

THE BREEDING OF BEEF CATTLE IN SOUTH AFRICA: PAST, PRESENT AND FUTURE

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In this paper the term "breeder" is discussed in its broader sense. In the narrow sense Haring and Gruhn (1971) confines breeding to purebred animals only. Commercial cattle are "produced" and not bred. In the broader sense which I prefer, "breeding" is seen as the utilisation of total genetic variation provided by different breeds, additive genetic variation, dominance, overdominance, heterosis and combining ability to "breed" and "produce" beef cattle. I therefore believe in the classical structure of the industry having

- purebred breeders or seed stock producers, and
- multiplier breeders producing purebreds and cross-breeds for the
- commercial breeders who produce slaughter stock.

In South Africa beef cattle are kept under widely varying environmental conditions which pose difficult problems to breeders and producers with regard to the performance and genetic improvement of beef cattle. The cattle breeder in South Africa therefore has to adjust his breeding goal and methods to fit in with given nutritional and climatic conditions.

South Africa, however, is pre-eminently a pastoral country due to the fact that 85 percent of its total area can only be utilised as grazing. It is therefore understandable that the authorities from the earliest days of the Cape of Good Hope were interested in livestock farming. However, there was no clear policy regarding the development of the livestock industry. The progress achieved was the result of the enthusiasm of individual farmers and civil servants.

During the early years of the cattle industry the multiplication of numbers was the major objective. A beef animal was, generally speaking, a draught animal first and provider of beef and possibly also milk second.

The animal was killed for its beef only at a fairly advanced age, by which stage it had a thick layer of fat which was useful for preserving food and for the candle industry (Evans and Evans, 1971).

Factors leading to changes within the beef industry

There were various developments that occurred both outside and inside of the beef industry that led to changes in breeding policies.

1. The first and most important factor to influence the industry was the changing economic situation within and without South Africa, forcing producers to change their production systems and making it difficult for cattle breeders to set themselves new breeding goals. Since 1972 beef has changed from being a commodity to become a "luxury item". Increased buying

power locally and an export market opened up new fields with new objectives. Feedlots offered a market for weaners but demanded a high rate of growth, efficient feed conversion and grading ability. This called for a standard type of steer. Due to this demand for weaners and young store oxen, the cow and calf operation is being intensified. The eastern high rainfall areas, hitherto ignored by cattlemen, as being sourveld, are fast becoming major breeding areas. Fertilizing of natural grazing, radical veld improvement and even bush clearing for the establishment of artificial pastures provide the nutritional environment for the introduction of intensified beef cattle production.

In this development the traditional types are being replaced by more productive types as mother stock while sires are being selected on a basis of growth rate, efficiency and carcass grading ability.

2. Technological developments also contributed to changes within the industry. Until recently continuous cross-breeding, artificial insemination and the development of new breeds were frowned upon, while frozen semen, farmer inseminators, synchronization of oestrus, performance testing and computers were still unknown. Now that they have become a reality breeders and producers do not know how to use these tools in modernising their breeding methods while scientists are already investigating new fields such as multiple births, egg transfers and sex control of semen which will increase the uncertainty of the breeder even more.
3. Consumers are becoming more demanding in their preferences. The consumers' interest in beef centres around three main factors namely quantity, quality and price. Broadly speaking, there are three classes of consumers:
 - 3.1 General (usually the housewife)
 - 3.2 Luxury (hotel and restaurant trade which is a growing one)
 - 3.3 Manufacturing industry.

We are therefore faced with the difficulty of catering for different and changing consumer requirements and preferences.

These changes are forced on the commercial breeder and in turn on the seed stock producer.

Genetic improvement of beef cattle

Breeds

South Africa was lucky indeed to have cattle breeds from the earliest days. Two of these namely the Africander and the Drakensberger not only contributed to the decision of establishing a settlement at the Cape of Good Hope by producing beef, milk, cheese and butter for passing ships but they also contributed to the opening of the hinterland by providing draught power and products for the Great Trek to the north.

About the Africander breed Opperman (1962) wrote: "Unlike other breeds, it did not start with a meeting of two unrelated animals at a given point in history. Rather did it spring from a long-drawn evolutionary process which extends for centuries: it is only during the last half century that the need to keep the product pure and able to withstand the heat and burden of the day has led to planned breeding and improvement".

About the Drakensberger breed one reads in the Drakensberger Handbook (1969): "The first black indigenous cattle were found in 1659 in the Bredasdorp district in the possession of Hottentots. Where they came from nobody knows".

At present the Africander breed outnumbers all other purebred beef and dairy cattle and forms the basis of crossbreeding in the ranching areas of South Africa. It contributed to the development of two new breeds namely the Bonsmara and more recently the Tauricus. Almost 70% of all beef cattle slaughtered in South Africa are either pure bred or carry Africander blood.

After a long period of struggle for recognition the Drakensberger is progressing fast especially in the more intensive high rainfall areas. Experimental work at Potchefstroom proved their excellent rate of gain, efficiency and good carcass characteristics. They are known to be regular calvers and good mothers.

The third group of indigenous cattle in South Africa is represented by different breeds of Bantu cattle. There are approximately 4,5 million Bantu cattle of mixed origin. Although their contribution to the beef industry is far too small due to tradition, custom, culture and a lack of knowledge, some of these breeds have merit due to their adaptability to unfavourable climate environments and could contribute ten times more than at present.

Importation of cattle breeds

Unlike in the U.S.A. where an "exotics explosion" has been experienced during the last decade, South Africa has had all the major beef and dual purpose breeds since almost the turn of the century. The first imported cattle came from Holland during the early years of 1700: Devon cattle in 1792, Shorthorns in the middle of the 19th century, Herefords in 1892. Brown Swiss, Simmentalers and Pinzgauers were imported to South West Africa by German immigrants during 1895. Regular importations are still carried out. Theunissen (1971) reports that of one breed alone 38 bulls and 628 females were imported from 1966 to 1969 at a value of R1,3m. About this he felt that although certain imports were necessary the amount of valuta spent served only to subsidise overseas breeders.

Through the years and even today many "owners" of exotic cattle only multiply imported animals and leave the selection and breeding to be done by overseas breeders. In many cases imported cattle proved to be failures in the warm extensive ranching areas because breeders did not recognise or acknowledge the lack of adaptability of certain breeds to the limitations posed by unfavourable climatic and nutritional environments. Instead of selecting within their cattle for adaptable types they imported "fresh blood" to compensate for environmental deterioration. They did not acknowledge that import regulations, however strict they may be, constitute no guarantee for good breeding results.

Table 1

Classification of cattle breeds used mainly for beef production in South Africa

Types		Breeds	
<i>Bos indicus</i>	Indigenous	4	Africander Bonsmara Drakensberger Nguni
	Imported	2	Brahman Santa Gertudis
British beef breeds		6	Aberdeen Angus Devon Galloway Hereford Shorthorn Sussex
Continental beef breeds		2	Charolais Limozine
British dual purpose breeds		3	Red Poll Shorthorn South Devon
Continental dual purpose breeds		3	Brown Swiss Pinzgauer Simmentaler

There are 20 cattle breeds which are used mainly for beef production in South Africa. Although the Friesland breed produces beef either as steers or culled cows as well as cross-breeds I have excluded them. Recently there has been a revolution in the preference for certain breeds. There was a dramatic increase in the number of dual purpose breeds. The increase in popularity was so sudden that official evaluation programmes could not keep pace. Due to the great demand some inferior cattle were imported and all bulls were raised with every little culling. The result was that after a decade producers had to find out, quite expensively in some cases, that the dual purpose breeds also are no universal breed. They only then became aware of dystocia, poor grading results, unadaptability under extreme conditions, poor mobility, high maintenance requirements

and therefore lower carrying capacity. Due to practically no culling, hereditary defects became apparent.

The imported *Bos indicus* types also enjoy a great demand for cross breeding, especially in the extensive areas. Gain tests, however, do not produce results to confirm this popularity. Some established breeds have become casualties, mainly through a reluctance of the breeders to change their traditional standards of excellence and their resistance to adopt performance testing and A.I as tools in their breeding programmes. Breeders will have to realise that the survival of a breed will depend on how it adjusts to future requirements, nutritional environment, incompatibility and combining ability in cross-breeding programmes. In Table 2 the beef breed types are classified according to their possible use in different production systems.

Table 2

Classification of breed types according to their estimated adaptability to environment and system of production (after Harwin, 1973)

Characteristic	British beef breeds	Dual purpose breeds	<i>Bos indicus</i> breeds	Continental beef breeds
Growth rate	Medium	Good	Poor	Good
Mature mass	Early=380kg	Late=580kg	Medium=420kg	Late=500kg
Milking ability	Variable	Good	Variable	Medium
Fertility	Good	Good	Medium	Medium
Mothering ability	Medium	Medium	Good	Medium
Occurrence of dystocia	Depends on bull used	High	Low	High
Sexual maturity	Early	Medium	Late	Medium – incidence of dystocia is prohibitive
Muscling	Medium	Good	Poor	Excellent
Grading	Good	Medium	Good	Good depends on mass at marketing
Feed requirements	Semi-intensive	Intensive	Extensive	Intensive
Adaptability: Subtropics and tropics	Poor	Fair in sweet veld areas	Good	Poor
Temperate and cold areas	Good	Good	Medium increased maintenance requirement	Medium – depends on soil fertility
Ranching -- Extensive areas	Poor	Poor	Good	Poor

Breeding methods

1. Breeding goal and objectives:

In the past and to a great extent still at present most breeders fix their breeding goal on the attainment of breed purity or type as expressed by standards of excellence. Other breeders have theoretical breeding goals expressed in vague terms of economical production and profitability but apply no method to measure this.

Too much attention is being paid to a theoretical breeding goal. Progress is also so slow that none of us will see the goal reached entirely. Moreover, the goal is likely to change, dependent on what the market wants or with changes in methods of production.

A more realistic approach would be to have functional efficiency as a breeding goal and apply methods to measure this. Rate of growth, efficiency of feed utilization, carcass characteristics, structural soundness, freedom from heritable defects, regular reproduction, good marketing characteristics and thriftiness under commercial conditions are all heritable traits and relatively easy to measure.

2. Pedigree breeding

Pedigrees form the basis of stud breeding and the primary object and activities of breed societies are intended to safeguard the "purity of the breed".

All breed societies have standards of excellence, score cards, inspection forms and breed descriptions. Some of these have never changed since the first drafts. Breed societies are very proud of this. Only lately some have added a few almost meaningless "minimum performance standards". In most cases breed standards of excellence ignore measurable and heritable economic performance characteristics. No wonder then that breeds lose their competitive position in an industry which is changing continuously due to changing consumer preference, the economic situation and production methods.

Hofmeyr (1971) states: "While the pedigree breeder has in the past contributed a great deal to the modern livestock industry, organised pedigree breeding has scarcely made any contribution to recent developments in animal breeding." In many cases the average herd size is too small to allow any selection pressure for production traits. Breeders argue that their cattle are "pure" and no culling is necessary. Coupled with the small herds many pedigree breeders are antagonistic to A.I and therefore use natural mating only. It is obvious that very little, if any, genetic progress can be expected under such conditions.

Pedigree breeding and breed societies, however, can

once again play a prominent role, but only if they are willing to lead the way rather than defend the past. The future role of pedigree breeding in the beef business depends on how fast they recognise the changes that are happening in the industry. To make a contribution to genetic progress within pure breeds and to beef production, fewer but larger and more specialised herds become a necessity.

Breed standards will have to be adjusted to current and future requirements and include production traits. Registration should not be automatic but depend on performance. Selection should be based upon traits of economic importance.

3. Show standards

Shows and judging of cattle are social institutions which had a great influence on cattle breeding in the past. There is no doubt that shows have an educational value where breeders and experts meet, where ideas are exchanged and problems are discussed. Shows also serve as show windows for breeds and breeders and advertising is a necessary part of the cattle business.

Judging of cattle at shows is based on conformation. It serves a purpose whereby cattle are placed in order of merit according to breed characteristics, structural soundness and development of secondary sex characters. However, judging is subjective and does not include measurable production traits.

As early as 1932 Lush showed that there was little relationship between conformation and production. Since then numerous research reports have emphasised the ineffectiveness of selection based on conformation in changing production traits of economic importance. Some report the undesirability of selecting for type; cattle became smaller, less efficient, had a poorer growth rate but became fatter (Preston & Willis, 1970). For too long a time show standards have been a "breeding goal" for many breeders. Show standards have contributed nothing to more economic and efficient beef production – instead it has retarded progress. It has also not contributed to the quality of beef because consumers have long since rejected over-fat meat.

Show standards as they are today are outdated. Show standards encourage, if not demand, the over-fattening of animals. Apart of the harmful effect to the animal it has also encouraged conformational standards which tend to be antagonistic to functional or productive merit. Excessive emphasis is placed on depth and width and smoothness of the top line. It is known that fat increases width and depth of beef cattle. These standards are misleading – merely encouraging excessive fatness rather than more muscling. If beef cattle shows continue to be administered

along existing lines, their impact on beef cattle breeding will continue to diminish.

4. Systematic genetic improvement

The commercial breeder traditionally depends on the stud breeder to supply him with bulls. The progress in the improvement of the national herd, therefore, depends on the efficiency of selection by the stud industry.

In the past and at present breeders and breed societies have relied on standards of excellence and visual appraisal to improve their cattle. There is sufficient evidence to state with certainty that due to a very low or complete absence of relationship between conformation and economically important production traits selection based on conformation is not effective. Selection based on show standards can even be negative.

The cattle breeder can change the genetic nature of the population under his control with the aid of two basic tools i.e. selection and the application of appropriate breeding systems.

A prerequisite for genetic improvement is genetic variation which can be divided according to gene action into additive and non-additive variation. Different breeding methods are employed to exploit the different kinds of genetic variance in the total genetic improvement of beef production.

- (i) Breeding systems and appropriate selection methods to improve populations which depend on additive gene action.
 - (a) within populations – pure bred breeding and – inbreeding
 - (b) between populations – grading up and cross-breeding followed by pure breeding, inbreeding and selection to create new breeds.
- (ii) Production of commercial cattle which exploits additive gene action as well as non-additive gene action (dominance and epistasis) combined with methods of selection. This includes different systems of cross-breeding and selection to fit.
 - a. Breeding of purebred cattle produces “seed” for the commercial industry.

The breeding system to be used is assortative mating or mating like to like. This system provides the best method whereby superior genetic material is transferred from one generation

to the next. Superior bulls are used on superior cows to produce, with the appropriate selection intensity, superior bull calves which, according to Rendel and Robertson (1950), contribute 76% to the total improvement in milk yield in dairy cattle. This system also enables the breeder to raise four times as many top replacement heifers from the herd each year than from random mating of unselected individuals.

Selection should be based on accurate records of performance of production traits. Production traits included in the selection programme should be limited to those which respond to selection (high heritability) and with high economic value.

The h^2 estimates of beef production traits are very well known. In Table 3 the h^2 of certain traits are given according to the system of production used.

Performance testing facilitates selection of production traits of economic merit and the culling of breeding stock which do not meet minimum requirements.

The official beef cattle performance testing scheme was initiated in 1960 by the Department of Agricultural Technical Services. During 1972/73 1 079 herds participated in the scheme including different breeds as shown in Table 4. (Bosman, 1973).

Bosman reports that during 1973, 370 bulls were tested at two central bull testing stations in the Republic and 94 in South West Africa while 780 bulls were tested on farms. However, the total bull requirement for the 2.1 million cows and heifers over two years on white farms and 700 000 in the Bantu Homelands are 17 500 and 9 000 respectively.

The pedigree industry with approximately 60 000 breeding females produces less than 10 000 registered bulls per annum of which only 1 244 were performance tested. More than fifty percent of the total annual bull requirements are being produced by commercial or inferior “Pedigree” cattle. When one considers that 80% of the potential genetic progress hinges upon the amount of selection which may be done amongst bulls it is obvious that even after 15 years of performance testing genetic progress in beef cattle is doubtful. It would be interesting to know how many of the 1 079 herds participating in phase A, and how many of the breeders who send bulls to the central testing stations are using tested bulls in their own herds. A recent survey amongst members

Table 3

Heritability estimates and relative economic values of certain production traits according to fee environment (after Harwin, 1973)

Trait	2	Intensive	Semi-intensive to semi-extensive	Extensive
% calf crop	Low (8%)	***	***	**
Weaning mass	Medium (30%)	***	**	*
Feed conversion	High (40%)	***	***	***
Growth rate	High (45%)	***	**	*
Carcass maturity	Medium (30%)	Late	Med-late	Med-early
Mature size	Very high (60%)	Large	Med-large	Med-small
Tenderness	Very high (60%)	**	**	**
Marbling	Low (5%)	*	*	*
Grade	Medium (30%)	***	***	***

Very important ***
 Important **
 Moderate important *

Table 4

Number of herds per breed which participated in the official beef cattle performance testing scheme during 1972/73 (Bosman, 1973)

Breed	No.	% of all herds
Commercial	540	—
Dual purpose breeds		
Simmentaler	120)	
Brown Swiss	34)	± 20%
Pinzgauer	21)	
South Devon	18)	
Exotic Beef breeds		
Hereford	38)	
Sussex	14)	
Charolais	13)	± 5%
Shorthorn	13)	
<i>Bos indicus</i> types		
Bonsmara	94)	
Africander	84)	
Brahman	37)	± 15%
Drakensberger	25)	
Other breeds	—	
	1 079	

of the boar testing scheme revealed that ten members who had had boars tested regularly did not have a single tested boar in their piggeries. It would appear that these breeders merely had their boars tested to cash in on the financial advantage connected with the sale of their boars. In dairy cattle Rendel and Robertson (1950) reported that the selection of heifers contributed only 24% but selection of bulls 76% to genetic progress. If this was the same for beef cattle one wonders whether the effort and expense of phase A of the National Beef Cattle Performance Testing Scheme are justified.

b. Producing cattle for slaughter

Available evidence makes it fairly certain that beef production will ultimately incorporate some exploitation of hybrid vigour. The advantages of cross-breeding include factors such as

- the manifestation of hybrid vigour in traits with a low heritability but high economic value such as reproductive ability.
- the breeding of types for better adaptability to unfavourable environments.
- combining the desirable characteristics of different breeds for specific production situations.

The application of cross-breeding could also benefit by the incorporation of technological advancements such as sexed semen, oestrus and ovulation control.

Due to the varying nutritional and climatic conditions as well as the fact that South Africa had indigenous cattle breeds, cross-breeding was in fact almost the first breeding system ever practised. History informs us that Fatherland bulls were imported from Holland before 1700 and used on "native" cows. Later almost all of the British breeds were used on indigenous cattle to improve their conformation to a beef type. Dairy Shorthorn and Red Polls were very popular for breeding cows for dairy ranching.

Following the classical work of Jan Bonsma at Messina Research Station, where he demonstrated the deterioration of Herefords, Aberdeen Angus and Shorthorn cattle under subtropical conditions, cross-breeding was applied to breed cattle that thrived and produced beef efficiently. South African scientists and cattlemen were almost forced to apply cross-breeding and they practised it with a purpose. It was successful because adapted indigenous types were available.

It is, however, also true that many breeders practised and are still practising cross-breeding in an effort to overcome poor management. Cross-breeding is also practised without a purpose using wrong combinations in wrong areas but to be in fashion.

Through cross-breeding one well known breed is already established in South Africa namely the Bonsmara. A second breed the Tauricus is in the final stages of development.

Although cross-breeding produced cow herds with increased productivity scientists and breeders frowned upon the use of crossbred bulls notwithstanding the fact that all "old" breeds and the "new" breeds were created by using crossbred bulls. It was only recently that Lombard (1971) investigated inter se mating and found that selected crossbred sires produced calves weaning heavier than the average of the parents of the crossbred bulls. Lombard's work indicates that the initial genetic variation among crossbred bulls had been largely additive and that mass selection could exploit this variation effectively. He arrives at the general conclusion that the commercial breeder who has already attained a high level of production in his herd will benefit more by the use of his own intensively selected crossbred sires than by the continued use of straight bred sires of the same breed or different breeds. Apart from the genetic basis of this argument there are also very real economic reasons for such a procedure since the cost of crossbred bulls is much less than the cost of pedigree bulls.

There remain, however, uncertainties in cross-breeding that still need to be solved such as

- size of crossbred cow
- breeds for terminal sires
- breeds for different nutritional and climatic conditions
- breeds with best combining ability
- incompatibility of certain breeds
- crossbreeding systems for size of the herd.

The future

It is not only difficult but it is also dangerous to predict the future. There are too many variables to consider in such a complex business -- too many changes are occurring at present. Even an authority like Keith Gregory felt himself out of his "comfort zone" when asked to give a talk on the future of beef cattle breeding.

There are, however, a few certainties in the uncertainty -- changes which will continue to take place.

1. The changing economic situation demands a dynamic business approach. Breeders and producers must be aware of this and keep pace or become casualties.

2. Production methods are changing. Due to rising land prices and technological improvements in pasture production and management, cattle production in high and low rainfall areas must be intensified demanding more efficient types of cows and bulls. Of the one million steers slaughtered annually only 200 000 are fed in the feedlot at present. There is still wide scope for feedlot operations which demand a specific standard type of steer.
3. Consumer preferences are changing. The S.A. Market demands smaller carcasses with a mass of 180 to 200 kilograms of younger and more tender meat. The meat should have less waste fat.

To cope with this changing scene breed societies will have to adjust their standards of excellence and include minimum performance requirements for animals to qualify for registration.

Artificial insemination will play an ever increasing role. Better use must be made of performance testing as a selection tool. In performance testing the testing of bulls should get priority since the bull is three-and-a-half times more important than the heifer in effecting genetic progress. More research is needed on methods of performance testing but with an eye to increasing the precision of the operation rather than the appeasement of breed societies.

Systematic cross-breeding will form the basis of production. Technological advances such as sexing of semen into male- and female-producing spermatozoa could lead to the breeding of cows for specific situations and of bulls as sire breeds with emphasis on growth rate, efficiency and carcass merit.

Research on cross-breeding should include factors such as size of cows, dystocia, calf survival, feed required for maintenance, lactation and reproduction of cows, feed required per kilogram of edible portion of the carcass and carcass merit.

Cross-breeding will also demand types and breeds that combine well to attain the objectives and requirements of the industry. Greater use of cross-bred bulls is a possibility which the pure-bred breeders will have to face and compete against. From this it is also realistic to assume that more new breeds will be developed to fit different environments and economic situations.

The changing economic situation, the changing consumer preferences and therefore the changing production methods to comply with these are the major forces dictating the future of cattle breeding. Breeders and producers will have to implement a systematic and business approach and to remain in the business all of the basic tools of biology and economics will have to be employed.

References

- BOSMAN, D.J., 1973. National Beef Cattle Performance and Progeny Testing Scheme. *Newsletters 6, 7 & 8. Dept. of Agric. Tech. Serv. Pretoria.*
- EVANS, J. RHYS & EVANS, ANTHONY, 1971. *Critical appraisal of the Role of Stud Stock in the Promotion of Commercial Animal Production in South Africa.* Jubilee Edn. Bloemfontein: S.Afr. Studbook Ass.
- FROHLICH, G., 1936. Blutlinienzucht bei Schweinen *Z. Schweinezucht*, 32, 503.
- HARING, F. & GRUHN, R., 1971. Zuchtmethoden pag. 419; *Tierzuchtungslehre*, ed. by G. Comberg. Stuttgart: Ulmer Press.
- HARWIN, G.O., 1973. Thoughts . . . on a holistic approach to increased profits from the Beef Herd. National Beef Cattle Performance and Progeny Testing Scheme, *Newsletter No. 6. Dept. Agric. Tech. Serv. Pretoria.*
- HOFMEYR, J.H., 1971. Future Task and Role of Stud Breeding Organisations in South Africa. Jubilee Edn. Bloemfontein: S. Afr. Studbook Ass.
- LE GRANGE, A.B., 1971. The future of A.I. in South Africa. Symposium: Modern Aspects of Animal Breeding, Management, Nutrition and Disease Prevention. Onderstepoort.
- LOMBARD, J.H., 1971. *Genetic and environmental factors affecting production of beef cattle in the highland sourveld areas.* D.Sc. (Agric.) thesis, University of Pretoria.
- OPPERMAN, H.B.K., 1962. *Africander Cattle and its Breeders' Society*, Bloemfontein: The Africander Cattle Breeders Society of South Africa.
- PRESTON, T.R. & WILLS, M.B., 1970. *Intensive Beef Production*, Oxford: Pergamon Press.
- RENDEL, J.M. & ROBERTSON, A., 1950. Estimation of Genetic Gain in Milk Yield by Selection in a Closed Herd of Dairy Cattle. *J. Genetics*, 50, 1.
- THEUNISSEN, R.J., 1971. Die Invoer van Plaasvee en die Invloed daarvan op Stoetteling in Suid-Afrika. Jubilee Edn. Bloemfontein: S. Afr. Studbook Ass.
- VERBEEK, W.A., 1971. Samewerking tussen die Stamboekorganisasie en die Departement van Landbou-tegniese Dienste. Jubilee Edn. Bloemfontein: S. Afr. Studbook Ass.
- VICKERY, C.Y. & BOTHA, J.P., 1969. *Die Drakensberger Handboek*. Volksrust: Die Drakensberger Beestelers Genootskap van S.A.