INVESTIGATION INTO GENETIC PARAMETERS FOR FEEDLOT TRAITS OF TWO CATTLE BREEDS IN SOUTH AFRICA

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Summary

A shift in selection goals for beef production has taken place with more emphasis being placed on efficient production. The reduction in feed costs, being the largest expense in beef production, may hold possibilities for increasing profitability. Various traits have been developed in the past with the aim of selecting for increased feed efficiency, it is, however, important to take into consideration the impact that selection for one trait might have on other traits throughout the production cycle. The aim of this study was to estimate genetic parameters for feedlot traits for the South African Angus and Simmental beef breeds, with specific emphasis on net feed intake (NFI) as means of selection for feed efficiency. Genetic parameters for various feedlot traits as well as body measurements were estimated, with special focus on the relationship that exists amongst these traits. Net feed intake (NFI) was used as an alternative for feed efficiency (feed conversion rate (FCR) was previously the most commonly used trait in South Africa as means of improving feed efficiency). FCR, however, has an unfavourably strong relationship with average daily gain (ADG), which in turn can lead to the selection of animals with higher mature weights. NFI is phenotypically independent of growth and body weight and should address the antagonism that exists with FCR. The results indicate a weak associations between NFI and body weight and growth traits, implying that NFI should have little effect on these and other related traits. This is in contrast to the moderate to strong correlations of FCR with the same traits. There is a significant difference in the strength of the correlations found for the above-mentioned feed efficiency traits with growth and body weight traits. If the aim is thus to improve feed efficiency without affecting the size of the breeding herd, NFI should be used as an alternative trait for feed efficiency.

Keywords: net feed intake, feed conversion ratio, Angus, Simmental

Introduction

Current selection goals placed much emphasis on increasing the level of production when considering beef production. This is done via selection for better growths (higher weaning weights) and increased reproduction with the goal of producing more calves at shorter intervals. Intensive animal production as seen in poultry systems has made significant improvements in the last few decades, with a tremendous increase in growth, as well as a decrease in the amount of feed required for a unit gain in body weight (Zuidhof *et al.*, 2014). The importance of feed efficiency to poultry producers is, however, much more noteworthy, since most of their production systems are under intensive conditions and the ability to measure feed efficiency is also more accessible. This is, however, not true for beef production in most African countries, where most of the feed requirements of the cow-calf system are met through natural pastures. The measures for feed efficiency is however similar to traits found under feedlot conditions.

Feed conversion ratio was previously the most commonly used trait to measure efficiency. Unfortunately, due to the fact that it measures both metabolic efficiency and growth, indirect selection for better growers might take place, which in turn, can increase the mature size of the animal (Mcgee, 2014) and thus the cow size in the case of beef cattle. This antagonism can be overcome by selecting for a trait like net feed intake (NFI) where feed intake is regressed against mid-test weight and daily gain. These regression coefficients are then used to calculate the expected intake for each animal, this enables the identification of animals that consumed less feed than expected (Koch *et al.*, 1963). Net feed intake serves the same function as feed conversion rate (FCR) but is not correlated with growth. Alternatively, the selection for growth and feed intake through the use of a selection index can be considered (Macneil *et al.*, 2013). It is also important to note that beef cattle with good NFI (low value) have lower enteric methane emissions Nkrumah *et al*. (2006).

The aim of the study was to estimate genetic parameters for feedlot traits for the South African Angus and Simmental breeds, with specific emphasis on NFI as means of selection for feed efficiency.

Material and methods

Data of the South African Angus and Simmental breeds was obtained from the South African Integrated Registration and Genetic Information System (INTERGIS). Performance data from young Angus and Simmental bulls tested at centralized growth test stations under management of the Agricultural Research Council (ARC) was used to calculate genetic parameters for several post weaning growth- and feed efficiency traits as well as for some body measurements. After editing there were 10003 average daily gain (ADG), 1035 daily feed intake (DFI), FCR, NFI and net daily gain (NDG) and 9744 scrotal circumference (SC) records left for the Angus and 3178 records for all traits for the Simmental. All records used for the Simmental analysis were collected from animals tested under a controlled environment where they received a standardized diet with a minimum energy content of 11 MJ/kg DM and between 13.5 and 15% crude protein. The animals were subjected to an adaptation period of 28 days where after they participated in the growth test for 84 days after wean. All feed intake records for the Angus were collected under similar conditions but additional records were included for ADG and SC collected through post weaning growth tests that were conducted on the breeder's farms.

Univariate and bivariate animal models were fitted to estimate variance components, using the ASREML (Gilmour *et al.*, 1999) with a three generation pedigree used to establish genetic relationships. Contemporary groups were defined as test centre, test year and test number and only animals belonging to a contemporary group of five or more were included. Breeder was included as a fixed effect for traits where it was found to be significant. Weight at the start or end of the test and age were fitted as a linear covariate where applicable. Only an additive genetic effect was fitted for traits tested.

The GLM procedure in SAS (2009) was used to determine the significance of fixed effects. For the Angus, starting weight was included as a covariate for all traits except for NFI and SC, age at the start of test was included as covariate for ADG, weight and age at end of test were included as covariate for SC, while breeder (levels) and contemporary group (levels) were included as fixed effects for all traits.

For the Simmental age and weight at start of test were included as a covariate for ADG, DFI, FCR, NDG, end test weight (ETW) and metabolic mid weight (MWT). Final weight and age at end of test were included as a covariate for hip height (HH) and SC. Contemporary group and breeder were included as a fixed effect for all traits.

The following univariate and two-trait animal models (in matrix notation) were fitted for ADG, DFI, FCR, NFI, NDG, MWT, ETW, HH and SC:

$y=X_b+Z_a+e$

Where: y = a vector of observations
b = a vector of fixed effects
a = a vector of direct additive genetic effects
e = a vector of residuals
X, Z = incidence matrices relating observations to their respective fixed and random effects

It was assumed that:
$V(a) = A\sigma^2_a$; $V(e) = I\sigma^2_e$

Where I is an identity matrix, σ^2_a and σ^2_e is the direct additive- and environmental variance respectively.

Results and discussion

The heritability estimates for the South African Angus are presented in Table 1 and the heritability estimates and genetic correlations between the different traits for the Simmental breed are presented in Table 2 respectively. The genetic correlations for the Angus could not be estimated, which might be attributed due to a lack of feed intake records.

Table 1. Heritability estimates for the Angus (h^2) and standard error (SE)

Trait	h^2	SE
ADG	0.18	0.02
DFI	0.41	0.12
FCR	0.09	0.10
NFI	0.31	0.11
NDG	0.01	0.08
SC	0.41	0.03

[1]ADG = average daily gain; DFI = daily feed intake; FCR = feed conversion rate; NFI = net feed intake; NDG = net daily gain; SC = scrotal circumference

Heritability estimates for most traits were within range of what would be expected with NFI having a heritability of 0.31 for the Angus and 0.26 for the Simmental. Arthur and Herd (2008) summarized heritability estimates for NFI from other studies to vary between 0.16 and 0.39. Heritability estimates for ADG in the Simmental was 0.26 and 0.18 for the Angus. In a review by Koots *et al*. (1994), the weighted heritability for post weaning gain was found to be 0.31. Correlations for NFI with body weight and growth traits were found to be not significant except for NDG having a correlation of -0.39.

Table 2. Heritability (se in brackets) (on diagonal) and genetic correlation estimates (above diagonal) for the Simmental

	ETW	ADG	DFI	FCR	NFI	NDG	MWT	HH	SC
ETW	0.24 (0.09)	0.82 (0.07)	NRV	-0.86 (0.05)	-0.26 (0.16)	0.65 (0.12)	NRV	-0.08 (0.15)	-0.23 (0.14)
ADG		0.26 (0.08)	0.62 (0.10)	-0.76 (0.07)	0.19 (0.16)	0.81 (0.06)	0.70 (0.10)	-0.12 (0.14)	-0.32 (0.14)
DFI			0.30 (0.09)	-0.08 (0.16)	0.71 (0.08)	0.04 (0.16)	0.41 (0.16)	-0.17 (0.13)	-0.14 (0.13)
FCR				0.21 (0.08)	0.51 (0.13)	NRV	-0.89 (0.04)	0.01 (0.16)	0.34 (0.15)
NFI					0.26 (0.08)	-0.39 (0.14)	0.19 (0.16)	-0.14 (0.14)	0.03 (0.14)
NDG						0.20 (0.08)	0.83 (0.07)	-0.05 (0.15)	-0.33 (0.15)
MWT							0.23 (0.08)	-0.06 (0.15)	-0.21 (0.14)
HH								0.42 (0.09)	-0.04 (0.12)
SC									0.41 (0.09)

[1]ETW = end test weight; ADG = average daily gain; DFI = daily feed intake; FCR = feed conversion rate; NFI = net feed intake; NDG = net daily gain, MWT = metabolic mid weight, HH = hip height; SC = scrotal circumference
[2]NRV = negative residual variation

A moderate to strong negative correlation exists between FCR and growth and body weight traits varying between -0.76 and -0.89. This association clearly indicates higher levels of growth and body weights when selecting for FCR.

Conclusions

These results provide the necessary genetic parameters for bio economical modelling to determine optimal testing strategies for bulls under feedlot conditions to obtain the much-needed increases in numbers of records. In the case of the Simmental, NFI overcomes the unfavourable properties of FCR. However, larger numbers of records are needed to confirm this for Angus.

Furthermore, the study demonstrates a proof of concept that it is possible to estimate genetic parameters for feed efficiency for both breeds under feedlot conditions in South Africa and considerable genetic variation exists for NFI, which is waiting to be exploited. Selection for NFI has the potential to reduce the carbon footprint of beef due to the associated lower methane emissions.

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