Feeding Recommendations and Example Diets Containing Minnesota-South Dakota Produced DDGS for Swine

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Use Only High Quality DDGS in Swine Diets.

Historically, distiller's dried grains with solubles (DDGS) have not been used extensively in swine diets. The primary reasons for this limited use are variability in quality and nutrient content, poor amino acid digestibility from some sources, and cost competitiveness with corn, soybean meal and dicalcium phosphate. However, our research at the University of Minnesota has clearly shown that DDGS produced by small, and relatively new ethanol plants in Minnesota and South Dakota, is very high quality and is an excellent partial substitute for corn, soybean meal, and dicalcium phosphate in swine feeding programs. Distiller's dried grains with solubles from Minnesota and South Dakota plants is higher in digestible and metabolizable energy, higher in total and digestible amino acids, and higher in available phosphorus compared to other DDGS sources and values listed in NRC (1998). Use of low quality, dark colored DDGS has reduced feeding value and pig performance may be reduced if the lower levels of digestible nutrients are not considered in diet formulation.

What Are the Recommended Maximum Inclusion Rates of DDGS in Swine Diets?

Based upon research studies we have conducted at the University of Minnesota, our current recommendations for maximum usage rate of DDGS in swine diets are as follows:

Production Phase	Maximum % of Diet
Nursery pigs (>15 lbs)	25
Grow-finish pigs	20
Developing gilts	20
Gestating sows	50
Lactating sows	20
Boars	50

These recommendations assume that high quality DDGS is free of mycotoxins. Nursery diets containing up to 25% DDGS will support growth performance equivalent to feeding pigs fed corn-soybean meal based diets provided that diets are formulated on a digestible amino acid and available phosphorus basis. Similarly, grow-finish and gilt development diets containing levels up to 30% DDGS should provide equivalent growth performance compared to pigs fed corn-soybean meal diets if they are formulated on a digestible amino acid and available phosphorus basis. However, due to concerns of reduced belly firmness and soft pork fat at high levels of DDGS inclusion, we recommend no more than 20% DDGS be added to grow-finish diets. If the DDGS supplier has a quality control program that includes screening corn and/or DDGS for

mycotoxins, developing gilt diets can contain up to 20% DDGS in the diet. For sows, up to 50% DDGS can be successfully added to gestation diets, and 20% DDGS can be added to the lactation diet if DDGS is free of mycotoxins. If there are no assurances that DDGS is mycotoxin free, no more than 20% should be added to gestation diets and no more than 10% DDGS should be added to lactation diets to minimize the risk of mycotoxicosis. However, when switching sows from a corn-soybean meal diet to diets containing DDGS, formulate gestation diets to contain 20% DDGS and then increase DDGS inclusion level when each new batch of feed is made to allow the sows to adapt to the DDGS diets and avoid reduced feed intake. Similarly, when switching from a corn-soybean meal diet to a DDGS diet for lactating sows, begin feeding a 10% DDGS diet to allow the sows to adapt (approximately 5 to 7 days) before feeding the maximum recommended level to allow the sows to adapt to the DDGS diet and avoid potential reductions in feed intake.

How Should I Formulate Diets Containing DDGS to Obtain Optimal Performance and Value?

Our research results have shown that energy and amino acid digestibility, as well as phosphorus availability of DDGS produced in Minnesota and South Dakota ethanol plants, is higher than nearly all of the values reported in NRC (1998) "Nutrient Requirements of Swine" and values we obtained from evaluating low quality DDGS (Table 1). Our apparent digestible amino acid and available phosphorus nutrient values should be used to formulate practical diets for all phases of production to ensure that the maximum nutritional value of DDGS is obtained, and that optimal performance is achieved, particularly when adding more than 10% DDGS to any swine diet. Formulating diets using total amino acid and phosphorus values may provide acceptable performance at low inclusion rates (< 10%) of DDGS in swine diets, but will not capture the full nutritional value of DDGS.

Table 1. Comparison of Nutrient Content, Apparent Amino Acid Digestibility, and Phosphorus Availability of MN/SD DDGS, a Low Quality DDGS Source, and NRC (1988).

Nutrient*	MN/SD DDGS	Low Quality DDGS	NRC (1998)
Dry matter, %	88.9	88.3	93.0
Crude protein, %	30.2	28.1	29.8
Crude fat, %	10.9	8.2	9.0
Crude fiber, %	8.8	7.1	4.8
Calcium, %	0.06	0.44	0.22
Phosphorus, %	0.89	0.90	0.83
Available phosphorus, %	0.80	?	0.64
Digestible energy, kcal/kg	3,965	3,874	3,441
Metabolizable energy, kcal/kg	3,592	3,521	3,032
Lysine, %	0.83	0.68	0.67
App. digestible lysine, %	0.44	0.00	0.31
Methionine, %	0.55	0.49	0.54
App. digestible methionine, %	0.32	0.24	0.39
Threonine, %	1.13	0.99	1.01
App. dig. threonine, %	0.62	0.36	0.56
Tryptophan, %	0.24	0.22	0.27
App. dig. tryptophan, %	0.15	0.15	0.13

* Values expressed on a 100% dry matter basis.

Are There Any Concerns in Feeding DDGS to Swine?

Quality

Historically, grain co-products like DDGS have been treated as commodities in the market place. However, like all co-products, there is large variation in the quality of DDGS available for livestock feeds. Cromwell et al. (1993) conducted a study to compare physical, chemical, and nutritional characteristics of nine different sources of DDGS for chicks and pigs. The color of these sources ranged from very light to very dark, and odor ranged from a sweet smell to smoky or burnt smell. There was also a wide range in nutrient concentration among DDGS sources. Ranges in nutrient concentration of selected nutrients were:

Dry matter – 87 to 93%
Crude protein – 23 to 29%
Crude fat – 3 to 12%
Ash – 3 to 6%
Lysine – 0.59 to 0.89%

Lysine concentration tended to be highest in light-colored DDGS and lowest in the darkest-colored DDGS sources. When the four darkest, burnt smelling sources were fed to chicks, growth rate, feed intake, and feed conversion were reduced 18 %, 13%, and 6 %, respectively,

compared to chicks fed the lightest-colored DDGS. Results from this study suggest that DDGS that is dark in colored and/or has a burnt smell should not be used in swine or poultry diets.

Source: Cromwell, G.L., K.L. Herkleman, and T.S. Stahly. 1993. Physical, chemical, and nutritional characteristics of distiller's dried grains with solubles for chicks and pigs. J. Anim. Sci. 71:679-686.

In order to differentiate DDGS sources that are suitable for swine and poultry diets from other nutritionally inferior sources, the Minnesota and South Dakota ethanol plants have established nutrient specifications and recommended physical characteristics when selecting DDGS sources for swine and poultry diets.

Minnesota-South Dakota Nutrient Specifications and Physical Characteristics for DDGS in Swine and Poultry Diets

Nutrient specifications

Moisture – maximum 12%
Crude protein – minimum 26.5%
Crude fat – minimum 10%
Crude fiber – maximum 7.5%

Physical characteristics

Bulk density – 34 to 37 lb/cubic foot
Particle size:
maximum coarse particles - 10% on 2000 screen
maximum fine particles - 15% on 600 screen & in pan
Smell – fresh, fermented
Color – goldenrod

Pork fat quality

Our studies have shown that when feeding DDGS to grow-finish pigs (50-250 lbs), the oil present in DDGS will make pork carcass fat softer and more oily with increasing levels of DDGS in the diet. Similar effects have been shown when adding any high oil grain or grain co-product to swine grow-finish diets. Although softer fat and reduced belly firmness are a concern for packers and meat processors, there currently are no price penalties for pork producers for marketing pigs with reduced pork fat quality. Results from our studies show that feeding up to 20% DDGS in grow-finish diets has no effect on belly thickness or belly firmness score compared to carcasses from grow-finish pigs fed conventional corn-soybean meal diets.

Mycotoxins

The incidence of documented cases of mycotoxicosis from feeding DDGS to swine is extremely low. However, corn is susceptible to molds that can produce mycotoxins prior to harvest, as well as during storage. The primary mycotoxins of concern to swine are zearalenone, vomitoxin

(deoxynivalenol), T-2 toxin, fumonisin, and aflatoxins. In the Midwestern U.S., zearalenone and vomitoxin are the greatest risks.

If corn containing mycotoxins is delivered to an ethanol plant for ethanol production, these mycotoxins are not destroyed or inactivated during the fermentation process and will be present in DDGS produced from this corn source. In fact, the concentration of mycotoxins in DDGS will be 2 to 3 times higher than the initial concentration in the grain because the removal of starch during the fermentation process concentrates all of the unfermentable residual portions of the grain that remain after fermentation.

Ethanol plants are encouraged to monitor incoming corn for mycotoxins and reject loads that are contaminated to prevent mycotoxins in DDGS. Buyers of DDGS are encouraged to work with their suppliers to establish a quality control protocol for the production of DDGS that should include screening tests and procedures for mycotoxins.

Feed intake

Our studies have shown that feeding nursery and grow-finish pigs diets containing up to 25-30% DDGS from a high quality source has no detrimental effect on feed consumption. However, abruptly switching gestating sows that are being fed 4 to 5 lbs per day of corn-soybean meal based diet to a diet containing 50% DDGS can cause sows to not consume all of the feed offered for a period of 5 to 7 days. After sows have adapted to the 50% DDGS diet, feed consumption and weight gains are equivalent to sows fed a conventional corn-soybean meal diet. We have observed a similar response when feeding lactating sows a diet containing 20% DDGS. Although our preliminary results suggest no negative effects on reproductive performance from this slight reduction in feed intake during this diet adaptation period, it can be avoided by feeding lower levels of DDGS initially and then gradually increasing the inclusion rate of DDGS to a higher, desired level for the duration of the production phase.

Calculating the Value of "New Generation" DDGS in Swine Diets Using Soybean Meal 46%

Additions/1000 kg diet

+ 100 kg DDGS	x	cost/kg	= $
+ 1.5 kg limestone	x	cost/kg	= $
TOTAL ADDITIONS (A)			**= $**

Subtractions /1000 kg diet

– 89 kg corn	x	cost/kg	= $
– 9.5 kg SBM (46%)	x	cost/kg	= $
– 3 kg dicalcium phosphate	x	cost/kg	= $
TOTAL SUBTRACTIONS (S)			**= $**

S – A = Opportunity cost for DDGS/100 kg

Calculating the Value of "New Generation" DDGS in Swine Diets Using Soybean Meal 44%

Additions/1000 kg diet

+ 100 kg DDGS	x	cost/kg	= $
+ 1.5 kg limestone	x	cost/kg	= $
TOTAL ADDITIONS (A)			**= $**

Subtractions /1000 kg diet

– 88.5 kg corn	x	cost/kg	= $
– 10 kg SBM (44%)	x	cost/kg	= $
– 3 kg dicalcium phosphate	x	cost/kg	= $
TOTAL SUBTRACTIONS (S)			**= $**

S – A = Opportunity cost for DDGS/100 kg

Nursery Diets

Phase II (15-25 lbs)

Diet	**0% DDGS**	**5% DDGS**	**10% DDGS**	**15% DDGS**	**20% DDGS**	**25% DDGS**
DDGS	0.00	5.00	10.00	15.00	20.00	25.00
Corn	50.43	45.72	41.00	36.29	31.58	26.86
SBM, 47%	23.43	23.24	23.06	22.87	22.69	22.50
Whey, dried	15.00	15.00	15.00	15.00	15.00	15.00
IPC 790 fish meal	6.00	6.00	6.00	6.00	6.00	6.00
Choice white grease	2.20	2.16	2.12	2.08	2.04	2.00
Dicalcium phosphate	1.18	1.03	0.87	0.72	0.56	0.41
Limestone	0.35	0.45	0.56	0.66	0.77	0.87
Vitamin premix	0.30	0.30	0.30	0.30	0.30	0.30
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Mecadox-10	0.13	0.13	0.13	0.13	0.13	0.13
Zinc oxide	0.28	0.28	0.28	0.28	0.28	0.28
Salt	0.30	0.30	0.30	0.30	0.30	0.30
L-lysine	0.15	0.15	0.15	0.15	0.15	0.15
DL-methionine	0.10	0.09	0.08	0.07	0.06	0.05
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition						
ME (kcal/kg)	3340	3340	3340	3340	3340	3340
Crude protein, %	22.39	23.29	24.19	25.09	25.99	26.89
Crude fat, %	5.42	5.71	6.00	6.29	6.58	6.87
Crude fiber, %	1.20	1.50	1.80	2.11	2.41	2.71
Calcium, %	0.95	0.95	0.95	0.95	0.95	0.95
Phosphorus, %	0.80	0.80	0.80	0.80	0.80	0.80
Avail. phosphorus, %						
App. dig. lysine, %	1.35	1.35	1.35	1.35	1.35	1.35
App. dig. met+cys, %	0.80	0.80	0.80	0.80	0.80	0.80
App. dig. threonine, %	0.79	0.80	0.82	0.83	0.85	0.86
App. dig. tryptophan, %	0.24	0.24	0.25	0.25	0.26	0.26

Phase III (25-50 lbs)

Diet	0% DDGS	5% DDGS	10% DDGS	15% DDGS	20% DDGS	25% DDGS
DDGS	0.00	5.00	10.00	15.00	20.00	25.00
Corn	61.68	57.20	52.72	48.23	43.75	39.27
SBM, 47%	32.62	32.20	31.77	31.35	30.92	30.50
Choice white grease	2.20	2.16	2.12	2.08	2.04	2.00
Dicalcium phosphate	1.67	1.52	1.37	1.22	1.07	0.92
Limestone	0.56	0.66	0.77	0.87	0.98	1.08
Vitamin premix	0.30	0.30	0.30	0.30	0.30	0.30
TM premix	0.15	0.15	0.15	0.15	0.15	0.15
Mecadox-10	0.13	0.13	0.13	0.13	0.13	0.13
Copper sulfate	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.40	0.40	0.40	0.40	0.40	0.40
L-lysine	0.15	0.15	0.15	0.15	0.15	0.15
DL-methionine	0.04	0.03	0.02	0.02	0.01	0.00
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition						
ME (kcal/kg)	3390	3390	3390	3390	3390	3390
Crude protein, %	20.94	21.75	22.55	23.36	24.16	24.97
Crude fat, %	5.41	5.70	6.00	6.29	6.59	6.88
Crude fiber, %	1.42	1.73	2.04	2.34	2.65	2.96
Calcium, %	0.80	0.80	0.80	0.80	0.80	0.80
Phosphorus, %	0.70	0.70	0.70	0.70	0.70	0.70
Avail. phosphorus, %						
App. dig. lysine, %	1.15	1.15	1.15	1.15	1.15	1.15
App. dig. met+cys, %	0.65	0.65	0.65	0.65	0.65	0.65
App. dig. threonine, %	0.69	0.70	0.71	0.72	0.73	0.74
App. dig. tryptophan, %	0.24	0.24	0.24	0.24	0.24	0.24

Grow-Finish Diets (50-250 lbs)

Gilt Diets **Diet**	**Grower 1 (45-80 lbs) 10% DDGS**	**Grower 2 (80-130 lbs) 10% DDGS**	**Finisher 1 (130-190 lbs) 10% DDGS**	**Finisher 2 (190-250 lbs) 10% DDGS**
DDGS	10.00	10.00	10.00	10.00
Corn	63.69	66.89	72.88	79.18
SBM, 47%	10.00	17.18	14.97	8.83
Choice white grease	4.00	3.50	0.00	0.00
Dicalcium phosphate	1.14	0.91	0.63	0.49
Limestone	0.67	0.72	0.82	0.83
Vitamin premix	0.20	0.20	0.15	0.15
Trace mineral premix	0.15	0.15	0.10	0.10
Salt	0.30	0.30	0.30	0.30
L-lysine	0.15	0.15	0.15	0.12
Total	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition				
ME (kcal/kg)	3470	3456	3320	3320
Crude protein, %	17.26	16.33	15.79	13.36
Crude fat, %	7.23	6.75	4.02	4.08
Crude fiber, %	2.76	2.75	2.83	2.77
Calcium, %	0.70	0.65	0.60	0.55
Phosphorus, %	0.60	0.55	0.50	0.45
Avail. Phosphorus, %	0.39	0.36	0.24	0.20
App. dig. lysine, %	0.77	0.71	0.67	0.50
App. dig. met+cys, %	0.47	0.45	0.44	0.39
App. dig. threonine, %	0.48	0.44	0.42	0.34
App. dig tryptophan, %	0.14	0.13	0.12	0.09

Gilt Diets **Diet**	**Grower 1 (45-80 lbs) 20% DDGS**	**Grower 2 (80-130 lbs) 20% DDGS**	**Finisher 1 (130-190 lbs) 20% DDGS**	**Finisher 2 (190-250 lbs) 20% DDGS**
DDGS	20.00	20.00	20.00	20.00
Corn	54.75	57.98	63.39	71.27
SBM, 47%	18.80	16.25	14.63	6.85
Choice white grease	4.00	3.50	0.00	0.00
Dicalcium phosphate	0.88	0.65	0.35	0.25
Limestone	0.77	0.82	0.92	0.92
Vitamin premix	0.20	0.20	0.15	0.15
Trace mineral premix	0.15	0.15	0.10	0.10
Salt	0.30	0.30	0.30	0.30
L-lysine	0.15	0.15	0.16	0.16
Total	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition				
ME (kcal/kg)	3451	3437	3300	3300
Crude protein, %	18.58	17.64	17.32	14.28
Crude fat, %	7.66	7.18	4.36	4.43
Crude fiber, %	3.15	3.14	3.20	3.15
Calcium, %	0.70	0.65	0.60	0.55
Phosphorus, %	0.60	0.55	0.50	0.45
Avail. phosphorus, %	0.38	0.36	0.26	0.23
App. dig. lysine, %	0.77	0.71	0.68	0.50
App. dig. met+cys, %	0.48	0.46	0.45	0.39
App. dig. threonine, %	0.49	0.46	0.44	0.35
App. dig. tryptophan, %	0.15	0.14	0.13	0.09

Barrow Diets **Diet**	**Grower 1 (45-80 lbs) 10% DDGS**	**Grower 2 (80-130 lbs) 10% DDGS**	**Finisher 1 (130-190 lbs) 10% DDGS**	**Finisher 2 (190-250 lbs) 10% DDGS**
DDGS	10.00	10.00	10.00	10.00
Corn	63.69	68.56	77.07	81.20
SBM, 47%	19.69	15.48	10.73	6.78
Choice white grease	4.00	3.00	0.00	0.00
Dicalcium phosphate	1.14	0.95	0.73	0.54
Limestone	0.67	0.71	0.79	0.82
Vitamin premix	0.20	0.20	0.15	0.15
Trace mineral premix	0.15	0.15	0.10	0.10
Salt	0.30	0.30	0.30	0.30
L-lysine	0.15	0.15	0.13	0.11
Total	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition				
ME (kcal/kg)	3470	3456	3318	3320
Crude protein, %	17.26	15.66	14.10	12.55
Crude fat, %	7.23	6.75	3.36	4.10
Crude fiber, %	2.76	2.73	2.77	2.74
Calcium, %	0.70	0.65	0.60	0.55
Phosphorus, %	0.60	0.55	0.50	0.45
Avail. phosphorus, %	0.39	0.36	0.33	0.21
App. dig. lysine, %	0.77	0.67	0.55	0.44
App. dig. met+cys, %	0.46	0.43	0.40	0.37
App. dig. threonine, %	0.47	0.42	0.36	0.32
App. dig. tryptophan, %	0.14	0.12	0.10	0.08

Barrow Diets **Diet**	**Grower 1 (45-80 lbs)** **20% DDGS**	**Grower 2 (80-130 lbs)** **20% DDGS**	**Finisher 1 (130-190 lbs)** **20% DDGS**	**Finisher 2 (190-250 lbs)** **20% DDGS**
DDGS	20.00	20.00	20.00	20.00
Corn	54.75	61.33	68.05	73.30
SBM, 47%	18.80	13.26	9.93	4.81
Choice white grease	4.00	3.00	0.00	0.00
Dicalcium phosphate	0.88	0.71	0.46	0.30
Limestone	0.77	0.80	0.88	0.90
Vitamin premix	0.20	0.20	0.15	0.15
Trace mineral premix	0.15	0.15	0.10	0.10
Salt	0.30	0.30	0.30	0.30
L-lysine	0.15	0.15	0.13	0.14
Total	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition				
ME (kcal/kg)	3451	3414	3300	3300
Crude protein, %	18.58	16.53	15.45	13.46
Crude fat, %	7.66	7.24	4.40	4.45
Crude fiber, %	3.15	3.13	3.17	3.12
Calcium, %	0.70	0.65	0.60	0.55
Phosphorus, %	0.60	0.55	0.50	0.45
Avail. phosphorus, %	0.38	0.32	0.27	0.23
App. dig. lysine, %	0.77	0.67	0.55	0.44
App. dig. met+cys, %	0.48	0.44	0.42	0.38
App. dig. threonine, %	0.49	0.43	0.39	0.33
App. dig. tryptophan, %	0.15	0.12	0.11	0.08

Example Grower Diet Containing 20% DDGS and 100 FTU Phytase/kg

Ingredient	**%**
Corn	60.70
DDGS	20.00
Soybean meal, 46%	17.65
Dicalcium phosphate	0.05
Limestone	0.95
Salt	0.30
Vitamin-trace mineral premix	0.15
L-lysine HCl	0.15
Phytase - 1000	0.05
Total	**100.00**
Nutrient Composition	
ME, kcal/kg	3,330
Crude protein, %	19.10
Calcium, %	0.44
Phosphorus, %	0.43
Avail. phosphorus, %	0.20
App. dig. lysine, %	0.74
App. dig. met+cys, %	0.51
App. dig. threonine, %	0.48
App. dig. tryptophan, %	0.15

Gestation and Lactation Diets

	Gestation 20% DDGS	Gestation 50% DDGS	Lactation * 10% DDGS	Lactation * 20% DDGS	Lactation ** 10% DDGS	Lactation ** 20% DDGS
DDGS	20.00	50.00	10.00	20.00	10.00	20.00
Corn	67.75	36.97	64.40	56.68	57.44	50.64
SBM, 44%	8.83	8.68	18.88	16.74	25.93	22.86
Choice white grease	0.00	0.00	3.00	3.00	3.00	3.00
Dicalcium phosphate	2.19	0.82	2.31	2.08	2.17	1.9
Limestone	0.48	2.58	0.41	0.50	0.46	0.55
Breeder vitamin premix	0.30	0.30	0.30	0.30	0.30	0.30
Breeder trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Salt	0.50	0.50	0.50	0.50	0.50	0.50
L-lysine	0.00	0.00	0.15	0.15	0.15	0.15
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
Nutrient Composition						
ME (kcal/kg)	3235	3254	3352	3336	3340	3325
Crude protein, %	14.47	20.94	16.14	17.07	18.62	19.24
Calcium, %	0.90	1.28	0.90	0.90	0.90	0.90
Phosphorus, %	0.80	0.73	0.80	0.80	0.80	0.80
Available P, %	0.59	0.57	0.55	0.57	0.54	0.56
App. dig. lysine, %	0.45	0.47	0.64	0.64	0.77	0.77
App. dig. met, %	0.41	0.49	0.45	0.45	0.50	0.50
App. dig. threonine, %	0.40	0.48	0.44	0.45	0.52	0.52
App. dig. tryptophan, %	0.11	0.13	0.13	0.13	0.16	0.16

* ADFI = 10.5 lbs/d, 21-d litter wt. < 120 lbs
** ADFI = 12.0 lbs/d, 21-d litter wt. > 120 lbs