Genetic and environmental effects on performance traits of Simmentaler cattle on the Transvaal Highveld

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Introduction

Weaner production forms the backbone of beef production in most of the ranching areas of South Africa (Van Zyl et al., 1992). Obviously the viability or profitability of most beef enterprises depends primarily on herd fertility and the birth of strong healthy calves. Furthermore, efficiency of production depends on a relatively high weaning mass, weaning mass and the mass gain from birth to weaning. During winter the animals were kept in four groups of roughly 40 cows each. The groups were: (i) Group 1 — animals were fed maize silage (Silage group), (ii) Group 2 — animals were fed foggage and hay as well as maize crop residues (Hay group), (iii) Group 3 — animals were kept only on veld (Veld group) and (iv) the Control group. Starting in 1982, data were collected over a period of nine years. The General Linear Models (GLM) procedure of SAS was used to analyse the data. The random effect of sire of calf was, for all traits investigated, highly significant (P < 0.01). Birth mass, weaning mass and the mass gain from birth to weaning was significantly (P < 0.01) lower for the silage group calves. There were no significant differences for birth mass, weaning mass and mass gain from birth to weaning between Groups 2 and 3. The combined mass gain of the cows and calves from birth to weaning for Group 3 was significantly (P < 0.05) higher than for Group 2.

Simmentaler cattle of the Highveld Region Development Institute were used in this study to determine the genetic and environmental effects on birth mass, weaning mass and the mass gain from birth to weaning. During the winter the herd was divided into four groups. The first three groups were divided into: (i) Group 1 — the cows are fed silage (Kuilvoergroep), (ii) the group is kept on standing hay, hay and maize silage (Hooi-groep), (iii) Group 3 — the group is kept on veld only (Veldgroep) and (iv) the Control group. Starting in 1982, data were collected over a period of nine years. The General Linear Models (GLM) procedure of SAS was used to analyse the data. The random effect of sire of calf was, for all traits investigated, highly significant (P < 0.01). Birth mass, weaning mass and the mass gain from birth to weaning was significantly (P < 0.01) lower for the silage group calves. There were no significant differences for birth mass, weaning mass and mass gain from birth to weaning between Groups 2 and 3. The combined mass gain of the cows and calves from birth to weaning for Group 3 was significantly (P < 0.05) higher than for Group 2.

Key words: Beef cattle, birth mass, environmental effects, gain, genetic effects, weaning mass.

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Materials and Methods

Environment

Data were collected at the Highveld Region Agricultural Development Institute (27°00' E, 26°45' S) in the Western Transvaal from 1982 to 1990. The average rainfall for this area is 600 mm per annum. The average grazing capacity, on veld, of the experimental farm is 6 ha/large stock unit.

Animals

Simmentaler cattle of the Highveld Region Agricultural Development Institute were used to study the genetic and environmental influences on birth mass, weaning mass and the mass gain from birth to weaning. During the winter the herd was divided into four groups. The first three groups were divided into: (i) an intensive management system, where the animals were kept in feedlots during the winter and fed maize silage (Silage group),
(ii) a semi-intensive system, where animals were kept on maize crop residues, *Digitaria eriantha* Steud., foggage as well as on *Digitaria eriantha* Steud. hay during the winter (Hay group), and (iii) an extensive system, where the animals were kept on veld for the duration of winter (Veld group). The fourth group of cattle (Control group) was a component group, used in mineral supplement trials, and was kept on veld as well as on *Digitaria eriantha* Steud. foggage during the winter. All the cows grazed on veld during the summer. Twenty per cent of the cows were *Digitaria eriantha* Steud. foggage during the winter. All the cows grazed on veld during the summer. Twenty per cent of the cows were replaced by pregnant heifers annually. In the silage group, the heifers were mated at 13 – 15 months of age, and in the other three groups at the more commonly used 25 – 27 months of age. The breeding season for all heifers was from 20 November to 2 January and for all cows from 10 December to 10 February annually. Thirty cows were allocated to each bull. All bulls were brought in from outside the herd and were kept for a maximum of three years. The bulls were randomly used in all four groups. All the animals received the same dosing, dipping and inoculation treatments. Calves were weaned as close as possible to the 5th of May every year.

**Recording procedure**

The following data were recorded for each calf born from 1982 to 1990: sire of calf, year and month in which calf was born, sex of calf, wintering treatment, inter-calving period (ICP) of the dam, the production status of the dam for the year n – 1 (n = year of calf’s birth), the body condition score of the cow at calving, dam age at birth of the calf, birth date, birth mass, 100-day mass, dam mass at weaning and weaning mass.

**Statistical procedure**

The General Linear Model (GLM) procedure of SAS (1985) was used to analyse the data. The random effect, sire of calf; fixed effects: year, sex of calf, wintering treatment (groups) and month of birth as well as the linear and quadratic regressions of weaning age of calf, cow mass and cow age at birth were included in the models for all traits. The final operational models for each trait included effects making a significant (P < 0.05) contribution to the variance only. Because of the number of effects involved, the complexity and the unbalanced nature of the data, no higher-order interactions were included in the model.

### Results and Discussion

Although sires appear to be allocated randomly to management systems, the random effect of sire influenced all the traits significantly (P < 0.01) (Table 1). This is an indication that the use of mixed model methodology should always be considered in an analysis of this kind. A significant (P < 0.01) regression of dam age at birth on the mass of the dam at birth was found, but the R² of the regression was 0.068 and it was decided that both parameters could be included in the model.

### Birth mass

The random effect of the sire of the calf was significant at a significance level of P < 0.01. The effect of age of the dam at calving was not significant on birth mass of the calf when the mass of the dam at birth of the calf was included in the operational model. All the management systems, except for the control, differed significantly (P < 0.05) from one another. The silage group was a component group, used in mineral supplement trials, and was kept on veld as well as on *Digitaria eriantha* Steud. foggage during the winter.

### Table 1 Analysis of variance for birth weight, weaning weight, Gain 1 and Gain 2

<table>
<thead>
<tr>
<th>Source</th>
<th>Birth mass df</th>
<th>Birth mass F</th>
<th>Weaning mass df</th>
<th>Weaning mass F</th>
<th>Gain 1 df</th>
<th>Gain 1 F</th>
<th>Gain 2 df</th>
<th>Gain 2 F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sire</td>
<td>39</td>
<td>3.89**</td>
<td>39</td>
<td>3.50**</td>
<td>39</td>
<td>2.81**</td>
<td>39</td>
<td>2.10**</td>
</tr>
<tr>
<td>Year</td>
<td>8</td>
<td>8.34**</td>
<td>8</td>
<td>8.23**</td>
<td>8</td>
<td>8.30**</td>
<td>8</td>
<td>8.46**</td>
</tr>
<tr>
<td>Month</td>
<td>2</td>
<td>36.63**</td>
<td>2</td>
<td>5.69**</td>
<td>2</td>
<td>232.31**</td>
<td>2</td>
<td>46.60**</td>
</tr>
<tr>
<td>Sex</td>
<td>1</td>
<td>114.73**</td>
<td>1</td>
<td>229.81**</td>
<td>1</td>
<td>155.45**</td>
<td>1</td>
<td>55.37**</td>
</tr>
<tr>
<td>Manage system</td>
<td>3</td>
<td>16.27**</td>
<td>3</td>
<td>12.80**</td>
<td>3</td>
<td>8.86**</td>
<td>3</td>
<td>12.29**</td>
</tr>
<tr>
<td>Weaning age</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>107.94**</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Dam age at birth</td>
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<td>–</td>
<td>1</td>
<td>24.78**</td>
<td>1</td>
<td>34.08**</td>
<td>1</td>
<td>5.67*</td>
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<tr>
<td>Dam mass at birth</td>
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<td>131.49**</td>
<td>1</td>
<td>287.75**</td>
<td>1</td>
<td>201.39**</td>
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<td>–</td>
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<tr>
<td>R²</td>
<td>0.347</td>
<td>0.538</td>
<td>0.508</td>
<td>0.405</td>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

* = (P < 0.05); ** = (P < 0.01)

Gain 1 = gain of the calf from birth to weaning
Gain 2 = gain of cow plus calf from birth to weaning
Table 2 The significant differences between the various management system groups for all traits investigated

<table>
<thead>
<tr>
<th>Management system</th>
<th>Birth mass</th>
<th>Weaning mass</th>
<th>Gain 1</th>
<th>Gain 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage group vs. rest</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Hay group vs. rest</td>
<td>**</td>
<td>*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Veld group vs. rest</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Control vs. rest</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Silage vs. Hay</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Silage vs. Veld</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Silage vs. Control</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay vs. Veld</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay vs. Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veld vs. Control</td>
<td>**</td>
<td></td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

* = P < 0.05 significance level; ** = P < 0.01 significance level

Gain 1 = gain of the calf from birth to weaning
Gain 2 = gain of cow plus calf from birth to weaning

differed highly significantly (P < 0.01) from Groups 2 and 3 for all traits investigated, and significantly (P < 0.05) from the control for birth mass (Table 1 & 2). The mean birth mass of all the calves in the maize silage group was lower (Table 3) than control for birth mass (Table 1 & 2). The mean birth mass of all heifers of the silage group were mated at 13 - 15 months of age. Scholtz et al. (1991) found that the mean birth mass of the progeny of a group of heifers mated at 13 - 15 months of age, was significantly lower than that of a group of heifers mated at 25 - 27 months of age. A further possible explanation may be the higher stress levels experienced by animals in the feedlots. There were no significant differences between the hay and the veld groups as well as between the hay group and the control, but the veld group differed significantly (P < 0.01) from the control.

Weaning mass

The random effect of the sire of the calf was significant at a level of P < 0.01. The silage group and the veld group differed highly significantly (P < 0.01) from the rest, but the hay group, is well as the control, did not differ from the rest (Table 2). The calves of the hay and veld groups showed a significantly (P < 0.01) better gain than the silage group, but the silage group did not differ from the control. The hay group did not differ from either the veld group or the control, but the veld group gained significantly (P < 0.05) more weight than the control. The least square means of Gain 1 for all the groups are given in Table 3.

Gain 1

Gain 1 represents the gain of the calf from birth to weaning. The random effect of sire of calf was significant at a level of P < 0.01. The silage and veld groups both differed highly significantly (P < 0.01) from the rest, but the hay group, is well as the control, did not differ from the rest (Table 2). The calves of the hay and veld groups showed a significantly (P < 0.01) better gain than the silage group, but the silage group did not differ from the control. The hay group did not differ from either the veld group or the control, but the veld group gained significantly (P < 0.05) more weight than the control. The least square means of Gain 1 for all the groups are given in Table 3.

Gain 2

Gain 2 represents the combined gain of the cow and the calf from birth to weaning. Again, the random effect of sire of calf was significant at a level of P < 0.01. Only the silage and veld groups differed highly significantly (P < 0.01) from the rest of the groups (Table 2). The silage group gained significantly (P < 0.01) less mass than the hay and veld groups and significantly (P < 0.05) less than the control . The silage group cows had difficulty in adapting to the pastures after spending the winter in the feedlots and showed a mass loss before they started to gain. The hay group gained significantly (P < 0.05) less mass than the veld group, but did not differ from the control. The veld group gained significantly (P < 0.01) more mass than the control. The least square means of Gain 2 for all the groups are given in Table 3.

Conclusions

Because random effect of the sire influenced all the traits significantly (P < 0.01), it is concluded that the random effect of the sire of the calf should always be included in an analyses of this kind. The value of mixed model analysis should therefore not be limited to genetic evaluations.

Although the veld group seems to be the most productive for all traits investigated, it must be noted that the maize silage (Group 1) and the foggage and hay (Group 2) groups were not fed ad libitum. An economic evaluation of the three management systems indicated that the gross margin per hectare for all three systems for the nine years are almost the same and that they fluctuate according to the year’s climate (Genis, 1989).

Acknowledgements

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References


