The Interaction Between Pig Density and Dietary Energy on Performance and Returns

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SUMMARY

Dietary net energy and stocking density independently affect performance, feed utilization and profits in the finisher barn. The objective of this experiment was to assess the interactions of stocking density and dietary energy, and determine how these interactions affect net income. When stocking density was increased, the performance of finishing pigs was reduced; however the income over feed cost (IOFC) was maximized when pigs were stocked at higher densities. Furthermore, finishing pigs responded to increasing dietary energy by decreasing feed intake and improving growth rate, feed efficiency, caloric intake, caloric efficiency, and IOFC. However, the dietary energy which maximized performance and economics did not vary with stocking density. Thus producers should optimize both of these factors separately when determining optimal production.

INTRODUCTION

Stocking density and dietary net energy concentration independently affect performance and feed utilization of growing finishing pigs. There is limited information however, on whether the interaction of these two factors is important for optimizing performance and income. This information is vital to producers facing new requirements for the Canadian Code of Practice on stocking density.

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Reduced space allowance has negative effects on growth, and is usually a consequence of reduced nutrient intake. We hypothesized that the negative effects of crowding can be reduced by increasing dietary energy concentration, and that the optimal dietary energy concentration which maximizes net income will depend on stocking density. Pork producers will be able to improve their return on investment by better understanding the relationship between dietary energy and stocking density.

EXPERIMENTAL PROCEDURE

There was a total of 18 treatments arranged as a 2 x 3 x 3 factorial, which included gender (barrows and gilts), dietary energy (2.15, 2.3 and 2.45 Mcal NE/kg) and stocking density (14, 17 or 20 pigs/pen providing 0.92, 0.76 and 0.65 m^2 per pig, respectively). Each of the 18 treatments had three replications, using a total of 918 pigs (Camborough Plus dam x line 337 sire PIC Canada Ltd.; Winnipeg, MB).

Rooms were fully slatted, and consisted of 10 rectangular (4.8 x 2.7m) pens. Each pen contained two single space wet-dry feeders providing 0.22 m^2 of feeder space per pen, and the feeders were the only source of water.

"Overall there were no interactions between dietary energy concentration and stocking density."

Pigs were selected to ensure typical barn variation and were started on test at an average of 75 kg BW (range of 60 to 90 kg BW). They were marketed weekly when they reached a BW of 115 kg.

The diets used for this experiment are presented in Table 1. Four sets of diets, with three dietary energy levels within each diet, were used. Diet sets 1 through 3 were fed as the three phases for gilt and diets 2 through 4 were used as the 3 phases for barrows. All diets were formulated to meet or exceed nutrient requirements (NRC, 2012). Feed was available *ad libitum* but weighed daily when added to the feeder.

Space allowance was calculated by using an allometric equation k = A $\div$BW$^{\wedge.667}$, where "A" represents area (m^2), k is a space allowance coefficient, and BW$^{.667}$ is the metabolic body weight. The k-value of 0.0336 was used to define crowding (Table 2) which occurred at about 85 and 108 kg BW with 20 and 17 pigs per pen respectively.

Table 1. Ingredient and nutrient composition of the diets formulated to contain 2.15 and 2.45 Mcal of NE/kg fed to both genders in this experiment. The 2.30 concentration was the intermediate (as-fed basis)[1,2]

Diet Phase	1		2		3		4	
Gilts	75-90 kg		90-105 kg		90-105 kg			
Barrows			75-90 kg		105-118 kg		105-118 kg	
	Dietary Net Energy (Mcal/kg)							
Item	2.15	2.45	2.15	2.45	2.15	2.45	2.15	2.45
Barley	48.83	5.79	54.84	30.36	66.55	50.27	68.8	61.81
Wheat	-	50.06	-	28.66	-	18.64	2.94	15.00
Millrun wheat	20.00	20.00	20.00	20.00	14.41	15.00	5.00	10.00
Peas	18.97	18.66	14.47	15.00	7.70	10.0	6.65	7.33
Oat hulls	7.37	-	7.89	-	8.53	-	13.08	-
Canola meal	2.00	-	-	-	-	-	-	-
Limestone	0.91	1.08	0.86	0.99	0.83	0.95	0.70	0.88
Tallow	0.50	2.80	0.50	3.41	0.50	3.57	1.37	3.45
L-Tryptophan 98%	0.01	-	-	-	-	-	-	-
Lysine HCL 78%	0.19	0.32	0.21	0.30	0.26	0.31	0.25	0.30
L-Threonine 98%	0.08	0.12	0.09	0.12	0.10	0.12	0.10	0.11
DL-Methionine 98%	0.03	0.05	0.02	0.04	0.01	0.03	-	0.01
Calculated composition								
ME, Mcal/kg	2.95	3.24	2.93	3.24	2.91	3.22	2.90	3.21
SID lysine g/Mcal of NE	3.23	3.23	2.97	2.97	2.73	2.73	2.52	2.52
Ca, %	0.60	0.60	0.56	0.56	0.53	0.53	0.50	0.50
P, %	0.25	0.25	0.24	0.24	0.23	0.23	0.23	0.23

[1] All diets were formulated to meet requirements for pigs of each phase (NRC 2012)

[2] Contain the same amount of vitamin, mineral, choline, salt, and ronozyme (phytase)

RESULTS AND DISCUSSION

As dietary energy increased feed intake was reduced, caloric intake increased, growth rate was increased, and feed efficiency improved (Table 3). Stocking 14 pigs per pen did not improve pig performance when compared to the pen of 17, presumably due to minimal crowding in the pen of 17 (Table 3). However, feed intake and ADG were reduced when stocking density was increased to 20 pigs per pen.

Feeding the high energy diet reduced days to market (75 to 118 kg BW), and increased barn throughput by 1.6% (Table 4). Despite the improvement in feed efficiency, feed costs were 11% higher with the high energy diet. There was no effect of dietary energy on carcass margin per pig. The improvement in barn throughput resulted in a tendency for increased income over feed cost (IOFC) with the high energy diets.

On a per pig basis, the pen of 20 had the lowest feed cost per day, but required 1.6 more days to reach market weight (118 kg BW) and there was no difference in total feed cost to reach market weight. Barn throughput increased by 40% when stocking density increased from 14 to 20 pigs per pen. There was no effect of stocking density on carcass value. The increase in barn throughput and no difference in feed cost to reach market weight, resulted in stocking density being the most important factor in determining IOFC. As stocking density increased there was a linear improvement in IOFC (Table 4). There was no statistically significant interaction effect on IOFC because the response to dietary energy was similar across all stocking densities. However, there were numerical differences in the IOFC within stocking densities.

Table 2. Space allowance and k-value for each stocking density at various weights throughout the finishing period (75-118 kg BW, crowding defined as a k-value≤0.0336)

	Stocking Density		
	14	17	20
Area/pig (m^2)	0.93	0.76	0.65
BW (kg)		k-value	
75	0.0520	0.0428	0.0364
85	0.0478	0.0394	0.0335
108	0.0405	0.0334	0.0284
118	0.0384	0.0316	0.0269

Figure 1 shows the interaction effects on IOFC. Stocking density of 20 pigs per pen and feeding the 2.30 NE, Mcal/kg resulted in the highest IOFC. However, this increase in IOFC was only $70 (CDN) higher per pen than the pigs fed the high energy diet. Pigs housed 20 per pen and fed the low energy diet had an IOFC that was $700.00 lower per pen than the pigs fed the high energy diet. In the pens that housed 17 pigs, IOFC of the high energy diet was $472.00 and $319.00 more than the pens fed the low and medium energy diets, respectively. Increasing dietary energy for pigs housed 14 per pen resulted in no IOFC improvement; all pens had an IOFC within $40.00 of each other.

CONCLUSION

As space allowance decreased, a linear reduction in caloric intake and growth was observed. The restriction in nutrient intake resulted in the growth reduction, suggesting that if pigs were able to maintain a comparable caloric intake at higher stocking densities effects on growth would be reduced. Overall there were no interactions between dietary energy concentration and stocking density. A similar response to dietary energy at all stocking densities was observed. The negative effects of a high stocking density on performance were not mitigated by dietary energy. Increasing the stocking density linearly increased the IOFC per pen but there was not an interaction between dietary energy and stocking density. Therefore the dietary energy which maximized the IOFC did not differ with stocking density.

ACKNOWLEDGEMENTS

Funding for this project was provided by Gowans Feed Consulting and Agriculture and Agri-Food Canada through the Canadian Agriculture Adaptation Program administered by the Agriculture and Food Council of Alberta. Program funding provided by Saskatchewan Pork, Saskatchewan Ministry of Agriculture, Manitoba Pork Council, Alberta Pork, and Ontario Pork.

Table 3. Main effects of stocking density and dietary energy concentration on ADG, ADFI, G:F, caloric intake, and caloric efficiency from 75-118 kg BW [1,2,3]

	Stocking density Pigs per pen (NP)			Diet regimes Dietary NE (Mcal/Kg)				P-value[4]	
Item	14	17	20	Low	Medium	High	SEM	Stocking	NE
ADFI, kg[5]	4.00[a]	3.97[a]	3.82[b]	4.09[a]	3.92[b]	3.77[c]	0.08	<0.001	<0.001
ADG, kg[6]	1.21[a]	1.21[a]	1.17[b]	1.17[a]	1.21[b]	1.23[b]	0.03	0.05	0.005
G:F[7]	0.30	0.31	0.31	0.29[a]	0.31[b]	0.33[c]	0.004	0.61	<0.001
Caloric intake, Mcal/d[5]	9.19[a]	9.12[a]	8.12[b]	8.81[a]	9.02[b]	9.29[c]	0.17	<0.001	<0.001
Caloric efficiency, Mcal:Gain	7.59	7.52	7.52	7.54	7.49	7.59	0.09	0.69	0.63

[abc] Within a row and treatment, means without a common superscript differ (P<0.05)
[1] Data presented on an as fed basis
[2] Quadratic contrasts were not significant
[3] Dietary energy x stocking density (P > 0.10)
[4] P-values: stocking= stocking density, NE= dietary net energy
[5] Gender x stocking density (P < 0.10)
[6] Gender x dietary energy (P< 0.05)
[7] Gender x dietary energy (P< 0.10)

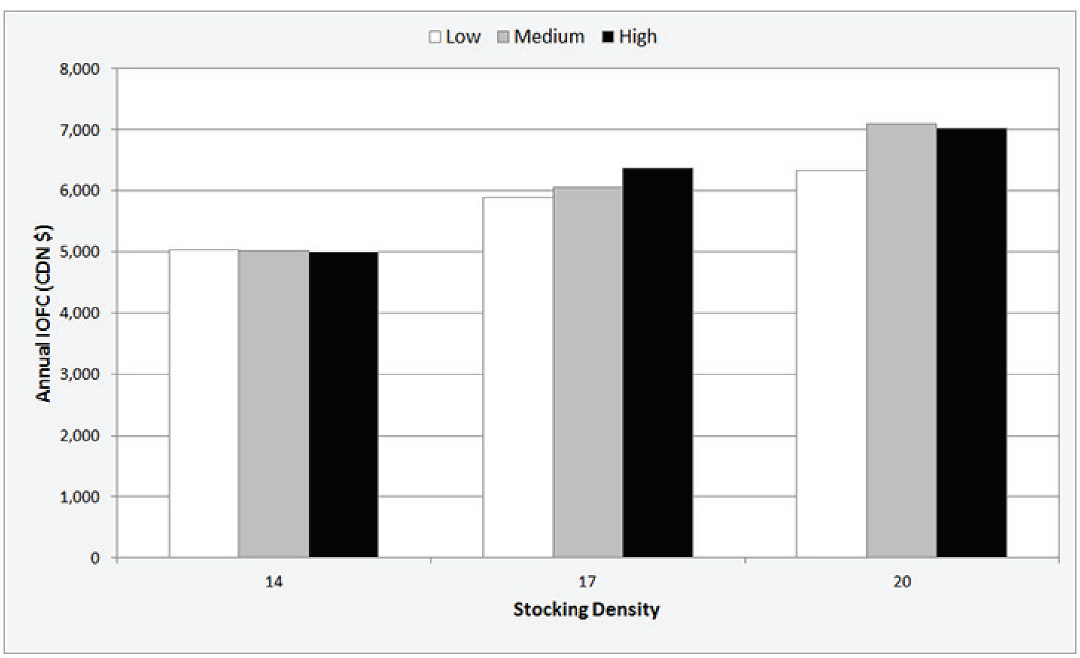

Figure 1. The interaction effect of dietary energy and stocking density effects on IOFC (CDN $) in pigs weighing 75 to 118 kg BW[1]
[1] Interaction was not significant (P>0.10)

Table 4. Main effects dietary energy concentration and pen density on barn throughput, carcass revenue, feed cost, and IOFC [1,2,3]

	Stocking density			Diet regimes				P-value[3]	
	Pigs per pen (NP)			Dietary NE (Mcal/Kg)					
Item	14	17	20	Low	Medium	High	SEM	Stocking	NE
Days to market[4]	35.4[a]	36.0[ab]	37.0[b]	36.9[a]	36.0[ab]	35.5[b]	1.3	0.03	0.06
Finisher rotations[5]	3.47[a]	3.45[ab]	3.41[b]	3.42[a]	3.45[ab]	3.47[b]	0.41	0.03	0.05
Barn throughput[6,7]	48.5[a]	58.6[b]	68.3[c]	58.0[a]	58.5[ab]	58.9[b]	0.7	<0.001	0.02
Carcass revenue/pig[8]	134.33	135.36	133.08	133.08[a]	134.35[ab]	136.10[b]	1.39	0.50	0.08
Feed cost/pig, CDN $[7]	30.66	30.91	30.71	29.85[a]	30.57[a]	31.86[b]	1.04	0.86	<0.001
Feed cost per kg gained, CDN $ [9,12]	0.73	0.72	0.72	0.70[a]	0.72[a]	0.75[b]	0.01	0.82	<0.001
Feed cost pig/d, CDN $[10,13]	0.87[a]	0.86[a]	0.83[b]	0.81[a]	0.85[b]	0.90[c]	0.02	0.002	<0.001
Feed cost/pen, CDN $[4]	429.48[a]	525.49[b]	614.14[b]	508.70[a]	520.31[a]	540.11[b]	16.76	<0.001	<0.001
Carcass margin/pig CDN $	103.40	104.19	102.89	102.98	103.50	104.01	1.58	0.67	0.78
IOFC CDN $[11,12]	5,012.50[a]	6,102.50[b]	7,015.90[c]	5,950.83	6,052.26	6,127.81	141.37	<0.001	0.22

[abc] Within a row and treatment, means without a common superscript differ (p<0.05)

[1] Dietary energy x stocking density (P > 0.10)

[2] Feed prices based on Saskatoon, SK 5 year average grain prices (2009-2013)

[3] P-values stocking= stocking density, NE= dietary net energy

[4] Days to market from 75-118 kg BW

[5] Finisher rotations= 365/(days to market +(70 day constant for all treatments 20-75 kg BW))

[6] Barn throughput= finisher rotations x pigs per/pen

[7] Value calculated from 75- market wt.

[8] Carcass revenue based on a 5 year average Saskatchewan carcass price (2009-2013)

[9] Feed cost per/kg gained = F:G x cost per tonne

[10] Feed cost per pig/d = ADFI x cost per tonne

[11] IOFC= annual income over feed cost based on carcass value and barn throughput (75-118 kg BW)

[12] Gender x Energy (P < 0.10)

[13] Gender x Energy (P < 0.05)