LETTER TO THE EDITOR

# Changes in Long-Term Soybean Compositional Patterns

Sir:

Component pricing of soybeans in U.S. markets is increasing. A number of processors are offering premiums for soybeans that have higher levels of soybean protein and oil than other soybeans (1,2) or for varieties that are known to be higher in protein and oil content (3,4). In part, processor reactions to component pricing are based on the consistency of geographic patterns in composition (5).

Economically significant variations in soybean composition have been documented within the United States (5,6) and among exporting nations (6,7), arising from differences in variety and growing region. Moreover, in annual surveys conducted from 1986 to 1993, Western Corn Belt (WCB) soybeans were consistently one percentage point lower in protein than soybeans from the rest of the nation (5).

Since 1993, at least three significant trends in soybean production have occurred that may have impacted soybean composition patterns. First, the Western Corn Belt (WCB: i.e., the states of Iowa, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) now leads in the nation with 48.1% of total soybean production in 2004 (8). Since WCB soybeans were lower in protein content, a decrease in the average U.S. soybean protein content is likely. Second, prior to 1993, genetically modified varieties made up an insignificant portion of U.S. production, but by 2004, accounted for approximately 85% (mainly RoundUp Ready® varieties) (9). No differences in protein and oil content between conventional and Roundup Ready® varieties in field test situations (10) or selected varieties (11) have been found, but no assessment has been made on the national impact. Third, the average national soybean yield increased at an annual rate of approximately 0.4 bushels per acre per year from 1986 to 2004 (12). Since yield is inversely related to protein in the absence of selection pressure for protein, as yield increases, protein content decreases (13).

The annual survey of U.S. soybean composition (5) has continued through 2004, using the same sample collection and NIR analysis procedures, as well as the same wet-chemistry laboratory for NIR calibration. These data provide an opportunity to assess the long-term soybean protein and oil patterns since 1993, and to estimate the impact of regional composition instability on processor yields. For the analysis, the 11 years of data (1994–2004) were grouped by year, region, and state. SD within and across years were calculated by region and state. Means and SD were rounded to ± 0.1 percentage point. The large number of samples made any difference of 0.1 percentage points or more between means statistically significant. The soybean processing model SPROC (14) was used to identify variations in meal and oil yields caused by protein and oil differences.

Table 1 shows the 11-yr data summary, with regional comparisons to the 1986–1993 data. Protein contents in the WCB continue to be about 1.0 percentage points lower than in other growing regions. WCB oil content is the same as the Eastern Corn Belt (ECB), but lower than the other regions.

While the overall U.S. average oil content did not change, the average protein content dropped by 0.1 percentage points relative to the previous survey. When calculating weighted national averages from the state protein and oil values in the 1986–2003 survey and the 2004 distribution of U.S. production, the result was similar. Given that the change in average protein can be accounted for by the shift in U.S. production to the WCB, it is unlikely to have been caused by the increased use of RoundUp Ready® varieties or increasing yields. Soybean breeders have maintained protein levels in the genetic base while increasing yields. Without their efforts, protein content would have decreased further.

There have been some regional changes in protein and oil content. The average ECB oil content rose 0.1 percentage points, while the average protein content remained unchanged. The average Mid-South (MDS), East Coast (EC), and Southeast (SE) oil contents fell significantly, by 0.3 to 0.5 percentage points. The average MDS protein content increased by 0.1 percentage points, while the average EC and SE protein content fell by 0.2 percentage points.

Variability in protein content increased significantly within regions and across years. Variability in oil content increased within regions. Variability in oil content decreased across years,

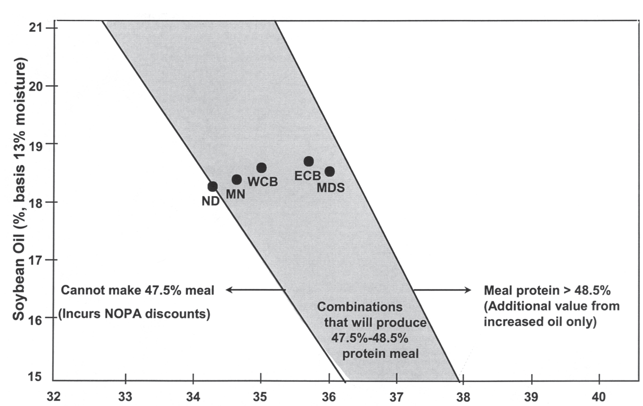


**FIG. 1.** Combinations of soybean protein and oil that yield soybean meal protein between 47.5 and 48.5%, as calculated by the SPROC model (14), with selected state and regional averages (1994–2004). WCB, Western Corn Belt; ECB, Eastern Corn Belt; MDS, Mid-South; MN, Minnesota; ND, North Dakota; NOPA, National Oilseed Processors Association.

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**TABLE 1**
**U.S. Soybean Protein and Oil Survey Data, 1994–2004 (13% moisture basis)**

| | | | Protein | | | Oil | | |
|---|---|---|---|---|---|---|---|---|
| Region[a] | State | *n* | Avg.[b] (%) | SD across years (%) | Avg. SD within region[b] (%) | Avg.[b] (%) | SD across years (%) | Avg. SD within region[b] (%) |
| WCB | IA | 3201 | 35.1 | 0.7 | | 18.6 | 0.4 | |
| | KS | 400 | 35.3 | 0.8 | | 18.7 | 0.5 | |
| | MN | 1540 | 34.7 | 0.8 | | 18.4 | 0.6 | |
| | MO | 908 | 35.3 | 0.6 | | 18.8 | 0.6 | |
| | NE | 1057 | 34.8 | 0.8 | | 18.9 | 0.4 | |
| | ND | 264 | 34.2 | 0.7 | | 18.3 | 0.8 | |
| | SD | 593 | 34.4 | 0.8 | | 18.6 | 0.4 | |
| Avg. | WCB | 7963 | 34.9 | 0.8 | 1.5 | 18.6 | 0.5 | 0.9 |
| Range | WCB | | (25.3–41.8) | | (1.1–1.8) | (11.1–23.9) | (0.7–1.1) | |
| Avg. | WCB 1986–2003 | 4483 | 35.0 | 0.3 | 1.3 | 18.6 | 0.8 | 0.8 |
| ECB | IL | 3367 | 35.3 | 0.8 | | 18.8 | 0.5 | |
| | IN | 1476 | 36.1 | 0.7 | | 18.4 | 0.5 | |
| | MI | 482 | 36.2 | 0.5 | | 18.0 | 0.7 | |
| | OH | 1157 | 36.2 | 0.5 | | 18.2 | 0.7 | |
| | WI | 240 | 35.5 | 0.7 | | 18.3 | 0.6 | |
| Avg. | ECB | 6722 | 35.7 | 0.7 | 1.5 | 18.6 | 0.7 | 0.9 |
| Range | ECB | | (26.9–42.0) | | (1.2–1.9) | (14.7–23.0) | | (0.8–1.0) |
| Avg. | ECB 1986–2003 | 4341 | 35.7 | 0.3 | 1.3 | 18.7 | 0.5 | 0.8 |
| MDS | AR | 599 | 36.0 | 0.5 | | 18.8 | 0.4 | |
| | KY | 215 | 35.9 | 0.6 | | 18.7 | 0.6 | |
| | LA | 127 | 36.4 | 0.7 | | 19.3 | 0.3 | |
| | MS | 346 | 35.8 | 0.7 | | 19.0 | 0.3 | |
| | OK | 43 | 35.3 | 1.0 | | 18.7 | 1.0 | |
| | TN | 170 | 35.7 | 0.6 | | 18.8 | 0.6 | |
| | TX | 35 | 34.4 | 0.9 | | 19.2 | 1.1 | |
| Avg. | MDS | 1535 | 35.9 | 0.9 | 1.6 | 18.9 | 0.7 | 1.0 |
| Range | MDS | | (28.7–41.4) | | (1.2–1.9) | (15.1–23.0) | | (0.9–1.2) |
| Avg. | MDS 1986–2003 | 1023 | 36.0 | 0.4 | 1.4 | 18.5 | 0.4 | 0.8 |
| SE | AL | 56 | 37.0 | 1.1 | | 18.8 | 0.8 | |
| | FL | 8 | 36.3 | 1.8 | | 18.7 | 1.0 | |
| | GA | 24 | 36.9 | 1.0 | | 19.2 | 0.9 | |
| | NC | 140 | 36.1 | 0.6 | | 18.7 | 0.8 | |
| | SC | 46 | 36.7 | 1.0 | | 18.9 | 0.5 | |
| Avg. | SE | 274 | 36.4 | 1.1 | 1.7 | 18.8 | 0.8 | 1.1 |
| Range | SE | | (31.5–41.7) | | (1.2–2.1) | (15.0–21.8) | | (0.8–1.3) |
| Avg. | SE 1986–2003 | 229 | 36.2 | 0.4 | 1.6 | 18.5 | 0.4 | 0.9 |
| EC | DE | 38 | 36.5 | 0.6 | | 18.6 | 1.2 | |
| | MD | 118 | 36.5 | 0.5 | | 18.4 | 0.7 | |
| | NJ | 58 | 36.5 | 1.0 | | 18.6 | 0.8 | |
| | NY | 17 | 35.1 | 1.8 | | 18.6 | 1.2 | |
| | PA | 87 | 36.3 | 0.8 | | 18.3 | 0.5 | |
| | VA | 78 | 36.0 | 0.8 | | 18.8 | 0.8 | |
| Avg. | EC | 274 | 36.4 | 1.1 | 1.7 | 18.8 | 0.8 | 1.1 |
| Range | EC | | (31.5–41.7) | | (1.2–2.1) | (15.0–21.8) | | (0.8–1.3) |
| Avg. | SE 1986–2003 | 164 | 36.2 | 0.5 | 1.2 | 18.3 | 0.4 | 0.7 |
| Avg. | US 1994–2004 | 16890 | 35.4 | 0.5 | 1.6 | 18.6 | 0.4 | 1.0 |
| Avg. | US 1986–2003 | 10240 | 35.5 | 0.2 | 1.4 | 18.6 | 0.6 | 0.8 |

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

due mainly to a marked decrease across years in the WCB oil content. Protein was more variable than oil. This is a change from the earlier surveys, when oil was more variable than protein. In light of these trends, it has become more difficult for purchasers of soybeans to predict meal and oil yields from year to year. Setting appropriate premium levels for purchasing soybeans on the basis of protein and oil is more challenging when there are large year-to-year variations.

Only states in the WCB had periodic protein-deficit situations. Protein deficit occurs when "hi-pro" meal (minimum 47.5% protein content) cannot be produced (Fig. 1). Of all the states, North Dakota (ND) experienced the greatest protein deficit. For the 1994 to 2004 survey period, average ND soybeans could just barely be processed into hi-pro meal, whereas in some individual years it was not possible to make hi-pro soybean meal with average ND soybeans.

The impact of processor premiums for protein and oil content remains to be seen. Most soybeans continue to be marketed without regard to composition, and most states and regions have sufficient protein content to make hi-pro soybean meal. However, if hi-pro meal continues to be the standard by which soybean meal is marketed (there is no reward yet for higher meal protein content or other constituents such as amino acids), processors will realize higher net value with increased soybean oil content.

## ACKNOWLEDGMENT

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