

- KLEIBER, M., 1947. Body size and metabolic rate. *Physiol. Rev.* 27, 511.
- KLEIBER, M., 1961. Metabolic rate and food utilization as a function of body size. *Res. Bull.* 767, University of Missouri, Missouri.
- SCHOLTZ, M.M., ROUX, C.Z., DE BRUIN, D.S. & SCHOEMAN, S.J., 1990. Medium term responses and changes in fitness with selection for parameters of the allometric autoregressive model. *S. Afr. J. Anim. Sci.* 20, 65.
- VAN WYK, J.B., ERASMUS, G.J. & KONSTANTINOV, K.V., 1993. Variance component and heritability estimates of early growth traits in the Elsenburg Donner sheep stud. *S. Afr. J. Anim. Sci.* 23, 72.

## A note on the evaluation of a simulation program for beef cattle breeding and production

P. du Toit\* and M.M. Scholtz

Irene Animal Production Institute, Private Bag X2, Irene, 1675 Republic of South Africa

I.F. Dickson

Vleissentraal, P.O. Box 980, Pretoria, 0001 Republic of South Africa

J. van der Westhuizen

Department of Animal Science, University of the Orange Free State, P.O. Box 339, Bloemfontein, 9300 Republic of South Africa

\* Author to whom correspondence should be addressed.

Received 28 May 1993; revised 10 November 1993; accepted 17 January 1994

The aim of the study was to evaluate results obtained from a computer simulation program (Vleissentraal Simulation Program for a Beef Production System). Simulation runs were carried out and the results were compared with published, scientifically proven results. The results obtained by simulation were found to be in the same numeric order as those used for comparison. This satisfies the need for model validation based on scientifically correct hypotheses. It can be concluded that the program is suitable for further studies.

Die doel van die studie was om die resultate van 'n rekenaar-simulasieprogram ('Vleissentraal Simulation Program for a Beef Production System') te evalueer. Simulasie-lopies is gedoen en resultate is vergelyk met gepubliseerde, wetenskaplik-korrekte resultate. Resultate was in dieselfde numeriese orde as dié wat vir vergelyking gebruik is. Dit verskaf genoegsame getuienis dat die program voldoen aan wetenskaplik-gefundeerde hipoteses. Die gebruik daarvan in verdere studies is derhalwe aanvaarbaar.

**Keywords:** Beef cattle, simulation.

When designing breeding programmes we consider how present actions are likely to affect future selection responses, performance and economic returns (William & Hill, 1986). Experimental evaluation of breeding and production systems is complicated by tremendous cost in both time and money. Such limitations can partially be overcome by using mathematical computer simulation models to simulate livestock breeding and production systems (Long *et al.*, 1975). The quantitative nature of animal breeding facilitates such computer modelling in many disciplines within agriculture and for a variety of purposes (Long *et al.*, 1975; Dent & Blackie, 1979). One of the areas suggested as being worthy of such an approach is the definition of bioeconomic objectives (Harris & Stewart, 1986).

Bioeconomic simulation models are crucially needed for animal production (Hohenboken, 1986). The development and validation of models which are suitable for each major production, climatic and managerial environment, were fuelled by the use of appropriate biological and economic inputs and also by the desire to integrate available genetic and economic information into a comprehensive computer simulation program for breeding purposes. Development of adequate models for simulation of any system requires accurate estimates of all parameters (Long *et al.*, 1975). Output variables alone are not sufficient, and therefore input variables should also be taken into consideration. Dent & Blackie (1979) stated that the requirement of the user for assessment will govern the type of testing most appropriate for a particular model. Bearing this in mind, it was decided to test the validity of the model under consideration against results from a mathematical approach published by Roux (1992). Roux's results are in reasonable agreement with results of a simulation study by Notter *et al.* (1979) as well as experimental results which formed the basis of the mathematical approach by Taylor *et al.* (1985).

The model evaluated is 'The Vleissentraal Simulation Program for a Beef Production System'. It is based on a typical Bushveld farm situation, but makes provision for changes to variables in order to allow evaluation of other farm types. The tables of Meissner (1982) which give the definition of a large stock unit and large stock unit equivalents of various classes of stock, were used in the development of this simulation program. Technical aspects, assumptions, arguments and comprehensive data used to establish the realistic and scientific accountable tables were published by Meissner (1982). Information supplied by this program is summarized in Table 1. It is important to note that costs mentioned in this table are strictly applicable to the biological system involved and do not include fixed costs. The program also allows for changes in breeding herd structure, marketing strategy, supplementary feeding program and many other factors. Du Toit (1993) can be consulted for a complete printout and more information on results obtained by the use of the program. The aim is, however, to use this model to predict the variation in both biological output and economic return for the different beef breeds, performance traits and production systems. The same assumptions made by Roux (1992) to compare his mathematically deducted results to other studies by Taylor *et al.* (1985) and Notter *et al.* (1979) were used in this comparison.

Data used in this simulation study are the national averages for beef cattle obtained from the National Beef Cattle Performance and Progeny Testing Scheme for the period 1980–1985.

**Table 1** An example of summarized information – Vleissentraal Simulation Program for a Beef Production System

No. of calves born	352	Total body mass sold (kg)	98 092		
Calving percentage	92.0	Total carcass mass sold (kg)	49 506		
No. of calves weaned	330	Body mass sold (kg/cow)	257.1		
Weaning percentage	86.5	Carcass mass sold (kg/cow)	129.8		
Birth mass as percentage of cow mass	6.4	Body mass sold (kg/ha)	19.6		
Weaning mass as percentage of cow mass	38.4	Carcass mass sold (kg/ha)	9.9		
Income per cow (Rc)	650.24	Income per LSU (Rc)	347.22	Income per ha (Rc)	49.61
Selected costs per cow	212.30	Selected costs per LSU	113.37	Selected costs per ha	16.20
Net return per cow	437.94	Net return per LSU	233.86	Net return per ha	33.41
Interest costs per cow	239.54	Interest costs per LSU	127.91	Interest costs per ha	18.28
NR – interest per cow	198.40	NR – interest per LSU	105.94	NR – interest per ha	15.14

LSU = Large stock units; NR = net return; Rc = Rand and cents.

To test the usefulness of this simulation program its results must be of the same numeric order as the results of Roux (1992) which are in turn in agreement with those of two previous studies. Results are given in Tables 2 and 3. In Table 2 the results are compared to the percentage gain in herd feed- or cost efficiency through an increase in sexual dimorphism compared to monomorphism (Roux, 1992 – Table 4). Roux (1992) defined sexual dimorphism as sire/dam mass. In cattle, the average sexual dimorphism was given as 1.4 by Taylor *et al.* (1985). After having adjusted between-breed sexual dimorphism to an average of 1.4, Roux (1992) claimed that sexual dimorphism of South African beef breeds varies between 1.2 and 1.6. As can be seen from Table 2 there are no real differences compared to the results published by Roux (1992). In the range of cattle (1.2–1.6) it is even in total agreement.

**Table 2** Comparison of the simulation program with results from Roux's study (Roux, 1992 – Table 4) for percentage gain in herd feed or cost efficiency through sexual dimorphism

Sire/dam body mass ratio	Simulation program	Roux's results	Numeric difference	Percentage difference
1.2	6	6	0	0
1.6	16	16	0	0
2.0	27	25	2	8

**Table 3** Comparison of the simulation program with results from Roux's study (Roux, 1992 – Table 5) on the percentage gain in herd efficiency by size manipulation of all market animals

Feeder:breeder body mass ratio	Simulation program	Roux's results	Numeric difference	Percentage difference
1.2	9	9	0	0
1.6	27	24	3	12.5
2.0	43	37	6	16.2
3.0	81	64	17	26.6

The percentage gain in herd efficiency for cattle from feeder–breeder dimorphism, achievable by size manipulation, is given in Table 3. Feeder–breeder dimorphism can be defined as a situation where large offspring for slaughter are obtained from small breeding animals. This is achievable through either terminal crossbreeding or growth modification by biotechnological or dietary means (Roux, 1992).

In Table 3, differences came to light where the feeder:breeder mass ratio became large (3.0). Dent & Blackie (1979) stated that the adequacy of a model must be seen in relation to its purpose and not from an absolute viewpoint. The difference in results for the feeder:breeder mass ratio of 3.0 between the two studies is omissible for the purpose of validating the simulation program as there are no recorded cases in beef cattle where feeders are three times heavier than breeders.

The fact that the two sets of information used for program development (Meissner, 1982) and program validation (Roux, 1992) were developed independently and that a similarity between the results exists, validates the scientific accountability of this program. In view of the above results it is thus concluded that the program is suitable to evaluate the bio-economic effect of different breeds, performance traits and breeding systems on total herd efficiency. This can be used in the construction of selection indices with, probably, the most accurate bioeconomical weights for performance traits to date.

### Acknowledgements

The financial assistance of Vleissentraal contributed towards making this project possible. The authors also thank Miss Gabrielle D. Meyer and Mr J.C. van der Walt for technical assistance.

### References

- DENT, J.B. & BLACKIE, M.J., 1979. Systems simulation in agriculture. Applied Science Publishers Ltd., London.
- DU TOIT, P., 1993. A simulation study on factors influencing total herd efficiency in beef cattle. M.Sc. Agric. thesis, Univ. Orange Free State, Bloemfontein (submitted).
- HARRIS, D.L. & STEWART, T.S., 1986. The role of computer simulation and laboratory animals in the design of breeding programmes. *3rd Wld. Congr. Genet. Appl. Livest. Prod.* XII, 257.
- HOHENBOKEN, W.D., 1986. Costs and benefits of breed utilization strategies in sheep. *3rd Wld. Congr. Genet. Appl. Livest. Prod.* IX, 509.

- LONG, C.R., CARTWRIGHT, T.C. & FITZHUGH Jr., H.A., 1975. Systems analysis of sources of genetic and environmental variation in efficiency of beef production: cow size and herd management. *J. Anim. Sci.* 40, 409.
- MEISSNER, H.H., 1982. Vevangingswaardes van verskillende klasse van plaasdiere en wild in terme van 'n biologies gedefinieerde grootvee-eenheid. *Vleisbeeste C.3/1982. Boerd. S.A.*
- NOTTER, D.R., SANDERS, J.O., DICKERSON, G.E., SMITH, G.M. & CARTWRIGHT, T.C., 1979. Simulated efficiency of beef production for a midwestern cow-calf-feedlot management system. *J. Anim. Sci.* 49, 92.
- ROUX, C.Z., 1992. Maximum herd efficiency in meat production. III Feeder-breeder dimorphism. *S. Afr. J. Anim. Sci.* 22, 11.
- TAYLOR, St C.S., MOORE, A.J., THIESSEN, R.B. & BAILY, C.M., 1985. Efficiency of food utilization in traditional and sex controlled systems of beef production. *Anim. Prod.* 40, 401.
- WILLIAM, G. & HILL, U.K., 1986. Population size and design of breeding programmes. *3rd Wld. Congr. Genet. Appl. Livest. Prod.* XII, 245.

## Genetic correlations between performance of individually fed and feedlot fed bulls

Helena E. Theron\* and M.M. Scholtz

Irene Animal Production Institute, Private Bag X2, Irene, 1675 Republic of South Africa

C.Z. Roux

Department of Genetics, University of Pretoria, Pretoria, 0002 Republic of South Africa

\* Author to whom correspondence should be addressed

Received 15 July 1993; accepted 18 January 1994

The performance of Bonsmara bulls tested in Phase C of the South African Performance Testing Scheme (intensive test in which individual feed intakes are measured) was compared with the performance of the half-sib bulls tested in Phase D (comparable to commercial feedlot conditions). Birth weight and yearling weight did not differ significantly between bulls tested in the two phases. Although bulls entering Phase C were selected for weaning weight, the ADG (average daily gain) and Kleiber ratios (ADG/yearling weight<sup>0.75</sup>) of bulls in Phase D were significantly higher than those of bulls in Phase C. Prewaning performance should thus not be used to predict postweaning performance. As the genetic correlations between half-sibs in Phases C and D for yearling weight ( $1.104 \pm 0.141$ ), ADG ( $1.008 \pm 0.005$ ) and the Kleiber ratio ( $0.777 \pm 0.179$ ) were close to unity, it is concluded that the progeny of bulls performing well in Phase C will perform well under intensive feedlot conditions.

Die prestasies van Bonsmarabulle wat in Fase C (intensiewe toets waar individuele voerinnames gemeet word) en Fase D (vergeelykbaar met kommersiële voerkrale) van die Suid-Afrikaanse

Prestasietoetskema getoets is, is met mekaar vergelyk. Geboortemassa en jaarmassa het nie betekenisvol verskil tussen bulle wat in die twee fases getoets is nie. Hoewel bulle vir Fase C geselekteer is vir speenmassa, was die GDT (gemiddelde daaglikse toename) en die Kleiberverhoudings (GDT/jaarmassa<sup>0.75</sup>) van bulle in Fase D betekenisvol hoër as dié van bulle in Fase C. Voorspeense prestasie behoort dus nie gebruik te word om naspeense prestasie te voorspel nie. Aangesien die genetiese korrelasies tussen halfsibbe in Fases C en D vir jaarmassa ( $1.104 \pm 0.141$ ), GDT ( $1.008 \pm 0.005$ ) en die Kleiberverhouding ( $0.777 \pm 0.179$ ) naby een was, kan afgelei word dat die nageslag van bulle wat goed presteer in Fase C, goed sal presteer in intensiewe voerkrale.

**Keywords:** Bonsmara, bulls, genetic correlations, growth traits.

One of the phases of the performance testing scheme conducted by the South African National Beef Cattle Performance and Progeny Testing Scheme is a centralized intensive test in which individual feed intakes are measured in order to estimate performance in both growth rate and efficiency of feed utilization. This test is commonly referred to as Phase C. Since almost 65% of all young slaughter cattle are finished in intensive feedlots, the role that Phase C can play in genetic improvement in this regard is important. Thus, the performance of Bonsmara bulls tested in Phase C at Irene near Pretoria was compared with the performance of the half-sib bulls tested under feedlot conditions in Phase D. Phase D of the testing scheme is regarded as comparable to commercial feedlot conditions and is also performed at Irene.

Data of Bonsmara cattle from the Roodeplaat Bonsmara herd of the Department of Agriculture and Water Supply were used. The animals were born between 1972 and 1986. The data involved were essentially similar to those of Hunlun (1989). The data were corrected by Hunlun (1989) for environmental effects, e.g. age of mother; year and season of birth.

The calves in this herd were reared on natural pasture at Roodeplaat near Pretoria (28° 22' E and 25° 36' S) until weaning. After weaning, bull calves were subjected to performance testing at Irene under intensive conditions either in Phase C or Phase D. Weaning weight was an important criterion in the selection of bull calves for testing in Phase C. Bulls that were included in Phase C were thus a selected group and not a random sample of the original population (Bergh, 1990). The intensive Phase D is comparable with Phase C with regard to diet, test length and age of the bulls. The basic difference between these tests is that bulls in Phase C received individual *ad libitum* feeding (intakes were recorded), while Phase D bulls received shared *ad libitum* feeding (Hunlun, 1989; Bergh, 1990). Bulls in both phases were fed an identical pelleted concentrate with 20% roughage and a metabolizable energy (ME) value of 11.35 MJ ME/kg DM for 140 days after an adaptation period of 35 days. They also received 1 kg teff hay per day. The data set included six sires with a total of 98 Phase C and 68 Phase D performance-tested sons. Each sire had at least nine sons in each phase.

The least-square means and tests of significance for certain production traits are listed in Table 1. From Table 1 it can be seen that birth weight did not differ significantly between bulls