NebGuide

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Full-Fat Soybeans for Pigs

Several factors should be considered when feeding full-fat soybeans to swine, including nutrient composition, performance, economic considerations and diet formulations.

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Soybean meal is the most common supplemental protein source used in pig diets. It is widely available, and often produces the most economical gains when compared with other protein sources. For various reasons, feeding full-fat soybeans to pigs, instead of soybean meal, may be an attractive alternative.

Nutrient Composition and Quality

Cooked, full-fat soybeans contain less protein and lysine than soybean meal, but more fat and energy (*Table I*). Because of their high fat content, full-fat soybeans offer a convenient method of adding fat to pig diets. Diets in which full-fat soybeans provide the sole source of supplemental protein contain 3 percent to 5 percent added fat (60 lb to 100 lb of added fat per ton of feed).

Table I. Average nutrient composition of soybean meal and cooked, full-fat soybeans.[a]

Item	*44% Soybean meal*	*Full-fat soybeans*
Protein, %	44.0	36.7
Lysine, %	2.9	2.25
Lysine digestibility, %	86	71
Fat, %	1.1	18.8
Metabolizable energy, kcal/lb	1,461	1,644

[a]As-fed basis.

Raw soybeans contain several anti-growth factors, so the beans must be cooked before they are used in all pig diets except diets for gestating sows. Properly cooking the soybeans with either a roaster (240°F to 250°F for 2.5 to 3.5 minutes) or an extruder (exit temperature of 280°F to 300°F) destroys several of these anti-growth factors and produces an acceptable supplemental protein source for all pigs.

Less heating time is required to adequately destroy the anti-growth factors when sodium metabisulfate is added to the soybeans (at levels of 1 percent to 2 percent) before cooking. Recent research suggests extrusion processing yields soybean products of greater nutritional value for weanling pigs than does roasting. Grain driers do not adequately cook soybeans.

Among the anti-growth factors in soybeans is a compound known as **Kunitz trypsin** inhibitor. New strains of soybeans have been developed that do not contain the Kunitz inhibitor, so these newer varieties should require less cooking. ***However***, current research indicates these new strains must be cooked to the same extent as regular soybeans if they are intended for weanling or growing pigs (12 lb to 120 lb). For finishing pigs only one half the cooking time may be necessary to achieve similar efficiency of growth as fully cooked regular soybeans.

Cooked soybeans should be checked periodically for anti-growth factor activity. Use tests that indirectly assess this activity. For information on how to obtain an on-farm test, contact LSB Products, 731 McCall Road, Manhattan, Kansas 66502. Producers also can submit cooked soybeans to a commercial laboratory for a urease test.

Generally a urease level of .20 to .05 pH unit change is indicative of proper cooking. Urease levels greater than .20 pH unit change indicate undercooking and a pH change of less than .05 unit may indicate overcooking. A urease test at a commercial laboratory costs $12 to $15 per sample. As a guide, test every third batch of cooked soybeans. See NebGuide *88-892, Mixing Quality Pig Feed*, for details on sampling procedures and laboratory locations.

Performance and Economic Considerations

Growing pigs. Summaries of research studies using cooked, full-fat soybeans as a substitute for soybean meal in diets for growing pigs are shown in *Tables II, III*, and *IV*. Data for cooked, full-fat soybeans that were obviously underheated were omitted. Also, data generated from diets containing soybeans that replaced soybean meal on an equal weight basis were not included.

The data in *Table II* suggest cooked, full-fat soybeans offer no advantage over soybean meal as a supplemental protein source for weanling pigs. However, when used in growing-finishing diets, cooked, full-fat soybeans slightly improved gain and efficiency of feed utilization (*Table III*). *Table IV* indicates pigs fed diets with cooked, full-fat soybeans may have more backfat and a smaller loin eye area than those fed soybean meal.

Table II. Performance of weanling pigs fed soybean meal or cooked, full-fat soybeans in grain-based diets.[a,b]

Item	*Soybean meal*	*Full-fat soybeans*
Daily gain, lb	.97	.88
Feed/gain	1.85	1.85

[a]Weighted averages from 15 trials using 1,495 pigs 14 to 51 lb (Herkelman and Cromwell, 1990).
[b]Cooking primarily by extrusion and roasting.

Table III. Performance of growing-finishing pigs fed soybean meal or cooked, full-fat soybeans in grain-based diets.[a,b]

Item	*Soybean meal*	*Full-fat soybeans*
Daily gain, lb	1.71	1.74
Feed/gain	3.28	3.13

[a]Weighted averages from 29 trials using 2,884 pigs 74 to 203 lb (Herkelman and Cromwell, 1990).
[b]Cooking primarily by extrusion and roasting.

Table IV. Carcass backfat and loin-eye area of finishing pigs fed soybean meal or cooked, full-fat soybeans in grain-based diets.[a,b]

Item	*Soybean meal*	*Full-fat soybeans*
Backfat, in.	1.24	1.29
Loin eye area, sq. in.	4.72	4.58

[a]Weighted averages from 15 trials using 1,052 pigs slaughtered at 216 lb (Herkelman and Cromwell, 1990).
[b]Cooking primarily by extrusion and roasting.

The economic feasibility of using cooked, full-fat soybeans as a substitute for soybean meal in growing-finishing pig diets is presented two ways. Producers who have raw soybeans available and are considering cooking them for inclusion in pig diets use *Tables V* and *VI*. Producers who don't have raw soybeans available but are considering buying cooked, full-fat soybeans (in meal form) use *Tables VII* and *VIII*. A computer model[a] and the response to full-fat soybeans shown in *Table III* were used in the economic analyses. Note the assumptions in the footnotes of *Tables V* and *VII*. No consideration was given to changes in either building dust levels or carcass merit in the economic analyses.
[a]Evaluating processed soybeans for swine, by C.R. Hamilton, South Dakota State University, 1987.

Table V. Value of cooked, full-fat soybeans ($/bushel) in a 15 percent crude protein grower-finisher diet.[a]

	Corn ($/bushel)				
44% SBM ($/ton)	*2.00*	*2.25*	***2.50***	*2.75*	*3.00*
175	3.44	3.55	**3.66**	3.76	3.87
200	3.99	4.10	**4.20**	4.31	4.41
225	4.54	4.64	**4.75**	4.86	4.96
250	**5.08**	**5.19**	**5.30**	5.40	5.51
275	5.63	5.74	5.84	5.95	6.06
300	6.18	6.29	6.39	6.50	6.60

[a]Soybean cooking cost = $45/ton, shrink = 5%, average daily housing temperature = 55 to 75°F and nonfeed cost = 9¢/pig/day. See *Table VI* to adjust soybean values if individual situations differ.

Table VI. Adjustments for full-fat soybean values in Table V.

Cooking cost

For each $5/ton increase (for example, $45 to $50/ton), subtract 15¢/ bushel
For each $5/ton decrease (for example, $45 to $40/ton), add 15¢/bushel

Shrink

For each 1% increase in shrink (for example, 5 to 6%), subtract 6¢/bushel
For each 1% decrease in shrink (for example, 5 to 4%), add 6¢/bushel

Housing temperature

For average daily temperatures less than 55°F, subtract 15¢/bushel
For average daily temperatures greater than 75°F, add 19¢/bushel

Table VII. Value of cooked, full-fat soybeans ($/ton) in a 15 percent crude protein grower-finisher diet.[a]

	Corn ($/bushel)				
44% SBM ($/ton)	*2.00*	*2.25*	***2.50***	*2.75*	*3.00*
175	160	163	**167**	170	174
200	178	182	**185**	188	192
225	196	200	**203**	206	210
250	**214**	**218**	**222**	225	229
275	233	236	240	243	247
300	251	255	258	261	265

[a]Average daily housing temperature = 55 to 75°F and nonfeed cost = 9¢/pig/day. See *Table VIII* to adjust soybean values if individual situations differ.

Table VIII. Adjustments for full-fat soybean values in Table VII.

Housing temperature

For average daily temperatures less than 55°F, subtract $5/ton
For average daily temperatures greater than 75°F, add $6/ton

To use *Table V*, locate the on-farm price of corn and 44 percent soybean meal. For example, assume corn is worth $2.50/bushel and soybean meal costs $250/ton. The table indicates cooked, full-fat soybeans would be an economical substitute for soybean meal if their cash or loan value is less than $5.30/bushel.

Because cooking costs, shrink and the ambient temperature in which the pig is housed can vary, some adjustment factors for the prices in *Table V* are necessary and are presented in Table *VI*. If cooking cost is $40/ton instead of $45/ton, soybeans would not be worth $5.30/bushel in the diet but 15¢ more, or $5.45/bushel. Adjust the value of one bushel of soybeans by 15¢ for each $5/ton change in cooking cost.

Similarly, if shrink is 10 percent, not 5 percent, the value of soybeans would decrease to $5/bushel. Adjust the value of one bushel of soybeans by 6¢ for each 1 percent change in shrink.

The adjustments for housing temperature recognize pigs respond to added dietary fat more during high temperatures than low ones. The adjustments above are cumulative, so adjust the soybean values in *Table V* for changes in cooking cost, shrink and housing temperature.

To use *Table VII*, locate the on-farm price of corn and 44 percent soybean meal. For example, assume corn is worth $2.50/bushel and 44 percent soybean meal costs $250/ton. The table indicates cooked, full-fat soybeans would be an economical substitute for 44 percent soybean meal if the cash value is less than $222/ton.

Adjustment factors for housing temperature are presented in *Table VIII*. For example, if feeding pigs during the summer when housing temperatures will exceed 75°F, add $6 to the values in *Table VII* ($222/ton + $6 = $228/ton).

The soybean values in *Tables V* and *VII* are based on a 15 percent crude protein (.72 percent lysine) diet. Although a different diet would affect the values in *Tables V* and *VII*, a 15 percent crude protein diet is most representative of feed provided to growing-finishing pigs.

Gestating sows. Research studies indicate raw, full-fat soybeans can replace all the soybean meal in gestation diets. In some studies small improvements in pig birth weight and survival to weaning have been observed when raw, full-fat soybeans were fed during gestation.

The economic feasibility of using raw, full-fat soybeans as a substitute for soybean meal in gestation diets is presented in *Tables IX* and *X*. The appropriate table to use depends on whether an improvement in pig preweaning survival rate from feeding full-fat, raw soybeans is expected. *Table IX* assumes no improvement in preweaning survival rate, whereas *Table X* assumes a 3 percent improvement. A 3 percent improvement in survival rate is most likely when herd preweaning survival rate is below 80 percent and no fat is added to the sow diet during gestation and lactation.

Table IX. Value of raw, full-fat soybeans ($/bushel) in a 13 percent crude protein gestation diet (no improvement in pig survival).[a]

	Corn ($/bushel)				
44% SBM ($/ton)	*2.00*	*2.25*	***2.50***	*2.75*	*3.00*
175	4.12	4.22	**4.31**	4.41	4.50
200	4.61	4.70	**4.80**	4.89	4.99
225	5.09	5.19	**5.28**	5.38	5.47
250	**5.58**	**5.67**	**5.77**	5.86	5.96
275	6.06	6.16	6.25	6.35	6.44
300	6.55	6.64	6.74	6.83	6.93

[a]Computer model developed by L.L. Bitney, University of Nebraska.

Table X. Value of raw, full-fat soybeans ($/bushel) in a 13 percent crude protein gestation diet (3 percent improvement in pig survival).[a,b]

	Corn ($/bushel)				
44% SBM ($/ton)	*2.00*	*2.25*	*2.50*	*2.75*	*3.00*
175	8.25	8.35	8.44	8.54	8.63
200	8.74	8.83	8.93	9.02	9.12
225	9.22	9.32	9.41	9.51	9.60
250	9.71	9.80	9.90	9.99	10.09
275	10.19	10.29	10.38	10.48	10.57
300	10.68	10.77	10.87	10.97	11.06

[a]Value of weaned pig = $30.
[b]Computer model developed by L.L. Bitney, University of Nebraska.

To use the tables, first determine expected improvement in survival rate. Then locate appropriate on-farm corn and soybean meal prices.
If, for example, a producer expects no improvement in preweaning survival rate, corn price is $2.50/bushel and soybean meal costs $250/ton, raw soybeans would be an economical substitute for soybean meal if their loan or cash value is less than $5.77/bushel.
Lactating sows. Feeding raw, full-fat soybeans as the sole source of supplemental protein during lactation decreases sow feed intake, resulting in increased lactational weight loss and reduced pig weaning weight. ***Raw soybeans are not recommended in lactation diets***.
If full-fat soybeans are included in lactation diets, they should be cooked to the same extent as for growing pigs. Cooked soybeans may be particularly useful in lactation diets when sows eat less than 11 pounds of feed/day and pig preweaning survival rate is less than 80 percent (two or more live born pigs die before weaning).

Comparison to Other Fat Sources

Sometimes previous economic analyses suggest full-fat soybeans are not a cost-effective substitute for soybean meal in pig diets. However, as a fat source *per se*, full-fat soybeans could represent a viable alternative to other sources such as tallow, choice white grease, soybean oil, coconut oil, and certain blends.
Ease of handling is an important consideration in evaluating fat sources. Choice white grease and tallow are solid at room temperature and must be melted before they can be blended into diets. In contrast, vegetable oils are liquid at room temperature and can be added to diets easily.
However, when the temperature of vegetable oils drops below about 40°F, heating is required to ensure proper blending of the oil into the diet. Adding fat to diets through full-fat soybeans is easily done over a wide range of environmental temperatures. The fat supplied by full-fat soybeans is in a "dry" form, so many inconveniences associated with handling liquid fat are eliminated.
The economics of adding fat to growing-finishing pig diets is discussed in *Specification Feeding Growing-Finishing Pigs* (NebFact 92-55) available at extension offices. The information in that publication requires that producers know the market price of one pound of fat.
While full-fat soybeans contain 18 percent fat, the price of that fat after it is included in a complete diet is not immediately obvious. *Table XI* shows the cost of added fat supplied by full-fat soybeans in a 15 percent crude protein diet given different corn, soybean meal, and full-fat soybean prices.

Table XI. Cost of fat (¢/lb) supplied by raw or cooked full-fat soybeans in a 15 percent crude protein diet (87 lb added fat/ton of feed).

		Corn ($/bushel)	
Price difference between full-fat soybeans and 44% SBM ($/ton)	*44% SBM ($/ton)*	**2.00**	3.00
	175	**20.8**	18.5
40	225	**24.7**	22.4
	275	**28.6**	26.3
	325	**32.5**	30.2
	175	**23.1**	20.8
	225	**27.0**	24.7
50	275	**30.9**	28.6
	325	**34.8**	32.5
	175	**25.4**	23.1
	225	29.3	27.0
60	275	33.2	30.9
	325	37.1	34.8

The farm prices of full-fat soybeans, 44 percent soybean meal, and corn are needed to use the table. Calculate the price difference between one ton of 44 percent soybean meal and one ton of full-fat soybeans. Given that price difference, choose the appropriate region of the table. Find 44 percent soybean meal and corn prices, and locate the cost of fat. For example, the price of fat supplied by $235/ton full-fat soybeans is 25.4¢/lb when 44 percent soybean meal and corn cost $175/ton and $2/bushel, respectively.
The fat prices in *Table XI* apply when full-fat soybeans represent the sole source of supplemental protein in a complete diet. In this case, a 15 percent crude protein diet contains 87 lb of added fat per ton of complete feed. Some producers may choose to add, for example, only 20 lb of fat to one ton of feed by using a combination of full-fat soybeans and soybean meal in the diet. The fat supplied by full-fat soybeans has a different value depending on the level of full-fat soybeans in the diet.
To adjust the fat prices in *Table XI* for different levels of added fat in the complete diet, use the following formula:
[1 - (A ÷ 87)] x B = adjusted fat price, ¢/lb

where *A = lb of added fat desired/ton of complete feed*

B = cost of fat from Table XI

For example, the fat supplied by full-fat soybeans costs 19.6¢/lb when 20 lb of fat (about 110 lb of full-fat soybeans) is added per ton of feed (see below).
[1 - (20 ÷ 87)] x 25.4 = 19.6¢/lb

Dust Control

Adding ground, full-fat soybeans to pig diets reduces aerial dust levels. Dust in confinement buildings may be decreased 30 to 40 percent by including full-fat soybeans instead of soybean meal in pig diets. Reducing dust levels may improve the health status of pigs and people who work in confinement buildings.

Formulating Diets

Results from Nebraska soybean variety trials indicate the crude protein content of soybeans ranges from 30 percent to 38 percent (13 percent moisture basis). Analyze soybeans for crude protein to help maintain optimum amino acid levels in complete diets. Adjust the lysine content by .064 percent for each 1 percent change in crude protein.
For example, 36.7 percent crude protein full-fat soybeans contains 2.25 percent lysine (*Table I*). If full-fat soybeans analyze 37.7 percent (as-fed basis) the lysine content is probably 2.31 percent (2.25 +.064). As a guide, test every third load of purchased

soybeans or meal. Home-grown soybeans should be tested at harvest and every three months thereafter. See NebGuide *88-892, Mixing Quality Pig Feed*, for details on sampling procedures and laboratory locations.

In general, diets containing full-fat soybeans should contain the same protein and lysine content as those with soybean meal. Exceptions may include diets for growing-finishing pigs fed during the summer and diets for weanling pigs. Under these conditions formulate full-fat, soybean-based diets so they contain slightly more protein (.7 to 1.0 percentage units) than soybean meal-based diets to maintain optimum intakes of amino acids.

Because soybeans contain less protein and amino acids than soybean meal, diets with full-fat soybeans should contain about 20 percent to 35 percent more soybeans by weight than 44 percent soybean meal to achieve expected results. ***Replacing soybean meal with full-fat soybeans on a pound-for-pound basis is not recommended, because the full-fat soybean diet will lack adequate quantities of protein and amino acids.***

Soybeans should be ground through a 1/8" to 1/4" screen and mixed with other diet ingredients before feeding. Because of possible rancidity problems, full-fat soybean-based diets should be consumed within two weeks of preparation. Otherwise, an antioxidant (BHT or ethoxyquin) should be added to the diet. If raw, ground soybeans will be stored during warm weather for more than one week, add an antioxidant when they are ground.

Frost-damaged Soybeans

Frost damage in immature soybeans does not affect their nutritional value for pigs. Apply the same guidelines as described above for normal soybeans.

Summary

Full-fat soybeans are an acceptable source of energy and amino acids for pigs. Because raw soybeans contain several anti-growth factors they must be cooked (commonly by roasting or extruding) before they can be used in all pig diets except diets for gestating sows.

Substituting full-fat soybeans for soybean meal in pig diets improves efficiency of feed utilization in growing-finishing pigs, preweaning survival rate in baby pigs and sow energy intake during lactation. Aerial dust levels also are reduced.

Analyze soybeans for crude protein and urease activity for quality assurance. Formulate diets to contain the same or slightly higher levels of crude protein and lysine as diets containing soybean meal; do not replace soybean meal with full-fat soybeans on a pound-for-pound basis. Evaluate the price relationships between grain, soybean meal, and soybeans to determine the economic feasibility of feeding full-fat soybeans to pigs.