United States Soybean Quality

Annual Report 2013

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QUALITY REPORT: 2013

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.

2013 ACREAGE, YIELDS, AND TOTAL PRODUCTION

According to the 8 November, 2013 United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) crop production report, the total US soybean harvested area decreased 0.6 percent from last year to 30.6 million hectares harvested (Table 1). Average yields increased to 2.89 MT per ha. The higher yields brought total US soybean production to an estimated 88.7 million MT. The 2013 crop will be 7.4% larger than the 2012 crop.

QUALITY OF THE 2013 US SOYBEAN CROP

Sample kits were mailed to 8,325 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 4 November, 2013, 1,627 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. Results are in Tables 2a, 2b, and 3.

INTERPRETATION OF PROTEIN AND OIL RESULTS

Overall, quality of the 2013 US soybean crop increased slightly from that of the 2012 crop, and there tended to be less regional variation in quality than has been noted in previous years. Average US soybean protein concentration was 0.4 percentage points higher in 2013, at 34.7%, and average oil concentration was 0.5 percentage points higher at 19.0% when

compared with 2012 (Table 4). As is noted in most years, Western Corn Belt states showed slightly lower protein concentrations than the US crop as a whole (Table 2a). In contrast to previous years, soybeans grown in the Midsouth and Southeast states did not have higher protein concentrations. East Coast states did produce a soybean crop with higher protein concentration than the main soybean production regions of the Western and Eastern Corn Belt, but the oil concentrations there tended to be low. Midsouth states produced a crop with an average oil concentration of 19.6%, the highest of any region.

Compared with the 2012 crop, protein concentrations remained similar in the East Coast, while increasing in the Western and Eastern Corn Belt regions. Protein levels decreased in the Midsouth and Southeast regions. Oil concentrations in 2013 were higher in the Western Corn Belt, Midsouth and Southeast regions. Protein and oil concentrations both increased by 0.5 percentage points in the Western Corn Belt when compared with 2012. The average soybean from the Eastern Corn belt also showed increased protein and oil, but the increases were more modest. In the Midsouth and Southeast, soybeans appeared to have higher protein at the expense of oil, when compared with 2012 soybeans from the same region.

Seed from the 2013 crop had higher harvest moisture when compared to the unusually dry 2012 crop (Table 2b). The average moisture of samples received in 2013 was 12.3%, up 1.1 percentage points from 2012. Some areas in the Midsouth experienced very wet conditions during harvest, and that is reflected in higher than average seed moisture. 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 increases to 35.0% and the average US soybean increased from 34.7 to 35.0%. Similarly, national oil values increased from 19.0 to 19.2%, on an 'as-is' basis.

INTERPRETATION OF SEED SIZE 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 2013, seed size was just 2.5% smaller than in 2012, with the average seed size decreasing from 16.4 grams per 100 seeds in 2012 to 16.0 in 2013 (Table 2a). Seed size tended to be smallest in the Midsouth region, likely due to hot, dry conditions and heavy disease pressure late in the season.

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.

Table 3 contains amino acid data grouped by growing region and state. In both 2011 and 2012 survey reports, we presented the amino acid data on a percent of protein basis; we have determined that a more accurate representation of any given amino acid would be as a percentage of the 18 primary amino acids in the sample, i.e., the five most critical essential amino acids would be the sum of: [(lysine/total 18 amino acids) + (methionine/total 18 amino acids) + …etc. for lysine, methionine, threonine, tryptophan, and cysteine].

2013 AMINO ACID SUMMARY

The 2013 amino acid results differ slightly than results obtained from previous work in our laboratory. When analyzed as a percent of the 18 amino acids, lysine, the 5 primary limiting essential amino acids, and 10 essential amino acids did not appear to vary much between the regions. There was a tendency for regions with higher protein values to also be higher in essential amino acids relative to other regions, again contrary to previous years.

WEATHER AND CROP SUMMARY

Planting: Some soybean production states (Kansas, Minnesota, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin) experienced a top ten cold April, and precipitation was well above normal for much of the Midwest in April, which helped ease the drought that persisted from 2012. This cool, wet weather delayed fieldwork, putting most states' planting progress behind normal at the end of April. In May, favorable weather in many areas allowed producers to make planting progress, but only 44% of the crop was in the ground by May 26, 43 percentage points behind last year and 17 percentage points behind the 5-year average.

Due to heavy localized rains, planting progress was highly variable at a local level, with some areas planted in early May and others in June.

Mid-Season: Temperatures were very close to normal in soybean production areas. By June 23, 92% of the soybean crop was planted and, where planting had already occurred, 81% of the crop had emerged – about 8 percentage points behind the 5-year average. In July, rainfall amounts dropped to below normal for Minnesota, Nebraska, Iowa, Wisconsin, and Indiana, but overall in July, 63% of the crop was in good or excellent condition, 34 percentage points better than the same time in 2012. In August, much of the soybean growing region continued or began to experience below normal precipitation. Some places in the central Midwest received no measurable rainfall (their driest August on record), though parts of Missouri had their wettest August on record. Exceptionally dry parts of the Midwest included Illinois, Indiana, Iowa, and Minnesota.

Harvest: Near-average temperatures and rainfall allowed some producers to begin harvesting, and by September 24th, 3% of the crop was harvested, 18 percentage points behind 2012. By the end of October, cool and dry weather conditions allowed rapid fieldwork progress in most of the northern Great Plains and in the Corn Belt. Nationally by October 27th, 77% of the soybean crop was harvested, equaling the 5-year average.

Overall, the 2013 production season started out slowly due to cool, wet weather. During the growing season, precipitation varied significantly, with the central and upper Midwest and Corn Belt enduring drier than normal conditions, and the southern and eastern production areas experiencing cooler and wetter conditions. The start of the 2013 harvest was around 20% delayed compared to the same time period last year, but caught up to the 5-year average by the end of October. Figures 1 and 2 contain US soybean planting and harvest progress, and crop condition, respectively; gaps in these figures are the result of no data being available during the US government shut-down in October.

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Figure 1. US Soybean Planting and Harvest Progress

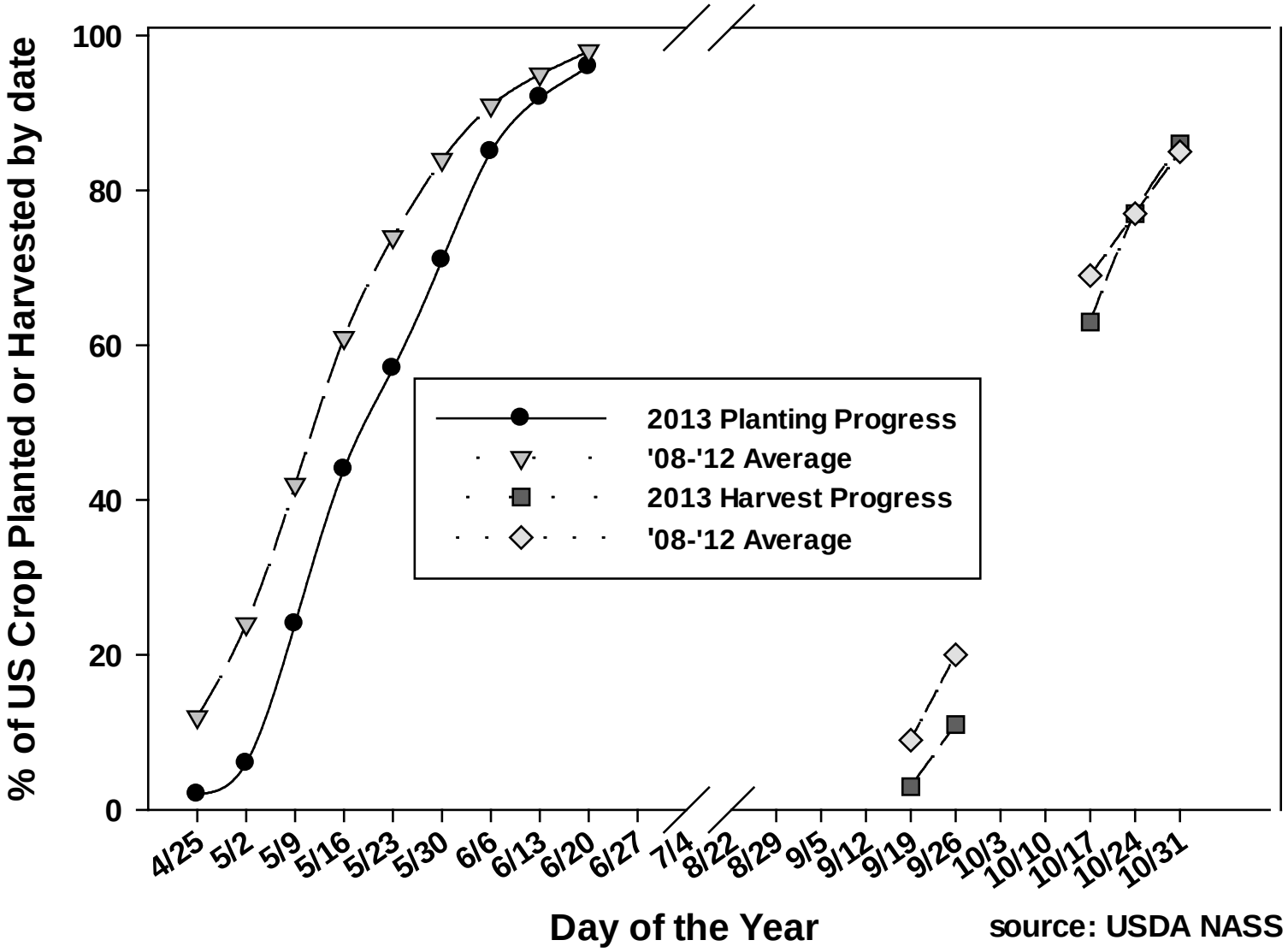

Figure 2. US Soybean Crop Conditions

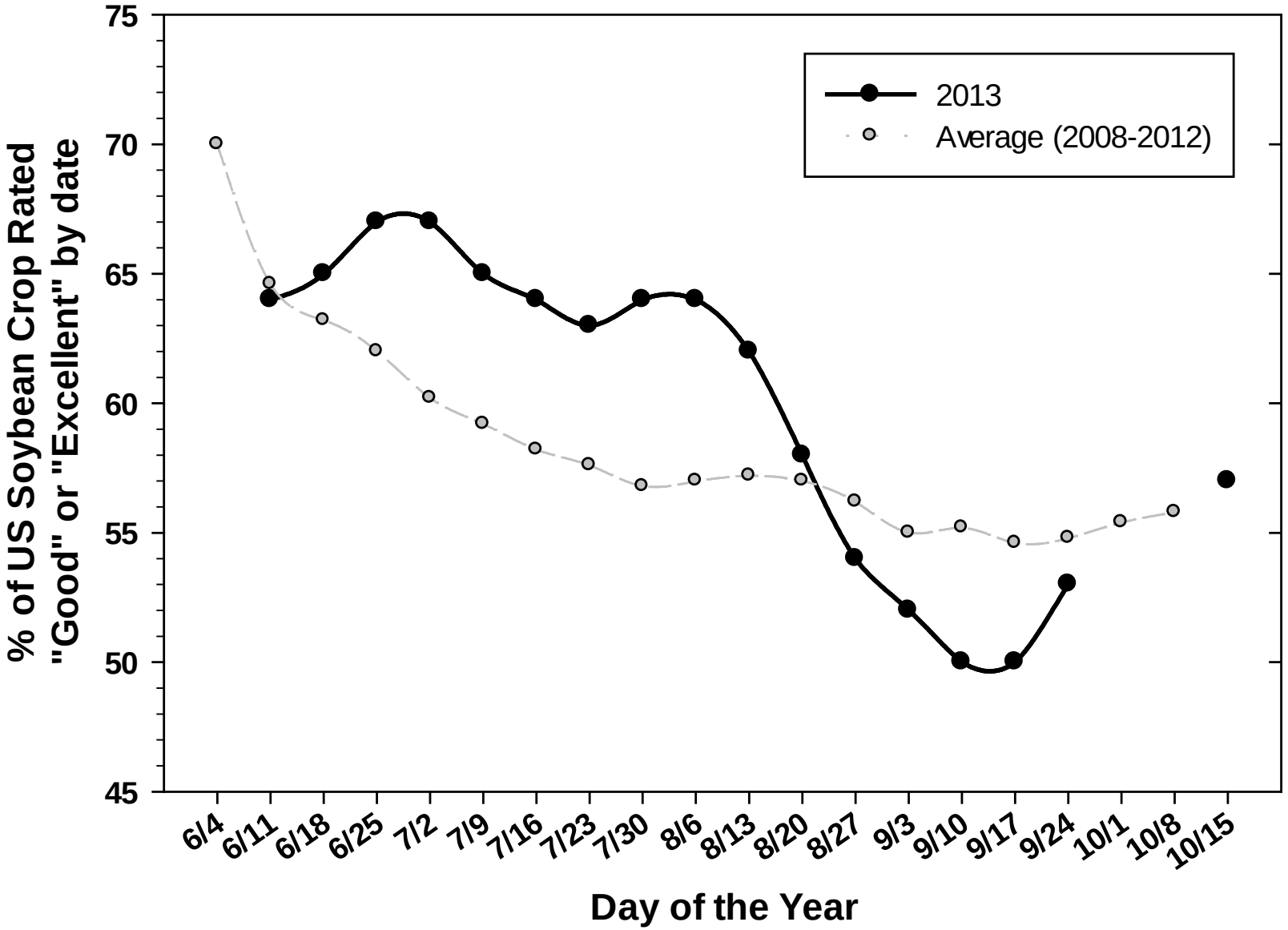

Table 1. Soybean production data for the United States, 2013 crop

Region	State	Yield (MT ha^{-1})	Area Harvested (1000 ha)	Production (M MT)
Western Corn Belt (WCB)	Iowa	3.0	3,738	11.3
	Kansas	2.4	1,434	3.4
	Minnesota	2.6	2,685	7.0
	Missouri	2.4	2,244	5.3
	Nebraska	3.5	1,924	6.7
	North Dakota	2.0	1,867	3.8
	South Dakota	2.7	1,843	5.0
	Western Corn Belt	2.6	15,734	42.5
				47.9%
Eastern Corn Belt (ECB)	Illinois	3.3	3,807	12.5
	Indiana	3.4	2,098	7.1
	Michigan	3.0	765	2.3
	Ohio	3.3	1,794	5.9
	Wisconsin	2.7	636	1.7
	Eastern Corn Belt	3.1	9,100	29.5
				33.2%
Midsouth (MDS)	Arkansas	3.0	1,296	3.9
	Kentucky	3.3	664	2.2
	Louisiana	3.2	441	1.4
	Mississippi	2.9	802	2.3
	Oklahoma	1.8	126	0.2
	Tennessee	3.2	616	2.0
	Texas	1.9	36	0.1
	Midsouth	2.8	3,981	12.1
				13.6%
Southeast (SE)	Alabama	2.9	170	0.5
	Georgia	2.6	89	0.2
	North Carolina	2.1	583	1.2
	South Carolina	1.7	126	0.2
	Southeast	2.3	968	2.2
				2.4%
East Coast (EC)	Delaware	2.7	66	0.2
	Maryland	2.7	192	0.5
	New Jersey	2.8	35	0.1
	New York	3.2	110	0.3
	Pennsylvania	3.3	207	0.7
	Virginia	2.7	239	0.6
	East Coast	2.9	849	2.5
				2.8%
USA 2013		2.89	30,654	88.7
USA 2012		2.67	30,846	82.6

Source: United States Department of Agriculture, NASS 2013 Crop Production Report (November 8, 2013)

Table 2a. USSEC 2013 Soybean Quality Survey Data

Region	State	Number of Samples	Protein (%)*	St. Dev.	Oil (%)*	St. Dev.	Seed Wt. g/100 seeds	St. Dev.
Western Corn Belt (WCB)	Iowa	233	34.6	1.0	19.1	0.9	16.1	1.7
	Kansas	55	34.6	0.9	19.2	0.7	15.9	1.8
	Minnesota	239	34.6	1.2	19.0	0.8	16.5	2.1
	Missouri	73	34.4	1.1	19.3	1.1	15.4	1.8
	Nebraska	138	34.5	0.9	19.1	0.9	17.2	1.7
	North Dakota	53	33.7	1.1	19.3	1.0	15.6	2.1
	South Dakota	89	34.8	1.0	18.9	0.8	16.1	1.8
Averages†	Western Corn Belt	880	34.5	1.1	19.1	0.9	16.2	1.9
Eastern Corn Belt (ECB)	Illinois	272	34.6	1.0	19.2	0.9	16.6	1.8
	Indiana	108	35.0	0.9	18.7	0.9	16.1	1.5
	Michigan	52	35.5	1.1	18.0	1.0	16.5	1.6
	Ohio	113	35.7	1.1	18.0	1.2	15.7	1.8
	Wisconsin	32	34.8	1.2	18.7	0.9	16.2	2.1
Averages†	Eastern Corn Belt	577	35.0	1.1	18.7	1.1	16.3	1.8
Midsouth (MDS)	Arkansas	39	34.2	1.4	19.8	1.0	15.0	1.6
	Kentucky	13	34.8	0.9	19.2	0.7	15.7	1.7
	Louisiana	19	34.9	1.7	19.9	1.0	14.7	1.7
	Mississippi	34	34.1	1.0	19.9	0.7	14.7	1.7
	Oklahoma	2	37.4	1.4	16.8	0.8	13.3	0.4
	Tennessee	8	34.9	1.2	19.1	1.1	14.5	1.6
	Texas	3	34.9	1.3	19.0	1.1	16.0	2.3
Averages†	Midsouth	118	34.6	1.4	19.6	1.0	14.9	1.7
Southeast (SE)	Alabama	3	35.1	0.4	19.7	0.1	16.9	2.3
	Georgia	3	35.4	1.1	19.1	1.1	15.0	2.1
	North Carolina	13	34.6	1.3	19.3	0.9	15.1	1.8
	South Carolina	--	--		--		--	
Averages†	Southeast	19	34.8	1.2	19.4	0.9	15.5	1.9
East Coast (EC)	Delaware	4	35.3	0.9	18.0	0.6	16.7	1.3
	Maryland	5	35.6	0.9	18.1	1.3	15.4	0.9
	New Jersey	6	36.0	1.3	18.0	1.1	15.7	1.2
	New York	5	35.9	1.7	16.9	0.5	17.6	1.5
	Pennsylvania	8	35.2	0.7	18.0	0.8	16.4	1.2
	Virginia	5	35.2	0.1	18.5	0.9	16.7	1.1
Averages†	East Coast	33	35.4	1.0	18.0	1.0	16.4	1.3
USA	Averages	1627	34.7		19.0		16.2	
	Average of 2013 Crop†		**34.7**	**1.1**	**19.0**	**1.0**	**16.0**	**1.9**
	US 1986-2013 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 8, 2013)

Table 2b. USSEC 2013 Soybean Quality Survey Data- As-Is Moisture

Region	State	Number of Samples	Moisture (%)	Protein (%)*	Oil (%)*
Western Corn Belt (WCB)	Iowa	233	12.0	35.0	19.4
	Kansas	55	11.0	35.3	19.7
	Minnesota	239	11.9	35.0	19.3
	Missouri	73	12.3	34.7	19.4
	Nebraska	138	10.8	35.4	19.5
	North Dakota	53	12.6	33.8	19.4
	South Dakota	89	11.2	35.5	19.2
Averages†	Western Corn Belt	880	11.7	35.0	19.4
Eastern Corn Belt (ECB)	Illinois	272	12.2	34.9	19.4
	Indiana	108	12.4	35.2	18.8
	Michigan	52	13.3	35.4	17.9
	Ohio	113	13.0	35.7	18.1
	Wisconsin	32	12.8	34.9	18.7
Averages†	Eastern Corn Belt	577	12.5	35.2	18.8
Midsouth (MDS)	Arkansas	39	13.6	34.0	19.7
	Kentucky	13	13.7	34.5	19.1
	Louisiana	19	12.6	35.1	20.0
	Mississippi	34	12.3	34.4	20.1
	Oklahoma	2	10.9	38.4	17.2
	Tennessee	8	14.5	34.4	18.8
	Texas	3	9.6	36.3	19.7
Averages†	Midsouth	118	13.3	34.4	19.5
Southeast (SE)	Alabama	3	12.9	35.2	19.7
	Georgia	3	13.3	35.2	19.0
	North Carolina	13	13.2	34.5	19.2
	South Carolina	--	--	--	--
Averages†	Southeast	19	13.1	34.8	19.3
East Coast (EC)	Delaware	4	12.5	35.5	18.1
	Maryland	5	13.4	35.5	18.0
	New Jersey	6	13.2	35.9	18.0
	New York	5	14.1	35.4	16.6
	Pennsylvania	8	13.1	35.2	18.0
	Virginia	5	13.0	35.2	18.5
Averages†	East Coast	33	13.2	35.3	17.9
USA	Averages	1627	12.1	35.0	19.4
	Average of 2013 Crop†		**12.3**	**35.0**	**19.2**

* 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 8, 2013)

Table 3. USSEC 2013 Soybean Quality Survey Data

Region	State	Number of Samples	Protein (%)*	Lysine (% of 18 AA's)	5 Essential Amino Acids‡ (% of 18 AA's)	10 Essential Amino Acids § (% of 18 AA's)
Western Corn Belt (WCB)	Iowa	233	34.6	6.8	15.0	42.1
	Kansas	55	34.6	6.8	15.1	42.0
	Minnesota	239	34.6	6.8	15.1	42.0
	Missouri	73	34.4	6.8	15.0	41.9
	Nebraska	138	34.5	6.8	15.1	42.0
	North Dakota	53	33.7	6.7	14.8	41.1
	South Dakota	89	34.8	6.9	15.1	42.3
Averages†	Western Corn Belt	880	34.5	6.8	15.0	42.0
Eastern Corn Belt (ECB)	Illinois	272	34.6	6.8	15.1	42.1
	Indiana	108	35.0	6.9	15.2	42.4
	Michigan	52	35.5	7.0	15.4	42.9
	Ohio	113	35.7	7.0	15.5	43.1
	Wisconsin	32	34.8	6.9	15.1	42.2
Averages†	Eastern Corn Belt	577	35.0	6.9	15.2	42.5
Midsouth (MDS)	Arkansas	39	34.2	6.7	14.9	41.7
	Kentucky	13	34.8	6.8	15.1	42.3
	Louisiana	19	34.9	6.9	15.3	42.6
	Mississippi	34	34.1	6.7	14.9	41.6
	Oklahoma	2	37.4	7.3	16.1	45.0
	Tennessee	8	34.9	6.8	15.1	42.4
	Texas	3	34.9	6.9	15.3	42.6
Averages†	Midsouth	118	34.6	6.8	15.0	42.1
Southeast (SE)	Alabama	3	35.1	6.9	15.2	42.7
	Georgia	3	35.4	6.9	15.3	42.9
	North Carolina	13	34.6	6.8	15.0	42.0
	South Carolina	--	--	--	--	--
Averages†	Southeast	19	34.8	6.8	15.1	42.3
East Coast (EC)	Delaware	4	35.3	7.0	15.2	42.5
	Maryland	5	35.6	7.0	15.4	43.1
	New Jersey	6	36.0	7.1	15.5	43.4
	New York	5	35.9	7.1	15.5	43.2
	Pennsylvania	8	35.2	7.0	15.2	42.6
	Virginia	5	35.2	6.9	15.3	42.6
Averages†	East Coast	33	35.4	7.0	15.3	42.8
USA	Averages	1627	34.7	6.8	15.1	42.2
	Average of 2013 Crop†		**34.7**	**6.8**	**15.1**	**42.2**

* 13% moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA NASS Crop Production Report November 8, 2013)

‡ 5 Essential amino acids: lysine, methionine, threonine, tryptophan, and cysteine

§ 10 Essential amino acids: leucine, histidine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, and cysteine

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	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‡	2889	34.7	19.0	53.7	30.7	88.7	1.60	0.93
Averages (1986-2013)	**2551**	**35.2**	**18.7**	**53.9**	**27.3**	**70.4**	**1.51**	**0.93**

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 - 2013 quality estimates are weighted by yearly production estimates by state

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