QUALITY OF THE 2001 SOYBEAN CROP FROM THE UNITED STATES [1/]

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Over the past few years, quality has been an increasingly important soybean marketing issue. This report summarizes current knowledge on the following soybean quality topics:

- Protein and oil composition of the 2001 U.S. soybean crop
- The 2001 crop in historical perspective
- Incentives in the U.S. market for improved quality
- Factors affecting soybean quality
- Quality of GM versus non-GM soybeans

The data and analysis in this report are intended to assist customers in the sourcing and use of U.S. soybeans.

The Quality Survey

Since 1986, Iowa State University (ISU) and the American Soybean Association (ASA) have been surveying the quality of new crop soybean harvests. In response to a mailed request producers, representing all 29 soybean production states, provided samples of 2001 crop soybeans for analysis. Samples were analyzed for protein and oil contents using an Infratec near-infrared instrument (Foss North America, Eden Prairie, Minn.). From other sources, data on the yield and physical quality (U.S. Grade factors) of U.S. soybeans has been collected. Data was organized by state and region (groups of states). This is the same procedure that has been utilized for the 16 years of the survey.

The 2001 U.S. Soybean Crop

The United States produced a record 2.92 billion bushels (79.5 million metric tons) of soybeans according to the November 1 USDA production estimates (USDA, 2001a). Soybean yields, at 39.4 bushels per acre, were the second highest recorded and harvested acreage was at an all time high, exceeding the previous record set in 2000 by 2%. Table 1 summarizes production statistics for the 2001 crop, by state and growing region. USDA surveyed producers as to their plantings of GMO varieties, primarily Roundup Ready™ soybeans (USDA, 2000). Approximately 53% of U.S. soybeans were GMO in 2000. These data were not repeated in 2001, but industry sources estimate that 60%-70% of 2001 soybeans were genetically modified.

Most of the production increases occurred in the central Corn Belt states (Iowa, Indiana, Illinois, and Nebraska). Weather related problems in far northern and southern areas were more than offset by Corn Belt increases.

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Composition data are given in Table 2. Average U.S. protein and oil contents are almost exactly on the long-term averages of 35% protein and 19% oil. These soybeans will produce – again on average – 43.4 lbs of 48% protein meal and 10.8 lbs of oil per bushel.

Averages are not totally representative of this crop. The variability (standard deviation) within states, regions, and the U.S. was the largest in the 17 years of the survey. The north to south protein pattern (lower north, higher south) was also abnormally large (over 3 percentage points). Both situations can be attributed to variable climate patterns. Early rains delayed northern planting; mid-season dry weather retarded development. Early frost was experienced, which deprived soybeans of the late season growth that often increases protein content. According to trade experts, moisture content of harvested soybeans was also highly variable, related to maturity. Expect moistures around 12.5%-13% this year, slightly higher than historical averages.

Crop variability will cause differences among export cargoes. These will not be as large as those among states, but depending on the origin of grain for a shipment, expect some fluctuation in composition. Requesting soybeans from specific locations may not be cost effective, however. As the domestic market moves toward testing and pricing based on composition, actual component specifications in export contracts may become necessary.

There have been further reports of purple and brown staining of seed coats in the 2001 crop, especially in specialty food-use soybeans. These were caused by viruses and enhanced by variable weather. These discolorations do not affect crushing value. The discoloration is an acceptance problem for food uses. Some firms have reported a bitter taste in soyfood products when discolored soybeans were used.

Historical Performance

Soybean yields and acreage have been increasing steadily. Table 3 shows a combination of USDA production (USDA, 2001b) and survey composition data. The same data is shown graphically in Figure 1. Yields have been increasing at approximately 0.5 bu/acre/year at the same time soybean acreage was also increasing, with little effect on average protein and oil content. The 2001 data are on the trend line. U.S. soybean breeders have continued to improve yield (the primary factor determining producer income), but have been successful in preventing a loss of quality.

The result of this trend is a steady increase in the output per acre of nutrients (Figure 2). Greater amounts of useful product are being produced which creates more affordable and abundant supplies. Concentration of nutrients is important, however. The processing chart in Figure 3 shows the combinations of protein and oil content that will produce 47.5%-48.5% protein soybean meal. Only once (1997) did U.S. soybeans fall to the left of the optimal area, shown by the shading. Soybeans from individual states and regions often fall to the far right, above 48.5% meal, and the long-term U.S. averages are regularly in the middle of this area, as they are in 2001.

The USDA Grain Inspection Packers and Stockyards Administration (GIPSA) collects results from Official soybean export inspections (GIPSA 2001). Official inspections establish Grade based on a set of physical factors and, on request, will report protein and oil contents. Historical data is given in Table 4. The majority of inspections are for U.S. No. 2 soybeans. There has been little change in physical quality over time, and the GIPSA composition measurements line up well with the ASA-ISU survey data.

GIPSA is using a new, updated Infratec near-infrared calibration in 2001. This calibration is based on a combination of the GIPSA and ISU calibration databases. Users should experience little change in readings for most situations. Food soybean buyers should receive more accurate tests of high-protein soybeans.

Quality Incentives in Domestic Markets

Since 1999, one U.S. soybean processing firm has been offering premiums for enhanced composition. The current premium scale is given in Table 5. In 2001, both protein and oil were included. Payments are made at the as-is moisture basis. Processors generally purchase from grain elevators so the elevators must also be testing in order to pass any premium back to producers.

Testing at the elevator requires more near-infrared equipment than is now present. The principal short-term effect of this premium is to create interest by genetics companies in having “preferred” varieties. These are varieties that consistently are above average in yield and in the sum of protein and oil. Last year we showed that about 20% of varieties fall into this category (Hurburgh, 2000).

Varieties identified in this way are easier for producers to accept even if there are no composition premiums to them. This strategy was designed for producer acceptance before testing and marketing capabilities were fully developed. The USB, Iowa Soybean Association (ISA), and others are supporting a major effort to set quality standards for data available to producers, so that information across genetics companies and universities is comparable.

Domestic market premiums will gradually change the average composition of U.S. soybeans. A rise in the trend lines of Figure 2 would be expected. In the short term, there will some redirection of higher quality soybeans in areas served by premium markets. This will reduce exporters’ ability to provide soybeans with average or above average composition, unless importers offer similar incentives.

Factors Affecting Soybean Quality

There are some studies relating soybean protein and oil content to environmental conditions. Table 6 is a qualitative summary of this information.

When a combination or succession of climatic/agronomic effects occurs, the end results are uncertain. For example, late planting, drought, and early frost were experienced in South Dakota, Minnesota, Wisconsin, and northern Iowa. Mixed effects were likely a major cause of the high variability within states or regions.

Variety selection is also an important factor influencing composition. Many public institutions report composition in variety comparisons. Generally, the difference among varieties (at a location) is approximately 50% of the total composition variation in an area. Studies leading to the premium payments showed that about 20% of varieties were above average in both yield and composition (Hurburgh, 2000).

Physical quality changes in handling. Genetic modifications for herbicide resistance have sharply reduced the amount of weed seed or plant parts in soybean foreign material. However, dry weather and other stress factors make soybeans prone to breakage. Typically, there is about 0.5-1.0 percentage point increase in foreign material through the export market chain. Herbicide-resistant soybeans may make purchasing soybeans with lower foreign material specifications (e.g., 1% versus 2%) more practical.

Oil quality deteriorates (free fatty acids increase) with increased split soybeans. With the 2001 crop probably closer to 12.5% - 13.0% moisture (rather than the typical 11% - 12% moisture), it will be important to maintain control over splits (to 10% or less) in export cargoes. Alternatively, a moisture specification lower than the common 13.0% or 13.5% may be useful to maintain oil quality in shipment.

Genetic Modifications

In recent years, public yield trials have provided separate comparisons for Roundup Ready™ and conventional soybeans. Table 7 summarizes the Iowa Soybean Yield Tests for 1998-2000, by GM classification. There was no consistent difference in composition between the RR and non-RR soybeans. There were several thousand data points per classification in each year.

The high percentage of planting of GM soybeans virtually ensures that soybeans purchased by U.S. grade factors (#1 or #2) will contain some level of GM. Non-GM markets are emerging within the U.S. Premiums are approximately 40-60 cents/bu ($15-$22/mt), with about 40% going to the producer. The remainder is divided across the rest of the market chain. Several U.S. grain elevator firms are developing documented ISO 9000 quality management systems in order to serve these specialized markets. Contract terms from importers backed by economic incentives would be very valuable in continuing this process.

The major genetic modification issue in 2001 was StarLink™ corn. Based on the data and other evidence received by its scientific panel (EPA, 2001), the U.S. Environmental Protection Agency has maintained a zero tolerance for StarLink™ corn in food and export markets. Approximately 25% of 2000 crop corn shipments to exporters tested positive for StarLink™ and were redirected to animal feed. Because StarLink™ was not planted in 2001, this percentage should decline to 5% or less, from carryover 2000 corn.

StarLink™ reshaped U.S. policy on biotechnology. A more unified (across U.S. and world agencies) approval process is likely. Regulatory agencies will be more active in requesting data rather than relying on company assessments of needs. Allergenicity and other medical issues will be much more influential in approvals.

Summary

The 2001 U.S. soybean crop has average protein (35%) and oil (19%) contents, but weather conditions produced abnormally large variations within states and regions. Yields were the second highest recorded. Total production was a record 2.92 billion bushels with 65%-70% being genetically modified (Roundup Ready). Market premiums for composition are developing within the U.S. domestic market, which may require exporters to respond similarly.

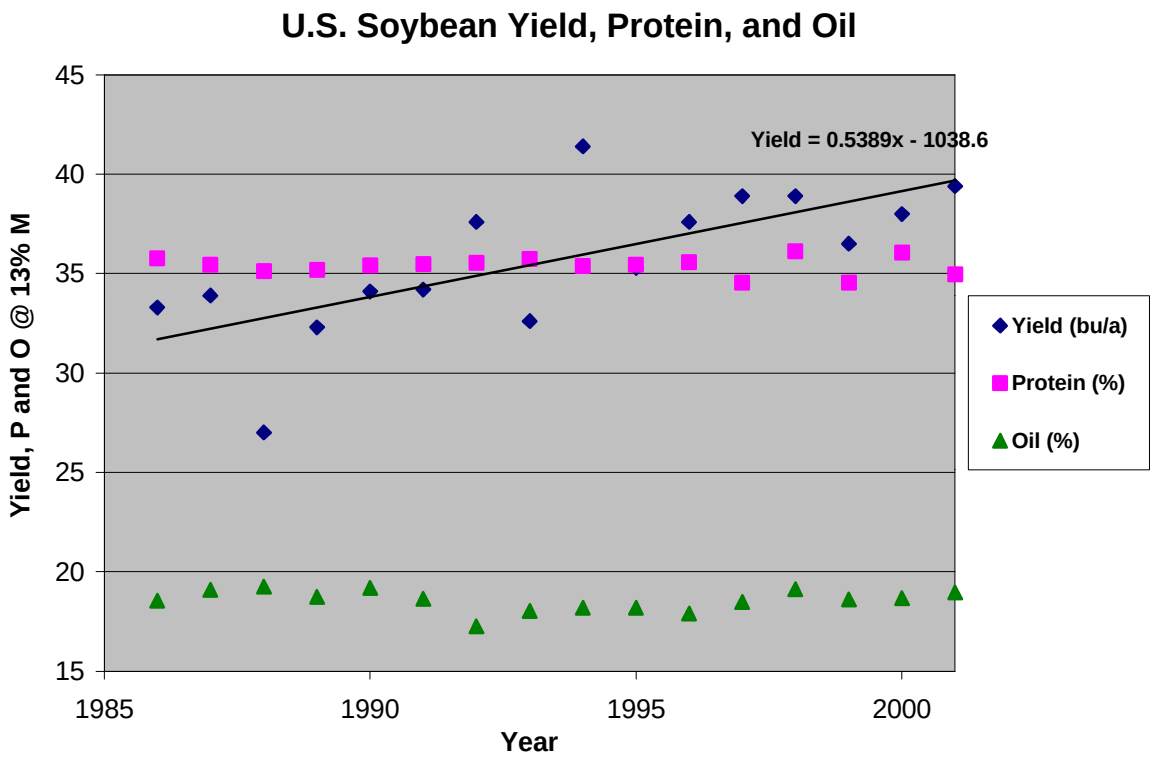

Figure 1. Trends in U.S. soybean yield, protein, and oil

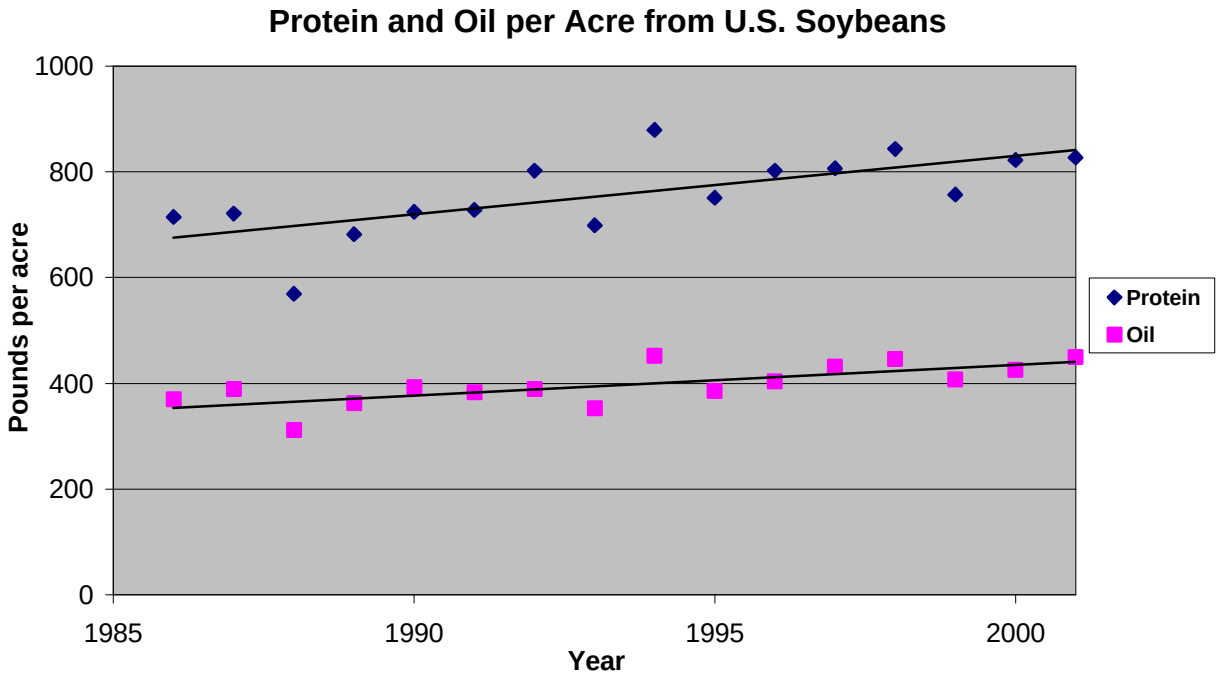

Figure 2. Output per acre of U.S. soybeans

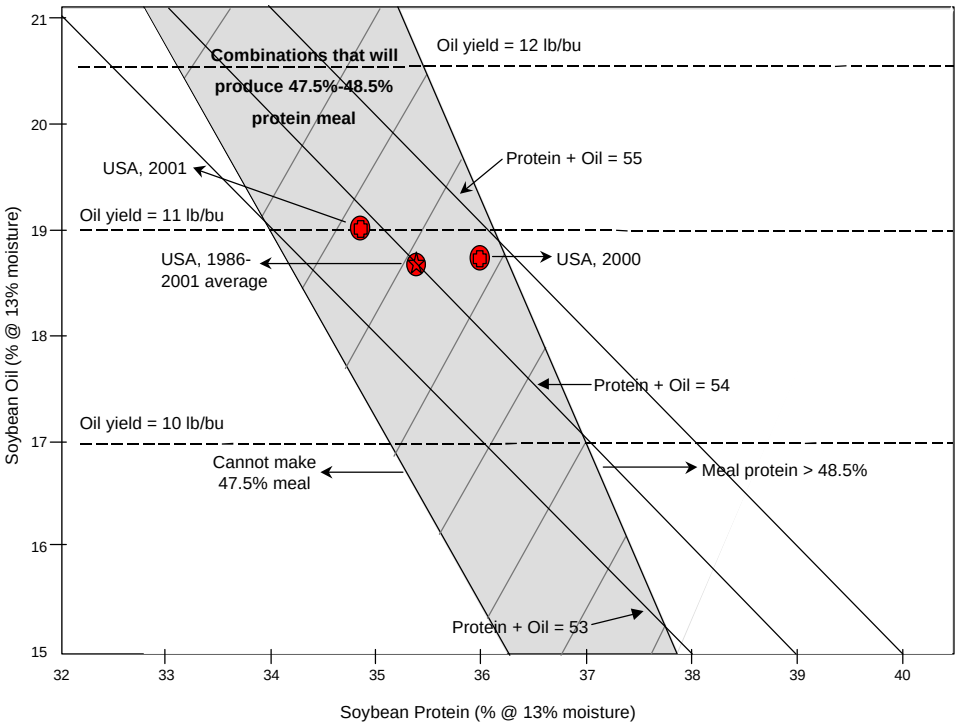

Figure 3. Protein and oil combinations that will produce 47.5%-48.5% protein meal

Table 1. Soybean production data for the United States, 2001 crop

Region	State	Yield (bu/a)	Acreage (000 acres)	Production (000 acres)	Percentage of acres in GMO*
Western Corn Belt (WCB)	Iowa	44.0	10,950	481,800	59
	Kansas	32.0	2,900	92,800	66
	Minnesota	36.0	7,000	252,000	46
	Missouri	37.0	4,900	181,300	62
	Nebraska	44.0	4,825	212,300	72
	North Dakota	33.0	2,270	74,910	22
	South Dakota	33.0	4,250	140,250	58
	Western Corn Belt	38.7	37,095	1,435,360	57
				49.1%	
Eastern Corn Belt (ECB)	Illinois	44.0	10,950	481,800	44
	Indiana	49.0	5,780	283,220	63
	Michigan	30.0	2,190	65,700	50
	Ohio	42.0	4,690	196,980	48
	Wisconsin	39.0	1,680	65,520	51
	Eastern Corn Belt	43.2	25,290	1,093,220	50
				37.4%	
Midsouth (MDS)	Arkansas	33.0	2,950	97,350	43
	Kentucky	41.0	1,240	50,840	54
	Louisiana	33.0	670	22,110	54
	Mississippi	34.0	1,270	43,180	48
	Oklahoma	17.0	350	5,950	54
	Tennessee	35.0	1,050	36,750	54
	Texas	27.0	260	7,020	54
	Midsouth	33.8	7,790	263,200	49
				9.0%	
Southeast (SE)	Alabama	32.0	150	4,800	54
	Florida	38.3	30	1,150	54
	Georgia	28.0	160	4,480	54
	North Carolina	32.0	1,300	41,600	54
	South Carolina	24.0	440	10,560	54
	Southeast	30.1	2,080	62,590	54
				2.1%	
East Coast (EC)	Delaware	38.0	206	7,828	54
	Maryland	40.0	510	20,400	54
	New Jersey	33.0	103	3,399	54
	New York	34.0	138	4,692	54
	Pennsylvania	37.0	425	15,725	54
	Virginia	33.0	500	16,500	54
	East Coast	36.4	1,882	68,544	54
				2.3%	
USA		39.4	74,137	2,922,914	54
USA 1986-2001 averages		35.7	62,957	260,283	

Source: United States Department of Agriculture

* MDS except AR, MI and all SE, EC states were grouped in one estimate of GMO percentage

Table 2. American Soybean Association 2001 soybean quality survey data.

Region	State	Number of Samples	Protein		Oil	
			Percent Average	Std. dev.	Percent Average	Std. dev.
Western	Iowa	176	34.34	1.41	18.51	1.04
Corn	Kansas	30	34.69	1.57	19.15	0.98
Belt	Minnesota	118	33.18	1.73	18.65	1.04
(WCB)	Missouri	67	35.61	1.49	18.56	0.95
	Nebraska	78	33.73	1.53	19.10	0.99
	North Dakota	22	33.36	1.41	18.73	1.21
	South Dakota	52	33.41	2.04	18.90	1.18
Averages	Western Corn Belt	543	34.05	1.76	18.71	1.06
Ranges	Western Corn Belt		(28.4 - 39.8)		(39.8 - 14.9)	
Eastern	Illinois	228	34.94	1.71	19.57	1.02
Corn	Indiana	112	36.05	1.49	19.05	0.93
Belt	Michigan	31	35.88	1.27	19.07	0.89
(ECB)	Ohio	74	35.77	1.54	19.19	1.02
	Wisconsin	27	34.23	1.64	18.71	0.82
Averages	Eastern Corn Belt	472	35.36	1.69	19.31	1.01
Ranges	Eastern Corn Belt		(29.5 - 39.8)		(16.2 - 22.96)	
Midsouth	Arkansas	68	36.40	1.55	18.70	1.08
(MDS)	Kentucky	14	36.56	1.39	19.15	0.83
	Louisiana	16	37.13	1.53	19.75	0.96
	Mississippi	19	37.15	1.79	19.11	1.03
	Oklahoma	2	36.30	1.98	19.60	1.41
	Tennessee	13	36.41	2.00	18.75	1.01
	Texas	2	32.85	3.32	20.70	0.42
Averages	Midsouth	134	36.56	1.70	18.98	1.09
Ranges	Midsouth		(30.5 - 41.2)		(15.4 - 21.7)	
Southeast	Alabama	9	37.73	1.82	19.01	1.49
(SE)	Florida	1	34.30	-	18.70	-
	Georgia	4	37.50	1.79	18.90	0.71
	North Carolina	28	35.51	1.52	19.10	0.98
	South Carolina	7	36.34	1.36	18.47	0.74
Averages	Southeast	49	36.17	1.80	18.97	1.03
Ranges	Southeast		(32.6 - 40.0)		(17.0 - 21.8)	
East	Delaware	4	37.38	0.48	18.75	0.67
Coast	Maryland	12	36.34	1.30	19.17	0.59
(EC)	New Jersey	6	35.60	2.76	19.60	0.65
	Pennsylvania	11	37.04	1.62	18.57	0.98
	Virginia	12	36.24	1.96	18.82	1.25
Averages	East Coast	45	36.48	1.77	18.95	0.94
Ranges	East Coast		(32.6 - 40.0)		(16.7 - 21.0)	
USA	Averages	1243	34.99	1.95	18.99	1.07
	Ranges		(28.4 - 41.2)		(14.9 - 22.96)	
	US 1986-2001 avg.		35.40		18.56	

Basis 13% moisture

Table 3. Summary of Yield and Quality Data for US Soybeans

Year	Yield (bu/a)	Protein (%)	Oil (%)	Sum (%)	Harvested (000 acres)	Production (000 bu)
1986	33.3	35.76	18.54	54.30	58,312	1,941,790
1987	33.9	35.46	19.11	54.57	57,172	1,938,131
1988	27.0	35.13	19.27	54.40	57,373	1,549,071
1989	32.3	35.18	18.73	53.91	59,538	1,923,077
1990	34.1	35.40	19.18	54.58	56,512	1,927,059
1991	34.2	35.48	18.66	54.14	58,011	1,983,976
1992	37.6	35.56	17.27	52.83	58,233	2,189,561
1993	32.6	35.73	18.03	53.76	57,307	1,868,208
1994	41.4	35.39	18.20	53.59	60,809	2,517,493
1995	35.3	35.45	18.19	53.64	61,544	2,172,503
1996	37.6	35.57	17.90	53.47	63,349	2,381,922
1997	38.9	34.55	18.47	53.02	69,110	2,688,379
1998	38.9	36.13	19.14	55.27	70,441	2,740,155
1999	36.5	34.55	18.61	53.16	72,476	2,645,374
2000	38.0	36.22	18.65	54.87	73,024	2,774,912
2001	39.4	34.98	18.97	53.95	74,100	2,922,914
Averages	35.7	35.41	18.56	53.97	62,957	2,260,283
Std. Dev.	3.6	0.47	0.54	0.68	6,506	410,307

Sources: United States Department of Agriculture and Iowa State University
Protein and oil contents basis 13% moisture

Table 4. Summary of GIPSA Grain Inspection Data for Soybeans

Calendar Year	Crop Years	Percent No. 2YSB	Moisture (%)	Foreign Material (%)	Damaged Kernels (%)	Protein (%)	Oil (%)	ISU Survey Results[a] Protein (%)	ISU Survey Results[a] Oil (%)
1990	89,90	86.1	11.7	1.8	1.1	35.5	18.6	35.3	19.0
1991	90,91	86.4	12.1	1.7	1.1	35.5	19.0	35.4	18.9
1992	91,92	75.3	12.0	1.7	1.2	35.2	18.9	35.5	18.0
1993	92,93	86.2	12.5	1.7	1.1	35.4	18.3	35.6	17.5
1994	93,94	90.3	12.6	1.7	1.1	35.5	18.4	35.5	18.1
1995	94,95	92.3	12.2	1.7	1.0	35.2	18.5	35.4	18.2
1996	95,96	92.2	12.1	1.7	1.1	35.1	18.5	35.5	18.0
1997	96,97	90.9	12.6	1.6	0.8	35.3	18.4	35.0	18.2
1998	97,98	90.0	12.2	1.6	1.0	35.5	18.8	35.3	18.8
1999	98,99	89.4	12.0	1.6	0.9	35.3	18.8	35.3	18.9
2000	99,00	90.0	11.4	1.7	1.0	35.0	18.5	35.4	18.6

Sources: USDA Grain Inspection Packers and Stockyards Administration and Iowa State University
Protein and oil basis 13% moisture

[a] Average of listed crop years

Table 5. Soybean Component Premium Schedule, 2001 crop

Percent Oil @ As-Is Moisture	Premium	Protein Premium 37% or Higher @ As-Is Moisture
19.4 or less	None	None
19.5 to 19.8	2.0 cents/bu	3.0 cents/bu
19.9 to 20.1	3.0 cents/bu	3.0 cents/bu
20.2 to 20.4	4.0 cents/bu	3.0 cents/bu
20.5 to 20.7	5.0 cents/bu	3.0 cents/bu
20.8 to 21.0	6.0 cents/bu	3.0 cents/bu
21.1 and higher	7.0 cents/bu	3.0 cents/bu

* Minimum oil required is 19.5% to receive protein premium
Source: Ag Processing, Inc., Omaha, NE

Table 6. Soybean component response to weather and non-agronomic variables

Variable	Impact on	
	Protein	Oil
High temperatures	Inconclusive	Inconclusive
Early season drought	–	+
Late season drought[a]	+	–
Early frost/cold temperatures	–	–[b]
Additional soil nitrogen	+	–
Increased fertility (P, S)	+	+
Late planting	+	–
Insect defoliation	–	–
Insect depodding	+	Inconclusive
Inoculation with Rhizobia (N-fixing bacteria)	+	–

[a] After Westgate et al. (1999)
[b] Oil reduced because of additional refining needs
+ = increase; – = decrease

Table 7. Comparison of Roundup Ready™ and conventional soybeans, Iowa Soybean Yield Tests; 1998, 1999, and 2000

Factor	Average value in					
	1998		1999		2000	
	RR	Conv.	RR	Conv.	RR	Conv.
Yield (bu/a)	56.6	60.4	52.6	55.4	57.5	57.7
Protein (%)	36.3	35.9	35.8	35.7	34.7	35.1
Oil (%)	19.4	19.4	18.1	18.2	19.2	19.1

Yield, protein and oil basis 13% moisture
Data averaged across districts and maturities

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