Feeder Space Availability and Dried Distillers Grains with Solubles Inclusion Level Interaction on Grow-finish Pig Performance and Total Tract Digestibility in a Commercial Setting

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Summary and Implications

Two studies were carried out on the same group of pigs within a commercial wean-finish system. For the nursery phase, a completely randomized design was used to compare 3 feeder space allowance treatments (2.1, 2.5, 2.9 cm/pig). Pigs (n = 3,720) were randomly allotted to same sex pens (10 feeders/ treatment) of 62 pigs/pen. Thirty 7-hole double sided feeders were utilized in the study. All pigs had equal floor space (0.85m²/pig). In the grow-finish phase, a total of 60 pens (n = 1,860 pigs; 31 pigs/pen) were utilized in a 2 x 3 factorial design with 3 feeder space allowances (4.1, 4.9, or 5.7 cm/pig) and 2 dietary DDGS treatments (D30 or D60). Fecal and diet samples were collected and analyzed to determine apparent total tract digestibility (ATTD %) and energy content. In the nursery portion of the trial, there was no effect of feeder space treatment on ADG, ADFI, or feed efficiency ($P > 0.05$) from weaning to d 56 post-weaning or during any weigh period. In the grow-finish portion of the trial, feeder space allowance and DDGS inclusion level did not affect ADG, ADFI, or feed efficiency ($P > 0.05$) from d 57 post-weaning to market. Pigs fed the D30 diet had greater HCW, percent yield, and loin depth than those on the D60 diet ($P < 0.05$). Pigs fed D30 DDGS treatment had greater ($P < 0.05$) ATTD for DM and GE for both collection periods compared to those on the D60 DDGS treatment. Energy content of the D30 diet was greater (P < 0.05) than the D60 diet during collection 1, but was lower (P < 0.05) for collection period 2. Neither feeder allowance nor DDGS inclusion level affected outcomes, but in the final phase indications of inadequate feeder space was observed.

Introduction

Providing animals with access to adequate, but not excessive, feeder space is an essential constituent of successful barn management, however, research on the impact of feeder space allowance is limited. Additionally, there are varying recommendations on the optimal DDGS inclusion rates that should be fed to pigs from weaning to market. Multiple studies suggest that DDGS can be fed at dietary concentrations up to 30% and serve as a satisfactory energy and protein source in growing-finishing pig diets.

However, the increased fiber content of DDGS makes including it in diets at a high inclusion challenging. Increased fiber content, especially when fed at aggressive levels, will impact nutrient digestibility in diets fed to grower-finisher pigs.

Therefore, the objective of this experiment was to determine the effect of feeder space allowance during the nursery phase on performance of pigs that were double stocked, and secondly, to determine the impact of feeder space allowance and DDGS inclusion level on pig performance and nutrient digestibility during the growing-finishing phase.

Materials and Methods

In a commercial wean-finish barn, a total of 3,720 crossbred pigs (16 d of age; 5.67 ± .12 kg) were allotted to a nursery experiment using a completely randomized design. Pigs were assigned to 1 of 3 feeder space treatments (2.1 cm, 2.5 cm, and 2.9 cm per pig), with 10 feeders per treatment. Initially, pigs were placed in groups of 180 animals and then divided into 3 weight categories: small, medium, and heavy. Twenty small, 22 medium, and 20 heavy pigs (half tagged and half not tagged) were randomly selected for placement in each experimental pen by sex. During the nursery phase, pens were double stocked with 62 pigs/pen. At d 56 post-weaning, all non-tagged pigs were removed to an offsite grow-finish barn. The remaining 1,860 pigs (31 pigs/pen) were utilized in a 2 x 3 factorial grow-finish study with 3 feeder space allowances (4.1 cm, 4.9 cm, and 5.7 cm per pig) and 2 dietary treatments (D30 and D60 DDGS). Pigs remained on test from d 57 post-weaning to market (d 153, 157, or 159 post-weaning). Intact pens were marketed when the mean pen BW was 122.6 ± 4.5 kg. Pigs had *ad libitum* access to feed and water for the duration of the study. Pigs per pen and floor space were constant for each pen in both the nursery and grow-finish phase.

A total of 30 double-sided feeders, with 7 spaces (60 pens) were used in this experiment. Feeders were modified with a galvanized steel cover to adjust feeder space and to provide feeder space treatments and were covered such that the same individual feeder spaces were inaccessible for all the feeders on the same treatment.

Pigs were fed according to an 8 phase feed budget regimen, and experimental diets were formulated to meet or exceed NRC (1998) requirements and were isocaloric within phase. For phases 5, 6, and 7 diets contained either approximately 30% (D30) or 60% (D60) DDGS. Phase 8 diets included 26% (D30) or 30% (D60) DDGS.

Complete pens (62 pigs) were weighed every 2 wks from weaning to d 56 post-weaning and complete pens (31 pigs) were weighed at each diet phase change from d 57 to the study conclusion. Pen weights within feeder were combined to calculate ADG. Daily gain was calculated on both a live and carcass weight basis to account for possible differences in gut fill from the higher fiber DDGS diet. Feed disappearance was measured at the time of weighing. Carcass measurements from one pen per feeder, including HCW, backfat, and loin depth were collected at the harvest facility.

Feed and fecal samples were oven dried, ground through a 1 mm screen, and analyzed for DM and GE digestibility, and diets for energy content (DE, ME, and NE).

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC), with feeder as the experimental unit. For the nursery phase, the fixed effects of feeder space treatment and sex were used in the model. For the grow-finish period and for ATTD, the model included feeder space treatment, diet treatment, and sex. The 2-way interactions for the fixed effects were tested, but dropped due to non-significance.

Results and Discussion

In the nursery study, feeder space allowance did not affect BW, ADG, ADFI, or G:F ($P > 0.05$) from weaning to d 56 post weaning or in any individual weigh period. During the grow-finish study, neither feeder space allowance nor DDGS inclusion affected overall (d 57 post-weaning to market) growth performance or feed intake ($P > 0.05$; Table 1). However, there was a trend for less feeder space to reduce market weight and ADG when expressed on a carcass weight basis ($P < 0.10$). Additionally, for approximately the last 30 d (96.1 – 122.6 kg) there was a linear decline in ADG ($P < 0.05$) and feed efficiency ($P < 0.01$) as feeder space declined. Feed intake was not affected by feeder space allowance during this time ($P > 0.05$). Feeders were adjusted at least 3 times each week to ensure at least one third but no more than one half of the trough was covered. This access to feed could explain the lack of ADFI response to feeder space. Increased feeder competition and animal energy expenditure are possible explanations for the decline in gain and efficiency with no change in feed intake.

There was no DDGS inclusion level impact on overall pig performance ($P > 0.05$; Table 1). However, during both feed intake periods 1 and 3, pigs on the D30 DDGS diet had a greater ADFI when compared to the pigs fed the D60 diet ($P < 0.05$). We observed no ADG ($P > 0.05$) differences during weigh periods 2 or 3. Although, at the end of weigh period 1 the pigs fed the D30 DDGS diet had increased ADG compared to the pigs on the D60 diet ($P > 0.05$). The differences in ADFI for weigh period 1 could be attributed to the higher fiber content of the D60 diet which would lead to increased intestinal fill and decreased appetite. Fiber is also known cause satiety. However, in weigh period 3 the energy of the D60 diet was greater than the D30 diet, so the difference in ADFI is possibly due to the pigs on the D60 diet needing to eat less feed to meet their energy needs. This is supported by there being no ADG response for this period.

There were no feeder space allowance treatment differences for HCW, backfat depth, or loin muscle depth ($P > 0.05$). Percent yield tended ($P < 0.10$) to linearly decline as feeder space allowance decreased, which was expected as there was a decline for market BW and HCW with decreasing feeder space allowance. Pigs fed the D30 DDGS dietary treatment had a heavier HCW and greater percent yield ($P < 0.05$) than those pigs fed the D60 DDGS diet. Due to the yield differences in the study, ADG and G:F were calculated on a carcass basis to mitigate any potential effects of increased intestinal gut fill providing a greater proportion of overall BW due to the fiber content of the D60 DDGS diet treatment. Dried distillers grains with solubles have roughly 3 times more NDF than corn, which is less digestible for pigs and potentially leads to greater gut fill and intestinal weights as it moves through the GIT. Pigs fed the D30 diet tended ($P < 0.10$) have a greater carcass ADG than those pigs fed the D60 dietary treatment, but there were no differences in efficiency ($P > 0.05$). There were no backfat differences ($P > 0.05$) between diet treatments. Although, increasing DDGS concentration in the diet decreased loin depth ($P < 0.05$).

There were no differences in DM and GE ATTD% or for dietary energy content of the diets for any of the 3 feeder space treatments ($P > 0.10$; Table 2). For both collections 1 and 2, the pigs fed the D30 DDGS treatment had a greater ATTD for DM and GE ($P < 0.05$; Table 2) than the pigs fed the D60 DDGS treatment. It is likely that reduced digestibility of the D60 diet was due to the higher fiber content as pigs are not able to digest fiber efficiently. Additionally, fiber becomes viscous in the GIT and can bind other nutrients which does not allow for their digestion and utilization.

For collection period 1, energy values (DE, ME, and NE) for the D30 DDGS diet were greater ($P < 0.05$; Table 2) than for the D60 DDGS diet. The DE differences between the low vs. high dietary treatments could be related to the ADF, fat, and starch content. As expected, the D30 DDGS diet had less ADF (4.65%) and more starch (30.75%) when compared with the D60 DDGS diet (7.56 and 14.72%, respectively); however it also had a lower fat content. During collection period 2, the energy content was greater ($P < 0.05$) for the D60 DDGS diet when compared to the D30 DDGS treatment. These results suggest that as pigs got older and BW increased they were able to digest dietary fiber more efficiently, and that passage rate through the intestine slowed as it had become longer as well. The analyzed ME values were less than the formulated values for the diets fed during collection period 1, but the values were greater for diets fed during collection period 2. For collection period 2, the calculated energy content of the diet was greater for the high DDGS treatment than the low (Table 2). The GE for the D60 DDGS diet was greater than for the D30 DDGS diet (4,793.95 and 4474.51 kcal/kg as fed respectively). Additionally, fat content of the D60 DDGS diet was greater than for the D30 DDGS diet (15.99 and 11.41% as fed, respectively). This suggests that the energy content of the DDGS was possibly underestimated during this period, and that the additional CWG added to make the diets isocaloric was overestimated.

Feeder space allowance did not impact BW or daily gain until pigs reached approximately 122 kg, but ADFI was not affected during any phase. Care has to be taken in applying these results to broader commercial conditions as factors such as feeder adjustment or greater ending BW could result in different performance outcomes. The high DDGS level did not decrease overall pig performance. The DM and energy digestibility was reduced during both collection periods for the pigs fed the high DDGS diet. This reduction is due to the higher amount of dietary fiber present in the diet.

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Table 1. Overall grow-finish performance and least squares means by feeder space, diet, and gender in a study investigating the effects of feeder space allowance and dietary DDGS inclusion rate on pig performance.[1]

	Feeder Space, cm/pig					Diet			
	4.1	4.9	5.7	SEM	*P*-value	D30[2]	D60[2]	SEM	*P*-value
No. of feeders	10	10	10			15	15		
No. of pigs/pen	31	31	31			31	31		
BW, kg									
d 0	29.9	29.8	29.8	0.298	0.98	30.3[a]	29.3[b]	0.245	0.005
Market	121.5	122.2	122.9[a]	0.502	0.07	122.4	121.9	0.451	0.41
CV, %									
d 61	18.3	17.9	17.2	0.731	0.57	18.0	17.6	0.649	0.72
d 152	11.1	11.0	9.8	0.552	0.21	10.9	10.5	0.327	0.59
ADG, kg	0.91	0.91	0.92	0.008	0.46	0.91	0.92	0.008	0.59
ADG carcass,	0.69	0.70	0.71	0.006	0.08	0.71	0.69	0.005	0.07
ADFI, kg	2.06	2.04	2.04	0.023	0.83	2.07	2.03	0.021	0.21
G:F[4]	0.44	0.45	0.45	0.005	0.34	0.44	0.45	0.005	0.11
G:F[5]	0.34	0.34	0.35	0.004	0.11	0.34	0.34	0.004	0.91

[ab]Within a row and main effect, means without a common superscript differ ($P < 0.05$).

[1]Final pig weight was used as a covariate for all models.

[2]Treatment diet labels. Labeled by approximate amount of DDGS in the diet during phases 5, 6, and 7.

[3]Feeders had a pen of barrows on one side and a pen of gilts on the opposite side.

[4]Gain:feed calculated using live ADG.

[5]Gain:feed calculated using carcass ADG.

Table 2. Effect of feeder space allowance, dietary DDGS inclusion rate, and gender on the apparent total tract digestibility (ATTD) of DM and energy in a commercial environment.[1,2]

	Feeder Space, cm/pig					Diet			
	4.1	4.9	5.7	SEM	*P*-value	D30[3]	D60[3]	SEM	*P*-value
No. of feeders	10	10	10			15	15		
No. of pigs/pen	31	31	31						
d 92-94									
ATTD, %[5]									
Dry matter	74.3	74.9	75.0	0.274	0.18	79.8[a]	69.7[b]	0.269	< .0001
Gross energy	75.6	76.0	76.1	0.248	0.29	79.8[a]	72.0[b]	0.243	< .0001
Energy Content , Mcal/kg									
GE	4.69	4.69	4.70	0.009	0.96	4.70	4.69	0.009	0.39
DE[6]	3.42	3.44	3.45	0.011	0.31	3.52[a]	3.36[b]	0.011	< .0001
ME[7]	3.26	3.28	3.28	0.011	0.31	3.36[a]	3.18[b]	0.011	< .0001
NE[8]	2.40	2.41	2.42	0.008	0.32	2.47[a]	2.35[b]	0.008	< .0001
d 115-118									
ATTD, %[5]									
Dry Matter	79.6	79.0	79.5	0.311	0.37	81.2[a]	77.5[b]	0.296	< .0001
Gross energy	80.5	80.0	80.5	0.296	0.35	81.2[a]	79.4[b]	0.282	0.001
Energy Content, Mcal/kg									
GE	4.66	4.66	4.69	0.008	0.80	4.62[b]	4.69[a]	0.008	< .0001
DE[6]	3.73	3.71	3.73	0.014	0.35	3.63[b]	3.81[a]	0.013	< .0001
ME[7]	3.57	3.55	3.57	0.013	0.35	3.50[b]	3.63[a]	0.013	< .0001
NE[8]	2.62	2.61	2.62	0.010	0.35	2.56[b]	2.67[a]	0.009	< .0001

[ab]Within a row and main effect, means without a common superscript differ ($P < 0.05$).

[1]Fecal grab samples were collected from each pen per feeder and then homogenized by feeder for each dietary DDGS

[2]Pig weight from the weigh period prior to collection period was used as a covariate for all models.

[3]Treatment diet labels. Labeled by approximate amount of DDGS in the diet during phases 5, 6, and 7.

[4]Feeders had a pen of barrows on one side and a pen of gilts on the opposite side.

[5]Calculated using the equation by Oresanya et al., 2007: DM or Nutrient ATTD Coefficient (%) =

100% - {[Diet Index Marker Concentration / Feces Index Marker Concentration) x (Feces Nutrient Concentration / Diet Nutrient Concentration

[6]Determined digestible energy concentration.

[7]Calculated using the equation by Noblet and Perez, 1993: ME (Mcal/kg) = DE x [1.003 - (0.0021 x %CP)].

[8]Calculated using the equation by Noblet et. al., 1994: NE (Mcal/kg) = 0.700 x DE + 1.61 x ether extract + 0.48 x starch - .091 x %CP - 0.87 x ADF.