Cracking and Dehulling Shriveled and Wrinkled Soybeans

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Midwest drought conditions in 1988 resulted in soybeans with shriveled and wrinkled seed coats. Processors expressed concerns about the processing of such misshapen seeds. The objective of this research was to determine the cracking and dehulling properties of shriveled and wrinkled (S/W) soybeans. Five lots of soybeans, two sound lots and three containing shriveled and wrinkled seeds, were cracked and dehulled, as were the sized and sorted fractions of these lots. Processing variables (% aspiration liftings, fiber removal in the liftings, % fines in the liftings, protein recovery, oil recovery, meats size distribution and oil-free meats fiber content) indicated significant differences between whole sound lots and whole lots containing S/W. There were differences in processing properties between these three types of soybeans (from best to worst)—sound soybeans from sound lots, sound soybeans from lots containing S/W beans and S/W soybeans. Size had an effect on processing; smaller beans did not process as well. The economic impact of S/W conditions was estimated by using a simulation model of soybean processing. Although the presence of S/W soybeans affected cracking and dehulling properties, it had a negligible effect on the Estimated Processed Value per Bushel (EPVB). Calculated blends of sound and S/W lots containing 20% S/W seeds had a decrease in EPVB of less than 0.2%.

KEY WORDS: **Cracking, dehulling, processing, shriveled, soybeans, value, wrinkled.**

The 1988 drought in the Midwest resulted in some harvested soybeans having atypical size and appearance, primarily from shriveled and wrinkled (S/W) seed coats. This condition was the result of hot and dry weather during the maturity period of the soybean crop (1). Soybean processors expressed concern about the processing of such misshapen soybeans (2). Some believe the S/W condition makes it difficult to remove the hull (seed coat). Dehulling is a common processing step in the milling and direct solvent extraction of soybeans, the predominant method of soybean processing. Dehulling is necessary to make high-protein (47–49% crude protein) soybean meal and to make low-protein (44% crude protein) meal from soybeans of low protein content (3). Incomplete dehulling will have a significant impact on a processor's ability to make soybean meal of a desired protein content and may increase oil loss to the hulls. Concern over the S/W problem was great enough that the Federal Grain Inspection Service issued a definition for S/W soybeans (2).

Soybean processing includes three major steps: i) soybean preparation (cleaning, drying, cracking, dehulling by aspiration and flaking); ii) direct solvent extraction; and iii) meal formulation. There are many published discussions of soybean processing in general (4–6) that include suggested operating conditions.

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Concerns about S/W soybeans center around the preparation step, specifically the amount and composition of material removed by aspiration after cracking. The amounts of protein and oil remaining with the meats (the inner part of the soybean seed) should be maximized. The amount of fibrous hull remaining with the meats should be minimized. The hulls should be low in protein and oil. The size distribution of the cracked meats is important for proper flaking.

There is little or no information that documents the effect of shriveled conditions on processing. To what extent are S/W soybeans more difficult to dehull? Does the seed coat remain attached to the inner meats? Are the meats higher in fiber content because of incomplete dehulling? Does less of the total protein and oil in the soybean remain with the meats? Is size an important criterion? Do more meats, thus more oil and protein, remain attached to hulls that are removed? Could sizing the seed remove soybeans with poorer processing characteristics?

If the extent of processing deficiencies can be established, then the economic loss due to S/W conditions can be determined. Brumm and Hurburgh (3) developed a model of soybean processing in which conditions such as dehulling efficiency can be varied. This model could be used to evaluate the economic impact of S/W soybeans, given estimates of the physical problems caused by the S/W condition.

The objective of this research was to determine the cracking and dehulling properties of shriveled and wrinkled soybeans. Specific objectives were to: i) determine differences in processing characteristics among whole lots of soybeans containing various levels of S/W soybeans; ii) determine differences in processing characteristics among sized fractions of sound soybeans from sound lots, sound soybeans from lots containing S/W soybeans, and S/W soybeans; and iii) evaluate the economic impact of S/W soybeans.

MATERIALS AND METHODS

Five lots (250 kg each) of soybeans were used in this study, all collected from farmers in central Iowa. Lots 1 and 2 were sound soybeans, containing less than 0.5% (by weight) shriveled and wrinkled soybeans. Lot 1 was 1988 crop Corsoy 79 soybeans and lot 2 was a mixture of 1987 crop soybeans. Lots 3, 4 and 5 all contained significant amounts of shriveled and wrinkled soybeans. These three lots were each of a single, but unknown, variety. All subsamples in this study were obtained by using a Boerner divider.

Sized subsamples from all lots were obtained with round-hole (RH) and slotted screens in a Carter-Day Dockage Tester (Carter-Day Company, Minneapolis, MN) (Fig. 1). Four sized fractions were generated: 8–10s [soybeans passing through a 10/64″ by 3/4″ (3.97 mm by 19.05 mm) slotted screen but remaining on top of an 8/64″ (3.18 mm) RH screen], 10s+ (soybeans remaining on top of the 10/64″ by 3/4″ slotted screen), 12–16 [remaining on top of a 12/64″ (4.76 mm) RH screen, but passing through a 16/64″ RH screen (6.35 mm) RH screen], and 16–20 [remaining on top of the 16/64" RH screen, but passing through a 20/64" (7.94 mm) RH Screen]. All material passing through an 8/64" RH screen and all hand-picked non-soybean material was foreign material (FM) (7) and was discarded. Damaged soybeans (7) were also discarded. Only one of the samples had more than 0.5% (by weight) remaining on top of an 20/64" RH screen or passing through a 12/64" screen. The exception was lot 4, in which 3.3% passed through the 12/64" screen. To maintain experimental design, this fraction was not processed. The 8-10s fraction for lot 1 was less than 1.0% and was not processed; lot 2 had 3.3% in this fraction and also was not processed to maintain experimental balance.

Within each size category of lots 3, 4 and 5, soybeans were hand-sorted into two conditions, sound and S/W. Soybeans with any degree of surface wrinkling were counted as shriveled and wrinkled (8). The Federal Grain Inspection Service (FGIS) definition of S/W soybeans only examines soybeans in the 8-10s size fraction and therefore was not used. Enough soybeans were sorted to generate approximately 1 kg of each condition. The sorting operation produced three types of soybeans—sound soybeans from sound lots, sound soybeans from lots containing S/W soybeans and S/W soybeans.

Duplicate samples of approximately 500 g from each lot, size and condition (sound and S/W) combination were dried in a hot-air dryer (maximum air temperature 70°C) to remove approximately 2 percentage points of moisture. This was a necessary step for dehulling—the shrunken inner meat detaches from the outer hull, facilitating good separation. The dried samples were tempered for seven days in sealed containers at room temperature.

After the tempering period, weight and moisture content (9) were determined. Each sample was then cracked in a Ferrel-Ross 10X12G cracking mill (Ferrell-Ross Co., Oklahoma City, OK). Mass flowrate into the mill was approximately 0.5 kg/min. The clearance between cracking rolls (0.25 cm) was adjusted in start-up trials with an independent lot of sound, whole soybeans to give a meats particle size distribution that met the recommendations of Barger (on 6-mesh, 10-15%; on 10-mesh, 60-70%; on 20-mesh, 5-15%; and through 20-mesh, 0-3%) (4).

The samples were immediately aspirated in a Kice Model 6DT4 Aspirator (Kice Metal Products Co., Witchita, KS), previously adjusted on the start-up lot for minimum meats carry over in the liftings. Material entered the aspirator at approximately 0.2 kg/min and was subjected to a maximum air velocity of approximately 7.7 m/seconds in each of six passes (10). The weight and moisture content (11) were determined for the meats and liftings. Samples were stored in sealed containers for further analysis.

Composition of whole beans, meats and liftings was determined—crude protein (12), oil (13) and crude fiber contents (14). Particle size distributions of the meats and liftings was determined using a 6-mesh sieve (U.S. Standard #6, 3.36-mm nominal openings), a 10-mesh sieve (U.S. Standard #12, 1.68-mm openings), and a 20-mesh sieve (U.S. Standard #20, 0.841-mm openings) (15). All weights and composition percentages were adjusted to a dry-matter basis.

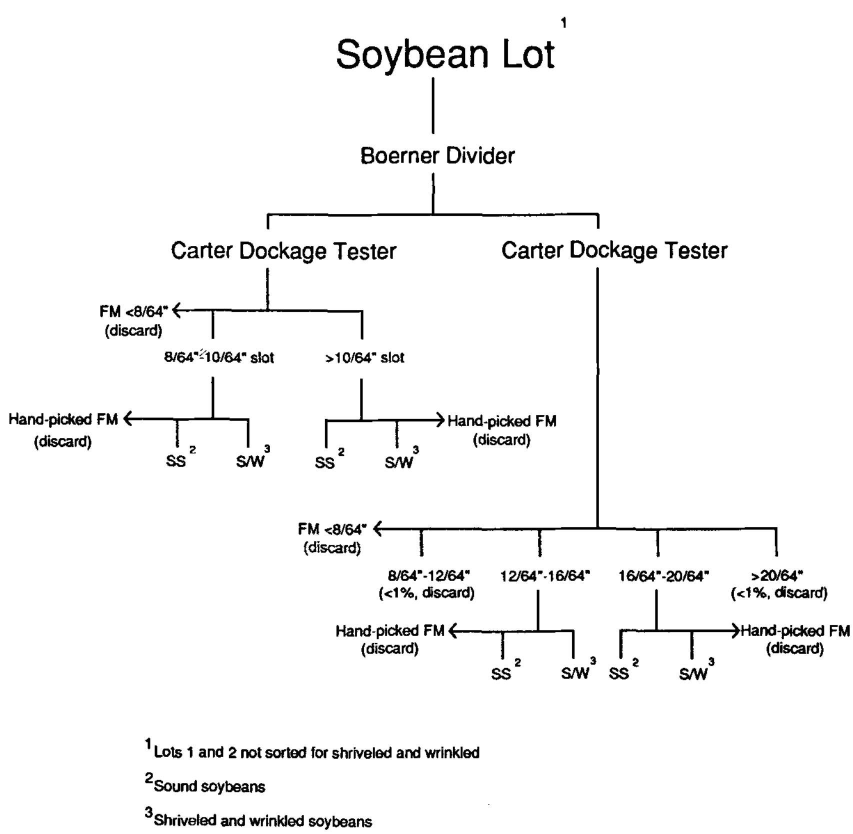

FIG. 1. Flowchart of sizing and sorting operation.

The dry weights of the protein, oil and fiber in the meats and liftings were compared with initial composition of the whole beans. Between 95 and 100% of the protein, 90-98% of the oil and 105-115% of the fiber was accounted for in the processed fractions. Some of the deficiency was dry-matter loss, which averaged 1.1% for all samples. Grinding liftings for chemical analyses yielded a greater proportion of smaller particle sizes than from the meats or whole beans, as determined by sieving with a 40-mesh sieve (U.S. Standard #40, 0.420-mm nominal openings) and a 100-mesh sieve (U.S. Standard #100, 0.149-mm openings) (15). Smaller particle sizes resulted in a higher yield of oil in determination by ether extraction (16). Thus, oil was under-predicted for the whole beans and meats relative to the liftings. Since fiber analysis was performed on an oil-free sample, mathematical adjustment for oil content resulted in relatively high whole bean and meats fiber content. There was no correlation between the percentage of protein, oil or fiber recovered in the two processing fractions and any of the treatments (lot, size or type). Although dry-matter losses and analysis problems may have made the absolute values slightly inaccurate, relative differences among treatments should be valid.

Cracking and dehulling properties were evaluated by considering the following variables (all on a dry-matter basis): liftings (% of initial weight removed by aspiration); fiber removal (% of initial fiber removed by aspiration); protein recovery (% of initial protein remaining in the meats after aspiration); fines in liftings (% of initial weight of particles in liftings passing through a 20-mesh sieve); size distribution in the meats (% large, particles remaining on a 6-mesh sieve; % medium, passing through 6-mesh but remaining on 10-mesh; % small, passing through 10-mesh but remaining on 20-mesh); and oil-free meats fiber content (% dry basis). Initial weight was the dry-matter weight of the soybeans entering the cracking mill.

TABLE 1

Analysis of Variance Table for Objective I

Source	Degrees of freedom	F-value
Lot	4	$F_{4,5}$
Error	5	
Total	9	

TABLE 2

Analysis of Variance Tables for Objective II

	Round-hole screen fractions		Slotted screen fractions[a]	
Source	Degrees of freedom	F-value	Degrees of freedom	F-value
Type[b]	2	$F_{2,26}$	2	$F_{2,23}$
Size	1	$F_{1,26}$	1	$F_{1,23}$
Type X size	2	$F_{2,26}$	1	$F_{1,23}$
Error	26		23	
Total	31		27	

[a]Interaction degrees of freedom reduced because only one slotted screen fraction was processed for sound lots.

[b]Types: sound soybeans from sound lots, sound soybeans from lots containing S/W soybeans, S/W soybeans.

Treatment effects were evaluated by using the PC-SAS Generalized Linear Model procedure (17). The analysis of variance tables for each objective are given in Tables 1 and 2. When size was a factor, separate analyses were performed for round-hole and slotted screen fractions because these two fractions are not mutually exclusive. Differences between effect means were examined by using contrasts (18) for objective I and Least Significant Differences (19) for the second objective.

The economic impact of S/W soybeans was determined using "SPROC," a computer model that simulates a direct solvent extraction plant that processes soybeans (3). The model calculates the Estimated Processed Value per Bushel (EPVB), which is the sum of revenues from the products (soybean meal, crude soybean oil and mill run) of soybean processing. EPVB was calculated by using the National Oilseed Processor's Association trading rules (20) and protein premiums for meal protein in excess of specifications. Product prices used were as follows: 44% protein meal, $183.10/ton; 48% protein soybean meal, $199.75/ton; and crude soybean oil, $0.193/lb. Processing parameters specified by the model (percent liftings, liftings oil content and liftings fiber content) were adjusted based on the results of the processing portion of the study.

RESULTS AND DISCUSSION

Sample characteristics. The results of proximate analyses are given in Table 3. There was no correlation between composition and the size or S/W condition within a lot. Lots 4 and 5 had greater fiber contents than the other lots. Soybean lots containing more small or shriveled and wrinkled seeds had a larger ratio of surface area to volume. Because the hull (surface) was higher in fiber content than the rest of the seed, a greater overall fiber content was expected.

TABLE 3

Composition of Samples, Whole Beans

Lot	Condition	Moisture after drying (%)	Protein[a] (%)	Oil[a] (%)	Fiber[a] (%)
1	Sound	7.6	33.5	19.9	4.9
2	Sound	7.5	33.1	20.2	5.1
3	S/W	7.1	33.4	19.7	5.2
4	S/W	6.7	34.1	19.3	5.9
5	S/W	6.3	33.4	19.6	5.7

[a]Basis 13.0% moisture

Table 4 gives the distribution of size and S/W soybeans for each lot. Shriveled and wrinkled soybeans were distributed across all sizes of beans. The S/W lots (3, 4 and 5) had a larger proportion of soybeans of smaller size.

Objective I. There were significant differences in processing between sound soybean lots and lots containing shriveled and wrinkled soybeans. Analysis of variance (Table 1) showed that the effect of lot significantly affected all processing variables. Table 5 gives the means of the processing variables by lot condition.

The S/W lots had moisture contents lower than the sound

TABLE 4

Size Distribution of Sound and S/W Soybeans

	Percent by weight of total sample[a]							
	Slotted screen fractions				Round-hole screen fractions			
	8-10s		10s+		12–16		16-20	
Lot	Sound	S/W	Sound	S/W	Sound	S/W	Sound	S/W
1	0.9[b]	–	99.1	–	39.6	–	60.4	–
2	3.1[b]	–	96.9	–	55.7	–	44.3	–
3	5.2	2.3	78.6	13.9	34.6	11.0	46.5	7.6
4[c]	3.7	11.3	51.2	33.8	46.2	42.2	5.7	2.5
5	2.9	3.1	64.7	29.3	40.0	28.1	25.3	5.8

[a]Total, clean, undamaged, FM-free sample.
[b]Not processed.
[c]This lot had 3.3% passing through a 12/64" RH screen and remaining on top of an 8/64" RH screen that was not processed.

TABLE 5

Processing Data for the Whole, Unsized, Unsorted lots[a] (1–5)

	Type of lot[b]	
Processing variable	Sound	S/W
Liftings (%)	15.1	17.9
Fiber removal (%)	67.2[A]	65.5[A]
Protein recovery (%)	89.2[B]	86.0[B]
Oil recovery (%)	86.5	84.1
Liftings fines (%)	3.1	4.2
Large meats (%)	29.2	15.5
Medium meats (%)	61.9	73.0
Small meats (%)	8.4	11.0
Oil-free meats fiber content (%)[c]	3.7	4.3

[a]Clean, undamaged, FM-free.
[b]Means with the same letter (A or B) are not statistically different at $\alpha = 0.05$.
[c]Dry-matter basis.

lots. Some of the processing variables showed some correlation with moisture content; e.g., percent liftings had a correlation coefficient of 0.62. However, when correlations were examined within lot type (sound or S/W) where there were also differences in moisture, they were no longer significant. The differences in moisture contents were coincidental and did not effect processing variables between lots.

The S/W lots had more of the initial weight removed as liftings. The S/W liftings had more fines than the sound liftings. In all cases, the amounts of fines in the liftings were large. The moisture content of these soybeans were extremely low as they entered the cracking mill (6.3-7.6%); thus, the beans shattered more when cut by the cracking rolls. Also, the cracking mill used in this study was not specifically designed for soybean cracking—a different corrugation on the rolls could have reduced the generation of fines. Despite the large absolute amount, the relative effect of treatments should be valid.

The meats size distribution of the S/W soybeans was better than that for the sound soybean lots, on the basis of Barger's recommendations. The cracking mill was adjusted by using a start-up lot that was approximately 2.5 percentage points higher in moisture. Hence, the mill could have been improperly adjusted for the sound lots. However, if the roller spacing was tightened to improve the size distribution of the sound soybeans, more small pieces would be generated in the S/W lots. This would cause problems when the S/W lots are flaked. A number of whole soybeans appeared in the large meats fraction of the S/W lots. They passed through the cracking mill without being broken. The abnormal shape of shriveled and wrinkled soybeans (a large proportion of flattened and elongated seeds) was a contributing factor.

More oil was recovered in the meats from sound lots than from the S/W lots, although there were no differences in fiber removal or protein recovery. The protein and oil recoveries for all lots were smaller than desired. This can be attributed to the large generation of fines, which contain material that should remain with the meats. The overall fiber removal agrees with what is generally found in dehulling operations. However, a difference between S/W and sound lots was expected, in light of the supposed dehulling problems and the occurrence of uncracked soybeans in the S/W meats.

The S/W lots had much greater meats oil-free fiber contents (an indicator of the fiber content of the defatted meats). Inasmuch as the S/W lots had greater initial fiber contents, the same percentage fiber removal in the sound and S/W lots resulted in this greater meats fiber content. There may be problems in the meal formulation step with S/W lots; high-protein meal has a typical limitation of 3.4-3.7% fiber (dry-matter basis). Anything higher will incur a price discount, lessening the product value.

Objective II. Soybean type (sound seeds, sound seeds from lots containing shriveled and wrinkled soybeans, and S/W soybeans) had a significant effect on processing. Analysis of variance (Table 2) showed that type was significant for all processing variable, with these exceptions--fiber removal (round-hole fractions); and protein and oil recoveries (slotted fractions). Tables 6 and 7 give the processing results for this part of the study.

In general, fractions from sound soybean lots had the least amount of liftings, the smallest amount of fines in the liftings, the largest fiber removal, and the largest protein and oil recoveries. As with the whole lots, the size distribution of the meats was better for soybeans from S/W lots, but proper adjustment of the cracking mill would change this. The soybeans from the S/W lots also showed a greater oil-free meats fiber content. Again, this may cause problems when making high-protein soybean meal.

There was a difference between S/W soybeans and sound soybeans from the same lot. The environmental conditions that created the S/W seeds in these lots also affected seeds that had no visual evidence of S/W seed coats. Although the sound beans from S/W lots processed better than the S/W beans, they were still worse than sound beans from sound lots. Examination of the sound beans from S/W lots showed that they were more oblong in shape, despite a smooth seed coat. Cracking mills adjusted to properly crack the proportionally larger and more spherical sound soybeans from sound lots may ot adequately crack these seeds. Visual inspection of surface texture may be an inadequate gauge of potential processing problems with soybean lots containing shriveled and wrinkled seeds.

Size also had a significant effect on processing, in frac-

TABLE 6

Processing Data for the Sorted, Slotted Screen Fractions

	Slotted-screen fraction[a]				
	8-10s		10s+		
Processing variable	Sound from S/W[b]	S/W[b]	Sound[c]	Sound from S/W[b]	S/W[b]
Liftings (%)	16.7^{A}	16.3^{A}	15.1	16.7^{A}	19.2
Fiber removal (%)	66.1^{B}	58.4	70.7	66.1^{B}	65.3^{B}
Protein recovery (%)	89.2^{C}	$87.4^{C,D}$	88.5^{C}	$85.9^{D,E}$	84.9^{E}
Oil recovery (%)	86.2^{F}	87.4^{F}	86.5^{F}	85.8^{8}	85.3^{F}
Liftings fines (%)	2.6	3.0^{G}	2.9^{G}	4.0	4.9
Large meats (%)	8.7^{H}	15.5^{I}	28.3	17.3^{I}	9.4^{H}
Medium meats (%)	83.2	77.8^{J}	62.6	70.8	77.2^{J}
Small meats (%)	7.6	6.3	8.7	11.3	12.4
Oil-free meats fiber content (%)[d]	4.6^{K}	5.3	3.8^{L}	$4.2^{L,K}$	3.9^{L}

[a]Mean of all lots. Means with the same capital letter are statistically equal at $\alpha = 0.05$.
[b]Lots 3, 4 and 5.
[c]Lots 1 and 2.
[d]Dry-matter basis.

tions generated by both round-hole screens and the slotted screen. Size was a significant factor for all processing variables except for oil recovery and the percentage of large meats (slotted fractions), protein and oil recoveries, liftings fines and oil- free meats fiber content (round-hole fractions). In general, smaller seeds did not process as well as larger seeds. Decreasing the clearance between cracking rolls is not a solution because the resulting size distribution of the meats would be unacceptable. Perhaps some concurrent adjustment of both the cracking and flaking operations is necessary to optimize the processing of S/W soybeans.

The processing results for the sized and sorted fractions were additive. The processing variables (% liftings, fiber removal, etc.) of each fraction summed to within two percentage points of that of the whole lots when weighted by the fraction's weight percentage of the unsized, unsorted sample. This was true for both the slotted and round-hole screen fractions. Because of the subjective nature of S/W determination (9), this is acceptable. Additivity means that the processing properties of blends can be predicted if the properties of the fractions are known.

Objective III. Changes in processing properties for S/W soybeans and sound beans from S/W lots relative to sound lot soybeans are given in Table 8. The average S/W lot in this study contained 31.2% S/W soybeans and 68.8% sound. Because the effects of size and condition are additive, a weighted mean can be calculated. The S/W lots had an increase in liftings of 17.2%, a decrease in fiber removal of 4.6% and a decrease in oil recovery of 0.3%. The average composition of the S/W lots was 33.6% protein, 19.5% oil and 5.6% fiber (basis 13.0% moisture).

TABLE 8

Change in Key Processing Variables by Soybean Condition

	% Change from sound soybean lots		
Condition	% Liftings	% Fiber removal	% Oil recovery
Sound from S/W lots	14.6	4.0	0.1
Pure S/W	23.1	5.9	1.2
Average S/W Lot[a]	17.2	4.6	0.3

[a]68.8% Sound from S/W lot, 31.2% S/W (by weight).

An actual soybean processing plant will rarely process S/W lots without some sort of blending taking place, either from on-site storage and handling or from mixing in the market channel before receiving. Hypothetical blends of sound lot soybeans and the average S/W lot in this study were calculated. Three different sound lot compositions were used: 33% protein, 20% oil; 35%, 19%; and 37%, 18%;

TABLE 7

Processing Data for the Sorted, Round-Hole Sized Fractions

	Round-hole screen fractions[a]					
	12-16			16-20		
Processing variable	Sound[b]	Sound from S/W[c]	S/W[c]	Sound[b]	Sound from S/W[c]	S/W[c]
Liftings (%)	$14.8^{A,B}$	17.9^{C}	18.7	13.7^{A}	15.9^{B}	17.9^{C}
Fiber removal (%)	67.7^{D}	66.4^{D}	$64.9^{D,E}$	$63.7^{D,E}$	59.9^{E}	$64.8^{D,E}$
Protein recovery (%)	$87.1^{7F,G}$	85.6^{G}	85.4^{G}	90.1^{F}	$87.2^{F,G}$	84.8^{G}
Oil recovery (%)	$86.0^{H,I,J}$	$86.4^{H,I,J}$	$85.1^{I,J}$	$87.9^{H,J}$	88.9^{H}	84.8^{I}
Liftings fines (%)	2.9^{K}	40.0^{L}	4.4	3.0^{K}	4.0^{L}	4.8
Large meats (%)	29.8	13.3^{M}	9.7	33.4	21.6	14.8^{M}
Medium meats (%)	60.6	74.0^{N}	78.1	58.6	67.7	72.3^{N}
Small meats (%)	9.1	12.0^{O}	11.6	7.7	10.2	12.2^{O}
Oil-free meats fiber content (%)[d]	3.8	$4.1^{P,Q}$	$4.4^{Q,R}$	3.6^{P}	4.3^{R}	$4.2^{Q,R}$

[a]Mean of all lots. Means with the same capital letter are statistically equal at $\alpha = 0.05$.
[b]Lots 1 and 2.
[c]Lots 3, 4 and 5.
[d]Dry-matter basis.

all at 4.4% fiber (basis 13.0% moisture). The S/W content of the blends ranged from 0 to 30%. The blend composition varied with the S/W content. The processing variables, percent liftings, liftings oil content and liftings fiber content were adjusted by using mass balances and the results in Table 8.

The Estimated Processed Value per Bushel (EPVB) was calculated for each blend. Two meal protein specifications were used, 44% protein (low-protein meal) and 48% protein (high-protein meal). The EPVB of sound lot soybeans at the same protein and oil content of the blend was also calculated. The difference in the two EPVBs isolates the effect of shriveled and wrinkled conditions from the effect of changes in composition due to blending. Table 9 presents the results for blends with sound-lot protein and oil contents of 35% and 19%, respectively.

TABLE 9

EPVB Calculations for Producing 44% Protein Meal from S/W Soybeans

S/W	Protein[a] (%)	Oil[a] (%)	Fiber[a] (%)	Liftings[b] (%)	Liftings Oil[c] (%)	Liftings Fiber[c] (%)	EPVB ($/bu)	Sound EPVB[d] ($/bu)
0	35.0	19.0	4.4	10.0	1.5	35.0	6.55	6.55
5	34.8	19.1	4.6	10.3	1.6	35.3	6.53	6.52
10	34.6	19.2	4.8	10.6	1.7	35.5	6.49	6.49
15	34.3	19.2	5.0	10.8	1.8	35.8	6.45	6.47
20	34.1	19.3	5.2	11.1	1.9	35.9	6.43	6.44
25	33.9	19.4	5.4	11.4	1.9	36.1	6.41	6.41
30	33.6	19.5	5.6	11.7	2.0	36.2	6.38	6.38

[a]Basis 13.0% moisture.
[b]Weight percent of soybeans entering the cracking mill removed by aspiration.
[c]Basis 12.0% moisture.
[d]EPVB of sound lot soybeans at the same protein and oil content as the S/W blend.

The differences between the EPVB of the sound and blended lots were small in all cases (Figs. 2 and 3). The largest differences were $0.03/bushel for low-protein meal, and $0.04/bushel for high-protein meal. Peaks in the curves were caused by different meal compositions among blends and sound lots of the same protein and oil content. Because meal pricing is not linear (discounts and premiums occur at discrete levels of meal quality), the EPVB differences were not linear. Because the EPVBs were rounded to the nearest cent, the differences may not even be as significant as they seem.

Blends resulting in 20% S/W, a level that might be encountered by processors receiving S/W soybeans, had an average EPVB difference of only $0.01/bushel for both low- and high-protein meal. This is less than 0.2% of the processed value. Although the presence of S/W soybeans affected processing properties, end-product value was not significantly affected.

Shriveled and wrinkled soybeans could have an influence on plant operations as the characteristics of various material streams in the plant change. Equipment adjustments may be needed to minimize potential problems.

ACKNOWLEDGMENTS

This research was supported by the U.S. Department of Agriculture, Federal Grain Inspection Service, and the Iowa Agriculture and Home Economics Experiment Station, Project 2339, Iowa State University. This is Journal Paper J-14010 of the Iowa Agriculture and Home Economics Experiment

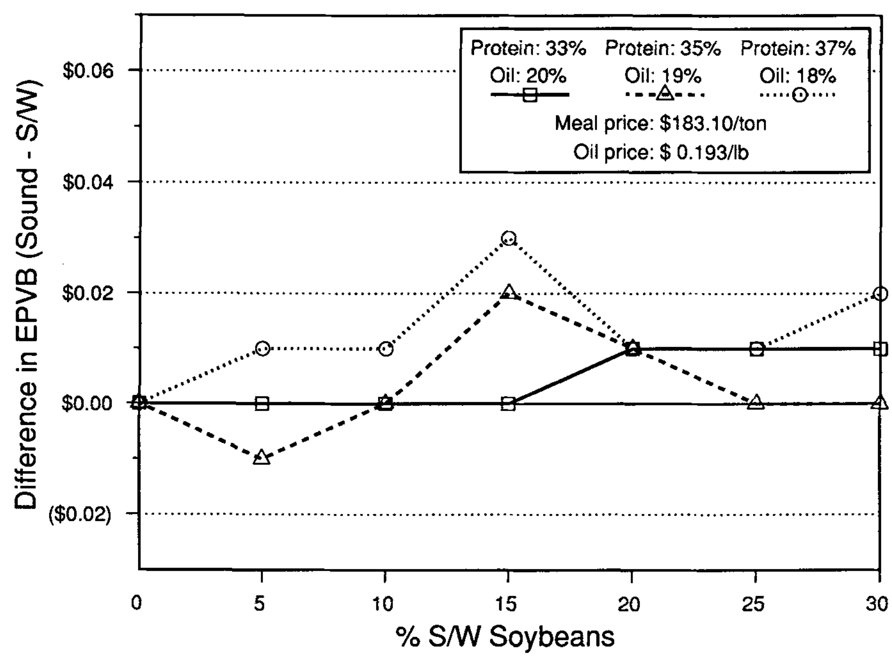

FIG. 2. Differences in EPVB between sound lots and blended lots containing S/W soybeans for production of 44% protein meal, for three compositions of sound soybeans.

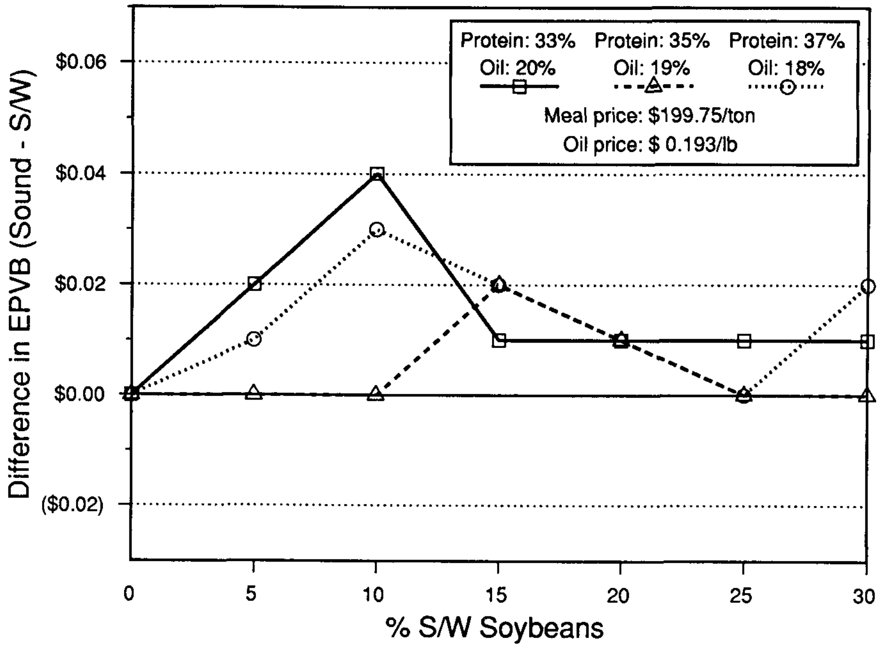

FIG. 3. Differences in EPVB between sound lots and blended lots containing S/W soybeans for production of 48% protein meal, for three compositions of sound soybeans.

Station, and ISU Agricultural Engineering Staff Paper Series 90-05.

Thanks goes to the students employed by the ISU Grain Quality Laboratory for the many hours spent sorting soybeans and assisting in this study: B.J. Abogunrun, G. Blom, E. Clark, M. Clark, R. Dorenbos, J. Grant, B. Leymaster, D. Lyon, K. Steinkamp and V. Westerkamp.

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[Received May 30, 1990; accepted August 15, 1990]