# EFFECTS OF FEEDING STRATEGIES USING ELECTRONIC FEEDERS ON DATA QUALITY, FEED INTAKE, GROWTH AND FEED EFFICIENCY OF SWINE

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## INTRODUCTION

It is widely recognized that feed represents a major component of the total cost of pork production. Therefore, feed intake (FI) and efficiency of lean growth are important components of the swine breeding objective and selection toward that objective may be enhanced by measurement of FI on individual pigs. In the past, the most common method to record FI was to pen pigs individually. This method had several drawbacks: it does not reflect the group housing condition commonly found in production units, genotype by environmental interaction may affect the selection of superior genotypes, and it is labor intensive and expensive. The advent of electronic feeders allows for accurate measurement of individual feed intake, body weight and feeding patterns of group-housed pigs. If modeling the trajectory of daily feed intake (DFI) of individuals is of interest, repeated measurement analyses using covariance functions, random regression models or character process models using mixed model methodology may be most appropriate and practical. This approach requires that pigs be on a continuous feeding regime, which may not be feasible due to limited test capacity. However, if the purpose is to measure feed efficiency traits for the entire performance test period, alternating continuous and conventional group feeding can be considered in order to make optimal use of the number of feeders available. Eissen *et al*. (1999), using complete data (feed intake records for each test day) and a first-order degree polynomial to estimate average daily feed intake (ADFI), concluded that biweekly deletions of DFI records did not greatly affect the accuracy of estimation. Schulze *et al*. (2001), using records from pigs under either periodic or continuous electronic feeding, showed that biweekly periodic feeding underestimated DFI. In their study, the first period on test was always in the electronic feeder, which would not be possible in an all-in-all-out system. Another factor to be considered is how the data quantity and quality might affect the selection strategy chosen, since collecting high quality electronic FI data on a large number of animals is not a trivial task (Buttram, 2001). The objectives of the present study were to estimate the effects of biweekly alternating feeding on electronic and conventional feeders on data quality, accuracy of ADFI, and the relationship of ADFI with average daily gain (ADG) and feed conversion rate (FCR), with particular application to an all-in, all-out testing system. The feeding strategies compared were switch feeding or biweekly switch from electronic to conventional feeders (S) and continuous feeding on electronic feeders (N).

## MATERIAL AND METHODS

**Data.** Electronic measurements (visits or events) of FI and body weight (BW) of 450 gilts from a single Monsanto Choice Genetics line were recorded using FIRE® (Osborne Industries, Inc.). Animals were housed in 10 rooms with 3 pens per room and 15 animals per pen. In each room the following 3 treatments were represented: N = continuous feeding on FIRE® (unswitched), S1 = biweekly switching between FIRE® and conventional feeder, with the first period on the conventional feeder, and S2 = biweekly switching with the first feeding period on FIRE®. To the extent possible, full-sibs were cross-classified within a room. For S1 and S2, a hinged gate allowed alternate access to FIRE® and conventional feeders. Animals were put on test at 101±11 days of age, and half of pens were off-tested after 94 days and half after 118 days. For FI and growth analyses, only the first 89 days were considered. Data from the electronic feeders at the farms were transferred on a daily basis to a central database for further quality control and processing.

**Data editing.** Step 1. Quality control of the FI event data was carried out by applying 16 editing criteria (Casey and Dekkers, 2002; Eissen *et al*., 1999). This resulted in ~23,500 valid FI visits and corresponding body weights. Missing values were assigned for DFI and BW < 0 grams. Step 2. Linear regressions of DFI and BW on day on test were fitted for each animal and observations were removed if |STD residual| > 2.5. Acclimation was taken as 3 days at the start of any given feeding period. Up to 5 days of acclimation was considered but too much data were discarded and the improvement in fit was minimal. Step 3. Linear regressions of DFI and BW on day on test were fitted for each animal and used to estimate missing and deleted DFI and BW records. These were added to valid records to compute feed intake and body weight gain for the whole testing period (89 days). Correlations for animals in group N between DFI derived using linear, quadratic and cubic regressors were > 0.99. However, for the S1 group only a first-order regression equation could be fitted to prevent negative intercepts and serious bias. Eissen *et al*. (1999) also recommended the use of first-degree polynomials to estimate DFI in growing pigs. Therefore, a first-order linear regression was used for all animals in steps 2 and 3. Finally, the ADFI and ADG for the whole testing period were computed. Feed conversion rate was computed as ADFI/ADG.

**Statistical analyses.** A mixed model was used to evaluate the effect of the treatment on ADFI, ADG and FCR, $Y_{ij} = \mu + \rho_i + \alpha_j + e_{ij}$ (model 1), where $Y_{ij}$ is the observation for treatment $j$ within room $i$, $\mu$ is the overall mean, $\rho_i$ is the random room effect, $\rho_i \sim NIID(0, \sigma^2_\rho)$, $\alpha_j$ is the fixed effect of the $j$th treatment and $e_{ij}$ is a normal error, $e_{ij} \sim N(0,\sigma^2_e)$. All statistics and results from analyses are shown for the edited data, as described above.

## RESULTS AND DISCUSSION

The overall data quality was very good. The percentage of identified visits that was free of errors was 96%, with a small difference between switch (95.41%) and un-switched (96.07%) groups. The percentage of DFI records with errors was 11.7% and the percentage of DFI outside biological limits (DFI > 4500 grams or DFI < 0 grams) was 0.1%. Data from other trials showed ranges from 81.3-95.7% for visits free of errors, 17.2-50% for DFI with errors and 2.7-5.5% for DFI out of biological limits (D. Casey, unpublished). Another important consideration is the number of days with valid DFI records per animal per period. This will impact not only the amount of data available to estimate FI, but also the number of animals that can be evaluated per electronic feeder. Eissen *et al*. (1999) concluded that deleting up to 70% of DFI records at random resulted in a correlation between true and estimated DFI of 0.96. This conclusion was based on a complete data set and continuous recording of FI, which is different from the present study. For a switch feeding strategy, Table 1 shows that even if we only require that animals have at least 50% valid DFI for each biweekly period, following 3 days of acclimation, the loss of animals with data may be substantial regardless of how accurate the estimated daily records might be. The N strategy tends to alleviate this problem, possibly due to the fact that fewer acclimation periods are required. These numbers can greatly vary depending on the correct functioning of the feeders, which ultimately determine the amount of data collected, and the stringency of the data editing criteria.

**Table 1. Data retention with increased restrictions on the minimum number of valid records required after 3 days of acclimation**

| | Number of animals with data that meet requirements for % valid DFI records | | | |
|---|---|---|---|---|
| Treatment | All data | Each period > 50% | Each period > 60% | Each period > 70% |
| S1 | 142 | 118 (83%) | 101 (71%) | 63 (44%) |
| S2 | 143 | 124 (87%) | 120 (84%) | 107 (75%) |
| N | 142 | 140 (99%) | 137 (96%) | 127 (89%) |

From the unadjusted means in Table 2, it can be seen that ADFI, ADG and FCR were greater and less variable for unswitched than for switched animals.

**Table 2. Means and standard deviations for ADFI, ADG and FCR**

| Treatment | N | DFI (gr) | ADG (gr) | FCR |
|---|---|---|---|---|
| S1 | 142 | 1952 ± 270 | 766 ± 108 | 2.48 ± 0.41 |
| S2 | 143 | 2007 ± 324 | 784 ± 103 | 2.52 ± 0.38 |
| N | 142 | 2127 ± 263 | 802 ± 98 | 2.64 ± 0.31 |

Based on model (1), treatment effects were significant for ADFI (P<0.01) but only approached significance for ADG and FCR (P<0.10). Table 3 show least square means differences between treatments. Average daily feed intake did not differ between treatments S1 and S2,

**Table 3. Least square means differences between treatments for DFI, ADG and FCR**

| LSM difference | DFI (gr) | ADG (gr) | FCR |
|---|---|---|---|
| S1 – S2 | -53 | -18 | -.03 |
| S1 – N | $-176^{**}$ | $-36^{*}$ | $-.15^{*}$ |
| S2 – N | $-123^{*}$ | -18 | -.12 |

Superscripts represent statistical significance of 5% (*) and 1% (**)

but each of the switch treatments (S1and S2) was different from N. However, there was a clear and consistent trend i.e., $DFI_{S1} < DFI_{S2} < DFI_N$ across and within rooms, which indicated a lower feed intake for the switch strategies. These results agree with those of Schulze *et al.* (2001) who compared continuous feeding and periodic feeding with treatments resembling our

N and S2, respectively. In the present study, ADG and FCR were not affected by the S2 strategy, which agrees with Schulze *et al.* (2001). However, results for the S1 strategy were not reported in Schulze *et al*. (2001), and in our case missing the first on-test period (i.e., spending the first period on a conventional feeder) had an impact on ADG and FCR. These results could indicate that, to some extent, animals under S2 might compensate their feed intake when they are moved on conventional feeders after the first period on the electronic feeder.

Schulze *et al*. (2001) reported differences in genetic correlations among the traits studied here for periodic and biweekly feeding and considering either 5 or 7 DFI records per week. In the present study, phenotypic correlations between DFI, ADG and FCR were high and of the same sign among treatments but different in size (Table 4). Given the high heritability of these traits, this could be an indication that these performance traits might be in fact different traits depending on the feeding regime.

**Table 4. Phenotypic correlations between DFI, ADG and FCR**

| | Treatment | | |
|---|---|---|---|
| Traits | S1 | S2 | N |
| DFI – ADG | .46 | .58 | .60 |
| DFI – FCR | .44 | .54 | .46 |
| ADG – FCR | -.57 | -.35 | -.42 |

## CONCLUSIONS

In a practical switch-pen feeding scenario with an all-in, all-out testing system switching may double the testing capacity and, therefore, lead to a more efficient use of electronic feeders. However, data quality has a large impact on the accuracy of estimates of ADFI and on the number of animals that will have sufficient feed intake for accurate estimation. This will depend on the number and distribution of DFI records and criteria set for data quality. Using a first-order degree polynomial function to estimate missing DFI and body weights for individual pigs, switching resulted in lower estimates of ADFI than continuous feeding. Switching also significantly impacted ADG and FCR estimates when records for the first on-test period were not available. Continuous feeding on electronic recording feeders provides more accurate estimates.

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