QUALITY OF THE UNITED STATES FOOD SOYBEAN CROP 2012

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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. 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 2012 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.

2012 Acreage, Yields, and Total Production

According to the 9 November, 2012 United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) crop report, the total US soybean harvested area increased 3 percent from last year to 30.7 million hectares harvested (Table 1). Average yields decreased, to 2.64 MT per ha. The lower yields brought total US soybean production to an estimated 80.9 million MT. The 2012 crop will be 4% smaller than the 2011 crop.

Quality of the 2012 US Food Soybean Crop

Participating companies provided a total of 140 samples by November 29, 2012. Samples were analyzed for protein and oil concentration by near infrared spectroscopy (NIRS) using a Perten DA7250 diode array instrument (Huddinge, Sweden) equipped with calibration equations developed at the University of Minnesota. The 140 samples were scanned whole, then ground and rescanned to provide us with soluble sugar and amino acid data. Additionally, we determined average seed size (grams per 100 seeds) for each sample. In 2012, the decision was made to group the food soybean samples using the same categories as in the commodity soybean quality report (see Table 1

for the list of states included in the various regions). In 2012, we received food soybean samples from regions now categorized as ECB (Eastern Corn Belt) and WCB (Western Corn Belt). Due to the new regional grouping of samples, we are not able to directly compare 2012 results with results from 2011 and earlier.

Average protein values for the food bean samples by region (Table 2) indicate that samples received from the WCB region (Iowa, Minnesota, Missouri, North Dakota, and South Dakota) had nearly identical protein concentrations when compared with the samples received from the ECB growing region (Illinois, Indiana, Michigan, Ohio, and Wisconsin) (WCB average 36.7 and ECB average 36.8). When we examined the protein concentration data using both regional and seed size categories to group the data (Table 3), the WCB-ECB protein differences were more pronounced. Protein was lower in the small-seeded WCB samples (34.0) compared to the small-seeded ECB samples (34.2). This lower WCB protein vs. ECB protein trend within the same seed size categories was reversed for the average and large-seeded samples as well. The range in protein values for samples from the ECB was generally higher than in samples from the WCB, perhaps reflecting the earlier timing of drought conditions in the ECB compared to the WCB (Figure 3), thus making environmental conditions more variable in the ECB region. As was found in previous food soybean surveys, the small-seeded samples were lower in protein than the average or large-seeded samples (34.0 versus 36.8 and 39.0 in the WCB, and 34.2 vs. 36.7 and 37.4 in the ECB, respectively). Lower protein concentrations are desirable for making natto.

Overall, oil concentrations in the WCB region were lower than in the ECB region (Table 2), and when the data were grouped by seed size category and region, WCB samples of all three seed size categories showed lower oil concentrations than those same seed size categories in the ECB samples (Table 3: small WCB 18.2 < ECB 18.4; average WCB 17.7 < ECB 18.0; large WCB 16.7 < ECB 17.4 large). Within each region, oil concentrations were higher in the small-seeded samples than in the average- and large-seeded samples. The range in oil values in samples grown in the the ECB is higher than in samples from the WCB, again possibly due to larger environmental variability in the ECB growing region.

Soluble Sugars

Within each of the two regions, small seed size samples had higher concentrations of sucrose than the average or large seed size samples (Table 4: small WCB 5.97 > 4.81 and 4.24 average- and large-seeded WCB samples, respectively; small ECB 5.79 > 4.60 and 4.92 average- and large-seeded ECB samples, respectively).

Amino Acids

Amino acids are the "building block" organic compounds linked in various combinations to form unique proteins. In humans, dietary proteins are critical for a number of vital functions; these needs are fulfilled by the essential and non-essential amino acids in dietary proteins. Soy in human nutrition is often part of a diet comprised of other protein sources. When soy was studied along with other foods (rice, corn flour, milk solids), its nutritive value was high, close to that of milk and similar to that for high quality animal protein (Young and Scrimshaw, 1979). Additionally, Young and Scrimshaw concluded in their review of studies evaluating the use of soybean in human diets, "When well processed soy products serve as the major or sole source of the protein intake, their protein value approaches or equals that of foods of animal origin, and they are fully capable of meeting the long term essential amino acid and protein needs of children and adults".

Although soybeans from the US are generally lower in crude protein, both US soybeans and soybean meal contained higher concentrations of critical amino acids (Thakur and Hurburgh, 2007), thus making the protein a better quality protein.

Table 5 contains amino acid data from the food soybean samples, grouped by seed size and growing region. Within both growing regions, the trend for the three sample size categories is the same and reflects our findings discussed in the first bulleted item above: lower protein samples have enriched concentrations of both the five most critical essential amino acids and the ten essential amino acids. For example, in the WCB, the small-seeded samples had an average protein of 34.0 compared to 36.8 and 39.0 for the average- and large-seeded samples, respectively; however, even with the lower protein of 34.0 we found that the concentrations of the five most critical essential amino acids and the ten essential amino acids were higher (lower protein of 34.0: 14.5 five essential amino acids,

39.1 ten essential amino acids compared to the average- and large-seeded samples (higher protein of 36.8 and 39.0, respectively: 13.9 and 13.9 five essential amino acids, and 38.1 and 38.3 ten essential amino acids, respectively). Again, this trend was found within both growing regions, WCB and ECB. Thus, although we examined fewer samples for the food soybean survey, the sample quality trends for amino acids were consistent with our previous amino acid findings: lower protein samples tend to have enriched concentrations of essential amino acids, making them a higher value product.

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 17 August, sample kits were mailed to approximately 8,317 producers that were selected based on total land devoted to soybean production in each state, so that response distribution would closely match projected soybean production. By 7 January, 2013, 1,912 samples were received. These were analyzed for protein, oil, and amino acid concentration by near-infrared spectroscopy (NIRS) using a Perten DA7250 diode array instrument (Huddinge, Sweden) equipped with calibration equations developed by the University of Minnesota in cooperation with Perten. Regional and national average quality values were determined by computing weighted averages using state and regional soybean production values, so that average values best represent the crop as a whole.

Average protein concentrations for the 2012 US soybean crop dropped slightly from that of the 2011 US crop, while oil slightly increased. Average US soybean protein concentration was 0.5 percentage points lower in 2012, at 34.3%, and average oil concentration was 0.3 percentage points higher at 18.5% when compared with 2011. As is noted in most years, Western Corn Belt states showed lower protein concentrations than the US crop as a whole. Soybeans grown in the Midsouth, Southeast, and East Coast states tended to have higher protein concentrations. Midsouth and Southeast states produced a soybean crop with higher oil concentration than the main soybean production regions of the Eastern and Western Corn Belt.

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Compared with the 2011 crop, protein concentrations remained similar in the Western and Eastern Corn Belt and Midsouth. Protein levels decreased in the Southeast and East Coast regions. Oil concentrations in 2012 were higher in the Western and Eastern Corn Belt regions.

Seed from the 2012 crop had a large range in harvest moisture. The Western and Eastern Corn Belt samples had an average range of 10 percentage points. The average moisture of samples received in 2012 was 11.2%. The driest soybeans were found in the Western states (Minnesota, Nebraska, North Dakota and South Dakota). The Western Corn Belt region had average moisture levels of 9.8%. When protein levels are examined on an 'as-is' basis rather than adjusted to a 13% moisture basis, the protein in the Western Corn Belt jumped to 35.4% and the average US soybean increased from 34.3 to 35.3%. Similarly, national oil values increased from 18.5 to 18.9%, on an 'as-is' basis.

Weather and Crop Summaries

Planting: Warmer-than-normal weather in the Great Plains provided favorable growing conditions for row crops, and promoted rapid fieldwork. Much-needed rain dampened the northern half of the Plains, but little or no rain fell on the southern Plains. Much of the Southeast remained dry, compounding the effects of abnormally low soil moisture levels. By the end of April, 12 percent of the soybean crop was planted (Figure 1). This was 10 percentage points ahead of last year, and the quickest pace on record. By the last week of May, 94 percent of the nation's soybean crop was planted, 31 percentage points ahead of 2011.

Mid-Season: Rainfall was scarce for much of the country, with accumulations in many areas totaling less than 2 percent of normal. Any rain that fell across the Plains and Midwest was more than offset by an historic, early-season heat wave that boosted weekly temperatures as much as 3 to 8°C above normal. Devastatingly hot weather continued to bake the Great Plains in July, further dimming soybean prospects and increasing stress on the crop (Figure 2). Multiple days near or above 40°C were noted in parts of Indiana, Illinois, Iowa, Missouri, Arkansas, and on the Great Plains from South Dakota to Texas. Enough rain fell across the northern Corn Belt to help stabilize or even improve crop conditions in some locations. In late August, Hurricane Isaac produced

rainfall totals of >10 cm in some drought-affected areas in Arkansas, Missouri, and Illinois. Later, remnant tropical moisture spread across the remainder of the eastern Corn Belt and into the Mid-Atlantic States. Producers in parts of the Corn Belt hoped that late season rainfall would benefit pod fill in later-planted soybean fields. Late season heat across the nation's midsection promoted fieldwork and summer crop maturation. Harvest was underway in a limited number of areas by the last week of August.

Harvest: In the regions affected by tropical or frontal rains, including the southern half of the Plains and the Ohio Valley (the southern Midwest), wet weather helped to ease the drought conditions, but slowed fieldwork. Farther west, dry weather prevailed from the northern Plains into the northern and western Corn Belt (the upper Midwest), expanding and intensifying the drought conditions (Figure 3). According to the U.S. Drought Monitor, late-September drought coverage in the contiguous U.S. reached 65.5 percent, surpassing by 1.6 percent the previous high established on July 24, 2012. Freezes on September 23 and 24th officially ended the growing season across the upper Midwest (Iowa, Minnesota, and Wisconsin). By November 4th, 93 percent of the soybean crop was harvested, 7 percentage points ahead of the 5-year average.

Overall the 2012 season was marked by a very rapid planting pace because of warmer-than-normal temperatures and adequate rainfall in the northern Plains, but the southern Plains and Southeast stayed dry. During the growing season, extreme heat and drought in southern parts of the Midwest stressed the soybean crop; however, in the upper Midwest, crop conditions were improved by timely rainfall. Harvest started early and proceeded very quickly. Harvested yields tended to be significantly larger than forecast based on midsummer conditions throughout the US. Late season yield recovery was so great that total production in 2012 will be only a few percent short of the 2011 crop.

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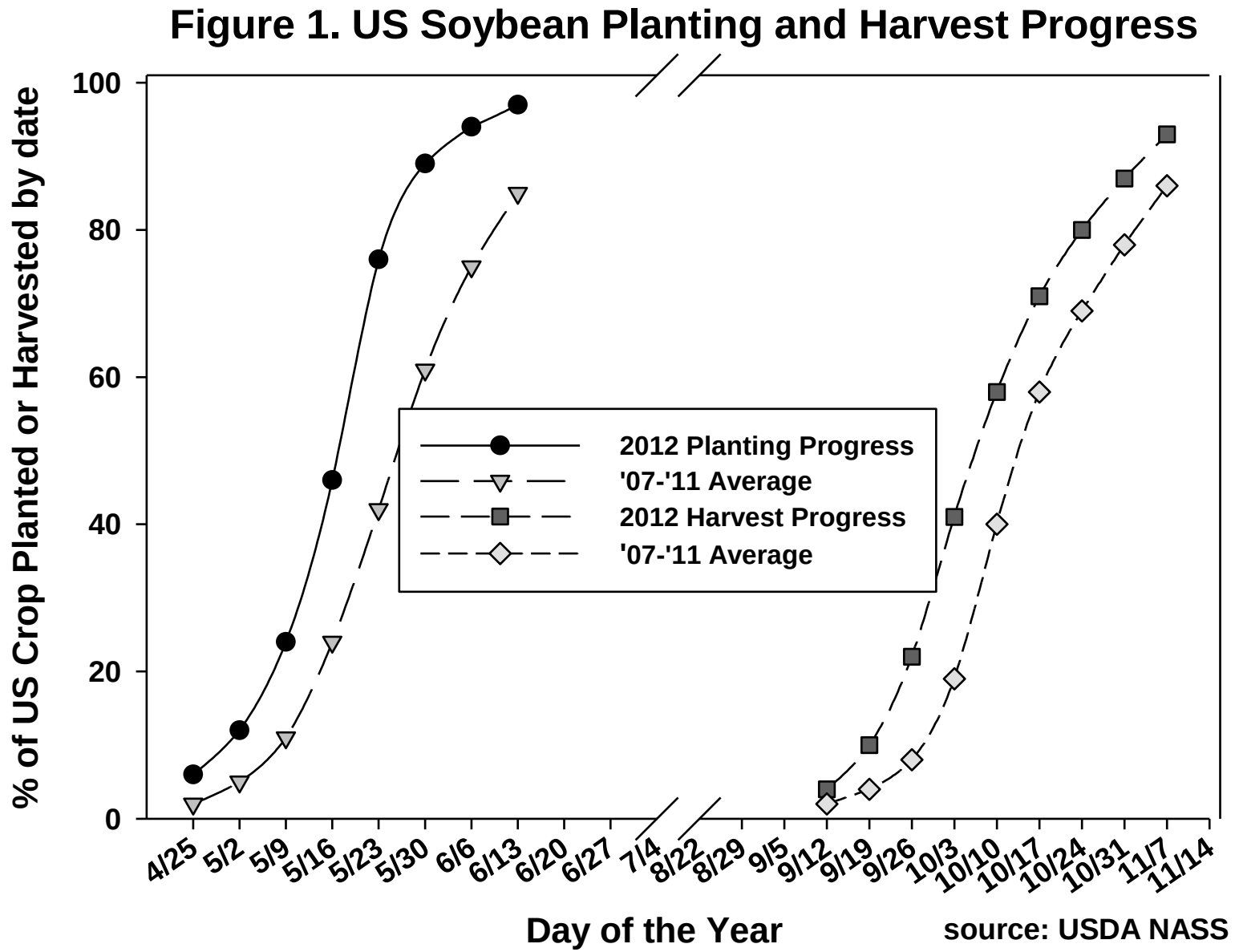

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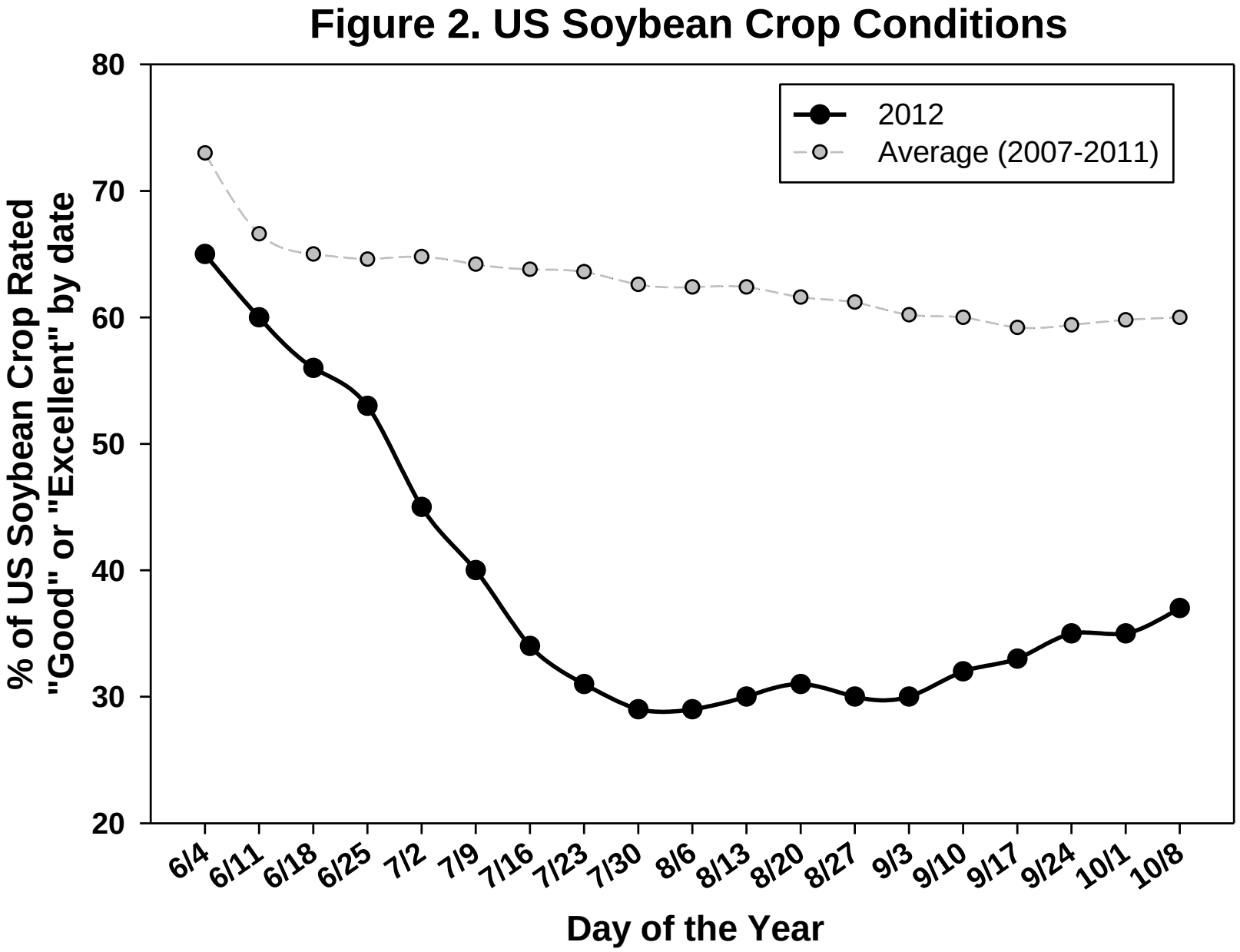

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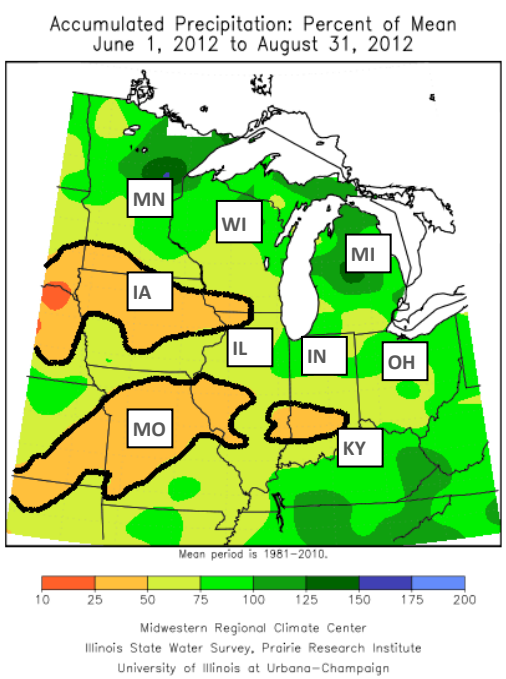
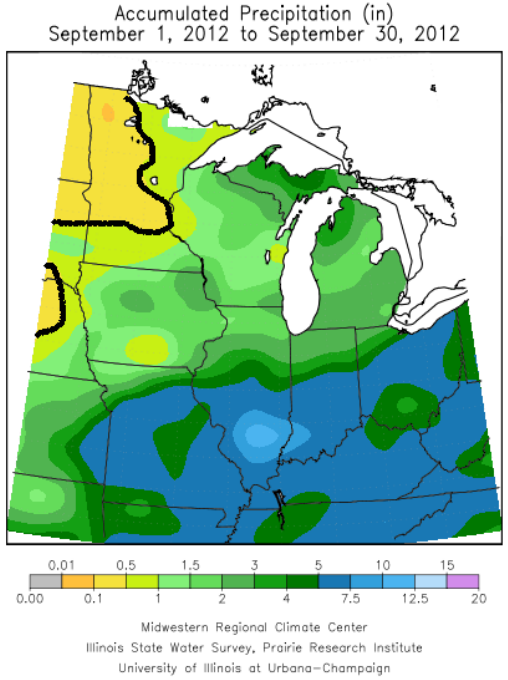
Figure 3. Areas outlined in black received less than 50% of average precipitation for the months indicated.





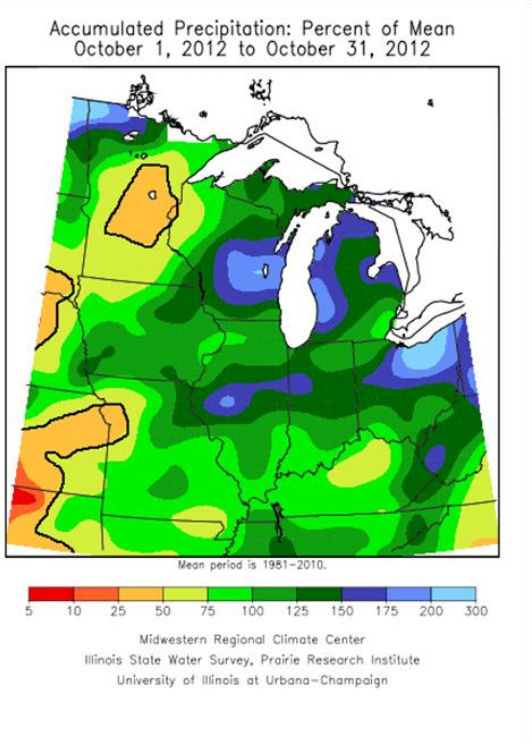


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Table 1. Soybean production data for the United States, 2012 crop

Region	State	Yield (MT ha^{-1})	Area Harvested (1000 ha)	Production (M MT)
Western Corn Belt (WCB)	Iowa	3.0	3,762	11.1
	Kansas	1.5	1,519	2.3
	Minnesota	2.9	2,823	8.2
	Missouri	2.1	2,126	4.4
	Nebraska	2.8	2,005	5.5
	North Dakota	2.3	1,904	4.4
	South Dakota	1.9	1,883	3.5
	Western Corn Belt	2.3	16,022	39.5
				46.9%
Eastern Corn Belt (ECB)	Illinois	2.9	3,564	10.3
	Indiana	3.0	2,082	6.2
	Michigan	2.8	806	2.3
	Ohio	3.2	1,855	5.9
	Wisconsin	2.6	689	1.8
	Eastern Corn Belt	2.9	8,995	26.4
				31.3%
Midsouth (MDS)	Arkansas	2.8	1,276	3.5
	Kentucky	2.6	587	1.5
	Louisiana	3.0	450	1.3
	Mississippi	2.8	794	2.2
	Oklahoma	1.1	122	0.1
	Tennessee	2.4	494	1.2
	Texas	1.8	43	0.1
	Midsouth	2.3	3,764	10.0
				11.9%
Southeast (SE)	Alabama	3.0	134	0.4
	Georgia	2.4	83	0.2
	North Carolina	2.4	624	1.5
	South Carolina	2.2	150	0.3
	Southeast	2.5	990	2.4
				2.9%
East Coast (EC)	Delaware	2.8	68	0.2
	Maryland	3.0	192	0.6
	New Jersey	2.7	38	0.1
	New York	3.0	124	0.4
	Pennsylvania	3.2	211	0.7
	Virginia	2.7	235	0.6
	East Coast	2.9	868	2.5
				3.0%
USA 2012		2.64	30,656	80.9
USA 2011		2.82	29,879	84.3

Source: United States Department of Agriculture, NASS 2012 Crop Production Report (November 9, 2012)

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Table 2. ASA-IM 2012 Food Soybean Quality Survey by State and Region[§]

State (# of samples)	Region	Protein [*] (%)	Protein Range	Regional Protein Average	Oil[*] (%)	Oil Range	Regional Oil Average
Iowa (1)	WCB	37.8			18.4		
Minnesota (34)	WCB	36.7	31.1 – 43.4		17.7	14.4 – 19.7	
Missouri (1)	WCB	32.8			20.0		
North Dakota (3)	WCB	36.3	35.2 – 37.3		17.3	16.8 – 17.7	
South Dakota (1)	WCB	38.5		36.7	16.6		17.7
Illinois (9)	ECB	35.6	32.2 – 38.3		18.3	16.2 – 20.2	
Indiana (4)	ECB	36.9	32.9 – 40.6		19.0	16.2 – 20.8	
Michigan (47)	ECB	37.7	34.1 – 46.1		17.4	14.7 – 18.9	
Ohio (16)	ECB	37.8	34.3 – 40.9		17.7	16.2 – 19.6	
Wisconsin (24)	ECB	34.6	31.9 – 37.0	36.8	18.6	18.1 – 19.1	17.9

Data as of November 29, 2012

[§] WCB: Western Corn Belt; ECB: Eastern Corn Belt (see Table 1 for complete list of states included in these regions)

[*] 13% moisture basis

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Table 3. ASA-IM 2012 Food Soybean Quality Survey by Seed Size[‡] & Region[§]

Region	Seed Size	Number Samples	Seed Size (g/100 seeds)	Protein[*] (%)	Protein Range	Oil[*] (%)	Oil Range
WCB	Small	4	10.3	34.0	31.1 – 36.1	18.2	17.4 – 18.7
	Average	34	17.6	36.8	31.5 – 43.4	17.7	14.4 – 20.0
	Large	2	21.5	39.0	38.9 – 39.2	16.7	16.6 – 16.8
ECB	Small	2	11.9	34.2	32.5 – 35.8	18.4	17.7 – 19.1
	Average	81	16.8	36.7	31.9 – 46.1	18.0	14.7 – 20.8
	Large	17	24.2	37.4	36.0 – 38.8	17.4	16.2 – 18.3

Data as of November 29, 2012

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

§ **WCB: Western Corn Belt (Iowa, Minnesota, Missouri, North Dakota, and South Dakota); ECB: Eastern Corn Belt (Illinois, Indiana, Michigan, Ohio, and Wisconsin)**

* **13% moisture basis**

Table 4. ASA-IM 2012 Food Soybean Quality Survey NIR-predicted Carbohydrate Data by Seed Size[‡] & Region[§]

Region	Seed Size	Number Samples	Seed Size Average (g/100 seeds)	Sucrose (% DM basis)	Raffinose (% DM basis)	Stachyose (% DM basis)
WCB	Small	4	10.3	5.97	0.47	4.25
	Average	34	17.6	4.81	0.44	3.87
	Large	2	21.5	4.24	0.41	3.64
ECB	Small	2	11.9	5.79	0.46	4.27
	Average	81	16.8	4.60	0.44	3.83
	Large	17	24.2	4.92	0.44	3.85

Data as of November 29, 2012

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

[§] **WCB: Western Corn Belt (Iowa, Minnesota, Missouri, North Dakota, and South Dakota); ECB: Eastern Corn Belt (Illinois, Indiana, Michigan, Ohio, and Wisconsin)**

Table 5. ASA-IM 2012 Food Soybean Quality Survey NIR-predicted Amino Acid Data by Seed Size[‡] & Region[§]

Region	Seed Size	Number Samples	Seed Size Average (g/100 seeds)	Protein[*] (%)	Lysine (as % of P)	Five Essential[¶] Amino Acids (as % of P)	Ten Essential[†] Amino Acids (as % of P)
WCB	Small	4	10.3	34.0	6.09	14.5	39.1
	Average	34	17.6	36.8	5.95	13.9	38.1
	Large	2	21.5	39.0	6.06	13.9	38.3
ECB	Small	2	11.9	34.2	6.12	14.4	38.8
	Average	81	16.8	36.7	6.02	14.0	38.2
	Large	17	24.2	37.4	6.01	13.9	37.9

Data as of November 29, 2012

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

§ **WCB: Western Corn Belt (Iowa, Minnesota, Missouri, North Dakota, and South Dakota); ECB: Eastern Corn Belt (Illinois, Indiana, Michigan, Ohio, and Wisconsin)**

* **13% moisture basis**

¶ **Five essential amino acids: lysine, cysteine, methionine, tryptophan, and threonine**

† **Ten essential amino acids: leucine, histidine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, and cysteine**

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