Valuing Dried Distillers Grains with Solubles for Use in Swine Diets

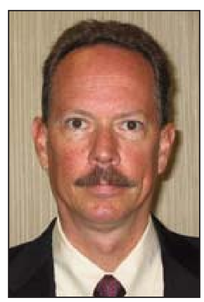
By Todd Hubbs, Bhawna Bista, Paul V. Preckel and Brian Richert

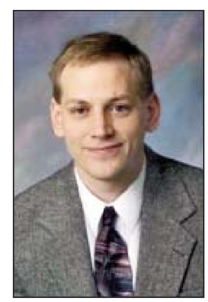
Abstract

The emergence of Dried Distillers Grains with Solubles (DDGS) as a viable feedstuff for swine producers coincides with escalating feedstuff prices, increased DDGS production and changes in processing resulting in increases in available nutrients in DDGS. Evaluation of the nutritional and market characteristics of DDGS is useful for both ethanol and swine producers in establishing the value of this co-product of ethanol production. This paper uses a minimum-cost feed formulation linear programming model to determine the value of DDGS in swine diets.

The ethanol industry in the United States is going through a period of extreme volatility. Government policy has helped to stimulate an increase in the production of biofuels increasing the fraction of corn production moving into the ethanol manufacturing process. Major corn production areas of the United States are well positioned to take advantage of this opportunity. However, the use of corn for ethanol production is in direct competition with the use of corn as a livestock feed ingredient. By using Dried Distillers Grains with Solubles (DDGS) as an ingredient in feed rations, livestock producers may be able to reduce feed costs. In response to this potential, a market has emerged for DDGS.

As the ethanol industry matures and changes over time, the need to better understand the value of the co-product DDGS becomes crucial to the sustained development of the industry. The livestock situation in some areas provides a different challenge. Many studies have shown cattle feeding operations can feed distillers grains while maintaining animal performance. However, in many locations, the lack of large cattle operations combined with numerous hog production facilities leaves hog producers as the most likely major users of DDGS as a feed ingredient.



Todd Hubbs is a doctoral student in Agricultural Economics at Purdue University with a focus on agricultural production and finance. He is currently a U.S.D.A. Needs Fellow.

Professor Preckel researches and teaches in the areas of decision analysis and mathematical modeling. He has had extensive experience in developing applications and methods over a wide range of subject matter areas. He became the Faculty Director of Indiana's State Utility Forecasting Group in February 2007.

Bhawna Bista completed her M.S. degree in Agricultural Economics on May 2005 at Purdue University with a focus on Environment and Natural Resource Economics. She is currently completing her Ph.D. with Environment and Natural Resource as well as International Development and Policy as her specialization. Her current research is focused on the impact of biofuels production on agricultural economies.

Dr. Brian Richert is an Associate Professor and Swine Extension Specialist in the Department of Animal Sciences at Purdue University with a focus on nutrition and management issues related to the swine industry.

DDGS as a Feed Ingredient for Swine

Several factors limit the use of DDGS as a swine feed ingredient. First, the variation in nutrient content from one ethanol plant to the next is high. Due to different drying processes for DDGS, varying production processes for ethanol and variation in the amount of solubles added to the product, nutrient availability is far from certain on any given batch produced from different ethanol facilities. In particular, the drying process can produce heat damage which reduces the availability of key amino acids. Secondly, the economics of transporting DDGS to producers is complicated by difficulties associated with moving the product in bins and railcars (Lemenager et al.). Finally, the high oil content of DDGS has been shown to have negative impacts on carcass quality, leading to pork bellies with high concentrations of soft fat. This has led to recommendations to either limit inclusion levels to less than 20 percent, remove DDGS from the ration at least three weeks before marketing or the inclusion of conjugated linoleic acid in diets with high inclusion rates of DDGS (Latour and Schinckel). While these issues represent challenges for using DDGS as a feed ingredient for swine, economic conditions that include high prices of commonly used alternative ingredients can make DDGS an economically viable swine feed ingredient. Most major feed ingredient prices increased in late 2007 to early 2008 with DDGS being no exception. As shown in Figure 1, DDGS market prices converged with corn on a per pound basis in 2007 (Livestock Marketing Information Center). Understanding the intrinsic value of DDGS as a swine feed ration ingredient is necessary for hog producers to understand when the byproduct is priced attractively.

Background

Much of the least-cost swine diet research has been performed by animal scientists and swine industry professionals. Nutrient requirements of swine are often based on the National Research Council's *Nutrient Requirements for Swine* (National Research Council Subcommittee on Swine Nutrition). This handbook is a compendium of various limiting nutrient levels for different growth periods of swine as well as the nutrient contents of feed ingredients. It provides the fundamental data necessary for evaluating the impact of DDGS on swine diets.

Research into the nutrient availability for DDGS is found in the leading animal science journals. One study conducted tests on the amino acid and energy digestibility of DDGS fed to finishing pigs and found high levels of variability in the levels of digestible lysine availability from ten separate ethanol plant samples (Stein et al.). Since most swine diets are formulated on an apparent digestible lysine basis, this variability has a substantial impact on the value of DDGS as a swine feed ingredient. Whitney et al. (2006) conducted a study on growth performance and carcass characteristics of grower-finisher pigs fed DDGS from one Midwestern ethanol plant. The findings led to a recommendation to limit the inclusion level for DDGS to 20 percent in swine diets to minimize effects on carcass characteristics. This particular recommendation falls in line with other recommendations. A nutrient study conducted on Minnesota and South Dakota produced DDGS reported higher levels of nutrient availability from the DDGS produced in those states relative to previous reports from around the Midwest (Speihs et al.).

Currently, the value of DDGS to hog producers is not fully understood. By comparing the nutritional content of DDGS with alternative major feed ingredients, an understanding of the value of DDGS is developed in this study that will benefit livestock producers and ethanol plant managers. The nature of the value of DDGS in this study is derived from the value of the feed ingredients it displaces, holding nutrient requirements constant.

Data and Methodology

Linear programming is the industry standard method for developing least-cost feed rations for livestock diets. This approach allows the derivation of feed input mixes which provide the necessary proportions of alternative ingredients that meet nutrient levels required for proper animal growth (Paris, 1991). In order to implement the linear program, it is necessary to specify the nutrient requirements for the specific stage of swine growth for which the feed is to be formulated. These requirements include the minimum and maximum levels of protein, amino acids and other nutrients necessary for healthy swine. In addition, the nutrient contents and their availability in each of the feed ingredients, including DDGS, are required. To allow the assessment of the cost of the feed ration, prices for the feed ingredients are also needed. Given these data, a least cost diet for the specific growth stage can be determined with the linear programming model.

Nutrient requirements for the swine diet formulation are based on apparent digestible lysine levels with the other essential amino acid contents specified as a percentage of digestible lysine. The levels of these amino acids are shown in Table 1 for the various growth stages (NRC). Lysine requirements decrease gradually throughout the growth periods. However, an increase in the lysine requirement occurs in the finisher stage containing the lean-tissue developing additive Paylean due to the added amino acid requirements necessary while using the product. Methionine-cystine and threonine increase incrementally for each successive grower-finisher stage and end at 62 and 64 percent of the lysine level, respectively. In addition to amino acid constraints, various other nutrient components are used to formulate the swine diets in our linear program (see Table 2 for a listing of the essential nutrients). Acceptable nutrient levels vary across growth stages. Minimum and maximum inclusion levels were derived from the Tri-State Swine Nutrition Guide.

The prices for major feed ingredients are taken from the ingredients section of Feedstuffs trade publication for the Chicago market (Feedstuffs). Synthetic amino acid prices were obtained from North American Nutrition Companies, Inc. (Akey's) during February of 2008.

The solution to this linear programming problem provides the cost minimizing swine diet which satisfies the nutrient requirements. This diet specifies the amount of each feed ingredient in the diet, including the DDGS inclusion rate. In addition to finding the appropriate inclusion level for each feed ingredient, the marginal values computed in the model provide the values of the nutrients in the diet. A modified version of this model can be specified in which the inclusion rate for DDGS is set at a fixed level. If the price of DDGS is artificially set at zero, then the shadow value on the constraint that fixes the DDGS inclusion level provides the marginal economic value of DDGS to the swine producer, specific to that stage of growth. The shadow value is the amount one would be willing to pay for an additional unit of DDGS added to the diet at the chosen inclusion level. An instance of this model is displayed in Appendix A.

The list of feed ingredients available in the model and the corresponding prices used in calculating the base cost minimizing swine diet are reported in Table 3. As these prices vary different inclusion levels for the specified DDGS will result.

The model chooses a cost minimizing mix of feed ingredients that sum on a weight basis to one pound. The reported inclusion rates for each ingredient are therefore in fractions of a pound. Apparent digestible lysine levels are fixed at a given level for each growth stage since lysine is considered to be the most limiting of the essential amino acids required in swine diets. The ratio of calcium to phosphorous is restricted to be no greater than 2:1 to maintain proper mineral nutrient levels for efficient hog growth across all stages (National Research Council Subcommittee on Swine Nutrition). Paylean, dried whey, fish meal, plasma protein, vitamin-trace mineral premix and blood meal are all at fixed inclusion levels for the growth stages in which they are included. This model computes diets and values for 10 separate growth stages in the hog life cycle, including: 4 nursery phases, 2 sow phases (gestating and lactating) and 4 grower-finisher phases. Additionally, another Finisher 2 phase is specified that includes the use of Paylean 9. Paylean (Ractopamine) is a feed additive for finishing swine which is produced by Elanco, and the 9 indicates the concentration of Paylean in the diet, which is 9 grams per ton.

Due to the negative carcass value effects attributed to high levels of DDGS inclusion, this model includes an adjustment for the impact DDGS has on carcass value. A 0.4 percent loss of carcass value is assumed for every 10 percent of DDGS inclusion (Cook et al.; Linneen et al.; Weimer et al.). Hot carcass weight and hog prices are used to model the loss in carcass value throughout the grower-finisher phase. This yield drag calculation is based on a hot carcass estimate of 75 percent of the live weight (USDA). The value of lost carcass weight adjusted to a per pound of feed basis is subtracted from the calculated marginal value of DDGS in the model. Figure 2 shows some shadow values and discount levels for 10 percent inclusion rates.

Therefore, this study focuses on the cost minimizing inclusion level of DDGS in swine diets based on nutrient availability and price of inputs. This study aims to supply timely information for hog and ethanol producers in this dynamic period of corn prices. This model is available in Excel format from the authors upon request.

Results

Based on the nutrient contents for DDGS specified by the National Research Council (National Research Council Subcommittee on Swine Nutrition), which is hereafter indicated as NRC DDGS, cost minimizing diets for each growth stage are calculated both with and without DDGS inclusion. The calculated diets for each growth stage are presented in Table 4. By using a traditional corn-soybean meal diet mix for hogs, the model provides inclusion rates for DDGS limited to no more than 20 percent of the diet across all growth stages, the exception being the gestating sow at 27 percent inclusion of DDGS.

As seen with typical hog diets, corn is the predominant feed ingredient in all stages. In most instances, soybean meal follows as the second predominant ingredient; in the finisher and early starter phases where DDGS is available, DDGS replaces soybean meal as the ingredient with the second highest inclusion level. An attribute for the diet profiles for finisher growth stages is a lower apparent digestible lysine requirement. This lower lysine requirement allows higher inclusion levels of DDGS in the aforementioned diets. Since the DDGS indicated by the National Research Council has a low lysine concentration level, it is possible to replace greater amounts of corn and soybean meal in those particular diets. This is the major tradeoff when using DDGS in swine diets. The high oil level in DDGS combined with low lysine levels reduces the degree to which DDGS can substitute for other ingredients in swine rations.

The inclusion of DDGS in swine diets for the NRC DDGS provides around $10 per ton of feed in cost savings with inclusion levels of DDGS around 15 percent. The cost savings comes from DDGS's ability to replace corn as well as a small amount of soybean meal in the swine diets. This is a substantial savings when one considers the DDGS price per pound compared to the corn price per pound in 2007. The savings per pig marketed are greatest during the grow-finish phases when a majority of the feed is consumed and when added together for the whole period from weaning to market, the feed cost savings per pig are $2.89. The sow herd has even greater savings, especially during gestation when the inclusion of DDGS increases to nearly 27 percent and will save $15.29 per gestating sow per year and $16.35 per sow per year in total feed costs. While DDGS does replace corn and soybean meal, grease must be added to the diet to help meet energy requirements based on the energy value for the NRC DDGS. Synthetic lysine must also be added to complete the diet formulation to meet the digestible lysine requirement for that phase of production.

Sensitivity Analysis

Linear programming models can yield large changes in the solution to a problem from relatively small changes in parameters. Since large changes are possible, sensitivity analysis is useful to test the robustness of the model solutions. Normally, one variable is changed while the remaining factors are held constant. In this analysis, crude protein and apparent digestible lysine levels vary while all others are held constant. Crude protein levels are often discussed as targets for ethanol producers in relation to nutrient characteristics desirable in a final product. Additionally, the importance of apparent digestible lysine levels in constructing a swine diet makes it a necessary component to analyze in the model. In order to understand the response to changing levels of crude protein, sensitivity analysis conducted on NRC DDGS shows the impact of increased levels on DDGS inclusion and diet costs. Only one growth stage (Grower 1) is shown in the sensitivity analysis to illustrate the response. The other growth stages show similar responses.

Figures 3 and 4 illustrate how the DDGS inclusion rate changes and how the total diet cost changes respectively, as the protein content of DDGS increases in the Grower 1 diet. For a Grower 1 diet, the DDGS inclusion level and cost effectiveness hits a ceiling at approximately 11 percent crude protein as shown in Figure 3. This example shows a rapid increase in inclusion until that point and then an end to the improvement. In Figure 4, the cost per ton for the diet flattens out as the protein level in DDGS increases. By increasing the crude protein level above approximately 11 percent, overall diet cost is not affected. That is, beyond an 11 percent protein content, no additional DDGS is included. Thus high protein DDGS produced for cattle rations may not have the same value and impact in swine diets.

In contrast, sensitivity analysis performed on apparent digestible lysine levels are shown in Figures 5 and 6. Figure 5 illustrates the step-wise increase in inclusion that is a feature of linear programs. At a 0.23 percent apparent lysine inclusion level, the inclusion rate for DDGS jumps from just over 6 to approximately 15 percent. Figure 6 illustrates the direct cost decreases for each 0.01 percent increase in synthetic lysine with DDGS available, including a rapid change in slope after 0.23 percent. This indicates, for this model, that increased apparent lysine levels will add value for swine producers feeding DDGS. A development of DDGS nutrient characteristics could include an effort to increase digestible lysine levels if it is directed at swine producers. This in turn, could help the amino acid profile for DDGS as a feed ingredient.

The sensitivity of the marginal value of DDGS to inclusion levels in a Grower 1 swine diet can be assessed by varying the DDGS content required in the linear program. As shown in Figure 7, the shadow value of NRC DDGS is well above the market value at the time of this study ($155 dollars/ton) at inclusion levels below four percent. There is a substantial drop in value at the three percent DDGS inclusion level in the diet from approximately $219/ton to $162/ton. Subsequent increases in DDGS inclusion from four to fifteen percent provide a value at $155/ton. This convergence to the market value indicates a place for DDGS in the swine diet. At levels greater than 15 percent, there is no solution found for inclusion of DDGS in the formulated diet. Note that these results are specific to the NRC DDGS nutrient configuration and that other types of DDGS will have different values and different maximum inclusion rates.

The analysis shows how rapidly the value of the NRC DDGS can drop by increasing the inclusion level in the ration. The lack of a feasible solution above 15 percent indicates a lack of ability to meet part or all of the nutritional constraints. Constraints on the amino acid levels, in particular lysine and tryptophan, prohibit a solution. While including the NRC DDGS in the Grower 1 diet provides value below 15 percent, inclusion at higher rates is not feasible.

Conclusion

Technologies to increase the nutritional value of the DDGS co-product of ethanol production are continuously evolving. Due to the limitations associated with transporting DDGS, areas which grow significant amounts of corn, but lack the cattle feedlots necessary for large amounts of DDGS consumption, will likely be fed to other livestock species. This study shows that development of technologies to create higher levels of digestible lysine in DDGS can add value for its use by swine producers. Contrary to the direction of DDGS production in the Midwest United States, the development of higher crude protein DDGS is not necessarily beneficial to swine producers in minimizing the cost of their feed inputs.

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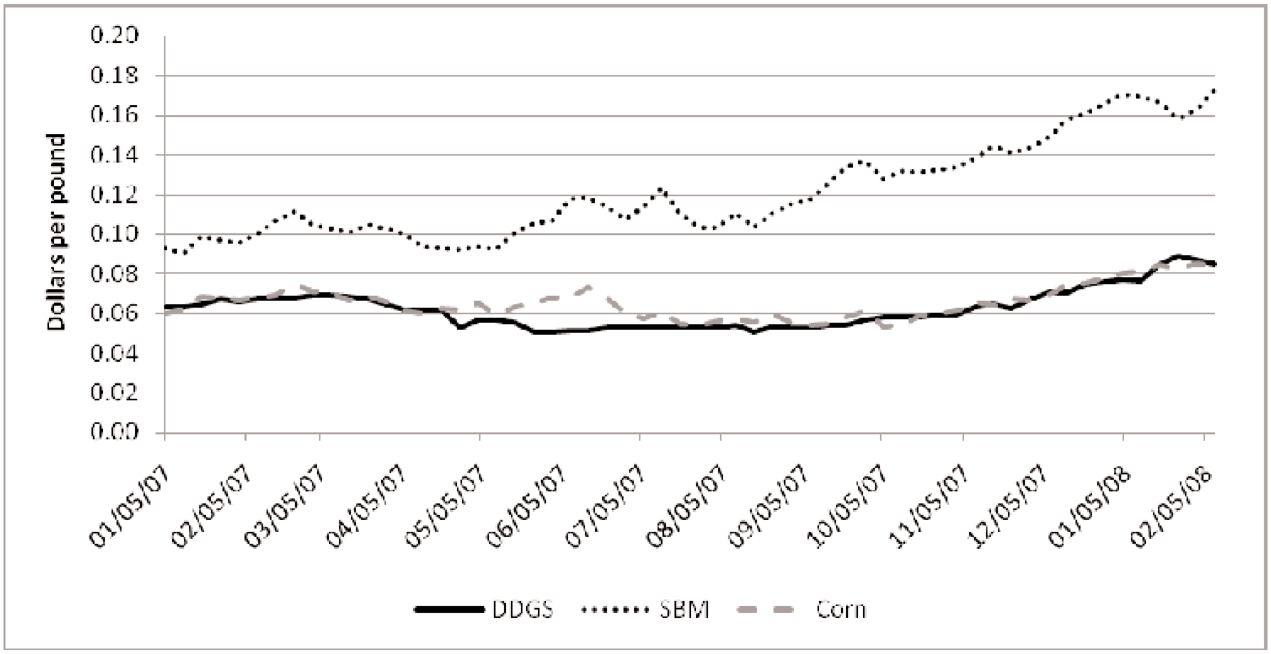
Figure 1. DDGS, corn and soybean meal prices from central Illinois



Source: Data from Livestock Marketing Information Center

Figure 2. DDGS shadow values with discounts for carcass yield drag when feeding NRC DDGS

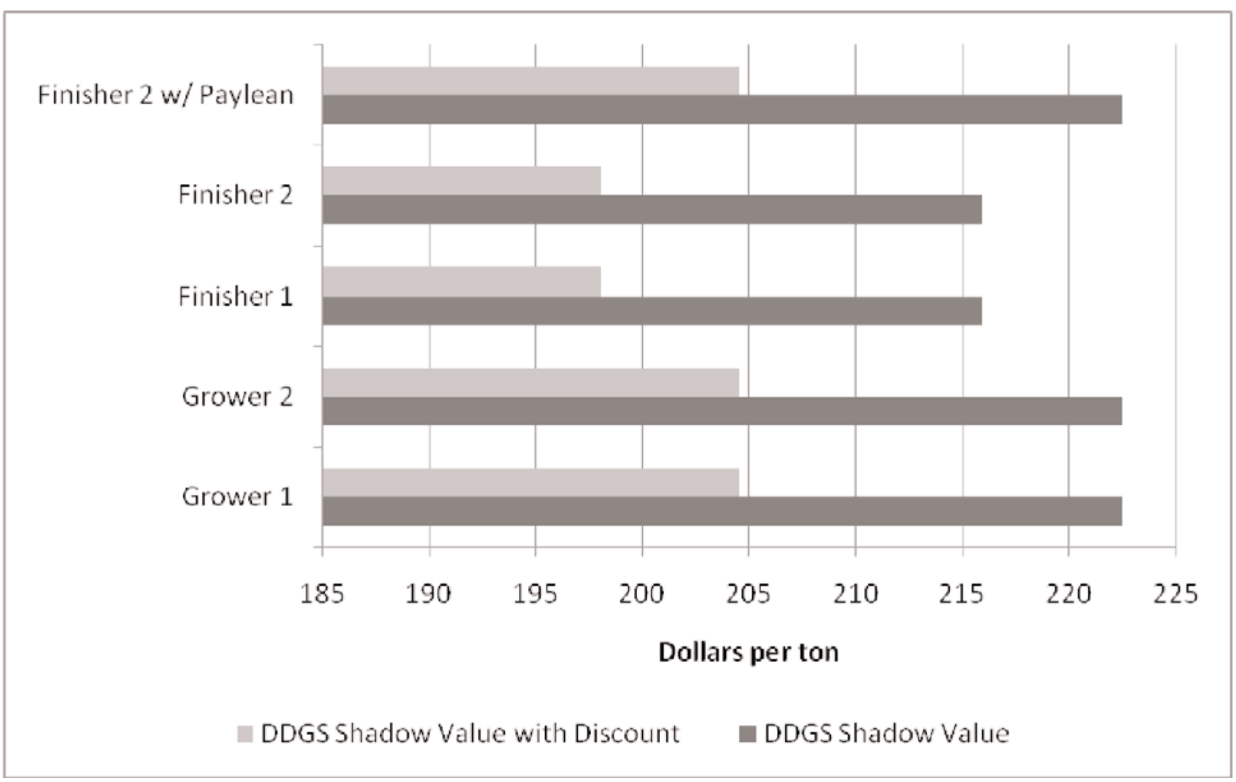


Figure 3. Sensitivity of NRC DDGS inclusion to crude protein levels for Grower 1 growth phase

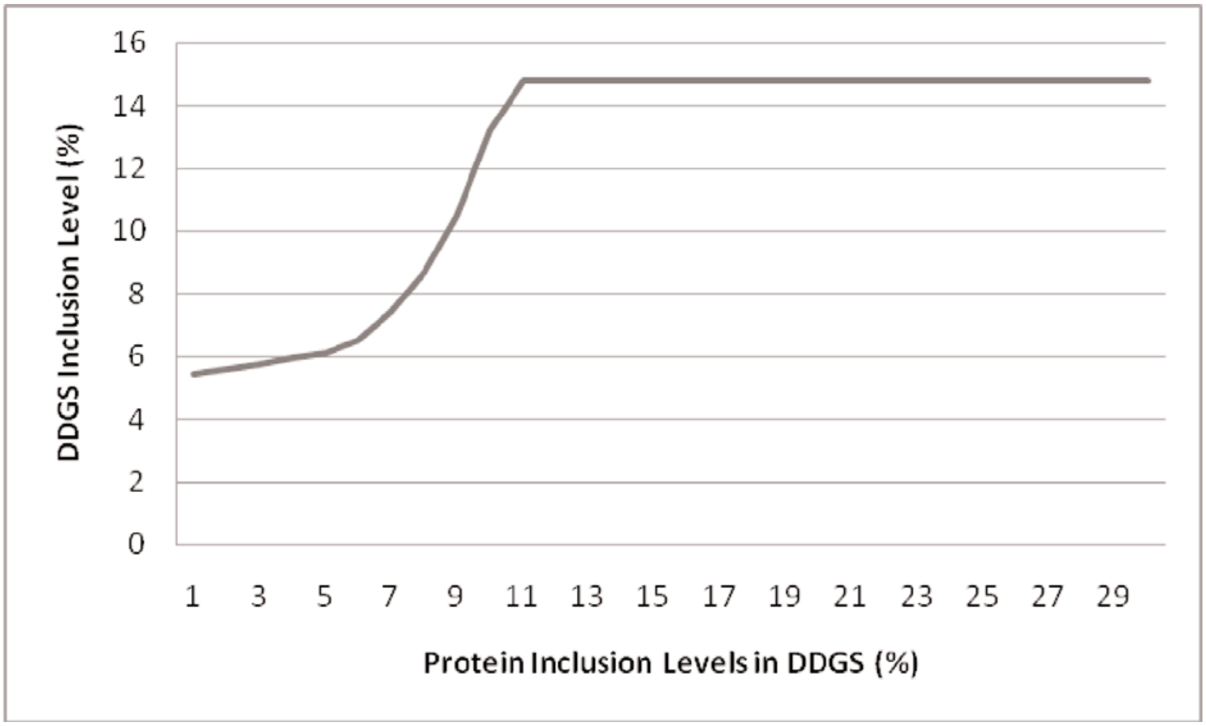


Figure 4. Sensitivity of total diet cost to protein inclusion level of NRC DDGS in Grower 1 growth phase

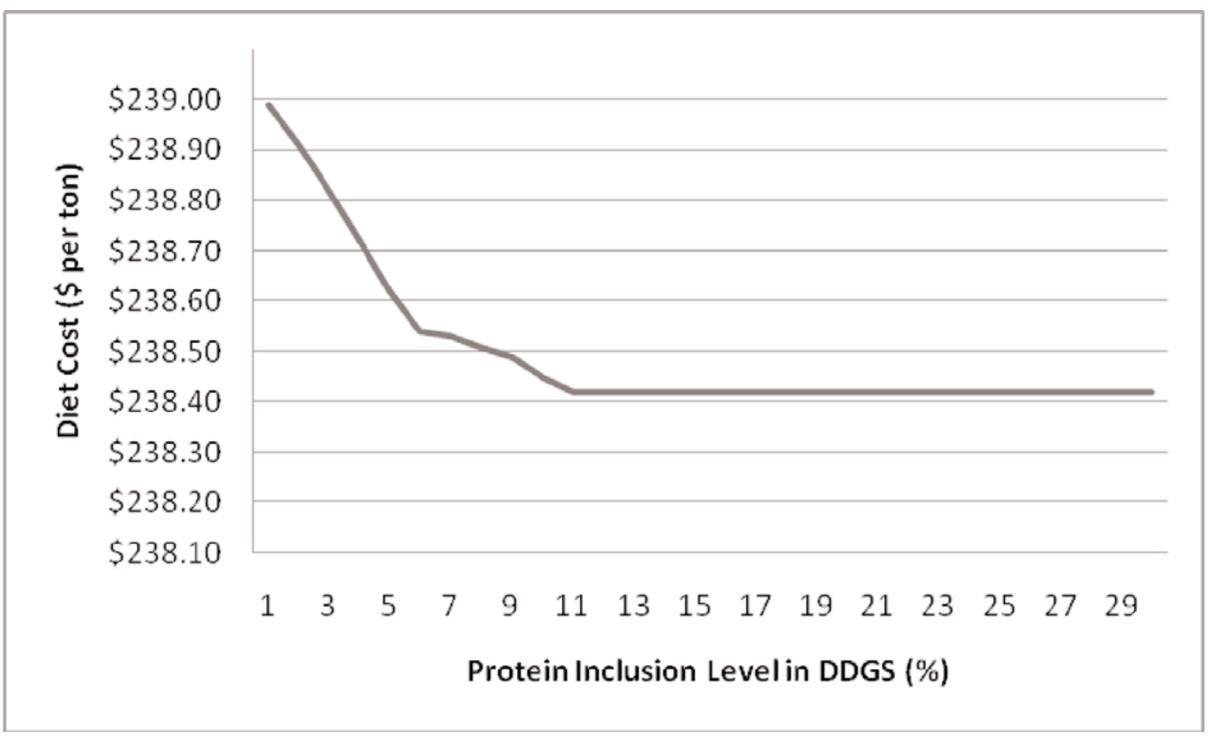


Figure 5. Sensitivity of NRC DDGS inclusion level to apparent lysine concentration for Grower 1 growth phase

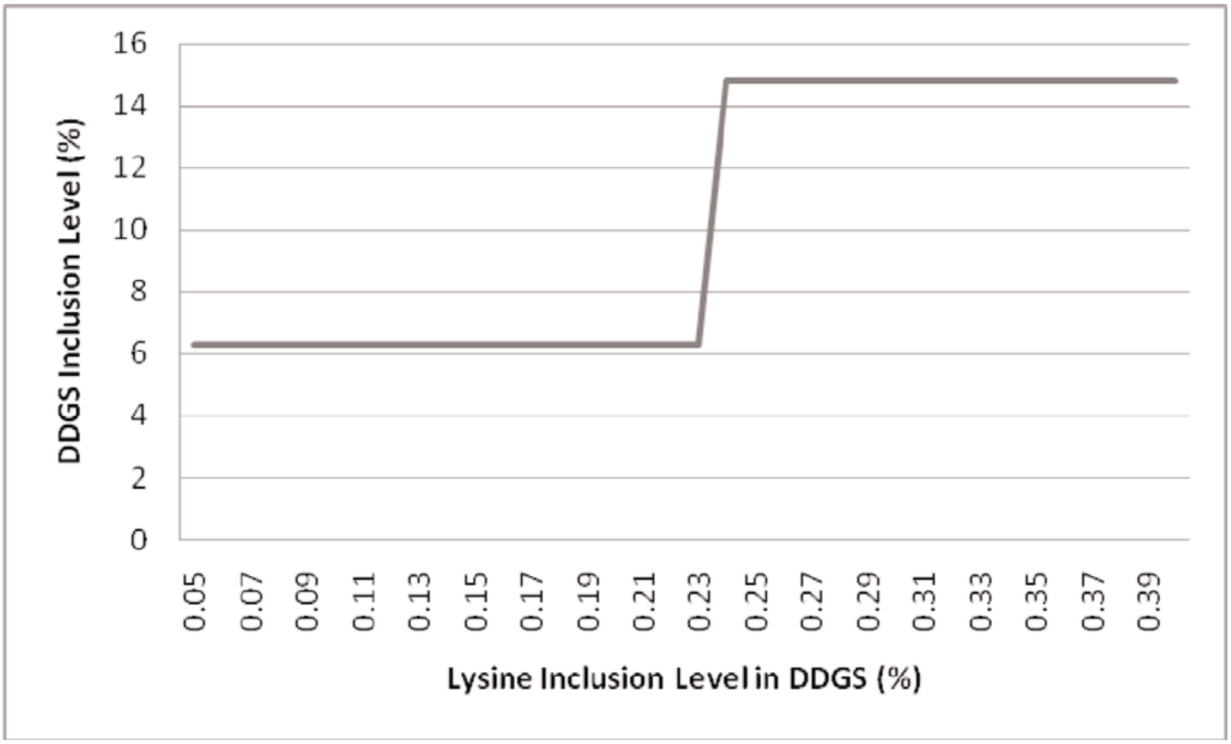


Figure 6. Sensitivity of diet cost to apparent lysine concentration level in NRC DDGS for Grower 1 growth phase

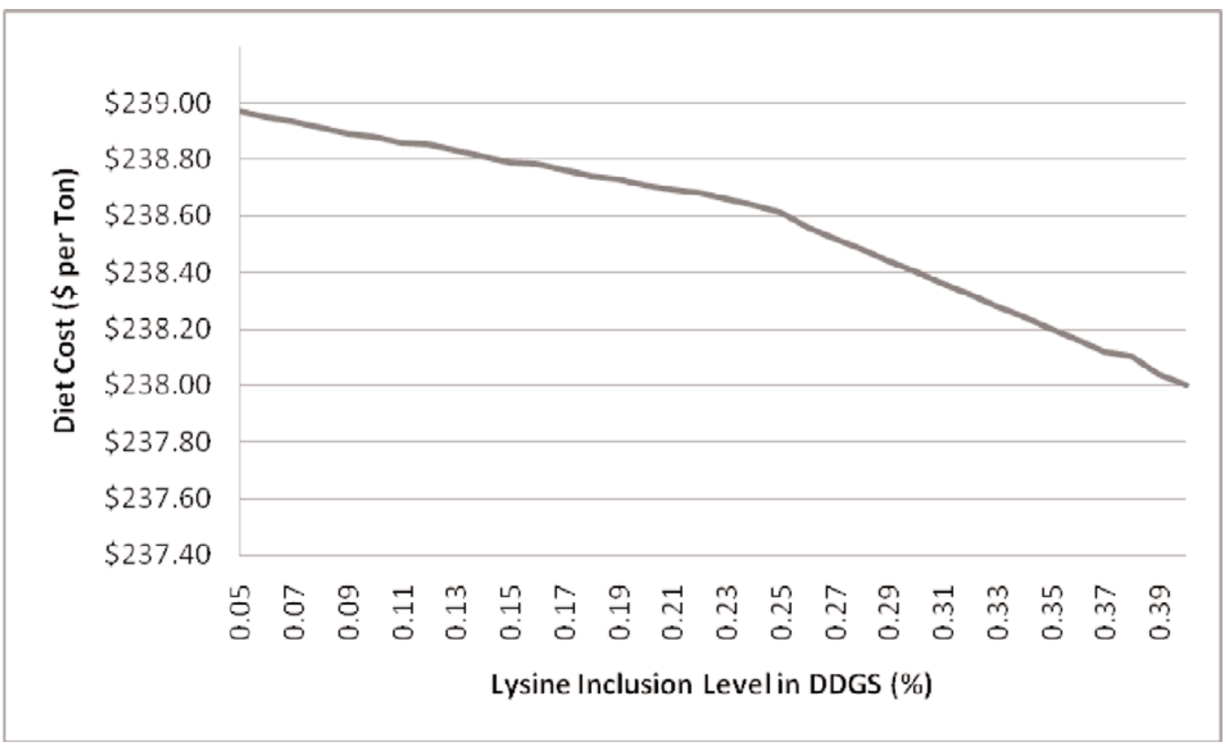


Figure 7. Shadow value of DDGS with respect to NRC DDGS inclusion level in Grower 1 growth phase

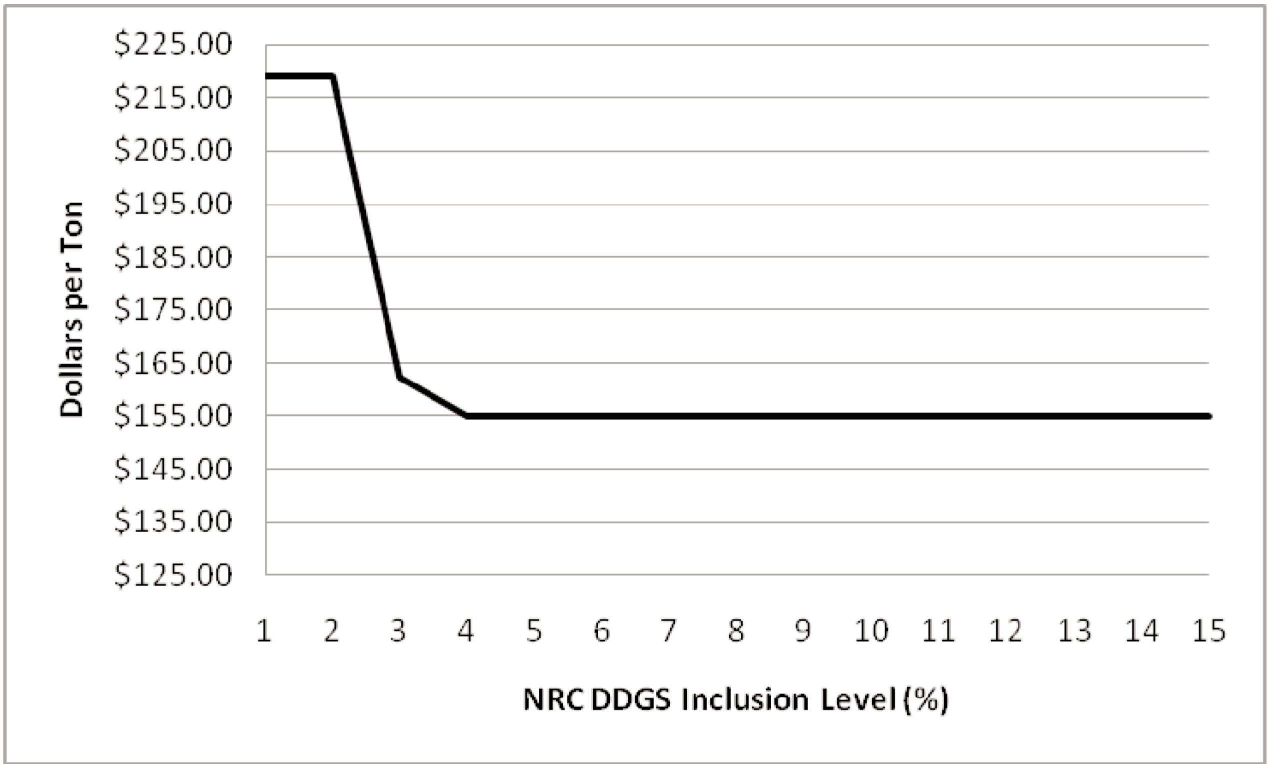


Table 1. Apparent ileal digestible amino acid requirements for lysine (%) and other amino acids as a percent of lysine

Amino Acid Growth Stage	Lysine	Methionine - Cystine	Threonine	Tryptophan	Isoleucine	Valine
Grower 1	.95%	58%	60%	17%	55%	67%
Grower 2	.85%	60%	62%	17%	55%	67%
Finisher 1	.725%	61%	63%	17%	55%	67%
Finisher 2	.60%	62%	64%	17%	55%	67%
Finisher 2 w/ Paylean	.95%	62%	64%	17%	55%	67%
Early Wean	1.4%	58%	60%	17%	55%	67%
Starter 1	1.2%	58%	60%	17%	55%	67%
Starter 2	1.1%	58%	60%	17%	55%	67%
Starter 3	1.0%	58%	60%	17%	55%	67%
Lactating Sow	.80%	50%	60%	18%	50%	85%
Gestating Sow	.40%	70%	80%	18%	60%	68%

Table 2. Essential nutrients

Essential nutrients
Apparent Digestible Isoleucine
Apparent Digestible Lysine
Apparent Digestible Methionine & Cystine
Apparent Digestible Threonine
Apparent Digestible Tryptophan
Apparent Digestible Valine
Available Phosphorous
Calcium
Crude Fat
Crude Fiber
Crude Protein
Metabolizable Energy
Phosphorous

Table 3. Feedstuffs with prices

Feedstuff	Price
DDGS ($ per Ton)	165
Corn ($ per Bushel)	5.23
[$ per Ton]	[186.79]
Soybean Meal ($ per Ton)	370
Limestone ($ per Ton)	91.6
DiCalcium Phosphate (Cents per lb)	31
Vitamin-Trace Mineral Premix (Cents per lb)	74
Lycine HCL (Cents per lb)	95.5
DL Methionine ($ per lb)	1.87
Grease (Cents per lb)	14
L Threonine ($ per lb)	1.46
L Tryptophan ($ per lb)	22.5
Paylean 9 (Finisher 2 level only) ($ per lb)	26
Dried Whey ($ per lb)	0.3557
Fish Meal ($ per lb)	0.5578
Plasma Protein ($ per lb)	2.115
Blood Meal (Flash Ring) ($ per lb)	0.6949

Table 4. Diets calculated for NRC DDGS 1 at different growth stages with and without DDGS included

Cost Minimizing Diets at 2/23/2008 prices.					DDGS=$165/t, Corn = $5.23/bu. ($186.79 / t), SBM(48)=$370/t						
NRC DDGS/ no DDGS included	**Grower 1**	**Grower 2**	**Finisher 1**	**Finisher 2**	**Finisher 2 w/ Paylean**	**Early Wean**	**Starter 1**	**Starter 2**	**Starter 3**	**Lactating Sow**	**Gestating Sow**
DDGS	15.45% / 0.00%	15.95% / 0.00%	16.41% / 0.00%	16.99% / 0.00%	15.14% / 0.00%	15.89% / 0.00%	16.77% / 0.00%	19.70% / 0.00%	15.37%/ 0.00%	6.42% / 0.00%	26.86% / 0.00%
Corn	57.32% / 71.10%	60.62% / 75.31%	65.45% / 80.19%	69.79% / 84.82%	58.56%/ 71.69%	33.30% / 48.17%	32.22% / 47.09%	40.33% / 58.91%	54.94% / 67.05%	66.34% / 72.34%	65.92% / 86.36%
SBM	22.83% / 26.07%	19.24% / 21.95%	14.74% / 17.56%	10.25% / 13.19%	22.81% / 25.99%	6.29% / 8.97%	12.68% / 16.44%	21.27% / 24.81%	24.63% / 30.01%	20.99% / 22.07%	2.49% / 10.17%
Lysine HCL	0.36% / 0.20%	0.26% / 0.20%	0.24% / 0.18%	0.21% / 0.15%	0.28% / 0.15%	0.13% / 0.07%	0.17% / 0.07%	0.25% / 0.16%	0.29% / 0.15%	0.16% / 0.14%	0.19% / 0.004%
Limestone	0.80% / 1.16%	1.56% / 1.36%	1.31% / 1.10%	1.19% / 0.97%	1.26% / 0.97%	0.29% / 0.08%	0.44% / 0.22%	1.42% / 0.99%	1.97% / 1.64%	0.71% / 0.63%	1.04% / 1.33%
DiCalPhos	0.80% / 1.23%	0.48% / 0.93%	0.33% / 0.80%	0.23% / 0.72%	0.32% / 0.75%	1.02% / 1.47%	1.46% / 1.94%	0.22% / 0.78%	0.52% / 0.94%	1.73% / 1.91%	1.24% / 1.96%
VitTMpremix	0.15% / 0.15%	0.15% / 0.15%	0.125% / 0.125%	0.125% / .125%	0.125% / 0.125%	0.25% / 0.25%	0.25% / 0.25%	0.25% / 0.25%	0.25% / 0.25%	0.25% / 0.25%	0.25% / 0.25%
DL Methionine	0.02% / 0.04%	0.00% / 0.03%	0.00% / 0.00%	0.00% / 0.00%	0.05% / 0.08%	0.24% / 0.26%	0.14% / 0.16%	0.04% / 0.07%	0.03% / 0.03%	0.08% / 0.09%	0.00% / 0.00%
Grease	1.76% / 0.00%	1.68% / 0.00%	1.36% / 0.00%	1.19% / 0.00%	1.34% / 0.00%	3.27% / 1.37%	3.42% / 1.38%	2.50% / 0.00%	2.04% / 0.00%	3.24% / 2.48%	2.10% / 0.00%
Lthreonine	0.05% / 0.05%	0.05% / 0.06%	0.03% / 0.04%	0.01% / 0.025%	0.09% / 0.03%	0.09% / 0.10%	0.04% / 0.04%	0.02% / 0.04%	0.06% / 0.03%	0.17% / 0.18%	0.01% / 0.01%
Ltryptophan	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%	0.00% / 0.00%
Paylean 9	-	-	-	-	0.03% / 0.03	-	-	-	-	-	-
Dried Whey	-	-	-	-	-	25.00% / 25.00%	25.00% / 25.00%	10.00%/ 10.00%	-	-	-
Fish Meal	-	-	-	-	-	6.00% / 6.00%	2.50% / 2.50%	4.00% / 4.00%	-	-	-
Plasma Protein	-	-	-	-	-	6.70% / 6.70%	2.50% / 2.50%	-	-	-	-
Blood Meal (Flash dried)	-	-	-	-	-	1.65% / 1.65%	2.50% / 2.50%	-	-	-	-
Diet Cost per Ton	$237.71 / $247.15	$228.58 / $238.09	$218.21/ $227.39	$208.37/ $218.04	$252.27 / $261.94	$694.49 / $703.71	$477.07/ $487.32	$322.30/ $333.83	$240.47 / $250.93	$242.92/ $247.11	$197.42 / $214.85
Feed Cost Savings/ pig ($)[1]	0.4956	0.6324	0.6940	0.8292	0.6219	0.0129	0.0251	0.0827	0.1135	1.0601	15.2905

[1] Feed cost savings are calculated based on the average feed intake for that phase of production and the average time that phase would be fed for a wean to finish pig. This results in a total cost savings per pig of $2.89 without Paylean and $2.68 with Paylean. The average inclusion rate without Paylean is 16.35% and results in a loss from yield drag of $0.95. The average inclusion rate with Paylean is 15.88% and results in a loss from yield drag of $0.92 per pig. The sow feed savings is savings per sow per year based on 2.2 litters per sow per year and the average feed intake for each phase for a sow. All average feed intake data and durations were derived from the Tri-State Swine Nutrition Guide.

Appendix A. The Linear Programming Model in table form, Grower 1

Objective Function	**0.089*DDGS + .082*Corn + .174*SBM + .955*Lysine HCL + .045*Limestone + .313* DiCalcium Phosphate + .74* Vitamin TM Premix + 1.87*DL Methionine + .138*Grease + 1.46*Lthreonine + 22.5*Ltryptophan**													
	Nutrient Requirement		**Nutrient Content for each Diet Component**											
Nutrient	Min (?)	Max (?)	DDGS	Corn	SBM	Limestone	DiCalPhos	VitTMpremix	Lysine HCL	DL Meth	Grease	Lthreo	Ltryp
Metabolizable Energy	1500	N/A	1279	1551	1533	0	0	0	0	0	3615	0	0
Crude Protein	0.18	N/A	0.291	0.083	0.475	0	0	0	0.78	0.98	0	0.98	0.98
Apparent Digestible Lysine	0.0095	0.0095	0.005	0.0017	0.02567	0	0	0	0.78	0	0	0	0
Apparent Digestible Methionine Cystine	0.0055	0.0065	0.008	0.0029	0.01163	0	0	0	0	0.98	0	0	0
Apparent Digestible Threonine	0.0057	0.0067	0.007	0.002	0.01443	0	0	0	0	0	0	0.98	0
Apparent Digestible Tryptophan	0.0016	0.0026	0.001	0.00038	0.00526	0	0	0	0	0	0	0	0.98
Calcium	0.0072	0.0082	0.0003	0.0003	0.0034	0.385	0.215	0	0	0	0	0	0
Phosphorous	N/A	0.0072	0.0081	0.0028	0.0069	0.0002	0.185	0	0	0	0	0	0
Available Phosphorous	0.003	N/A	0.0049	0.00042	0.0016	0.0002	0.185	0	0	0	0	0	0
Crude Fiber	N/A	0.035	0.062	0.023	0.034	0	0	0	0	0	0	0	0
Apparent Digestible Isoleucine	0.0052	N/A	0.0074	0.00308	0.01814	0	0	0	0	0	0	0	0
Apparent Digestible Valine	0.0063	N/A	0.0098	0.00221	0.01839	0	0	0	0	0	0	0	0
Vitamin-TM Premix	0.0015	0.0015	0	0	0	0	0	1	0	0	0	0	0
Crude Fat	N/A	0.07	0.1	0.039	0.03	0	0	0	0	0	1	0	0