Quality of the United States Food Soybean Crop: 2010[1]

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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 was conducted for the first time in 2007, and is intended to assist international buyers, as well as to provide producers valuable information about the quality of these specialty soybeans. Due to both the wide range of food bean types (tofu, natto, edamame, etc.) and the range of varieties grown for each type in different geographic regions of the US, it is difficult to provide generalized conclusions regarding the 2010 United States food soybean crop as a whole. This report provides state by state food soybean quality information (protein and oil), regional quality averages by seed size, and quality trends for the entire US food soybean crop. The commodity soybean crop information is provided as a guide for better understanding the regional environmental influences affecting both commodity and food soybean crops.

2010 Acreage, Yields, and Total Production

According to the 8 October, 2010 United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) crop report, the total US soybean production area is expected to increase slightly (1%) from last year to 31.1 million hectares harvested (Table 1). Average yields are also expected to increase slightly, to 2.98 Mg ha^{-1}. With greater yields than in 2009, total US soybean production is expected to be 92.9 million MT. If realized this will be the largest soybean crop in history.

Quality of the 2010 US Food Soybean Crop

Participating companies provided a total of 294 samples as of October 27, 2010. These samples were analyzed for protein and oil concentration and fiber by near infrared spectroscopy (NIRS) using a Perten DA7200 diode array instrument (Huddinge, Sweden) equipped with calibration equations developed at the University of Minnesota. Additionally, we determined average seed size (grams per 100 seeds) for each sample.

Average protein values for the food bean samples by region (Table 2) indicate that samples received from the Northern growing region (Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin) had similar protein concentrations to samples received from the Southern (Missouri) region (36.3% and 36.6%, respectively), but samples from the Central region had higher protein concentrations (37.7%). In general, protein concentrations from northerly regions in the US tend to be lower than those from more southerly regions.

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When we examine the protein concentration data using sample seed size categories to group the data (Table 3), the north-south protein differences are more apparent. For small seed size samples (≤13.0 g per 100 seeds), the Northern region averaged 34.2% protein, the Central region 36.9%, and the Southern region 37.3%. Many of the small-seeded samples were identified by sample submitters as intended for use in making natto, for which lower protein concentrations are desirable. As in 2007-2009, the 2010 small-seeded samples show an average protein level lower than those of the average- and large-seeded samples. Large seed size samples (>21 g per 100 seeds) from the Northern and Central regions were equivalent in protein levels (38.2%). Within a region, large seed size samples were higher in protein than average seed size samples in the Northern and Central regions.

Oil concentrations in the Northern, Central, and Southern regions were very similar (17.9%, 17.7%, and 18.1%, respectively; Table 2). When the oil data are grouped by seed size and region (Table 3), only the small seed size samples differ in oil concentration (17.4 in the Northern region versus 17.9% in the Central region). Within a region, average seed size samples show higher oil concentrations than do large seed size samples (Table 3).

Fiber levels in the Southern region are slightly higher than those in the Central and Northern regions (Table 2). When the data are grouped by seed size, the same trend is seen: fiber levels for average seed size samples are higher in the Southern region than in more northerly regions, as was also seen in 2007-2009. Within both the Northern and Central regions, small seed size samples (probably natto varieties) are higher in fiber than large seed size samples. This also was seen in 2007-2009. We received two very large-seeded samples (36.4 and 32.5 g/100 seeds) grown in the Central region which were very low in fiber (3.5% and 3.8%) and oil (15.2% and 14.9%) compared with the average fiber and oil of the other large-seeded, Central region samples.

US Commodity Soybean Survey

The quality of the overall US soybean crop is estimated yearly by a separate project supported by the United Soybean Board and the international marketing committee of the American Soybean Association (ASA-IM). By August 31, 2010, sample kits were mailed to approximately 9,325 producers. Producers were selected based on total land devoted to soybean production in each state, so that response distribution would closely match soybean production. We received 1,850 samples by October 25, 2010. These were analyzed for protein and oil concentration by near-infrared spectroscopy (NIRS) using a Perten DA7200 diode array instrument (Huddinge, Sweden) equipped with calibration equations developed by Perten in cooperation with the University of Minnesota. Regional and national average protein values were determined by computing weighted averages using state and regional soybean production values, so that average values better represent the crop as a whole.

Average protein and oil concentrations for the 2010 US soybean crop differed only slightly from the 2009 US soybean crop. Average US soybean protein concentration was 0.4% lower in 2010, at 34.9%, and average oil was 0.1% higher, at 18.7%, when compared with 2009. The 2010 crop has nearly identical quality characteristics to the long-term average (35.3% protein and 18.7% oil). As is noted in most years, Western Corn Belt states showed lower protein concentrations

than the US crop as a whole. Midsouth states commonly have higher protein concentrations than other regions. In 2010, protein levels in this region were not significantly different than regions other than the Western Corn Belt. Southeastern states produced a soybean crop with higher oil concentration than other regions. The other regions did not differ from one another.

Protein concentrations from the Eastern and Western Cornbelt regions, as well as from the Midsouth, decreased slightly from 2009 to 2010. Protein levels increased slightly in the East Coast region. Oil concentrations were much lower in the Midsouth in 2010, but higher in the Eastern Corn Belt, the Southeast, and the East Coast.

When we compared commodity soybeans to food grade soybeans for average protein and oil concentrations on a state-by-state basis, we found that food grade soybeans were higher in protein and lower in oil concentrations than commodity soybeans, with the exception of the three samples from South Dakota. This finding is not unexpected, since many of the food soybean samples are likely varieties improved for traits important in tofu production, including higher protein.

Climate Summary

Planting: *April* precipitation was below normal for most of the Midwest, expanding moderate and severe drought classifications into the upper Midwest. However, northern Missouri and parts of Iowa, Illinois, and Wisconsin experienced above normal rainfall. Temperatures in the Midwest were well above normal, particularly in the early part of the month. At least four Midwest states recorded record high monthly temperatures. For the first time since modern weather record keeping began in 1891, there was no measurable snow in Minnesota in April of 2010. *May* allowed soybean planting to proceed well ahead of normal, though temperatures were below normal for the first two weeks of the month (Figure 1). During the second half of May, temperatures were well above normal. Most of the Midwest received normal to well above normal amounts of rain. Spring in the Midwest was, with a few exceptions, warmer and wetter than normal.

Mid-season: *June* was a very wet month for most of the Midwest, although Missouri was quite dry. The high rainfall caused flooding in many states, however, the negative impact on crops varied depending on how well-drained fields were. Temperatures in the Midwest during June were normal in northern regions to above normal in southern regions. In *July*, very heavy rain fell, causing river flooding over large parts of Illinois, Iowa, Missouri, and Wisconsin. Temperatures were slightly above normal, particularly minimum temperatures. *August* was a warmer month and rainfall varied; southern Kentucky, areas in Iowa, and parts of Minnesota and Wisconsin were quite wet, whereas southern Missouri, Indiana, and Michigan were very dry (these areas received less than fifty percent of normal precipitation). August temperatures in the Midwest were slightly higher than normal, particularly in southern and eastern parts of the Midwest, which contributed to drought conditions there. In *September*, the northwest half of the Midwest (Minnesota, Wisconsin, and the Upper Peninsula of Michigan) experienced cooler and wetter than average conditions, while the southeastern half was warm and dry. The growing season in some of the largest soybean-producing areas of the Midwest was, with some exceptions, warmer and wetter than average.

Harvest: *October* in the upper Midwest was slightly above normal for temperature, and below normal for precipitation. This combination of weather conditions helped farmers harvest what may be a record soybean crop. As of October 24, 2010, 91% of the US soybean crop had been harvested; this percentage is vastly higher than that in 2009, when just over 50% of the crop had been harvested by November 1, and higher than the 72% harvested by October 24 which is the 2005 to 2009 average (Figure 1).

Soybean Disease Impact

Soybean rust (*Phakopsora pachyrhizi*) is a fungal pathogen of soybean that is known to cause very large yield losses in South America; it 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 have been noted since 2005. Each year, soybean rust has spread further into the central soybean producing regions of the US. In 2010, soybean rust was found in 27 US counties across seven states and in three states and 13 municipalities in Mexico. In contrast, in 2009, soybean rust was found in 16 states and over 576 counties in the United States, and in three states and nine municipalities in Mexico.

The growing conditions in the upper Midwest in 2010 were very conducive to development of a soybean disease called Sudden Death Syndrome (SDS). Cool, wet weather at planting sets the stage for the causal fungus, *Fusarium virguliforme*, to infect soybean roots. Warm and wet conditions around seed set favor SDS development. A toxin produced by the fungus eventually causes leaf death and yield reduction of perhaps 20–40%, or more, depending on the variety, when the plants were infected, and at which growth stage symptoms begin to show. Many soybeans grown in poorly-drained, low-lying fields or compacted soils in the upper Midwest suffered yield loss due to SDS during the 2010 season because of favorable environmental conditions. SDS was seen at unusually widespread and high levels in southern MN and much of IA, IL, WI, and IN due, in part, to wet weather conditions in July and early August.

References

Federal Grain Inspection Service. 2004. Test Weight. *In* Grain Inspection Handbook II (Chapter 10). Washington DC: USDA-GIPSA-FGIS.

National Agricultural Statistics Service (NASS). 2010. Available at (verified 25, October, 2010) <http://usda.mannlib.cornell.edu/usda/nass/CropProg//2000s/2010/CropProg-10-25-2010.pdf>. USDA-NASS, Washington, DC.

Midwestern Regional Climate Center (MRCC) <http://mcc.sws.uiuc.edu/cliwatch/watch.htm>. Champaign, IL.

Soybean rust information <http://sbr.ipmpipe.org/cgi-bin/sbr/public.cgi>

Table 1. Soybean production data for the United States, 2010 crop

Region	State	Yield (MT ha^{-1})	Area Harvested (1000 ha)	Production (M MT)
Western Corn Belt (WCB)	Iowa	3.49	3,989	14.0
	Kansas	2.28	1,721	3.9
	Minnesota	3.02	2,961	9.0
	Missouri	2.75	2,078	5.7
	Nebraska	3.70	2,066	7.6
	North Dakota	2.49	1,640	4.1
	South Dakota	2.69	1,681	4.5
	Western Corn Belt	2.9	16,135	49
				52.6%
Eastern Corn Belt (ECB)	Illinois	3.49	3,665	12.8
	Indiana	3.36	2,159	7.3
	Michigan	2.96	846	2.5
	Ohio	3.23	1,895	6.1
	Wisconsin	3.29	660	2.2
	Eastern Corn Belt	3.3	9,226	31
				33.3%
Midsouth (MDS)	Arkansas	2.35	1,268	3.0
	Kentucky	2.42	559	1.4
	Louisiana	2.96	405	1.2
	Mississippi	2.55	790	2.0
	Oklahoma	1.55	186	0.3
	Tennessee	2.22	571	1.3
	Texas	2.08	75	0.2
	Midsouth	2.3	3,854	9
				10.0%
Southeast (SE)	Alabama	1.95	142	0.3
	Georgia	2.08	103	0.2
	North Carolina	1.68	628	1.1
	South Carolina	1.78	182	0.3
	Southeast	1.9	1,055	2
				2.0%
East Coast (EC)	Delaware	2.28	70	0.2
	Maryland	2.22	186	0.4
	New Jersey	2.22	37	0.1
	New York	3.29	114	0.4
	Pennsylvania	2.89	196	0.6
	Virginia	1.61	223	0.4
	East Coast	2.4	827	2
				2.1%
USA 2010		2.98	31,113	92.8
USA 2009		2.96	30,931	91.5

Source: United States Department of Agriculture, NASS 2010 Crop Production Report (October 8, 2010)

Table 2. USSEC/ASA 2010 Food Soybean Quality Survey by State and Region[‡]

State (number of samples)	Region	Protein Average[*] (%)	Protein Range	Regional Protein Average	Oil Average[*] (%)	Oil Range	Regional Oil Average	Fiber Average[†] (%)	Fiber Range	Regional Fiber Average
Michigan (94)	Northern	36.1	31.8 – 42.4		18.1	15.6 – 22.3		5.5	5.0 – 6.0	
Minnesota (33)	Northern	37.1	31.9 – 42.9		17.4	14.4 – 20.6		5.6	4.5 – 6.6	
North Dakota (22)	Northern	35.6	33.1 – 39.0		17.2	15.4 – 19.7		5.9	5.4 – 6.5	
South Dakota (3)	Northern	33.4	31.9 – 34.7		18.2	17.9 – 18.7		5.7	4.7 – 6.6	
Wisconsin (24)	Northern	37.0	33.9 – 40.7	36.3	18.4	16.6 – 20.3	17.9	5.8	5.1 – 6.2	5.6
Iowa (53)	Central	37.7	33.0 – 43.5		17.4	14.9 – 19.5		5.7	3.5 – 6.3	
Illinois (20)	Central	37.3	34.9 – 41.5		18.1	15.3 – 21.3		5.9	5.6 – 6.3	
Ohio (27)	Central	38.2	35.0 – 42.1	37.7	17.9	16.2 – 20.0	17.7	5.6	5.1 – 5.9	5.7
Missouri (18)	Southern	36.6	34.4 – 41.0	36.6	18.1	16.1 – 19.8	18.1	6.0	5.5 – 6.5	6.0

Data as of October 27, 2010

[‡] Northern region = Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin; Central region = Iowa, Illinois, and Ohio; Southern region = Missouri

[*] 13% moisture basis; [†] Percent dry matter basis

Table 3. USSEC/ASA 2010 Food Soybean Quality Survey by Seed Size[§] & Region[‡]

Region	Seed Size	Number Samples	Seed Size Average (g/100 seeds)	Protein Average[*] (%)	Protein Range	Oil Average[*] (%)	Oil Range	Fiber Average[†]	Fiber Range
Northern	Small	18	9.2	34.2	31.9 – 38.2	17.4	15.4 – 19.7	6.0	4.7 – 6.6
	Average	134	17.4	36.3	31.8 – 42.9	18.1	14.4 – 22.3	5.6	4.5 – 6.6
	Large	24	22.5	38.2	35.6 – 40.5	17.3	16.3 – 19.4	5.4	5.2 – 5.9
Central	Small	7	12.3	36.9	34.5 – 39.9	17.9	16.5 – 19.1	5.9	5.6 – 6.2
	Average	80	16.1	37.7	33.0 – 43.5	17.7	15.3 – 21.3	5.8	5.2 – 6.3
	Large	13	24.0	38.2	36.7 – 39.9	17.0	14.9 – 18.3	5.3	3.5 – 6.0
Southern	Small	1	12.6	37.3		16.1		5.9	
	Average	17	15.1	36.5	34.4 – 41.0	18.2	16.3 – 19.8	6.0	5.5 – 6.5
	Large	0							

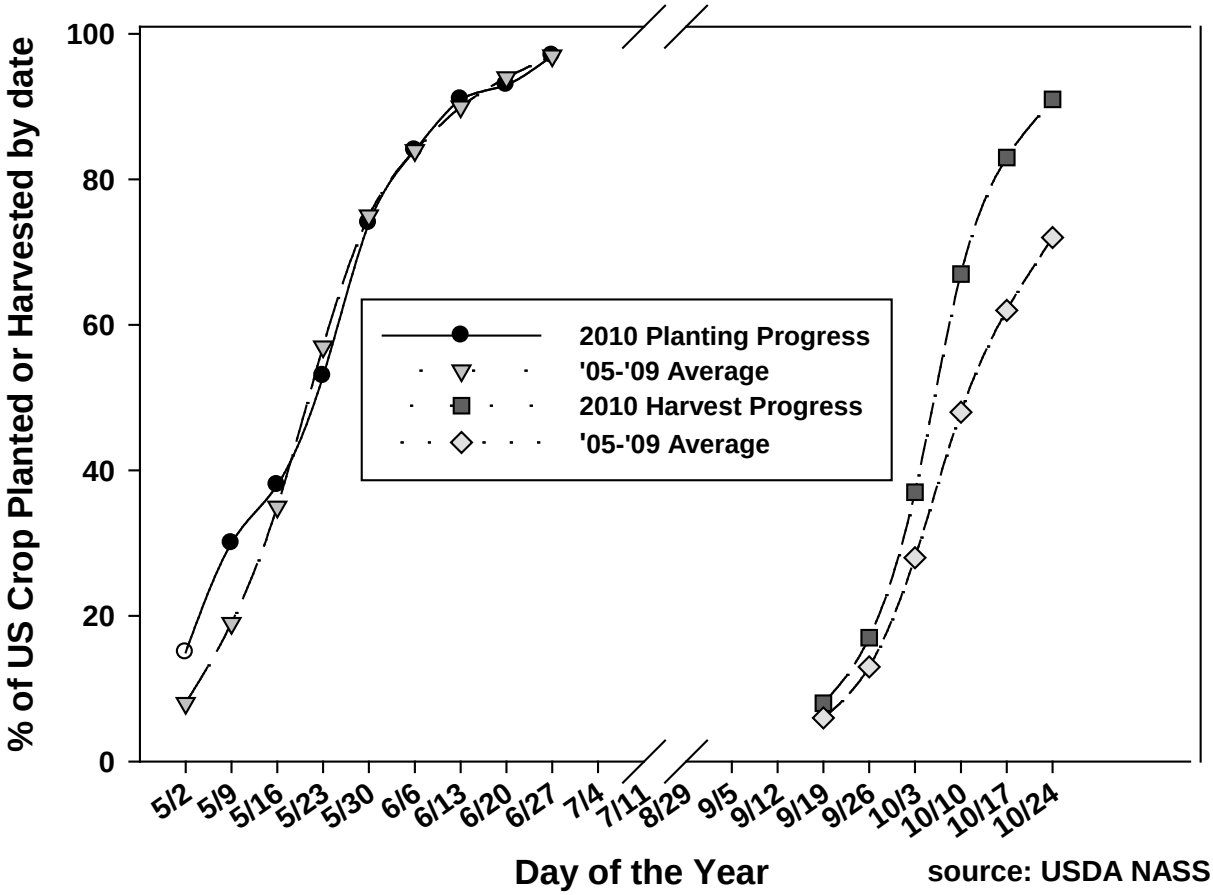
Data as of October 27, 2010

[§] **Small seed: ≤13.0 g/100 seeds; Average: 13.1-21.0 g/100 seeds; Large: >21 g/100 seeds (unofficial categories)**

[‡] **Northern region = Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin; Central region = Iowa, Illinois, and Ohio; Southern region = Missouri**

[*] **13% moisture basis;** [†] **Percent dry matter basis**

Figure 1. US Soybean Planting and Harvest Progress



source: USDA NASS