

# Size Determination of Shriveled and Wrinkled Soybeans

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Drought stress created shriveled and wrinkled (S/W) soybeans in the 1988 soybean crop. Seven lots of 1988 soybeans were examined to validate the Federal Grain Inspection Service (FGIS) definition of S/W. Lots were subdivided into sized fractions with both slotted and round-hole screens. Shriveled and wrinkled soybeans were found in all size fractions, whether those fractions were determined by a slotted or a round-hole screen. None of the size fractions adequately isolated or characterized S/W soybeans. The FGIS definition of shriveled and wrinkled does not consider larger wrinkled soybeans, but only shriveled soybeans passing through a 10/64" by 3/4" slotted screen. The most accurate determination of S/W soybeans can be made by examining the entire soybean sample, not a sized fraction.

**KEY WORDS:** Screens, shriveled, size, soybeans, wrinkled.

The 1988 drought in the Midwest resulted in some harvested soybeans having atypical size and appearance, primarily because of shriveled and wrinkled (S/W) seed coats. This condition resulted from hot and dry weather during the maturity period (1). There are three distinct types of shriveled and wrinkled conditions: i) misshapen seeds, shriveled and wrinkled; ii) round seeds with a wrinkled seed coat; and iii) dented, misshapen seeds with no wrinkles (Fig. 1). These deformed seeds range in size just as do whole, sound soybeans.

Soybean processors expressed concern about the processing of such misshapen soybeans (2). The S/W condition of the beans seemingly made it difficult to remove the hull (seed coat). Dehulling is necessary to make high-protein (47-49% crude protein) soybean meal or to make low-protein (44% crude protein) meal from whole 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.

On September 15, 1988, the Federal Grain Inspection Service (FGIS) issued a definition for S/W soybeans as an optional factor that could be reported on the inspection certificate (2). This definition responded to processor concerns over unexpected levels of S/W soybeans. The percentage of S/W soybeans, by the FGIS definition, is determined by sieving 125 g of the sample over a 10/64" by 3/4" (3.97 mm by 19.05 mm) slotted screen. Inspectors manually remove all whole soybeans (both S/W and smooth) from the material that passes through the screen. Any undamaged, smooth soybeans are considered sound. Damage refers to the U.S. Grade Factor total damage which includes weathered, moldy and discolored soybeans (4). The weight percentage of non-damaged S/W soybeans is reported on the inspection certificate in the Results and Discussion section. Any wrinkled soybeans remaining on top of the screen are considered sound soybeans (unless damaged). This definition seemingly determines shriveled soybeans (shrunken seeds with deformed surface texture) but ex-

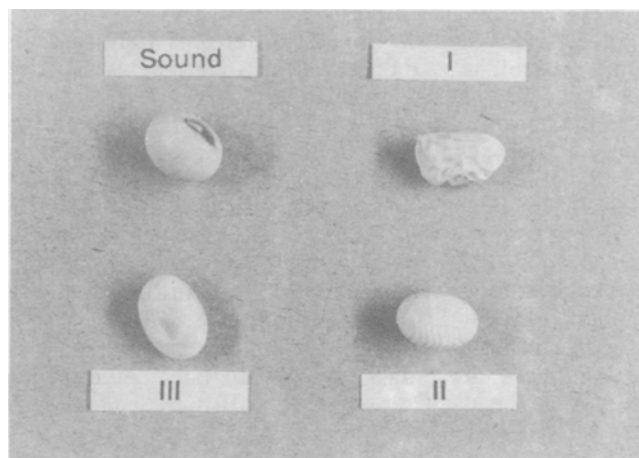


FIG. 1. Types of shriveled and wrinkled soybeans.

cludes larger, wrinkled soybeans. Sieving has the advantage of reducing the amount of sample the inspector must examine.

The percentage of splits (i.e., undamaged soybeans with more than 1/4 of the bean removed) is routinely measured in market-channel soybeans. A 125-g sample is sieved with a 10/64" by 3/4" slotted screen to facilitate splits determination. Because not all splits pass through the screen, the entire sample is examined (4). Splits are reported as a percentage of the total weight. Use of the slotted screen for S/W determination thus simplifies the inspection procedure. The same separation can be used for determination of both split and S/W soybeans.

There is little or no scientific data or published information on S/W soybeans in market-channel soybeans. The size distribution of wrinkled soybeans is unknown. A significant portion of wrinkled soybeans could remain on top of a 10/64" by 3/4" slotted screen. These beans would not be included in the reported percentage.

The objectives of this research are to: i) determine the size distribution of shriveled and wrinkled soybeans; and ii) evaluate the current FGIS definition, proposing an alternative if appropriate.

## MATERIALS AND METHODS

Seven lots of soybeans (2-20 kg), all with some level of shriveled and wrinkled seeds, were obtained from the 1988 crop—four from farmers and three from seed companies. All soybeans came from areas of Iowa that had significant drought conditions. Each seed lot contained a single, but unknown, variety of soybeans. Moisture contents of the seven lots varied from 8.8% to 11.3%, as measured by a Dickey-john GACII moisture meter (Dickey-john Corp., Auburn, IL). All sublots used in this study were created with a Boerner divider.

Sublots of approximately 125 g were used to determine the amount of S/W soybeans according to the FGIS definition. Two size fractions were generated by hand screening: 10s+ [soybeans remaining on top of a 10/64" by 3/4" (3.97 mm by 19.05 mm) slotted screen] and 8-10s [soybeans passing

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through a 10/64" by 3/4" slotted screen but remaining on top of an 8/64" (3.18 mm) round-hole screen]. All material passing through an 8/64" round-hole screen, and hand-picked nonsoybean material is defined as foreign material (FM) (4) and was discarded.

On different sublots, three size fractions were made by using round-hole (RH) screens in a Carter-Day Dockage Tester: 8-12 [passing through a 12/64" (4.76 mm) RH screen, but remaining on top of an 8/64" RH screen]; 12-16 [passing through a 16/64" (6.35 mm) RH, but remaining on top of a 12/64" RH]; and 16-20 [passing through a 20/64" (7.94 mm) RH, but remaining on top of a 16/64" RH]. FM from these sublots was also discarded. None of the samples had more than 0.5% (by weight) remaining on top of a 20/64" RH screen. These fractions were further subdivided to obtain 125 g for S/W determinations.

Unlike other forms of soybean damage, there are no Interpretative Line Slides for reference in the determination of S/W soybeans. Discussions with a local federal grain inspection agency led to creating reference standards of S/W soybeans mounted on cards. All three types pictured in Figure 1 were counted as shriveled and wrinkled.

Shriveled and wrinkled soybeans were hand-picked from each of the size fractions. The weight of S/W soybeans in each fraction was reported as a weight percentage of the total lot of clean, FM-free soybeans. The average of two determinations from duplicate sublots was used. The difference between duplicates never exceeded 2.5 percentage points.

## RESULTS AND DISCUSSION

Shriveled and wrinkled soybeans were distributed over all size fractions used in this study. Table 1 lists the results from the slotted screen fractions, Table 2 the round-hole screen fractions. The tables list both the percentage of S/W seeds and all seeds (including S/W) in each size fraction. In the fractions generated with the slotted screen, most of the S/W soybeans remained on top of the screen. In only one sample did the amount of S/W soybeans passing through the screen exceed the amount remaining on top. Shriveled and wrinkled soybeans were found in all fractions generated by the round-hole screens, with most in the 12-16 size.

TABLE 1

Weight Percentage of Soybean Seeds in Slotted Screen Fractions

Sample	Percent by weight of total, clean, FM-free sample				
	8-10s		10s+		Total S/W
	S/W	All seeds	S/W	All seeds	
1	2.3	7.5	13.9	92.5	16.3
2	1.4	4.8	13.5	95.2	14.9
3	11.3	15.0	33.8	85.0	45.1
4	3.1	6.0	29.3	94.0	32.4
5	18.0	38.9	7.8	61.1	25.8
6	4.7	9.5	11.6	90.5	16.4
7	10.7	22.5	15.2	77.5	26.0

The small discrepancies between the total amount of S/W soybeans by using the slotted and round-hole screens were not significant. The standard deviation of total S/W

TABLE 2

Weight Percentage of Soybean Seeds in Round-Hole Screen Fractions

Sample	Percent by weight of total, clean, FM-free sample						
	8-12		12-16		16-20		Total S/W
	S/W	All seeds	S/W	All seeds	S/W	All seeds	
1	0.0	0.3	11.0	45.6	7.6	54.1	18.6
2	0.0	1.0	10.4	68.9	3.4	30.1	13.8
3	1.0	3.3	42.2	88.4	2.5	8.2	45.7
4	0.1	0.8	28.1	68.1	5.8	31.1	34.0
5	2.2	5.8	22.8	88.0	0.5	6.2	35.5
6	0.0	0.7	11.9	58.1	6.3	41.2	18.2
7	1.0	3.5	18.4	80.3	4.9	16.2	24.3

differences between slotted-screen and round-hole screen determinations was 0.95 percentage points. The standard deviation for individual S/W determinations across duplicates was 0.54 percentage points.

The FGIS definition, by examining only the 8-10s fraction, misses a large portion of shriveled and wrinkled soybeans. This is illustrated more clearly in Figure 2, where the percentages of the total amount of S/W soybeans within each of the two slotted fractions are shown. Except for one sample, most of the S/W soybeans were in the 10s+ fraction. The relative proportion of S/W soybeans was not constant between the two fractions. Similarly, there was no round-hole size fraction that contained a constant portion of S/W soybeans (Fig. 3). Most were in the 12-16 fraction, which generally contained the majority of sound beans.

Because the samples in this study showed large variability in the size distribution of S/W soybeans, it is unlikely that any constant-sized proportion of S/W soybeans exists in market-channel soybeans. Separation by size did not isolate wrinkled soybeans. A more accurate method would be to examine the whole soybean sample. Although such a procedure would increase inspection time, conditions conducive to S/W soybeans are infrequent and localized.

Determination of shriveled and wrinkled soybeans is a subjective test. A set of Interpretative Line Slides, similar to those that exist for other forms of soybean damage, would promote uniform grading of this deformity and would make information derived from S/W determinations more useful.

The extent to which S/W conditions impact soybean processing is unknown. Large, wrinkled soybeans may not cause the same problems as do smaller shriveled soybeans. Further research is necessary to quantify the processing properties of S/W soybeans.

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## DETERMINATION OF SHRIVELED AND WRINKLED SOYBEANS

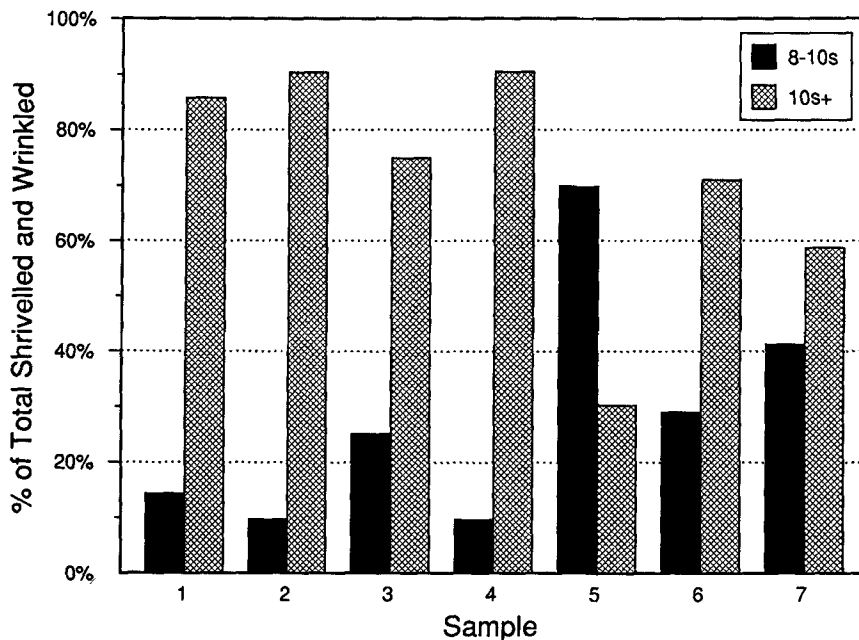


FIG. 2. Percentage of total shriveled and wrinkled soybeans in slotted screen fractions.

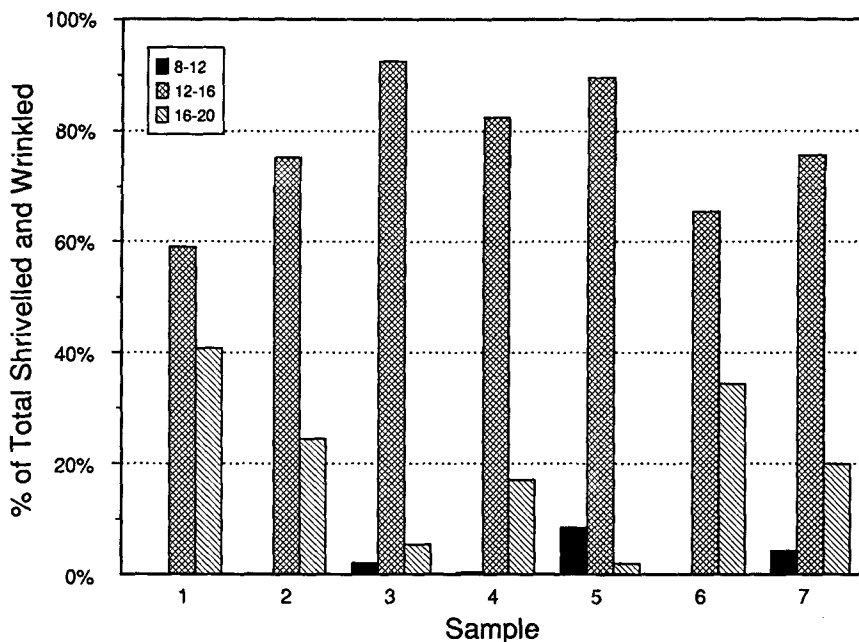


FIG. 3. Percentage of total shriveled and wrinkled soybeans in round-hole screen fractions.

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