# Effects of Environment, Genotype, Sex, and Antibiotic Treatment on Pig Growth, Carcass Characteristics, and Pork Quality

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## Introduction

The consumption of pork products can be increased either through decreased prices via improvements in efficiency of production or through improvements in pork quality which target consumer preferences. Commercial pork producers are considering cost-effective genetic and health management changes to improve both the rate and efficiency of lean growth. Substantial genetic variation for lean growth rate, lean efficiency, and carcass lean percent exists between different genetic populations of pigs. When evaluated under near ideal conditions, and optimal diets, 40% differences in lean growth rate and efficiency exist between genotypes (Schinckel et al., 1996). There is also substantial variation in pork quality traits between genotypes. In general, genotypes selected for efficient lean growth via selection for increased lean growth and decreased fat accretion, have lower feed intakes, lower intramuscular fat levels, and less desirable eating quality.

Substantial differences in performance also exist between different environments and health management strategies. In a recent trial, pigs with minimal diseases via segregated early weaning (SEW), which were fed a series of non-limiting diets, achieved 230 lb. at 136 days of age and 264 lb. at 151 days of age. Pigs raised on the original commercial farm, conventionally weaned with all-in, all-out production, required 184 days to attain 230 lb. live weight. These types of observations are prompting producers to make health management changes.

## Objectives

Pork producers have the economic incentive to produce quality lean pork as efficiently as possible. To produce quality lean pork more efficiently, the direct effects and interactions between genetic potential for lean growth and health-management level on pork quality must be understood. Producers need to have some expectations as to the magnitude of performance and pork quality changes as a result of both genetic and health status changes. However, no research has been conducted which evaluates the effect of SEW-three site production practices on pork quality, and pork producers are currently considering management changes without any information as to the consumer acceptance of the pork produced.

Therefore the objectives of this study were to:

1. Evaluate possible interactions between genetic potential for lean growth, sex, antibiotic treatment, and health status environments on lean gain and pork quality.
2. Evaluate the effect of improved health status via segregated early weaning-three site production on traditional measures of pork quality and taste panel eating quality.

3. Evaluate the relationships between measurements of carcass composition, traditional pork quality measurements and ultimate eating characteristics in pigs of different genotypes reared in different health status-management environments.

**Materials and Methods**

Two genotypes were reared under two health-management conditions. The two health-management treatments were segregated early weaning, three site production (EW) versus conventional 28-day weaning with continuous flow grow-finish management (CF). One genotype was European Terminal Sire derived (ETS) and had a high genetic potential for lean growth, moderate to low feed intake, and below average pork quality scores. The second genotype was a Yorkshire-Landrace cross (YL) and had average genetic potential for lean growth, feed intake, and pork quality scores.

Two hundred eighty-eight pigs from the subject herd were randomized by litter, sex, and weight into either the segregated early weaned group or the continuous flow group. There were 24 pens of pigs in each health status-management environment. In each health status environment, 12 pens were allocated to each genotype, where 6 pens were assigned pigs of the same genotype and sex. These 6 pens were then assigned either a control diet or a diet that contained antibiotics for the remainder of the trial. Table 1 describes the experimental design; the diets are given in Table 2.

At farrowing, each litter had 4 pigs cross-fostered with another litter of the same genotype. One sow was conventionally weaned and the other early weaned. This allowed equal representation of littermates in both health status environments.

In the EW group, 14-day-old pigs were weaned, moved to an isolated early wean facility, and reared until eight weeks old. They were then placed in a curtain-sided building that had been previously emptied, cleaned, and disinfected. Pigs stayed in this facility until they weighed approximately 250 pounds, at which time they were taken to slaughter.

In the CF group, 28-day-old littermate pigs were weaned and placed in an all-in, all-out nursery. They remained in the nursery until they were eight weeks old. At that time they were placed in a continuous flow finisher. They remained there until they weighed approximately 250 pounds, when they were taken to slaughter.

The pigs were weighed and feed consumption recorded every 2 weeks in the nursery and every 3 weeks in grow-finish until near market weight, when pigs were weighed weekly. Tenth rib backfat, loin muscle area (LEA), and warm carcass weight were obtained at a pork processor (IBP, Logansport, Indiana). These values were then used to calculate percent lean using equations provided in Procedures to Evaluate Market Hogs (NPPC, 1991).

Loins from 142 of the experimental pigs (3 pigs/pen) were obtained from the pork processor and were delivered to the Purdue Meats Laboratory. Fresh pork color (24-hr color), firmness, and marbling scores at the cut surface of the 10-11 rib interface were evaluated at 36$^{o}$F. Quality scores were reported on a 1 to 5 scale estimated in the Procedures to Evaluate Market Hogs (NPPC, 1991).

Ultimate pH was obtained 24 hours after exsanguination by a glass electrode pH probe. The probe was inserted in the *longissimus dorsi* muscle at the 11th rib.

Drip loss was measured using a sample of the *longissimus dorsi* (1 inch thick cut) that was suspended in nylon netting and sealed in a plastic pouch to prevent contact with the released exudate. Drip loss was calculated as the percentage of weight lost by the meat sample over 24 hours.

After visual quality assessment, the last rib chop was removed and analyzed for objective color using a HunterLab® Colorimeter. The Hunter "L", "a", and "b" values were then converted to "L*", "a*", and "b*" values to allow direct comparison to "L*" values found in Procedures to Evaluate Market Hogs (NPPC, 1991).

The caudal portion of the loins were sent to the University of Illinois Meats Laboratory. Chops (1 inch thick) from the *longissimus lumborum* sample were cut with a band saw from the frozen section to ensure a uniformity of thickness. Chops were thawed for 24 hours in a 39°F cooler. The chops were cooked on open-hearth grills to an internal temperature of 158°F. When the internal temperature of the chops reached 95°F, they were turned to prevent charring. Tenderness, juiciness, and off-flavor intensity were then evaluated by a six member, trained panel.

Cooked chops from the *longissimus* sample were also used for Warner-Bratzler shear force determination. Cooking loss was evaluated using raw and cooked weights. After cooling to 77°F, five 0.51-in. diameter cores were removed parallel to the muscle fibers and sheared using an Instron model 1122 Universal Testing Machine (Instron, Canton, MA) fitted with a Warner-Bratzler shear attachment.

Data were analyzed as a factorial arrangement of health status-management, sex, genotype, and antibiotic treatments. Correlations between measures of carcass composition, pork quality, and taste panel scores were estimated.

**Results and Discussion**

Growth performance results are given in Tables 3 (EW) and 4 (CF). In the nursery, the EW pigs had greater ADG than CF pigs (P<.01). There was also a treatment effect in the nursery. Medicated pigs regardless of their environment had greater ADG (P<.001) and higher ADFI (P<.05). Pigs in the CF nursery also showed a greater response than the EW pigs to medication (P<.01). This caused variation in weights when pigs left the nursery. The EW pigs were 3.25 pounds heavier than the CF pigs (P<.01) and the medicated pigs were nearly 4 pounds heavier than those pigs fed the control diets (P<.01).

From day 53 to day 101, the EW pigs had higher ADG and ADFI (P<.001). During this same period barrows had higher ADG (P<.05) and ADFI (P<.01) than gilts. It was also found that the YL pigs were consuming more than the ETS pigs (P<.001), which was to be expected.

Barrows again had higher ADFI than gilts from day 101 to day 142 (P<.01), but did not have higher ADG. The ETS pigs were gaining approximately 0.25 pounds more per day than the YL pigs (P<.001) during this time period.

During days 142 to market, barrows had a slightly higher ADG than gilts (P<.05). This trend is most evident in the EW environment, where the YL barrows were gaining 0.24 pounds per day more than the YL gilts. Because the YL pigs in the EW environment had very high ADFI, the EW pigs had statistically higher ADFI than the CF pigs (P<.01). Again, barrows were consuming more feed than gilts (P<.001), and the YL pigs in both environments had higher ADFI than the ETS pigs (P<.01).

ETS pigs reached market weight faster than the YL pigs (P<.01). There was no statistical difference in days to market between the two environments. At approximately day 85, pigs in the EW environment became serologically positive for Porcine Respiratory Disease Complex (PRDC) which is common in the other environment. The greatest effects of the disease can be found in ADG from days 101 to 142. During this period in the EW environment, ADG went down compared to the previous 6 week period and ADFI continued to rise, while in the CF environment both ADG and ADFI increased.

The differences in death loss between the two environments were significant (P<.001). Pigs in the CF environment had an average death loss of 12% and the EW pigs had 3.2% death loss. Antibiotic treatment did not have a significant effect on death loss in the CF environment. The ETS pigs had a higher death loss as compared to the YL pigs (P<.05). The death loss of the ETS pigs in the CF environment was 18.5% while the YL pigs in this environment had a 5.6% death loss. Antibiotic treatment did reduce death loss in the EW environment. Medicated pigs in this environment had an average death loss of 1.4% and the non-medicated control pigs had an average death loss of 5.0%. Pigs fed the control diet also tended to have a higher morbidity rate (pigs not reaching a market weight of 220 lbs. by the end of the trial) compared to the pigs fed the medicated diet (P<.12).

Off-test weights of pigs in the CF environment were lower than in the EW environment (244.6 vs. 247.6, P<.05). Barrows had higher off-test weights than gilts (P<.05) and medicated pigs had higher off-test weights than non-medicated pigs (P<.05). There were also statistical differences between slaughter weights in both the environments (CF=245.7 and EW=249.3, P<.001) and sexes (B=248.9 and G=246.1, P<.01). The objective of this study was not to determine the effects of slaughter weight on carcass characteristics; therefore, slaughter weights were adjusted for when calculating the carcass characteristics of the pigs.

Carcass and pork quality results are given in Tables 5 (EW) and 6 (CF). Loin eye areas of the gilts were larger than the barrows (7.31 versus 6.35 $in^2$, P<.001). ETS pigs had larger LEA (7.47 versus 6.01 $in^2$; P<.001) and less backfat (0.66 vs. 0.96 in; P<.001) than YL pigs. Pigs reared in the EW environment had thicker backfats than pigs reared in the CF environment (0.84 vs. 0.78 in; P<.01). This difference was caused by the YL pigs in the EW environment overconsuming energy in the last phase of the finisher. This overconsumption resulted in fat deposition as opposed to lean deposition. The changes in LEA and backfat thickness account for the differences in percent lean measurement. The ETS gilts in the EW environment had the largest LEA and lowest $10^{th}$ rib backfat and therefore

they had the highest percent lean. Because barrows had the highest 10th rib backfats (P<.001) they also had the lowest percent lean (P<.01).

The ETS pigs had lower 24-hr color scores than the YL pigs (P<.01). The ETS pigs also had numerically lower firmness scores than the YL pigs (P<.10). Barrows had more marbling than gilts (1.31 versus 1.19, P<.01). This slight difference in marbling is likely to be the result of increased feed intake of barrows in the last phase of the grow-finish going to greater adipose deposition. Various research indicates that pork with more intramuscular fat is more tender, juicy, and palatable.

The differences in drip loss percent show the ETS genotype had a 1.65% higher drip loss value than the YL genotype (P<.001). This project also shows a difference in drip loss percent between the control pigs and the medicated pigs (P<.05). The average drip loss for medicated pigs was 5.72% and pigs fed the control diet had an average drip loss of 4.85%.

Significant differences were also found between genotypes for 24-hr pH (P<.01). The pH values for the YL pigs averaged 5.62 versus 5.45 for the ETS pigs. Pork which is low in pH will also have high drip loss and cooking loss, and subsequently be less tender. A low pH is also an indicator of pale color scores. PSE pork normally has a 24-hr pH below 5.5, while the preferred range for good quality pork is from 6.1 to 5.7.

The HunterLab® Colorimeter results indicate that the L* values for the ETS genotype are higher than those for the YL genotype (P<.001), corresponding to ETS loins being more pale. The L* values were also higher for barrows (P<.01). These values agree with the 24-hr color measurements taken in the Purdue University Meats Laboratory. The higher b* values for the ETS pigs is also an indicator of paleness (positive b* values would indicate that the sample has a yellow tint while negative b* values are an indicator of blueness). The ETS loins had b* values 0.55 greater than those for YL loins (P<.05).

The ETS loins were 1.0% higher in cooking loss as compared to YL loins (P<.10). This reflects the drip loss percentages of the ETS loins. Shear force tests were similar across all treatments. The average tenderness score for YL loins was 7.91 which is significantly better than the ETS loins which averaged 7.39 (P<.01). It was also found that pigs on the medicated diet had lower tenderness scores than those pigs on the control diet (P<.01). Juiciness scores were higher for pigs in the CF environment (P<.05). ETS loins also scored higher for juiciness compared to the YL loins (P<.05). Off-flavor scores showed no statistical differences between the environments, genotypes, sexes, or antibiotic treatments.

**Applications**

The data collected from this project has shown that there are environment and genotype interactions, which need to be further studied. This research trial has found that the environment can and does influence such things as ADFI, carcass characteristics, and death loss. It is becoming increasingly evident that producers need to match the genotype of their hogs to their environment in order to efficiently produce quality pork and make it the meat of choice by the 21st century.

## References

Schinckel, A. P., J. C. Forrest, E. Berg, E. Sheiss, and M. E. Einstein. 1996. Swine lean growth and pork quality evaluation trials. Purdue Swine Day Report. pp. 11-17.

Table 1. Experimental Design[a].

| EW - 3 site | | | | | | | | CF | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETS | | | | YL | | | | ETS | | | | YL | | | |
| Med. | | Non. | | Med. | | Non. | | Med. | | Non. | | Med. | | Non. | |
| B | G | B | G | B | G | B | G | B | G | B | G | B | G | B | G |
| Number of pens: | | | | | | | | | | | | | | | |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

[a] Environments: EW = segregated early weaning three site production,
CF = conventional weaning with continuous flow grow-finish.
Genotypes: ETS = European terminal sire derived, YL = Yorkshire-Landrace cross.
Treatments: Med. = diet containing antibiotics, Non. = control diet with no antibiotics.
Sexes: B = barrow, G = gilt.

Table 2. Diet Sequence[a].

| Item | EW - 3 site[b] | CF[b] | CP, % | Lysine, % | Ca, % | P, % |
|---|---|---|---|---|---|---|
| SEW | 7 days | 0 days | 21.5 | 1.7 | .9 | .8 |
| Transition | 7 days | 0 days | 21 | 1.45 | .9 | .8 |
| Phase II | 14 days | 14 days | 20.5 | 1.35 | .9 | .8 |
| Phase III | 21 days | 21 days | 20.71 | 1.3 | .8 | .7 |
| Grower I[c] | 42 days | 42 days | 18.42, 19.97 | 1.1, 1.2 | .75 | .65 |
| Finisher I[c] | 42 days | 42 days | 15.87, 17.11 | .9, 1.0 | .75 | .65 |
| Finisher II[c] | to market | to market | 13.66, 15.04 | .75, .85 | .8 | .55 |

[a] All diets were standard corn-soy based.
[b] Medicated groups were fed 50g/ton carbadox in the nursery and 30g/ton bacitracin methylene disalicylate in the grow-finisher and replaced corn.
[c] For CP and lysine, the first number represents the barrow diet and the second represents the gilt diet.

Table 3. Early wean - 3 site growth performance.

| Environment | EW | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | ETS | | | | YL | | | | | |
| Sex | Barrows | | Gilts | | Barrows | | Gilts | | | |
| Treatment | Med. | Non. | Med. | Non. | Med. | Non. | Med. | Non. | C.V. | Significance[b] |
| ADG, lb/day | | | | | | | | | | |
| d 0 - d 53 | .769 | .670 | .811 | .717 | .825 | .756 | .780 | .774 | 8.64 | E** T*** ExT** |
| d 53 - d 101[a] | 1.542 | 1.460 | 1.512 | 1.399 | 1.538 | 1.541 | 1.436 | 1.439 | 7.24 | E*** S* ExG$^{+}$ GxT$^{+}$ |
| d 101 - d142[a] | 1.361 | 1.423 | 1.250 | 1.416 | 1.274 | 1.355 | 1.104 | 1.409 | 11.1 | G*** T* ExG*** ExS$^{+}$ |
| d 142 - market[a] | 1.691 | 1.807 | 1.557 | 1.382 | 1.748 | 1.921 | 1.482 | 1.713 | 11.2 | S* ExS* ExT* |
| ADFI, lb/day | | | | | | | | | | |
| d 0 - d 53 | .939 | .894 | 1.052 | 1.010 | 1.058 | 1.109 | 1.065 | 1.077 | 10.1 | G** T* ExT* |
| d 53 - d 101[a] | 3.140 | 3.104 | 3.128 | 2.923 | 3.654 | 3.569 | 3.264 | 3.457 | 5.50 | E*** S** G*** ExG*** GxT$^{+}$ |
| d 101 - d142[a] | 3.800 | 4.094 | 3.519 | 3.882 | 4.350 | 4.374 | 3.608 | 4.044 | 7.88 | S** ExG** GxT* T$^{+}$ ExGxT$^{+}$ |
| d 142 - market[a] | 5.640 | 5.866 | 5.120 | 4.938 | 7.010 | 7.324 | 6.042 | 6.750 | 6.01 | E** S*** G*** ExG*** ExS* ExT* |
| Nursery Weight, lb | 41.47 | 36.83 | 41.23 | 37.33 | 43.57 | 40.40 | 39.97 | 41.20 | 10.2 | E** T** |
| Days to Market | 187.0 | 187.6 | 192.4 | 197.1 | 185.2 | 182.2 | 199.3 | 191.6 | 2.80 | S* G** ExS*** ExG*** |
| Slaughter Wt., lb | 249.3 | 256.0 | 246.0 | 248.3 | 250.0 | 248.0 | 248.3 | 248.3 | 1.40 | E*** S** ExT*** G$^{+}$ T$^{+}$ |
| Off-test Wt.[c], lb | 249.3 | 252.6 | 245.9 | 241.1 | 249.9 | 248.6 | 242.5 | 251.0 | 1.82 | E* S* T* ExG* ExT** |
| Death Loss, % | 0 | 4.77 | 0 | 9.53 | 0 | 5.57 | 5.57 | 0 | 118 | E** G* ExG* ExSxT$^{+}$ |
| Morbidity, % | 0 | 11.13 | 0 | 10.33 | 5.57 | 0 | 5.57 | 5.57 | 190 | ExGxT* |

[a] Values adjusted for nursery (d53) weight.

[b] Significance P-values : $^{+}$ P<.10, * P<.05, ** P<.01, *** P<.001; E=Environment, G=Genotype, S=Sex, T=Treatment, x=interaction.

[c] Average weight off all pigs at end of trial.

Table 4. Continuous Flow growth performance.

| Environment | CF | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | ETS | | | | YL | | | | | |
| Sex | Barrows | | Gilts | | Barrows | | Gilts | | | |
| Treatment | Med. | Non. | Med. | Non. | Med. | Non. | Med. | Non. | C.V. | Significance[b] |
| ADG, lb/day | | | | | | | | | | |
| d 0 - d 53 | .752 | .651 | .807 | .588 | .865 | .585 | .782 | .645 | 8.64 | E** T*** ExT** |
| d 53 - d 101[a] | 1.546 | 1.386 | 1.354 | 1.326 | 1.281 | 1.330 | 1.284 | 1.321 | 7.24 | E*** S* ExG$^{+}$ GxT$^{+}$ |
| d 101 - d142[a] | 1.315 | 1.506 | 1.494 | 1.773 | 1.144 | 1.095 | 1.233 | 1.035 | 11.1 | G*** T* ExG*** ExS$^{+}$ |
| d 142 - market[a] | 1.905 | 1.697 | 1.901 | 1.698 | 1.868 | 1.606 | 1.755 | 1.663 | 11.2 | S* ExS* ExT* |
| ADFI, lb/day | | | | | | | | | | |
| d 0 - d 53 | .952 | .919 | 1.119 | .872 | 1.137 | .953 | 1.086 | .970 | 10.1 | G** T* ExT* |
| d 53 - d 101[a] | 3.074 | 2.901 | 2.806 | 2.769 | 2.862 | 2.999 | 2.883 | 2.940 | 5.50 | E*** S** G*** ExG*** GxT$^{+}$ |
| d 101 - d142[a] | 4.129 | 4.458 | 3.940 | 4.622 | 4.130 | 3.924 | 3.947 | 3.586 | 7.88 | S** ExG** GxT* T$^{+}$ ExGxT$^{+}$ |
| d 142 - market[a] | 5.851 | 5.578 | 5.459 | 5.413 | 6.358 | 5.837 | 5.870 | 5.763 | 6.01 | E** S*** G*** ExG*** ExS* ExT* |
| Nursery Weight, lb | 37.50 | 34.10 | 40.27 | 34.20 | 41.30 | 34.00 | 39.03 | 35.13 | 10.2 | E** T** |
| Days to Market | 185.4 | 187.7 | 182.8 | 182.7 | 193.5 | 202.5 | 195.3 | 199.2 | 2.80 | S* G** ExS*** ExG*** |
| Slaughter Wt., lb | 250.7 | 244.1 | 249.2 | 243.5 | 248.7 | 244.2 | 245.5 | 239.4 | 1.40 | E*** S** ExT*** G$^{+}$ T$^{+}$ |
| Off-test Wt.[c], lb | 251.4 | 244.1 | 249.1 | 243.5 | 248.7 | 237.3 | 243.0 | 239.4 | 1.82 | E* S* T* ExG* ExT** |
| Death Loss, % | 20.67 | 11.13 | 15.87 | 26.20 | 5.57 | 5.57 | 0 | 11.13 | 118 | E** G* ExG* ExSxT$^{+}$ |
| Morbidity, % | 0 | 0 | 0 | 0 | 0 | 16.67 | 5.57 | 0 | 190 | ExGxT* |

[a] Values adjusted for nursery (d53) weight.

[b] Significance P-values : $^{+}$ P<.10, * P<.05, ** P<.01, *** P<.001; E=Environment, G=Genotype, S=Sex, T=Treatment, x=interaction.

[c] Average weight of all pigs at end of trial.

Table 5. Early wean - 3 site carcass characteristics and pork quality.

| Environment | EW | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | ETS | | | | YL | | | | | |
| Sex | Barrows | | Gilts | | Barrows | | Gilts | | | |
| Treatment | Med. | Non. | Med. | Non. | Med. | Non. | Med. | Non. | C.V. | Significance[a] |
| LEA[c], in[2] | 6.70 | 7.21 | 8.23 | 8.41 | 5.80 | 5.77 | 6.26 | 6.20 | 6.80 | S*** G*** SxG* ExT$^{+}$ |
| 10th Rib BF[c], in | .733 | .803 | .523 | .523 | 1.163 | 1.187 | .853 | .917 | 9.32 | E** S*** G*** ExG** ExS$^{+}$ |
| Lean[c], % | 54.23 | 54.73 | 60.23 | 60.90 | 48.17 | 47.90 | 52.17 | 51.47 | 3.01 | S** G*** ExG* |
| 24-hr Color[b] | 2.30 | 2.00 | 2.10 | 2.37 | 2.48 | 2.36 | 2.45 | 2.23 | 25.6 | G* |
| Firmness[b] | 2.75 | 2.75 | 2.60 | 2.82 | 2.59 | 2.78 | 2.97 | 2.82 | 19.9 | G$^{+}$ SxGxT* |
| Marbling[b] | 1.14 | 1.30 | 1.11 | 1.04 | 1.38 | 1.36 | 1.27 | 1.32 | 27.1 | S** G$^{+}$ |
| Drip Loss, % | 5.93 | 5.44 | 6.61 | 4.25 | 5.17 | 5.14 | 3.97 | 3.71 | 40.0 | G*** T* ExS* SxT* |
| pH | 5.56 | 5.44 | 5.48 | 5.48 | 5.55 | 5.50 | 5.72 | 5.65 | 3.56 | G*** ExT* |
| HunterLab L*[d] | 51.67 | 54.29 | 50.94 | 49.38 | 50.94 | 50.53 | 47.12 | 49.65 | 6.53 | G*** S** ExT* SxGxT* |
| a* | 9.56 | 8.48 | 9.35 | 9.53 | 10.15 | 10.14 | 10.22 | 9.70 | 16.2 | ExG$^{+}$ |
| b* | 13.02 | 14.23 | 12.87 | 12.11 | 13.12 | 12.70 | 11.89 | 12.97 | 9.17 | G* S$^{+}$ SxGxT** |
| Cooking Loss, % | 22.61 | 28.82 | 27.18 | 25.34 | 26.28 | 26.17 | 23.15 | 26.84 | 22.7 | T$^{+}$ ExSxT* ExSxG$^{+}$ SxGxT$^{+}$ |
| Shear Force, kg | 3.51 | 3.50 | 3.56 | 3.47 | 3.70 | 3.46 | 3.55 | 3.51 | 20.3 | ---- |
| Tenderness[e] | 7.82 | 7.22 | 7.49 | 6.99 | 7.39 | 8.70 | 8.19 | 8.09 | 33.9 | G** T** ExT* GxT** |
| Juiciness[e] | 8.34 | 6.63 | 8.50 | 7.42 | 7.50 | 7.44 | 7.69 | 6.92 | 28.1 | E* G* ExT*** GxT** ExS* |
| Off-flavor[e] | 14.47 | 14.39 | 14.60 | 13.68 | 13.95 | 14.44 | 13.97 | 14.51 | 10.5 | GxT*** SxT$^{+}$ |

[a] Significance P-values : $^{+}$ P<.10, * P<.05, ** P<.01, *** P<.001; E=Environment, G=Genotype, S=Sex, T=Treatment, x=interaction.

[b] Subjective score: 1 = pale, soft, and devoid of marbling, to 5 = dark, firm, and abundance of marbling.

[c] Values adjusted for Market Weight.

[d] Values correspond to color scores: L* of 35 = color score of 5, to L* of 61 = color score of 1.

[e] Subjective score: 0 = extremely dry, tough, and intense off-flavor, to 15 = extremely moist, tender, and no off-flavor.

Table 6. Continuous Flow carcass characteristics and pork quality.

| Environment | CF | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | ETS | | | | YL | | | | | |
| Sex | Barrows | | Gilts | | Barrows | | Gilts | | | |
| Treatment | Med. | Non. | Med. | Non. | Med. | Non. | Med. | Non. | C.V. | Significance[a] |
| LEA[c], in[2] | 7.03 | 6.70 | 7.95 | 7.56 | 6.08 | 5.50 | 6.25 | 6.22 | 6.80 | S*** G*** SxG* ExT$^{+}$ |
| 10th Rib BF[c], in | .760 | .717 | .613 | .580 | .980 | 1.023 | .797 | .733 | 9.32 | E** S*** G*** ExG** ExS$^{+}$ |
| Lean[c], % | 54.73 | 54.73 | 58.57 | 58.20 | 50.50 | 48.80 | 52.80 | 53.60 | 3.01 | S** G*** ExG* |
| 24-hr Color[b] | 1.98 | 1.88 | 1.77 | 2.28 | 1.87 | 2.60 | 2.42 | 2.53 | 25.6 | G* |
| Firmness[b] | 2.87 | 2.40 | 2.37 | 2.55 | 2.78 | 2.99 | 2.95 | 2.49 | 19.9 | G$^{+}$ SxGxT* |
| Marbling[b] | 1.24 | 1.13 | 1.19 | 1.35 | 1.41 | 1.48 | 1.02 | 1.20 | 27.1 | S** G$^{+}$ |
| Drip Loss, % | 5.74 | 6.76 | 8.26 | 5.86 | 4.33 | 3.44 | 5.72 | 4.23 | 40.0 | G*** T* ExS* SxT* |
| pH | 5.42 | 5.40 | 5.39 | 5.43 | 5.53 | 5.74 | 5.60 | 5.67 | 3.56 | G*** ExT* |
| HunterLab L*[d] | 53.15 | 52.98 | 53.15 | 51.68 | 52.95 | 47.52 | 48.31 | 47.55 | 6.53 | G*** S** ExT* SxGxT* |
| a* | 9.31 | 9.56 | 9.28 | 9.49 | 8.35 | 8.77 | 9.69 | 9.82 | 16.2 | ExG$^{+}$ |
| b* | 12.80 | 13.39 | 12.91 | 12.90 | 13.07 | 11.42 | 12.53 | 12.12 | 9.17 | G* S$^{+}$ SxGxT** |
| Cooking Loss, % | 29.29 | 28.05 | 24.68 | 28.50 | 25.04 | 22.91 | 25.48 | 30.77 | 22.7 | T$^{+}$ ExSxT* ExSxG$^{+}$ SxGxT$^{+}$ |
| Shear Force, kg | 3.91 | 3.80 | 3.27 | 3.58 | 3.39 | 3.38 | 3.47 | 3.22 | 20.3 | ---- |
| Tenderness[e] | 7.39 | 8.01 | 7.01 | 7.22 | 7.27 | 8.15 | 6.78 | 8.68 | 33.9 | G** T** ExT* GxT** |
| Juiciness[e] | 7.73 | 8.97 | 8.11 | 7.24 | 7.58 | 8.25 | 6.93 | 8.08 | 28.1 | E* G* ExT*** GxT** ExS* |
| Off-flavor[e] | 14.29 | 14.00 | 14.54 | 14.24 | 13.90 | 14.34 | 14.37 | 14.11 | 10.5 | GxT*** SxT$^{+}$ |

[a] Significance P-values : $^{+}$ P<.10, * P<.05, ** P<.01, *** P<.001; E=Environment, G=Genotype, S=Sex, T=Treatment, x=interaction.

[b] Subjective score: 1 = pale, soft, and devoid of marbling, to 5 = dark, firm, and abundance of marbling.

[c] Values adjusted for Market Weight.

[d] Values correspond to color scores: L* of 35 = color score of 5, to L* of 61 = color score of 1.

[e] Subjective score: 0 = extremely dry, tough, and intense off-flavor, to 15 = extremely moist, tender, and no off-flavor.