

## Specialty Soybean Production and Management in Kentucky

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Kentucky farmers are interested in increasing market share on crops such as soybeans. While soybeans are commonly grown for oil or protein and marketed through the commodity grain markets, other types of soybeans, or “specialty soybeans,” are grown for specific markets and could offer a premium or a secure market.

Soybeans originated in Asia, where people have been eating the whole soybean seed for centuries. Records indicate that soybeans were perceived to have medicinal value in Asia 2,000 years ago. While soybean oil is a common ingredient in many foods, eating the entire soybean seed or soy foods is a relatively new concept in North America. This new concept could create added value for the soybean crop.

Farmers must consider markets, soybean types, adaptability of these soybeans, agronomic management, harvest, and handling before raising specialty soybeans.

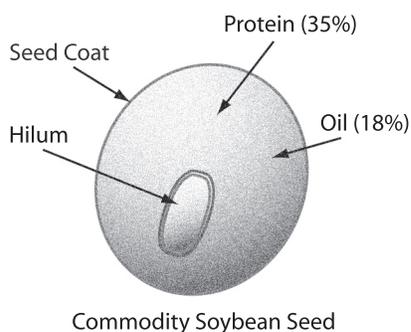


Figure 1. Seed (at 13% moisture) of typical commodity soybean grown in Kentucky.

### Markets

Specialty soybeans are raised for specific markets and should be grown only under contract. The specialty markets have more stringent standards for seed type and quality than the commodity soybean market. Buyers of specialty soybeans typically require a quality rating of Grade U.S. No. 1 or higher (Table 1); whereas, the commodity soybean market is based on a standard of Grade U.S. No. 2. Uniform seed size is very important for specialty markets. Seed lots free of weed seeds and inert material are preferred, and in some cases, demanded. Specialty soybean markets

require fewer defects, such as breaks or discoloration, in seed coats. Staining from weed seeds is heavily docked. Currently, there are no U. S. marketing standards for edamame soybeans. However, buyers/consumers would expect to have pods that are neither seedless nor damaged.

Specialty soybean contracts reflect the desires of the consumer, and many consumers seem to prefer non-genetically-modified soybeans and/or organic production practices. While the contracts for most specialty soybeans offer a premium, producers will need to determine if the premium and the value of a secure market offset the additional management and probable lower yields associated with specialty soybeans.

While a producer of commodity soybeans often has very little interaction with the person buying the soybean, a producer of specialty soybeans should develop a relationship with a specialty soybean buyer. Finding buyers can be a challenge. One avenue is working with exporters of specialty soybeans. The American Soybean Association has a list of food grade exporters, which are listed at the following Web site: <http://www.soygrowers.com/library/export%20resources/ExportersFoodGradeSoybeans.htm>

**Table 1.** United States Grades and Grain Requirements for Soybeans. (Adapted from United States Standards for Soybeans)

Grading Factors	Grades	
	U.S. No. 1	U.S. No. 2
Minimum test weight per bushel	56.0	54.0
Damaged Kernels	Maximum Percent Limits	
Heat (part of total)	0.2	0.5
Total	2.0	3.0
Foreign Material	1.0	2.0
Splits	10.0	20.0
Soybeans of Other Colors <sup>1</sup>	1.0	2.0
Other Materials	Maximum Count Limits	
Animal Filth	9	9
Castor Beans	1	1
Crotalaria Seeds	2	2
Glass	0	0
Stones <sup>2</sup>	3	3
Unknown Foreign Substance	3	3
Total <sup>3</sup>	10	10

<sup>1</sup> Disregard for mixed soybeans. Stones must not exceed 0.1 percent of the sample weight.

<sup>2</sup> In addition to the maximum count limit, stones must not exceed 0.1 percent of the sample weight.

<sup>3</sup> Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, and unknown foreign substances. The weight of stones is not calculated in total other material.

## Soybean Types

All of the soybeans discussed in the publication are of the same genus and species (*Glycine max* L. Merrill) and are segregated by seed traits that make them suitable for a particular market. Commodity soybean characteristics will be described first to serve as a comparison with other types.

### Commodity Soybeans

Most soybeans produced in Kentucky and the United States are grown for oil and meal production and are sold on the cash grain market. The seeds of these varieties are yellow to brown in appearance with black, imperfect black, buff, or brown hila (scars where the seeds were connected to seedpods).

Commodity soybean seeds in Kentucky range in concentration from 34 to 39% protein and 16 to 20% oil at 13% moisture and typically range in size from 2,600 to 3,600 seeds per pound.

Commodity soybean seeds typically are not consumed directly by humans, but are crushed for oil that is used for cooking and as an ingredient in crackers, cookies, pastries, and other snack foods. The meal residue left after the oil is extracted from the seed contains about 44% protein. Dehulled soybean meal contains approximately 47 to 48% protein. Soybean meal is used mainly for animal feeds but is also used to a lesser extent as a protein source in food.

### Tofu

Soybeans raised for tofu currently are the largest sector of the specialty soybean market. These seeds also are used in soy milk. Soy milk is normally produced by soaking whole beans with water and then grinding. Tofu is a cheese-like substance that is produced by coagulating the protein in soy milk to make a food with 5 to 15% protein. Tofu can be eaten raw or cooked and can be used as a meat substitute in some food products or recipes. Seeds of tofu varieties are higher in protein (40% or higher) and lower in oil concentration than commodity soybean seeds. Tofu type seeds must have clear hila and a large size.

### Natto

Natto is traditional Japanese soybean food. The seeds are served whole after fermentation, often on top of rice. Smaller seeds, clear hila, and higher starch (or sugar) concentrations are preferred for better fermentation. A new germ plasm line for the natto market, S99-3181, also has resistance to soybean cyst nematode.

### Sprout

Small to medium-sized seeds are preferred for the sprout soybean market.

### Edamame (vegetable)

Edamame (pronounced “edd-a-mommy”) soybean seeds are eaten while still green, either raw or cooked, and are sometimes referred to as “vegetable” soybeans. Some markets offer fresh pods with seeds, and other markets offer the entire cut plant. Only the green seed is consumed. Large seeds with thin seed

coats and clear hila are preferred in this market. High sugar and free amino acid concentrations are desirable for better palatability. Since edamame seeds are eaten green, producers must harvest them at full seed development and prior to maturity (R6 growth stage). Harvesting fresh, entire soybean pods and fresh, entire plants produces a higher premium than just harvesting the seeds.

### Soy Nuts

Large seeds, clear hila and thin, seed coats are preferred for the soy nut market. Soy nuts are harvested as ripe seeds, cleaned, and roasted. Salt or flavors are often added to provide options for the consumer. Soybeans grown for the edamame market would be good candidates for the soy nut market.

### Other Specialty Soybeans

Scientists are trying to modify certain soybean characteristics for various nutritional markets. Modifications include reducing the need for hydrogenation of the oil, increasing sugar concentration, increasing protein concentration, decreasing concentration of saturated and polyunsaturated fats, and removing some of the flavors that are objectionable to some consumers. The soybean types described below are in various stages of development, and some of these lines are being tested in the Kentucky Soybean Performance Tests.

#### Lipoxygenase Free

Three lipoxygenase enzymes in soybean seeds produce a “bean” flavor that is objectionable to some consumers. The three enzymes causing this flavor have been removed from some lines. Efforts are under way to develop adaptable varieties with this trait. Varieties currently tested in the variety trials are referred to as “triple null” soybeans, referring to the removal of the three enzymes.

#### High Sucrose

These soybean seeds contain higher sucrose concentrations than seeds from commodity soybean varieties and are used to improve food product flavor.

#### High Oleic

Foods produced with high oleic acid soybean oil are believed to be more heart healthy. This type of soybean has an oleic acid concentration of up to 80% (compared to 23% from seeds of commodity varieties) and also contains less polyunsaturated fat. These factors reduce the need for hydrogenation, a process that increases saturated fat and produces most of the trans-fatty acids in foods.

#### High Stearate

Oil from these soybean seeds has a much higher stearate concentration (about 15% or higher) than the 4% in oil from seeds of commodity varieties. Like high oleic oil, high stearate oil does not require hydrogenation. The reduced hydrogenation will result in oil and foods that are perceived to be healthier. High stearate oil is used for margarine and shortening.

### Low Linolenic

Linolenic acid is a highly unstable polyunsaturated fat, and the oil from low linolenic soybean seeds has approximately half the linolenic acid concentration (3.5%) of oil from commodity seeds. The low concentration of linolenic acid improves stability of the soybean oil, reducing or eliminating the need for hydrogenation in many foods. The oil from these seeds is also used for industrial lubrication.

### Low Saturate

The oil from these soybean seeds has approximately 50% less saturated fat (particularly the undesirable palmitic acid) than oil from the commodity soybean varieties. Less saturated fat results in a healthier oil that is used for cooking oils, salad dressings, and other food products.

### High Protein

These soybean seeds contain slightly higher protein concentrations (about 1 to 2%) than seeds from commodity soybean varieties. Processors are interested in high-protein soybean seeds because more protein per pound of seed can be extracted for use in soy foods such as soy flour, soy protein concentrates, isolated soy proteins, textured soy protein, soy meat analogs, and other soy food products.

Soybean seeds produced in Michigan, Ohio, and the Southeast typically have higher protein concentrations than seeds produced in other areas of the United States. High-protein soybeans are being developed for the Midwest.

Weather conditions as well as geography affect protein concentration in soybean seeds. As a result, high-protein soybean seeds cannot be guaranteed at planting.

### Adaptability

Specialty soybean varieties typically have been in the maturity group II or early III range, making these varieties less suitable to Kentucky. Scientists are developing specialty soybean varieties in maturity groups III, IV, and V. The majority of specialty soybean varieties available for Kentucky are in maturity group III.

The Kentucky Soybean Performance Test evaluates several of these specialty soybean varieties each year. The yield and concentrations of protein and oil of each variety is reported. These reports provide a very good comparison with commodity soybean performance. Specialty soybeans typically yield about 15% less than commodity soybeans in these tests.

### Agronomic Management

With some exceptions, management of specialty soybean crops is similar to management of commodity soybeans from planting to harvest, but it differs from harvest to sale. The following section addresses some of these similarities and differences.

### Variety Selection and Fertilization

Variety selection of specialty soybeans should be based on market demand and adaptability. The contracts for specialty

soybeans dictate what type of soybean should be grown and may dictate which varieties should be grown. In these cases, check the variety specified to determine if it is suitable to Kentucky. If the contract does not specify a variety, consult the Kentucky Soybean Performance Test for comparison of several specialty soybean varieties.

Fertility practices for specialty soybeans are similar to fertility practices for commodity soybeans. See AGR-1, *Lime and Fertilizer Recommendations*, for more details.

### Planting Practices

Planting practices for specialty soybean varieties are similar to those for commodity soybean varieties. Optimum planting dates for Western Kentucky range from May 1 through June 10, while the optimum planting dates for Central and Eastern Kentucky range from May 15 to June 15. Soybeans should be planted at 1 to 1.5 inches deep into moist soil. Avoid planting deeper than 2 inches in most soils. Soybeans can fix nitrogen if they have been inoculated. If a field has not grown soybeans for four or five years, the seeds should be inoculated with *Bradyrhizobium japonicum*. More information on the inoculation process is available in AGR-130, *Soybean Production in Kentucky, Part III: Planting Practices and Double Cropping*.

The seeds of specialty soybean varieties have a wide range of sizes, so knowing the size of seed is critical to planting the proper amount of seed. Seeding rates should be calculated on seeds per acre and not pounds per acre to keep from planting too many or too few seeds. Table 2 contains the recommended seeding rates for Kentucky soybeans. The higher rates within each row spacing are for soybeans planted later in the season or in unfavorable planting conditions or those with poor seed quality. These rates provide a balance between maximizing early crop canopy development and minimizing lodging.

Seeding costs may be more expensive for specialty soybeans than for commodity soybeans. Some types of specialty soybeans sell at a higher seed cost per unit because of lower availability and/or additional costs associated with production and management. Likewise, some specialty soybeans have a large seed size and will require more pounds of seed per acre to achieve the recommended seeding rate.

Row widths suitable for commodity soybean production in Kentucky would be suitable for most specialty soybeans as well. One exception to this would be edamame soybeans, which should be in at least 30-inch-wide rows to facilitate with either modified equipment or hand labor. Specialty soybeans in maturity groups earlier than group III would likely benefit from row widths of 20 inches or narrower.

**Table 2.** Recommended soybean seeding rates for Kentucky.

	Row Spacing (Inches)			
	7	15	20	30
Seeding Rate (Seeds/Ft of Row)	2 – 3	5 – 6	6 – 8	8 – 10
Expected plants / acre*	119,000 – 179,000	139,000 – 167,000	125,000 – 167,000	111,000 – 139,000

\*Assumes 80% emergence of planted seed.

## **Weed, Disease, and Insect Control**

Keeping specialty soybeans free of weeds is extremely important because of the need for clean, non-stained seeds. Nightshade and pokeweed seeds will stain soybean seeds and are not acceptable in specialty soybean fields. Most farmers raising commodity soybeans are using Roundup Ready varieties and have become accustomed to spraying glyphosate to control weeds with little to no injury to soybeans. Specialty varieties are not Roundup Ready and will require the use of other herbicides or alternative weed control methods. Farmers have been successful at controlling weeds in fields with non-Roundup Ready soybeans for many years, and it is still possible. *AGR-6: Weed Control Guide Recommendations for Field Crops* contains information on specific herbicides and other aspects of weed control.

Specialty soybean varieties are susceptible to the same diseases and insects as commodity varieties. Specialty varieties typically have fewer disease-resistance traits than current commodity soybean varieties. For example, specialty soybean varieties may not have resistance to pathogens such as soybean cyst nematode. Crop rotations to keep disease pressures low are critical for specialty soybeans. Insect and disease management are more important for specialty soybeans because of the stricter requirement for less seed damage or defects. The edamame soybean, in particular, has enhanced marketability and appeal to buyers and consumers if the green seeds, pods, or entire plant is not damaged by diseases or insects. Two publications, PPA-10, *Kentucky Plant Disease Control Guide for Field Crops*, and ENT-13, *Insecticide Recommendations for Soybeans*, provide information on pesticides for management of diseases and insects.

Many pesticides have a preharvest interval, which is the time allowed between pesticide application and harvest. Since some specialty soybean varieties are harvested earlier than commodity soybeans, the preharvest interval must be considered before using the pesticide.

## **Harvesting and Handling**

The harvesting and handling practices for specialty soybeans can differ greatly from those used for commodity soybeans. Edamame vegetable soybeans are harvested once the plants reach R6 growth stage (full seed), when the seed and plants are still green. Since these green seeds are very moist, gentle harvesting and handling is necessary to prevent damage. Edamame soybeans are perishable and should be marketed within 24 hours of harvest or refrigerated and sold within a few days. Planting edamame soybeans across a range of dates would spread out harvest and also lengthen the market season. The edamame market pays higher premiums for either detached pods with seeds or fresh whole soybean plants with seeds in the pods. Harvesting individual pods or whole plants cannot be accomplished with a

regular soybean combine and will require different machinery, such as a modified green bean picker, and/or a larger labor force. Other specialty soybeans are harvested after seed moisture drops below 16% but before it reaches 11%, similar to commodity soybeans.

Mechanical damage to specialty soybean seeds when harvested, dried, stored, and shipped must be minimized. Harvesting and handling seed at moistures less than 11% must be avoided. In addition, proper equipment function is necessary to minimize damage and losses. All equipment and storage facilities must be clean of seeds from other varieties or plants, dirt, pathogens, and other foreign material before using for specialty soybeans. Some contracts may require an inspection of the handling and storage facilities.

Identity preservation of specialty soybeans is necessary to ensure that the soybean seeds harvested for a specific market are shipped to that market. The need to keep specialty soybeans separate from commodity soybeans may require adjustments to normal harvest schedule, additional storage facilities, and/or different handling equipment. These markets may require the seeds to be at a certain moisture level, which could require seed conditioning equipment. Specialty soybean markets may require the seeds to be delivered to a specific elevator or other handling facility.

## **Organic Soybean Production**

Some specialty markets require soybeans to be raised according to organic standards. In general, organic markets demand that organically-grown soybean seeds be seeded, grown, harvested, and handled without synthetic fertilizers or synthetic pesticides. In some markets, the field in which the soybeans are being raised cannot have received synthetic fertilizers or synthetic pesticides for three years or more prior to the current crop of soybeans.

Soil fertility in organic conditions will rely heavily on animal waste, which has its own set of requirements. Weed control will rely on a combination of crop rotation, tillage prior to plant, inter-row cultivation, and hand-weeding. Insect and disease control is managed primarily through crop rotation, although some pesticides produced by living organisms are allowed. Clean storage facilities are a must for organically-grown soybeans.

Individual markets may have their own set of standards for organically-grown soybeans. When considering organically-grown soybeans, be sure to review the contract requirements and factor in the additional costs associated with changes in management.

## **Making a Decision**

Use the following as a guide to determine if specialty soybeans are an option for your business.

<b>Are Specialty Soybeans an Option for You?</b>		
<b>Factors to Consider</b>	<b>Specialty Market</b>	<b>Commodity Market</b>
<b>1. Market Available (Yes or No)</b> If No for Specialty Market, then proceed no further.		
<b>2. Soybean Type</b> Record available specialty market. Use <i>commodity</i> for Commodity column.		
<b>3. Variety Adaptability, Expected Yield (bu/A)</b> If variety is not in the Kentucky Soybean Performance Test, then assume a 15% lower yield for the specialty soybean. Use the five-year average for the commodity.		
<b>4. Expected Price (\$) per Bushel</b> Specialty: Based on specialty contract prices. Commodity: Based on commodity prices as influenced by the Chicago Board of Trade.		
<b>5. Expected Gross Return (\$) per Acre</b> (Multiply Line 3 x Line 4) If commodity gross return per acre exceeds specialty gross return per acre, you likely will not need to proceed further.		
<b>6. Seed Cost (\$) per Acre</b> Seeding rate should be assumed similar for both categories unless the specialty market outlines a seeding rate that is different from your normal seeding rate. Seed cost per unit may be more expensive for a specialty soybean variety.		
<b>7. Fertilizer Cost (\$) per Acre</b> Should be similar unless the specialty market outlines a different level or type of fertilizer.		
<b>8. Weed Control Cost (\$) per Acre</b> Specialty market may specify what herbicide(s) to use. Roundup Ready likely will not be an option in specialty markets. If herbicides are not allowed, then factor in additional tillage, inter-row cultivation, and/or hand-weeding costs.		
<b>9. Insect Control Cost (\$) per Acre</b> Specialty market may specify what insecticide(s) to use.		
<b>10. Disease Control Cost (\$) per Acre</b> Specialty market may specify what fungicide(s) to use.		
<b>11. Harvest Cost (\$) per Acre</b> Will be similar for most specialty soybeans and commodity soybeans, except for edamame soybeans, which require an earlier harvest and different machinery or more labor. Include additional labor costs, if applicable.		
<b>12. Cleaning Cost (\$) per Acre</b> Most commodity soybeans are not cleaned. The specialty market may require soybean seeds to be cleaned prior to delivery.		
<b>13. Storage Cost (\$) per Acre</b> Should be similar between both categories, unless the specialty market requires a specified delivery date for the soybean seeds.		
<b>14. Shipping Cost (\$) per Acre</b> Should be similar between both categories, unless the specialty market requires soybean seeds to be delivered to a location different than commodity soybeans.		
<b>15. Other Cost (\$) per Acre</b>		
<b>16. Other Cost (\$) per Acre</b>		
<b>17. Total Production, Harvest, and Handling Costs (\$) per Acre</b> Sum of lines 6 through 16.		
<b>18. Expected Net Return (\$) per Acre</b> Line 5 minus Line 17.		

This checklist is a guideline but is not comprehensive in all costs and returns associated with all farming operations. For example, the cost of time associated with management of a specialty soybean versus a commodity soybean was not included. In addition, there are no specific lines for additional equipment or tillage costs, but differences can be included in the lines listed as “other” costs per acre. Another item not included is the cost of the transition from a conventional field to an organic field if the market demands organic production.

Web sites with more information on specialty soybeans or organic production guidelines include:

- American Soybean Association, Exporters of Food Grade Soybeans  
<http://www.soygrowers.org>  
<http://www.soygrowers.com/library/export%20resources/ExportersFoodGradeSoybeans.htm>
- Illinois Specialty Farm Products, University of Illinois  
<http://web.aces.uiuc.edu/value/factsheets/soy.htm>
- Ohio FG1 and FG2 Soybean Varieties, Ohio State University Special Circular 151-96  
[http://ohioline.osu.edu/sc151/sc151\\_9.html](http://ohioline.osu.edu/sc151/sc151_9.html)
- ATTRA - National Sustainable Agriculture Information Service  
<http://attra.ncat.org/attra-pub/ediblesoybean.html>
- USDA, National Organic Standards Board  
<http://www.ams.usda.gov/nosb/>