

## **Chapter Two: Quality Standards for U.S. Soybeans and Soy Products**

### **Dependable Quality**

One of the reasons for the dominant position of the United States in the world soybean market is the dependability and efficiency of the domestic and export markets. This is due, in part, to the U.S. marketing system's clear quality standards, which are governed by both contract specifications and a government-regulated system of guidelines that control the export inspection, sampling, grading and weighing of grain and oilseeds. The Federal Grain Inspection Service (FGIS) oversee these standards and inspection procedures.

FGIS is a division of the U.S. Department of Agriculture's (USDA) Grain Inspection, Packers and Stockyards Administration (GIPSA). FGIS establishes the Official Standards for Grain, which are used each and every day by sellers and buyers to communicate the type and quality of grain bought and sold.

The principal functions of FGIS are:

- Establish and maintain official U.S. standards for grain and oilseeds.
- Inspect and weigh grain and oilseeds for export and domestic commerce.
- Establish standard testing methods and procedures and approve equipment used in such inspection and weighing.
- Create a national inspection and weighing system that applies grading and weighing procedures in a uniform, accurate and impartial manner.
- Monitor grain handling practices to prevent fraud, deception and intentional degradation of grain quality by illegal introduction of foreign material or other non-grain material.

Throughout its history, FGIS has performed these functions remarkably well, and it has earned a well-deserved worldwide reputation while doing so. The existence of the system of official U.S. grading standards and an independent, impartial agency to perform the inspection and weighing functions are a distinct advantage for U.S. soybeans over other origins.

### **Grading Standards for Soybeans**

The U.S. Grain Standards Act requires specific standards to identify and measure the important physical characteristics and quality factors for most U.S. grains and oilseeds. The grades, classes and conditions reported on official certificates are determined according to the factors defined in these standards. A grade certificate for each lot or shipment is issued with other conditions, such as insect infestation and noxious odors, noted.

There are three classes of measurements in the U.S. system of grades: grade determining factors, non-grade standards, and informational criteria. Current grading standards list six grade-determining factors for yellow soybeans. These are test weight (bulk density), splits, total damaged soybeans, heat damaged, foreign material and soybeans of other colors. Moisture is a non-grade standard and is determined on each lot with the results appearing on all official inspection certificates. Oil and protein analysis is informational criteria and will be performed upon request.

Grade determining factors use maximum or minimum limits to assign a numerical grade to a sample. The specific grade standards for soybeans are contained in the following table:

**Soybean Grade and Grade Requirements**

Grading Factors	Grades U.S. Nos.			
	1	2	3	4
Minimum limits of				
Test weight lbs/bu	56.0	54.0	52.0	49.0
Damaged kernels:				
Heat (part of total)	0.2	0.5	1.0	3.0
Total	2.0	3.0	5.0	8.0
Foreign Material	1.0	2.0	3.0	5.0
Splits	10.0	20.0	30.0	40.0
Soybeans of other colors 1/	1.0	2.0	5.0	10.0
Maximum count limits of:				
Other materials				
Animal waste	9	9	9	9
Castor Beans	1	1	1	1
Crotalaria seeds	2	2	2	2
Glass	0	0	0	0
Stones 2/	3	3	3	3
Unknown foreign substance	3	3	3	3
Total 3/	10	10	10	10
U.S. Sample grade soybeans that:	<ul style="list-style-type: none"> <li>• Do not meet the requirements for U.S. Nos. 1, 2, 3, 4; or</li> <li>• Have a musty, sour, or commercially objectionable foreign odor (except garlic odor); or</li> <li>• Are heating or of distinctly low quality.</li> </ul>			
	<p>1/ Disregard for Mixed soybeans.                  2/ In addition to the maximum count limit, stones must exceed 0.1 percent of the sample weight.                  3/ Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stone, and unknown foreign substances. The weight of stones not applicable for total other material.</p>			

One of the most significant factors in grade requirements is foreign material (FM). Foreign material is defined as all material that readily passes through an 8/64 inch (3.2 mm), round-hole, perforated sieve and any material other than soybeans remaining atop the sieve. The limitation in U.S. #2 soybeans is two percent. FM levels at the first point of sale in the U.S. are commonly one percent, however, each handling of the soybean lot can generate more FM because of breakage of the soybean seeds, especially when the moisture content is low. The presence of foreign material in soybeans adversely affect storability and drying/aeration efficiency, and, unless removed prior to processing, will affect the quality of both the oil and the protein meal.

A second significant factor in grade requirements is damaged kernels, specifically heat damage. Damaged kernels have an effect on oil quality such as higher acid values, higher peroxide values, higher non-hydratable phosphatides, off color and reduced shelf life. FGIS defines damaged kernels as soybeans and pieces of soybeans that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, stinkbug-stung, or otherwise materially damaged. Stinkbug-stung kernels are considered damaged kernels at the rate of one-fourth of the actual percentage of the stung kernels.

Test weight is a measure of weight per unit volume and expressed in pounds per volume bushel. There is no correlation of test weight to quality factors such as protein and oil and is only useful for determining the relationship between weight and volume when calculating storage space or processing capacity.

Splits are broken soybeans, with one-quarter or more of the seed missing, generally half-pieces, but otherwise undamaged. A 10/64-inch by 3/4-inch (4.0 mm by 19.0 mm) slotted screen is used to separate splits for grade determination. Splits can impact oil quality.

There are two classes of soybeans, yellow soybeans and mixed soybeans. Yellow soybeans have a yellow or green seed coat and are yellow in a cross section. They may not contain more than 10 percent of seeds of other colors. Mixed soybeans are any that do not meet the standard for yellow soybeans.

Moisture content is not part of the grade determining factors but is mandatory information in official inspections. Proper moisture specification and storage management are the keys to successful long-term storage of soybeans. Dependent on end use and ambient storage condition, there is a range of recommended moisture contents considered safe for storage. For direct food use, or for use as seed, moisture at or below 11% is recommended. For solvent extraction, 12.5-14% moisture is suggested if processed within a year. Average moisture beyond 13%, widely divergent moisture lots, or storage conditions that lead to moisture migration and accumulation can often result in serious quality deterioration in a relatively short time span. In most years, U.S. exports of soybeans contain moisture well below 13%.

Protein and oil content are not part of the U.S. Grades but is an important informational factor in quality standards. FGIS will perform an analysis of protein and oil upon request. This analysis is recommended as it provides significant information to determine value or end use preference. Results are reported to the nearest tenth percent on a standard 13% moisture basis or other moisture basis, if desired. The long-term average for soybeans produced in the U.S. is 35% protein and 19% oil on a 13% moisture basis. Soybean protein can be as low as 25% and as high as 50%, although a range of 30% to 40% is common in commodity-type soybeans. Oil content can range from 13% to 25%, with a commodity-range of 16% to 23%.

Grades and quality determination are conducted by FGIS personnel or by other independent inspectors and agencies specifically trained and authorized by FGIS. The inspections follow specified standard procedures. This process assures foreign and domestic buyers that the quality of the U.S. soybeans they receive is what they expected as determined by an independent inspection conducted by trained and unbiased inspectors.

Grade standards do not change by the season or the year or due to a quality problem that may be prevalent in a certain year. They can be and are changed when market practices or commercial realities clearly make the old standards out of date. U.S. government requirements call for a cautious and deliberate rule-making process that relies heavily on public comment and debate. Such changes are infrequent and usually more than a year is required to make changes to grade standards. This provides the interested public notice and time for input before any change in grading standards is officially made.

If an importer of U.S. soybeans believes there is a discrepancy between the grade determined at loading and the quality received at discharge, the importer can file a complaint with the agricultural counselor or attaché at the U.S. Embassy or with the Agricultural Trade Office if there is not an agricultural office at that Embassy. The Embassy forwards the complaint to FAS in Washington, D.C., who submits the complaint to FGIS. Since FGIS keeps file samples from every export shipment for 90 days, the chances are good that the points of the complaint can be compared with that sample. Sometimes, the receiver of the cargo draws a sample at discharge and submits it along with the complaint. If so, it is also examined by FGIS personnel. After collecting all available information, FGIS sends the information and its response back to the Embassy to be passed on to the complainant. FGIS is not empowered to change its original grade certificate, nor will it place itself between buyer and seller as an arbitrator.

### **Weighing and Inspection Procedures**

FGIS is also responsible for the system of weighing grain and soybeans to determine and officially certify exactly the quantity that has been loaded and shipped. Official weighing under FGIS supervision is mandatory for all export shipments of soybeans and grains. Most weighing is done on an electronic weighing system that has been installed and operated under FGIS supervision. This equipment is checked and tested regularly. For export shipments, the complete weighing process is officially supervised from the start of loading until it is completed.

Official U.S. quality inspections are required on most grain and soybean shipments exported from the U.S. Official inspections of domestic shipments of grain and soybeans are not required unless requested by a party with contractual interest in the shipment. Usually, either the shipper or the receiver of domestic grain requests an official inspection to ensure contract terms are met unless both parties are part of the same organization.

If an importing country has phytosanitary regulations prohibiting the entry of certain pests, exporters must determine if that country requires certification that the commodity meets regulations. If so, the cargo is examined by the Animal and Plant Health Inspection Service (APHIS), who then issues the actual phytosanitary certificate stating that the cargo meets the regulations of the importing country. For additional information regarding phytosanitary importing regulations, contact APHIS at 301-734-8537.

The official grain inspection and weighing system serves producers, handlers, processors, exporters, importers and end-users of U.S. soybeans by providing consistent and professional inspection and weighing services. The system includes federal, state, and private agencies authorized by FGIS to provide these services to the domestic and export grain trade. For additional information about U.S. grading, sampling and inspection standards, contact:

USDA, Grain Inspection, Packers and Stockyards Administration  
Federal Grain Inspection Service  
Stop 3601, 1400 Independence Avenue  
Washington, D.C. 20250-3601  
Phone: 202-720-5091  
Fax: 202-205-9237  
Website: <http://www.usda.gov/gipsa>

## Quality Determination for Soybean Meal and Oil

Soybean meal and soybean oil are considered processed products or by-products; therefore, governmental standards have not been established to describe those products. In U.S. domestic markets, the quality specifications and trading rules adopted by the National Oilseed Processors Association (NOPA) serve as “de facto” standards for soybean meal and soybean oil. NOPA is a private trade association consisting of nearly all U.S. oilseed processors. A complete copy of the NOPA trading rules is available at: <http://www.nopa.org/>.

NOPA stresses and makes clear that their specifications and trade rules are not an effort to enforce mandatory rules on contracting parties. Rather, they are only guidelines. Changes can and should be negotiated by contracting parties if desired, or they can be ignored altogether if buyer and seller agree.

Standards for soy protein products, including soy flour, soy concentrates and soy isolates, as well as further processed specialty soy protein products, do not have established quality standards. However, the processor or manufacturer will have product specifications available upon request for review prior to purchase. Certificates of Analysis (COA) should accompany each shipment of the product to verify the actual analysis results for the purchased product.

### ***Soybean Meal***

NOPA standards for soybean meal state that it shall be of fair merchantable quality, conforming to the following standard definitions and standard specifications of the association, as set forth in the NOPA trading rules.

#### *Standard Definitions:*

*Soybean cake* is the product after the extraction of part of the oil by pressure or solvents from soybeans. A name descriptive of the process of manufacture, such as expeller, hydraulic or solvent extracted shall be used in the brand name. It shall be designated and sold according to its protein content.

*Soybean meal* is ground soybean cake, ground soybean chips or ground soybean flakes. As with soybean cake, a name descriptive of the process of manufacture, such as expeller, hydraulic or solvent extracted shall be used in the brand name. It shall be designated and sold according to its protein content.

*Soybean mill feed* is the by-product resulting from the manufacture of soybean flour or grits and composed of soybean hulls and the offal from the tail of the mill. A typical analysis is 13 percent crude protein, 32 percent crude fiber and 13 percent moisture.

*Soybean mill run* is the product resulting from the manufacture of dehulled soybean meal and is composed of soybean hulls and such bean meats that adhere to the hull in normal milling operations. A typical analysis is 11 percent crude protein, 24 percent crude fiber and 13 percent moisture.

*Soybean hulls* is the product consisting primarily of the outer covering of the soybean. A typical analysis is 13 percent moisture and varying degrees of protein and fiber.

*Solvent extracted soybean flakes* is the product obtained after extracting part of the oil from soybeans by the use of hexane or homologous hydrocarbon solvents. It shall be designated and sold according to its protein content.

*Standard Specifications:*

Soybean Flakes and 44% Protein Soybean Meal are produced by cracking, heating, and flaking soybeans and reducing the oil content of the conditioned product by the use of hexane or homologous hydrocarbon solvents. The extracted flakes are cooked and marketed as such or ground into meal. Standard specifications are as follows:

<b>Protein</b>	Minimum	44.0%
<b>Fat</b>	Minimum	0.5%
<b>Fiber</b>	Maximum	7.0%
<b>Moisture</b>	Maximum	12.0%

Soybean Flakes and High Protein or Solvent Extracted Soybean Meal are produced by cracking, heating, and flaking dehulled soybeans and reducing the oil content of the conditioned flakes by the use of hexane or homologous hydrocarbon solvents. The extracted flakes are cooked and marketed as such or ground into meal. Standard specifications are as follows:

<b>Protein</b>	Minimum	47.5-49.0%*
<b>Fat</b>	Minimum	0.5%
<b>Fiber</b>	Maximum	3.3-3.5%*
<b>Moisture</b>	Maximum	12.0%

(\*as determined by buyer and seller at time of sale.)

Any of the above meal products may contain a non-nutritive, inert, nontoxic conditioning agent to reduce caking and improve flowability in an amount not to exceed that which is necessary to accomplish its intended effect and in no case to exceed 0.5 percent or 10 pounds per ton by weight of the total meal product. The name of the conditioning agent must be shown as an added ingredient.

**Soybean Oil**

Soybean oil like soybean meal is not covered by governmentally prescribed standards. There are a number of standard specifications for soybean oil that could be used in international trade. For the domestic market, NOPA has generated export trading rules for three types of soybean oil; i.e., crude degummed, once refined and fully refined. For crude degummed and once refined oils only NOPA trading rules are in common use in the U.S. For fully refined oils there are two other standard specifications issued by governmental agencies that do not carry the weight of an “official” U.S. standards and are not widely used in private trade. In practice, end users have their own specifications for fully refined oils and only use NOPA trade rules as the absolute minimum values on which to build their own more stringent requirements.

NOPA defines the standard of quality for soybean oil as a designated type of pure soybean oil of fair average quality based on the season’s production, which must conform to standard specifications of the Association, must be made a part of NOPA

trading rules and are subject to modification from time to time as conditions may warrant and upon recommendation of the technical committee. Current NOPA trading rules are available at: <http://www.nopa.org>.

NOPA defines the types of crude soybean oil and says that edible crude soybean oil is any of the following designated types:

- Expeller pressed
- Expeller pressed degummed
- Hydraulic pressed
- Hydraulic pressed degummed
- Solvent extracted (state solvent used)
- Solvent extracted degummed (state solvent used)
- Mixtures of any of the above types. (In which case the seller should specify that the analysis be made corresponding to one of the specific types.) (State solvent used.)

The primary traded soybean oil in the U.S. is crude degummed soybean oil. It is defined as the product resulting from the removal of phosphatides from crude soybean oil and should contain no more than 0.02 percent of phosphorous determined by the American Oil Chemists Society (AOCS) Official method, Ca 12-55. Crude soybean oil is sold as a degummed oil because of the tendency of gums to settle out during transportation, which can cause numerous difficulties with emptying and cleaning the transportation equipment.

The grade and quality of crude soybean oil sold under this rule are to be any of the above designated types and conform to the following specifications:

- Not more than 0.5 percent moisture and volatile matter.
- A refined and bleached color not darker than 6.0 Red.
- A neutral oil loss not exceeding 7.5 percent.
- Not more than 1.5 percent unsaponifiable matter (exclusive of moisture and insoluble impurities).
- A flash point not lower than 250 degrees Fahrenheit.

For crude degummed soybean oil, the specific standards are:

Analytical Requirements	Maximum	Minimum	Method
Unsaponifiable Matter	1.5%		Ca 6a-40 (97)
Free Fatty Acids, as Oleic	0.75%		Ca 5a-40 (97)
Moisture and Volatile Matter and Insoluble Impurities	0.3%	M&V	Ca 2d-25(97) Ca 3a-46(97)
Flash Point		250 Degrees F	Cc 9c-95(97)
Phosphorous	0.02%		Ca 12-55(97)

The chemical analysis to determine quality includes the qualitative test for fish oil and marine animal oils as prescribed by the AOAC Method No. 28.121 and should be negative.

Only the following are allowable with discounts to apply as shown:

**Free Fatty Acids**

0.76-0.85%	0.2% of contract price
0.86-0.95%	0.4% of contract price
0.96-1.05%	0.6% of contract price
1.06-1.15%	0.8% of contract price
1.16-1.25%	1.2% of contract price

**Phosphorous**

Shipment up to 0.025 percent permitted with the following discounts for excess over 0.020 percent:

0.021%	0.2% of contract value
0.022%	0.4% of contract value
0.023%	0.6% of contract value
0.024%	0.8% of contract value
0.025%	1.2% of contract value

To be pure soybean oil, its physical requirements are that it be crude degummed soybean oil sold for export. It is to be produced from fair average quality crude soybean oil from which the major portion of the gums naturally present have been removed by hydration and mechanical or physical separation. It is to be in equal quality to soybean oil produced for domestic consumption. Crude degummed soybean oil not meeting the above specifications is rejectable and should be sold by sample only.

Once refined oil is not a commonly traded commodity since most buyers are interested in doing their own refining to finished product and will buy crude degummed or have no refining capacity and would buy fully refined (refined, bleached and deodorized, RBD). However, for those interested, refer to the NOPA trading rules.

In the definitions of grade and quality of export oils, all quality determinations shall be made from a composite sample of the shipment. NOPA regulates the determination of grade and quality by methods and sampling rules.

NOPA has also developed a standard for inspection, sampling and measuring procedures for bulk shipment and transfers of soybean oils. This standard may be incorporated in sales contracts.

It is very important that buyers and importers of U.S. soybeans and soybean products realize that any quality specification can be subject to modification through negotiations between buyer and seller and that any modification agreed to would replace any so-called “standard” specification as a term of the contract. Standards established by FGIS or NOPA regarding quality specifications, grades or terms are negotiable. Any change that is physically possible to achieve can be made part of any contract between a buyer and seller if both parties agree to the change and to whatever adjustment in the contract price and other contract terms that may be necessary to accommodate a change in quality specifications.

## Impact of Quality and End Results

### *Quality vs. Price*

The most important considerations in purchasing soybeans are all related to economics. When several sources of a raw material are available with different price and quality characteristics, a decision must be made to select the best value for the company. In the end, this will depend not only on the price and quality of the ingredients in question but also on the prices and nutritional levels of other ingredients and the demand for nutrients in each formula required.

In the processing of feed for use in aquaculture, poultry, swine, and cattle, the quality of soybean meal can have a profound effect on animal performance and profitability. Soybean meal must be toasted to denature certain proteins with antinutritional properties such as trypsin inhibitors. Too little toasting results in a meal with low digestibility. Too much toasting also results in a meal with low digestibility as amino acids can be denatured. Perfectly toasted meal is best for high animal performance and profit. The nutrients most sensitive to heat damage are the amino acids lysine and cystine. However, other amino acids and energy may also be affected by excess toasting.

The protein solubility test (KOH) and protein dispersibility index in water (PDI) have been found useful in estimating the degree of toasting and damage in soybean meal. Meals with a KOH between 73 and 88% are considered acceptable quality. However, the best meals within this KOH acceptable range can be determined using protein dispersibility index (in water) of PDI. Soybean meal tested to have PDI between 20% and 35% with urease levels between 0.3 delta pH units (but above 0.01) gives the best animal performance.

The energy content factor is often overlooked because it is expensive to test. Soybean meal supplies approximately 25% of the energy to animal feeds. Dehulled soybean meal, such as that produced in the U.S., not only has higher protein (48% vs 44%) but also higher energy content as compared to non-dehulled meal. Removal of indigestible hulls increases the level of all nutrients in the meal, not just protein. Hulls have relatively little protein, amino acid or energy content for poultry, swine or fish. Depending on the residual fiber content and other factors, dehulled soybean meal contains about 150 kcal/kg more energy than soybean meal with hulls.

Following is an economic case for purchasing dehulled soybean meal.

Table 1 defines the units of protein contained in several differing qualities of soybean meal. Meal A, purchased on a 44% “pro-fat” contract contains 40.5% protein; Meal B contains 44% protein; and Meal C is dehulled soybean meal containing 48% protein.

<b>Amount of Protein Contained Per Ton in Soybean Meals of Varying Quality Specifications</b>		
<i>Sample</i>	<i>Type of Soybean Meal</i>	<i>Total Protein (kg/MT)</i>
Meal A	44% Profat (40.5% Protein)	405
Meal B	44% Protein	440
Meal C	Dehulled (48% Protein)	480

To determine the cost per unit of protein, the total price at the feed mill is divided by the amount of protein received. While the price per metric ton will vary at the F.O.B. port, the cost for ocean freight and local transportation will be the same. Import duty and other taxes are normally based upon landed tonnage or value. These duties may vary. Table 2 compares the three types of soybean meal based on cost per unit of protein delivered.

<b>Table 2</b>			
<b>Economic Comparison of Cost Per Unit of Protein Of Three Types of Soybean Meal (\$US)</b>			
<i>Cost Factor</i>	<i>40.5 % Protein</i>	<i>44% Protein</i>	<i>48% Protein</i>
Price \$US/MT FOB	\$228	\$235	\$245
Ocean Freight	40	40	40
Unloading, local freight	10	10	10
Cost at Feed Mill	278	285	295
Price ÷ Kg of Protein	\$278/405 Kg	\$285/440 Kg	\$295/480 Kg
Price per Kg of Protein at Feed Mill	\$0.686	\$0.648	\$0.615

Based on the comparative costs presented in Table 9 it is obvious that the logical choice should be dehulled (48% Protein) soybean meal. Although it costs \$17/MT more than 44% profat and \$10 more than 44% protein soybean meal, its price per unit of delivered protein is decidedly lower.

As demonstrated in Table 3, the variation in protein content between 40.5% and 44% protein soybean meal is not 3.5%. In fact, 44% protein is more than 6% higher than 40.5% (3.5 + 41.5). The far right column demonstrates the added value of purchasing 48% protein soybean meal versus 44% profat. That is, at the feed mill even after paying the higher price for 48% protein soybean meal the feed mill receives 8.25% more value by purchasing 48% meal.

Further advantages of dehulled soybean meal are not reflected in the above analysis. These factors include lower fiber, higher metabolizable energy, and lower coefficients of variability. This latter attribute enables the feed miller to make lower allowances for variations, translating into less over formulating and better utilization of the protein.

<b>Table 3</b>			
<b>Variation in Quantity and Value of Soybean Meals of Differing Protein Contents to supply 10,000 MT of Protein</b>			
<i>Type of Soybean Meal</i>	<i>Variation in Protein (%)</i>	<i>MT Soybean Meal</i>	<i>Variation in Value (%)</i>
44 Profat (41.5)	0	24,096	0
44% Protein	6.02	22,727	3.31
Dehulled (48%)	14.77	20,833	8.25

Based on the foregoing quality considerations and economic analyses, it is recommended that the soybean meal buyer specify at a minimum soybean meal quality characteristics as shown in Table 4.

<b>Table 4</b>	
<b>Recommended Purchase Contract Specifications For US Soybean Meal</b>	
<i>Factor</i>	<i>Specification</i>
Protein	Minimum 48%
Fat	Minimum 0.5%
Fiber	Maximum 3.3%
Moisture	Maximum 12%
Urease Activity	pH rise between 0.12 and 2.0 units

Buyers should specify quality no lower than that contained in NOPA domestic trading rules, and that a minimum specification for proper heat treatment also be incorporated into the contract. This presumes that the purchaser will buy dehulled soybean meal and that the meal will be fed to non-ruminants.