

Quality of the United States Food Soybean Crop: 2007¹

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Summary

The American Soybean Association has supported a survey of the quality of the US commodity soybean crop since 1986. That survey is intended to provide new crop quality data to aid international customers with their purchasing decisions for the upcoming year. The food soybean survey is being conducted for the first time in 2007, and also is intended to assist international buyers, as well as to provide producers valuable quality information.

2007 Acreage, Yields, and Total Production

According to the October 12, 2007 USDA-NASS crop report, the total US soybean production area is expected to decrease 16% from last year to 25.4 million hectares harvested. With average yields also expected to be lower than in 2006, total US soybean production is expected to be only 70.8 million MT. If realized, this will be only slightly larger than the disastrous 2003 crop of 67.2 million MT, and a large decrease from 2004-2006 crops that averaged 85 million MT. Data are shown in Table 1.

Quality of the 2007 US Food Soybean Crop

From late August through mid September, we distributed a total of 670 food soybean sample kits to food bean contracting companies. Participating companies provided a total of 210 samples as of December 7, 2007. These samples were analyzed for protein and oil concentration by near-infrared spectroscopy (NIRS) using a Pertent DA7200 diode array instrument (Huddinge, Sweden) equipped with calibration equations developed at the University of Minnesota. Results can be found in Tables 2 and 3.

Interpretation of Protein and Oil Results

Average protein values for the food bean samples across seed size categories by region (Table 2) show lower (by ~1.7%) protein concentrations in the Northern Corn Belt (NCB) region than in the Central Corn Belt (CCB) and Eastern Corn Belt (ECB) regions. Upon closer examination of the protein concentrations by seed size in the three regions, we see that the small and average seed size samples pull down the overall NCB regional average disproportionately, in part due to

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the much greater representation of small-seeded samples from the NCB. The large seed size NCB samples are more closely aligned with the large seed size averages for the other two regions. Oil concentrations in the NCB were higher than in the CCB and ECB, when comparing within and across seed size classes.

When the sample data are categorized by the end use information supplied by the individual submitting the sample (Table 3), a trend similar to that found in Table 2 can be seen. Average protein concentrations in the NCB are about 1.5% lower than in the CCB and ECB. Again, the disproportionately large number of natto and miso types in the NCB versus the CCB and ECB, likely lowers the NCB regional average for protein. This is not surprising, as natto and miso types tend to be lower protein than tofu types. Oil concentrations in the NCB again were higher than in the CCB and ECB.

Soluble sugars

Some international customers have expressed interest in soluble sugar concentrations within the US soybean crop. Soluble sugars are difficult to accurately quantify by traditional wet chemical analysis and NIRS technology. A small subset of samples (30) was analyzed for soluble sugar concentrations using wet chemistry. Results can be found in Tables 5 and 6. A large sample-to-sample variability in all soluble sugar values was identified. This indicates that local environmental conditions may play a large role in determining relative concentrations of important soluble sugars. In general, average seed size samples from the NCB were higher in sucrose and lower in raffinose and stachyose than average seed size samples from the CCB.

US Commodity Soybean Survey

The quality of the overall US soybean crop is estimated yearly by a separate project supported by the international marketing committee of the American Soybean Association (ASA-IM). In August of 2007, 9187 sample kits were mailed to US soybean producers. Producers were surveyed in proportion to the total production within each of 30 US states. As of October 31, 2007, 1685 samples were received and analyzed. Average protein and oil concentrations for the overall US soybean crop were similar, to those described in the 2006 quality survey. Average US soybean protein concentration was higher in 2007, at 35.4% and average oil was slightly lower, at 18.7%. Region by region analysis indicates almost identical trends as were noted in 2006, except that regional protein values tended to be about 0.9 percentage points higher, while oil was about 0.5 percentage points lower.

Midwest climate summary

April average daily temperatures were below normal across most of the Midwest, following much warmer than normal temperatures the last ten days of March. From April 6-9, temperatures averaged 7-11°C below normal across the Midwest. In Minnesota, the first week of April brought a spring snow storm, and the third week brought 2-3 times normal weekly

precipitation in the form of showers and thunderstorms. Spring flooding at various locations in the Midwest persisted throughout April.

May average daily temperatures were generally above normal for almost all of the Midwest. Precipitation was generally above normal, resulting in flooding across North central Missouri and South western Iowa, slowing planting but not generally adversely affecting crop conditions. Moderate drought conditions set in across parts of Missouri, Kentucky, Minnesota, Wisconsin, and Ohio; this assisted planting greatly.

June rainfall was below normal for many parts of the Midwest in the first part of the month, but late June rains across most of the region eased concerns for the developing corn and soybean crops. Most of Kentucky, and southern Ohio, however, were in severe drought. June temperatures were generally near normal.

July was unusually cool and dry. Approximately 75% of the Midwest region experienced drought conditions. Beneficial rains fell over portions of the region (Iowa, Illinois, Indiana, Ohio, and Kentucky) later in the month, but areas of Minnesota, Iowa, Missouri, and Wisconsin were missed by the rains and experienced their driest Julys in recorded history.

August saw severe drought conditions in the northern and southern thirds of the Midwest, while the central third received record rainfall resulting in major flooding. Maximum temperatures records were set in the southern Midwest through southern Illinois, southern Indiana, Kentucky, and parts of Ohio.

September was a mixed bag of near normal and well above normal temperatures in the Midwest. Rain fell where it was cooler and not where it was warmer. In the northern half of the Midwest drought conditions improved from near record rainfall, but drought conditions in the southern portion of the Midwest continued, and were beginning to again move northward into Illinois, Indiana, and Ohio. Temperatures were warmer than normal for much of the region, but not record-setting.

Overall, the midseason drought affected soybean yields more than any other weather phenomenon. It significantly reduced yields in major soybean producing states such as Minnesota, Iowa, Illinois, Indiana, and Missouri.

Drought in southeastern states

The most serious production problem for individual US producers was found in the southeastern US where an extreme drought affected soybean crops throughout the season, especially during the late season. The drought had a major effect on yields in eastern states of North Carolina, Virginia, and Maryland, as well as mid-south states of Tennessee and Kentucky. In these states, yields are expected to be reduced by one-third when compared with last year, and total production is expected to be down by 43%.

Soybean Rust

Soybean rust (*Phakopsora pachyrhizi*) is a fungal pathogen of soybean that is known to cause very large yield losses in South America. Soybean rust was first reported in the continental US in November of 2004. Soybean rust is spread by spores, but it requires a living host to remain viable over winter periods. In the US it is known to overwinter on a weedy plant - kudzu - in large areas of Florida and extreme southern Texas. Outbreaks of soybean rust on commercially produced soybean crops were noted since 2005. Each year, soybean rust has spread further into the central soybean producing regions of the US. In 2007, soybean rust was identified in 19 states, including Iowa, Illinois, and Missouri. However, rust was identified very late in the season, after it would affect soybean yields or composition. Applications of fungicides to reduce losses from rust were not needed in most states. Fungicide application for rust was recommended only in Florida, Mississippi, Louisiana, Arkansas, and Oklahoma. In these states, rust suppression through fungicide applications has reduced production losses to the disease to extremely low levels. While producers in the Central soybean producing region are more cognizant of the potential for rust and rust management, it appears that large scale rust infection and subsequent fungicide applications will be rare, at best.

Food-Grade Soybean Breeding Priorities – University of Minnesota

Because soybean has many uses, ranging from human and livestock food to various industrial applications, a wide range of breeding objectives must be simultaneously considered. For food-grade soybeans, agronomic traits of highest priority include yield, earliness, disease and insect resistance, iron chlorosis tolerance, increased competitive ability, and uniformity. Soybean mosaic virus, Phytophthora, and aphid resistance, in particular, are important for ensuring good yield and uniformity of seed size and appearance. Iron chlorosis tolerance is important because the growing regions affected by iron deficiency chlorosis are often the same regions producing large acreages of food beans. Increased competitive ability is of great importance for organic food bean production, which comprises ~20-30% of food bean acreage, because weed control options under organic production are limited to mechanical cultivation, thus, soybean plants must be better able to compete against weeds for nutrients, water, sunlight, etc.

When considering breeding objectives for quality traits in food-grade soybeans, higher protein, the ratio of 7S to 11S protein subunits (producing softer or firmer tofu, respectively), protein stability, soluble sugar and structural carbohydrate levels, seed size (and seed color to a lesser extent), and total isoflavone content are high priorities. Breeding goals for tofu varieties include higher protein (protein solubility index), larger seed size (>20g/100 seeds), and yellow hilum. Goals for natto varieties include higher sucrose, smaller seed size (<10g/100 seeds), and yellow hilum. For edamame, larger seed, gray pubescence, higher sucrose, and minimal bitterness are important. Finally, sprouting types should be small-seeded with excellent germination and long radicles, and miso and soy sauce specifications are generally company specific.

Table 1. Soybean production data for the United States, 2007 crop

Region	State	Yield (MT ha ⁻¹)	Area Harvested (1000 ha)	Production (M MT)
Western Corn Belt (WCB)	Iowa	3.49	3,451	12.1
	Kansas	2.28	1,013	2.3
	Minnesota	2.82	2,491	7.0
	Missouri	2.49	1,843	4.6
	Nebraska	3.49	1,519	5.3
	North Dakota	2.42	1,215	2.9
	South Dakota	2.75	1,276	3.5
	Western Corn Belt	2.8	12,806	38 53.4%
Eastern Corn Belt (ECB)	Illinois	2.96	3,321	9.8
	Indiana	2.89	1,895	5.5
	Michigan	2.22	705	1.6
	Ohio	3.09	1,673	5.2
	Wisconsin	2.75	543	1.5
	Eastern Corn Belt	2.8	8,136	24 33.3%
Midsouth (MDS)	Arkansas	2.55	1,126	2.9
	Kentucky	1.88	435	0.8
	Louisiana	2.69	239	0.6
	Mississippi	2.75	579	1.6
	Oklahoma	1.61	69	0.1
	Tennessee	1.55	401	0.6
	Texas	2.15	32	0.1
	Midsouth	2.2	2,882	7 9.5%
Southeast (SE)	Alabama	1.48	71	0.1
	Florida	n/a	5	n/a
	Georgia	2.02	107	0.2
	North Carolina	1.34	555	0.7
	South Carolina	1.28	176	0.2
	Southeast	1.5	914	1 1.8%
East Coast (EC)	Delaware	1.48	59	0.1
	Maryland	1.68	158	0.3
	New Jersey	1.75	32	0.1
	New York	2.55	82	0.2
	Pennsylvania	2.62	168	0.4
	Virginia	1.68	198	0.3
	East Coast	2.0	697	1 2.0%
Other Sts	2.15	11	0.02 0.03%	
USA 2007		2.78	25	70.8
USA 2006		2.89	11	87.3

Source: United States Department of Agriculture (12-Oct-07)

Table 2. USSEC/ASA 2007 Food Soybean Quality Survey by Seed Size

Region*	Seed Size [‡]	Number of Samples	Protein (%) [†]		Oil (%) [†]	
			Average	Range	Average	Range
Northern Corn Belt	Small	26	34.9	32.3 – 38.7	17.2	15.0 – 18.5
	Average	70	35.4	31.0 – 41.6	18.3	15.7 – 19.5
	Large	32	37.7	34.8 - 40.3	17.9	15.7 – 19.3
	Average		36.0		17.8	
Central Corn Belt	Small	2	37.1	35.9 - 38.3	16.5	15.7 – 17.3
	Average	40	37.1	33.6 - 43.1	18.1	15.0 – 19.6
	Large	13	38.6	37.3 – 40.7	17.4	16.4 – 18.5
	Average		37.6		17.3	
Eastern Corn Belt	Small	0	NA	NA	NA	NA
	Average	12	36.7	31.6 - 40.3	18.1	16.0 - 19.9
	Large	15	38.7	36.8 – 40.5	16.9	15.6 – 18.0
	Average		37.7		17.5	

Data as of December 7, 2007

* Northern Corn Belt region includes Minnesota, North Dakota, South Dakota, and Wisconsin

Central Corn Belt region includes Arkansas, Illinois, Iowa, Missouri, and Nebraska

Eastern Corn Belt region includes Ohio and Michigan

[‡] Small seed: 8.5-13.0 g/100 seeds; Average: 13.1-21.0 g/100 seeds; Large: 21.1-34.3 g/100 seeds (unofficial categories)

[†] 13% moisture basis

Table 3. USSEC/ASA 2007 Food Soybean Quality Survey by Reported End Use

Region*	End Use [‡]	Number of Samples	Protein (%) [†]		Oil (%) [†]	
			Average	Range	Average	Range
Northern Corn Belt	Tofu	42	37.1	33.1 - 40.2	17.9	15.7 – 19.5
	Miso	29	35.1	32.0 – 37.8	18.4	17.1 – 19.4
	Natto	30	34.4	31.0 – 38.7	17.4	15.0 – 19.4
	Other	8	35.0	33.0 - 38.0	18.8	17.9 – 19.2
	Not specified	19	37.2	34.2 – 41.6	18.0	15.7 – 19.0
		Average	35.8		18.1	
Central Corn Belt	Tofu	48	37.6	33.6 - 43.1	17.8	15.0 – 19.6
	Miso	5	36.1	35.6 – 36.8	18.8	18.0 – 19.3
	Natto	2	37.1	35.9 - 38.3	16.5	15.7 – 17.3
	Other	0	NA	NA	NA	NA
		Average	36.9		17.7	
Eastern Corn Belt	Tofu	21	38.0	35.8 – 40.5	17.4	15.6 – 19.0
	Miso	1	34.6	NA	18.8	NA
	Natto	0	NA	NA	NA	NA
	Other	5	37.7	31.6 - 40.3	17.2	15.7 - 19.9
		Average	36.8		17.8	

Data as of December 7, 2007

* Northern Corn Belt region includes Minnesota, North Dakota, South Dakota, and Wisconsin

Central Corn Belt region includes Arkansas, Illinois, Iowa, Missouri, and Nebraska

Eastern Corn Belt region includes Ohio and Michigan

[‡] Information supplied by the individual submitting the sample

[†] 13% moisture basis

Table 4. Historical Summary of Yield and Quality Data for US Soybeans

Year	Yield (kg ha ⁻¹)	Protein* (%)	Oil* (%)	Sum† (%)	Harvested (M ha)	Production (M MT)	Protein Std. Dev.	Oil Std. Dev.
1986	2237	35.8	18.5	54.3	23.6	52.9	1.39	0.70
1987	2278	35.5	19.1	54.6	23.2	52.8	1.59	0.71
1988	1814	35.1	19.3	54.4	23.2	42.2	1.50	0.83
1989	2170	35.2	18.7	53.9	24.1	52.4	1.51	0.82
1990	2291	35.4	19.2	54.6	22.9	52.5	1.22	0.66
1991	2298	35.5	18.7	54.1	23.5	54.0	1.38	0.86
1992	2526	35.6	17.3	52.8	23.6	59.6	1.38	0.97
1993	2190	35.7	18.0	53.8	23.2	50.9	1.24	0.87
1994	2782	35.4	18.2	53.6	24.6	68.6	1.36	0.93
1995	2372	35.5	18.2	53.6	24.9	59.2	1.39	0.86
1996	2526	35.6	17.9	53.5	25.7	64.9	1.25	0.87
1997	2614	34.6	18.5	53.0	28.0	73.2	1.51	0.96
1998	2614	36.1	19.1	55.3	28.5	74.6	1.50	0.81
1999	2452	34.6	18.6	53.2	29.4	72.1	1.88	1.05
2000	2553	36.2	18.7	54.9	29.6	75.6	1.68	0.94
2001	2647	35.0	19.0	54.0	30.0	79.6	1.95	1.07
2002	2486	35.4	19.4	54.8	29.1	72.2	1.58	0.93
2003	2284	35.7	18.7	54.3	29.4	67.2	1.71	1.19
2004	2822	35.1	18.6	53.7	30.0	84.6	1.47	0.90
2005	2889	34.9	19.4	54.3	28.9	83.4	1.46	0.87
2006‡	2876	34.5	19.2	53.7	30.2	86.9	1.64	1.01
2007‡	2782	35.4	18.7	53.9	25.4	70.6	1.24	0.76
Averages (1986-2007)	2477	35.3	18.7	54.0	26.4	65.9	1.49	0.89

Sources:

United States Department of Agriculture
Iowa State University
University of Minnesota

* Protein and oil concentrations expressed on a 13% basis moisture

† Sum represents sum of protein and oil concentrations

‡ 2006 and 2007 quality estimates are weighted by 2006 production estimates
2007 production estimates as of November 9, 2007

Table 5. Carbohydrate Analysis of a Small Number of Food Bean Samples from Two U.S. Regions*

Region [‡]	Seed Size [†]	#of Samples	Protein (%)	Oil (%)	Fiber (%)	Glucose mg g ⁻¹	Sucrose mg g ⁻¹	Raffinose mg g ⁻¹	Stachyose mg g ⁻¹
Northern Corn Belt	Small	2	34.8	16.0	6	6.1	50.2	5.3	44.4
	Average	4	35.3	19.0	4.4	15.2	44.8	6.2	36.6
	Large	7	37.1	18.4	4.2	12.9	47.2	7.1	32.2
	Average		36.2	18.2	4.5	12.5	46.9	6.5	35.4
Central Corn Belt	Small	0	NA	NA	NA	NA	NA	NA	NA
	Average	17	36.3	18.9	4.6	7.7	41.5	7.3	39.9
	Large	0	NA	NA	NA	NA	NA	NA	NA
	Average		36.3	18.9	4.6	7.7	41.5	7.3	39.9

* Wet chemistry analysis conducted at the University of Missouri Analytical Laboratories

[‡] Northern Corn Belt region includes Minnesota, North Dakota, South Dakota, and Wisconsin

Central Corn Belt region includes Arkansas, Illinois, Iowa, Missouri, and Nebraska

[†] Small seed: 8.5-13.0 g/100 seeds; Average: 13.1-21.0 g/100 seeds; Large: 21.1-34.3 g/100 seeds (unofficial categories)

Table 6. Carbohydrate Analysis of a Small Number of Food Bean Samples from Two U.S. Regions*

Region [‡]	End Use [†]	Number of Samples	Protein (%)	Oil (%)	Fiber (%)	Glucose mg g ⁻¹	Sucrose mg g ⁻¹	Raffinose mg g ⁻¹	Stachyose mg g ⁻¹
Northern Corn Belt	Tofu	8	37.3	18.2	4.2	12.6	45.8	7.1	33.4
	Miso	0	NA	NA	NA	NA	NA	NA	NA
	Natto	2	34.8	16.0	6.0	6.1	50.2	5.3	44.4
	Other	3	34.1	19.5	4.4	16.7	47.7	5.9	34.9
	Average		36.2	18.2	4.5	12.5	46.9	6.5	35.4
Central Corn Belt	Tofu	17	36.3	18.9	4.6	7.7	41.5	7.3	39.9
	Miso	0	NA	NA	NA	NA	NA	NA	NA
	Natto	0	NA	NA	NA	NA	NA	NA	NA
	Other	0	NA	NA	NA	NA	NA	NA	NA
	Average		36.3	18.9	4.6	7.7	41.5	7.3	39.9

* Wet chemistry analysis conducted at the University of Missouri Analytical Laboratories

[‡] Northern Corn Belt region includes Minnesota, North Dakota, South Dakota, and Wisconsin

Central Corn Belt region includes Arkansas, Illinois, Iowa, Missouri, and Nebraska

[†] Information supplied by the individual submitting the sample