphology stain (Bloms stain, eosin-nigrasin, fine grain India ink, etc.).

III. Semen Evaluation
- A. Volume -- observation.
- B. Concentration -- observation.
- C. % motility -- observation.
- D. Morphology*
- E. Scrotal circumference - record in centimeters

* Percentage primary abnormalities counted on a stained smear at 1,000 magnification. Primary emphasis should be on % normal sperm. Head and midpiece abnormalities are especially important; i.e., primary abnormality.

The society for Theriogenology (formerly American Veterinary Society for the Study of Breeding Soundness) has developed criteria for Breeding Soundness Evaluation of beef bulls. These criteria are outlined in a publication by Leslie Ball, DVM, of Colorado State University and published in the 1974 Proceedings of AVSSBS annual meeting, September, 1974, Columbia, MO. The reproduction committee of BIF recommends that BIF acquire copies of this publication and make available to interested members and extension personnel. The scoring system recommended by the Society for Theriogenology is presently being used by University of Missouri and Colorado State University bull test stations. The BIF reproduction committee suggests other test stations evaluate the Society scoring system.

Most bulls with gross deficiencies or abnormalities detected by physical examination should be culled.

Scrotal circumference measurements should be scored as actual measurements. Percent primary abnormalities may be expressed as a ratio for the group of bulls tested together.

The scrotum, penis and rectal examinations should be recorded as acceptable or unacceptable. If unacceptable, the report should tell why.

The screening examination should be performed by experienced, competent personnel.

Motion to accept ammended guidelines made by Rice and seconded by Brinks. Question was called for and carried.

Massey moved and Jones seconded a motion to reference and make available the publication by Dr. Ball.

No change in the calving difficulty scoring with no discussion due to absence of Bill Durfy who was unable due to family illness.

Motion to adjourn made by Vander Velde and seconded by Rice.

Meeting adjourned.

Secretary,

Keith Vander Velde

REPORT OF COMMITTEE ON MERCHANDISING PERFORMANCE

May 17, 1976 Kansas City, MO

Mack Patton reviewed past accomplishments of the committee and stated that 30,000 copies of last years brochure on Merchandising Performance Records have been distributed.

There was a discussion led by Dixon Hubbard on setting up a BIF approved pilot project to form a cooperative marketing association to merchandise and market top performance tested cattle.

It is proposed that South Dakota and neighboring states set up this project under the leadership of South Dakota State University Animal Science Department. Specifications for participation are to be drawn up by the group setting up the project.

The committee on Merchandising Performance unanimously recommends to the board the approval of this project.

Jim Ross, Missouri Department of Agriculture, described the cattle marketing program being conducted by the Mid-Continent Farmers Association. This program of feeder calf sales specifies the use of performance tested sires.

Dean Frischknecht reported on a new method of merchandising reputation cattle in Oregon where colored slides of cattle are shown on a screen at the auction instead of bringing the cattle to the auction.

Mack Patton, Chairman
Dean Frischknecht, Secretary

May 17, 1976 Kansas City, MO

The National Sire Evaluation Committee met at 10:05 AM on May 17, 1976. Dr. Cundiff, because of an accident was unable to attend, so the meeting was chaired by Dr. Willham, the secretary of the committee. Dr. Miller served as secretary for the meeting.

Willham reviewed the reports by the breeds on their sire evaluation programs given at last years meeting. He noted that the new guidelines for BIF, that will contain the updated guidelines for national sire evaluation, should be available soon.

Willham discussed the results obtained from an analysis of the Angus Sire Evaluation program. He noted that besides identifying superior sires these programs can be used to learn about the genetics of the various breeds. A copy of the hand-out is attached.

Jim Glenn then reported on the progress of the Iowa Beef Improvement Association custom progeny testing program to date. Attached are copies of the results for the four breeds in the test. It was noted that conducting such custom progeny testing programs could be a logical extension of BCI activity in many states.

Willham then discussed the evaluation of maternal ability using field data as a procedure to go along with national sire evaluation. Attached is a copy of the hand-out.

Willham outlined a procedure that can be used to estimate herd means adjusted for sires so that ratios using these means can be used for over herd evaluation of individual performance. Miller noted that all field data needs to be used in national sire evaluation programs even when designed programs are in use. Attached is a copy of the hand-out.

The meeting was opened up for discussion and an expression of concerns. The subject of testing for recessive genes was discussed at some length. L. Tom brought up the point that slaughter end point for these programs needs to be considered. C. K. Allen expressed concern as to how to evaluate maternal ability using daughter of a sire when part of the data were field data and part designed data. The meeting was adjourned at 11:30 AM. The committee members were asked and none felt that another meeting of the committee needed to be held. The programs are progressing nicely.

CARCASS EVALUATION COMMITTEE

May 17, 1976 Kansas City, MO

This committee covered several important aspects of carcass evaluation and the use of carcass evaluation data.

(1). Discussion included data collection through the Beef Carcass Data Service (BCDS) prior to and after the February changes in USDA grading standards. It is recommended that member organizations with Sire Evaluation Programs recompute carcass grade data for cattle on which data was collected prior to the February grading changes. If the member organization doesn't have the necessary basic carcass data the organization from which BCDS tags were obtained or the USDA does. USDA will cooperate in finding and summarizing such data. Presently USDA compiles an IBM listing of all data and returns the IBM listing to the cooperating member. In the event other changes occur in the future, it is recommended that the organization selling BCDS tags maintain a complete file on carcass data received.

(2). Also relative to BCDS tags the Committee thinks that those who purchase the BCDS tags should be clearly informed that the tag buyer needs to monitor the tags through slaughter to make sure that the data is actually collected. This means that the breeder or feeder or his representative should either be present when the cattle are slaughtered, or have firm assurance from the packer or grader that the tags will be recognized and the data collected. Tag purchasers should recognize when carcass data is not received the information lost is of far greater value than the 50¢ cost of the tag. We think the program will work for those who want it enough to make it work.

(3). The committee reviewed the recommendation for quality scoring of carcass for USDA grade as recommended by the Carcass Evaluation Committee last year. We concluded that there is a need for more precise scoring for degrees of marbling. We recommend that a scoring system from 0 for devoid to 27 for abundant plus be used. By assigning each 1/3 degree of marbling a number score actual differences in marbling over sire averages can be calculated. By comparison using whole numbers for each degree of marbling does not result in sufficiently accurate evaluation. If it is deemed advisable to maintain the present numbering system of 1 thru 9, each 1/3 degree of marbling can be expressed as 1/3 or .333.

Respectfully submitted,

Jim Wolf, Chairman
Craig Ludwig, Secretary

BIF RECORD UTILIZATION COMMITTEE

May 17, 1976 Kansas City, MO

The following committee members attended the meeting: Bre Dahl, Gosey, Maddox, Ufford, Nelson (Secretary), and Nichols (Chairman). Several other interested people also attended.

Nelson reviewed the highlights of the minutes of the 1975 committee meeting. Chairman Nichols then called on Willham to discuss some items of old business.

(1) Use of performance data in the show ring.
Three items were proposed for use in the show ring:
(a) structure - height at the hooks
(b) growth rate - actual weight per day of age
(c) body composition - back fat probe
The question was raised as to how performance of non-contemporary animals can be used in the show ring. It was concluded that there was some social value in use of performance data in the show ring. No action was taken on this proposal.

(2) Types of performance programs. What types of programs are available? In what ways can performance data be utilized in the industry? Chairman Nichols appointed a committee of Willham, Bre Dahl and Ufford to refine the draft entitled, "The Beef Industry and Performance Records". It was recommended that BIF publish this in the form of a two-fold brochure similar to others already published.

Nichols stressed that guidelines needed to be developed to help the commercial producer improve his productivity and profitability per cow. What are the steps, or stages, that a producer should follow? Baker said the two most important items were having each cow pregnant every year and using superior bulls. Chairman Nichols named Maddox and Nelson to develop a rough draft re: a recommended, simple improvement program for the commercial producer that may not be identifying or weighing his calves.

De Baca raised the question about giving guidance to producers with small or medium-sized herds re: utilization of cross-breeding programs. One comment was that educators were making cross breeding recommendations too sophisticated.

Willham voiced the need for more breeding and calving records in order to compute and use maternal breeding values. Too many performance records begin with weaning data rather than the breeding and calving information. There was a general feeling that the importance of maternal breeding values needed to be stressed in the BIF Guidelines.

Respectfully submitted,

Dave Nichols, Chairman
Larry A. Nelson, Secretary

BIF FARM AND RANCH PRE AND POST WEANING TESTING PROGRAMS COMMITTEE

May 17, 1976 Kansas City, MO

REPORT AND RECOMMENDATIONS

CENTRALIZED COMPUTING FACILITIES

Dr. James Martin, University of Arkansas, reviewed a computer management information system utilized by a number of large feedlots. Dr. Martin discussed the system as it will be applied in the Arkansas Central Bull Test system and how it could possibly be used on a national basis. He commented on a number of questions from the floor.

COW EFFICIENCY

Discussion was initiated by a presentation from Richard Benson concerning equations that could possibly be used to estimate efficiency. Indicies for biological efficiency and economic efficiency of cows were presented.

BIRTH WEIGHTS AND THEIR USE IN PERFORMANCE PROGRAMS

Larry Nelson reviewed the work of this subcommittee in this area.
Motion: A motion wasmade by Cliff Iverson and seconded by Dusty Rich that the subcommittee look into age-of-dam effects on birth weights. The motion carried. The subcommittee consists of : Don Vaniman, Chairman; Larry Nelson; C. Greig; C. Ludwig; W. Rowden; D. Strohbehn; D. Vaniman and J. Wolf.

AGE-OF-DAM CORRECTION FACTORS

Jim Glenn reviewed the work of his subcommittee in this area. Several of the subcommittee recommendations had already been adopted earlier by the board.

REPRODUCTIVE EFFICIENCY IN PERFORMANCE PROGRAMS

Paul Miller reviewed some of the concepts involved in the estimation of breeding value for maternal performance. It was suggested that the committee investigate this procedure in more detail.

CALCULATION OF ADJUSTED WEIGHTS

There was considerable discussion concerning the calculation of adjusted weights when the calves are weighed out of age limits. Concern for length of post-weaning test was expressed by several members. It was suggested that a poll be taken to determine what length of test (eg. 140 day, 160 day, etc.) various organizations are using across the country. Motion: A motion was made by Gary Ricketts and seconded by Clar Acord to have the present subcommittee working on new methods of calculating adjusted weights for out of age limits cattle. This committee consists of Larry Benychek, Chairman; Chris Dinkel; J. D. Mankin; Jim Gosey; John Massey; Bobby Rankin and Lee Nichols.

The Farm and Ranch Testing Committee Adjourned.

Respectully submitted,

Martin Jorgensen, Chairman
Larry Benyschek, Secretary

CENTRAL BULL TEST COMMITTEE REPORT

May 17, 1976 Kansas City, MO

Over the past year the BIF Committee on Central Bull Testing has had considerable discussion to standardize testing procedures and reporting of the data. The last revised BIF report has served as a guideline toward this standardization. The two primary problem areas which have been discussed thoroughly during the past two years in subcommittee are:

1. the variation of bulls age on test
2. calculation of adjusted yearling weight

The Central Bull Test Committee recommends that BIF advocate the adoption of the following procedural changes at all Central Bull Test Stations:

1. Age of calves at time of delivery to test stations should be at 180 days and not more than 275 days.
2. Adjusted yearling 365 day weight = $\frac{\text{final test weight}}{\text{days of age}} \times 365 +$ additive age of dam factor — * Referred to <u>Subcommittee</u>
3. Height and length measurements be taken on all bulls and reported as an optional descriptive measurement. — * Stricken from <u>Report</u>

Future committee discussions should pursue:

1. The determination of which height and length should be taken and recommend 365 day adjustments.
2. The evaluation of bull's growth curve and

determine the point of maturity through the use of individual daily gain on test and feed conversion.

Sincerely submitted,

Richarly Whaley, Chairman, BIF Central Bull Test Committee
C. J. Christians, Secretary

J. A. Carpenter	D. Nelson
R. Deese	B. Rankin
R. Fincham	G. Ricketts
B. Morgan	W. Severin
	R. Wallace

"Reflections on BIF and its Future"

by Frank H. Baker

May 17, 1976

BIF is an institution where all individuals interested in the performance movement are joined together in the acquisition of knowledge and the search for truth. BIF functions in the transfer of knowledge and concepts between and among organizations which are routinely providing performance programs, data and activities for the benefit of their members. BIF recognizes and identifies for the industry a group or body of knowledgeable individuals who serve the industry and/or its components as resource persons in the broad field of beef cattle improvement. BIF is a force in the expansion of the boundaries of beef cattle improvement knowledge and the discovery of new truths related thereto.

The beef industry on the U.S. scene has accepted and/or established BIF as the vehicle for (1) independent and objective criticism on beef improvement, (2) flow of ideas concerning beef improvement, and (3) consultation or advice concerning beef improvement. To date, BIF has been able to meet this responsibility because it was the focal point for the interaction and fermentation of the views, ideas and facts from individual cattle breeders of all breeds, beef cattle researchers and educators from many institutions, government officials concerned with methods and regulations, commercial cattle producers and cattle industry service representatives. Among these individuals, BIF in its research forums and committee activities not only permitted but encouraged individuals to

> ...think unthinkable thoughts and explore intolerable ideas and to proclaim their findings.

The future course for BIF represents a special challenge because of the past acceptance of concepts and ideas that found their origins or recognition in BIF. The future challenge for BIF can be met if the basic ingredients for establishing the strength and validity of ideas and concepts in the past are retained. These ingredients are:

1. the equality of stature of individuals based on ability to perform in BIF committees regardless of experience, education or organizational identity.

2. the checks and balance among interest groups, i.e. breed organizations, state associations, universities, etc., in BIF activities and governance.

3. a policy which provides for public release and exposure of data and information during development stages regardless of source, impact or consequences of concept if accepted and recommended.

4. an operational guide of performing needed functions which are not and/or logically cannot be performed by other organizations.

5. a policy of planned periodic review of all concepts in performance programs with appropriate revision of concepts and/or discarding of concepts which are outdated or no longer functional.

6. continuation of BIF member relationships policy which permits and encourages autonomy, initiative, and innovation by member organizations.

ROLE OF EXTENSION IN BEEF IMPROVEMENT PROGRAMS *

by Robert C. de Baca - Iowa

In addressing myself to the topic, let me assert that I equate "Extension" and the "Land Grant University." In my mind Extension is one arm of the Land Grant unit and not a separate entity. Where I was in Extension, we were full staff members with full academic rank and generally the same training level as those in research and teaching.

I happen to have strong feelings about the role of the Land Grant system and its Extension arm. I express my feelings as a 14-year veteran livestock specialist and now as a full-time taxpayer and user of Extension resources. I wish to assess the topic as it relates not only to beef improvement but to total effort.

The most obvious and most accepted role of the Land Grant University has been to do research and to teach undergraduates. In the eyes of some teachers and researchers, Extension has been an inferior stepchild. Indeed, in the past 25 years we have had some prima donna researchers who have set themselves and their graduate students above and apart from undergraduate teaching and from Extension. Please, I am not speaking from an inferiority complex--I am trying to set a stage. I deplore the stratification that has existed. I am more than a strong advocate of basic research--I am a strong believer that our researchers, our classroom teachers and our "field teachers" need to be current with their industry and its real world problems. Too many university people are out of step with the drums from the real world. Let me motivate you to fill a role perhaps as is seen for you by those outside of academia.

The role of the Land Grant University and Extension is to be innovative, to find the new, to cause change and hopefully progress and to teach--indeed, to extend itself and its new ideas to the populace, to its clients and to those who pay for its existence. The record of the Land Grant

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* Talk given at Southern Section - American Society of Animal Science in Mobile, Alabama on February 2, 1976.

Universities in accomplishing these tasks has been great. There is no other farm population as highly educated or as highly productive as ours, but we can't rest on yesterday's accomplishments. The role is to continue to build.

During the last three years I have been an outsider looking in at academia. I am now a member of the critic set. Since I am no longer on a university staff, people speak freely to me of their criticism for the university. Generally, your critics are those who are friends of the university, but they want results. They criticize in one breath and brag in the next that their sons or daughters are enrolled at your university. Yes, they want results. They want it in crop production, in livestock production, in social action programs--in many aspects. The reason they criticize is they know what good you've done, but they know there's more.

Your clients want leadership from their university. They want directional programs and I think they want courage. I hear too many Extension specialists criticized for trying to be nice guys, for taking the easy way out and for unwillingness to lead out or to be criticized. I hear you criticized for building programs to build your own ego. I hear you criticized for not having today's technology written up in applicational form. I not only hear these criticisms, I have seen them be justifiable. At the present time I am doing a large developmental consulting project with a minority group that has its own "specialist" available. And I dare say he's retired at under 45. He has essentially given up. He's a nice fellow but he has no program. He hurts your image and mine.

Specifically concerning beef improvement--we need help. We need help right out of the Dean's office to chart direction. I think directional policy should be known to the state. Where does your Dean and Department Head stand on developing beef improvement--where do they stand? Some would prefer for the stand to be taken down the line. Basically, all schools have "beef specialists." It's part of the furniture--but what of direction? How does the direction compare with the the classroom? Are the classroom and Extension saying the same thing? How does research fit in? Are you headed in a direction or in opposites? The coordination of beef breeding projects nationally is giving us good research--good answers. We have lots of firm basis on which to decide. Yet, lots of this is not converted to cattlemen's language. And then at the classroom level we have great teaching materials but somehow we're graduating too many youngsters who think life is just an extended rodeo or county fair. We turn out too many who philosophically are not matured to the extent of their training. We train them well in science and technology, then they graduate and really don't want to work and would rather clip hair. I've dealt with several like this in the past three years.

The greatest leadership that the Land Grand University can give to beef improvement programs is to believe in them, to have the courage to try to build them strong, to map out and write up usable and applicable programs, and to organize breeders to underwrite and carry out their own programs with strong university guidance. The balance between conviction and convenience is often uncomfortable. It's certainly easier to be accommodating than courageous, but what we need is direction, purpose and pursuit of program. I have a list of the Extension Specialists in areas and at state level, and it's several pages long. There are enough that we should have no weak beef cattle improvement associations. We should have crossbreeding being done systematically by now; we should have more bulls being tested; we should have more carcass tags being used. I know you are busy but I ask the same question I asked as a livestock specialist, "Do we hide behind the word 'Educator'?" Are we too much educator and not enough doer?

It is my feeling that we have all the technology to move out on better programs in beef production--at the breeding and management levels. The successful programs today exist in pockets generally centered around a key person.

It is time to move out together. It is time to launch programs in thrusts. This is something I couldn't get my colleagues to do in 14 years as a specialist. It's time for team approaches. It is time to concentrate on specifics and give less priority to the brush-fire approach. If you really want a strong performance program in your state (and I think you should), get the direction set at every level from Dean to Extension assistant, then go. Too often one can't get any program action at the county level. They're too bogged in red tape. If you want a bull test station (and I think you should), go get it. Nothing but inertia stops you. If you want systematic crossbreeding (and I think you should), write a simplified bulletin and preach it from every orange crate, from every microphone, fill the newspapers with it, but go get it.

Frankly, I think our beef improvement programs are being sidetracked by inertia, steer shows, cattle traders and the packing industry. Inertia is the failure to build the programs. Is this a problem with you? The steer shows are giving us misguided breeding goals and misguided evaluation. (Are you strong enough to face up to them?) Cattle traders talk down cattle that aren't today's market need--they're either too big or too little or too fat or too thin or wrong colored. (Can you redirect them?) The packer buyers promote what they need today. Most of them don't know genetics and know very little nutrition. They guess weight real well but if we changed breeding programs at each of their suggestions, we'd do so each six weeks. (Do you have the courage to change them?) We must decide what's right and follow it.

The research of the last 50 years gives us guidance. The efforts of the Beef Improvement Federation in charting method gives us direction. Now what we need is conviction, courage and to kick the inertia. The breeding herds of America are in better shape and better hands than 15 years ago but there's lots of work to be done. Your role is to lead--not to follow.

SIRE EVALUATION--A LEARNING EXPERIENCE

R. L. Willham
Iowa State University

The Angus Sire Evaluation Group Three Report--Fall, 1975--is published. Although only 54 sires are listed, 95 have expected progeny differences. Some had fewer than 10 progeny while others were dropped after their initial listing. These 95 differences are new data that has not been available in the Angus breed. The results from Angus Sire Evaluation will open new doors to genetic improvement not only by breeders using the results in their selection decisions, but by what can be learned about the genetic structure of the Angus breed. The purpose of this writing is to report on what has been learned about the genetics of the Angus breed using the sire evaluation data up to this time. Specific topics are as follows: (1) the variation among expected progeny differences that can be attributed to pedigree groups or strains of Angus sires, (2) the genetic correlations among the traits evaluated, (3) the evidence for sires ranking nearly the same in diverse test groups, and (4) the inclusion of maternal breeding values for each sire. Each topic will be discussed in turn.

Sires were placed in broad pedigree groups by examination of their four-generation pedigree. Then the variation among expected progeny differences for each trait was partitioned into that due to pedigree groups (strains) and that due to sire differences within pedigree groups. The general result is that the majority of differences among the expected progeny differences for all traits are due to sire differences within pedigree groups. That is, there are sires with relatively high expected progeny differences in all pedigree groups. This may change as more data are added. However, it indicates that at present there is a rather wide base of Angus germ plasm from which to select superior sires.

The genetic correlations among the traits evaluated in the program are generally low except for the one between weaning and yearling weight which was +.6. Weaning weight is 7/12 of yearling weight as was expected. This information reveals that the program is measuring traits that need to be measured, since being high in yearling weight does not mean superior cutability or carcass quality.

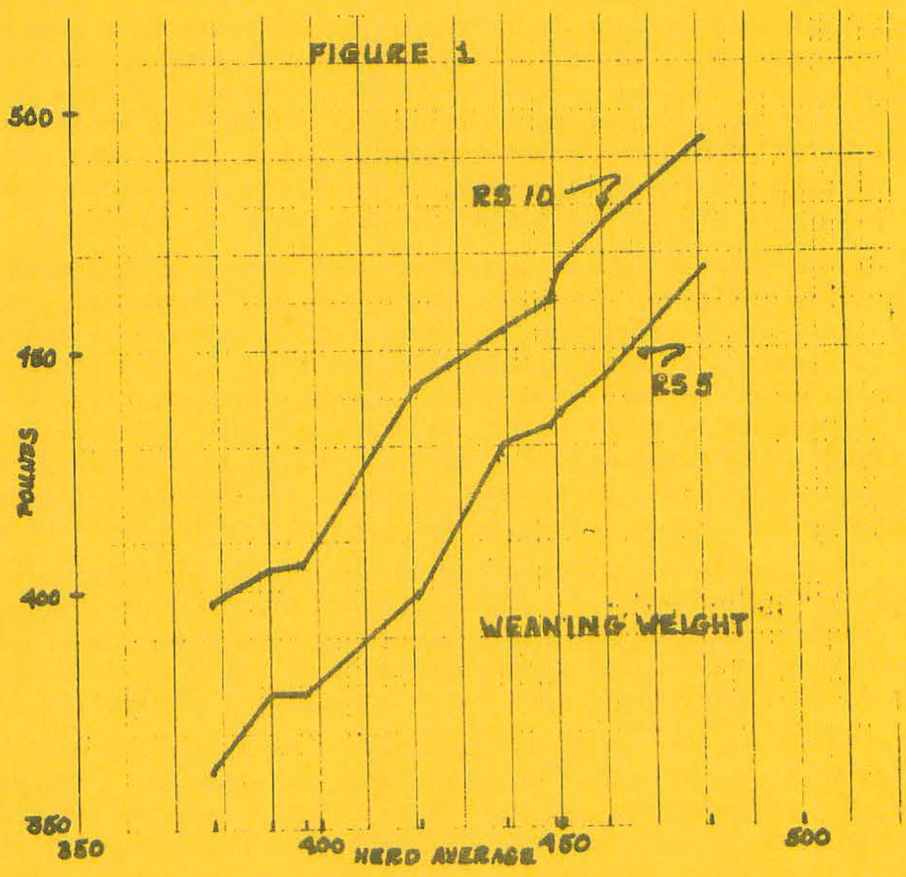
The reason for using 12 reference sires initially was to find out if sires ranked the same in rather diverse management groups. Analysis of the reference sire data suggests for weaning weight that a near constant difference between the high and low reference sire exists when the groups differ in average weight from 380 pounds to 480 pounds. They never change rank. The same is true for yearling weight when the groups differ in average weight from 550 pounds to 990 pounds. The difference between the high and low reference sire was nearly constant suggesting also that the expected progeny differences should be expressed in pounds not in ratios. At this time there is no evidence to suggest that sires change rank depending on the management or location of the progeny test. See figures.

Included as an insert in the group 3 report is a listing of the maternal breeding values for all the sires evaluated in the program. The maternal breeding value reported compares the ability of these sires to produce daughters that will milk. The value is obtained not as a part of the sire evaluation program, but from all of the accumulated AHIR data. Included in the maternal breeding value, when available, are the average weaning weight ratio of calves of the dam and the average ratio of calves of the daughters of the two grandsires and the sire. This new piece of information concerning milk potential of daughters adds much to the description of the sires and probably is enough on this trait in beef production. The attached sheets give the maternal weight breeding values for Angus sires.

THE REASON FOR TWELVE REFERENCE SIRES INITIALLY

Twelve reference sires were selected to start the Angus national sire evaluation program. There were two reasons for so many when all that would have been needed was one. The expected progeny differences of the twelve will form the base group of Angus sires. In the future, average genetic change can be monitored using this base group. The second reason was to evaluate the possibility that progeny of sires do not rank the sires the same in each environmental group or progeny test. This can be measured in terms of the sire by test herd interaction.

The reference sire data available to date was analyzed using a model that fit a fixed herd effect and random sire and sire by herd effects. This analysis

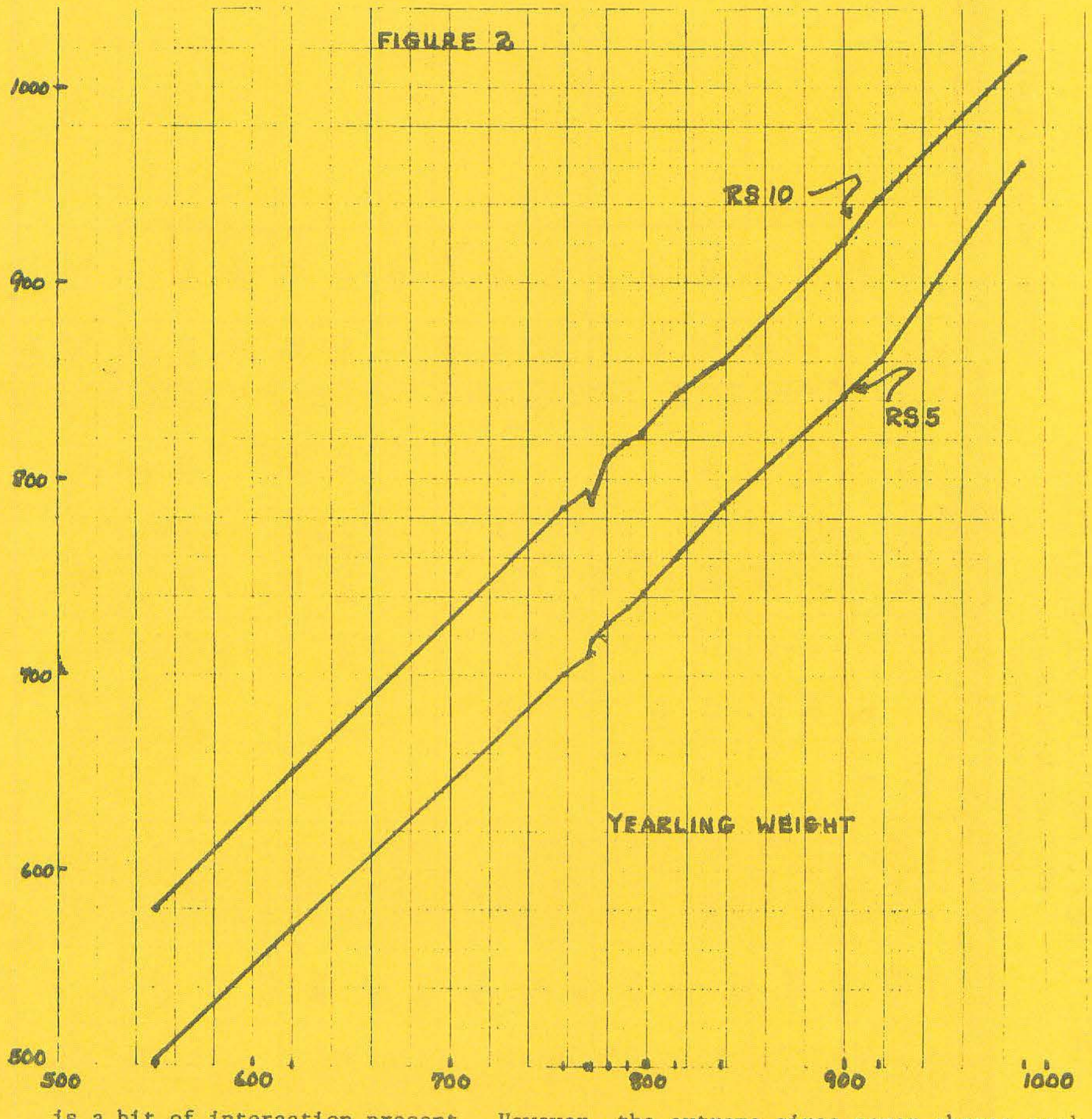


was done using the analysis suggested by Henderson where the sire by herd equations were augmented on the lead diagonal by the ratio of the error variance to the interaction variance (20) and then these equations were absorbed into the herd and sire equations. The resulting herd equations were absorbed into the sire equations and to obtain a solution for the remaining sire equations the ratio of the error variance to the sire variance (12 for weaning weight and 7 for yearling weight) was added to the lead diagonal. Then the sire equations were solved. The sire EPD values were used to solve the herd equations and both effects were used in the sire by herd equations to obtain the sire by herd effects.

This accomplished, the reference sire with the highest EPD (code 10) and the reference sire with the lowest EPD (code 5) were used to demonstrate the extent of interaction evidenced in the data. There were 9 herds where sire 5 and 10 were directly compared and 13 for yearling weight. The herds were ordered from the lowest to the highest average weight and the value

HERD + EPD + INTERACTION

was calculated for the two sires in each herd. The result is graphed in Figure 1 for weaning weight and Figure 2 for yearling weight. The failure of the two lines to be exactly parallel and have exactly the same slope indicates that there



is a bit of interaction present. However, the extreme sires never change rank. Sires having similar EPD values will often exhange rank. The two figures show really very little evidence that interaction (rank change) is important. In fact, when yearling weight herd means differ from 554 to 987 pounds, the difference between RS5 and RS10 is quite similar as it is over the complete range. Also, the figures suggest that EPD values should be reported as a difference rather than a ratio because as the herd means go up the difference remains constant. If the difference (EPD) increased as the herd mean increased the EPD values should be reported in ratios.

The tenative conclusions arrived at from this analysis are as follows:

1. The extent of interaction or the failure of Angus sires to rank the same in each test appears to be minimal. This suggests that the program as designed should do a reasonable job of comparing sires even though some sires are tested in only one herd.
2. The EPD values should be reported as differences since there is no evidence that the differences increase as the herd mean increases.

ANGUS HERD IMPROVEMENT RECORD

PRODUCTION MEASURE

SELECTION WORK SHEET

Group 3 Sire Evaluation

MATERNAL WEANING WEIGHTS

ANIMAL INFORMATION										AVAILABLE INFORMATION								RANK	REMARKS
CALF IDENTIFICATION NUMBER	SEX	TATTOO		BIRTH DATE			SIRE REGISTRATION NUMBER	DAM CHAIN NO.	DAM REGISTRATION NUMBER	DAM		PGS (PATERNAL HALF SIBS)		MGS (MATERNAL HALF SIBS)		SIRE (PROGENY)		BREEDING VALUE RATIO	SELECTION DECISIONS
		LEFT EAR	RIGHT EAR	MO.	DAY	YR.				ADJ. PROG	WEIGHT RATIO	NO	AVERAGE RATIO	NO.	AVERAGE RATIO	NO.	AVERAGE RATIO		
Black Band Barmald				6	25	PGS 64	2749793 3881739	MGS	2072993 3117759	3	99							100	
Form of Wye				3	22	PGS 65	2090692 2677295	MGS	2066939 3323282	10	98	2 9	97	37 248	101	18 76	101	101	
Green Valley O B 67				3	10	PGS 66	1730806 3060499	MGS	2301609 2905160	2	113	1 1	78			16 50	101	103	
Elban Bardo of Spur				1	9	PGS 67	2821353 4443607	MGS	2821353 4622752	5	116	1 2	84	1 2	84	45 70	97	101	
Bardolier 717 G D A R				3	7	PGS 67	3498384 4428893	MGS	1036227 1700954	3	107					33 77	98	100	
Hidden Hills Executive			4167	6	3	PGS 67	1693106 2754008	MGS	2135919 2527288	7	111	12 40	99			39 69	99	103	
Federal 7366 E W T				5	14	PGS 67	3323325 4144440	MGS	3286998 4279103							10 22	103	102	
Nichols Weighmaster				5	11	PGS 67	3849800 4839480	MGS	3072764 4386493	8	102	46 177	100	56 254	96	82 183	102	100	
Riverbend Challenger		288	66	6	22	PGS 66	-164097- 5475692	MGS	-176432- -228145-							68 99	106	105	
Black Revolution 568				3	24	PGS 68	1107054 3007898	MGS	3265203 4109965									100	
Menteith of Graham 37				12	30	PGS 68	3582452 5090936	MGS	3386394 5079038	3	113	65 166	100	110 318	103	7 15	95	102	
Emulous 921 of Arrowhead				2	13	PGS 69	3336024 4692462	MGS	4443607 5716862			1 1	78	45 70	97	18 33	98	96	
Camilla Jumbo 75Z				4	1	PGS 68	-273305-	MGS	-164097- -212350-							1 2	96	100	
Chesley of Wye				1	23	PGS 69	1835608 2467117	MGS	2653264 3899322	10	107	14 64	98	29 114	102	45 203	101	103	
Anders of Wye				1	25	PGS 69	2677295 4020208	MGS	2467117 4792431	7	105	18 76	101	45 203	101	53 106	102	103	
Cheney of Wye				4	10	PGS 69	4020214 4792473	MGS	4020210 5221185	1	124	6 25	98	5 9	97	7 7	99	102	
Camilla Chance 2W				4	1	PGS 65	-164097- 5475692	MGS	-127966- -164830-							68 99	106	105	
T N Emulous 365				12	20	PGS 69	4692462 5918385	MGS	4017278 5162692			18 33	98	12 51	104	6 6	93	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.

ANGUS HERD IMPROVEMENT RECORD

PRODUCTION MEASURE

SELECTION WORK SHEET

Group 3 Sire Evaluation

MATERNAL WEANING WEIGHTS

ANIMAL INFORMATION										AVAILABLE INFORMATION								RANK	REMARKS
CALF IDENTIFICATION NUMBER	SEX	TATTOO LEFT EAR	TATTOO RIGHT EAR	BIRTH DATE MO.	BIRTH DATE DAY	BIRTH DATE YR	SIRE REGISTRATION NUMBER	DAM CHAIN NO	DAM REGISTRATION NUMBER	DAM ADJ. PROG	DAM WEIGHT RATIO	PGS SIBS NO.	PGS SIBS AVERAGE RATIO	MGS SIBS NO.	MGS SIBS AVERAGE RATIO	SIRE NO.	SIRE AVERAGE RATIO	BREEDING VALUE RATIO	SELECTION DECISIONS
		27140				PGS	3336024	MGS	4285112			1		8		31			
Ankonian T N Emulous				2	21	70	4285114		5471965			1	78	12	103	54	102	102	
						PGS	3582452	MGS	1465995			65				13			
Menteith of Graham 66				1	5	70	5468462		2463143	11	109	166	100			22	102	104	
						PGS	4020208	MGS	2066939			53		37		13			
Quartermaster of Wye				4	25	70	5221331		2683216	10	112	106	102	248	101	23	103	106	
						PGS	3175139	MGS	2719761			117		71		48			
Rito 707 of Ideal 533 70				3	28	70	5770651		4889506	8	106	403	100	296	102	80	101	103	
						PGS	2886844	MGS	2563728					2		27			
Juanada Blackcap of PJM				3	24	70	3492260		3491456					13	98	80	102	101	
						PGS	2467117	MGS	2286652			45		11		17			
Quantity of Wye				5	30	70	3523842		3599230	8	102	203	101	46	96	40	99	100	
						PGS	2255635	MGS	1867834							10			
H M H Commodore 100				3	21	70	3291689		2358912	1	104					14	98	100	
						PGS	4020204	MGS	4120330					2					
Marc Pittman 08246				5	11	70	5221252		5609388					5	104			100	
						PGS	4795419	MGS	4795419										
Elban 4 of Duncan				3	17	70	6143438		6143435									100	
						PGS	2821353	MGS	2487803			1				45			
Stone Gate Elbar				12	26	70	4443607		3324030	7	101	2	84			70	97	97	
						PGS	2821353	MGS	3548656			1		26		45			
Stone Gate Elbar 2				12	30	70	4443607		4203214	6	103	2	84	86	102	70	97	99	
						PGS	4338557	MGS	3386394					110		14			
Graham Emulous 12				12	30	70	6173011		4329617	9	97			318	103	23	102	102	
						PGS	3341730	MGS	3182129			16		1		45			
Tehama Emulous Bob 130				9	1	70	5483012		4293095	4	115	51	99	3	115	72	100	104	
						PGS	3582452	MGS	4717200			65							
Coastal Graham 125				1	24	71	5907199		5489332			166	100					100	
						PGS	3175139	MGS	3981517			117		1		48			
Biffles Emulous 016				11	4	70	5770651		5307756	6	98	403	100	1	73	80	101	100	
						PGS	4830664	MGS	2154701							44			
Emulation N Bar 1201				3	29	71	6064368		2951052	13	103					60	109	109	
						PGS	3341730	MGS	1367735			16				8			
C&S Emulous Bob 109				2	16	71	5984075		2079872	2	105	51	99			10	110	104	
						PGS	3336024	MGS	4443607			1		45		18			
Emulous Arrowhead 194				3	27	71	4692462		5716863	1	114	1	78	70	97	33	98	98	

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 [illegible] and those of its paternal half sibs, maternal half sibs, and progeny. The [illegible] 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.

ANGUS HERD IMPROVEMENT RECORD

PRODUCTION MEASURE

SELECTION WORK SHEET

Group 3 Sire Evaluation

MATERNAL WEANING WEIGHTS

ANIMAL INFORMATION										AVAILABLE INFORMATION								RANK	REMARKS
CALF IDENTIFICATION NUMBER	SEX	TATTOO LEFT EAR	TATTOO RIGHT EAR	BIRTH DATE MO.	BIRTH DATE DAY	BIRTH DATE YR.	SIRE REGISTRATION NUMBER	DAM CHAIN NO.	DAM REGISTRATION NUMBER	DAM PROG	DAM RATIO	PGS NO.	PGS AVERAGE RATIO	MGS NO.	MGS AVERAGE RATIO	SIRE NO.	SIRE AVERAGE RATIO	BREEDING VALUE RATIO	SELECTION DECISIONS
Spur T N Emulous 24				3	17	71	PGS 4692462 5918385	MGS	3951140 5550220	6	103	18 33	98	46 154	100	6 6	93	98	
Elevate 24 El Rancho Grande				1	3	71	PGS 3206512 4580059	MGS	2125186 4148376			8 14	105					102	
Wineglass Bar Emulous			21B	11	17	70	PGS 3336024 5791520	MGS	-231275- 6466265	1	115	1 1	78			3 3	94	100	
Robbins Z 23 R131				1	20	71	PGS 4731697 5969727	MGS	4091447 5352383	5	96	76 218	102			14 23	93	97	
F C R Emulous Pride 152				3	24	71	PGS 4285112 5555086	MGS	3342900 5434141	3	106	8 12	103	5 10	99	12 15	99	101	
Burly Revolution 621				3	25	71	PGS 3007898 6081898	MGS	2886844 3902898	5	105					2 2	107	102	
Flints Zara K M F021				2	10	71	PGS 3668660 4731697	MGS	2874290 4080245	8	107			7 9	111	76 218	102	105	
Stardust Bandolier 406				1	18	71	PGS 3679781 4768995	MGS	2676325 4785847	5	105	7 15	98	6 10	101	21 33	102	103	
L Taurus of R R 1141				2	4	71	PGS 5308372 6443711	MGS	3662739 5396937	1	113	36 73	100	11 29	98			101	
Emulous 30 of Ideal		105 71		3	22	71	PGS 4285114 5869738	MGS	3077233 3916519	7	98	31 54	102	4 31	102	42 77	97	97	
Rito 707 of Ideal			644 71	3	22	71	PGS 3175139 5770651	MGS	3175139 5343325	6	104	117 403	100	117 403	100	48 80	101	101	
H M Jumbo 49				2	1	71	PGS -171607- 6370772	MGS	1637770 2489606	9	110					69 97	104	107	
Stone Gate Cahan 18				4	9	71	PGS 4020208 6026177	MGS	3548656 5397914	6	99	53 106	102	26 86	102	24 37	102	102	
Marshalls Keyban				3	26	71	PGS 4986887 6195045	MGS	2843566 4970271	5	108	1 1	115	21 54	102	6 11	106	105	
Bell Boy X L 114				5	3	71	PGS 3620688 5386048	MGS	2207451 4699145	6	111	31 72	100	9 49	96	71 123	100	102	
Toms Big Bonanza				10	9	71	PGS 2677295 4792475	MGS	2690463 5075271	5	114	18 76	101	45 118	101	95 138	103	106	
Pinkertons Emulous A131				11	4	71	PGS 4285114 6304777	MGS	2184140 3987075	3	104	31 54	102			6 6	97	101	
R R R Emulous M E 192				11	13	71	PGS 3302455 4716406	MGS	3645979 5186606	7	105			42 189	102	80 208	99	101	

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SIRE EVALUATION PROCEDURES APPLIED TO THE ESTIMATION OF HERD MEANS

R. L. Willham
Iowa State University

The beef industry is using principles of animal breeding at an ever increasing rate. One major deterent to the use of performance records for selection over herds is that little is known about the magnitude of genetic differences among herds. Cundiff et. al. (1975) have given some estimates on a small sample of herds, but they have not supplied a procedure by which this knowledge can be incorporated into existing performance programs of the beef industry. This lack of knowledge on the extent of genetic herd differences has led at least 11 beef breeds into national sire evaluation programs. In these programs, progeny of sires are fairly compared through the use of reference sire progeny in each of the contemporary groups. This progeny testing is appealing since the dairy industry has made genetic change using it. However, as Dickerson and Hazel (1947) so aptly pointed out, when heritability is high and the trait is measurable on the individual, the performance test of the individual himself can be used to obtain more rapid genetic gain per unit of time than can the more accurate progeny test. For highly heritable production traits in beef cattle, the progeny test should be generated as the result of using yearling bulls selected on their own performance. These progeny tests can best be used to advantage as sib tests on sons of the sires.

The real differences that exist between the two breeding problems (beef versus dairy) need to be understood and taken into account in the design of all performance programs as well as those developed for sire evaluation in the beef industry. Also, the problems now being encountered in the dairy program might as well be recognized and approaches taken to solve them in beef programs now being developed.

The production traits of economic importance in the beef industry are moderate to highly heritable and are measurable in both sexes before sexual maturity. This means that the performance test can be used to select superior parents and can result in a reduced generation interval. The problem to date with using this advantage is that many important selection decisions occur among animals from different herds. Such comparisons are made now using ratios which are the individual records divided by the contemporary group average. As with deviations, this procedure eliminates all differences among the contemporary group averages. Since environmental differences are expected to be largely responsible, the procedure is not without merit. However, a procedure is needed to make deviation or ratio records more useful in selection of parents over herds.

The purpose of this paper is to explore the potential of mixed model sire evaluation techniques for the estimation of fixed herd means that are adjusted for genetic differences among herds. These herd means could be used to ratio or deviate individual performance records. These resulting ratios or deviations could be used to rank individuals on their own performance over herds since the genetic differences among herds would remain in the ratios or deviations.

Fitting simultaneously the herd means and sire effects eliminates the genetic differences among the herd means due to differential use of sires which accounts for one-half of the problem. Eliminating the average dam contribution from the herd means is the difficult part of the problem. This results because dams remain in the herds confounding the genetic and environmental contribution in the herd means.

However, since sire selection in beef accounts for the majority of the pressure, ignoring the average genetic level of the dams may not be too important. To date, the only way to estimate genetic differences over herds is by using AI to spread at least some sire groups over herds. This suggests to estimate the genetic level of the dams in a herd will require that open AI in beef must progress to the point that sires of the dams in each of the herds as well as the sires of the calves can have a sire effect estimated for the performance of the calves of their daughters. At present, not enough sires are available to do this, but the time will come when this refinement can be made. Then the majority of the genetic differences among herds could be eliminated from the herd means.

In current beef data, AI is not extensive and many sires are used in their herd of origin. To be included in such an analysis a herd would need to have progeny from one or more sires used extensively enough in the breed to serve as reference sires.

ANALYSIS PROCEDURE

The linear mixed model used assumes herds fixed and sires random. This is the model proposed for dairy sire evaluation by Henderson and co-workers. The method estimates the maximum likelihood herd effects when a normal distribution is assumed and the sire effects meet the selection index criteria, Henderson (1973). The model is as follows:

$$y = Xh + Zs + e$$

where

- y = m x 1 vector of progeny records,
- X = m x q known design matrix,
- h = q x 1 vector of herd means $(\mu + h_i)$,
- Z = m x p known design matrix,
- s = p x 1 vector of sire effects with $E(s) = \phi$ and $E(ss') = D = I_p\sigma_e^2$ and
- e = m x 1 vector of random deviaitons with $E(e) = \phi$ and $E(ee') = R = I_m\sigma_e^2$ and s and e are independent.

The equations to be solved for the sire effects and the herd means are as follows:

$$X'X\hat{h} + X'Z\hat{s} = X'y$$

$$Z'X\hat{h} + (Z'Z + RD^{-1})\hat{s} = Z'y$$

This assumes $R = I_m\sigma_e^2$ so that the generalized least squares equations can be multiplied by R to eliminate R^{-1} from the equations. The term RD^{-1} equals $I_p \cdot (\sigma_e^2/\sigma_s^2)$. The h vector includes the mean with each herd effect as $\mu + h_i$ so no restrictions are needed on the herd equations. Since σ_e^2/σ_s^2 is added to the lead diagonal element of each sire equation, no restirctions are needed to obtain a unique solution. The sire estimates derived sum to zero. To reduce the number of equations for solution, the herd equations are absorbed into the sire equations as

$$\left[(Z'Z + RD^{-1}) - (Z'X(X'X)^{-1}X'Z)\right] \hat{s} = \left[Z'y - (Z'X(X'X)^{-1}X'y)\right]$$

These equations are in the form $C\hat{s} = Q$ where

$$\hat{s} = C^{-1}Q.$$

The sire equations with herd means absorbed are easy to generate computationally. The sire-herd groups are read in herd sequence and only the herd absorbed; sire equations are made. Using summation notation the values of C and Q are as follows:

$$C = \begin{bmatrix} \sum_i n_{i1}\left(1 - \frac{n_{i1}}{n_{i\cdot}}\right) + \frac{\sigma_e^2}{\sigma_s^2} - \sum_i \frac{n_{i1} \cdot n_{i2}}{n_{i\cdot}} & - \cdots \\ -\sum_i \frac{n_{i2} \cdot n_{i1}}{n_{i\cdot}} + \sum_i n_{i2}\left(1 - \frac{n_{i2}}{n_{i\cdot}}\right) + \frac{\sigma_e^2}{\sigma_s^2} & \cdots \\ \vdots & \cdots \end{bmatrix}$$

$$Q = \begin{bmatrix} \sum_i n_{i1}(\bar{y}_{i1\cdot} - \bar{y}_{i\cdot\cdot}) \\ \sum_i n_{i2}(\bar{y}_{iz\cdot} - \bar{y}_{i\cdot\cdot}) \\ \vdots \end{bmatrix}$$

Note that as each herd read in is concluded, the several values of

$$n_{ij}(1 - \frac{n_{ij}}{n_{i\cdot}}) ,$$

$$\frac{n_{ij}n_{ij'}}{n_{i\cdot}} , \text{ and}$$

$$n_{ij}(\bar{y}_{ij\cdot} - \bar{y}_{i\cdot\cdot})$$

pretaining to each sire (j) can be added to the sire equations. When all herd-sire groups are read in the lead diagonal of C is augmented with σ_e^2/σ_s^2 and the inverse of C or C^{-1} obtained. Then $C^{-1}Q$ gives the sire estimates that are regressed for numbers of progeny and for incomplete heritability.

Back solution yields estimates of the herd means as

$$n_{i\cdot}(\widehat{\mu + h_i}) + \sum_j n_{ij}\hat{s}_j = y_{i\cdot\cdot}$$

$$\widehat{\mu + h_i} = (y_{i\cdot\cdot} - \sum_j n_{ij}\hat{s})/n_{i\cdot}$$

noting that the herd means are adjusted for the sires used in the particular herd.

The practical aspect of using sire evaluation techniques to estimate herd means adjusted for genetic effects is that it can be done at the end of the season. Large numbers of herds and sires can be evaluated using iteration to solve the sire equations.

Each bull and heifer calf that has a record in the season can have its record either divided by $(\widehat{\mu + h_i})$ to form a ratio or deviated by $(\widehat{\mu + h_i})$ to form a deviation. Then these records can be ranked over herds at the end of the season. A listing of the top 50 yearling bulls could be quite valuable in selecting those sires to progeny test for carcass data in the breed wide sire evaluation program while using these top bulls in the breed so that sons would be available on them when the progeny test for carcass was complete.

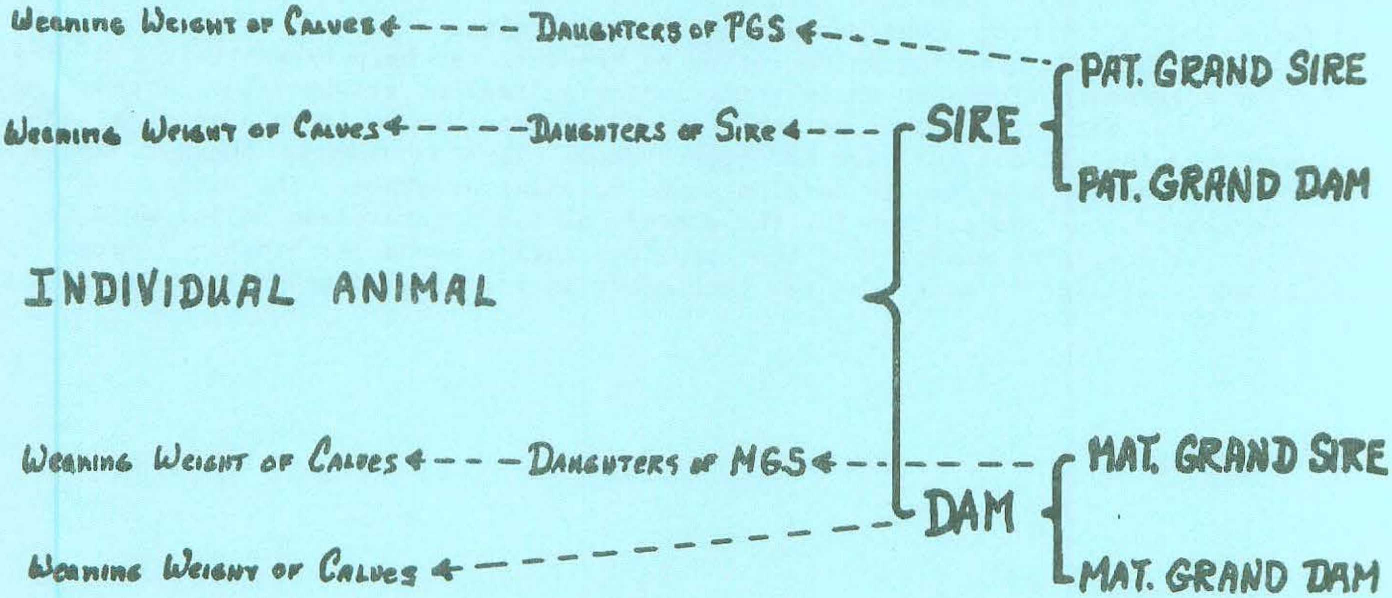
MATERNAL BREEDING VALUES

R. L. Willham

Starting November 1, 1975, Angus breeders received MATERNAL BREEDING VALUE RATIOS on the calves weaned during the month of October. These selection worksheets are sent out monthly. Like the regular selection worksheets the bull calves and the heifer calves have maternal breeding value ratios and are ranked on this value. The regular selection worksheets sent out at weaning and at yearling time give the estimated breeding value of the animals for the ability to grow. These new values have to do with maternal ability and, in particular, with milk production potential. These maternal breeding value ratios and the yearling breeding value ratios can both be used to merchandize yearlings as well as select herd replacements.

There exists in the breeds many strains that grow lean tissue rapidly. Progress has been made in this highly heritable trait. The time is now to develop objective means of evaluating yearlings, especially bulls, on their potential to sire daughters that have mothering ability or milk in the right amount to wean a heavy calf and yet rebreed for the next calf. This is difficult to accomplish because of the sex-limited nature of the trait and the time required to measure it. If the dairy approach is used there will be a six year progeny testing program before calves of daughters of a sire can be used as the selection criterion of sires. This is the reason for developing these maternal breeding value ratios rather than adding on the daughter evaluation to national sire evaluation programs. With the opening of records for use in breed improvement, estimating maternal breeding value ratios using all breed data is a possibility.

Now let us consider how these maternal breeding value ratios are calculated. The following is a pedigree diagram of an animal of interest:



Note that, with the exception of the calves by the dam, each set of weaning weights are from daughters of a sire, meaning that the maternal ability being measured is passed on a generation, so it is genetic. The maternal breeding value ratio uses four pieces of information when they are available. These are as follows:

1. The average weaning weight ratio of calves of daughters of the paternal grand sire. The diagonal value for this average is

$$\frac{1 + (m-1)R}{nmH} + \frac{n-1}{8n}$$

   where m = average number of calves per daughter, n = number of daughters, R = repeatability, and H = heritability.
2. The average weaning weight ratio of calves of daughters of the sire. The diagonal value for this average has the same structure.
3. The average weaning weight ratio of calves of daughters of the maternal grandsire. The diagonal value for this average has the same structure.
4. The average weaning weight ratio of calves of the dam. The diagonal for this average is

$$\frac{1 + (m-1)R}{mH}$$

   where m is the number of calves of the dam.

These averages are weighted heavily for maternal ability rather than growth rate. Any information that is available is combined into a single breeding value as was done with the regular breeding values for weaning and yearling weight. This procedure would have little information if it were not for the opportunity to look up the weaning ratios of all calves of the daughters of the paternal or maternal grandsire in the herds in which they were used. See the example of the selection worksheet for maternal breeding values on the attached sheet.

Real problems exist to include fertility information. The values of m and n of the relatives with the value of the possible average number of calves (m') would give a good picture of fertility if one could assume that all calves were recorded, but they are not in most performance programs. Use of the calf crop percentage of the dam is probably all that is practical at this time. This is unfortunate because fertility is much more important than milk production. However, this will serve to get breeders thinking about measuring maternal traits.

Use of maternal breeding value ratios by breeders can help breeds maintain their superior maternal performance while still improving feedlot growth rate. Without these maternal performance indications it would be possible to loose a maternal advantage by going all out for size and growth rate. This represents another opportunity for creative breeders to develop sound breeding programs. The breeds that survive the intense competition for the commercial man's germ plasm dollar will be those breeds having an association that provides them a sound performance program and breeders willing to adopt the new technology in practical breeding programs.

ANGUS HERD IMPROVEMENT RECORD

PRODUCTION MEASURE

SELECTION WORK SHEET

MATERNAL WEANING

ANIMAL INFORMATION										AVAILABLE INFORMATION								RANK	REMARKS
CALF IDENTIFICATION NUMBER	SEX	TATTOO LEFT EAR	TATTOO RIGHT EAR	BIRTH DATE MO.	DAY	YR.	SIRE REGISTRATION NUMBER	DAM CHAIN NO.	DAM REGISTRATION NUMBER	ADJ. WEIGHT (DAM PROG)	WEIGHT RATIO	PATERNAL HALF SIBS (PGS) NO.	AVERAGE RATIO	MAT. HALF SIBS (MGS) NO.	AVERAGE RATIO	PROGENY (SIRE) NO.	AVERAGE RATIO	BREEDING VALUE RATIO	SELECTION DECISIONS
						PGS	4017278	MGS	2274749			12							
512	B	512	512	3	18	75	7494970	51	4022492	4	113	51	104					106	
						PGS	4017278	MGS	7027439			12		2					
51	B	51	51	1	6	75	7494970	31	7796529	1	117	51	104	2	116			105	
						PGS	4017278	MGS	7027439			12		2					
54	B	54	54	2	1	75	7494970	34	7796530	1	115	51	104	2	116			105	
						PGS	4017278	MGS	5447597			12		10					
511	B	511	511	3	17	75	7494970	86	6726237	4	93	51	104	30	102			101	
						PGS	4285114	MGS	5037196			31		28		49			
52	B	52	52	1	15	75	5037029	74T	6973344	3	91	54	102	54	103	102	101	100	
						PGS	4017278	MGS	4017278			12		12					
59	C	59	59	3	11	75	7494970	27	7490338	2	100	51	104	51	104			103	
						PGS	4017278	MGS	5037196			12		28					
510	C	510	510	3	13	75	7494970	75	6973324	3	101	51	104	54	103			103	
						PGS	4017278	MGS	3512902			12		58					
53	C	53	53	1	16	75	7494970	607	6653871	4	103	51	104	208	101			103	
						PGS	4017278	MGS	5955603			12		52					
55	C	55	55	2	10	75	7494970	96	6973350	2	102	51	104	82	100			102	
						PGS	4285114	MGS	5447597			31		10		49			
415	C	415	415	12	9	74	5037029	4	6890715	2	103	54	102	30	102	102	101	102	
TOTAL CALVES:				10															

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.

RECORD USE IN THE SHOW RING

R. L. Willham

Iowa State University

Even with the shift from purely subjective appraisal to more objective means of evaluating the breeding value for economic traits, the show circuit is a viable part of the beef industry and reportedly is demonstrating the "modern" type that is growthy, sound, and muscular. Well defined performance tests are readily available to the beef industry. They are simple to conduct and provide records useful in estimating the breeding values of animals for the commercially important traits. Such evaluations can easily be eclypsed or enhanced by show ring winnings, even using untested relatives.

The purpose of this is to consider the role of records in the show ring. This is done by looking at some relevant genetic concepts and outlining opportunities for the integration of the means available to evaluate the commercial breeding value of beef animals.

GENETIC CONCEPTS

Consider some concepts that will clarify what has been accomplished genetically in the show ring and what can be hoped for in the future. Humans have always perceived the world in terms of differences. It takes at least two animals to make a class and, unless there is deviation from the norm, genetic influence is unobservable. The science of genetics and, consequently of animal breeding, deals exclusively with differences, never with absolutes. The concept of heritability involves differences. Heritability is defined as the fraction of the differences among animals treated alike, as nearly as is possible, that are hereditary. Heritability of a trait is useful in determining the average change to be expected in a group by selecting superior parents. The fraction of the superiority of the parents transmitted to the progeny is the heritability. Note the use of the word difference.

Three general classes of traits exist in beef cattle: reproductive, physiological, and morphological. The reproductive complex is lowly heritable. The physiological traits, such as growth rate, are moderate (20-50%), and the morphological ones, such as skeletal structure, are highly heritable (50-80%). These evaluations of heritability are from measuring differences among animals treated alike. The heritability of a trait can be drastically reduced when environmental differences are an important part of the variation. Bringing animals together from extremely diverse environments reduces the heritability of the differences that are observable in the ring. In fact, with the exception of the very highly heritable morphological or structural traits, there are few traits that have a reasonable fraction of the differences that are heritable. Except through the genetic correlations with structural traits, differences in reproductive or physiological traits (such as gain in the show ring) are mostly environmental. Based on this premis, it is relatively easy to account for the changes made by the show ring and those that are currently being made. Long bone length is very highly heritable; no matter how the animal is treated, skeletal structure develops first. Thus, to refine the ox for beef production, selection for short long bone length reduced general size and, because of the genetic relationship with rate of maturity, tended to decrease the time at which fat was deposited. This achieved the desired result of a thick, blocky animal that matured early and had a relatively small mature size.

Today, the judges are again influencing long bone length, only in the opposite direction. Selection for long bone length increases general size and, as a result of the genetic relationship with rate of maturity, tends to increase the age at which fat is deposited. The result is a long, tall and relatively immature individual that has little fat deposited. Some selection appears to be done on immature form at a given age. This, coupled with increasing long bone length, makes for large mature size which is not desirable. What upsets the person looking at commercial production is the fact that measuring growth rate through the relevant commercial period is really so easy and measures directly the trait of economic importance, rather than using an indicator trait.

This is not the only factor basic to the problem of beef improvement. Another factor is the concept of type, that ideal combination of characteristics that better fit an animal for a specific purpose. To assert what "modern type" is without letting the animals perform and then looking at the resulting ones, puts a definite limit on the variation from which to select superior performance since only those that conform to a type can be chosen. Replacing the static idea of type with the dynamic notion of an interbreeding population moving erratically at variable speeds towards an unknown future, is ranked as the greatest conceptual revolution in biology. And Darwin started it. Really, beef breeders are moving their herds in a direction, not really toward a goal or a formalized type. Goals or directions must, in the final analysis, be in terms of economic relevance to the commercial producer, not of a formalized concept of "modern type".

OPPORTUNITIES

Performance that is of relevance to the commercial industry, in the end, must dictate type. Much greater opportunity to achieve in a given direction exists when beauty, pride of ownership, etc. are relegated a second place position. After all, beauty is in the eye of the beholder. The long faced heifers look better than they once looked. Long bone length, what the show ring can influence, is really determined by setting the carcass weight desired, the percentage fat required in the carcass, and the availability of nutrients to specific cow operations. Enough latitude exists in these to produce beef from coast to coast and from border to border.

It does not make sense in this day and age, when simple performance programs that measure relevant commercial traits are available in most beef breeds, to use eye judgement alone to access long bone length, or to use selection based on an indicator trait. The issue in beef production is the specification of the product offered for sale. But eye judgement can be used to evaluate structural soundness and the records used to evaluate performance. Bunk. There is no research evidence available that clearly defines what is sound structure in the beef animal. Judges and cattlemen assert what is sound structure based on their limited observations. Post legged animals are not in fashion right now. How simple it would be to design and conduct an experiment to evaluate how important various visible structural characters are to soundness and, as a result, to longevity. It would take time, but the result would be a much clearer idea of how important being sickle hocked is to longevity.

The show ring and performance evaluation can be integrated, but to do it correctly will require some drastic revisions in current show practices. Animals simply can not be compared on moderately heritable traits unless they have some common environment. The differences in performance due to environment (feed level), for example, can be so much larger than the genetic differences that comparison is impossible. To really integrate performance, the calves need to be fed a common ration from at least weaning to show time. Even then problems can arise. This takes the steer away from the youth. Having weight per day of age figures on each animal handed to the judge will not help. Possibly ratios with contemporaries would be better, but that ignores herd differences. And if a show string is kept, few contemporaries exist. For a judge to evaluate absolute performance information he must assume each animal in class has had maximum treatment. Fat thickness measures are more heritable than growth, but the figure comes from differences among animals treated alike. In a show situation, feed level, exercise, and other things can cause large differences making the heritability much lower.

From a geneticists point of view, what our youth are taught by show participation is suspect. Granting the responsibility they acquire, what they are seeing is that lavish care, proper blocking, correct set up, and other environmental crutches will, in the end, create the first place ribbons. The genetics has already been paid for by dad. In a world that is moving toward specification of product and animal units requiring minimum individual attention and real evaluation of genetic differences, what is being taught our youth may not be what they really need to learn.

SUMMARY

No livestock person will deny that the British show ring has and does have a profound impact on the beef industry. Shows are fun and the winners are promoted. In the business of raising breeding stock for the beef industry, promotion is critical. Promotion is no substitute for specified performance, but in our economy it is an essential complement! When measures of performance can be integrated into an event equally rewarding both aesthetically and economically as the show ring is today, that event will replace the show ring as we know it, but not before. Beef production must be competitive to survive. The ultimate purpose of a breeding stock industry is to sell breeding value to the commercial segment that it serves. Commercial producers followed the lead as breeding stock became more compact, but the newly introduced Continental draft breeds would not have been as successful as they have been if there had not been a need to convert cheap feed grain into beef with less fat. Breeds need to expend effort to become extremely relevant commercially to survive the competition. With only so much available selection pressure, it seems a waste to squander part of it on forcing a formalized type. To be modern requires that breeders understand their herds as an interbreeding population moving at a maximum rate in an anticipatory direction!

BIF Awards' Program

The Commercial Producer Honor Roll of Excellence

Chan Cooper	MT	1972
Alfred B. Cobb, Jr.	MT	1972
Lyle Eivens	IA	1972
Broadbent Brothers	KY	1972
Jess Kilgore	MT	1972
Clifford Ouse	MN	1973
Pat Wilson	FL	1973
John Glaus	SD	1973
Sig Peterson	ND	1973
Max Kiner	WA	1973
Donald Schott	MT	1973
Stephen Garst	IA	1973
J. K. Sexton	CA	1973
Elmer Maddox	OK	1973
Marshall Mc Gregor	MO	1974
Lloyd Nygard	ND	1974
Dave Matti	MT	1974
Eldon Wiese	MN	1974
Lloyd De Bruycker	MT	1974
Gene Rambo	CA	1974
Jim Wolf	NE	1974
Elmer Maddox	OK	1974
Henry Gardiner	KS	1974
Johnson Brothers	SD	1974
John Blankers	MN	1975
Paul Burdett	MT	1975
Oscar Burroughs	CA	1975
John R. Dahl	ND	1975
Eugene Duckworth	MO	1975
Gene Gates	KS	1975
V. A. Hills	KS	1975
Robert D. Keefer	MT	1975
Kenneth E. Leistritz	NE	1975
Marshall S. Mc Gregor	MO	1975

1976

Ron Baker	OR	1976
Dick Boyle	ID	1976
James D. Hackworth	MO	1976
John Hilgendorf	MN	1976
Kahua Ranch	HI	1976
Milton Mallery	CA	1976
Marshall Mc Gregory	MO	1976
Robert Rawson	IA	1976
Wm. A. Stegner	ND	1976
U.S. Range Experiment Station	MT	1976

The Seedstock Breeder Honor Roll of Excellence

John Crowe	CA	1972
Dale H. Davis	MT	1972
Elliot Humphrey	AZ	1972
Jerry Moore	OH	1972
James D. Bennett	VA	1972
Harold A. Demorest	OH	1972
Marshall A. Mohler	IN	1972
Billy L. Easley	KY	1972
Messersmith Herefords	NE	1973
Robert Miller	MN	1973
James D. Hemmingsen	IA	1973
Clyde Barks	ND	1973
C. Scott Holden	MT	1973
William F. Borror	CA	1973
Raymond Meyer	SD	1973
Heathman Herefords	WA	1973
Albert West III	TX	1973
Mrs. R. W. Jones, Jr.	GA	1973
Carlton Corbin	OK	1973
Wilfred Dugan	MO	1974
Bert Sackman	ND	1974
Dover Sindelar	MT	1974
Jorgensen Brothers	SD	1974
J. David Nichols	IA	1974
Bobby Lawrence	GA	1974
Marvin Bohmont	NE	1974
Charles Descheemaeker	MT	1974
Bert Crane	CA	1974
Burwell M. Bates	OK	1974
Carlton Corbin	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chesnut	WA	1975
George Chiga	OK	1975
Howard Collins	MO	1975
Jack Cooper	MT	1975
Joseph P. Dittmer	IA	1975
Dale Engler	KS	1975
Leslie J. Holden	MT	1975
Jorgensen Brothers	SD	1975
Robert D. Keefer	MT	1975
Frank Kubik, Jr.	ND	1975
Licking Angus Ranch	NE	1975
Walter S. Markham	CA	1975
Gerhard Mitteness	MN	1975

1976

Ancel Armstrong	KS	1976
James Bennett	VA	1976

Glen Burrows	NM	1976
Jackie Davis	CA	1976
Sam Friend	MO	1976
Healy Brothers	OK	1976
Jorgensen Brothers	SD	1976
Stan Lund	MT	1976
Jay Pearson	ID	1976
L. Dale Porter	IA	1976
Robert Sallstrom	MN	1976
M. D. Shepherd	NB	1976
Lewellyn Tewksbury	ND	1976

Continuing Service Awards

Clarence Burch	Oklahoma	1972
F. R. Carpenter	Colorado	1973
E. J. Warwick	ARS-USDA, Washington,DC	1973
Robert de Baca	Iowa State University	1973
Frank H. Baker	OK State University	1974
D. D. Bennett	Oregon	1974
Richard Willham	Iowa State University	1974
Larry V. Cundiff	U.S. Meat Animal Research Center	1975
Dixon D. Hubbard	USDA-FES, Washington,DC	1975
J. David Nichols	Iowa	1975

1976

A. L. ELLER, JR. - Extension Animal Scientist at the Virginia Polytechnic Institute and State University. Eller has been active in BIF since its beginning. He has served on numerous committee activities and has served as Eastern Regional Secretary of BIF.

RAY MEYER - Sorum, South Dakota was Red Angus Association representative to BIF. He was president of the Red Angus Association after and during his appointment as BIF representative. He has been active in committee work including the chairmanship of the Farm and Ranch Committee. Meyer ably served BIF as its president for 2 terms. Meyer and his family own and operate SODAK Red Angus Farm in north western South Dakota where they also produce many acres of wheat.

Commercial Producer of the Year

Chan Cooper	MT	1972
Pat Wilson	FL	1973
Lloyd Nygard	ND	1974
Gene Gates	KS	1975

1976 COMMERCIAL PRODUCER OF THE YEAR

RON BAKER - Hermiston, Oregon is the BIF Commercial Producer of the Year. Beginning as a rancher in 1955 and establishing a commercial feedlot in 1957, Baker is now President of C & B Livestock Company. This company includes divisions for ranching, beef improvement, farming and feed yard. Its procedures, practices and philosphies typify many BIF recommendations. The current scope of the operation includes ranching operations of more than 2,000 cows and the feed yard division with an 18,000 capacity. Key improvement practices includes sire selection, progeny testing, heifer selection, carcass evaluation, AI for extended use of superior sires.

Breeders of the Year

John Crowe	CA	1972
Mrs. R. W. Jones	GA	1973
Carlton Corbin	OK	1974
Leslie J. Holden	MT	1975
Jack Cooper	MT	1975

1976 SEEDSTOCK PRODUCER OF THE YEAR

JORGENSEN BROTHERS - Martin and Don, Registered Angus breeding partnership, Ideal, South Dakota, is the BIF Seedstock Producer of the Year. The award commends the Jorgenson's for being outstanding in demonstration of beef improvement principles. The 250 cow operation which involves approximately 5,000 acres oringinated as a commercial operation 30 years ago and changed to registered cattle breeding in the late 1950's. In the early 1960's they acquired 4 certified-meat sires. About 5 years later they began using their own sires and concentrating on rigid culling of the cow herd. Soon they were emphasizing the use of yearling bulls exclusively to increase genetic improvement. The partnership has previously been recognized as Master Seedstock Producers and Master Swine Producers by South Dakota Associations and has received BIF citations for excellence in breeders in 1974 and 1975.

Organizations of the Year

Beef Improvement Committee, Oregon Cattlemen's Assn.	1972
South Dakota Livestock Production Records Assn.	1973
American Simmental Association, Inc.	1974
American Simmental Association, Inc. (Breed)	1975
Iowa Beef Improvement Association (BCIA)	1975

1976 BREED ASSOCIATION OF THE YEAR

THE AMERICAN ANGUS ASSOCIATION is the BIF Breed Organization of the Year, based on breed improvement activities. Richard Bell of Osceola, Iowa is President, Lloyd D. Miller is Executive Secretary and Fred Francis is in charge of beef improvement activities. The program includes weaning weights on 75,400 calves and yearling weights on 29,969 animals. Eleven hundred and thirty nine breeders reported performance data. The performance pedigree began in 1967; National Sire Evaluation and open AI began simultaneously in 1972. Maternal breeding values were calculated in 1975. The Association's commercial program links these improvement activities recommended by BIF to the commercial farms and ranches.

1976 STATE BEEF IMPROVEMENT ORGANIZATION OF THE YEAR

THE NORTH DAKOTA BEEF CATTLE IMPROVEMENT ASSOCIATION, Lewellyn Tewksbury, President and M. A. Kirkeide, Secretary is the Beef Improvement Federation's state organization this year. Collecting and adjusting 101,053 individual calf records and 8,265 yearling records from 918 herds, the organization tops all similar groups in the excellence of its program this year. Over 101,050 cows in the state have been individually identified as part of the total program. Members received cow herd summaries and the Association sponsors a "Super Cow Contest" at the North Dakota State Fair. Meetings and schools for breeders are designed to up-date them on interrupting herd reports, sire and cow herd certification project, and USDA carcass evaluation program and the super cow contest.

The Pioneer Awards

Jay L. Lush	Iowa State University	Research	1973
John H. Knox	New Mexico State University	Research	1973
Ray Woodward	American Breeders Service	Research	1974
Fred Willson	Montana State University	Research	1974
Chas. E. Bell, Jr.	USDA - FES	Education	1974
Reuben Albaugh	University of California	Education	1974
Paul Pattengale	Colorado State University	Education	1974
Glenn Butts	Performance Registry Internat'l.	Service	1975
Keith Gregory	US Meat Animal Research Center	Research	1975
Bradford Knapp, Jr.	USDA	Research	1975

1976

FORREST BASSFORD - Denver, Colorado - Journalism

Forrest Bassford has been a champion of progressive livestock production. In his role with the Western Livestock Journal, Bassford has kept his reading public abreast of the progress in performance testing and crossbreeding. Where breeders were willing to scoff at change, Bassford was able to temper their judgement with reason and openmindedness. Bassford has been a friend to the performance movement.

DOYLE CHAMBERS - Baton Rouge, Louisiana - Research

Dr. Chambers is Dean of Agriculture at Louisiana State University. For many years he taught Animal Breeding and conducted research in beef cattle which provided the performance movement with many answers. His work included studies in growth and efficiency, heritabilities, inbreeding and the like. Many of today's top research men in the beef industry studied under Chambers.

MRS. WALDO EMERSON FORBES - Sheridan, Wyoming - Breeder

Mrs. Forbes has been a leader in the performance movement since its early days. The Forbes family were among the earliest Red Angus developers. She was instrumental in making the Red Angus breed one which required performance data for registry. She has been most active in Performance Registry International, in Beef Improvement Federation and in many other cattle organizations.

C. CURTISS MAST - Blacksburg, Virginia - Education

Mast was in on the ground floor of performance testing. He was instrumental in developing the first Beef Cattle Improvement Association -- the Virginia BCIA which has served as a model for many others in methodology, success and continuity. Mast was keynote speaker at one of the BIF Conferences and has played a continual leading role in BIF.

DR. H. H. STONAKER - Fort Collins, Colorado - Research

Dr. Stonaker spent many years in teaching animal breeding and in conducting beef breeding research in Colorado. His research into genetic and applicational opportunities in beef cattle has given us much insight applicable in BIF. Through his research into growth, linebreeding and inbreeding some of the most popular.

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