SELECTING AND BREEDING THE UNIQUE BRAHMAN

PART I - INTRODUCTION

The American Brahman, unique in many ways, differs from cattle of European origin in form, physiology and genetic make-up. The Brahman is generally utilized to complement rather than compete with others breeds. Even though the same basic genetic principles operate for Brahmans as for any other breed, goals are different and the gene pool and distribution of the Brahman population is different. It follows, then, that breeding and selection programs for the Brahman should be designed especially for this breed.

Foundation stock for the American Brahman was introducted and the breed developed for reasons more definitely established and more logical than those for any other breed introduction into the United States. The primary purpose was to obtain the ability to thrive in the Gulf Coast and surrounding areas. This semi-tropical environment is characterized by hot, humid weather and low quality forage. Uncounted generations of natural selection under similar conditions had developed in the humped cattle of India the ability to survive and reproduce in such an environment. Selection within the European breeds available in the United States in the early 1900's for a comparable level of adaptability to the Gulf Coast, if possible at all, would have taken hundreds of years. Development and utilization of the Brahman breed in the United States and in the some 60 other countries which have followed the lead, is a prime example of wise utilization of genetic resources.

The newly introduced Brahman could be widely exploited only through mating imported bulls with cows which prevailed at the time in the U.S. The combining ability of Brahman sires is such crosses certainly must have contributed to the breed's esteem and popularity. Later, the 'inspired' performance of these first crosses came to be known as hybrid vigor or heterosis and methods for continuous utilization of hybrid boost were developed. Brahman hybrid vigor stands out among all crosses between breeds in the United States. The unique character of the Brahman in the U.S. and its breeding and selection requirements result principally from its:

1. Indian origin or classification as BOS INDICUS rather than BOS TAURUS.

2. Natural selection for adaptability to tropical or semi-tropical environments.

3. Ability to combine well in crosses, adding hybrid vigor in extra measure.

These characteristics of the Brahman for natural adaptation and hardiness for production in hot climates do not, however, contribute per se to high producing ability in temperate climates with improved conditions. Here the Brahman gains its eminence through its genetic reservoir. A complement of Brahman genes has the capacity to create in crossbred progeny qualities of adaptability and hybrid vigor. The genetic uniqueness of the Brahman provides high levels of both.

Nonetheless, Brahman crossbreds must be competitive with all other breeds of cattle - both beef and dairy. Keeping Brahman uniqueness in mind, it is still necessary to consider them in context of current trends in beef production.

Beef cattle breeding and selection has improved continuously in the United States since 1900, when the science of genetics was founded. This trend has been stimulated by economic conditions and technical developments in breeding. As expected, the pace has tended to increase so that the last few years have been the most dramatic. Planning for change, which is inevitable, has paid dividends for breeders with foresight. The increasingly dynamic nature of the beef industry places even more value on advance planning.

Selecting and breeding cattle is an investment of capital and other resources. But it seems that breeders give too little thought to the future when making breeding and selection decisions and plans. There is always danger in projecting into the future, but some general trends in beef cattle breeding and selection seem fairly certain at this time. Even if prediction is hazardous, beef cattle breeders must do so because of the long time taken for results of breeding and selection programs to have an impact.

Noticeable results require the cumulative effects of several generations of consistent effort. An average of generation interval in cattle, the time required to replace a herd with a new set of their selected progeny, is at least five years for most breeds and probably six or more for the Brahman.

Major trends in the beef cattle industry which appear reasonably certain to occur over the next 10 to 20 years and which are reasonably certain to affect Brahman breeding are summarized below:

1. An increased emphasis on objective, accurate measurement of breeding value for economically important production traits. There will be more demand for well-designed record programs so that performance of the progeny of a sire or dam can be predicted more accurately. Data collected on growth will include weight at weaning, postweaning average daily gain and yearling or 18-month wight. These records on individuals will be used to evaluate their breeding value, but we will witness increasing use of cumulative data on progeny to obtain rather sophisticated, computer analyses of breeding value, but we will witness increasing use of cumulative data on progeny to obtain rather sophisticated, computer analyses of breeding value. Added to growth data will be mature weight and fertility records. Pedigrees will have performance data added to them - ancestors listed in a pedigree without performance data will become almost equivalent to a short-ended pedigree (unknown or unqualified ancestors).

2. Increased use of exotic and dairy breeds. At present there are many people breeding continental European breeds for speculation - without any intention of becoming established breeders. Nevertheless, many of these breeds, if not all, will have an impact on commercial beef production in the U.S. The Brown Swiss, Holstein end Jersey have made new inroads into beef production. There will be more breeds with a wide range of characteristics. If a producer is convinced any breed or combination of breeds will increase profits, he is going to use them much more readily than in the past. Hard earned experience will be gained in learning how to best feed, manage and market some of these cattle. Marketing difficulties will be worked out more quickly than in the past, largely because of the influence of large feedlots. The Brahman, of course, was the original exotic of the 20th century and now stands to gain a larger share of the market. The current exotics will enhance rather than cut into the Brahman's market.

3. Use of crossbreeding will become much more widespread and systematic. Crossbreeding will be utilized to (a) gain desired traits of combinations of traits (b) capitalize on hybrid vigor, especially in the cow and (c) match breeding in the cow herd with specific sire breeds to increase efficiency of production and retain desired growthiness in the calves (complementarity). More and more producers in all parts of the country are considering crossbreeding and learning more about how to best utilize it. Crossbred cattle have become respectable and even prestigious, especially if they are "hybrids" for "F1's". But hybrid cattle will not predominate to the same extant as hybrid corn or even hybrid swine. One reason is that the relatively low fertility of cattle requires a large percentage of purebreds in order to sustain an efficient hybrid system.

4. AI of beef cows will increase, especially in the purebreds. The consent decree handed down July 9, 1970, in the case of the American Angus Association opened the doors and all associations will be required to adopt liberal AI rules and regulations to avoid unlawful restraint of trade. Apparently, the only restrictions which will be permitted are those based on maintaining or protecting the quality or genetic purity of the breed. More widespread use of AI within a breed (i.e. without ownership restrictions) has the effect of providing a mechanism for a breed, considered as a whole, to change more rapidly. The change may be either to more uniformity or to more variability, depending on how it is used.

These trends are associated with, or are a part of, developments which are non-genetic. There is an increasing awareness of the benefits of applying techniques of managements, financing, etc. to the cattle business just as in other industries involved in producing a product. Increase in the number of large cow-calf operations, which probably will become more numerous along with an increase in the average size of operations, will be a major factor in bringing about adoption of sound, modern business practices. The availability and adaption of high speed computers to almost all businesses is convincing evidence that even those segments of the beef cattle business not yet using computer power will do so in the future.

There is little doubt that efficiency of beef production (in terms of return on investment) will be emphasized. Specialized management, feeding and marketing will be employed Specialized cattle will be utilized; i.e. breeds to fit special functions or needs will be required. Certainly there is an array of breeds with a wider range of characteristics than we ever bad before. For example, consider size differences such as that between Jersey and Chianina; or the milking ability difference between Hereford and Simmental. One question which arises is what role a breed as a whole should play. Should individual Brahman breeders be encouraged to diversify so that the breed can fill a wider variety of needs and thereby widen its market? Or should a breed conform to more rigid specifications so that their "brand name" will assure certain qualities?

The Brahman breeder, breeding cattle unique in their characteristics as a genetic reservoir, has a special challenge in breeding and selecting. The purpose of this discussion is to introduce the challenge within a context useful for discussing basic genetic principles applied to the Brahman.

PART II - SELECTION

In order for a breed to remain viable and for the breeders to make a profit, there must be a demand for the breed in commercial beef production. To remain to improve each generation so that the cattle can more nearly fulfil current demands. The first article in this series emphasized the need to think ahead and project beef production trends. In order to bring about improvement and remain current the breeder has only two procedures to apply: (1) selection and (2) breeding or mating plans. Although the two can't be separated in practice, this second article in the series will treat selection separately. The third article will discuss mating plans or matching sire and dam, and the fourth will describe selection and mating programs designed specifically for Brahmans.

Selection is simply choosing which bulls and heifers or cows are brought into the herd, how long they remain and how many opportunities they will be given to reproduce. Generally a cow, one selected, remains in the herd as long as she is productive, bus a bull may be bred to a few cows in only one year, to a few cows in several years, or to many cows (through AI) in many years. Thus, there are different degrees of selection. Culling, the extreme form of selection, completely eliminates an individual from the breeding herd, preventing further production of progeny.

BREED SELECTION

Selection is usually thought of as the process of choosing among individuals within a breed. More properly, the process of selection should be considered across all cattle rather than being limited to individuals. Some commercial producers, particularly those using crossbreeding, select sire on the basis of general breed characteristics, with relatively little attention to the individual. The Brahman, in fact, was introduced (selected) for its adaptability and crossing characteristics because selection within the breeds in the United States could not have been expected to yield these advantages within a reasonable time period. (We believe it is erroneous to assume that the Indian cattle which were developed into the Brahman breed were selected only because of their adaptability to Gulf Coast conditions. It appears, in retrospect, that Brahman crossing ability was an important, though not fully appreciated characteristic which, through the hybrid vigor of their crossbred progeny, led to their popularity). Even within a breed, selection may be based largely on characteristics of a line or reputation of a particular breeder's herd with little or no attention to be individual.

All of these levels at which selection is practised have their place but must be considered in proper context. Selection across breeds is usually of great magnitude and has great effect. Consider selecting a Holstein sire to put on Hereford cows to increase milk production. The effect would be dramatic. However, breed selection is a one time "shot" - you can't select a new breed and jet the same effect every year.

INDIVIDUAL SELECTION

This article will deal with selecting among individuals within the Brahman breed. Selection, long practised as an art, has been effective in molding almost all of the present day breeds. As with the practice of any art, the effectiveness of selection has varied widely according to the talent and attention of the breeder. An understanding of the scientific principles of genetics applied to selection is of very recent origin- only a few cattle generations back.

Understanding and application of principles rather than simply observing outcome can have two major effects: (1) improvements can be achieved more rapidly and (2) more breeders can acquire a "talent" that was once acquired only after a lifetime of experience.

In order for the scientific approach to have full effect, careful objective evaluation of traits is necessary. Subjective evaluations, some important and some of little or no importance, will probably always influence selection decisions. Some subjective scores such as temperament may, on occasion, be the most important consideration. However, quantitative, measurable traits have come to be recognized as the most important selection considerations. Weight is an example of an objective quantitative character. Weight at a given age, say at 365 days, is partly a function of the genes, of genotype, and partly a function or environment. Here environment is defined to include all non-genetic affects due to such factors as nutrition, health, temperature, humidity, etc. This function for weight of an individual may be expressed as

$$P = G + E$$

where: P stands for phenotype (weight in this example)
G stands for genotype
E stands for environment

emphasizing that weight of an animal at a given age is determined by both genotype and environment. For example, a typical Hereford simply does not have the genotype (G) to produce 12 000 lb. of milk a year regardless of the nutrition (E). A Holstein has the genotype (G) but cannot produce it without adequate nutrition (E).

We are generally interested in selecting from cattle which have similar environmental

opportunities (E) so that differences in P among cattle being considered for selection tend to reflect differences in G; that is, we are interested in selecting sires and dams that are superior for some trait because of their superior genotype, not because they have had superior opportunities. When it is impossible for two individuals to have similar environmental opportunities, correction factors may be applied to improve the accuracy of comparing individuals. Weaned calves from first-calf cows do not have the same nutritional opportunities (E) to gain weight up to the usual 205-day mark as do calves from mature cows. Therefore, the 205-day weight is corrected upward to equalize the E value so that the P values more accurately reflect G values of the calves. An analysis of data from several Brahman herds (Fitzhugh and Cartwright, 1970)
indicated that calves from young Brahman cows need less correction to the mature equivalent than calves from the British breeds. The special set of weaning weight correction factors for Brahmans developed from this analysis are being used in the breed's official BHIR program.

The effects of good husbandry - adequate nutrition, disease control, and other good management practices - should not be confused with good genotype. Some herd prospects - superior genetically - are passed over because they have not been managed as well as other cattle. A simple example: if any, herd replacements would be produced by two-year-old would be expected to be genetically the same as a calf from the same cow (and same sire) when she was six years old. Selection, to be effective, should distinguish superior breeding value - the heritable part of an individual's phenotype which will be passed on to the next generation.

HERITABILITY AND BREEDING VALUE

The term "heritability" indicates the relative influence or contribution of G compared to E in causing differences among individual cattle. Heritability actually estimates only the portion of G which, on average, is transmitted from sires and dams to progeny in a typical herd' that is, the portion due to breeding value. Heritability varies from character to character (see Table I) and is useful to the breeder in the following ways:

1. To estimate the expected response or change from selection for a character.

2. To estimate the breeding value for an individual; that is, to determine the accuracy with which and individual's phenotype can be performance of his (or her) progeny.

Response to selection depends on the level of heritability and the intensity of selection. for example, if a bull is selected which weights 1 040 lb. at 365 days and the herd average is 920 lb., he is 120 lb. above average.

Heritability of 365-day weight is high around 50%. On the average, the bull progeny of this selected sire bred to average cows would be expected to exceed the herd average (920 lb. by 30 lb., calculated as follows:

$$\frac{.50 \times 120 \text{ lb.}}{2} = \frac{60 \text{ lb.}}{2} = 30 \text{ lb.}$$

The bull progeny of this selected sire would be expected to average 950 lb. at 365 days (920 lb. + 30 lb. = 950 lb.). This calculation is the heritability fraction (,50) of the selection differential (120 lb.) divided by 2 since only the sire was selected and bred to average cows. The sire transmits one-half of the genes and the dam the other one-half to the progeny.

It is obvious rom this example that the higher the heritability, the greater the response. Likewise, the higher the intensity of selection (or selection differential), the greater the response. Some characters respond well to selection, while others do not.

Any observant breeder is well aware of this fact, whether her refers to it as heritability or has gained the concept from his experience and knowledge. Heritability is a convenient term which makes it possible to utilize information from controlled research for practical application.

Breeding value can be estimated from the individual's own phenotype (record of weight, etc.). For characters of high heritability, the individual's own record is expected to be a reliable indicator of breeding value. For a character of low heritability, additional information from relatives and indicator traits are needed to increase the accuracy of estimating the individual's breeding value. The breeding value of a sire predicts the deviation of his progeny's average from the herd average, assuming the progeny are from matings with "average" cows.

PEDIGREE, PROGENY TEST, SIBS AND INDICATOR TRAITS

Relatives providing information to estimate breeding value include ancestors, progeny and collateral relatives, such as halfsibs (a sib is a brother or sister). Although use of this type of information has a great deal of theoretical appeal, the data (records) required are often either not available or not suitable for evaluation. There is no way to go back and get the weaning weight of a sire, for example, if he was not weighed at the appropriate time. If he was weighed, there is still the problem of properly accounting for the environmental conditions when the sire was weighed. Information from relatives can be more misleading because of more differences in environment (E) than most breeders generally recognize.

The accompanying pedigree (Table II) shows at a glance that going back beyond the sire and dam to the grandparents adds very little to evaluation and beyond that point almost nothing (pedigrees do have other uses as will bee seen). Be especially cautious about using information from any ancestor in the pedigree if the line of information is broken; for example, if the sire record is missing the record of the paternal grandsire should carry little or no weight. At best, missing the sire's record sharply lowers the accuracy of estimating breeding value from ancestral performance; at worst, the record may not be made available because it was unimpressive. The sire cannot pass on some particular desirable genes from the grandsire if he did not get them from him.

The breeding value of a sire or dam can be estimated from progeny testing. The number of progeny records averaged is a major factor influencing the accuracy of estimation. As a rule of thumb, five calves per progeny group are needed to equal the accuracy of estimating a parent's breeding value from his (of her) own individual record. Progeny testing with cattle is thus more useful for sires because of the time required to obtain five progeny per cow.

Each calf in a progeny group has received a sample half of the parent's genes. If the calves included in a progeny group are either all of the progeny or a random sample (not, a select sample of the best progeny) and if all progeny groups have been given equal opportunity, then twice the difference between the progeny averages for two sires, for example, will tend to equal the difference between their breeding values (G). Failure to include enough progeny in die group, failure to use either all progeny of at least a truly random sample or failure to provide the same environmental opportunity to all progeny groups will invalidate progeny testing as a means of estimating breeding values.

Information on half-sibs is similar but less useful than that from progeny tests. In a sense, the half-sibs are used as a combination progeny testpedigree evaluation since the half-sibs are used as progeny to prove the sire and the proven sire is then used to indicate the breeding value of the individual under consideration, which is his offspring.

TABLE I

The heritability estimates below are based on averages taken from research reports and experience of the authors.

Trait	Heritability
Birth Weight	,40
Weaning Weight	,30
Weaning Score	,32
ADG, Feedlot	,50
Efficiency Food Conversion	,50
ADG, Pasture	,35
12-Month Weight	,50
18-Month Weight	,60
Mature Weight	,70
Slaughter Grade	,35
Dressing Percent	,45
Carcass Grade	,45
Rib-Eye Area	,45
Retail Cuts, Percentage	,40
Tenderness	,60
Temperament	,35
Calving Interval	,05
Semen Fertility	,30

Levels of heritability and genetic correlations may be divided for convenience as follow:

Very High	,60 and over
High	,50 to ,60
Medium to High	,40 to ,50
Medium	,30 to ,40
Low to Medium	,20 to ,30
Low	,10 to ,20
Very Low	0 to ,10

Genetic correlations indicate the degree to which selection for an "indicator" trait will also change another, correlated trait. For example, many of the same genes which affect feedlot gain likewise affect feedlot efficiency of gain (gain/feed) during the same time period. The genetic correlation between gain and efficiency is approximately 0,7.

Since both traits are highly heritable, selection for gain will also improve efficiency of feed conversion without the effort required to take individual feed consumption to measure efficiency. This type of indirect selection can usually best be accomplished using a selection index, as described in the next section.

Genetic correlations are also useful for predicting the various consequences - favourable and unfavourable - of selection for a given trait. Since weights at weaning, 12 months, 18 months, etc., are positively correlated with weight at maturity, positive selection for any one will tend to increase mature weight and, hence, increase nutrient costs of maintenance.

Selection based solely on performance of relatives or on indicator traits is rarely as successful as selection based on the individual's own performance. However, as such information is accumulated in a well organized record keeping program, its use may substantially augment the accuracy of selection, particularly when combined in a selection index.

SELECTION INDEX

A selection index provides a consistent selection procedure combining properly weighted observations on the individual and his relatives for either a single trait or for many traits. The development of a selection index designed to the specifications of a particular situation is a relatively complicated statistical procedure, even on a large computer.

In concept, however, the selection index simply accounts for the heritability of each trait, the correlations among the traits, the closeness of relationship to, relatives and the economic value of the selected traits.

An example of a simple selection index used in Colorado to evaluate gain tested bull is:

1 = 205-day weight + 50

(ADG on postweaning gain test). The weight and gain records for each bull are "plugged in" this index equation to yield a single index value. A bull with a higher index would be favoured over a bull with a lower index.

205-Day Postweaning

BULL	**WEIGHT TEST ADG**
A	416 2,80
B	491 2,66

I or Index value

416 + 50(2,80) = 556
941 + 50(2,66) = 623

Bull B has an index of 623 which is obviously more desirable than the index value of 556 for bull A. This particular index equation gives about twice as much selection emphasis to weaning weight as to ADG on postweaning test.

An index we developed was used to rate bulls entered in the International Cattlemen's Expo held in Las Vegas in 1969. The selection index used for evaluation of growth was:

I = 1 500 + 2,3(205-day wt.) +
4,6(Gain, 205 days to 12 mo.) + 5,5(Gain, 12 to 18 mo.)

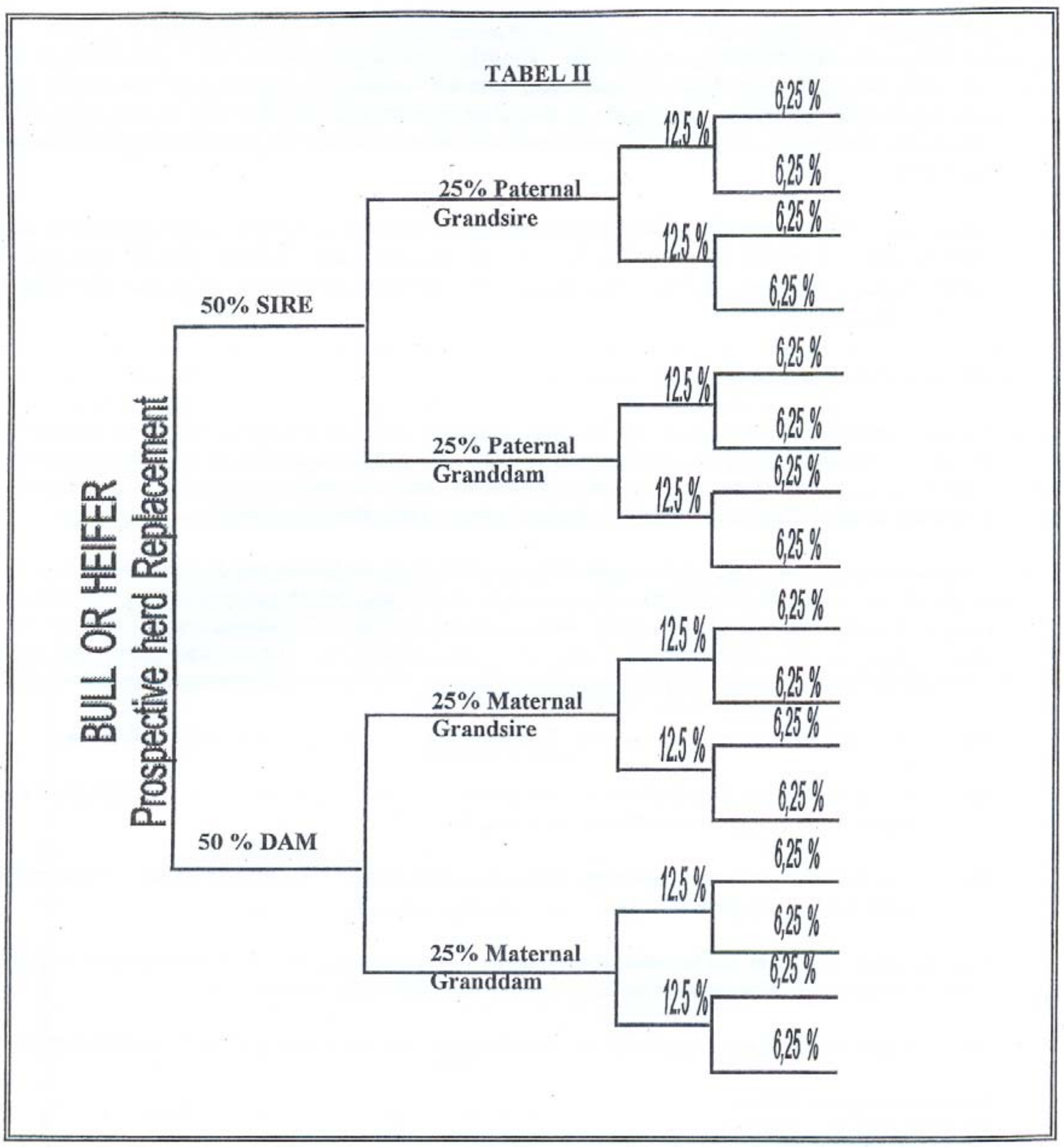
The selection emphasis given by this index is greatest for gain from 12 to 18 months (about 43% of the total) followed by gain from 205 days to 12 months (about 36%) and 205-day weight (about 21%). The value of 1 500 is a constant which was added so that an ultimate bull would reach an index value of 10 000; it does not affect the ranking of a bull.

Neither of these examples of selection indices for beef cattle are really adequate for fulfilling the objectives of most Brahman breeders. Selection programs specifically for Brahmans will be the subject of the fourth article is this series.

SPECIAL SELECTION CONSIDERATIONS

Data from ancestors, progeny, collateral relatives, and correlated traits were indicated for secondary rather than primary use in evaluating breeding value. There are, however, some cases where data from these sources become primary:

1. Evaluation of traits limited to one sex. Breeding value of a sire for milking ability of calving ease must depend on the records of his dam, daughters, or sisters.



2. Evaluation of traits that would destroy the individual. Breeding value for carcass or meat characteristics can be evaluated either through indicator traits or data from carcasses of progeny of sibs.

3. Traits very low in heritability or very difficult to measure. In order to estimate breeding value for cow fertility, many years are required to accumulate sufficient data. Indicator traits and information from relatives may replace direct measurement on the individual.

4. Evaluation of general combining ability. Combining or crossing ability (to be discussed under mating plans) can only be measured in the crossbred progeny.

INTENSITY OF SELECTION

Intensity of selection of selection differential was referred to earlier. (The example used was for a selected bull weighing
1 040 lb. where the herd average was 920 lb. The selection differential was 1 040 lb. less 920 lb. or 120 lb.) Obviously, the greater the selection differential, the greater the improvement expected from selection for that trait. For this reason, keep selection programs as simple as practical and limited to only include traits of definite importance. Each additional trait considered in selection reduces the selection intensity possible for each of the other traits.

The majority of the potential for selection improvement (selection differential) must come through the sire side. However, the dam side should not be ignored. The selection differential for heifers depends very much on net fertility, mortality and longevity. These traits are also very important economically and may be greatly improved by good management.

QUALITATIVE TRAITS

As indicated earlier, the most important traits are quantitative traits controlled by many pairs of genes. These include growth rate, maturing rate, weight at various ages, milking ability, adaptability, temperament, intelligence, conformation, carcass characteristics, and meat qualities. However, there are a number of qualitative genetic characters, controlled by one or a very few pairs of genes, of importance to breeders.

The polled-horned character, which is quite simple genetically in the British breeds, is conditioned by one pair of genes. However, in the Brahman there are at least two pairs which make inheritance somewhat more complicated. An Angus bull, for example, will not completely "dehorn" Brahman but will "dehorn" Hereford cattle. A third pair of genes controlling scurs also adds some complications. The dominant polled gene possessed by British breeds (Angus and Polled Hereford) is most familiar. There are three genotypes possible for this pair:

HH Two dominant genes for polledness. This genotype is homozygous or pure for polledness.

Hh One dominant gene for polledness and one recessive gene for hornedness. This genotype gives a polled individual in British cattle which is not a "true breeder".

hh Two recessive genes for hornedness. This genotype is homozygous for hornedness - all horned British cattle are homozygous.

This dominant polled gene has become infused into the American Brahman. In Brahman crosses it apparently does not always cause polledness in the heterozygous state, especially in bulls. The

Brahman has a recessive gene, apparently at a low frequency, for polledness called African hornedness:

HaHa Homozygous, horned.
Haha Heterozygous, Horned.
haha Homozygous, polled.

There are a number of lethal or otherwise undesirable genetic characters in every breed. These characters, such as dwarfism, are almost always due to a homozygous state of recessive genes. Since the heterozygote or carrier is not affected (at least, is not grossly affected) these genes are often harboured in cattle populations. No one of these characters is serious unless it builds up to a high frequency, such as dwarfism once did because of selection preference for the carrier which was slightly more compact. However, the many different kinds of these undesirable characters cause some problems through death loss and reduction of the selection differential. When an undesirable genetic recessive appears in a herd, almost all selection effort has to be placed on getting rid of the recessive genes with none left for improvement of quanitative traits. It is wise for a breed to encourage its breeders to cull any sire of dam having one or more genetically defective progeny.

In this way, the frequency of all undesirable recessive genes can be kept very low. Genetic trash, as these genes are called should be kept at a low level to protect the reputation of the breed as well as to avoid undue losses from dead or deformed calves and decreased positive selection pressure. Certainly, bulls going into wide Al use should be carefully evaluated for being carriers or tested by mating to carriers or daughters (test mating will be discussed in the next article). The qualitative genetic traits of greatest interest to most purebred cattle breeders are hair colour and skin pigmentation. Colour and pattern have often served as the "trademark" of a breed and, as such, have often acquired disproportionate economic value. Otherwise outstanding individuals have been eliminated from the breeding population because of trivial faults in colour or pattern. Of course, colour and dark skin pigmentation in the Brahman has been an effective adaption mechanism against the intense sun radiation of the tropics and semi-tropics.

The general mode of inheritance of hair colour and pigmentation is well documented from studies with many species. Genes affect the type and distribution of melanin in the skin and hair. There are two basic types of melanin: eumelanin - yellow or reddish. Various colours result from mixing pigment granules of these two types.

Very little research on colour inheritance has been done with Brahmans, however, observation of Brahmans and their crossbred offspring indicates that the Brahman breed carries genes for bridling, restriction of black (giving red colour) and recessive dilution (giving the grey or silver colour). Again, observation
suggests that colour inheritance in the Brahman no doubt involves some different genes (or alleles) than are formed in European cattle. The Brahman breed, as any breed, is composed of the cattle of the many individual breeders. The continued development and improvement of the breed depends to a large extent on the correctness with which breeders set their selection goals and the dedication with which they apply selection within their herds.

In die current swirl of new and redirected breeds, the Brahman enjoys a future which is basically sound and bright. But the beef industry is dynamic and constantly seeking better choices with less traditional breed loyalty. Selection is the mechanism by which individual breeders and the breed can remain viable.

GUIDELINES FOR BRAHMAN SELECTION

* Establish Selection Objectives Carefully For Future
* Limit Number Of Traits Selected
* Concentrate on Important Economic Traits
* Provide Uniform Management For Accurate Comparison
* Provide Good Management To Increase Selection Response
* Keep Records And Use Them For Making Selection Decisions
* Test Young Sires Freely, Include Your Own
* Test Sire In Purebreeding And Commercial Crossbreeding
* Turn Old Bull As Young Ones Are Proven
* Be Objective And Ruthless In Culling
* Make Introductions And Changes Carefully
* Be Consistent And Persistent In Selection

PART III - MATING PLANS

After setting his goals and selecting individuals superior for the traits embodied in his goals, the Brahman breeder must then decide which sire to mate with which dams. This decision will largely depend on the mating plan he uses. Basically, he can either ignore pedigrees to insure matings between related individuals (inbreeding) or between unrelated individuals (outbreeding). While mating of selected individuals with little or no regard for the pedigree may be the best cause for some breeders, wise use of the pedigree may be the best course for some breeders, wise use of the pedigree can be an effective tool in accomplishing goals of genetic improvement. To use the pedigree wisely requires understanding of the underlying genetic basis for the effects of each mating plan. First, let's consider inbreeding.

INBREEDING

Inbreeding, which may be practiced in several forms, results from the mating of a sire to a dam which is his relative; that is, they show one or more common ancestors in their pedigrees. The calf produced from mating a related sire and dam will be inbred; the degree of inbreeding will depend on the degree or closeness of relationship between the sire and dam.

When are two individuals closely "related"? Obviously, all cattle share common ancestors and, hence, are related. But generally, relationship is worth considering only when two individuals share common ancestors no more than five or six generations back. The degree to which two individuals are related is measured by the "relationship coefficient" which indicates the probable percentage of identical genes shared by the relatives because of their common ancestors (or because one individual is a direct descendant of the other). The relationship between sire and progeny is 50% meaning that 50% of their genes are identical because they are related.

Full sibs also have a calculated relationship coefficient of 50%; however, chance assortment and recombination of genes in the production and union of separate sperm and ova may cause the exact percentage of identical genes to vary slightly above or below the expected 50%. A number of other common relationships is given in the chart on relationships and inbreeding coefficients.

Genes occur on pairs; one member of each pair from the sire, one from the dam. If both members of a pair are identical, the individual is "homozygous" for that pair. Obviously, if the parents are related and thus share more identical genes than unrelated parents, the progeny of related parents will have a greater chance for homozygosity. The inbreeding coefficient for an individual measures this probable increase in genetic homozygosity due to the parents being related.

All of the consequences of inbreeding are explained by the increased homozygosity. The inbred animal itself is different and its breeding characteristics are different. Inbreeding
causes a general depression of vigor. Vigor is used here in a general sense to refer to all performance traits (gainability, size, fertility, hardiness, activity). The degree of inbreeding depression tends to increase as the degree of inbreeding increases. For example, the weaning weight of a calf is expected to decrease about one pound for every percentage point increase in his own inbreeding and an additional 3/4 pound for each percentage point increase of his dam's inbreeding. Lowly heritable traits, such as fertility, tend to be more severely depressed by inbreeding than highly heritable traits, such as mature size. Selection can somewhat counteract inbreeding depression but the effects of intense inbreeding overwhelm short-term selection efforts.

PREPOTENCY AND LINEBREEDING

Since inbreeding tends to depress performance, the inbred bull or heifer from selected, related parents will rarely perform or appear as well as noninbred individuals from similar, but unrelated parents. However, since the inbred individuals are more homozgous, they are more likely to breed true; that is, their progeny will bear a closer resemblance and will be more uniform than usual. This ability of a parent to stamp his progeny with uniform characteristics is called prepotency. The only truly predictable way to create prepotency is by inbreeding.

LINEBREEDING is a special form of inbreeding in which the primary objective is to perpetuate the favourable genetic characteristics of a superior individual. LINEBREEDING based on a favoured sire is accomplished by mating him to related cows (we can also linebreed to a favoured dam but the relatively fey progeny possible from a cow is a major limitation). The favoured sire may be bred to daughters, granddaughters, nieces, etc., as long as he lives; subsequently his sons, grandsons, etc. may be used to perpetuate the line. Very frequently, an outstanding sire is not recognized and appreciated until he is fairly old and logical mating choice are limited.

The degree of relationship of members of a line back to the favoured sire determines the degree to which his superior genotype is perpetuated. Relationships are increased by inbreeding; however, as pointed out earlier, inbreeding tends to depress performance. Thus, the objective of a good, practical LINEBREEDING program should be to maintain a high relationship between the superior foundation sire and the members of the line but to keep inbreeding low.

Inbreeding in any form, including line breeding, will depress performance and reveal inferior genes in homozygous form (see Next section on deleterious recessives). There will necessarily be a higher culling rate as lines are initiated.

Economic losses from this heavy culling can only be compensated for by the eventual evolution of lines of uniformly superior breeding value. Yet, this potential breeding value is essentially set by the foundation sire of the line. Obviously, therefore, lines should only be initiated when a truly superior individual is identified and better sires are not available. Identification of these superior sires should use all means available, especially performance records and ratios such as those available through the BHIR program.

COMMON RELATIONSHIPS BETWEEN SIRE AND DAM WHICH LEAD TO INBREEDING OF THEIR PROGENY

Type of Relationship	Examples	Relationship coefficient between Sire and Dam	Inbreeding coefficient of Progeny*
Parent & Progeny	Sire & Daughters - Dam & Son	50%	25%
Full Sibs	Brother & Sister (Same sire and dam)	50%	25%
Half Sibs	Half Brother & Sister (Same sire and different dams or same dam and different sires)	25%	12,5%
Grandparent & Grandprogeny	Grandsire & Granddaughter Granddam & Grandson	25%	12,5%
Great Grandparent & Great Grandprogeny	Great Grandsire & Great Granddaughter	12,5%	6,25%
First, Own or Full Cousins	Son and Daughter of sires which are brothers	12,5%	6,25%
Half Cousins	Sons and Daughters of sires which are ½-brothers	6,25%	3,125%
Second Cousins	Son and Daughter of sires which are first cousins	3,125%	1,5125 %

* Minimum. These values could be greater if there was inbreeding carried over from the sire and dam.

INBREEDING AND GENETIC DEFECTS

A common, very dramatic result from inbreeding is the increased incidence of genetic defects, many of which are lethal. At least some individuals in all breeds carry defective recessive genes. We usually do not recognize these carriers because the effect of their single deleterious gene is masked by the other, dominant member of the gene pair. These genes, called "genetic trash", have increased in some populations because carriers were favoured by selection. For example, when compactness was fancied as a desirable trait, carriers of the dwart gene were apparently favoured in selection because they were essentially normal in appearance but jest a bit more compact, shorter headed and blockier.

Likewise, selection for very thick, muscular, trim steers, which are currently favoured, seems to favour carriers of the double muscled gene may increase in frequency.

Inbreeding tends to expose "trash genes". In fact, an important practical application of inbreeding is the testing for deleterious genetis recessives. For example, potential herd sire, particularly those expected to be used in AI, can be screened for carrying undesirable recessive genes by breeding each sire to his daughters. One defective offspring proves the sire to be a carrier: 32 or more completely normal offspring is excellent evidence that he is not a carrier.

There is generally strong natural selection against genetic trash and thus these undesirable genes are kept at low frequency. But while it is easy to reduce the frequency of undesirable recessive genes, they are also impossible to completely eliminate since carriers often appear entirely normal. Thus, even herds without a history of genetic defects are likely to uncover undesirable genetic trash if they initiate a program of systematic inbreeding. These recessive culling losses, plus the expected depression of performance, must be considered as part of the expense of an inbreeding program.

Inbreeding has both advantages and disadvantages. Depending on the situation, it may be the mating plan of choice. but what about the opposite side of the coin, outbreeding, and when should it be used?

OUTBREEDING

Outbreeding is mating a sire and dam which are not relatives. The term is sometimes used to refer to matings which simply avoid inbreeding but, like inbreeding, there are different intensity levels of outbreeding. Crossing two families - an outcross- is mild outbreeding, the intensity depending on the degree of genetic difference between the two families. Crossing two breeds - crossbreeding - is extreme outbreeding, again the intensity depending on the genetic divergence between the two breeds.

Recall that inbreeding leads to increased homozygosity and accompanying inbreeding depression. Outbreeding, the opposite of inbreeding, leads to decreased homozygosity or rather to increased heterozygosity, the situation in which the members of a gene pair are not identical. Outbreeding can also lead to new combinations of genes and cover the effects of undesirable recessive genes. All these results of outbreeding - increased heterozygosity, new gene combinations and covering effects of undesirable recessive - contribute to the genetic basis for the extra vigor generally noted for outbred cattle. The degree of vigor depends largely on the degree of genetic divergence between the sire and dam. Progeny of line crosses within a breed will have extra vigor but not to the same extent as the progeny of crosses between two breeds. Crossing two lines within a breed which are quite different genetically may create very noticeable outcross vigor which is often referred to as a good nick. (See the Chart on Expected effects of mating plans).

If the sire and dam are both inbred, but do not share common ancestors (e.g. sire from line A and dam from line B), then their progeny will not be inbred at all. Instead of showing inbreeding depression, the progeny, which are outbred, will enjoy, which are outbred, will enjoy vigor for performance traits.

The genetic basis for the extra vigor of outbred cattle within a breed is the same as for hybrid corn, hybrid chickens and cattle breed crosses. We know that hybrids do not "breed true" for their extra vigor; their progeny tend to be quite variable and generally do not resemble their hybrid parent. We could call this "negative prepotency". Similarly outbred sires tend to have progeny which perform poorly compared to the sire's own vigorous performance. Hybrid vigor is sharply reduced when an F1, firstcross, is mated to a similar F1 and further reduced in the F2 x F2, etc. so that after several generations all the hybrid vigor is dissipated.

Performance testing is a powerful aid to beef cattle improvement but may be used judiciously and not as a sole criterion of breeding value. Unrestricted enthusiasm for performance testing, though often well-intentioned, has in some cases led to outbreeding (within breeds) in order to attain better records from the extra vigor even though the outbreds will not pass this extra vigor to their progeny.

HERITABILITY, INBREEDING DEPRESSION AND OUTBREEDING VIGOR

There are two basic types of gene action - additive and nonadditive. Heritability, the percent of total genetic and environmental variation due to additive gene effects, is a good indicator of the potential improvement from selection (see previous article in this series). Both inbreeding depression and outbreeding vigor are due to the nonadditive gene effects. Therefore, in general, highly heritable traits respond well to selection but are little affected by either inbreeding or outbreeding. Table I of the previous article on selection lists heritability estimates for various traits. This table is also a good indicator of the expected inbreeding depression or outbreeding vigor. For example fertility traits, such as calving intervals, which are lowly heritable tend to be severally depressed by inbreeding but tend to be markedly improved by outbreeding.

MATING PLANS FOR PROFITABLE BRAHMAN BREEDING

Which mating plan is best? Mating of selected parents simply to avoid inbreeding or a wide outcross is perhaps the simplest and safest, but the purebred breeder will miss the opportunity to augment the effects of selection. The real breeding surprises - both good and bad - result either from OUTBREEDING when a superior individual fails to breed true or from INBREEDING when an unimpressive individual gets comparatively outstanding progeny. The pedigree will provide insight into the reason for these surprises. Were the sire and dam related to each other? Were they from different lines?

Inbreeding per se is rarely justified in beef cattle breeding because fertility is sharply reduced. Linebreeding, assuming that a superior sire has been found, does have potential. However, a limited number of breeders are in a position to establish any main lines. Line breeding is expensive and has a high risk factor (you never hear about all the lines which fall by the wayside). A successful line must be sufficiently superior to command premium prices to make these risks worthwhile.

The Brahman breed was created in the United States during the last half century by utilizing a relatively small base of cattle introduced from India. The breed progressed through the expansion phase and has now more or less progressed through the first phase of family lines. The next phase consists of subdividing these families into sublines and establishing new families by crossing two or more family lines. The better sublines and new families will expand (they are favoured in selection in the breed) and the poorer ones will fade away (they are essentially culled from the breed). There are many challenges and opportunities for Brahman breeders to create distinctive, useful lines. However, it must be kept in mind that the role of the family name is not as all important as it once was - the performance record has taken up some of the emphasis. Actually both types of information are needed. The pedigree should be combined with a full set of performance records. This "performance pedigree", one of the most useful by-products of the BHIR program, provides evidence of both prepotency and breeding value for performance trait such as gainability, size, conformation, fertility and temperament.

The next article will summarize this series in terms of application of selection and mating practices to the Brahman and will discuss future contribution of the Brahman breed to commercial beef production. Again, the Brahman enjoys a prospect for the future which is basically sound and bright-but no breed can remain static in the currently dynamic beef industry and still retain a viable future.

Selection and mating are the methods by which breeders mold their breed for the future.

INBREEDING & LINEBREEDING SUMMARY

USES	DRAWBACKS	GUIDELINES
To test for undesirable recessive genes	Decreases vigor for performance	Confidence in accuracy of evaluations for superior performance
To obtain and maintain close relationships	Increases frequency of undesirable recessive traits	Frequency of undesirable recessives
To increase prepotency	Amplifies effect of erroneous or outdated selection goals	Superiority and age of base sire
To form families	Produces more culls in early stages	Adequacy of herd size and structure

PART IV - BREEDING AND SELECTION PROGRAMS

The unique Brahman is a very useful breed resource for beef production. Both the Brahman sired steer and the Brahman sired heifer have established an excellent reputation for production efficiency. Can Brahman breeders, through individual and collective selection programs, breed an even more efficient and more competitive Brahman?

The genetic principles are the same for all breeds, but the goals and structure of the Brahman breed are different; consequently specific selection schemes and mating plans appropriate for the Brahman are required for a genetic improvement program.

An understanding of the principles of livestock genetics, reviewed in the first three articles of this series, enables the breeder to select cattle with more certainty of the outcome. Also, these principles provide the younger, less experienced breeder with an understanding and appreciation of cattle breeding usually gained only after a lifetime of experience.

The first step in developing a genetic improvement program is to determine the goals. Specific goals or degree of emphasis will vary from one breeder to another; however, a major role of the Brahman as a breed is production of crossbreds. We do not see Brahmans competing with large, growthly breeds such as the Charolais. Brahman cattle have a role to play - an important role - in the development of highly efficient, profitable systems of commercial crossbreeding. No other breed can provide the extra hybrid vigor, adaptability and maternal ability in crossbred brood cows.

What breeding program is best suited to fulfilling these goals? Our general recommendations are that the selection and breeding goals for Brahmans be directed toward:

a) Improved Economic Efficiency Of Herd Production

b) Improved Economic Efficiency Of Marketing

1) Within The Breed
   i) Domestic Market
   ii) Export Market

2) Outside The Breed
   i) Sires Of Brood Cows
   ii) Sires of Slaughter Cattle

Fortunately, the specific selection and mating procedures needed for any one of these objectives tend to overlap the others and are in some cases identical. However, important differences should be recognised so that the most suitable overall program can be implemented.

The economic efficiency of herd production in registered cattle (production of seedstock rather than slaughter cattle) depends largely on net lifetime fertility of the cow and net fertility of the bull; that is, the number of purebred sale calves produced per cow. These fertility characters have little direct sales value in the purebred market, but they are extremely important in establishing the reputation of the breed as a whole. Since fertility is so very important to the individual breeder and to breed reputation, it deserves major consideration, even though heritability for the trait is low.

The contribution of the bull to fertility of a herd (or of a breed) is usually overlooked except in cases of complete or nearly complete sterility. Hormonal production and balances and other qualities of a highly fertile bull have their counterpart in highly fertile females. Thus it is logical, though untested by research, that highly fertile bulls tend to sire highly fertile daughters. Because of this relationship and the importance of cow fertility, bull fertility will be included in the selection goals.

The second major category - Economic Efficiency of Marketing - relates to the demand for a breeder's cattle, which largely depends upon the reputation of the breed, the reputation of the breeder and the performance, conformation and pedigree of his cattle. Objective performance records have been marketed very seccussfully by some breeders in some breeds, but not generally within the Brahman breed. The reason is related to the fact that Brahmans are very effective for crossbreeding, and the crossing performance of the breed, rather than individual merit, has been relied upon by commercial buyers. However, continued emphasis on increased efficiency makes performance testing - though a special brand of performance testing - a necessity for Brahman breeders.

Within the registered Brahman market, domestic and export standards are quire similar. However, each market emphasizes somewhat different aspects. The traditional export market places more emphasis on characteristics related to breed type and adaptability. The horizons of the domestic Brahman market are rapidly broadening as crossbreeding becomes even more widely adapted in the Midwest and West - in a way, a new "export" market.

The results of breeding programs for registered cattle quickly filter down to the commercial level. For the Brahman, most use to the commercial level is in production of F1 brood cows and crossbred slaughter calves.

The reputation of Brahman hybrids for high levels of general combining ability primarily reflects a general breed characteristic. The pedigree is useful in evaluating combining ability but the level of hybrid vigor in Brahman crosses is not generally associated with particular bloodlines.

The fact that the Brahman does have a very high level of general combining ability is a valuable, merchandisable characteristic, which should be given increased consideration in Brahman selection programs. In other words, some selection should be based on progeny testing crossbred offspring for performance.

Complementarity is another advantage gained from crossbreeding that is only now becoming recognized and appreciated. Complementarity adds to efficiency of beef production largely through mating cows that are especially efficient as brood cows to sires that have the characteristics desired in steers - growthiness and meatiness. The economy results from lower costs required to maintain the brood cow that still produces a calf with good growth potential because of his growthy sire plus hybrid vigor. The ability of the brood cow to calve without assistance when mated to a large sire assumes primary importance.

Brahman and Brahman cross cows have this ability well established so selection for calving ease is probably not necessary; however, this trait should be constantly kept in mind so that calving ability is not inadvertently lost as a result of selecting for some other character.

Brahman breeders should give a major portion of their selection consideration to brood cow efficiency and thereby avoid the sort of selection that leads to disproportionate increases in mature size relative to rate of gain at mature size relative to rate of gain at young ages. At the present point in time there is no apparent need to increase average mature size in the Brahman cow. This could change if much of the beef cattle population in the United States increased in size and the very large breeds, such as the Chianina, continue to be introduced, then the industry may adapt to larger cow sizes and create some need for the Brahman to increase in size. Nevertheless, as long as Brahman cross cows can deliver calves sired by the growthiest, largest sires available, there is no reason to increase size in the Brahman. This point may be difficult to appreciate and accept when there is so much interest and demand for size and gaining ability. However, recall that selection and breeding practiced at this time will not begin to show effect for several years, probably five to ten years. There can be little question that beef cattle producers in general have already begun to realize the false economy of unqualified selection for size. The value of the well-balanced, medium size cow will become increasingly appreciated during the next few years.

Also, Brahman breeders should always be conscious of the fact that their cattle are highly unique in their adaptability to tropical, and subtropical beef production conditions. Since efficient heat dissipation, one of the aspects of tropical adaptability, is impaired as body size increases, and additional caution about increasing size in the Brahman is warranted. The number and availability of very large, growthy breeds of cattle in the United States are rapidly increasing while cattle which have the qualities of good brood cows are not. The profit position us usually favourable for those producing a product in high demand and short supply.

These general comments which have preceded should be considered along with more specific recommendations given below for the Brahman.

BREED CHARACTER AND ADAPTABILITY

The Brahman is quite different from other cattle in the United States, which are all of European origin. Since the Brahman is used widely in crossbreeding, one might conclude that breed character is not as important in the Brahman as in other breeds. However, just the opposite is true because the uniqueness of the Brahman is largely responsible for it's high level of general combining ability. It would be an error for breeders to consume too much of their selection opportunities with breed type, but selection should definitely not be directed toward European breed standards. The Distinctive Brahman breed character is quite well established and individuals not reasonably meeting those standards should be culled.

This is more a question of culling or eliminating a few nonconforming individuals rather than selecting the top end.

Even though a part of the Brahman's adaptability is associated with its physical appearance, this trait is much more complex. Selecting for just one of the many components of adaptability such as ear length or heat dissipating ability, would create more problems than benefit and, as mentioned before, would waste valuable selection opportunities. (If concerted selection effort was based on adaptability, it would be more effective to use a character which reflects the summation of adaptability features. Longevity is one of the better, if not the best, indicators of adaptability; lifetime fertility is another.)

CONFORMATION

Brahman conformation contributes to breed character and adaptability. In addition, it is often implied that conformation is associated with production and somewhat more directly with carcass characteristics. There, is no question that conformation has definite value - justified or not - when selling registered cattle. However, the Brahman pioneered in educating the U.S. cattle industry that there are many variations in conformation and quite wide limits within conformation can vary in sound, productive cattle. Selection for production traits should be directly based on well-taken records of production rather than using conformation as an indirect indicator of production.

Conformation is a subjective (judgement) evaluation in the main and is not highly heritable. There is no definite yard stick for conformation and consequently, standards vary from one individual to another. The low heritability of the trait indicates that altering conformation is a relatively slow, unsure process and that variability will remain in a herd even after being closed to outside breeding for many generations.

Specific points of conformation that relate to soundness fall into a different category. Cattle with obvious unsoundnesses - distinctly abnormal feet and legs, toes that grow out in a foundered condition, retained testis, etc. - should definitely be culled.

Individual breeders are going to place emphasis on conformation according to their own ideas and therefore there is little that should be said additionally except to repeat that it would be a mistake for Brahmans to emulate European breeds and that the heritability for the character is relatively low.

COW FERTILITY

It is well established that the Brahman cow is slow to cycle when under nutritional stress, especially if she is under the additional stress of nursing a calf. A fact that is a great deal less widely appreciated is that the sensitivity or responsiveness of the Brahman cow to nutrition works both ways; that is, the valuable survival mechanism that prevents her from cycling during stress also operates promptly to initiate cycling when nutrients are plentiful. From the selection standpoint, it is obviously poor procedure to cull a cow which does not conceive under nutritional stress and select one which does conceive because of nutritional plenty. One of the chief reasons that heritability of cow fertility is low is that the environmental factors such as seasonal differences, age, disease and a host of other factors, obscure the true genetic differences among individuals for fertility.

A well-managed breeding herd assures that all cows are provided the opportunity to express their genetic ability to conceive. This is an economically sound practice even without considering the genetic aspects.

Following conception, the second component of net fertility is the ability of the cow to deliver a live calf and the ability of the calf to survive. There is little need for concern about the Brahman cow delivering a calf; however, survivability of the calf is quite a different matter. First consider the calf aspect of survivability. At the present time there is no definite knowledge about the problem of postnatal survival of Brahman calves. However, since crossbred calves from either Brahman sires or Brahman dams are especially vigorous, it indicates a within breed problem that may be thought of as "negative heterosis". Selection against "negative heterosis" is no more likely to succeed than selection for "positive heterosis" or hybrid vigor. The best advice is to avoid close matchings)unless there is very good reasons for inbreeding) and to always mate a cow to a different bull if she produces a weak calf that doesn't live. Sires or dams which produce a distinctly higher than average percentage of calves that die shortly after birth, should be culled. More research is needed before a better recommendation can be offered.

The other aspect of calf survival is the ability of the cow to properly mother the calf. This ability includes her physical as well as behavioral characteristics. Replacements should not be saved from any cow, which under normal circumstances, can not or does not mother her calf without assistance.

The milking ability of the Brahman cow is about ideal on average for raising beef calves except that her relatively high milk yield does tend to place nutritional stress on her unless she has access to excellent nutrition for several months following calving. Once the caw has conceived, the nutritional stress is not as critical. Just as the Brahman cow is responsive to either nutritional stress or plenty, as noted above, the Brahman heifer responds in a similar manner. Brahman heifers should have optimal nutritional opportunities if they are to be expected to reach puberty, cycle and calve before 30 months of age.

BULL FERTILITY

Some Brahman bulls limit the fertility of the cow herd. There are two aspects of the limitation placed by the bull: (1) his libido or mating aggressiveness and (2) the quality of his semen. Brahman breeders are well aware that observation of a Brahman bull during a limited portion of the day may give a very poor indication of his breeding activity. Professor Bonsma has very usefully listed the easily observed characteristics which should be required of a bull. These include well-developed, firm, symmetrically suspended testes and a generally masculine appearance with darker pigmentation around the shoulders and quarters. (More details are given in The Wortham Lecturers In Animal Science, Texas A&M University). After initial screening on appearance, the semen should be tested and evaluated by a qualified person. The standards required of the semen should be that the bull is not only fertile, but highly fertile. Again, even though there is no rigorous research data to substantiate the opinion, it is logical that even for bulls in natural service, semen should be of the volume, density and motility suitable for commercial AI collection and that it should be able to withstand the freezing and thawing required. This rigorous standard should be taken into consideration in the selection process; the closer a bull comes to meeting the screening standard the more desirable he is. Certainly those bulls which miss the mark by quite a margin should be culled. As mentioned above, this selection is practiced to improve cow fertility, not only from the standpoint of providing fertile bull mates, but also the replacement heifers sired by this type of bull would be expected to have fewer fertility problems.

RATES OF GAIN AND MATURING

Rate of gain (sometimes equated with performance testing) has gained considerable popularity among registered and commercial beef cattle breeders. However, changing rate of gain in a more or less stable, well-adapted breed or herd of cattle should not be taken lightly because there are correlated or "spinoff" effects. The major concern is that selecting for increased rate of gain, particularly during a five or six month interval around 12 months of age, will have a strong tendency to increase mature size and delay age at which puberty is reached. Increased rate of gain to slaughter weight does tend to increase efficiency of feed conversion of slaughter cattle. However, as pointed out a number of times the delayed maturity and increased mature weight will decrease efficiency in the brood cow herd, other things being equal.

The major advantage in Brahman breeders selecting for increased average daily gain would be to increase gainability in Brahman crossbred steer progeny. Even though the Brahman sired steer has an excellent reputation in the feedlot, the Brahman is not primarily a sire for terminal steers. He is principally a sire breed for adapted, productive, hybrid cows - and the Brahman cross cow is already quite large enough. Indicated for the Brahman, then, is a mote comprehensive approach to selection for increased average daily gain. Performance data should be used to increase rate of gain, but without increasing mature size. Changing the shape of the growth curve in his manner is best accomplished by use of a selection index.

A selection index gives proper emphasis to each trait of an individual so that when the values for all traits are added, the resulting sum is the best representation of the overall genetic merit of the individual. The index is devised in such a way that overall genetic merit, or breeding value, is consistent with the goals of the breeder.
In the case above of changing the shape of the growth curve, characters that affect both rate of gain and mature weight (for example weaning weight, 12-month weight and 18-month weight, all of which are correlated with one another) would be programmed into the index. Specific indexes can be developed for Brahmans when sufficient performance data are accumulated for use in estimating the necessary genetic parameters. Until breeders build up a larger backlog of data, the soundest approach is to give preference to those individuals which have higher rates of gain but mature at medium sizes. If progeny data are available, sires which have higher gaining progeny but are themselves average size should be given selection preference.

At the present time and with the current state of accumulated data in breeder's performance files, performance testing of only bulls for rate of gain appears to justify the effort and expense. However, it is recommended that heifers be weighed at times established in the BHIR program: weaning, 12 months and 18 months. Heifers should be developed normally, without effort to achieve maximum gains, to avoid the detrimental effect of early fattening on later fertility as a cow.

TEMPERAMENT

The temperament of the Brahman is even more famous than its hybrid vigor. The athletic performance of "professional" rodeo bulls which have some Brahman "blood" has contributed to this reputation. Even though it may be unfair, the Brahman does have a poor image and the fact must be faced. Brahmans and Brahman crosses can be worked without undue difficulty (actually more easily in some cases) by experienced cattlemen with proper facilities, but the fact remains that a vast number of potential Brahman buyers have neither the knowledge nor the facilities. Is it easier to change people or to change cattle? The solution must be a little of both.

Temperament is conditioned by both heredity and treatment. It is difficult to separate these effects, but the heredity effect in temperament can be improved by selection. The heritability of temperament is demonstrated by the different reactions of individual cattle to people moving toward them - even if the cattle were all raised together and treated alike.

Cattle which are wild or unmanageable should be culled. However, culling them from a herd in which the cattle have not been given proper management or treatment is not effective. Cattle must be given the chance to exhibit their inherent temperament, good or bad, under comparable conditions. After culling out the "trouble makers", gentleness should be favoured, other characters being equal, in selecting among the top end.