Effects of Environment, Genotype, and Health Management System on Pig Growth Performance and Carcass Characteristics

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Introduction

A number of research trials and producer observations suggest that the lean growth rates of high lean growth genotypes are substantially reduced under commercial conditions. Pigs reared under commercial conditions have lower feed intakes and reduced growth rates in comparison to pigs reared under ideal conditions.

It has also been observed that when low-medium lean growth genotypes are raised under ideal conditions, lean growth rate is only marginally increased from 100 to 260 pounds. Low-medium lean growth genotypes respond to more ideal conditions by consuming feed in excess of that needed for maximum lean growth, and subsequently become fatter. Barrows of a number of low to average lean growth genotypes have .1 to .3 inch greater backfat depths when fed under more ideal conditions.

A number of antibiotics have growth promoting effects through the lowering of disease levels and increased nutrient utilization. Tilmicosin (Pulmotil®), a product from Elanco Animal Health, is a medication designed for use in pigs at risk for bacterial pneumonia. Various research trials have shown pigs receiving tilmicosin have an increased average daily gain and feed efficiency in addition to a reduction in or elimination of death loss. This product requires a Veterinary Feed Directive from a veterinarian before it can be bought and used by producers. The increased growth rates may be associated with increased production of growth promoting factors such as insulin-like growth factor (IGF-1) and the reduction of inhibitory factors via an ability to reduce disease levels.

Little research has been conducted on the response of growth promotants in high health status pigs and the underlying biology of the mode of action. It would be expected that high health status pigs would show less of a response to therapeutic medications than pigs of average health status for respiratory diseases.

Objectives

Economic incentives have been put in place for producers to generate quality lean pork. For producers to take full advantage of these incentives, pork production must be done as efficiently as possible without compromising quality. Without adequate understanding about the direct effects and interactions between genetic potential for lean growth and health-status/rearing environment on pig growth performance, making genetic or management changes may actually decrease producer profitability.

Therefore, the objectives of this study were to:

1. Evaluate the impact of health-status/rearing environment differences on three high lean growth genotypes.

2. Determine the magnitude of genotype by environmental interactions on growth performance and carcass characteristics, and the need to recommend different terminal sires for different environmental conditions.

3. Evaluate the effect of strategic vaccination-therapeutic antibiotic use to increase average daily gain and feed efficiency in two health-management environments.

4. Evaluate the biological causes for the changes in lean growth caused by genetic, therapeutic antibiotic and health-management environmental differences.

Materials and Methods

Three terminal sire lines were used (L, M, and H), respectively increasing in genetic potential for percent lean; these were bred to European Landrace x Duroc-Large White sows. Previous data had shown that the L genotype had the highest live weight growth rate, feed intake, and lipid accretion, and the H genotype had the lowest live weight growth rate, feed intake, and lipid accretion. The M genotype was a cross of the L and H genotypes. All three sire genotypes had similar lean accretion rates when evaluated in prior trials.

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.

For the early weaned group (TS-EW), 12-day-old pigs were weaned and moved to an isolated early wean facility and reared until eight weeks old. The eight-week-old pigs were then placed in a curtain-sided building that had been previously emptied, cleaned, and disinfected. For the conventionally weaned group (CON), 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. All pigs were housed 7 pigs per pen in the nursery and 5 pigs per pen in the grow-finish. The pigs were weighed and feed consumption was recorded every 2 weeks in the nursery and every 3 weeks in grow-finish until near the market weight of 250 pounds, when pigs were weighed weekly.

In the nursery, all pigs received 50 g/ton Carbadox followed by one week of 400 g/ton Chlorotetracycline. Following the Chlorotetracycline, the two antibiotic treatment regimes began. The treatments were no vaccination with non-medicated diets from days 50 to 91 (C), or *Mycoplasma hyopneumoniae* vaccination (Respisure®) on days 28 and 42 followed by two veterinary feed directives of 272 g/ton Tilmicosin (Pulmotil®) from days 50 to 70 and days 70 to 91 (VT). After this treatment period, all pigs consumed diets containing 40 g/ton Tylosin (Tables 1 and 2).

Ultrasound measurements were taken on the same 2 pigs per pen every 3 weeks starting in the grow-finish phase (day 56) and on all pigs as they reached market weight. Using this data, protein and lipid accretion curves will be generated.

Two pigs per pen were bled on days 50, 70, 91, 112, and 133 to determine IGF-1 concentrations using a double antibody radioimmunoassay, and antibody titer levels for *Mycoplasma hyopneumoniae* and PRRS (porcine reproductive and respiratory syndrome) using an ELISA assay.

At market, tenth rib backfat (10th Rib BF), last rib backfat (Last Rib BF), loin muscle area (LEA), and carcass weight (Carcass Wt.) were obtained at the pork processor plant (IBP, Logansport, Indiana). These values were then used to calculate fat-free lean index (FFLI). Visual color, firmness, and marbling scores at the cut surface of the 10-11 rib interface were evaluated at 32°F. Quality scores were reported on a 1 to 5 scale as estimated in the Procedures to Evaluate Market Hogs (NPPC, 1991).

Growth and carcass data were analyzed as a factorial arrangement of health status-environment, genotype, sex, and antibiotic/vaccination treatments. The blood parameters were analyzed using a factorial arrangement as repeated measures.

Results

The results of the growth performance criteria of average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F) are in Table 3 (CON) and Table 4 (TS-EW). From days 29 to 50, the TS-EW pigs had higher ADG ($P<.05$) and ADFI ($P<.001$), but lower G:F ($P<.001$). Gilts had greater ADG ($P<.05$) and G:F ($P<.01$) than barrows. The L genotype had the greatest ADFI ($P<.05$) and lowest G:F ($P<.01$) during this time period. There was also an environment by sex interaction; the gilts in the CON environment had greater G:F than the barrows, but in the TS-EW environment both sexes performed similarly ($P<.05$). During the last week in the nursery, which was also the first week of dietary treatments (days 50 to 56), barrows had greater ADG ($P<.01$), ADFI ($P<.01$), and G:F ($P<.05$) than gilts. The VT pigs also had greater ADG ($P<.01$) and G:F ($P<.001$) than the C pigs. An environment by sex interaction also occurred for G:F. Within the TS-EW environment, both barrows and gilts had similar G:F; however, in the CON environment, the gilts had a greater G:F ($P<.05$). Overall, the barrows were 0.9 pounds heavier than the gilts at the end of the nursery phase on day 56 ($P<.01$).

Growth performance data in the grow-finish phase were adjusted for end of nursery weights (Weight d 56) to ensure that any differences in this phase were not due to the variation in the nursery. During the first phase in the grow-finisher, which was also the last 5 weeks of dietary antibiotic treatments (days 56 to 91), the TS-EW pigs had greater ADG ($P<.01$) and ADFI ($P<.001$), but a lower G:F ($P<.001$). The VT pigs also had increased ADG ($P<.001$) and ADFI ($P<.001$) compared to the C pigs. The L genotype again had the greatest ADFI ($P<.01$) and lowest G:F ($P<.05$). Environment by genotype interactions were significant for ADG and G:F. In the CON environment the L genotype had the greatest ADG, but in the TS-EW they had the lowest ADG ($P<.01$). For G:F, the three

genotypes in the CON environment were similar; however, in the TS-EW environment the L genotype was lowest (P<.01).

In the 6 weeks following treatments (days 91 to 133), the L genotype maintained the highest ADFI and the lowest G:F (P<.001). Barrows gained and consumed more than gilts during this period (P<.01 and P<.001, respectively). The VT pigs also had greater ADG and ADFI compared to the C pigs (P<.01). The interaction of rearing environment and genotype was due to differences in ADFI in the CON environment where the L genotype had the greatest feed intake, versus similar consumptions of all the genotypes in the TS-EW environment (P<.05). Pigs in the CON environment had a greater ADG and ADFI (P<.001) than those in the TS-EW environment. This difference was due to disease exposure in the TS-EW environment between days 112 and 133 and potentially compensatory gain in the CON environment, as evident in the PRRS titer levels (Figure 3). This ultimately influenced the overall grow-finish (day 56 to market) ADG and G:F. The differences overall were that pigs reared in the CON environment had a 0.1 pound greater ADG (P<.001) and a 4 percent greater G:F (P<.001) than the pigs in the TS-EW environment. Throughout the grow-finish phase, the L genotype maintained greater ADG (P<.05) and ADFI (P<.001) compared to the H genotype, which had the greatest G:F (P<.01). Again, barrows had greater ADG and ADFI compared to gilts (P<.001). The VT pigs also had greater ADG (P<.001) and ADFI (P<.01) compared to the C pigs. Interactions for environment by genotype and genotype by sex were also present for ADG and G:F. In the TS-EW environment, all three genotypes had similar ADG, but in the CON environment the L genotype had the greatest and the H genotype had the lowest ADG (P<.001). For G:F, the interaction was due to a change in rank of the genotypes within the two environments. In the CON environment the L genotype had the second greatest G:F; however, in the TS-EW this genotype had the lowest G:F (P<.05). The genotype by sex interaction was a result of the L barrows that had greater ADG compared to the L gilts, while the barrows and gilts of the other two genotypes had similar ADG (P<.05). The L barrows also had greater G:F than the L gilts, yet the barrows of the other two genotypes had lower G:F than the gilts (P<.05).

The L pigs reached market weight faster than the M and H pigs in the CON environment; however, L pigs had the greatest days to market in the TS-EW environment (P<.05). Days to market was not influenced by the rearing environment (P>.10) due to the disease outbreak in the TS-EW. The VT pigs reached market weight approximately 6 days faster than the C pigs (P<.01). Although not significantly different, VT pigs in the CON environment were marketed approximately 8 days faster than C pigs, while in the TS-EW environment, there was approximately a 3.5 day reduction in days to market for the VT pigs (P>.20). Barrows were marketed 4.5 days faster than gilts across environments (P<.05).

Pigs of the L genotype had the highest morbidity (P<.05), and although not statistically different, this genotype also had slightly lower death loss. For morbidity, there were also interactions that were significant. The H genotype's morbidity was reduced in the TS-EW environment compared to the CON environment, yet the L and M genotypes' morbidity increased in the TS-EW environment (P<.05). The sex by treatment interaction was that C gilts had more morbidity than VT gilts, while barrows had similar morbidity regardless of treatment (P<.05). Barrows had a 2% greater death loss compared to gilts

(P<.05), and C pigs had more death loss than VT pigs (P<.05). The death loss of the C barrows was greater than the VT barrows; however, the gilts of both treatments had similar death loss (P<.05).

Carcass characteristics are given in Table 5 (CON) and Table 6 (TS-EW). The objective of this study was not to determine the effects of market weight on carcass characteristics; therefore, carcass characteristics were adjusted for slaughter weight. Color scores for the TS-EW loins were 17% greater than those for the CON loins (P<.001). The H genotype had lower color scores than the L and M genotypes (P<.01). There was an 8% increase in marbling score values in the TS-EW loins compared to the CON loins (P<.05), and the L genotype had higher marbling scores (P<.001) than the other two genotypes. The environment by genotype interaction was that in the TS-EW environment, the L genotype had higher marbling scores than the M and H genotypes, yet in the CON environment all genotypes had similar marbling scores (P<.05). Loins from the gilts had a 7% greater firmness score compared to the barrows (P<.05).

FFLI values were highest for the H genotype compared to the L and M genotypes (P<.05), and gilts were 2.8% more lean than barrows (P<.001). Loin eye area measurements indicated that TS-EW loins were 0.3 in^2 larger than those from the CON environment (P<.01). Gilts had greater LEA than barrows (P<.001). The H genotype had the lowest last rib (P<.01) and tenth rib (P<.001) backfat compared to the L and M genotypes. Barrows had 0.1 inch more last rib and 0.13 inch more tenth rib backfat than the gilts (P<.001). The VT pigs also had greater last rib and tenth rib backfat depths than the CON pigs (P<.05). Although not significantly different, carcass weights were greater from the TS-EW environment (P<.10). There was a 25 percent increase in carcass premium for gilts compared to the barrows (P<.05).

IGF-1 concentrations (Figure 1) were higher in VT pigs versus the C pigs (P<.05). The L genotype had the highest IGF-1 concentrations compared to the M and H genotypes (P<.05), and gilts had greater concentrations than barrows (data not shown, P<.05). *Mycoplasma hyopneumoniae* titer levels (Figure 2) were lower in the VT pigs versus the C pigs (P<.001). The titer levels for PRRS (Figure 3) were lower in the TS-EW environment when compared to the CON environment (P<.001), and lower in the VT pigs compared to the C pigs (P<.05).

Discussion

The health-status/rearing environment influences were inconsistent in this trial due to the disease outbreak in the TS-EW facility between days 112 and 133. Before the disease outbreak occurred, pigs in this facility consistently had improved ADG and ADFI and reduced feed efficiency. This trend was reversed later in the grow-finisher, such that the pigs in the CON environment had greater ADG and ADFI. Carcass characteristics were also influenced by the environmental effects on growth performance. The increased marbling scores in the TS-EW environment may be associated with pig health and increased ADG early in the grow-finisher. Other research shows that pigs have greater lean accretion rates during the grower phase of production. The TS-EW pigs had the greater growth rates in the grower phase compared to the CON pigs; this can explain some of the subsequent differences in LEA between the two environments. Besides the main effects of health-status/environment, there were also interactions with the three genotypes. Most of the interactions were caused by differences in

variation among the three genotypes in the two environments. In the CON environment there was greater variation among the genotypes, whereas in the TS-EW environment the genotypes' responses were more similar. The data suggests that the genotype with the lower potential for percent lean performs better in the continuous flow or low health-status environment, while in the early wean/high health-status environment each of the three genetic lines were comparable. There were also significant improvements in ADG and ADFI due to the use of vaccination with medicated feeds in both environments. This response also carried over during the 6 weeks following the medicated diets. The underlying biological causes of these differences in growth performance are complex and must be further examined before any definite conclusions can be made.

Applications

In order for producers to efficiently produce quality pork, they must be aware of all the factors that can influence production. These factors are such things as genetics, health-status/rearing environment, therapeutic antibiotics, and vaccinations. This research trial has shown that strategic vaccination-therapeutic antibiotic use can reduce and even prevent the inhibitory effects that disease exposure has on growth. In addition, this trial indicates that there are environmental factors that influence the growth performance of pigs, and there are definite environment by genotype interactions affecting the growth performance criteria. Therefore, producers need to utilize the proper management program with the genetics they are using to continue to make quality lean pork the meat of choice throughout the world.

Table 1. Experimental design[a].

Environment	CON												TS-EW											
Genotype	L				M				H				L				M				H			
Treatment	C		VT		C		VT		C		VT		C		VT		C		VT		C		VT	
Sex	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G
Pens	2	3	2	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	2	3	3	2	3	2

[a] Environments: CON = conventional weaning with continuous flow grow-finish; TS-EW = segregated early weaning, three site production.
Genotypes: L = Lowest genetic potential for percent lean; M = medium genetic potential for percent lean; H = highest genetic potential for percent lean.
Treatments: C = no vaccination with non-medicated diets from days 50 to 91; VT = *Mycoplasma hyopneumoniae* vaccination on days 28 and 42 with diets containing Tilmicosin from days 50 to 70 and days 70 to 91.
Sex: B = barrows; G = gilts.

Table 2. Diet sequence[a].

Phase	CON	TS-EW	Lysine, %	Ca, %	P, %	Antibiotic
SEW	0 d	7 d	1.7	.9	.8	Carbadox
Transition	0 d	7 d	1.45	.9	.8	Carbadox
Nursery P2	14 d	14 d	1.35	.9	.8	Carbadox
Nursery P3	7 d	7 d	1.3	.85	.75	Chlorotetracycline
Grower 1	20 d	20 d	1.2	.75	.65	*Tilmicosin*[c]
Grower 2[b]	21 d	21 d	1.1, 1.2	.75	.65	*Tilmicosin*[c]
Finisher 1[b]	42 d	42 d	.9, 1.0	.75	.65	Tylosin
Finisher 2[b]	to market	to market	.75, .85	.65	.55	Tylosin

[a] All diets were standard corn-soy based.
[b] For lysine, the first number represents the barrow diet and the second represents the gilt diet.
[c] Treatments were C = no vaccination and non-medicated diets, and VT = *Mycoplasma hyopneumoniae* vaccination and Tilmicosin.

Table 3. Continuous Flow (CON) growth performance[a].

Genotype	L				M				H					
Sex	Barrows		Gilts		Barrows		Gilts		Barrows		Gilts			
Treatment	C	VT	C	VT	C	VT	C	VT	C	VT	C	VT	C.V.	Significance[b]
ADG, lbs														
d 29-50	.761	.757	1.044	1.030	.904	.918	1.064	.950	.903	.797	.905	.929	13.7	E^1 S^1
d 50-56	1.190	1.242	1.045	1.207	1.191	1.290	.997	1.245	1.030	1.246	1.057	1.171	11.6	S^2 T^2
d 56-91[c]	1.849	1.964	1.646	1.869	1.698	1.810	1.675	1.860	1.594	1.726	1.601	1.738	5.99	E^2 T^3 ExG^2 S^T GxS^T
d 91-133[c]	2.153	2.220	1.909	2.050	1.918	2.121	1.822	1.913	1.798	2.138	1.827	1.977	2.44	E^3 S^2 T^2
d 56-market[c]	2.120	2.140	1.819	2.035	1.805	1.964	1.780	2.003	1.809	1.917	1.662	1.902	5.13	E^3 G^1 S^3 T^3 ExG^3 GxS^1
ADFI, lbs														
d 29-50	1.171	1.267	1.222	1.249	1.053	1.145	1.223	1.163	1.078	.986	1.083	1.065	10.5	E^3 G^1
d 50-56	2.320	2.401	2.164	2.127	2.193	2.172	2.085	2.188	2.055	2.267	2.069	2.165	7.10	S^2
d 56-91[c]	3.455	3.670	3.017	3.592	3.206	3.482	3.193	3.583	3.022	3.153	3.077	3.103	6.30	E^3 G^2 T^3
d 91-133[c]	6.134	6.589	5.674	6.210	5.353	6.060	5.257	5.666	5.019	5.834	4.719	5.196	8.01	E^3 G^3 S^3 T^2 ExG^1 ExT^T
d 56-market[c]	5.414	5.721	4.974	5.519	4.998	5.388	4.964	5.188	4.912	5.135	4.656	4.660	5.04	G^3 S^3 T^2
G:F														
d 29-50	.649	.593	.856	.824	.856	.808	.877	.820	.848	.813	.833	.869	8.44	E^3 G^2 S^2 ExS^1 $ExGxS^1$
d 50-56	.513	.518	.485	.570	.543	.593	.478	.570	.500	.558	.513	.542	8.89	S^1 T^3 $ExGxT^T$
d 56-91[c]	.538	.537	.550	.522	.532	.522	.525	.521	.530	.558	.523	.562	4.55	E^3 G^1 ExG^2 $ExGxT^1$
d 91-133[c]	.350	.337	.337	.330	.359	.351	.347	.341	.358	.367	.390	.380	6.26	G^3 $ExGxS^1$
d 56-market[c]	.392	.374	.366	.369	.362	.364	.359	.386	.369	.373	.357	.409	4.05	E^3 G^2 T^T ExG^1 GxS^1
Weight d 56	46.26	43.10	43.12	44.10	43.45	44.03	42.29	43.51	42.74	44.04	42.63	43.31	2.48	S^2 $ExGxT^1$ E^T SxT^T $GxSxT^T$
Days to Market[d]	154.6	155.6	172.3	158.1	169.2	159.4	171.3	158.6	173.4	169.0	180.8	166.4	5.08	ExG^1 T^2 S^1
Market Wt., lbs	248.8	248.3	246.6	250.7	246.2	250.5	246.7	249.4	244.2	248.6	242.0	243.8	4.61	E^3 G^1 ExT^3
Morbidity, %	0.00	7.62	10.65	0.00	0.00	5.95	0.79	0.16	4.28	9.38	10.14	0.00	144.5	G^1 ExG^1 ExS^T SxT^1 $ExSxT^1$
Death Loss, %	8.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.56	0.00	0.00	0.00	387.2	S^1 T^1 SxT^1

[a] Data during d 50-56 and d 56-91 are during non-medicated control diets or Tilmicosin.
[b] E = Health-status/rearing environment, G = Genotype, T = Treatment, S = Sex, x = an interaction; ^{1}P<.05, ^{2}P<.01, ^{3}P<.001, and ^{T}P<.10.
[c] Adjusted for Initial Grow-Finish Weight (day 56).
[d] Adjusted for Market Weight.

Table 4. Early Wean 3-site (TS-EW) growth performance[a].

Genotype	L				M				H					
Sex	Barrows		Gilts		Barrows		Gilts		Barrows		Gilts			
Treatment	C	VT	C	VT	C	VT	C	VT	C	VT	C	VT	C.V.	Significance[b]
ADG, lbs														
d 29-50	1.051	.943	.915	1.011	1.003	.952	1.070	1.063	.975	.964	.984	.911	13.7	E^1 S^1
d 50-56	1.149	1.234	.815	1.228	1.242	1.148	.960	1.080	1.164	1.285	1.063	1.100	11.6	S^2 T^2
d 56-91[c]	1.798	1.897	1.577	1.877	1.851	2.006	1.805	1.895	1.835	1.868	1.816	1.973	5.99	E^2 T^3 ExG^2 S^T GxS^T
d 91-133[c]	1.848	1.872	1.604	1.648	1.582	1.896	1.758	1.765	1.902	1.827	1.708	1.695	2.44	E^3 S^2 T^2
d 56-market[c]	1.840	1.875	1.598	1.758	1.778	1.929	1.763	1.827	1.840	1.773	1.720	1.854	5.13	E^3 G^1 S^3 T^3 ExG^3 GxS^1
ADFI, lbs														
d 29-50	1.552	1.398	1.331	1.580	1.492	1.367	1.436	1.486	1.402	1.396	1.417	1.315	10.5	E^3 G^1
d 50-56	2.406	2.196	1.911	2.143	2.196	2.235	2.156	2.118	2.185	2.168	2.110	2.092	7.10	S^2
d 56-91[c]	3.657	3.858	3.740	4.037	3.733	3.877	3.579	3.686	3.531	3.849	3.620	3.826	6.30	E^3 G^2 T^3
d 91-133[c]	5.649	5.465	4.541	4.833	5.082	5.513	4.770	5.025	4.986	5.019	4.487	4.809	8.01	E^3 G^3 S^3 T^2 ExG^1 ExT^T
d 56-market[c]	5.346	5.342	4.873	4.987	5.226	5.359	4.776	5.139	4.934	5.120	4.563	4.764	5.04	G^3 S^3 T^2
G:F														
d 29-50	.673	.672	.680	.644	.677	.695	.744	.716	.694	.683	.700	.696	8.44	E^3 G^2 S^2 ExS^1 $ExGxS^1$
d 50-56	.475	.559	.407	.573	.562	.514	.449	.511	.529	.587	.497	.528	8.89	S^1 T^3 $ExGxT^T$
d 56-91[c]	.495	.492	.428	.466	.497	.519	.506	.518	.522	.490	.510	.516	4.55	E^3 G^1 ExG^2 $ExGxT^1$
d 91-133[c]	.328	.342	.352	.342	.311	.345	.369	.351	.384	.365	.382	.352	6.26	G^3 $ExGxS^1$
d 56-market[c]	.345	.351	.328	.352	.341	.360	.369	.356	.375	.347	.377	.390	4.05	E^3 G^2 T^T ExG^1 GxS^1
Weight d 56	43.18	43.70	41.18	43.67	43.74	43.09	42.04	42.77	43.28	44.00	42.67	42.88	2.48	S^2 $ExGxT^1$ E^T SxT^T $GxSxT^T$
Days to Market[d]	167.6	167.6	181.0	172.5	168.6	160.0	172.0	168.0	165.9	171.0	171.2	166.0	5.08	ExG^1 T^2 S^1
Market Wt., lbs	259.0	247.0	254.8	245.4	265.1	253.2	252.1	249.5	247.5	248.6	252.9	247.2	4.61	E^3 G^1 ExT^3
Morbidity, %	8.95	0.00	17.76	11.40	1.23	1.05	5.89	0.73	0.39	0.27	1.55	0.33	144.5	G^1 ExG^1 ExS^T SxT^1 $ExSxT^1$
Death Loss, %	0.00	0.00	0.00	0.00	8.34	0.00	0.00	0.00	5.56	0.00	0.00	0.00	387.2	S^1 T^1 SxT^1

[a] Data during d 50-56 and d 56-91 are during non-medicated control diets or Tilmicosin.
[b] E = Health-status/rearing environment, G = Genotype, T = Treatment, S = Sex, x = an interaction; ^{1}P<.05, ^{2}P<.01, ^{3}P<.001, and ^{T}P<.10.
[c] Adjusted for Initial Grow-Finish Weight (day 56).
[d] Adjusted for Market Weight.

Table 5. Continuous Flow (CON) carcass characteristics[a].

Genotype	L				M				H					
Sex	Barrows		Gilts		Barrows		Gilts		Barrows		Gilts			
Treatment	C	VT	C	VT	C	VT	C	VT	C	VT	C	VT	C.V.	Significance[b]
Color	1.83	2.00	1.90	1.74	2.18	1.86	1.81	1.86	1.69	1.54	1.86	1.91	34.4	E^3 G^2 GxS^T
Marbling	1.11	1.50	1.43	1.19	1.18	1.32	1.29	1.14	1.31	1.04	1.26	1.21	31.6	E^1 G^3 ExG^1
Firmness	1.94	2.69	2.38	2.30	2.64	2.28	2.65	2.43	2.38	2.35	2.35	2.62	28.3	S^1
LEA, in^2	6.95	6.34	7.24	7.26	6.73	7.30	7.11	7.50	6.69	6.97	7.69	7.73	12.4	E^2 S^3 $ExGxS^1$
Last Rib BF, in	.61	.75	.57	.60	.64	.72	.52	.56	.60	.61	.52	.52	19.1	G^2 S^3 T^1 $ExSxT^1$
10th Rib BF, in	.73	.80	.66	.67	.70	.83	.61	.64	.68	.72	.54	.58	20.1	G^3 S^3 T^1
FFLI, %	52.3	50.2	53.5	53.5	51.8	52.3	53.5	54.3	51.9	52.5	55.8	55.5	5.16	E^T G^1 S^3
Carcass Wt, lbs	177.4	177.7	179.1	177.5	178.0	179.2	179.4	178.1	179.3	178.1	181.3	178.7	2.43	E^T G^T
Premium, $	3.34	2.40	3.69	4.02	4.22	1.56	3.27	3.49	3.03	2.74	3.59	4.12	83.2	S^1 $ExSxT^T$ $GxSxT^T$

[a] Data adjusted for Market Weight.
[b] E = Health-status/rearing environment, G = Genotype, T = Treatment, S = Sex, x = an interaction; $^1P<.05$, $^2P<.01$, $^3P<.001$, and $^TP<.10$.

Table 6. Early Wean 3-site (TS-EW) carcass characteristics[a].

Genotype	L				M				H					
Sex	Barrows		Gilts		Barrows		Gilts		Barrows		Gilts			
Treatment	C	VT	C	VT	C	VT	C	VT	C	VT	C	VT	C.V.	Significance[b]
Color	2.47	2.10	2.52	2.20	2.17	2.82	2.23	2.19	1.74	1.96	2.06	1.88	34.4	E^3 G^2 GxS^T
Marbling	1.28	1.62	1.64	1.86	1.26	1.23	1.34	1.31	1.13	1.29	1.08	1.18	31.6	E^1 G^3 ExG^1
Firmness	2.49	2.45	2.58	2.67	2.42	2.44	2.85	2.85	2.21	2.25	2.85	2.11	28.3	S^1
LEA, in^2	7.32	6.92	8.11	7.90	6.67	6.66	8.08	7.57	7.47	7.15	7.67	7.82	12.4	E^2 S^3 $ExGxS^1$
Last Rib BF, in	.72	.67	.53	.64	.66	.65	.50	.55	.62	.64	.54	.55	19.1	G^2 S^3 T^1 $ExSxT^1$
10th Rib BF, in	.81	.83	.65	.76	.74	.72	.57	.60	.69	.76	.61	.60	20.1	G^3 S^3 T^1
FFLI, %	52.6	51.4	55.6	54.4	51.7	51.7	56.3	54.9	53.9	52.7	54.9	55.4	5.16	E^T G^1 S^3
Carcass Wt, lbs	177.5	178.8	179.7	178.5	180.9	181.9	180.1	181.0	178.6	179.0	180.0	180.5	2.43	E^T G^T
Premium, $	0.63	3.23	4.16	2.66	4.07	2.87	3.62	4.06	3.69	2.58	4.38	2.85	83.2	S^1 $ExSxT^T$ $GxSxT^T$

[a] Data adjusted for Market Weight.
[b] E = Health-status/rearing environment, G = Genotype, T = Treatment, S = Sex, x = an interaction; $^1P<.05$, $^2P<.01$, $^3P<.001$, and $^TP<.10$.

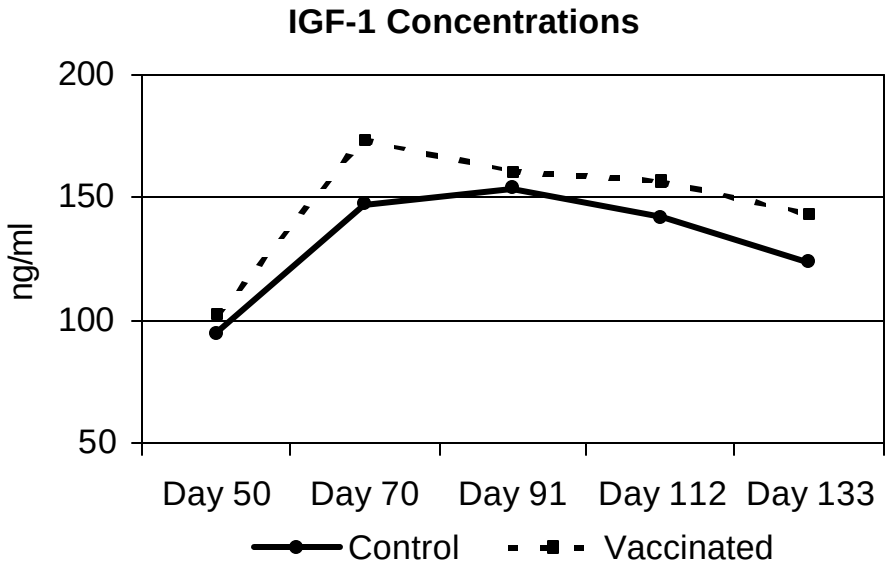

Figure 1. Insulin-Like Growth Factor-1 concentrations for the Control versus Vaccinated and Tilmicosin treatment (C.V.=32.7, P<.05).

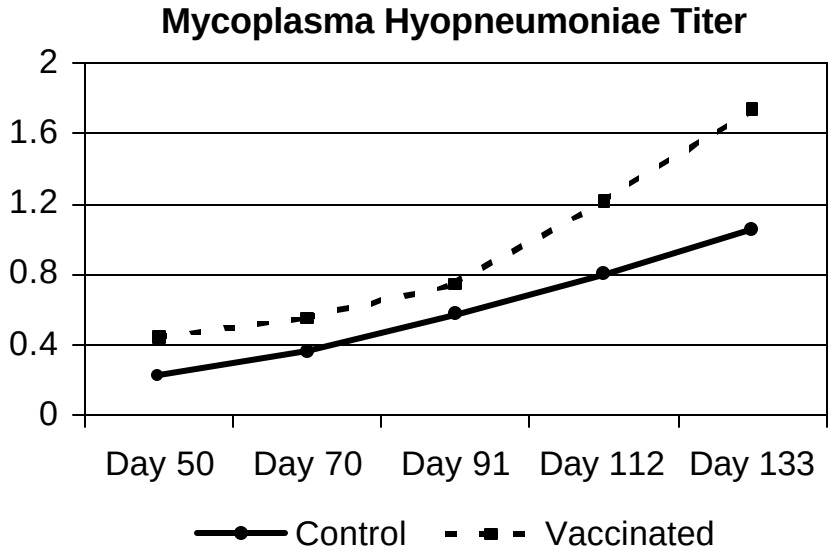

Figure 2. *Mycoplasma hyopneumoniae* titer levels for the Control versus Vaccinated and Tilmcosin treatment (C.V.=50.0, P<.001).

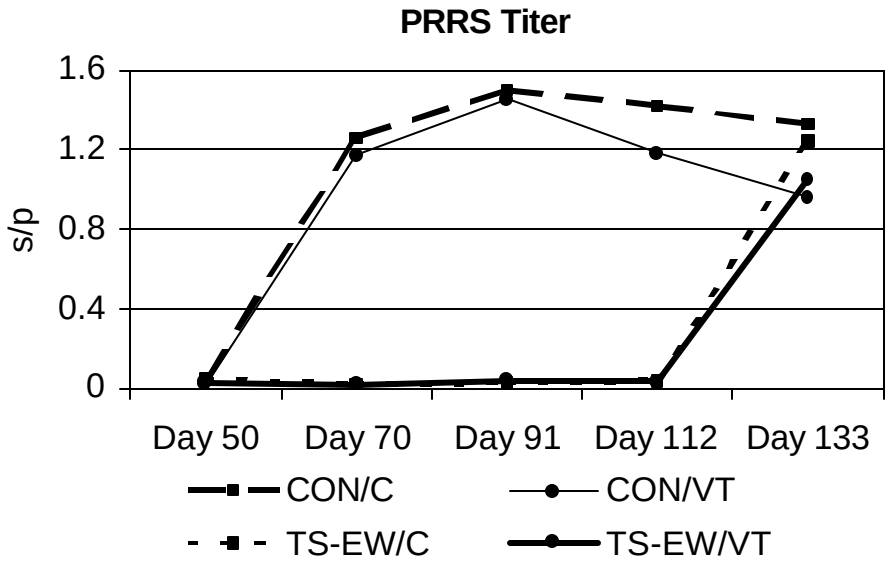

Figure 3. PRRS titer levels for the two health-status/environments and the two treatment regimes:
CON/C = Continuous Flow/Control;
CON/VT = Continuous Flow/Vaccinated and Tilmicosin;
TS-EW/C = Early Weaning 3-site/Control; and
TS-EW/VT = Early Weaning 3-site/Vaccinated and Tilmicosin (C.V.=73.0).
Pigs in the Continuous Flow environment had higher PRRS titer levels compared to the pigs in the Early Weaning 3-site facility (P<.001). Vaccinated and Tilmcosin treated pigs had lower titer levels than the Control pigs (P<.05).