Preliminary Investigation into Genetic Parameters for Feedlot Traits of Angus Cattle in South Africa

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ABSTRACT: Selection to improve feed efficiency in beef production is aimed at reducing feed cost. However, breeding animals also contribute to feed cost, not only feedlot animals. Selection for residual feed intake (RFI) differs from other feed efficiency traits since it is independent from growth and body weight, thus not leading to increased maintenance requirements in mature animals. Performance data from young South African Angus bulls tested at centralized growth test stations were used to calculate genetic parameters for seven post weaning growth- and feed efficiency traits. Data collected from 1979 to 2009 of performance tested bulls were used in the analysis. Difficulties were experienced determining correlations for residual traits and FCR (feed conversion rate), this supports MacNeil et al. (2013) argument that it is more beneficial to base selection on the component traits used to determine ratio and feed efficiency traits.

Keywords: residual feed intake; residual daily gain

Introduction

Feed cost is of major importance in beef production since variation for intake among animals independent from body size can influence profitability (Koch et al. (1963)) and Parnell et al. (1994)). It has been shown that a 10% improvement in feed efficiency can improve profitability more than twice as much as when a 10% improvement in growth was achieved (Fox et al. (2001)).

Common measures of efficiency is feed conversion ratio (feed consumed/weight gain) or feed efficiency (weight gain/feeding consumed) which are ratio traits. However, efficiency is highly associated with growth rate, thus when selecting for better efficiency, indirectly selection for higher growth takes place (Koch et al. (1963)). This leads to an increase in mature size, which in turn increases the maintenance cost of the breeding herd (Koots et al. (1994)). Another problem when selecting for ratio traits is that the change in the component traits (growth and feed intake) is unknown (Arthur et al. (2001)).

Another big concern of beef production is the contribution to global warming. Selection for RFI will not only improve feed efficiency but it will also lead to less methane emissions. A positive correlation exists between RFI and methane production thus reducing the carbon footprint of beef cattle (Nkrumah et al. (2006)).

It has been shown that residual feed intake (RFI) is phenotypically independent from growth rate and mature weight, making it possible to compare among animals who differ in body weight and growth rate (Arthur et al.(2001)). Improvement in RFI leads to the reduction of feed intake without affecting growth performance or mature size. Residual feed intake (RFI) is defined as the difference between the actual feed intake and that predicted from the requirements for maintenance and growth (Koch et al.(1963)). Residual gain (RDG) defined by MacNeil et al. (2013) is the difference in growth rate for a certain level of intake. Both these are feed efficiency traits since RFI will reduce the amount of feed use to reach a certain weight whereas RDG will improve consumption since the animal will reach his aimed weight in fewer number of days (MacNeil et al. (2013)).

Material and methods

The data used were of the South African Angus breed and was obtained from the South African Integrated Registration and Genetic Information System (INTERGIS). Performance data from young Angus bulls tested at centralized growth test stations and on farm tested were used to calculate genetic parameters of seven post weaning growth- and feed efficiency traits. Feed intake is not recorded for the on farm tested bulls, only growth and body weights. The animals were subjected to an adaptation period of 28 days where after they participate in the growth test for 84 days or more.

For feed intake and efficiency traits 1035 records were used in the analysis after editing and for body weight and growth there was 9008 records available. Traits included in the analysis were, weight at the beginning of test (begin weight), weight at the end of test (end weight), feed conversion ratio (FCR), average daily gain (ADG), total feed intake over test period (TFI), RFI and residual daily gain (RDG).

RFI was determined by regressing daily feed intake (DFI) on metabolic weight (MBW) and ADG; RDG was determined by regressing ADG on DFI. Thus RFI is the difference between the actual intake of the animal and that predicted for its body weight and level of growth, whilst RDG is the difference between the actual growth rate of the animal and that predicted for the level of intake for the animal. More efficient animals will be those with a negative RFI value, meaning the animal had a lower level of intake.
than expected and a positive RDG value; the animal had a higher growth rate than expected.

Phenotypic values for RFI and RDG were calculated through the use of regression coefficients:

\[ \text{RFI}_p = \text{DFI} - 0.09543 \times \text{MBW} - 1.8576 \times \text{ADG}, \text{ and} \]
\[ \text{RDG}_p = \text{ADG} - 0.28817 - 0.1296 \times \text{DFI} \]

The intercept for RFI was found to be not significant.

Records varying more than 3.5 standard deviations from the mean were removed. The software program ASREML (Gilmour et al. (2002)) was used to obtain (co)variance components, by fitting univariate models for variance components and 3 trait animal models for covariances.

Results and discussion

Heritabilities found were 0.38 for initial weight, 0.30 for end weight, FCR which is usually a moderately heritable trait (van der Westhuizen et al. (2004)) was found to have a lower heritability with 0.08, 0.22 for ADG and 0.79 for TFI. The heritabilities obtained for RFI and RDG were 0.32 and 0.16 (unfortunately with a high standard error for RDG), respectively. Heritabilities found in other studies for RFI were also moderately heritable (Arthur et al. (2001) and van der Westhuizen et al. (2004)). The antagonism between growth and intake as described by MacNeil et al. (2013) are depicted by the low positive genetic correlation (0.27) between these two traits. Genetic correlations were determined using 3 trait models. It was suspected that the size of the dataset used in this study was insufficient since certain correlations could not be determined; difficulties were experienced especially with the three ratio traits.

Conclusion

Selection to improve feed efficiency is aimed at improving profitability through means of decreasing inset costs. Unfortunately many of the covariance estimates (Table 1) could not be determined; this could be due to the fact that the data set was too small. Macneil et al. (2013) found significant differences in ranking for RFI and RDG and this could be due to the fact that an antagonism exists between the components traits used to determine these residual traits. It is recommended that ADG and DFI are included in a selection index rather than direct selection on RFI and RDG.

| Table 1. Heritability (on diagonal) and genetic correlation estimates (above diagonal) for and among traits |
|----------------------|----------|----------|----------|----------|----------|----------|
|                      | W205     | Begin weight | End weight | TFI       | ADG       | FCR      | RFI       | RDG       |
| Begin weight         | 0.38     | (0.01)     | 0.30     | 0.22     | 0.44     | -0.27    | -0.24     | 0.57      |
| End weight           | 0.38     | 0.30      | 0.88     | 0.10     | 0.46     | NRV      | NRV       | NRV       |
| TFI                  | 0.30     | 0.30      | 0.50     | 0.81     | SING     | NRV      | NRV       | NRV       |
| ADG                  | 0.79     | (0.12)     | 0.53     | 0.53     | 0.68     | NRV      | NRV       | NRV       |
| FCR                  | 0.22     | (0.03)     | NRV      | NRV      | NRV      | NRV       | NRV       | NRV       |
| RFI                  | 0.08     | (0.12)     | NRV      | NRV      | NRV      | NRV       | NRV       | NRV       |
| RDG                  | 0.33     | (0.12)     | NRV      | NRV      | NRV      | NRV       | NRV       | NRV       |
|                      |          |           |          |          |          |          |          | 0.17 (0.13) |

Notes:

1W205 = 205 day weight; begin weight = weight at the beginning of the test; end weight = weight at the end of the test; TFI = total feed intake; ADG = average daily gain; FCR = feed conversion rate; RFI = residual feed intake; RDG = residual daily gain

2NRV = negative residual variation

3NSS = negative sum of squares

Literature cited


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