Quality of the United States Soybean Crop: 2007[1]

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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 for the upcoming year.

2006 Acreage, Yields, and Total Production

According to the October 12, 2007 United States Department of Agriculture, National Agricultural Statistics Service (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 poor 2003 crop, of 66.7 million MT, and a large decrease from 2004-2006 crops that averaged 85 million MT (Table 1).

Quality of the 2007 US Soybean Crop

By August 24, 2007 sample kits were mailed to 9,193 producers. Producers were selected based on total land devoted to soybean production in each state, so that response distribution would closely match soybean production. One thousand six hundred eighty five samples were received by October 31, 2007. 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. Results can be found in Table 2.

Foreign Material (FM) was estimated by sieving and handpicking non-soybean material from each sample according to Federal Grain Inspection Service (FGIS) standards where, “Foreign material is defined as all material that readily passes through an 8/64 inch (3.2 mm), round-hole, perforated sieve and any material other than soybeans remaining atop the sieve.” For this analysis, splits and otherwise broken soybeans were not considered. Foreign material is simply provided on a percentage basis. Seed weights were estimated by counting and weighing 1000 seeds from each sample. Foreign material and seed weight summaries can be found in Table 3.

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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 (41) were randomly selected to represent total soybean production by state, and analyzed for soluble sugar concentrations using high performance liquid chromatography (HPLC) at the University of Missouri Analytical Laboratories. Results can be found in Table 4.

Interpretation of Protein and Oil Results

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 0.9% higher in 2007, at 35.4% and average oil was 0.5% lower, at 18.7%, when compared with 2006 (Table 5). Region by region analysis indicates almost identical trends as were seen in 2006, except that regional protein concentrations tended to be nearly 1 percentage point higher, while oil was about 0.5 percentage points lower.

Interpretation of Foreign Material Results

Foreign material found in samples was on average very low. Foreign material among 1685 farmer collected samples averaged 0.37%, with an overall range of 0 to 28%. Of 1685 samples, 1611 had FM below 1%, and 74 (4.4%) had FM greater than 1%. Only 23 (1.4%) had FM above 2%. While there was a tendency for samples harvested from Southern states to have somewhat above average FM, individual samples with above 2% FM could be found in all regions.

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 later 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) reduces the energy available for each seed and seed size may be smaller than average.

In 2007, seed size tended to be largest in Northern Iowa, Sothern Minnesota, Wisconsin, Michigan, as well as several East coast states. Seed size tended to be smaller across the Southern ranges of the US soybean production area. The large seed size noted in the northern states in 2007 is likely due to midseason drought that occurred in this range. Late season rainfall allowed the smaller number of remaining seeds on each hectare to fully expand and enlarge. Smaller seeds in the southern states are likely do to the season long drought found there.

Interpretation of Soluble Sugar Results

A large sample-to-sample variability in all soluble sugar values was identified (Table 4). This indicates that local environmental conditions may play a large role in determining relative concentrations of important soluble sugars. On average, samples contained 39.4 mg / g sucrose, 34.6 mg / g stachyose, and 7.6 mg / g raffinose. Southern states tended to have lower concentrations of sucrose and stachyose and higher concentrations of raffinose. This same trend was noted in the 2006 survey.

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. Early April 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 Southwestern 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 mixture 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 phenomena. 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 affect on yields in eastern states of North Carolina, Virginia, and Maryland, as well as mid-south states of Tennessee and Kentucky. In theses 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 over-winter on a weedy plant - kudzu - in 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 currently appears that future large scale rust infection and subsequent fungicide applications will be rare, at best.

References

National Agricultural Statistics Service. 2007. Available at http://usda.mannlib.cornell.edu/usda/current/CropProd/CropProd-10-12-2007.pdf (verified 7 November 2007). USDA-NASS, Washington, DC.

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

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	2.35	1,215	2.9
	South Dakota	2.69	1,276	3.4
	Western Corn Belt	2.80	12,806	38
				53.3%
Eastern Corn Belt (ECB)	Illinois	2.96	3,321	9.8
	Indiana	2.96	1,895	5.6
	Michigan	2.42	705	1.7
	Ohio	3.09	1,673	5.2
	Wisconsin	2.62	543	1.4
	Eastern Corn Belt	2.81	8,136	24
				33.6%
Midsouth (MDS)	Arkansas	2.49	1,126	2.8
	Kentucky	1.81	435	0.8
	Louisiana	2.69	239	0.6
	Mississippi	1.75	579	1.6
	Oklahoma	1.61	69	0.1
	Tennessee	1.34	401	0.5
	Texas	2.28	32	0.1
	Midsouth	2.00	2,882	7
				9.3%
Southeast (SE)	Alabama	1.34	71	0.1
	Florida	n/a	n/a	n/a
	Georgia	2.02	107	0.2
	North Carolina	1.41	555	0.8
	South Carolina	1.14	176	0.2
	Southeast	1.48	909	1
				1.8%
East Coast (EC)	Delaware	1.55	59	0.1
	Maryland	1.75	158	0.3
	New Jersey	1.75	32	0.1
	New York	2.49	82	0.2
	Pennsylvania	2.69	168	0.5
	Virginia	1.81	198	0.4
	East Coast	2.00	697	1
				2.0%
Other States		2.02	11	0.02
				0.03%
USA 2007		**2.77**	**25,441**	**70.6**
USA 2006		2.89	30,175	87.3

Source: United States Department of Agriculture (November 9, 2007)
n/a = not available

Table 2. U.S. Soybean Export Council 2007 Soybean Quality Survey Protein and Oil Data.

Region	State	Number of Samples	Protein (%)*		Oil (%)*	
			Average	Std. dev.	Average	Std. dev.
Western Corn Belt (WCB)	Iowa	274	36.2	1.13	18.8	0.66
	Kansas	32	35.5	1.26	18.6	0.58
	Minnesota	302	34.2	1.19	18.9	0.72
	Missouri	90	35.7	1.47	18.7	0.82
	Nebraska	132	35.3	1.00	18.5	0.71
	North Dakota	58	33.5	1.22	18.1	0.76
	South Dakota	77	34.3	1.13	18.4	0.71
Averages†	Western Corn Belt	965	35.2	1.20	18.7	0.70
Ranges	Western Corn Belt		(30.2 - 40.1)		(16.2 - 20.8)	
Eastern Corn Belt (ECB)	Illinois	268	35.7	1.13	18.5	0.80
	Indiana	117	35.6	1.32	18.5	0.79
	Michigan	47	35.4	1.11	18.6	0.72
	Ohio	115	35.6	1.42	18.4	0.82
	Wisconsin	38	35.1	1.40	18.5	0.71
Averages†	Eastern Corn Belt	585	35.6	1.26	18.5	0.79
Ranges	Eastern Corn Belt		(31.3 - 39.5)		(14.8 - 20.5)	
Midsouth (MDS)	Arkansas	41	35.8	1.47	19.1	0.77
	Kentucky	11	35.1	1.61	18.9	0.94
	Louisiana	6	36.4	1.39	19.9	1.00
	Mississippi	30	36.0	1.23	19.4	0.98
	Oklahoma	0				
	Tennessee	9	35.9	1.97	19.3	1.14
	Texas	2	35.0	0.64	20.1	0.57
Averages†	Midsouth	99	35.8	1.44	19.3	0.88
Ranges	Midsouth		(32.0- 39.4)		(17.2 - 21.6)	
Southeast (SE)	Alabama	2	36.2	0.49	19.7	1.77
	Florida	0				
	Georgia	0				
	North Carolina	6	35.7	1.27	18.9	0.91
	South Carolina	0				
Averages†	Southeast	8	35.8	1.17	19.0	1.02
Ranges	Southeast		(33.6 - 37.2)		(18.0 - 20.9)	
East Coast (EC)	Delaware	3	35.2	0.70	19.8	1.01
	Maryland	7	35.2	1.57	18.8	0.90
	New Jersey	0				
	New York	4	36.1	0.73	18.3	0.61
	Pennsylvania	9	35.0	2.49	19.0	1.22
	Virginia	5	35.1	1.48	19.0	1.16
Averages†	East Coast	28	35.3	1.66	18.9	1.03
Ranges	East Coast		(29.7 - 38.2)		(17.1- 20.9)	
USA	Averages	1685	35.5	1.23	19.0	0.94
	Ranges		(29.7 - 40.1)		(14.8 - 21.6)	
	Average of 2007 Crop†		**35.4**	**1.2**	**18.7**	**0.76**
	US 1986-2007 avg.		35.3	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, October 12, 2007 Crop Production Report

Table 3. U.S. Soybean Export council 2007 Soybean Qualtiy Survey Foreign Material and Seed Size Data.

Region	State	Number of Samples	Foreign Material (%)*		g 100 seeds^{-1} *	
			Average	Std. dev.	Average	Std. dev.
Western Corn Belt (WCB)	Iowa	274	0.29	0.0075	16.0	2.08
	Kansas	32	0.35	0.0041	14.4	1.60
	Minnesota	302	0.27	0.0163	16.3	2.00
	Missouri	90	0.53	0.0233	14.6	1.96
	Nebraska	132	0.26	0.0054	15.9	1.50
	North Dakota	58	0.16	0.0012	14.6	1.80
	South Dakota	77	0.40	0.0148	15.9	1.93
Averages†	Western Corn Belt	965	0.32	0.0107	15.7	1.90
Ranges	Western Corn Belt		(0 -28.23)		(9.7 - 39.2)	
Eastern Corn Belt (ECB)	Illinois	268	0.38	0.0106	15.2	2.01
	Indiana	117	0.25	0.0027	16.1	1.98
	Michigan	47	0.24	0.0036	17.8	1.91
	Ohio	115	0.31	0.0032	16.2	1.75
	Wisconsin	38	0.36	0.0087	17.3	1.98
Averages†	Eastern Corn Belt	585	0.32	0.0065	15.9	1.94
Ranges	Eastern Corn Belt		(0 -16.0)		(7.7-24.0)	
Midsouth (MDS)	Arkansas	41	0.55	0.0055	13.9	2.06
	Kentucky	11	0.51	0.0051	13.9	2.46
	Louisiana	6	0.45	0.0032	14.1	1.34
	Mississippi	30	1.50	0.0379	13.9	1.78
	Oklahoma	0				
	Tennessee	9	0.54	0.0044	12.3	1.38
	Texas	2	0.30	0.0035	15.0	1.80
Averages†	Midsouth	99	0.76	0.0129	13.8	1.91
Ranges	Midsouth		(0 - 21.02)		(8.1 - 18.0)	
Southeast (SE)	Alabama	2	0.98	0.0037	14.6	1.44
	Florida	0				
	Georgia	0				
	North Carolina	6	1.17	0.0174	14.6	2.21
	South Carolina	0				
Averages†	Southeast	8	1.14	0.0157	14.6	2.12
Ranges	Southeast		(0.04 - 4.55)		(11.6 - 18.2)	
East Coast (EC)	Delaware	3	0.10	0.0003	17.2	1.42
	Maryland	7	0.26	0.0018	16.4	2.72
	New Jersey	0				
	New York	4	0.06	0.0005	17.1	2.07
	Pennsylvania	9	0.15	0.0015	17.8	1.82
	Virginia	5	0.48	0.0088	16.2	0.40
Averages†	East Coast	28	0.24	0.0032	16.9	1.66
Ranges	East Coast		(0 - 2.05)		(12.5- 20.7)	
USA	Averages	1685	0.51	0.0078	15.5	1.82
	Ranges		(0 - 28.23)		(7.7 - 39.2)	
	Average of 2007 Crop†		**0.37**	**0.0095**	**15.6**	**1.91**

* 13% moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA, October 12, 2007 Crop Production Report

Table 4. Carbohydrate Analysis of a Small Number of 2007 Soybean Quality Survey Samples.

Region	State	Number of Samples	Protein*	Oil*	Fiber*	Glucose	Sucrose	Raffinose	Stachyose
			Percent Average	Percent Average	Percent Average	mg / g	mg / g	mg / g	mg / g
Western Corn Belt (WCB)	Iowa	6	34.0	19.7	4.5	10.9	47.8	6.4	41.5
	Kansas	2	36.4	20.1	4.2	7.9	34.5	9.4	38.2
	Minnesota	4	33.0	20.1	4.3	8.9	55.4	5.3	40.8
	Missouri	3	34.9	19.0	5.1	6.6	36.7	7.5	32.8
	Nebraska	3	34.9	19.6	4.5	10.0	47.6	6.0	39.7
	North Dakota	2	32.6	19.0	4.9	4.4	64.0	7.1	34.5
	South Dakota	2	35.3	20.1	4.4	5.2	33.4	6.2	41.0
Averages	Western Corn Belt	22	34.4	19.7	4.6	7.7	45.6	6.8	38.4
Ranges	Western Corn Belt		(31.7 - 35.3)	(18.7 - 20.7)	(3.3 - 5.4)	(3.1 - 25.4)	(30.8 - 61.4)	(4.5 - 11.8)	(26.1 - 46.5)
Eastern Corn Belt (ECB)	Illinois	5	35.0	18.9	5.1	6.9	44.1	6.9	36.6
	Indiana	3	35.5	19.6	4.5	5.3	40.1	7.4	38.2
	Michigan	1	34.3	19.4	4.6	3.8	51.2	5.6	35.6
	Ohio	4	34.8	20.1	4.4	7.0	46.0	6.7	35.9
	Wisconsin	1	34.2	19.3	4.8	3.3	45.6	4.9	35.3
Averages	Eastern Corn Belt	14	34.8	19.5	4.7	5.3	45.4	6.3	36.3
Ranges	Eastern Corn Belt		(33.6 - 36.7)	(17.9 - 21.0)	(3.7 - 5.6)	(2.9 - 13.7)	(30.6 - 51.2)	(4.9 - 8.8)	(31.6 - 42.8)
Midsouth (MDS)	Arkansas	0							
	Kentucky	1	36.4	18.0	4.6	6.8	37.3	9.7	34.7
	Louisiana	1	34.4	19.3	4.9	9.6	28.1	10.5	35.2
	Mississippi	1	32.5	21.4	4.2	6.7	39.7	11.5	23.7
	Oklahoma	0							
	Tennessee	1	34.9	19.4	4.6	5.0	34.2	8.4	30.3
	Texas	0							
Averages	Midsouth	4	34.6	19.5	4.6	7.0	34.8	10.0	31.0
Ranges	Midsouth		(32.5 - 36.4)	(18.0 - 21.4)	(4.2 - 4.9)	(5.0 - 9.6)	(28.1 - 39.7)	(8.4 - 11.5)	(23.7 - 35.2)
Southeast (SE)	Alabama	1	36.9	21.4	4.3	19.8	31.8	7.4	32.9
	Florida	0							
	Georgia	0							
	North Carolina	0							
	South Carolina	0							
Averages	Southeast	1	36.9	21.4	4.3	19.8	31.8	7.4	32.9
Ranges	Southeast								
East Coast (EC)	Delaware	0							
	Maryland	0							
	New Jersey	0							
	New York	0							
	Pennsylvania	0							
	Virginia	0							
Averages	East Coast	0							
Ranges	East Coast								
USA	Averages	41	35.2	20.0	4.5	9.9	39.4	7.6	34.6
	Ranges		(31.7 - 35.3)	(17.9 - 20.7)	(3.3 - 5.6)	(2.9 - 25.4)	(28.1 - 61.4)	(4.5 - 11.8)	(23.7 - 46.5)
	Average of 2007 Crop†		**34.5**	**19.6**	**4.6**	**7.7**	**45.3**	**6.8**	**37.8**

* 13% moisture basis

† US average values weighted based on estimated production by state as estimated by USDA, October 12, 2007 Crop Production Report

Table 5. 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‡	2774	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% moisture basis

†Sum represents sum of protein and oil concentrations

‡ US average values weighted based on estimated production by state as estimated by USDA, November 9, 2007 Crop Production Report

Figure 1. Soybean, Corn, and Wheat in the US (planted ha)

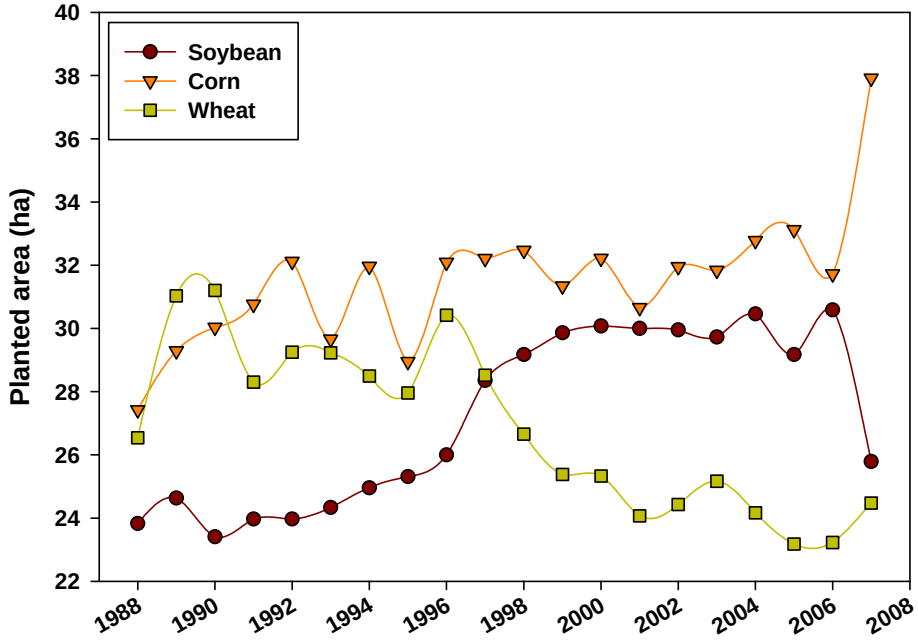

Figure 2. US Soybean Crop Conditions (2004-2007)

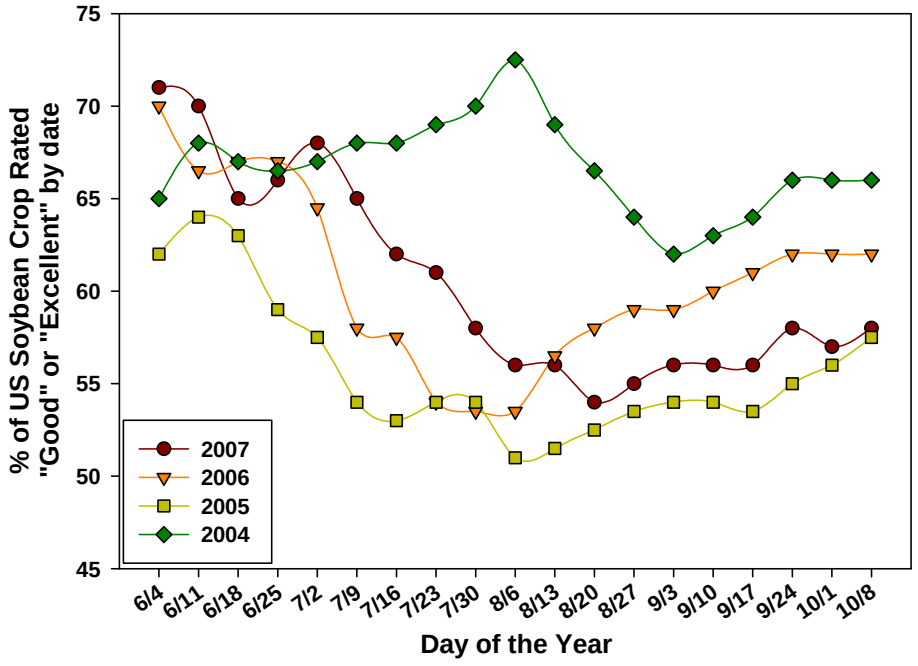

Figure 3. Average Protein and Oil values by state