Effect of mortality rate, breed type and breed on total herd efficiency

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The influence of two scenarios of mortality rates (assumed average and observed) on total herd efficiency of the four main breed types in South Africa (Sanga/Zebu, composite, British and European), as well as all the individual breeds participating in the National Beef Performance Testing Scheme (1980–1985), was investigated by means of a computer simulation program. Simulation runs were done for an 18/18 month production system (all market animals sold at 18 months of age) in the case of the evaluation of breed types and for an 8/18 month (steers sold at eight months of age / surplus heifers sold at 18 months of age), as well as an 18/18 month production system in the case of the evaluation of the individual breeds. Mortality rate had a marked influence on ranking of breed types as well as individual breeds in terms of relative income per hectare. Composite breed types normally performed well, indicating that use of such breeds in a variety of environments is a good choice. This study also indicated that bio-diversity does exist between breeds and further research is needed on breed characterization, since no framework currently exists for the characterization of breeds for bio-economic important traits.

Die invloed van twee scenarios betreffende mortaliteitsyfers (veronderstelde gemiddelde en waargenome mortaliteitsyfers) op die totale kuddedoeltreffendheid van die vier hoof rastipes in Suid-Afrika (Sanga/Zebu, komposiete, Britse, Europese) asook van al die individuele rasse wat aan die Nasionale Vleisbeesprestasietoetsskema (1980–1985) deelgeneem het, is ondersoek met behulp van 'n rekenaarsimulasieprogram. Simulasie-opies is vir 'n 18/18 maande produksiestelsel (alle markdiere op 18 maande bemark) gedoen in die geval van die vergelyking tussen rastipes en vir 'n 8/18 maande (speenkalwers op agt maande bemark/surplus verse op 18 maande bemark) sowel as 'n 18/18 maande produksiestelsel in die geval van die vergelyking tussen individuele rasse. Mortaliteitsyfers het 'n drastiese invloed gehad op die rangorde van rastipes sowel as individuele rasse in terme van relatiewe inkomste per hektaar. Komposietrastipes het normaalweg goed presteer, wat aandui dat die gebruik van komposiete in 'n verskeidenheid omgewings gewoonlik 'n goeie keuse is. Hierdie studie het ook aangedui dat bio-diversiteit wel tussen rasse bestaan en dat verdere navorsing ten opsigte van raskarakterisering nodig is, aangesien geen raamwerk tans in Suid-Afrika bestaan vir die karakterisering van rasse ten opsigte van bio-ekonomies belangrike eienskappe nie.

Keywords: Breed, breed type, mortality rate, total herd efficiency.

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Introduction

Breed differences exist for most bio-economic traits and in various environmental situations. Variation in biological traits that are important for beef production is vast and also under a high degree of genetic control (Cundiff *et al.*, 1986; Cundiff *et al.*, 1990). Taking into account the much greater knowledge on the world's genetic resources together with technical developments and computer-based genetic evaluation, the potential for greater exploitation of variability among current genetic resources is largely enhanced. Cartwright & Fitzhugh (1988), therefore, do not find it unduly speculative to predict that a vast recording and reshaping of beef populations will take place during the next few decades. They also foresee a vast array of possible combinations of beef cattle, taking into account the variability among production environments and among populations of beef cattle throughout the world. This clearly highlights the need for breed characterization in South Africa. An example of breed characterization is the Germ Plasma Evaluation Program at Clay Center where germ plasma evaluation and utilization of breeds on a number of economically important traits are being done. In South Africa, however, lack of funds prohibits such expensive experimentation and the use of computer simulation programs, as described by Du Toit *et al.* (1994), must be relied on. Ample input data for use in simulation programs are available from the South African Beef Cattle Performance Testing Scheme. The data are derived from field and central testing center data recorded from 1980 to 1985 by the National Beef Cattle Performance Testing Scheme. The field data have been recorded on 'commercial' privately owned land and in average- to well-managed herds.

The aim of this study was to (a) indicate the effect of mortality rate on total herd efficiency for the four main breed types and for the individual breeds; (b) show that diversity does exist between breeds and that improvement is feasible; and (c) elaborate on possible breeding strategies for improving total herd efficiency under South African extensive beef cattle farming conditions.

Material and methods

A computer simulation program, as described by Du Toit *et al.* (1994), was used to do 68 simulation runs. Data were those for all major beef breeds participating in the National

Beef Cattle Performance Testing Scheme (1980–1985) (Anon., 1986). For the first eight simulation runs breeds were divided into the four main breed types, namely, Sanga/Zebu type (Brahman, Nguni), composite type (Bonsmara, Drakensberger and Santa Gertrudis), traditional British/medium-frame types (Hereford, SA Angus, Shorthorn and Sussex) and traditional European/large-frame types (Charolais, Limousin, Pinzgauer, Simmentaler and South Devon).

Inputs needed for simulation were calving percentage, age at first calving, average cow weight, average weaning age, average weaning weight, 540-day weight of heifers and average 540-day weight of steers (taken as final weight of bulls tested in centralized growth tests).

The first eight simulation runs were done for an 18/18 month production system where all market animals were sold at 18 months of age. Two scenarios concerning mortality rates were simulated. In Scenario 1, applicable to simulations one to four, the preweaning and postweaning mortality rates were assumed to be 6% and 2% respectively for all four breed types. For Scenario 2, applicable to simulation runs five to eight, the actual preweaning and postweaning mortality rates for the four breed types (Schoeman, 1989), managed as contemporary groups, were used (Table 1). Where actual breed mortality data were not available, values from the breed type under which it was initially classified were used.

Table 1 Preweaning and postweaning mortality rates used for the four breed types at Omatjenne Research Station, Namibia, as reported by Schoeman (1989)

Breed type	Preweaning mortality (%)	Postweaning mortality (%)
Sanga/Zebu (Nguni)	4.05	1.35
Composite (Santa Gertrudis)	4.43	1.47
British (Hereford)	11.25	3.75
European (Simmentaler)	10.05	3.35

Average price differences of 19% between 18-month-old market animals and cull cows and 34% between 8-month-old and 18-month-old market animals were used in this study (Du Toit *et al.*, 1995). The results were expressed as relative income per hectare (I/ha).

Results and discussion

The relative income per hectare (I/ha) and changes in ranking of breed types owing to changes in mortality rates are given in Table 2.

The superior I/ha for European and British breed types in Scenario 1 (assumed constant mortalities) is a probable indication of their superior merit for both milk and meat production characteristics when environmental stresses are minimal (Gregory *et al.*, 1982). For Scenario 2, which depicts the actual situation of extensive beef production in Southern Africa as far as mortality rates are concerned (Table 1), the situation changes drastically in favour of composite and indigenous Sanga/Zebu breed types. This is also an indication that it is prudent to assume that most breeds would be more productive if the genetic potential for fitness is increased.

Table 2 Relative income per hectare (I/ha) for a 18/18 month production system for two different mortality rate scenarios and changes in ranking of breedtypes

Breed type	Scenario 1	Rank	Scenario 2	Rank
Sanga/Zebu	1.00#	4	1.00*	2
Composite	1.03	3	1.02	1
British	1.05	2	0.94	4
European	1.06	1	0.97	3

Scenario 1: Relative income per hectare (I/ha) with preweaning and postweaning mortality rates taken as 6% and 2% respectively (as assumed by simulation program) for all four breed types

Scenario 2: Relative income per hectare (I/ha) with preweaning and postweaning mortality rates of the four breed types taken as described in Table 1

#: I/ha of 1.00 = 11.90 kg/ha

*: I/ha of 1.00 = 12.21 kg/ha

Du Toit *et al.* (1995) indicated differences between production systems with the 18/18 month system usually biologically more efficient than the 8/18 month system. The results and changes in ranking of breeds based on I/ha for the two production systems and for two mortality rate scenarios are given in Table 3.

Under Scenario 1 it was found that a British breed performed best in the 8/18 month production system while a European breed performed best in the 18/18 month production system. The reason might be that European breeds reach maturity later because of their large mature body size (Burns *et al.*, 1988), thereby causing them to perform better in the 18/18 month system. Under Scenario 2 the best performance for the 8/18 month system was jointly achieved by a composite and a Sanga/Zebu breed while the composite performed best in the 18/18 month production system with the Sanga/Zebu breed dropping to the fourth position. The reason for this might be the lower postweaning growth potential of the Sanga/Zebu breed. It was proved by Van Zyl *et al.* (1992) that Sanga-type sires could have a negative influence on the growth performance of their progeny.

Comparing the production systems for each of the scenarios, it is evident that the 18/18 month production system is more efficient than the 8/18 month system (Du Toit *et al.*, 1995). Comparing Tables 2 and 3, it can be concluded that irrespective of whether cattle are classified in breed types or not, results remained the same. The only exception is the fact that the third position was taken by a European breed under Scenario 2 for the 18/18 month production system. This is probably a result of (a) better postweaning growth of the breed; (b) the poorer postweaning performance of the Sanga/Zebu breed as mentioned; or (c) bias in the dataset of the particular European breed due to the dominating effect of one particular breeder. Sanga/Zebu performed worst in all situations, the reason probably being the atypical low performance of the breed. Another theory may be that this indigenous breed evolved under circumstances where the ability to survive was of greater importance than production merit (Hofmeyr, 1974).

Comparing results in Table 3, it can be seen that considerable variation exists between the breed that performed worst and the one that performed best within a production system.

Table 3 Relative income per hectare (I/ha) for two production systems for two different mortality rate scenarios and changes in ranking of breeds

	Scenario 1				Scenario 2			
Breed	8/18 month prod. system	Rank	18/18 month prod. system	Rank	8/18 month prod. system	Rank	18/18 month prod. system	Rank
Sanga/Zebu 1	1.000#1	14	1.000*1	15	1.000#2	14	1.000*2	15
Composite 1	1.172	7	1.196	7	1.159	1	1.188	1
Sanga/Zebu 2	1.153	12	1.097	13	1.145	3	1.097	7
European 1	1.185	6	1.221	2	1.050	6	1.110	5
Composite 2	1.058	13	1.073	14	1.046	8	1.068	11
British 1	1.191	5	1.210	3	1.030	12	1.088	9
European 2	1.199	3	1.165	10	1.059	5	1.054	12
Sanga/Zebu 3	1.171	8	1.147	12	1.159	1	1.142	4
European 3	1.192	4	1.252	1	1.061	4	1.147	3
British 2	1.208	1	1.203	5	1.049	7	1.086	10
Composite 3	1.164	10	1.169	8	1.152	2	1.162	2
British 3	1.154	11	1.168	9	1.001	13	1.048	13
European 4	1.164	10	1.198	6	1.031	11	1.095	8
European 5	1.168	9	1.209	4	1.033	10	1.101	6
British 4	1.203	2	1.154	11	1.038	9	1.031	14

Scenario 1: Relative income per hectare (I/ha) with preweaning and postweaning mortality rates taken as 6% and 2% respectively (as assumed by simulation program) for all the breeds in both production systems
Scenario 2: Relative income per hectare (I/ha) with preweaning and postweaning mortality rates taken as those of the particular breed type
#1: I/ha of 1.000 = 8.90 kg/ha
*1: I/ha of 1.000 = 10.51 kg/ha
#2: I/ha of 1.000 = 9.32 kg/ha
*2: I/ha of 1.000 = 10.81 kg/ha

Percentage differences between best and worst performers were as follows: 21% (8/18 month/Scenario 1), 26% (18/18 month/Scenario 1), 16% (8/18 month/Scenario 2) and 19% (18/18 month/Scenario 2). This is an indication of the diversity existing among the breeds. When comparing production systems across scenarios, the 8/18 month system performed 5% better in Scenario 1 and the 18/18 month system 6% better in the same scenario than in Scenario 2. Bearing in mind that Scenario 2 depicts the actual mortality rates, this is an indication of substantial scope for increasing productivity, by trying to lower mortality rates.

Furthermore, results from both Tables 2 and 3 indicate that utilization of composite breeds could be meaningful. They probably offer the greatest opportunity to exploit additive genetic variation among breeds (Cundiff *et al.*, 1986), but some of the opportunity to exploit heterosis may be sacrificed relative to exploitation of heterosis by crossbreeding systems which are the most effective means of managing genetic antagonisms (Cundiff *et al.*, 1986; Koch *et al.*, 1989).

Conclusions

There are indications that European and British breeds have superior genetic merit in environments with low stress levels (Gregory *et al.*, 1982; Burns *et al.*, 1988), while composite and Sanga/Zebu breed types have superior adaptive capacity in stressful environments (Gregory & Cundiff, 1980; Burns *et al.*, 1988; Scholtz, 1988; Schoeman, 1989). This study has highlighted the gap in breed characterization in South Africa, since no framework currently exists for the characterization of a breed for bio-economic important traits at different production levels. Since bio-diversity among breeds exists, further research on breed characterization is needed.

Mortality rate proved to be a major detrimental factor in animal productivity and therefore also on herd efficiency. Table 3 and the discussion above indicate scope for improvement in mortality rates by utilizing genetic variation either within or between breeds.

Composite breed types normally performed well, indicating that use of such breeds in a variety of environments is a good choice. These results are in line with general conclusions on composite breeds. Crossbreeding systems may be used to achieve high levels of heterosis, but optimal crossbreeding systems are difficult to adapt and sustain in herds that use fewer than four bulls (Gregory & Cundiff, 1980). Composites, however, offer a procedure more effective than continuous crossbreeding for utilizing high levels of heterosis on a continuous basis, providing for optimal performance levels for major bio-economic traits in a variety of different production and market situations (Gregory *et al.*, 1991). Composite breeds also generally compete with crossbreds for utilizing heterosis and they are easier to manage regardless of herd size (Gregory & Cundiff, 1980).

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