2006

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The Professional Animal Scientist 22 (2006):189–193

# Effects of Removal and Remixing of Heavyweight Pigs on Performance to Slaughter Weights[1]

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## Abstract

*An experiment was conducted to determine the effects of heavyweight pig removal and remixing on performance. The experiment used a total of 450 pigs (31 kg initial BW) that were sorted and remixed at a mean replicate BW of 73 kg. Treatments were 15 pigs/pen from initial BW to slaughter (**15S**), 20 pigs/pen from initial BW to time of sort and remix, then reduced to 15 pigs/pen (**20/15**), and 15 pigs/pen from time of sort and remix to slaughter, comprised of the 5 heaviest pigs from each of three 20/15 pens per replicate (**15M**). Space allocation was 0.56 $m^2$/pig to the day of remixing and 0.74 $m^2$/pig thereafter. There was no effect (P > 0.1) of treatment on ADG before 73 kg BW when pens were the experimental units. There was no effect (P > 0.1) of treatment on ADG or feed conversion to slaughter BW following removal and remixing using the contrast 20/15 + 15M vs. 15S. The average of the replicate for 20/15 and 15M was used as the experimental unit in a second statistical analysis. Daily feed was less (P = 0.079) from placement to 73 kg BW for the 20/15 + 15M population vs. the 15S population resulting in a lesser (P = 0.067) overall ADG (0.875 vs. 0.887 kg/d, respectively) with no effect (P > 0.1) on feed conversion or CV sample population BW. Removal and remixing of heavyweight pigs at a midpoint in the growth process had minimal effects on performance to slaughter and CV for BW at slaughter.*

**Key words:** finishing, growth, mixing, pigs

## Introduction

Research on possible management techniques to reduce BW variation at slaughter is limited. The NCR-89 Committee on Confinement Management of Swine (1992) reported that pigs identified as having slow growth rates during the grow-finish phase did not respond differentially to a growth-promoting feed additive regimen. Both Tindsley and Lean (1984) and O'Quinn et al. (2001) reported that sorting pigs into finishing pens by uniform BW groups was not effective in improving performance to slaughter. O'Quinn et al. (2001) further suggested that pigs grow variably to a common end point variability, reducing the need for initially sorting by BW. Brumm et al. (2002) reported that removal of lightweight pigs and remixing of the removed pigs into pens of similar-BW pigs at some point during the growth process was ineffective in improving overall performance of a population of pigs. However, in that experiment, the socially disadvantaged pigs, as defined by BW, were removed to a new pen and mixed with other disadvantaged pigs. It is possible that these pigs, if allowed to remain in the same pen from placement to slaughter, would have improved performance following removal of the largest pigs from the pen. The following experiment was conducted to determine the effect of removing heavyweight pigs from pens and remixing them with similarly-sized pigs on performance to slaughter BW of a population of pigs.

## Materials and Methods

Three experiment stations in the North-Central region of the United

[1]A contribution of the University of Nebraska Agricultural Research Division, Lincoln, NE 68583. Journal series no. 14679.

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**TABLE 1. Cooperating experiment stations and floor type.**

| Station | Full or partial slats | Sex |
|---|---|---|
| Michigan | Full | Mixed |
| Minnesota | Full | Mixed |
| Nebraska | Partial | Gilts |

States cooperated in this experiment. Station identification, floor type, and sex of pig used are presented in Table 1. Within the station with partially-slatted pens, the ratio of slatted floors to solid floors was 50% solid to 50% slats across all treatments. The experiment was conducted with the approval of each station's institutional animal care committee.

Experimental treatments were 1) 15 pigs/pen from initial BW to slaughter (**15S**); 2) 20 pigs/pen from initial BW to 73 kg BW, then reduced to 15 pigs/pen to slaughter (**20/15**); and 3) 15 pigs/pen from 73 kg mean replicate BW to slaughter, comprised of the 5 heaviest pigs from each of three 20/15 pens per replicate (**15M**). Thus, each full replication of experimental treatments consisted of one pen of 15S, one pen of 15M, and three pens of 20/15 treatments.

Two of the cooperating stations used pens with both barrows and gilts. At the start of the experiment, the sex ratio in the pens was 3:2. That is, there were 12 and 8 pigs of each sex, respectively, in the 20/15 pens and 9 and 6 pigs of each sex, respectively, in the 15S pens.

On the week the mean BW of a replicate averaged 70 kg or greater, the 5 heaviest pigs were removed from each of the three 20/15 treatment pens in the replicate, and the 15 removed pigs were combined into a new pen (15M) at the Nebraska station. For the stations with mixed-sex pens, the pigs removed were balanced by sex, with the 3 heaviest pigs from the dominant sex and the 2 heaviest pigs from the other. The removal of 5 pigs from the 20/15 pen increased space allocation from 0.56 to 0.74 $m^2$/pig and the 15M were given 0.74 $m^2$/pig. At the same time, the space allocation of the 15S treatment was increased from 0.56 to 0.74 $m^2$/pig by adjusting one or more pen partitions within each station. Pen size was adjusted to maintain space allocation in the event of pig removal or death. The replicate was terminated on the week the first pig in a replicate weighed 113.6 kg or greater.

Within a station, there was a minimum of 1 feeder space per 8 pigs and 2 nipple drinkers or 1 cup drinker per pen. All pigs were provided ad libitum access to diets and diets were switched on the week the mean replicate BW was 36, 59, and 86 kg.

Diets were formulated from corn and soybean meal with no added fat according to the recommendations of Reese et al. (2000) for gilts of high lean gain potential. Diets were formulated to contain 1.10, 1.01, 0.87, and 0.68% lysine, respectively, for pigs from 30 to 36 kg BW, 36 to 59 kg BW, 59 to 86 kg BW, and 89 kg BW to slaughter. All diets met or exceeded NRC (1998) recommendations for vitamin and mineral additions. Tylosin (Elanco Animal Health, Indianapolis, IN) was added at 44 mg/kg to the diets from 30 to 59 kg BW and at 22 mg/kg from 59 kg BW to slaughter.

**Statistical Analysis.** Analysis of variance was conducted using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). In the first analysis, the pen of pigs was considered the experimental unit. The mean square of the station × treatment interaction was used as the error term to test treatment effects, and the treatment × replication within station mean square was used to test the station × treatment interaction. The orthogonal contrast of 20/15 + 15M vs. 15S was examined to test whether there was a difference between sorted and unsorted groups of pigs.

Because the sample population of pigs represented by the 20/15 and 15M treatments was the outcome of interest, a second statistical analysis was conducted. In this analysis, the response variable for the sorted pigs was the mean of the treatment population within that particular replicate. Similar to the first statistical analysis, the pen of pigs for 15S represented the population of unsorted pigs. However, the daily feed and BW gain for the three 20/15 and one 15M pens within a replicate were combined into a single value to represent the sorted population of pigs. This resulted in 6 replicates of each population (2 per station for each of 3 stations).

The Kruskal-Wallis test for nonparametric data was used to test for differences in BW distribution between populations at the time the first pig in a replicate weighed 113 kg or greater (Motulsky, 1995). Death loss was examined by Chi-square analysis.

## Results and Discussion

There were only a limited number of station by treatment interactions ($P < 0.05$) in the first statistical analysis, and in every instance the interaction was in the magnitude of the response, not the direction of the response. Thus, the main effects of treatment are presented in Tables 2 and 3. There was no effect ($P > 0.10$) of experimental treatments on pig ADG or feed conversion prior to the removal of the heaviest pigs from the 20/15 treatment (Table 2) when pen was used as the experimental unit. Although the original intent was to have the initial CV of within-pen BW be in the range of 15%, the actual CV was 9.4% for the 20/15 and 10.0% for the 15S treatments. By the time the pigs weighed 73 kg BW, this had declined approximately 1% for each treatment. This decline in CV as the pigs grew is typical for grow-finish pigs (Brumm et al., 2004). There was a trend ($P = 0.063$) for pigs in pens with 15 pigs (15S) to eat more feed than pigs in pens with 20 pigs (20/15), a response predicted by Kornegay and Notter (1984).

**TABLE 2. Least squares means (± SE) for effect of experimental treatments on pig performance to 73 kg BW using individual pens as the experimental unit.**

| | Treatment[a] | | *P*-value | |
|---|---|---|---|---|
| Item | 20/15 | 15S | Treatment | Station |
| No. of pens | 18 | 6 | — | — |
| Pig BW, kg | | | | |
| Initial | 30.7 (0.1) | 31.0 (0.1) | 0.120 | < 0.001 |
| Sort/mix | 72.3 (0.3) | 73.4 (0.5) | 0.138 | 0.056 |
| Coefficient of variation (pig BW within pen) | | | | |
| Initial | 9.4 (0.2) | 10.0 (0.3) | 0.185 | 0.114 |
| Sort/mix | 8.4 (0.3) | 9.1 (0.5) | 0.344 | 0.287 |
| ADG, kg | 0.836 (0.006) | 0.855 (0.010) | 0.256 | 0.017 |
| ADFI, kg | 2.045 (0.009) | 2.114 (0.017) | 0.063 | 0.007 |
| Gain:feed, kg/kg | 0.408 (0.003) | 0.403 (0.005) | 0.444 | 0.004 |

[a]20/15 = 20 pigs/pen; 15S = 15 pigs/pen, both at 0.56 $m^2$/pig space allocation.

Using individual pen as the experimental unit, removal of the 5 heaviest pigs from 3 pens and remixing to create a pen of the 15 heaviest pigs within a replicate reduced within-pen variation in BW from 8.4% to 7.7% for the pens with 15 original pigs remaining and to 3.1% for the pens with the heaviest pigs (Tables 2 and 3). Although within-pen BW variation continued to decrease as expressed by CV for the 20/15 and 15S treatment, it increased approximately 1% for the 15M treatment from the time of sorting to when the experiment ended. This suggests that sorting to minimize variation within a pen may not result in a continued decrease in variation as expressed by CV. This is in agreement with the results of Tindsley and Lean (1984)

**TABLE 3. Least squares means (± SE) for effect of pig removal and remixing on pig performance using individual pens as the experimental unit.**

| | Treatment[a] | | | *P*-value | | |
|---|---|---|---|---|---|---|
| Item | 20/15 | 15M | 15S | Treatment | Station | 20/15 + 15M vs 15S |
| No. of pens | 18 | 6 | 6 | — | — | — |
| Pig BW, kg | | | | | | |
| Sort/mix | 70.6 (0.5) | 78.7 (0.8) | 73.4 (0.8) | 0.003 | 0.003 | 0.002 |
| First marketed[b] | 100.3 (0.6) | 109.2 (1.0) | 103.7 (1.0) | 0.004 | <0.001 | 0.002 |
| CV, % (pig weights within pen) | | | | | | |
| Sort/mix | 7.7 (0.3) | 3.1 (0.5) | 9.1 (0.5) | 0.002 | 0.629 | 0.020 |
| First marketed | 7.1 (0.3) | 4.0 (0.5) | 8.3 (0.5) | 0.010 | 0.754 | 0.114 |
| ADG, kg | | | | | | |
| Sort to first marketed | 0.918 (0.010) | 0.945 (0.016) | 0.940 (0.016) | 0.348 | 0.028 | 0.173 |
| ADFI, kg | | | | | | |
| Sort to first marketed | 2.879 (0.025) | 2.883 (0.043) | 2.976 (0.043) | 0.258 | < 0.001 | 0.273 |
| Gain:feed, kg/kg | | | | | | |
| Sort to first marketed | 0.322 (0.003) | 0.329 (0.005) | 0.319 (0.005) | 0.431 | <0.001 | 0.618 |
| Dead/removed, % | 3.0 | 0.0 | 1.1 | — | — | — |

[a]20/15 = 20 pigs/pen reduced to 15 by removal of the heaviest 5 at 73 kg; 15M = 15 pigs/pen comprised of 5 heaviest from each of three 20/15 pens; 15S = 15 pigs/pen from start to slaughter; all treatments at 0.74 $m^2$/pig space allocation.

[b]Week first pig in a replicate weighed 113.6 kg.

who noted no change in within-pen CV when pens were created with a large variation in pig BW (approximately 18% CV) at placement, but variation increased during the growing period when a small CV at placement was created (2% CV increasing to 14% CV).

There was no effect of treatment ($P > 0.10$) on ADG, daily feed intake or feed conversion efficiency following removal and remixing. When the population effects were examined by means of the 20/15 + 15M vs. 15S orthogonal contrast, there was no effect of treatment ($P > 0.10$) on performance following removal and mixing. This agrees with Brumm et al. (2002) who reported no effect on performance following removal and mixing of the lightest pigs in a pen in a multi-station experiment.

Because of the mixing procedure used, it is not possible to examine the overall effect of treatments on pig performance from placement to slaughter when pen was the experimental unit. In Table 4, the replicate mean is the experimental unit and the results are presented for the 2 sample populations of pigs where 20/15 + 15M is one sample population and 15S is the other. Although the performance data in this table are the same as that in Table 2 for the period from placement to the time of sorting and mixing, the data from sorting and mixing to slaughter can be combined with the prior period performance to examine the impact of treatment on overall performance.

**TABLE 4. Effect of pig removal and remixing on pig performance using the replicate mean as the experimental unit.**

| Item | Treatment[a] Sorted | Treatment[a] Unsorted | SE | *P*-value |
|---|---|---|---|---|
| No. of observations | 6 | 6 | — | — |
| Pig BW, kg | | | | |
| Initial | 30.7 | 31.0 | 0.1 | 0.228 |
| Sort/mix | 72.2 | 73.4 | 0.4 | 0.175 |
| First marketed[b] | 102.5 | 103.7 | 1.1 | 0.524 |
| CV for sample population wt, % | | | | |
| Initial | 9.3 | 10.0 | 0.2 | 0.127 |
| Sort/mix | 8.5 | 9.1 | 0.3 | 0.277 |
| First marketed | 7.5 | 8.3 | 0.2 | 0.159 |
| ADG, kg | | | | |
| Initial to sort/mix | 0.836 | 0.853 | 0.009 | 0.334 |
| Sort to first marketed | 0.940 | 0.940 | 0.011 | 0.966 |
| Overall | 0.875 | 0.887 | 0.002 | 0.067 |
| ADFI, kg | | | | |
| Initial to sort/mix | 2.036 | 2.114 | 0.017 | 0.079 |
| Sort to first marketed | 2.882 | 2.976 | 0.026 | 0.126 |
| Overall | 2.367 | 2.454 | 0.027 | 0.147 |
| Gain:feed, kg/kg | | | | |
| Initial to sort/mix | 0.412 | 0.406 | 0.004 | 0.373 |
| Sort to first marketed | 0.325 | 0.317 | 0.003 | 0.239 |
| Overall | 0.361 | 0.359 | 0.002 | 0.476 |
| Dead/removed, % | 2.2 | 1.1 | — | — |

[a]Sorted = 20 pigs/pen reduced to 15 by removal of the heaviest 5 at 73 kg BW and 15 pigs/pen comprised of 5 lightest from each of three 20/15 pens; Unsorted = 15 pigs/pen from start to slaughter.

[b]Week first pig in a replicate weighed 113.6 kg.

When examined in this manner, there was no effect of pig removal treatment ($P > 0.10$) on the variation in pig BW within the sample population for any of the weigh points examined. Coefficient of variation declined 1.7 % from placement to slaughter for the 15S treatment group and 1.8% for the 20/15 + 15M group. There was a slight ($P = 0.067$) effect of treatment on overall ADG, with the 15S group having the greater ADG. However, this effect occurred prior to sorting and mixing because ADG following sorting and mixing was identical for both treatments (0.940 kg/d; $P = 0.966$). Because the treatments prior to sorting and mixing did not differ ($P = 0.334$), this suggests that the overall difference in treatments for ADG was minimal.

The difference in the level of significance from the effect of treatments on daily feed intake from placement to the time of sorting and mixing between Table 2 ($P = 0.063$) and Table 4 ($P = 0.079$) is most likely related to the number of degrees of freedom available for the error term in the statistical model. Although valuable information was gained regarding overall performance of the sample populations of pigs when the replicate mean was used as the experimental unit (Table 4), statistical power to detect significant treatment differences was decreased due to fewer degrees of freedom (observations) compared with when pen was the experimental unit (Table 2).

There was no effect of treatment ($P = 0.127$) when the Kruskal-Wallis statistic was used to examine the BW distribution of both populations on the week the first pig in a replicate weighed 113.6 kg (Figure 1). This further supports the conclusion that removal and remixing of the heaviest pigs in a pen at a midpoint in the growth process had no effect on overall performance to slaughter.

Payne et al. (1999) concluded that variation in performance is a cost to the industry that is hard to quantify. They also concluded that a certain amount of variation in pig BW within a pen is normal and necessary

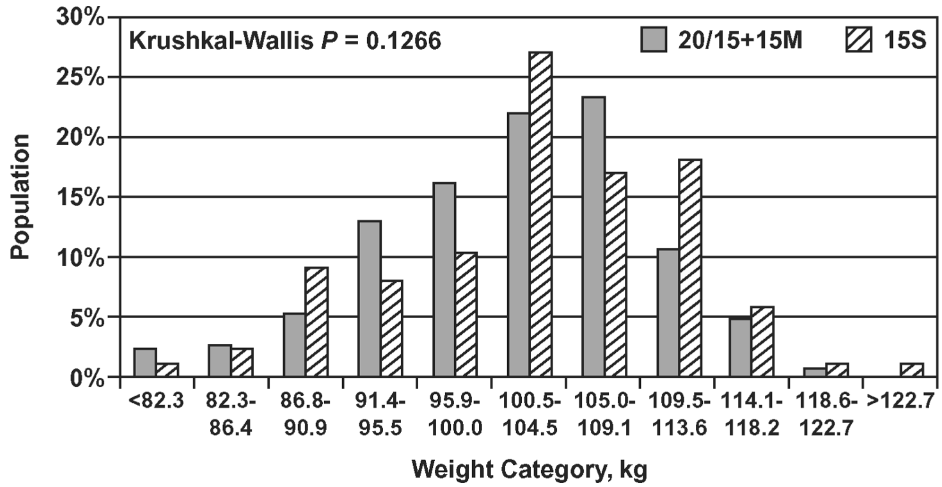



*Figure 1. Effect of experimental treatments on BW distribution when the first pig in a replicate weighed 113.6 kg.*

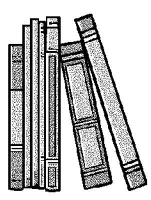
for maintenance of social order within the pen group. The motivation for the research presented in this paper and previous studies has been to investigate whether management can reduce variation in performance and slaughter BW. In addition to the work herein, several authors have investigated sorting at placement (Tindsley and Lean, 1984; O'Quinn et al., 2001). Their conclusions were that sorting at placement reduced variation in BW and did not improve performance.On the other hand, DeDecker et al. (2005) concluded that removal of a portion of the pigs from a pen as the pigs near slaughter BW resulted in an improvement in growth rate for the pigs remaining in the pen compared to pigs in pens where no pigs were removed. Further, the response was determined to be only partly due to increased floor and feeder space. Results from the experiment reported in this manuscript support the conclusion that sorting and mixing of pigs during the growth process does not reduce variation in growth or improve overall performance.

## Implications

Removal and remixing of the heaviest pigs in a population of pigs had no effect on overall pig performance during the grow-finish phase of production. When combined with results from previous experiments where there was no effect of removal and remixing of the lightest pigs, these results suggest that once a population of pigs is placed in a grow-finish facility, attempts to modify performance by removal and remixing of either the lightweight or heavyweight pigs from pens in the facility will be unsuccessful.

## Acknowledgements

Appreciation is expressed to Wanda Kreikemeier and Sheri Colgan for data summarization and statistical analysis.



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