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AN APPRAISAL OF BEEF BREEDING IN THE REPUBLIC OF SOUTH AFRICA

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Genetic improvement of a specie proceeds in various phases:

A. The development of a theory governing the inheritance of traits and development of appropriate statistical technique to estimate parameters.

B. Defining characteristics of importance and appropriate *measures* of these characteristics.

C. Testing the theory in relation to the traits defined.

D. Evaluating *available material* in terms of the theory and the qualities defined.

E. Designing breeding systems and selection procedures.

F. Applying these systems and procedures in practice.

The Theory

The theory of animal genetics is well established with major contributions from 1908 to 1914 when Nielsson-Ehle and Shull elaborated on multiple factors, Similarly, the mathematical theory founded by Fisher (1918) has since been adequately developed by Wright (1921) and its practice expounded by Lush (1945). There is no reason yet to doubt the general theory and its mathematics and a very sound foundation therefore is available from which to develop furhter.

Defining Characteristics of Economic Importance and their Measures

Sheets (1933) was probably first in modern times to consider beef characteristics of economic importance and how best to measure these. It is now generally accepted that high reproductivity, high weight-for-age and carcase quality are all of economic importance and easily measured. Of these qualities however, only reproductivity is not subject to the prevailing economic climate. Weight-for-age and carcase quality as selection criteria however have some weaknesses.

In the first place they are normally considered as characteristics of the *individual* and not of the herd which has available only a limited feed source. It has for instance not been clearly established what the optimum size at a given age should be to maximize herd profitability, bearing in mind the association between growth rate and mature weight, between growth rate and body composition and between growth rate and reproductive fitness. In the second place, it is sometimes forgotten that live weight is an extremely variable measure and only an estimate of the weight of edible meat. Thirdly the unit value at any given live weight is seldomly known and difficult to measure. Surely in order to determine the stage of maximum profitability an exact measure of unit value at various weight intervals should be known. This applies primarily to the finishing phase but indirectly also to the cow herd. This principle is illustrated in Table 1 where a large, fast growing type (Simmentaler oxen) is compared with a smaller, slower growing type (Hereford oxen).

Table 1

*Efficiency, Unit Value and Feed Margin of Simmentaler (Si.) and Hereford (Her.) oxen at various live weight intervals**

Weight Range (kg)	Efficiency		Value/kg gain (c) 1		Feed margin (c)	
	Si.	Her.	Si.	Her.	Si.	Her.
341–352	6,12	5,00	18,3	29,9	0.6	7.3
352–364	6,80	9,48	19,8	33,0	0.6	3.1
364–375	7,40	10,48	19,8	33,0	-0.3	1.9
375–386	8,08	11,56	19,8	33,0	-1.1	0.5
386–398	8,76	12,60	20,9	35,9	-1.5	0.5
398–409	9,36	13,64	23,8	35,9	-0.9	-0.8
409–420	10,04	14,68	23,8	35,9	-1.8	-2.1
420–432	10,68	15,76	23,8	35,9	-2.6	-3.4
432–443	11,32	16,80	25,3	35,9	-2.7	-4.7
443–454	12,00	17,84	26,8	35,9	-2.8	-6.0

1. Determined by serial slaughter.

* Lombard J.H. (1970), Unpublished data.

Table 1 shows that the larger type oxen were much more efficient in the feed lot at all weights considered when efficiency is expressed as kg feed per kg live weight gain. The value per unit gain on the other hand was throughout in favour of the smaller type oxen while the latter were economically also more efficient up to 409 kg live weight. In the same experiment it was found that the Simmentalers, reached maximum profitability (R9) at 545 kg. The fact that weight effects here were confounded with breed effects is a further complicating factor, illustrating the need for better definition of economic qualities.

In the fourth instance beef cattle geneticists are quick to define *economic* traits while at the same time, ignoring the economic trends or sometimes ascribing these trends to the vagaries of temporary fashions and ignorance. We have, as an example, for long stressed the desirability of lean beef, yet the trade consistently pays more for a well finished than a lean carcase, all other attributes being equal. Defining the "well finished" carcase is often a matter of experience and shrewd questimates but seldomly the result of comprehensive research. Our marketing system affords a uique opportunity for continuously monitoring trends and this we should exploit in order to establish trends which may be projected into the future; we are after all now establishing criteria for future application.

Biological measures of economic criteria must be continued with but considerable difficulty is encountered when, for example, one tries to equate energetic efficiency with feed margin. Definition of characteristics are of course further complicated by environment and by the possibility of genetic-environmental interaction. It would appear as if in this context we need to postulate only two types of environment namely environment as production system and environment as climate. Again, defining characteristics of economic importance under these two types of environments is often a matter of lively debate rather than scientific and economic research.

Testing Genetic Theory in terms of Traits defined

A genetic theory can only be substantiated by comparing expected change, (using estimates of heritabilities and genetic correlations) with actual change when a population is subjected to selection. With farm animals it is difficult to separate the genetic and environmental components of time trends in traits under selection and possibly the only instance where the validity of additive gene action has been demonstrated with a fair degree of confidence, is to be found in the improvement with selection shown by the Danish Landrace breed of pigs (Fredeen, 1966). However, the higher degree of heterosis generally encountered with traits of lower theoretical heritability than with traits of higher theoretical heritability must also be interpreted as partial verification of the current genetic theory. Genetic correlations pose even greater problems of experimental verification by the geneticist and intuitively one feels that the physiologist is better equipped to determine functions which are biologically compatable or otherwise.

Evaluating avail..ble material in terms of theory and qualities

In beef cattie the "available material" consists of both individuals and of breeds. The genetic theory was developed in terms of individuals and populations of random individuals. Early American work, comparing the Aberdeen Angus, Hereford and Shorthorn breeds indicated that these breeds were in fact only random samples of the same population and the conclusion was drawn that there were "no differences between breeds" in terms of traits determined by multiple genetic factors.

On the other hand breeders of any one breed insist that such a breed is distinctly different from other breeds but breed societies nevertheless discourage breed comparisons for the very good reason that such comparisons must show up weaknesses of certain breeds. Animal scientists in South Africa have largely refrained from such comparisons and have soothed their conscience by falling back on the "no difference between breeds" argument. While it is true that it is difficult to define breeds genetically in quantitative terms such an attempt has not been made.

In South Africa we have a large selection of breeds, possibly larger than any other country and to insist that an Aberdeen Angus is simply a black Simmentaler is nothing less than political expediency. Differences between groups of breeds or types are real as has in fact been demonstrated by the Omatjenne project. These differences are invaluable for the industry since almost any quality in demand at any time can be obtained from a breed in which such a quality predominates. One wonders whether it is a wise policy that improvement of, say rate of gain be persued within a breed which perhaps does not excell in this quality and when such a change can only be achieved very slowly. It would be far simpler for the commercial breeder to obtain this quality from another breed which already possess it in an advanced degree.

However, in order to select a breed for a certain quality we must have a better knowledge of the qualities of different breeds which necessitates extensive experimental breed comparisons. Such a comparison must be considered as the first priority in our research projects. Comparing breed crosses will yield valuable information but must be motivated on the assumption that hybrid vigour plays an important role. This in turn presuppose that non-additive gene action is of major importance in the inheritance of beef qualities which is not substantiated by our present knowledge.

Designing Breeding Systems and Selection Procedures

The above considerations lead to the following conclusions:

Firstly pure-breeding must continue to play an important part if it can be established that at least some breeds differ significantly in terms of production traits Emphasising the qualities of a particular breed would then result in the quickest genetic change in terms of those qualities considering the national herd as a whole. The pure-breeders are also more likely to adopt such a procedure than to select for traits which occur at low frequency in the breed.

In the second place a knowledge of the qualities of individual breeds would allow the prediction of crossbred performance with a high degree of accuracy for commercial production. This would certainly be a more

Table 2

*Variance of weaning weight according to type of sire**

Source of variation	df.	Mean square			F	V_G2	V_E2	h^2
		Total	Sires	Ind.				
Pure-bred Sires(1)	15	3543	15,682	3156	4,96**	1 687,3	1 883,3	0,47
Hereford Sires	6	3052	12,618	2818	4,48**	1 165,0	1 943,8	0,37
Crossbred Sires	8	3566	9,761	3320	2,94**	1 181,0	2 435,0	0,33

(1) of different breeds
* Lombard J.H., 1971. Unpublished data.

economical approach than to conduct crossbreeding experiments with the vast number of possible crosses. Of course, the variation within breeds would tend to reduce the effectiveness of such an approach but one can expect to make more progress with the reduction of variation within breeds than with the improvement of any one trait over all breeds; uniformity after all is a quality pursued by all breed societies.

Thirdly, the development of new strains should be investigated in terms of the genetic consequences. Straightbreeding has certain advantages also for commercial production. If additive gene action is postulated, development of new strains would undoubtedly ensure quicker progress than changing some existing breeds to suit prevailing economic requirements. Furthermore improvement within the new strain is then likely to be as effective as within the existing pure breeds except that it would start at a higher level. In Table 2 the variance between pure-bred sires and crossbred sires is analysed in terms of weaning weight.

Table 2 suggests that the additive genetic variance between breeds is larger than within the one breed considered which of course lends support to the argument that differences do exist between breeds. The comparison between pure bred bulls of the same breed and crossbred bulls shows no difference in the genetic variance of weaning weight of calves lending support to the logical theoretical argument that the same type of gene action operates in both instances and that genetic change will be similar if one used *inter se* breeding as opposed to pure breeding.

Applying Breeding Systems and Selection Procedures in Practice

Results in practice are achieved not by the animal scientist but by the breeder who is guided by research findings. If no progress can be detected then either research has failed to convince the breeder that the cost of selection will be less than the resuliing additional income or communication is inadequate between research and practice.

That very little genetic progress if any has been made with pure breeds in recent years is a fair assumption. Both research and breeders are to be blamed. On the one hand research has not demonstrated adequately that "economic" traits are in fact "profit" traits and has emphasized the same qualities for all breeds which of course is not acceptable to any one breed society. On the other hand pure breeders have capatalised so heavily in breeding stock that the cost of selection even when resulting in dramatic improvement will be far higher than additional income.

The only solution to this economic checmate is to investigate economic qualities more thoroughly, to emphasize within breed qualities, to define betweenbreed differences, to encourage development of new strains and allow the market for breeding stock to find a new level. The philosophy that beef breeds generally must follow the same history as poultry breeds, in other words, disappear and be replaced by strains developed for special functions cannot be supported because such strains may in fact already be at hand, in the form of breeds. Furthermore the long generation interval of cattle makes such a procedure impractical.

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