Alternative testing procedures to measure feed intake and growth rate in South African beef cattle

J. Hendriks[1,2], M.M. Scholtz [1, 2#], J.B. van Wyk[2] & F.W.C. Neser[2]
[1]Agricultural Research Council, Animal Production Institute, Private Bag X 02, Irene, 0062, South Africa;
[2]University of the Free state, Department of Animal, Wildlife and Grassland Sciences, PO Box 339, Bloemfontein, South Africa.

Abstract

The possibility of shortening the test length of beef bulls will be of great benefit. Not only will it save costs since collecting feed intake data is expensive, but more animals can be tested, enabling higher selection pressure on efficiency. Individual feed intake data from 3 070 Simmentaler bulls were consolidated into a standard 84-day test and four alternative test periods. The Pearson and Spearman correlations were estimated in respect of the conventional growth and efficiency traits (average daily gain, daily feed intake and feed conversion ratio) and alternative efficiency traits (metabolic mid weight, net daily gain and net feed intake) for the different test lengths. Shortening of the test length does not seem feasible, since the correlation for traits among different test lengths are too low. It is concluded that daily feed intake can be measured accurately at shorter test lengths; but average daily gain, feed conversion ratio and net feed intake (which are all dependant on weight gain) require a test length of at least 70 days. The combination of data from central tests, where feed intake is measured, with that of on-farm tests where only growth is measured, may be a solution. Another option is to collect body weight more frequently. However, this implies that alternative testing procedures will have to be investigated.

Keywords: central tests, feed efficiency, GrowSafe, Simmentaler, test length
#Corresponding author: GScholtz@arc.agric.za

Introduction

Feed cost is important in beef production since it has a major influence on profitability (Koch *et al.*, 1963; Parnell *et al.*, 1994). Gibb & McAllister (1999) indicated that the economic value of a 5% improvement in feed efficiency could be four times greater than a 5% improvement in average daily gain. The conversion of feed into human food also plays an important role in livestock production. If the efficiency can be improved, livestock production will become more sustainable and will lead to an increase in production of nutritious food for humans (MacNeil *et al.*, 2013).

Common measures of efficiency are feed conversion ratio (feed consumed/weight gain) or feed efficiency (weight gain/feed consumed). These ratio traits are still widely used to select for efficiency. Although Byerly (1941) suggested net feed intake (NFI) as an alternative efficiency trait, it not generally applied as an efficiency trait. Net feed intake is defined as the difference between the actual feed intake and the expected feed intake of an animal to fulfil its maintenance requirements and growth. Likewise, Koch *et al.* (1963) suggested Net Daily Gain (NDG) as an alternative measure, which is defined as the difference between actual and predicted body weight gain based on the regression of body weight gain on metabolic mid-weight (MMW) and feed intake (Crowley *et al.*, 2010). Irrespective of which measure of efficiency is used, it requires the measurement of individual feed intake of young bulls.

The test procedure currently used in South Africa by the Agricultural Research Council (ARC) makes use of Calan Gates, with an 84-day test period after a 28-day adaptation period. This is however, expensive and only a limited number of animals can be tested due to capacity and financial restrictions. Recently there has been some discussions on the optimal time required to obtain accurate measures of feed efficiency (e.g. Retallick, 2015). The USA and Australia have shortened the time period for feed efficiency testing to a 70-day period (Archer *et al*., 1997; Archer & Bergh, 2000). Some researchers have suggested that the test period could even be shortened to 56 or even 35 days; if growth rate of the animals can be predicted or measured more accurately (Retallick, 2015) or if growth rate and feed intake are not measured simultaneously (MacNeil *et al*., 2011). This study investigates alternatives or changes to the present testing procedure, to allow for a larger number of animals to be tested at a reduced cost, without compromising accuracy.

Materials and Methods

Data of the Simmentaler breed collected in the central tests (Phase C) of the ARC (140, 112 and 84 day tests) were consolidated into a standard 84-day test using the first 84 days of each test. In addition four alternative test periods were simulated. After eliminating all contemporary groups with less than 5 animals a total of 3 070 records were available for analysis. For the estimation of NFI and NDG, information on the daily feed intake (DFI), average daily gain (ADG) and metabolic mid weight (MWT) is required. The following four "test periods" were simulated using the 3 070 records:

NFI84 – the normal Phase C test of 84 days
NFI70e – 14 days were cut off at the end of the test to create a 70-day test
NFI70s – 14 days were cut off at the start of the test to create a 70-day test
NFI70 – 7 days were cut off at the start of the test and 7 days at the end of the test to create a 70-day test

Prediction equations for NFI and NDG for each of the tests were developed as indicated below:

$$NFI = DFI - X1 - bADG - cMWT$$
$$NDG = ADG - X2 - dDFI$$

Where *X1* and *X2* are the respective intercepts and b, c and d the respective slopes.

The NFI equations for the different test lengths are:

$$NFI84 = DFI - 0.296444693 - 1.716419374*ADG - 0.083955332*MWT$$
$$NFI70e = DFI - 0.568468086 - 1.613342280*ADG - 0.086456887*MWT$$
$$NFI70s = DFI - 0.079198782 - 1.572077176*ADG - 0.085731528*MWT$$
$$NFI70 = DFI - 0.152489735 - 1.490269600*ADG - 0.088265311*MWT$$

The NDG equations for the different test lengths are

$$NDG84 = ADG - 0.0313533403 - 0.1221225079*DFI$$
$$NDG70e = ADG + 0.164728924 - 0.129877826*DFI$$
$$NDG70s = ADG - 0.1844216486 - 0.1199237698*DFI$$
$$NDG70 = ADG - 0.2178364225 - 0.1214785205*DFI$$

Where, *NFI* = Net feed intake, *DFI* = Daily feed intake, *ADG* = Average daily gain, *MWT* = Metabolic mid weight and *NDG* = Net daily gain.

Results and Discussion

Pearson (above the diagonal) and Spearman (below the diagonal) correlations were estimated in respect of the conventional growth and efficiency traits [ADG, DFI, FCR] and the alternative efficiency traits [MWT, NDG, NFI] for the different test lengths and summarized in Tables 1 and 2. Both Pearson's and Spearman's correlations are measures of the relationship between two variables. Pearson's correlations measure the linear relationship between variables and Spearman's correlation measures the re-ranking effect (Minitab Inc., 2016).

Pearson correlations between ADG for the different test lengths varied between 0.78 and 0.91, whereas that for FCR varied between 0.73 and 0.90 (Table 1). Correlations that are substantially less than 1.0 may indicate that it is not feasible to shorten the test length. It is important to note that the correlations between DFI for the different test lengths are very high (0.94 to 0.98). This may indicate that DFI can be measured accurately over a shorter test period.

From Table 2 it can be seen that the correlations between NFI for the different test lengths varies between 0.91 and 0.97 which is much higher than that of FCR (0.73 - 0.90), whereas that of NDG varies between 0.74 and 0.89. The correlations for MWT are very close to one (0.98 to 0.99). The correlation between NFI for NFI84 and the other three test lengths are quite strong (0.96 to 0.97), implying that it might be feasible to shorten the test length. However, for traits like NDG, ADG and FCR the correlation drops to below 0.9, which might suggest that the test length should be kept at 84 days. This is caused by the fact that they depend on weight gain, which needs a longer time to be measured accurately.

Table 1 Pearson (above the diagonal) and Spearman (below the diagonal) correlations between the conventional growth and efficiency traits

		NFI_{84}	**NFI_{70e}**	**NFI_{70s}**	**NFI_{70}**
NFI_{84}	ADG	X	0.91	0.91	0.88
	DFI		0.98	0.98	0.99
	FCR		0.88	0.88	0.84
NFI_{70e}	ADG	0.91	X	0.79	0.87
	DFI	0.98		0.95	0.98
	FCR	0.90		0.73	0.82
NFI_{70s}	ADG	0.90	0.78	X	0.85
	DFI	0.98	0.94		0.98
	FCR	0.90	0.77		0.78
NFI_{70}	ADG	0.88	0.86	0.85	X
	DFI	0.98	0.98	0.98	
	FCR	0.85	0.84	0.82	

NFI_{84}: normal Phase C test of 84 days; NFI_{70e}:14 days were cut off at the end of test to create a 70 day test; NFI_{70s}: 14 days were cut off at start of test to create a 70 day test; NFI_{70}: 7 days were cut off at start of test and 7 days at end of test to create a 70 day test; ADG: average daily gain; DFI: daily feed intake; FCR: feed conversion rate

Table 2 Pearson (above the diagonal) and Spearman (below the diagonal) correlations between alternative efficiency traits

		NFI_{84}	**NFI_{70e}**	**NFI_{70s}**	**NFI_{70}**
NFI_{84}	MWT	X	0.99	0.99	0.99
	NDG		0.89	0.89	0.84
	NFI		0.96	0.97	0.96
NFI_{70e}	MWT	0.99	X	0.98	0.99
	NDG	0.89		0.74	0.83
	NFI	0.96		0.92	0.96
NFI_{70s}	MWT	0.99	0.98	X	0.99
	NDG	0.89	0.75		0.80
	NFI	0.97	0.91		0.96
NFI_{70}	MWT	0.98	0.99	0.99	X
	NDG	0.84	0.83	0.80	
	NFI	0.96	0.95	0.95	

NFI_{84}: normal Phase C test of 84 days; NFI_{70e}:14 days were cut off at the end of test to create a 70 day test; NFI_{70s}: 14 days were cut off at start of test to create a 70 day test; NFI_{70}: 7 days were cut off at start of test and 7 days at end of test to create a 70 day test; MWT: metabolic mid weight; NDG: net daily gain; NFI: net feed intake

Archer & Bergh (2000) analysed data collected at test stations in South Africa for five different breeds. The test data were collected over a 112-day period where animals were weighed on a weekly basis with a 12 hour fasting period before weights were taken. In this case the ADG could be measured accurately within 42 days, which is much lower than mentioned in a previous study where the minimum was 70 days (Archer *et al.*, 1997). In contrast, 56-70 days were required to measure feed intake without too much loss of accuracy. This might be due to the differences in procedures when measuring the traits. This is in contrast to the results of this study that suggest that the test length should be kept at 84 days under the current testing procedures that use the Calan Gates to measure feed intake and chute weights to estimate growth rate (body weight).

Retallick (2015) and Thallman *et al.* (2018) described a procedure in which it is feasible to shorten the test length from 70 days to 35 days. A selection index is proposed, which include DFI, ADG and post weaning gain of cohorts that are not tested on-station, which resulted in higher heritabilities for both DFI and ADG. The fear existed that there would be a loss in accuracy due to the shortening of the test length, however to compensate for loss in accuracy, the selection pressure was increased. Manafiazar *et al.* (2017) indicated that the period in which feed intake is recorded can be reduced from 84 days to 42 days, and that a longer test length will only add 5% in the accuracy of feed intake recording. However, they also found that body weight

gain cannot be recorded accurately over a period of 42 days and suggested that body weight should be measured for an additional period outside of the feed intake measurement period.

The current tests at the ARC are done over 84 days after a 28-day adaptation period. These tests are expensive with a limited capacity and a shortening of the test length will be beneficial in the sense that both costs will be reduced and more animals can be tested, which could increase selection pressure on efficiency. From the results of this study, the shortening of test length of the current system of the ARC does not seem feasible, since the correlation between traits, except for DFI, among different test lengths are too weak.

A further in depth study is needed to establish the minimum test length needed to measure growth and feed intake accurately without compromising the accuracy of the data. MacNeil *et al.* (2019) investigated alternative models for genetic evaluation of feed intake in Afrikaner cattle and suggested the combination of data from central tests where feed intake is measured with that of on-farm tests where only growth in measured. However, this will imply some modification in the current testing procedures and ultimately the genetic evaluations.

GrowSafe® is currently recommending that a test length of 70 days is required for the accurate calculation of ADG when chute weights are used (Culbertson et al., 2015). With the GrowSafe Beef System®, a partial body weight is taken each time the animal is drinking water. This is done by weighing only the front legs and using a formula to calculate the total weight. Thus several body weights for each animal is recorded daily. In a study of 27 trials, with 1 874 animals, weighed through the GrowSafe Beef System®, it was concluded that a 49-day test, following an adequate adaptation period, was sufficient to measure ADG accurately (GrowSafe, 2019).

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Authors' contributions

This short communication is partly based on the MSc research of JH, MMS, FWCN and JBvW initiated the investigation. JH prepared the data for analysis and analysed the data under the guidance of FWCN and JBvW. MMS, FWCN and JBvW contributed to interpretation of the results. The short communication was initiated and drafted by MMS. All authors read and approved the final manuscript.

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