OPTIMUM TEST DURATION FOR THE MEASUREMENT OF GROWTH AND FEED EFFICIENCY IN PIGS

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SUMMARY
The optimum duration of test for the measurement of average daily gain, feed intake, feed conversion ratio and residual feed intake was examined using data from 77 hybrid (mainly Large White x Landrace) pigs. The pigs were housed in individual pens from about 70 days of age and fed ad libitum, a pelleted commercial diet. Feed intake and liveweight were recorded at intervals of one week. Phenotypic residual variance and correlation using shortened (7-, 14-, 21-, 28-, 35-, 42 and 49-day) tests compared with the full length 56-day test were used as criteria to assess the optimum test duration. The results indicate that for all four traits, a 35-day test was required without compromising the accuracy of measurement.

INTRODUCTION
In most livestock production systems feed costs represents the single largest expense. Improvement in efficiency of feed utilisation is currently a major consideration in most livestock breeding programs. For genetic improvement, accurate measurement of individual animal feed intake and growth is required, and it usually involves a test over a period of time. Management and feed costs increase as the duration of test increases, hence it will be beneficial to identify the optimal test duration to reduce the cost of management without compromising data accuracy and reliability. In previous studies on feed intake and efficiency in pigs, the test duration has ranged from 28 days to 110 days (Eissen et al. 1999; Hermesch et al. 2000; Nguyen et al. 2000). In recent years, the optimum length of test for feed efficiency in beef cattle has been examined in several studies (eg. Archer et al. 1997 and Wang et al. 2006), and the results indicated that the traditional 120- to 140-day test can be shortened considerably to as low as a 70-day test without significant loss of accuracy. There is a need for similar analysis for other species of livestock.

The aim of this study was to determine the optimum test duration for the measurement of average daily gain, daily feed intake, feed conversion ratio and residual feed intake in pigs.

MATERIALS AND METHODS
The data used in this study consisted of feed intake and weight records from a pig experiment which was replicated in time as two runs conducted at the Elizabeth Macarthur Agricultural Institute during 2003 and 2005 respectively. Each run consisted of two parallel components. The first component was a longitudinal study of live performance and body composition using Computed Tomography (CT) imaging. The second component was a serial-slaughter experiment to study the association between body composition assessed from CT imaging and whole-body chemical analysis.

For each replicate, ninety hybrid pigs were sourced from a PIC multiplier herd (Kings Partnership piggery, Bendigo, Victoria). Three piglets (1 male, 1 female and 1 castrate male) were selected from each of 30 litters at 7 days of age. Following weaning at 28 days, the 90 pigs were transported from
Bendigo to the Elizabeth Macarthur Agricultural Institute (EMAI) at about 42 days of age. The pigs were housed in group pens with supplementary heating. The main experiment commenced when the pigs were approximately 70 days of age. Seventy two pigs were selected [mean (± SD) weight of 32.4 ± 3.5 kg] on the basis of sex, live weight and litter and allocated to individual pens. The pigs were housed in four rooms maintained at 22°C, each room consisting of 18 pens. The pigs were fed a pelleted diet adequate in energy with amino acids 0.25 in excess of requirements to maximise protein accretion. Fresh feed was weighed and offered daily, but the weigh-back of unconsumed feed was conducted at intervals of one week. Water was provided using nipple drinkers. The diet was offered ad libitum to each pig, and feed intake and live weight were recorded at intervals of one week.

Due to the fact that some of the pigs were part of the serial slaughter component of the main experiment, the data used for this study consisted only of the pigs with full feed intake and weight records for 10 weeks. From the two replicates, 26 entire males, 25 females and 26 castrates met this criterion. The first two weeks of the study was considered as pre-test adjustment period, followed by a 56-day test period. The pre-test adjustment period was necessary to allow the pigs to adjust to their individual pens, and being weighed on a weekly basis.

The traits studied were average daily gain (ADG, kg), daily feed intake (DFI, kg), feed conversion ratio (FCR) and residual feed intake (RFI, kg/day). Each trait was calculated separately for each pig and for every test duration considered in the study. The growth of each pig was modelled by linear regression of weight against time (days), and the regression estimates were used to describe its growth. The regression coefficients were used to calculate ADG during the test, the weights at the start and end of the test, the mid-weight (i.e. the mean of the start and end weights) and the metabolic mid-weight (mid-weight raised to the power 0.75; MMWT) from each test. Total feed intake for each test was divided by the number of days on test to obtain DFI. Feed conversion ratio was calculated as daily feed intake divided by ADG. Residual feed intake was calculated by using ADG and MMWT to model DFI. A separate model was fitted for each sex within replicate. The model fitted was

\[ Y_i = \beta_0 + \beta_1 ADG_i + \beta_2 MMWT_i + e_i \]

where \( Y_i \) = DFI of animal \( i \), \( \beta_0 \) = intercept, \( \beta_1 \) = partial regression coefficient of DFI on ADG, \( \beta_2 \) = partial regression coefficient of DFI on MMWT, and \( e_i \) = residual error term. Residual feed intake was equated to the residual error term in the model.

One criterion used to assess the accuracy of a shortened test was the phenotypic correlation of the trait measured using a shortened test with the same trait measured over the full 56-day test, which included the maximum amount of data. This criterion helps to assess the degree of re-ranking among pigs on a shortened relative to the full test duration. Pearson correlations were computed. The second criterion was the phenotypic residual variance for each test. This was used to determine whether adding extra data to the test was effective in reducing the amount of unexplained variation in the trait. Variance components were estimated using residual maximum likelihood (REML) procedures in ASREML (Gilmour et al. 1999). The model fitted included the fixed effects of replicate (2 levels), sex (3 levels) and their interaction. Random effects fitted included room, dam and residual.

**RESULTS AND DISCUSSION**

Phenotypic residual variances and correlation coefficients for the growth and feed efficiency traits are presented in Table 1. For ADG, the residual variance decreased sharply as the duration of test
increased from 7 days to around 28 days, after which an increase in test duration had only a small relative change in variance. This result indicates that after 42 days adding extra days to the test was not effective in reducing the amount of unexplained variation in ADG. The correlation between the shortened test duration and the 56-day test was low to start with at 7-day test duration but rose quickly to above 0.80 with the 28-day test duration. This result indicates that the degree of re-ranking of pigs for ADG assessed on a 28 day test was small compared to a 56-day test.

Table 1: Phenotypic residual variance and correlation coefficients for growth and feed efficiency traits assessed at different test durations

<table>
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<tr>
<th>Trait</th>
<th>Statistic</th>
<th>Days of test</th>
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<tbody>
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<tr>
<td>ADG</td>
<td>Variance</td>
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<td>Correlation</td>
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<tr>
<td>DFI</td>
<td>Variance</td>
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<tr>
<td>FCR</td>
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<tr>
<td>RFI</td>
<td>Variance</td>
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<tr>
<td></td>
<td>Correlation</td>
<td>0.48</td>
</tr>
</tbody>
</table>

1ADG, DFI, FCR and RFI denote average daily gain, daily feed intake, feed conversion ratio and residual feed intake, respectively.
2Variance denotes phenotypic residual variance; Correlation denotes the phenotypic correlation coefficient between a shorter test duration and the full length (56 days) test duration.

The changes in residual variance and correlations for FCR and RFI were similar to those described for ADG, except that with RFI, the correlation rose to above 0.80 with a 35-day test, and the variances were more stable after 35 days on test. For DFI, changes in residual variance of the shortened duration tests did not stabilise until the 42-day test. However the correlation with the full length test was high (0.74) right from the 7-day test, and by the 14-day test the correlation coefficient had reached 0.83. This result is similar to those obtained in beef cattle studies (Archer et al. 1997; Wang et al. 2006) for DFI, whereby the correlation with the full length test was high (above 0.7) right from the 7-day test and rose above 0.8 by the 14-day test. This indicates that DFI, in particular, has a low degree of re-ranking of pigs (as well as cattle) on a very short duration test compared to the full length test.

In practice, whenever the efficiency of feed utilisation is being considered, the traits of interest include those related to growth and feed efficiency, and a single test is usually conducted to assess these traits. Hence the recommended test duration should be adequate for accurate measurement of both growth and feed efficiency traits. For all the traits studied, the results of this study indicate that by the 35-day test, there was a low degree of re-ranking among pigs compared to the full length test (correlation greater than 0.8) and the reduction in unexplained error variance with any increase in test duration was small.
A consequence of the reduction in the duration of test, is a reduction in management and feed costs and an increase in throughput of the equipment.

CONCLUSIONS
A test duration of 35 days is recommended for the measurement of growth and feed efficiency traits in pigs. This duration ensures that, for all the growth and feed efficiency traits studied, there is a low degree of re-ranking among pigs compared to the full length (56 days) test and that there is no marked reduction of the unexplained error variance in most traits.

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REFERENCES