Long-Term Soybean Composition Patterns and Their Effect on Processing

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Soybean protein and oil data from eight years of national surveys showed Western Corn Belt soybeans to consistently be one percentage point lower in protein than soybeans from the rest of the nation. There was year-to-year variability in protein patterns among other regions. Oil percentages were more variable than protein percentages among different years. Except for the far northern states, which typically produce low protein soybeans, improvement and stabilization of oil content would produce the most certain increases in processor yields. Increased protein would be valuable only if soybean meal were priced to reward protein content in excess of specifications.

KEY WORDS: Composition, meal yield, oil, oil yield, processing, protein, soybeans.

The ability of near-infrared analyzers to measure protein and oil content of soybeans (1,2) has opened the possibility of component pricing in the grain market (3). Economically significant regional and varietal variations in composition have been documented within the United States (4,5) and among exporting nations (4,6). In general, within the United States, protein content increases from north to south (4,7). Oil content is normally inversely related to protein, but with correlations of less than −0.5 in market soybeans. Processor reactions to component pricing will be determined partly by the consistency of geographic patterns in composition.

An annual survey of U.S. soybean composition (4) has been continued for eight years. These data provide an opportunity to: (i) assess the long-term soybean protein and oil patterns; and (ii) estimate the impact of regional composition instability on processor yields.

MATERIALS AND METHODS

Each year from 1986–1993, sample requests were sent to soybean growers in the 29 states that contribute to national production estimates. Requests were sent in proportion to state and county production volume, using mailing lists provided by the American Soybean Association (St. Louis, MO). Samples weighing 400–600 g were returned to Iowa State University (Ames, IA) in postage prepaid Tyvek envelopes. The response rate was generally 30–40%, and over 90% of respondents identified the soybean variety sampled. Varietal data were not analyzed for this study because this is generally an uncontrollable variability.

Samples were analyzed for moisture, protein and oil with a Dickey-john Instalab 800 near-infrared reflectance analyzer (Dickey-john, Inc., Auburn, IL) or a Tecator Infratec 1225 near-infrared transmittance analyzer (Perstorp Analytical, Inc., Silver Springs, MD). The analyzer converted data to a 13% moisture basis by using the measured moisture content. Both instruments were calibrated at Iowa State University against wet-chemical methods done by Woodson Tenant Inc. (Des Moines, IA). More complete details are available in Reference 4.

For the analysis, the eight-year data were grouped by year, region and state. Standard deviations within and across years were calculated by region and state. The soybean processing model SPROC (8) was used to identify variations in meal and oil yields caused by protein and oil differences.

RESULTS AND DISCUSSION

Table 1 shows the eight-year data summary. Means and standard deviations were rounded to ±0.1% for ease of interpretation. The large number of samples made any difference of 0.1% or more statistically significant. The overall average trends were similar to those in the previously cited studies, which had less data and could not assess variability.

Oil was much more variable than protein from year-to-year. States most distant from the center of the Corn Belt (probably those with the greatest weather extremes) experienced the most variability in composition. Northern states were, on average, lower in both constituents, but the high year-to-year variations certainly would complicate advance planning for meal quality by processors.

The larger geographic units had progressively less variability. As a whole, U.S. soybean composition was reasonably consistent. This explains why exporter contracts (mainly Taiwan) listing 35% protein and 18.5% oil (as is basis) can be met without great effort. Table 1 also shows the much greater variability of either constituent within a year than across years. In any year, economically important composition differences will exist from lot to lot.

The year-to-year regional averages (Figs. 1 and 2) again demonstrate greater oil variability than protein variability. A one percentage point change in oil content represents 0.6 lb per bushel change in oil yield (10–20 cents per bushel).

Only the Western Corn Belt (WCB) had periodic protein-deficit situations. Protein deficit occurs when 48% protein meal cannot be produced, or when 44% meal requires dehulling (Fig. 3). The northern states in the WCB (Minnesota, North Dakota, South Dakota) produced the lowest-protein and the lowest-oil soybeans.

Increased oil represents a more certain value to processors, because protein over the minimum required to produce meal within specifications is not rewarded. The greater apparent regional and environmental influences on oil content mean that the greatest improvement to processing value for the nation as a whole can be realized by agricultural science developments that improve and stabilize oil levels. In selected areas that experience protein deficits, improved protein under adverse conditions would be a net gain. If soybean meal markets rewarded protein in excess of specifications, then these conclusions would change to unilaterally favor increased protein content.

TABLE 1

Soybean Protein and Oil Survey Data, 1986–1993 (13% moisture basis)

			Protein			Oil		
Region[a]	State	n	Avg.[b] (%)	Std. dev. across years (%)	Avg. std. dev. within region[b] (%)	Avg.[b] (%)	Std. dev. across years (%)	Avg. std. dev. within region[b] (%)
WCB	IA	1690	34.9	0.5		18.7	0.9	
	KS	208	35.3	0.3		18.8	0.8	
	MN	872	34.8	0.6		18.4	1.2	
	MO	766	35.7	0.3		18.6	0.4	
	NE	537	34.8	0.3		18.8	0.7	
	ND	197	34.2	1.0		18.4	1.1	
	SD	213	34.7	0.6		18.5	1.2	
Avg.	WCB	4483	35.0	0.3	1.3	18.6	0.8	0.8
Range	WCB		(28.4–40.8)		(1.2–1.5)	(13.5–22.1)		(0.6–0.9)
ECB	IL	2350	35.5	0.4		18.9	0.5	
	IN	906	35.9	0.4		18.5	0.6	
	MI	188	35.7	0.4		18.1	0.8	
	OH	866	35.9	0.4		18.4	0.6	
	WI	31	35.3	0.7		18.5	0.9	
Avg.	ECB	4341	35.7	0.3	1.3	18.7	0.5	0.8
Range	ECB		(30.5–40.4)		(1.0–1.5)	(14.5–21.5)		(0.7–0.9)
MDS	AR	347	35.9	0.5		18.4	0.5	
	KY	140	36.0	0.3		18.4	0.4	
	LA	146	36.4	0.4		18.9	0.5	
	MS	258	36.2	0.6		18.6	0.4	
	OK	15	34.6	1.2		19.1	0.5	
	TN	98	36.1	0.5		18.4	0.6	
	TX	19	35.5	1.5		18.6	0.8	
Avg.	MDS	1023	36.0	0.4	1.4	18.5	0.4	0.8
Range	MDS		(30.6–40.4)		(1.2–1.6)	(15.3–21.4)		(0.7–1.0)
SE	AL	54	36.3	0.7		18.7	0.4	
	FL	12	36.5	2.2		18.6	1.0	
	GA	41	36.6	0.7		18.7	0.5	
	NC	88	36.0	0.5		18.4	0.5	
	SC	34	35.9	0.7		18.6	0.3	
Avg.	SE	229	36.2	0.4	1.6	18.5	0.4	0.9
Range	SE		(30.4–40.5)		(1.1–2.1)	(15.2–20.7)		(0.6–1.2)
EC	DE	35	36.1	0.7		18.3	0.6	
	MD	75	36.3	0.7		18.4	0.3	
	NJ	20	6.0	0.6		18.5	0.6	
	PA	4	34.9	0.6		19.2	0.3	
	VA	30	36.7	0.9		17.9	0.7	
Avg.	EC	164	36.2	0.5	1.2	18.3	0.4	0.7
Range	EC		(31.6–40.0)		(0.9–1.7)	(15.7–20.5)		(0.5–1.0)
Avg.	US	10240	35.5	0.2	1.4	18.6	0.6	0.8

[a]WCB, Western Corn Belt; ECB, Eastern Corn Belt; MDS, Midsouth; SE, Southeast; EC, East Coast.
[b]Average of individual years' data.

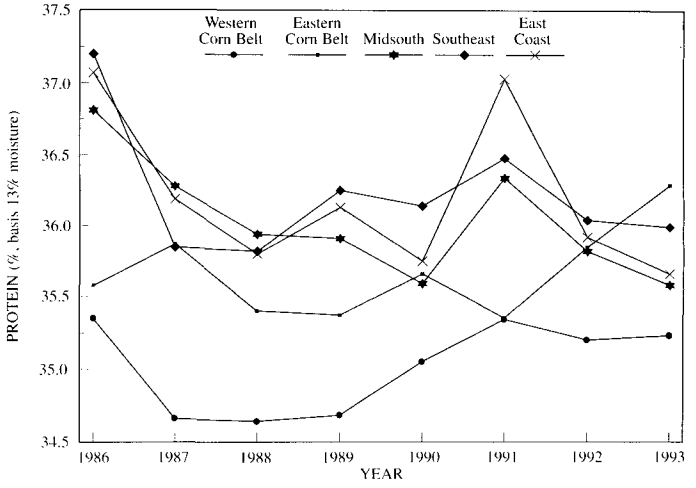

FIG. 1. Soybean protein content by region (1986–1993).

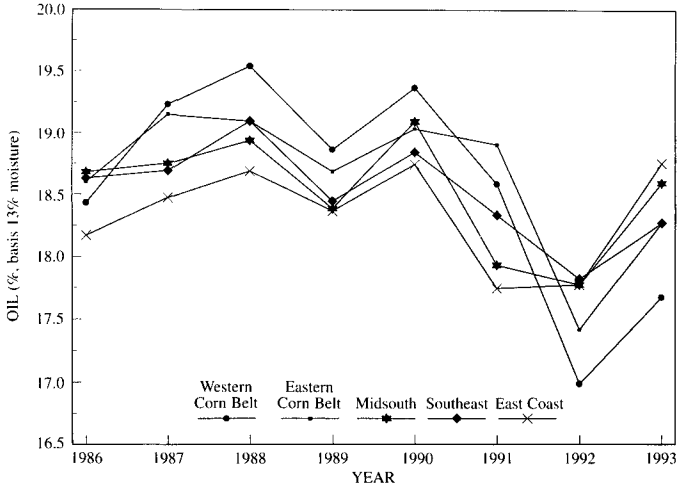

FIG. 2. Soybean oil content by region (1986–1993).

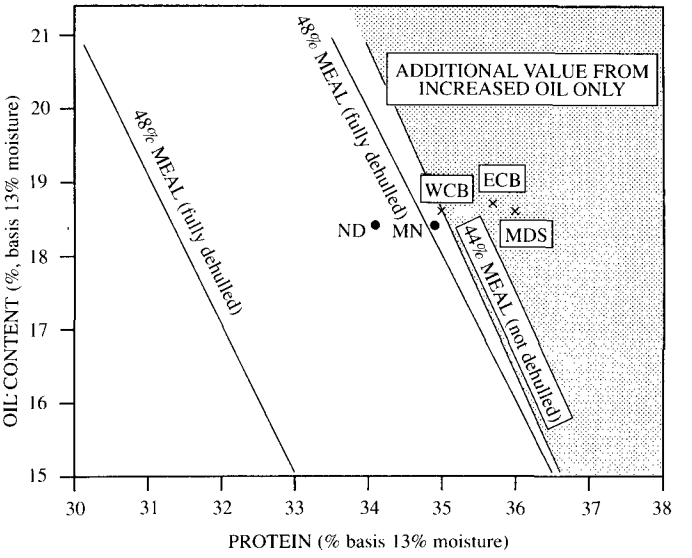

FIG. 3. Protein content of soybean meal-related protein and oil content of raw soybeans, as calculated by the SPROC model (Ref. 8), with selected state and regional averages (1986–1993). WCB, Western Corn Belt; ECB, Eastern Corn Belt; MDS, Midsouth.

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