IMPLEMENTATION AND MAINTENANCE OF SELECTION PROGRAMS FOR BEEF CATTLE

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Selection of beef cattle is traditionally based on a subjective evaluation according to a conceptual image of the ideal animal. Selection is therefore practised as an art acquired by study and experience. In contrast the science of cattle breeding is the application of the principles of population genetics to selection and is relatively new. It demands the use of objective measurement rather than subjective evaluation. The two systems do have elements in common and can be combined to various degrees to provide an infinite number of relatively unique selection programs. No single blue print for a selection program can therefore exist. To discuss the present situation and outline existing problems and current and potential developments for implementation and maintenance of selection programs, the two systems have to be contrasted.

Selection programs are systems of management designed to create genetic change in populations. Management objectives should therefore be:-

(a) The best and most accurate way to obtain a measure of a desired trait;

(b) Decisions about compromise between less accurate but quicker measures and more accurate but more time consuming measures;

(c) The level of management which will bring out the maximum genetic differences among animals in a given environment;

(d) Husbandry practices which protect the individuals from the forces of undesirable natural selection;

(e) Evaluation procedures that minimise environmental differences.

Breeders, extension officers and scientists often have a poor appreciation of the importance of one or other of these objectives.

Selection can hardly ever be directed towards only one trait in economic species. One trait may be primary, but others will have to be considered. Selection can be applied to one trait only until the desired improvement for each trait is achieved (Tandem Selection). This method is rarely used. For each trait independent culling levels (ICL) below which individuals are culled can be set up. The level of culling should be relative to the economic value for each trait. ICL has the advantage of allowing culling to proceed as the traits are measured but this advantage may lead to too much culling for traits expressed at any early age leaving no room for selection of traits at other ages. There is only one combination of levels in terms of fraction saved that permits maximum genetic gains and this combination depends on heritabilities, correlations, relative economic values and the total fraction of the population that must be saved. The index selection (1) method comes closest to satisfying these conditions. Index Selection combines all the measures of the trait into one figure for each individual. Selection is then practised among index values which are weighted sums of the several phenotypic values. The weights attached to the various phenotypic values are relative to the economic values, heritabilities and genetic and phenotypic correlations among the traits. This method combines all the information. The extra merit in one trait can compensate for a lower merit in another.

The problem with implementing ICL and I is obtaining reliable economic weights and genetic parameters. Also the complicated computations add to costs and delays. Culling levels are therefore usually set by breeders by intuition and other considerations. In practice selection of bulls contributes most towards genetic gains, while culling in the female herd contributes immediate phenotypic improvements. Immediate monetary returns are enhanced by short-term phenotypic selection while genetic gains are long-term. The emphasis in selection is not necessarily the same for the two purposes or, therefore, in males and females.

A major problem in implementation and maintenance of breeding programs is the inability of breeders to clearly define their goal. The goal is often unnecessarily complicated and at times impossible to define. Indecision and oscillation are major factors contributing to the failure of well-planned and carefully-executed programs.

The goal for a subjective breeding program is the conceptual image of the ideal beef animal. Environmental modification, notably nutrition, allowing animals to achieve the most desirable appearance is confused with genetic superiority so that the bench mark for genetic excellence is achieved in the show-ring. Blood lines (pedigrees) and purity of breed play an important role. The average cattle breeder is conservative and traditional and in general an ardent supporter of subjective evaluation so that breeders implementing traditional selection programs have a relatively assured market. Traditional management is therefore largely concerned with costly environmental modification to the extremes of foster mothers, high grain diets and protection from all environmental stresses. The extravagent costs of maintaining pure-bred cattle contributes to inflated prices paid for them. Price which is often unrelated to breeding value, has become the measure of genetic excellence.

The goal for an objective selection program should be based on the analyses of the available economic and genetic information.

Reliable economic information is not always available and the breeder faces the problem of having to base his long-term goal on a subjective evaluation of the future market.

A plausible long-term goal may be "the highest yield of red meat in the shortest time for the minimum of labour and cost from grass". The characteristics of the animal that contribute to this goal are therefore fertile, fast-growing, easy-care cattle. The animal may be any colour, shape or type and need not belong to a recognised breed. To avoid possible genotype x environmental interactions cattle should be selected under conditions in which their progeny are expected to produce beef. The animal's appearance may therefore be unconventional.

Breeders implementing objective selection programs without extreme environmental modification appear to be *avant garde* and face strong market resistance, criticism and often ridicule by their peers. There are thus sociological and market pressures for breeders to conform to traditional management systems. The pioneers of realistic objective selection therefore need encouragement and moral support from the professionals promoting it. Evaluation of genotype x environmental interactions, advantages and disadvantages in genetic and monetary terms of the traditional stud cattle industry to the whole beef cattle industry, the role of nondescript synthetic groups and the practical demonstration of the concepts of genotype (breeding value) and phenotype are required.

Annual genetic gains (ΔG) are dependent on the selection differential (S), heritability (h^2) and generation interval (L), so that $\Delta G = h^2 S/L$. If h^2 or $S = 0$, then $\Delta G = 0$. Breeders have most control over S which should be as large as possible and L which should be as small as possible. For any one trait S will be increased as the number of other traits selected for is reduced. Only heritable traits of real economic importance should be measured and included. Traits which are expensive to measure such as rib eye area and libido test need to be carefully evaluated for the genetic and phenotypic contribution to the goal.

S is dependent on the number of animals available for selection. Fertility, herd size and bull: cow ratio are therefore important. The optimum breeding herd size to maximize ΔG could theoretically be in the vicinity of 600-800 cows. Except for group breeding schemes such numbers in any highly selected herd are rarely achieved. In practice stud herds rarely exceed 150 breeding cows. Measurement and recording becomes difficult and costly in large herds and unless plenty of labour is available, less accurate. Efficiency in terms of time, cost and possibly lower accuracy of selection in large herds have to be weighted against possible ΔG.

Optimum size and structures for nucleus or elite herds and their management relative to the main herds need evaluating.

The ratio of 3% bulls is commonly accepted. The effect of using much lower proportions of bulls on herd fertility needs evaluation. AI could maximise S if the accuracy of selection is high. However, the cost of accurate evaluation of breeding values and testing for deleterious recessives must be considered. In addition, the increase in inbreeding and the long-term consequences of intensive selection for a single trait need to be evaluated.

Having all animals in the herd as young as possible will minimise L. In terms of profitability and ΔG, yearling mating is advantageous. Reducing L tends to decrease S in the replacement animals, e.g. more heifer replacements are needed if heavy culling on age is practised in the cow herd. Management and selection practises which enhance mating at an early age and high fertility are therefore important.

Yearling mating, by stressing heifers tends to reduce cow size. In addition calves are lighter at weaning and dystocia increased in certain breeds. Yearling mating is therefore unacceptable to an industry committed to phenotypic excellence who like to see large fat animals. Demonstration of the economic and genetic advantages of yearling mating are therefore important.

Progeny testing lengthens L and the additional accuracy of selection possible should be weighed against the lengthening of L.

Basic to maintenance of breeding programs are the records. For most breeders book-work is tedious and unrewarding, a task usually fitted into spare time and evenings. It therefore enjoys a low priority. Records have to be relevant, simple and easily accessible.

Traditional selection relying heavily on pedigrees and being obsessed with purity, evolved elaborate pedigree records retained by the breed societies. These records are rarely used for decision making and accessibility is of low priority. Pedigree records are of less importance in performance selection. However, the animals own performance records are often required as a matter of priority for decision making. Ease of recording and rapid feedback are therefore important. In most cases it would be the most efficient in terms of labour and costs to make crush-side decisions and maximum genetic gains may have to be sacrificed for expediency. Sophisticated central recording which increases on-farm costs and delays decision making, may therefore be counter-productive. Improved genetic gains possible by the use of composite derived records such as selection indexes (1), estimated breeding values (EBV), most probably producing ability (MPPA), etc. need to be evaluated in terms of time and cost per increment of genetic or phenotypic gain.

Pedigrees are usually only required to avoid inbreeding. Inbreeding is not serious if mating of close relatives is avoided. Complicated long pedigrees are therefore not needed and add little information but add greatly to the costs. The advantages and need for single sire matings therefore needs to be evaluated and may be justified, only if progeny testing is required.

Management practices associated with objective selection which cause most problems to breeders are those concerned with minimizing environmental differences. The importance of differences such as paddocks are not always appreciated. It is difficult to manage large groups identically and it often becomes necessary to subdivide them. Groups can be subdivided by sex which is then confounded with paddocks or treatment but may have other management advantages. Confounding sex with paddock may only be important for sire evaluation where the numbers of calves per sire are small. Where sub-division of groups within sex becomes necessary the importance of randomising calves by sires must be stressed. In many cases it may be more efficient and accurate to reduce the herd size under recording and establish an elite herd for intensive selection.

The traditional urge to practice assortive or corrective mating and the environmental correlations caused by preferential treatment of cows mated to and progeny of "fashionable", or high priced, or superior bulls can seriously bias sire evaluations.

When implementing a selection program breeders are faced with the choice of adopting the traditional system involving the mystique and art of selecting the ideal animal. On the other hand they have the geneticist's theoretical ideal of an index based on the most precise and most accurate records on large populations weighted by economic factors, the amount of information and information from relatives. To the layman, objective selection therefore conjurs up an image of complicated records, computers and unfamiliar values not necessarily associated with his expectations of an animal. However, in practice, a seemingly complicated objective selection program, due to management, information and cost constraints, simplifies into a basic system which is usually easier and less costly to implement and maintain than the traditional system. Promoting a simple system of objective selection based on on-farm records is possibly the most efficient method of getting objective selection accepted by the marjority of sceptical beef cattle breeders. Extension offices and in particular scientists should be careful to point out that selection programs based on the theoretical ideal are not necessarily conditions for implementing useful programs.

In general the technology for implementing and maintaining objective selection is sufficient. However the areas of deficiency are:-

(1) Communication: Scientist, extension office and producer all need to make the effort;

(2) Information: Lack of reliable genetic and economic parameters from research stations and under industry management;

(3) Evaluation: Empirical evaluation in terms of efficiency of traditional and objective selection and of genetic and phenotypic consequences of long-term selection.

(4) Simplification: Of existing technology, terminology and practices.