United States Soybean Quality

Annual Report 2014

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QUALITY REPORT: 2014

SUMMARY

The American Soybean Association and the US Soybean Export Council have supported a survey of the quality of the US soybean crop since 1986. This survey is intended to provide new crop quality data to aid international customers with their purchasing decisions.

2014 ACREAGE, YIELDS, AND TOTAL PRODUCTION

According to the 1 November, 2014 United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) crop production report, the total US soybean harvested area increased 9.4 percent from last year to 33.8 million hectares harvested (Table 1). Average yields increased to 3.2 MT per ha. The higher yields brought total US soybean production to an estimated 107.8 million MT. The record 2014 crop is estimated to be 17.8% larger than the 2013 crop.

QUALITY OF THE 2014 US SOYBEAN CROP

Sample kits were mailed to 5,000 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 17 December, 2014, 1,800 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 data, so that average values would best represent the crop as a whole. Results are in Tables 2a through 5.

INTERPRETATION OF PROTEIN AND OIL RESULTS

Overall, the 2014 US soybean crop quality, as measured by protein and oil concentration, decreased slightly from that of the excellent 2013 crop, and there was less regional variation for oil and more regional variation for protein than was noted in 2013. Average US soybean protein concentration was 0.3 percentage points lower in 2014, at 34.4%, and average US oil

concentration was 0.4 percentage points lower at 18.6% when compared with 2013 (Table 5). As is noted in most years, Western Corn Belt states showed slightly lower protein concentrations than the US crop as a whole (Table 2a), but the Western Corn Belt oil was near the US average. Soybeans grown in all regions other than the Western Corn Belt had higher protein concentrations than the US average; however, the Eastern Corn Belt and East Coast regions had oil concentrations slightly below the US average. The Midsouth and Southeast regions had oil concentrations higher than all of the other regions, and higher than the US average.

Compared with the 2013 crop, 2014 protein concentrations were lower in nearly every region, ranging from 0 to 0.5 percentage point lower. Oil concentrations in the Midsouth, Southeast, and East Coast regions were higher in 2014 than in those regions in 2013, but Western Corn Belt and Eastern Corn Belt oil values were lower in 2014 than in 2013. In the Midsouth, Southeast, and East Coast regions, soybeans appeared to have higher oil at the expense of protein, when compared with 2013 soybeans from the same regions.

Seed from the 2014 crop had slightly higher harvest moisture in all regions except the Midsouth and Southeast when compared to 2013 (Table 2b). The average moisture of samples received in 2014 was 12.4%, up 0.1 percentage points from 2013. When protein levels were examined on an as-is moisture basis rather than adjusted to a 13% moisture basis, protein in the Western Corn Belt increased slightly from 34.1 to 34.4%, and the average US soybean protein increased from 34.4 to 34.6%. Similarly, national oil values increased from 18.6 to 18.8%, on an as-is basis.

INTERPRETATION OF SEED SIZE AND FOREIGN MATERIAL RESULTS

While seed size may not be important for most commodity soybean purchasers, seed size does provide some insight into the environmental conditions present during the production season. Seed size can also be correlated with changes in protein and oil concentration due to

these same environmental conditions. In general, environmental stresses such as drought in the early seed-filling period (late July and early August) tend to reduce the number of seeds on individual plants; if conditions return to normal; these remaining seeds can expand, resulting in larger than average seed size. Alternatively, stresses at the end of the seed-filling period (late August through September) reduce the energy available for each seed and seed size may be smaller than average. In 2014, seed size was the same as in 2013, at 16.0 grams per 100 seeds (Table 3). Seed size tended to be smallest in the Midsouth and Southeast regions, and largest in the Eastern Corn Belt; many comments on samples from growers in parts of the Eastern Corn Belt noted that July and early August were dry then turned wet, perhaps explaining the larger than average seed size in the Eastern Corn Belt.

Foreign material (FM) found in US samples was, on average, very low at 0.1%, with regional averages ranging from 0.1 to 0.3% (Table 3). Of the 1,800 samples, 98% of them (1,764 samples) had FM values below 1%, 1.4% (26 samples) had 1-2% FM, and only 0.6% of them (ten samples) had >2% FM.

AMINO ACIDS

Amino acids are the “building block” organic compounds linked in various combinations to form unique proteins. In human diets, amino acids are supplied by the variety of plant and animal proteins ingested. In animal feed, amino acids come from feed proteins such as soybean meal, or from synthetic amino acid supplements. Soybean meal is the major feed protein source in poultry, swine, and cultured fish diets because of its high nutritional quality including its balanced amino acid profile. Optimal animal performance occurs when the feed protein contains an ideal amount and proportion of all essential amino acids (those amino acids which cannot be formed by animals) – this is an “ideal protein”. Typically, feed diet formulation, seeking to achieve an ideal feed protein, is based on knowing crude protein then adding “insurance” levels of amino acids in order to avoid any amino acid shortage. Often this approach results in an excess of nitrogen compounds because the protein supply does

not ideally match the animals' needs; the excess is excreted and lost, and can pose an environmental contamination risk. Additionally, this approach involves higher production costs.

Preferably, the use of a high quality protein source with an excellent balance of amino acids to meet the most limiting amino acid requirements at a lower protein concentration is a far more efficient option than using a lower quality protein source. In a comparison of soybean meal from US and other origins, US soybean meal had lower protein content than Brazilian soybean meal, but better quality of protein – higher concentrations of essential amino acids (Park and Hurburgh, 2002; Thakur and Hurburgh, 2007; Bootwalla, 2009). Although soybeans from the US are generally lower in crude protein, both US soybeans and soybean meal contained higher concentrations of essential amino acids (Thakur and Hurburgh, 2007), thus making their protein fraction of higher quality.

The 2014 amino acid results were similar to those found in 2013, in that there was little regional variation for lysine (expressed as a percent of the 18 primary amino acids) or the five most limiting amino acids (cysteine, lysine, methionine, threonine, and tryptophan). Regional differences alone did not appear to explain amino acid concentration differences in the samples because of variation within states and regions. When we evaluated the amino acid concentrations in the 30% of samples with the lowest and highest protein concentrations, we found that the top 30% (540 samples) for protein had a significantly lower sum of the five most limiting amino acids, 14.5%, compared to the bottom 30% for protein that had a sum of the five limiting amino acids of 14.7%. The protein in lower protein samples is more concentrated in those five amino acids than is the protein in higher protein samples.

WEATHER AND CROP SUMMARY

Planting: A large area of the Midwest experienced above normal precipitation (IA, IL, IN, KY, MI, MN, MO, OH, and WI) and below normal temperatures (IA, IL, MI, MN, MO, and WI)

during April. Consequently, by the end of April, only 3% of the US soybean crop was planted in the 18 US states that represent 95% of the US soybean acreage. May brought continued excess rain to the more northern parts of the Midwest, but warmer and drier conditions in the southern parts of the Midwest allowed for planting to catch up and surpass the 5-year average.

Mid-Season: In June, nearly all of the Midwest experienced well above average rainfall and near or above average temperatures; planting was completed by the end of June. July brought cooler and drier than average conditions to the Midwest, though the dry conditions did not negatively impact the crop due to the cooler conditions and reservoir of moisture in the soil; at the end of July, 71% of the crop was in good or excellent condition – 8% better than at the same time last year. August was wetter than normal and started out cool, but turned warmer later in the month. Overall, the 3-month growing period from June to August was wetter and cooler than normal.

Harvest: September was generally wet and cool early (on September 11-12, MN, WI, MI, and IA received their first frosts of the season), and dry and warm late in the most northern states in the Midwest. In more southern states in the Midwest (IA, MO, WI, IL, IN, NE), conditions stayed wetter than normal into October. Nationally by at the end of October, 70% of the crop was harvested, 5 percentage points behind the same period in 2013, and 6 percentage points behind the 5-year average – likely due to delayed crop maturation and lingering wet conditions. Fortunately, by November 2, the 2014 harvest had caught up to the 5-year average – 83% of soybeans were harvested.

Overall the 2014 growing season was generally a cooler and wetter than normal one in many soybean growing regions (Weather Figure 1), but some production areas experienced near-ideal conditions.

QUALITY REPORT: 2014

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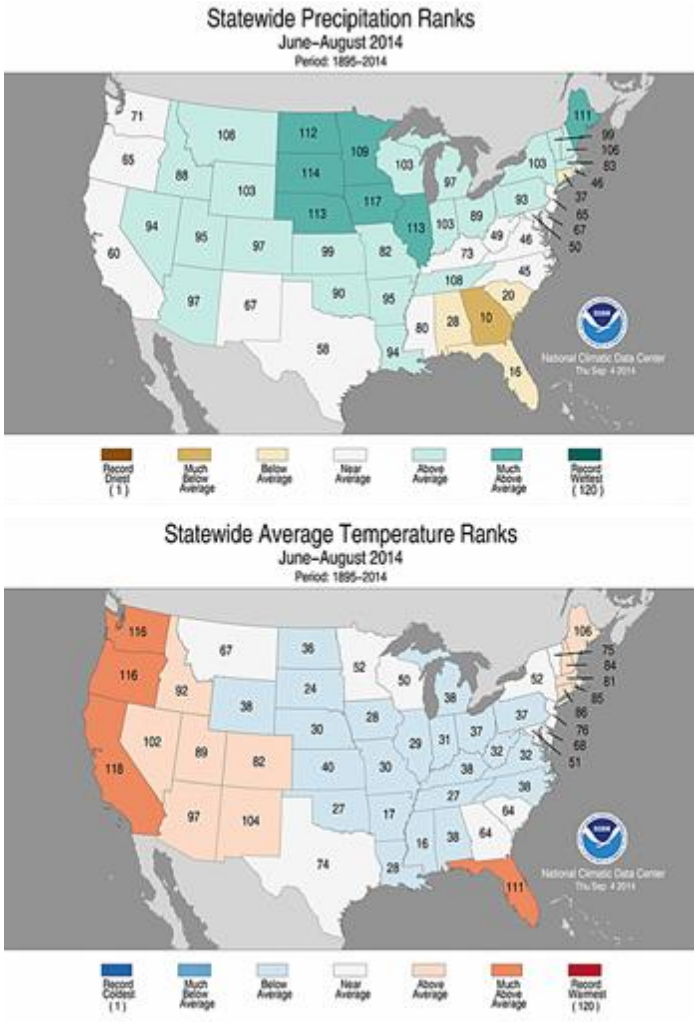
Weather Figure 1



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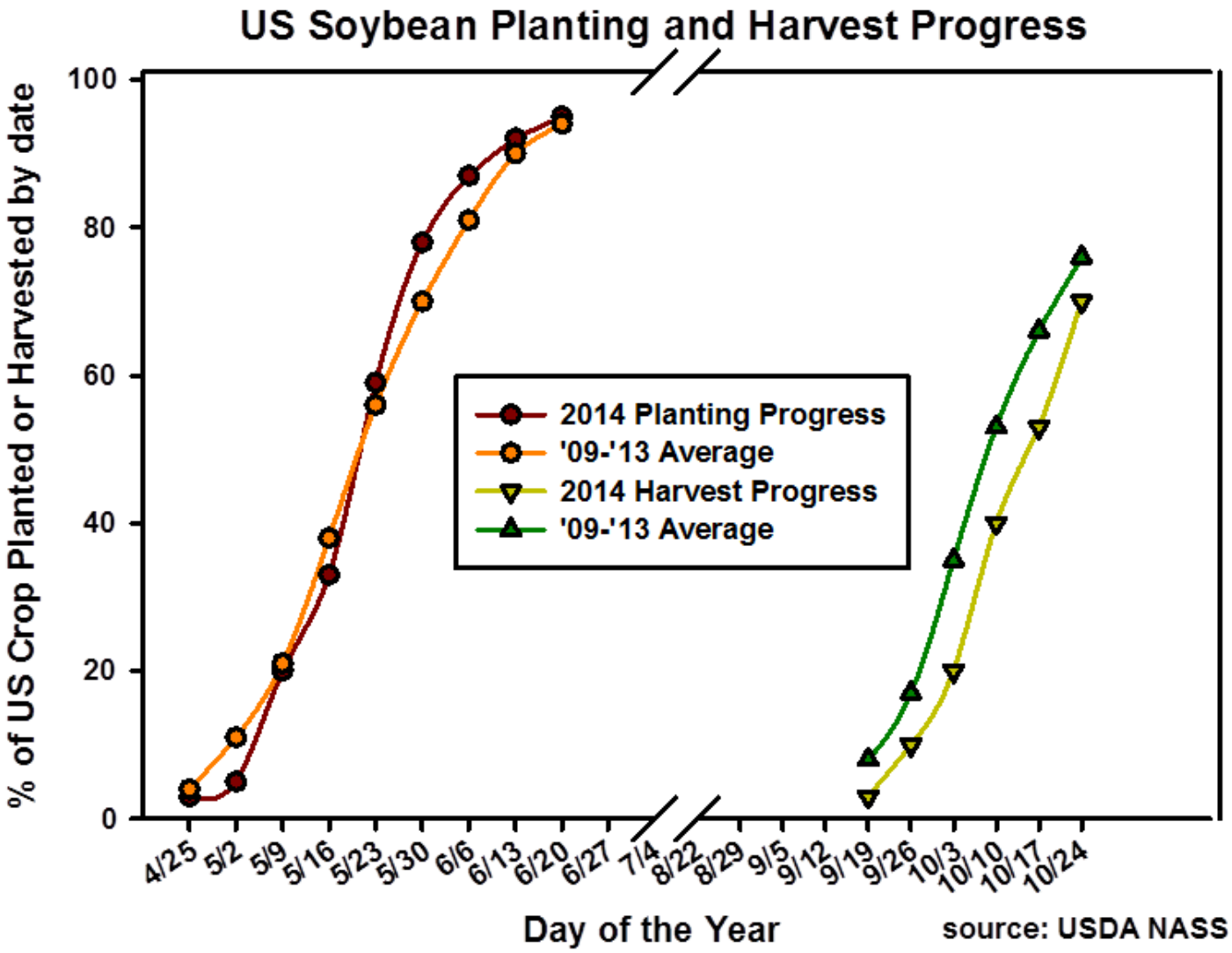

Figure 1

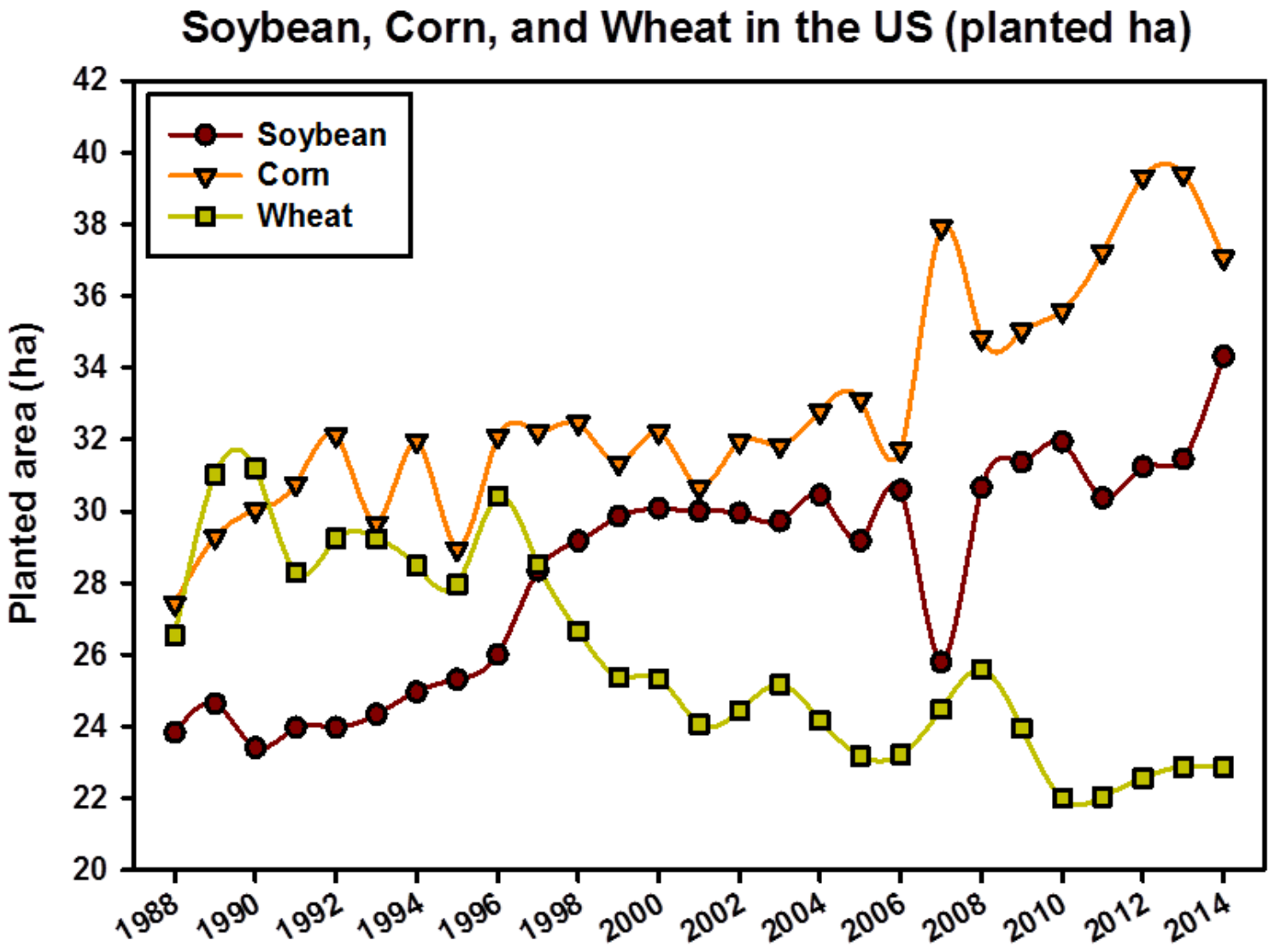
Soybean, Corn, and Wheat in the US (planted ha)
Planted area (ha)
Soybean
Corn
Wheat
42
40
38
36
34
32
30
28
26
24
22
20
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

Figure 2

Table 1. Soybean production data for the United States, 2014 crop

Region	State	Yield (MT ha^{-1})	Area Harvested (1000 ha)	Production (M MT)
Western Corn Belt (WCB)	Iowa	3.5	4,005	14.0
	Kansas	2.5	1,616	4.0
	Minnesota	2.8	2,944	8.3
	Missouri	3.0	2,268	6.9
	Nebraska	3.6	2,167	7.9
	North Dakota	2.3	2,390	5.5
	South Dakota	3.0	2,070	6.3
	Western Corn Belt	3.0	17,460	52.8
				49.0%
Eastern Corn Belt (ECB)	Illinois	3.8	3,989	15.0
	Indiana	3.6	2,223	8.1
	Michigan	3.0	887	2.7
	Ohio	3.4	1,980	6.7
	Wisconsin	3.0	721	2.1
	Eastern Corn Belt	3.3	9,801	34.6
				32.1%
Midsouth (MDS)	Arkansas	3.2	1,337	4.3
	Kentucky	3.2	709	2.3
	Louisiana	3.6	567	2.1
	Mississippi	3.5	887	3.1
	Oklahoma	2.1	134	0.3
	Tennessee	3.2	640	2.1
	Texas	2.4	55	0.1
	Midsouth	3.0	4,327	14.2
				13.2%
Southeast (SE)	Alabama	2.8	198	0.6
	Georgia	2.8	117	0.3
	North Carolina	2.7	697	1.9
	South Carolina	2.3	178	0.4
	Southeast	2.6	1,191	3.2
				2.9%
East Coast (EC)	Delaware	3.2	74	0.2
	Maryland	3.0	205	0.6
	New Jersey	2.8	42	0.1
	New York	3.0	153	0.5
	Pennsylvania	3.4	243	0.8
	Virginia	2.8	259	0.7
	East Coast	3.0	975	3.0
				2.7%
US 2014		3.2	33,778	107.8
US 2013		3.0	30,882	91.5

Source: United States Department of Agriculture, NASS 2014 Crop Production Report (November 2014)

Table 2a. USSEC 2014 Soybean Quality Survey Data

Region	State	Number of Samples	Protein (%)*	Std. Dev.	Oil (%)*	Std. Dev.
Western Corn Belt (WCB)	Iowa	244	34.0	1.2	18.6	0.9
	Kansas	56	34.9	1.7	19.0	0.8
	Minnesota	261	33.9	1.3	18.2	0.8
	Missouri	91	34.4	1.3	19.0	0.8
	Nebraska	127	34.2	1.3	18.6	0.9
	North Dakota	82	33.4	1.4	18.1	0.9
	South Dakota	89	34.4	1.2	18.2	0.9
Averages†	Western Corn Belt	950	34.1	1.3	18.5	0.9
Eastern Corn Belt (ECB)	Illinois	292	34.4	1.4	18.7	0.9
	Indiana	104	34.7	1.4	18.6	1.0
	Michigan	51	35.5	1.3	17.9	0.9
	Ohio	139	35.5	1.2	18.1	1.1
	Wisconsin	34	34.8	1.4	17.8	0.9
Averages†	Eastern Corn Belt	620	34.8	1.4	18.4	1.0
Midsouth (MDS)	Arkansas	51	34.5	1.4	19.5	0.9
	Kentucky	23	34.4	1.1	18.5	1.0
	Louisiana	19	35.3	1.5	20.1	0.9
	Mississippi	33	34.3	1.3	20.3	0.8
	Oklahoma	6	35.1	2.4	18.0	1.5
	Tennessee	14	34.4	1.2	19.3	0.9
	Texas	1	35.0		20.7	
Averages†	Midsouth	147	34.6	1.3	19.5	0.9
Southeast (SE)	Alabama	5	34.1	0.9	20.0	0.7
	Georgia	3	34.8	1.2	19.2	1.2
	North Carolina	21	34.6	1.8	19.1	0.7
	South Carolina	6	34.2	1.1	19.5	0.7
Averages†	Southeast	35	34.5	1.5	19.3	0.7
East Coast (EC)	Delaware	7	35.3	1.3	18.8	0.7
	Maryland	9	34.7	1.4	18.3	0.7
	New Jersey	5	35.5	1.6	18.5	0.8
	New York	7	35.2	1.4	17.4	0.6
	Pennsylvania	12	34.7	1.3	18.2	1.0
	Virginia	8	34.1	0.9	18.6	1.0
Averages†	East Coast	48	34.7	1.2	18.3	0.8
US	Averages	1800	34.4		18.6	
	Average of 2014 Crop†		**34.4**	**1.3**	**18.6**	**0.9**
	US 1986-2014 avg.		35.2	1.5	18.7	0.9

* 13% moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (November 2014)

Table 2b. USSEC 2014 Soybean Quality Survey Data As-Is Basis

Region	State	Number of Samples	Moisture (%)	Protein (%)*	Oil (%)*
Western Corn Belt (WCB)	Iowa	244	12.7	34.1	18.7
	Kansas	56	11.1	35.6	19.4
	Minnesota	261	12.6	34.0	18.3
	Missouri	91	12.2	34.7	19.2
	Nebraska	127	11.2	34.9	19.0
	North Dakota	82	12.4	33.6	18.2
	South Dakota	89	11.6	34.9	18.5
Averages†	Western Corn Belt	950	12.1	34.4	18.7
Eastern Corn Belt (ECB)	Illinois	292	12.6	34.6	18.8
	Indiana	104	12.7	34.8	18.6
	Michigan	51	14.2	35.0	17.6
	Ohio	139	12.7	35.6	18.2
	Wisconsin	34	13.3	34.7	17.7
Averages†	Eastern Corn Belt	620	12.8	34.9	18.4
Midsouth (MDS)	Arkansas	51	12.2	34.8	19.7
	Kentucky	23	13.3	34.3	18.5
	Louisiana	19	12.5	35.5	20.2
	Mississippi	33	12.4	34.5	20.4
	Oklahoma	6	10.7	36.1	18.4
	Tennessee	14	12.8	34.5	19.4
	Texas	1	9.8	36.3	21.5
Averages†	Midsouth	147	12.5	34.8	19.7
Southeast (SE)	Alabama	5	12.3	34.4	20.2
	Georgia	3	11.3	35.5	19.6
	North Carolina	21	12.7	34.7	19.2
	South Carolina	6	12.8	34.3	19.6
Averages†	Southeast	35	12.5	34.7	19.5
East Coast (EC)	Delaware	7	12.0	35.7	19.0
	Maryland	9	13.6	34.4	18.2
	New Jersey	5	13.9	35.2	18.3
	New York	7	13.8	34.9	17.2
	Pennsylvania	12	12.4	34.9	18.3
	Virginia	8	12.1	34.5	18.8
Averages†	East Coast	48	12.8	34.8	18.3
US	Averages	1800	12.4	34.6	18.7
	Average of 2014 Crop†		**12.4**	**34.6**	**18.8**

* As-is moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (November 2014)

Table 3. USSEC 2014 Soybean Quality Survey Seed Data

Region	State	Number of Samples	Seed Weight g 100 seeds^{-1}	Std. Dev.	Foreign Material (%)	Std. Dev.
Western Corn Belt (WCB)	Iowa	244	16.1	1.8	0.1	0.2
	Kansas	56	15.8	1.8	0.1	0.1
	Minnesota	261	15.7	1.8	0.1	0.2
	Missouri	91	15.7	1.8	0.2	0.8
	Nebraska	127	16.6	1.4	0.1	0.1
	North Dakota	82	15.6	1.8	0.2	0.9
	South Dakota	89	16.5	1.5	0.1	0.3
Averages†	Western Corn Belt	950	16.0	1.7	0.1	0.4
Eastern Corn Belt (ECB)	Illinois	292	16.6	1.9	0.1	0.6
	Indiana	104	17.0	1.7	0.1	0.2
	Michigan	51	17.2	2.0	0.2	0.9
	Ohio	139	16.5	1.5	0.1	0.2
	Wisconsin	34	16.9	1.9	0.5	2.1
Averages†	Eastern Corn Belt	620	16.7	1.8	0.1	0.6
Midsouth (MDS)	Arkansas	51	14.0	1.2	0.2	0.2
	Kentucky	23	14.5	1.8	0.1	0.2
	Louisiana	19	15.1	1.4	0.3	0.4
	Mississippi	33	14.4	1.3	0.5	0.9
	Oklahoma	6	14.0	1.7	0.1	0.1
	Tennessee	14	14.8	1.9	0.3	0.5
	Texas	1	18.2		0.0	
Averages†	Midsouth	147	14.5	1.5	0.3	0.4
Southeast (SE)	Alabama	5	14.7	1.3	0.1	0.1
	Georgia	3	14.5	2.0	0.0	0.0
	North Carolina	21	14.9	1.8	0.1	0.1
	South Carolina	6	15.1	1.5	0.1	0.2
Averages†	Southeast	35	14.9	1.7	0.1	0.1
East Coast (EC)	Delaware	7	16.2	2.1	0.0	0.1
	Maryland	9	16.4	1.4	0.0	0.1
	New Jersey	5	15.5	1.0	0.1	0.2
	New York	7	16.2	2.2	0.1	0.3
	Pennsylvania	12	15.9	1.4	0.0	0.0
	Virginia	8	15.9	1.4	0.2	0.2
Averages†	East Coast	48	16.1	1.6	0.1	0.1
USA	Averages	1800	16.1		0.1	
	Average of 2014 Crop†		**16.0**	**1.7**	**0.1**	**0.4**

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (November 2014)

Table 4. USSEC 2014 Soybean Quality Survey Amino Acid (AA) Data

Region	State	Number of Samples	Protein (%)*	Lysine (%18 AAs)	5 EAAs‡ (%18 AAs)
Western Corn Belt (WCB)	Iowa	244	34.0	6.7	14.6
	Kansas	56	34.9	6.7	14.6
	Minnesota	261	33.9	6.7	14.6
	Missouri	91	34.4	6.7	14.6
	Nebraska	127	34.2	6.7	14.7
	North Dakota	82	33.4	6.8	14.7
	South Dakota	89	34.4	6.7	14.6
Averages†	Western Corn Belt	950	34.1	6.7	14.6
Eastern Corn Belt (ECB)	Illinois	292	34.4	6.7	14.6
	Indiana	104	34.7	6.7	14.6
	Michigan	51	35.5	6.7	14.4
	Ohio	139	35.5	6.7	14.5
	Wisconsin	34	34.8	6.7	14.6
Averages†	Eastern Corn Belt	620	34.8	6.7	14.6
Midsouth (MDS)	Arkansas	51	34.5	6.7	14.6
	Kentucky	23	34.4	6.7	14.6
	Louisiana	19	35.3	6.7	14.6
	Mississippi	33	34.3	6.7	14.7
	Oklahoma	6	35.1	6.6	14.6
	Tennessee	14	34.4	6.7	14.6
	Texas	1	35.0	6.7	14.6
Averages†	Midsouth	147	34.6	6.7	14.6
Southeast (SE)	Alabama	5	34.1	6.7	14.6
	Georgia	3	34.8	6.7	14.5
	North Carolina	21	34.6	6.7	14.6
	South Carolina	6	34.2	6.7	14.5
Averages†	Southeast	35	34.5	6.7	14.6
East Coast (EC)	Delaware	7	35.3	6.7	14.4
	Maryland	9	34.7	6.7	14.6
	New Jersey	5	35.5	6.7	14.5
	New York	7	35.2	6.7	14.5
	Pennsylvania	12	34.7	6.7	14.5
	Virginia	8	34.1	6.7	14.6
Averages†	East Coast	48	34.7	6.7	14.5
USA	Averages	1800	34.4	6.7	14.6
	Average of 2014 Crop†		**34.4**	**6.7**	**14.6**

* 13% moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (November 2014)

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

Table 5. Historical Summary of Yield and Quality Data for US Soybeans

Year	Yield (kg ha^{-1})	Protein* (%)	Oil* (%)	Sum† (%)	Harvested (M ha^{-1})	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	29.2	83.4	1.46	0.87
2006‡	2869	34.5	19.2	53.7	30.2	86.8	1.64	1.01
2007‡	2802	35.2	18.7	53.9	26.0	72.9	1.23	0.76
2008‡	2641	34.1	19.1	53.2	30.1	79.6	1.40	0.82
2009‡	2956	35.3	18.6	53.9	30.9	91.5	1.23	0.88
2010‡	2950	35.0	18.6	53.6	31.1	91.9	1.38	1.19
2011‡	2788	34.9	18.1	53.0	29.8	83.4	2.20	1.79
2012‡	2674	34.3	18.5	52.8	30.8	82.6	1.60	0.93
2013‡	2956	34.7	19.0	53.7	30.9	91.5	1.60	0.93
2014‡	3192	34.4	18.6	53.0	33.8	107.8	1.31	0.90
Averages (1986-2014)	**2575**	**35.2**	**18.7**	**53.8**	**27.6**	**71.7**	**1.51**	**0.93**

Sources: United States Department of Agriculture
Iowa State University
University of Minnesota

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

†Sum represents sum of protein and oil concentrations

‡2006 - 2014 quality estimates are weighted by yearly production estimates by state

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