PROJECT – PRELIMINARY DATA:

NUTRITIONAL APPROACHES TO REDUCE GROWTH RATES AND FEED INTAKE IN FINISHING PIGS

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THE RATIONALE

Typically, producers aim to optimize grow-finish pig growth rates and feed intakes to maximize pig performance and profitability. However, sometimes there is a need to slow growth rates and/or reduce feed intake to conserve feed. These situations could occur in response to feed supply interruptions for an extended period of time, when the movement of animals to market is delayed or impaired due to an animal movement standstill, such as could occur during a suspected outbreak of a FAD, or in situations when access to harvest facilities is temporarily suspended or delayed. Numerous dietary strategies could be implemented to slow growth rates and feed intake of finisher pigs. However, little controlled study data are available to producers to aid them in making decisions on what would be the best strategy to slow pig growth down in a manner that is in accordance with optimal animal welfare. In response to this, the following study is being conducted and is currently ongoing.

THE OBJECTIVES

The objective of this project is to evaluate dietary formulations to slow pig growth rates and reduce feed intake. To develop a strategy to reduce feed or nutrient intake, we must reverse our thinking. Normally we try to maximize feed and nutrient intake, as this is the way to maximize barn throughput; now, we must think of the practices we normally try to avoid when maximizing feed intake and actually employ them in our barns when we want to conserve feed and slow animal growth.

Disclaimer: The data presented in this document represent potential strategies that could be employed to influence feed intake and growth in unique situations. Producers need to ensure that any production practice utilized maintains their ability to follow production standards, guidelines, laws, etc. to which they are subject and/or governed by and in particular maintain animal well-being.

METHODOLOGY

All procedures were reviewed and approved by the Iowa State University Institutional Animal Care and Use Committee (IACUC# 20-057). The project is being conducted at the Iowa State University Swine Nutrition Farm, Ames, IA.

Forty-six barrows and gilts (166±13.5 lbs BW; Camborough (1050) X 337) were blocked by body weight and sex, and assigned to 1 of 8 dietary treatments (n=5-6 pigs/trt). The dietary treatments included:

1. Control diet (**CON**)
2. 15% Neutral detergent fiber (**15% NDF**)
3. 20% Neutral detergent fiber (**20% NDF**)
4. 25% Neutral detergent fiber (**25% NDF**)
5. No Soybean meal (**97% Corn**)
6. Half soybean meal of #1 (**89% Corn**)
7. Calcium chloride 4% (**4% CaCl**)
8. Calcium chloride 2% (**2% CaCl**)

The eight dietary treatments are described in Table 1a and 1b. The CON diet was formulated as a straight corn-soybean meal diet that met or exceeded NRC (2012) nutrient requirements for this size pigs and is consistent with a commercial production diet. To examine the effect of NDF on growth and feed intake, NDF was increased by increasing the inclusion rate of soy hulls (12.5-33.2% of diet in diets 2-4, respectively). Amino acids were kept the same as the CON, but dietary ME was reduced by 5.4, 9.6 and 14.5%, in diets #2-4, respectively. In other words, dietary energy was allowed to float downwards at dietary fiber increased. Diets #5 and #6 utilized the formulation approach of reducing amino acids by the complete or 50% removal of soybean meal from the CON diet formulation and adding this quantity back as corn. Thus, diet #5 was a 97% corn diet and #6 consisted of a 89% corn diet. In both these diets, ME, vitamins, and minerals were formulated to be the same as the CON diet. Diet #7 and #8 explored the effects of calcium chloride on growth and appetite. These two diets were formulated to contain 4% and 2% calcium chloride, respectively. This resulted in a 6- and 3-fold increase in chloride, respectively from the CON diet. Calcium chloride is an acidogenic salt and is known to reduce feed intake.

All pigs were individually penned in 8 ft x 6 ft partially slatted concrete pens, *ad libitum* fed and had free access to water at all times. Pig body weights and feed disappeared were recorded weekly and feed efficiency (G:F and F:G) calculated.

The SAS program was used for the statistical analysis of all data (SAS Institute Inc., Cary, NC). Pen was considered the experimental unit and block used as a random effect. Least square means of treatment (diet) were determined using the LS means statement and differences in LS means were produced using the pdiff option. All data are reported as LS means with a pooled SEM. Differences were considered significant when $P \leq 0.05$ and a tendency when $P \leq 0.10$.

Table 1a. Diet ingredient, as fed

Ingredients (%)	CON	15% NDF	20% NDF	25% NDF	97% corn	89% corn	4% CaCl2	2% CaCl2
Corn	80.98	69.75	60.42	51.69	97.13	89.06	75.59	78.29
Soybean hulls	0.00	12.50	22.42	32.33	0.00	0.00	0.00	0.00
Soybean meal (47% CP)	16.03	14.92	14.43	13.30	0.00	8.02	16.41	16.22
L-lysine HCl	0.25	0.25	0.24	0.25	0.00	0.13	0.25	0.25
DL-methionine	0.01	0.03	0.04	0.06	0.00	0.01	0.02	0.02
L-threonine	0.06	0.06	0.07	0.08	0.00	0.03	0.06	0.06
L-tryptophan	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.01
Soybean oil	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix[1]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Trace mineral premix[2]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Limestone	1.16	1.01	0.87	0.73	1.23	1.20	0.31	0.74
Monocalcium phosphate, 21%	0.13	0.11	0.14	0.18	0.27	0.20	0.00	0.07
Monosodium phosphate[3]	0.00	0.00	0.00	0.00	0.00	0.00	2.30	1.15
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.20	0.35
Anhydrous Calcium Chloride[3]	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00
Optiphos 5000 (500 FTU/kg)[4]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[1]Provided per kilogram of diet: 6,125 IU vitamin A, 700 IU vitamin D_3, 50 IU vitamin E, 30 mg vitamin K, 0.05 mg vitamin B_{12}, 11 mg riboflavin, 56 mg niacin, and 27 mg pantothenic acid.

[2]Provided per kilogram of diet: 22 mg Cu (as $CuSO_4$), 220 mg Fe (as $FeSO_4$), 0.4 mg I (as $Ca(IO_3)_2$), 52 mg Mn (as $MnSO_4$), 220 mg Zn (as $ZnSO_4$), and 0.4 mg Se (as Na_2SeO_3).

[3]Nutra Blend, Neosho, MO

[4]Huvepharma, Peachtree City, GA

Table 1b. Diet energy and nutrient composition, calculated

Ingredients (%)	CON	15% NDF	20% NDF	25% NDF	97% corn	89% corn	4% CaCl2	2% CaCl2
DE, Mcal/kg	3.42	3.24	3.10	2.96	3.40	3.41	3.25	3.34
ME, Mcal/kg	3.32	3.14	3.00	2.86	3.34	3.33	3.15	3.24
NE, Mcal/kg	2.54	2.34	2.18	2.02	2.63	2.59	2.40	2.47
Crude protein, %	14.33	14.16	14.18	13.94	8.00	11.17	14.07	14.20
Ether extract, %	3.56	3.32	3.11	2.92	3.88	3.72	3.38	3.47
NDF, %	8.69	15.00	20.00	25.00	8.85	8.77	8.23	8.46
ADF, %	3.18	7.99	11.82	15.62	2.80	2.99	3.04	3.11
SID LYS, %	0.77	0.77	0.77	0.77	0.18	0.48	0.77	0.77
SID MET, %	0.23	0.23	0.24	0.24	0.15	0.19	0.23	0.23
SID CYS+MET, %	0.44	0.44	0.44	0.44	0.29	0.37	0.44	0.44
SID TSAA:Lys	0.58	0.57	0.57	0.57	1.63	1.11	0.57	0.58
SID THR, %	0.48	0.48	0.48	0.48	0.21	0.35	0.48	0.48
SID Thr:Lys	0.63	0.62	0.62	0.62	1.17	0.90	0.62	0.63
SID TRP, %	0.14	0.14	0.14	0.14	0.05	0.10	0.14	0.14
SID Trp:Lys	0.18	0.18	0.18	0.18	0.26	0.22	0.18	0.18
Ca, %	0.54	0.54	0.54	0.54	0.54	0.54	1.55	1.05
P Total, %	0.49	0.48	0.47	0.46	0.47	0.48	1.02	0.76
STTD P, %	0.27	0.27	0.27	0.27	0.27	0.27	0.78	0.52
Ca:STTD P	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Na, %	0.23	0.22	0.22	0.22	0.22	0.23	0.55	0.39
K, %	0.39	0.36	0.34	0.32	0.30	0.21	0.39	0.39
Mg, %	0.16	0.14	0.13	0.11	0.14	0.15	0.14	0.15
Cl, %	0.41	0.40	0.40	0.39	0.34	0.38	2.64	1.53
S, %	0.16	0.16	0.17	0.17	0.11	0.14	0.16	0.16
Dietary undetermined anion, mEq/kg	172.8	150.9	136.0	120.9	100.9	137.6	-137.6	15.8

PRELIMINARY RESULTS

CAUTION- This is an ongoing study and these results represent the first three weeks of data collection. Results may vary as additional data are being collected in coming weeks.

Normally we try to maximize feed and nutrient intake to support maximal lean accretion in growing pigs by composing diets based on requirement needs and palatability. However, unique situations may arise when grow-finish pig growth and feed intake needs to be attenuated. Due to the lack of public data available to producers to help make decisions towards attenuating pig performance in a control and animal welfare considerate manner, this projects aims to evaluate different dietary formulation considerations in control pig growth and feed intake. Three key approaches are being examined. First, increasing the NDF content of the diets from ~10-25% (treatments #2-4). Second, reducing dietary essential amino acid concentrations (treatments #5 and #6). Third, increasing the ionic concentration of diets (treatments #7 and #8).

After 21 days of feeding pigs their respective diets, pig body weights and delta body weight changes are reported in Table 2 and Figure 1, respectively. These data indicate that the 97% corn and 4% CaCl2 treatments attenuated body weight gains over time compared to the control within week 1, 2 and 3. Over the first 21 days of the study, diets within each strategy were able to attenuate growth performance from the CON treatment (Table 3 and 4). Increasing the soy hull content of the diet (15% and 25% NDF) decreased ADG over the first week on test. Only the 25% NDF diet reduced ADFI in pigs compared to the CON pigs. After 14 and 21 days on test, the ability of increased NDF to reduce growth substantially waned. In the second strategy, soybean meal was replaced with corn. This resulted in dietary amino acids being lower than requirement for optimal lean growth. Consequently, the 97% corn diet significantly reduced ADG at 7, 14, and 21 days, and ADG was reduced 60% compared to CON pigs over the 21 day test period (Tables 2 and 3). The 88% corn diet was intermediate and growth rates were only reduced 21% compared to CON pigs over 21 days. These two corn diets had similar ADFI compared to the CON pigs, and numerically pigs on the 88% corn diet consistently consumed more feed than CON pigs. The final strategy assessed the use of anhydrous calcium chloride. This type of calcium chloride salt can be added to the diet to reduce feed intake by altering the dietary undetermined anion concentration of the feed. However, prolonged use of anhydrous calcium chloride may have negative health and meat quality effects. Therefore, concentration and duration needs to be carefully considered when using. In the present study, anhydrous calcium chloride added at 4% and 2%,decreased dietary undetermined anion concentrations compared to the CON diet (-138, 15.8, and 173 mEq/kg, respectively; Table 1b). As a result, both these diets significantly reduced ADFI and ADG compared to the CON pigs over first 7 days, with ADG being reduced by 113% and 42%, respectively. However, at day 14 and 21 only the 4% calcium chloride diet continued to significantly reduce ADG, with reductions of 75% at day 14 and 73% at day 21. Over the entire 21 day test period, the 4% calcium chloride diet significantly reduced growth by 86% compared to CON pigs.

Caution must be taken with these data as it only represents 21 days on diet and small numbers of pigs per treatment with high individual variation. Pigs may metabolically adapt to their respective diets over time. We will be sharing this data set over the next 2 weeks.

Table 2. Pig body weight changes

	Diet									
	CON	15% NDF	20% NDF	25% NDF	97% corn	89% corn	4% CaCl2	2% CaCl2	SEM	*P*-value
BW Day 0, lbs	164.4	159.1	162.0	166.3	162.4	174.5	171.5	167.4	5.42	0.156
BW Day 7, lbs	184.4	170.1*	178.9	178.4	167.5*	187.9	169.0*	178.8	7.35	0.102
BW Day 14, lbs	203.9	190.7	193.2	195.5	177.7*	206.1	173.9*	196.3	13.65	0.002
BW Day 21, lbs	224.8	204.8	213.7	213.2	186.8*	222.0	179.6*	213.5	14.73	<0.001

*denotes treatments that differ significantly from CON (*P*<0.05)
Pigs blocked by Day 0 BW, used as a random effect in statistical model
n=5-6 pigs/trt, mix of barrows and gilts

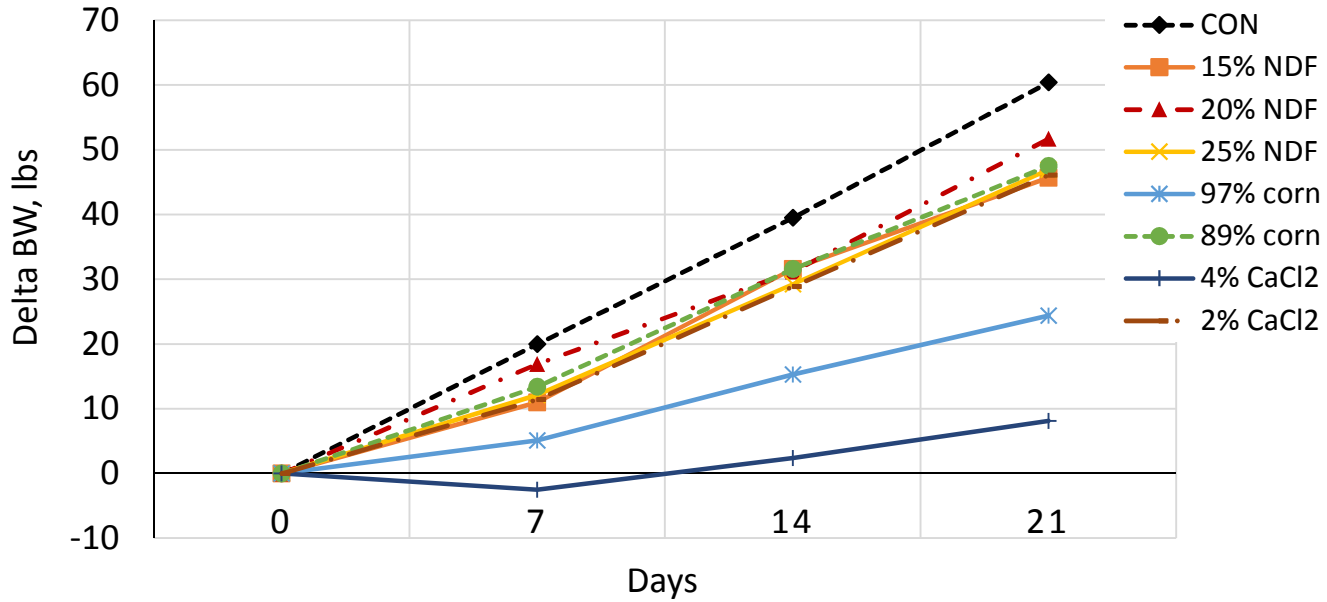

Figure 1. Delta body weight changes over time

Table 3. Day 0-21 performance data

	Diet								
	CON	15% NDF	20% NDF	25% NDF	97% corn	89% corn	4% CaCl2	2% CaCl2	SEM	*P*-value
Day 0-7										
ADG, lbs	2.85	1.57*	2.40	1.72*	0.73*	1.91	-0.37*	1.66*	0.558	<0.001
ADFI, lbs	6.72	6.18	6.33	5.55*	6.17	7.14	3.90*	6.00	0.532	<0.001
G:F	0.42	0.23	0.38	0.31	0.15*	0.26	-0.13*	0.28	0.071	<0.001
FCR	2.44	5.92	3.11	3.93	9.45	4.16	71.42	4.72	26.05	0.563
Day 8-14										
ADG, lbs	2.77	2.97	2.07	2.43	1.43*	2.61	0.70*	2.51	0.372	<0.001
ADFI, lbs	7.27	6.25	7.45	6.88	6.15	7.43	3.63*	6.75	0.575	<0.001
G:F	0.39	0.49	0.28	0.37	0.24	0.35	0.16*	0.36	0.056	0.003
FCR	2.74	2.12	0.39	2.98	4.56	3.11	3.73	2.91	1.511	0.608
Day 15-21										
ADG, lbs	2.99	2.02	2.92	2.54	1.30*	2.33	0.82*	2.50	0.347	<0.001
ADFI, lbs	7.93	6.47	7.55	7.26	6.12	8.25	3.50*	7.10	0.590	<0.001
G:F	0.38	0.32	0.38	0.36	0.20	0.29	0.19*	0.35	0.059	0.019
FCR	2.74	3.34	3.06	2.92	5.24	3.70	3.78	3.08	1.328	0.854
Day 0-21										
ADG, lbs	2.87	2.18	2.46	2.23	1.16*	2.27	0.39*	2.20	0.241	<0.001
ADFI, lbs	7.31	6.29	7.11	6.57	6.15	7.61	3.67*	6.62	0.496	<0.001
G:F	0.39	0.35	0.35	0.35	0.19*	0.30	0.07*	0.33	0.042	<0.001
FCR	2.55	2.98	2.94	2.99	5.66	3.30	2.62	2.99	1.140	0.456

*denotes treatments that differ significantly from CON (*P*<0.05)
Pigs blocked by Day 0 BW, used as a random effect in statistical model
n=5-6 pigs/trt, mix of barrows and gilts

Table 4. Pig performance data expressed as a percentage decrease from the control (CON) dietary treatment (day 0-21)

	Diet							
	CON	**15% NDF**	**20% NDF**	**25% NDF**	**97% corn**	**89% corn**	**4% CaCl2**	**2% CaCl2**
BW Day 7, lbs	100%	-8%	-3%	-3%	-9%	+2%	-8%	-3%
BW Day 14, lbs	100%	-6%	-5%	-4%	-13%	+1%	-15%	-4%
BW Day 21, lbs	100%	-9%	-5%	-5%	-17%	-1%	-20%	-5%
Day 0-7								
ADG, lbs	100%	-45%	-16%	-40%	-74%	-33%	-113%	-42%
ADFI, lbs	100%	-8%	-6%	-17%	-8%	+6%	-42%	-11%
Day 8-14								
ADG, lbs	100%	+7%	-25%	-12%	-48%	-6%	-75%	-9%
ADFI, lbs	100%	-14%	+2%	-5%	-15%	+2%	-50%	-7%
Day 15-21								
ADG, lbs	100%	-2%	-2%	-15%	-57%	-22%	-73%	-16%
ADFI, lbs	100%	-18%	-5%	-8%	-23%	+4%	-56%	-10%
Day 0-21								
ADG, lbs	100%	-24%	-14%	-22%	-60%	-21%	-86%	-23%
ADFI, lbs	100%	-14%	-3%	-10%	-16%	+4%	-50%	-9%