U.S. GRAINS COUNCIL

2022/2023 SORGHUM QUALITY REPORT

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The U.S. Grains Council (Council) is pleased to present the findings from its *2022/2023 Sorghum Quality Report*. This is the fourth annual edition of a report designed to provide international customers and other interested parties with accurate, unbiased information about the quality of the U.S. sorghum crop. A total of 97 samples were collected from the outbound shipments of fifteen country elevators and one farmer and analyzed for the grade factors established by the U.S. Department of Agriculture as well as chemical composition and other quality characteristics not reported elsewhere. The results are summarized at the U.S. Aggregate level.

The Council's mission is one of developing markets, enabling trade and improving lives. To help fulfill this mission, the Council is pleased to offer this report as a service to our partners. We hope it provides valuable information about the quality of U.S. sorghum to our valued trade partners.

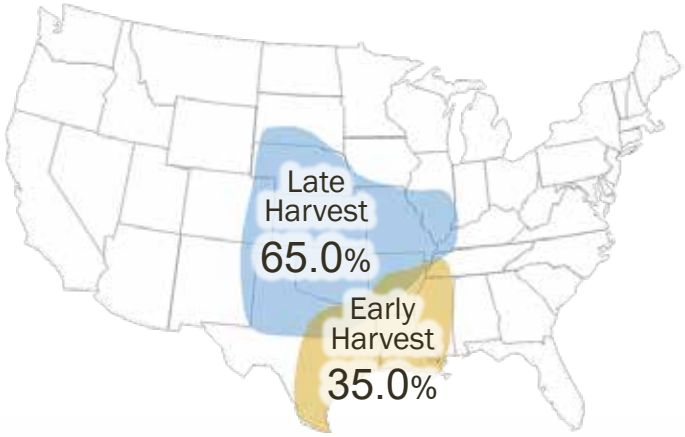
LIVE the MISSION

METHODOLOGY

Sorghum production in the United States can be grouped into the two main harvest areas shown in the map below (the Early Harvest Area and the Late Harvest Area). For this *2022/2023 Sorghum Quality Report*, the target population was sorghum from these two key U.S. sorghum-producing areas representing nearly 100% of the U.S. sorghum exports.[1] The results reflect the quality of blended samples pulled from the outbound sorghum shipments of U.S. elevators and a large sorghum producer.

The targeted number of samples were proportionately stratified according to each sorghum-producing area's share of total U.S. sorghum exports, as shown on the map.

SORGHUM HARVEST AREAS



The Council recruited participating elevators across these two areas by email or phone. Participants were instructed to collect 2,200 grams (about five pounds) of sorghum per sample bag provided. Samples were requested to be collected from individual outbound rail or truck shipments as the sorghum was being loaded or from inventories expected to be shipped for export.

- A total of 97 blended sorghum samples from fifteen participating elevators and one participating farmer were received from August 9, 2022, through March 8, 2023. Samples were received by the Amarillo Grain Exchange, Inc. in Amarillo, Texas, and tested for the sorghum grade factors. The samples were then sent to the Cereal Quality Lab at Texas A&M University in College Station, Texas, for chemical composition and physical factor analysis.
- Averages and standard deviations for each quality factor were calculated for the Early Harvest Area and the Late Harvest Area. The U.S. Aggregate average and standard deviation were then calculated based on each Harvest Area's proportion of total U.S. sorghum exports following standard statistical techniques for proportionate stratified sampling. The results are reported only for the U.S. Aggregate and not the individual Harvest Areas.

[1] *Source: USDA NASS and Centrec estimates*

A. GRADE FACTORS

The U.S. Department of Agriculture's Federal Grain Inspection Service (FGIS) has established numerical grades, definitions and standards for grains. The attributes that determine the numerical grades for sorghum are test weight, broken kernels and foreign material (BNFM), foreign material, total damage and heat damage.

SUMMARY: GRADE FACTORS

	2022/2023					2021/2022					2020/2021				
	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate						U.S. Aggregate					U.S. Aggregate				
Test Weight (lb/bu)	96	58.8	2.03	50.7	61.8	97	59.1	1.55	52.9	62.0	108	58.3	1.92	47.8	61.5
Test Weight (kg/hl)	96	75.7	2.61	65.3	79.5	97	76.1	1.99	68.1	79.8	108	75.1	2.47	61.5	79.2
BNFM (%)	96	1.4	1.15	0.2	8.3	97	1.5	0.85	0.1	7.3	108	1.6	1.08	0.1	5.7
Foreign Material (%)	97	0.7	0.67	0.0	5.8	97	0.7	0.53	0.0	2.6	108	0.6	0.45	0.0	3.0
Total Damage (%)	97	0.0	0.00	0.0	0.0	97	0.0	0.16	0.0	1.8	108	0.0	0.26	0.0	3.0
Heat Damage (%)	97	0.0	0.00	0.0	0.0	97	0.0	0.00	0.0	0.0	108	0.0	0.00	0.0	0.0

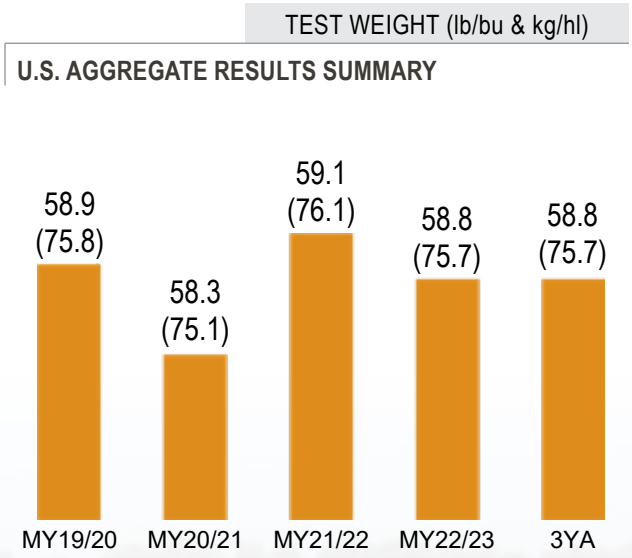
[1]*One of the 97 samples collected weighed less than the 1000 grams required to conduct tests for test weight and BNFM.*

TEST WEIGHT

Test weight is defined as the weight of grain required to fill a specific volume (Winchester bushel). This measure of bulk density is often used as a general indicator of overall quality and as a gauge of endosperm hardness for value-added processing.

The test involves filling a test cup of known volume through a funnel held at a specific height above the test cup to the point where grain begins to pour over the sides of the test cup. A strike-off stick is used to level the grain in the test cup, and the grain remaining in the cup is weighed. The weight is then converted to and reported in the traditional U.S. unit, pounds per bushel (lb/bu). Results are also reported in kilograms per hectoliter (kg/hl) in this report. The average and standard deviation for the 2022/2023 samples were the following:

- Average: **58.8 lb/bu (75.7 kg/hl)**, lower than 2021/2022 (59.1 lb/bu or 76.1 kg/hl), the same as the 3YA[1] and higher than the minimum for U.S. No. 1 grade (57.0 lb/bu or 73.4 kg/hl)
- Standard deviation: **2.03 lb/bu (2.61 kg/hl)**, higher than 2021/2022 (1.55 lb/bu or 1.99 kg/hl) and the 3YA (1.68 lb/bu or 2.17 kg/hl)



[1]*The 3YA represents the simple average of the quality factors' average or standard deviation from the 2019/2020, 2020/2021 and 2021/2022 Sorghum Quality Reports.*

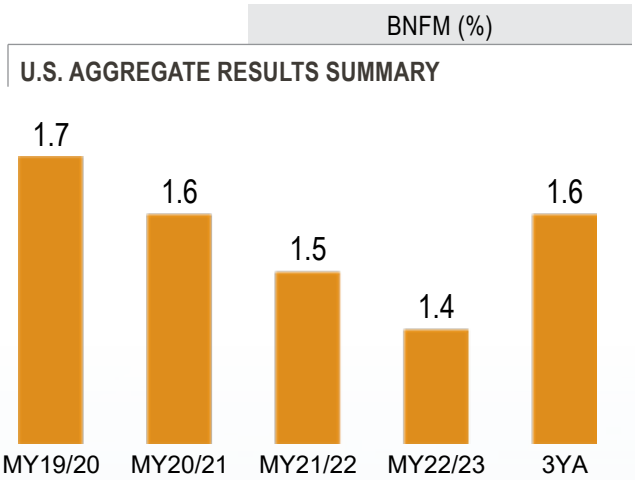
BROKEN KERNELS AND FOREIGN MATERIAL

Broken kernels and foreign material (BNFM), an indicator of the amount of clean, sound sorghum available for feed and processing, is reported as the sum of broken kernels as a percent of the dockage-free sample weight and the foreign material.

Broken kernels is defined as all material that passes through a 5/64th-inch triangular-hole sieve and over a 2.5/64th-inch round-hole sieve.

Foreign material is defined as all material, except sorghum, that remains on top of the 5/64th-inch triangular-hole sieve and all matter other than sorghum, which passes over a No. 6 riddle. Foreign material is reported as a sum of the mechanically-separated foreign material as a percent of the dockage-free sample weight and the handpicked foreign material as a percent of the handpicked sample portion weight. The average and standard deviation for the 2022/2023 samples were the following:

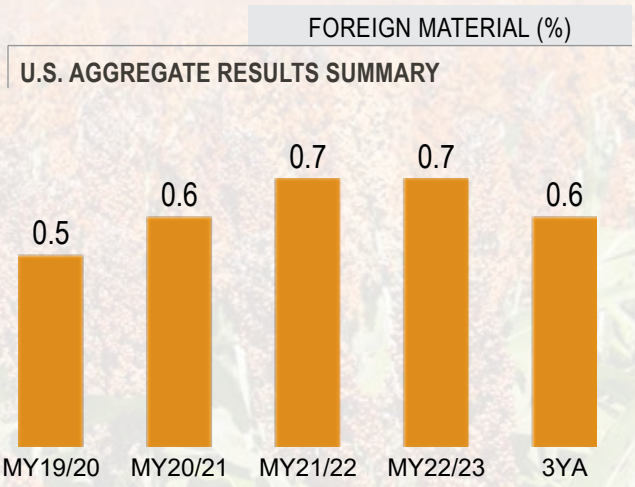
- Average: **1.4%**, lower than 2021/2022 (1.5%), the 3YA (1.6%) and the maximum for U.S. No. 1 grade (3.0%)
- Standard deviation: **1.15%**, higher than 2021/2022 (0.85%) and the 3YA (0.89%)



FOREIGN MATERIAL

Foreign material, a part of BNFM, consists of non-sorghum material and dust. Foreign material is generally higher in moisture content than the sorghum itself and reduces feed and processing value. The average and standard deviation for the 2022/2023 samples were the following:

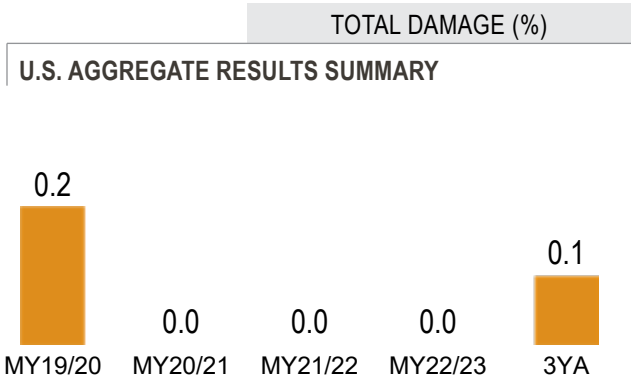
- Average: **0.7%**, same as 2021/2022, higher than the 3YA (0.6%) but below the maximum for U.S. No. 1 grade (1.0%)
- Standard deviation: **0.67%**, higher than 2021/2022 (0.53%) and the 3YA (0.46%)



TOTAL DAMAGE

Total damage is the percentage of kernels and pieces of kernels that are damaged in some way. A representative working sample of 15 grams of BNFM-free sorghum is visually examined by a properly trained individual for the content of damaged kernels. Types of damage include germ-damaged kernels, ground- or weather-damaged kernels, diseased kernels, frost-damaged kernels, heat-damaged kernels, insect-bored kernels, mold-damaged kernels (surface or internal), mold-like substance, purple-pigment-damaged kernels and sprout-damaged kernels. Total damage is reported as the weight percentage of the working sample that is total damaged grain.

- Average: **0.0%**, same as 2021/2022 (0.0%), but lower than the 3YA (0.1%) and the maximum for U.S. No. 1 grade (2.0%)
- Standard deviation: **0.00%**, lower than 2021/2022 (0.16%) and the 3YA (0.44%)



HEAT DAMAGE

Heat damage is a subset of total damage and consists of kernels and pieces of sorghum kernels that are materially discolored and damaged by heat. It occurs during heated air drying or in storage. Heat-damaged kernels are determined by a properly trained individual visually inspecting a 15-gram sample of BNFM-free sorghum. Heat damage, if found, is reported separately from total damage. The average for the 2022/2023 samples was the following:

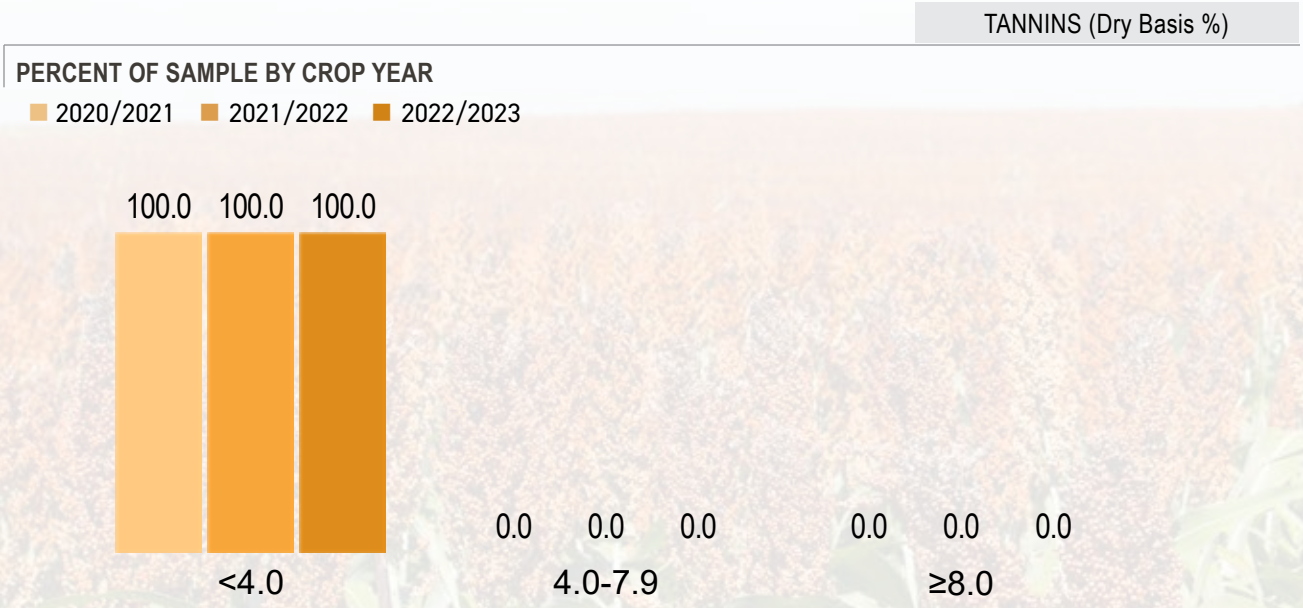
- Average: **0.0%**, no heat damage was observed, the same as in 2021/2022, 2020/2021 and 2019/2020

B. TANNINS

Tannins are present in sorghum varieties that have a pigmented testa within their kernels. Tannins affect nutritional and functional properties as a result of interactions of the tannins in sorghum-containing rations. Values near or below 4.0 mg catechin equivalents (CE) per gram (g) sample by this method generally imply the absence of condensed tannins. Type III tannin sorghums usually have values greater than 8.0 mg CE/g.

Leucoanthocyanidins (catechins) and proanthocyanidins (tannins) are a class of flavonoids known as flavanols that react with vanillin in the presence of mineral acids to produce a red color. Vanillin reacts with flavanols, but other flavonoid compounds can give specific color development. The test involves grinding approximately 50 g of sound seed using a UDY grinder with a 1 mm sieve and accurately weighing 0.30 g of this sample for analysis. Extraction and analysis are performed using the vanillin-HCl test with blank subtraction to remove interference by sorghum pigments. Developed color is measured using a UV-Vis spectrophotometer at 500 nanometers. A standard curve is run using pure catechin. Tests are run in triplicates, and the average value is reported as mg CE/g sample on a dry basis.

- Tannin levels in all 97 samples were less than 4.0 mg CE/g, implying an absence of tannins, the same as in 2021/2022, 2020/2021 and 2019/2020.



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C. CHEMICAL COMPOSITION

Chemical composition of sorghum is important because the components of protein, starch and oil are of significant interest to end-users. These attributes provide additional information related to nutritional value for livestock and poultry feeding and other processing uses of sorghum. Chemical composition tests for protein, oil and starch were conducted using an approximately 50-gram sample in a Perten DA 7250 Near-Infrared Reflectance (NIR) instrument. Results are reported on a dry basis (percent of non-water material).

SUMMARY: CHEMICAL FACTORS

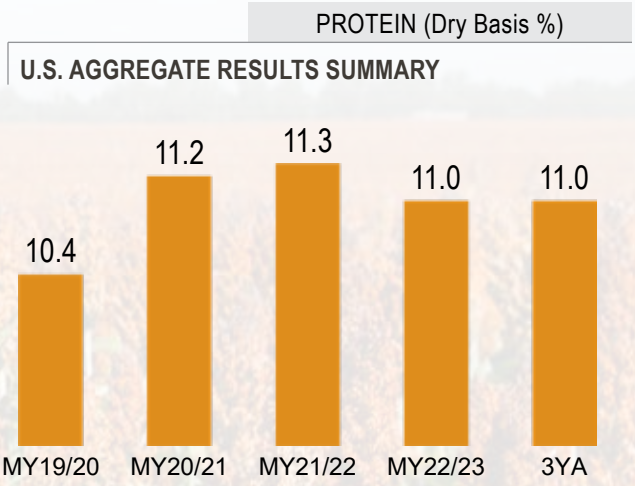
	2022/2023					2021/2022					2020/2021				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate						U.S. Aggregate					U.S. Aggregate				
Protein (Dry Basis %)	97	11.0	0.64	9.1	12.4	97	11.3*	0.89	9.2	14.5	108	11.2*	0.79	9.3	12.8
Starch (Dry Basis %)	97	72.2	1.11	69.2	75.1	97	73.4*	0.97	71.2	75.5	108	72.6*	1.01	69.1	75.2
Oil (Dry Basis %)	97	4.7	0.19	4.3	5.2	97	4.7*	0.32	2.9	5.2	108	4.7	0.20	3.9	5.2

*Indicates average was significantly different from current year's sorghum, based on a 2-tailed t-test at the 95.0% level of significance.

PROTEIN

Protein is very important for poultry and livestock feeding, as it supplies essential sulfur-containing amino acids and improves the feed conversion efficiency. Protein is usually inversely related to starch concentration. Results are reported on a dry basis. The average and standard deviation for the 2022/2023 samples were the following:

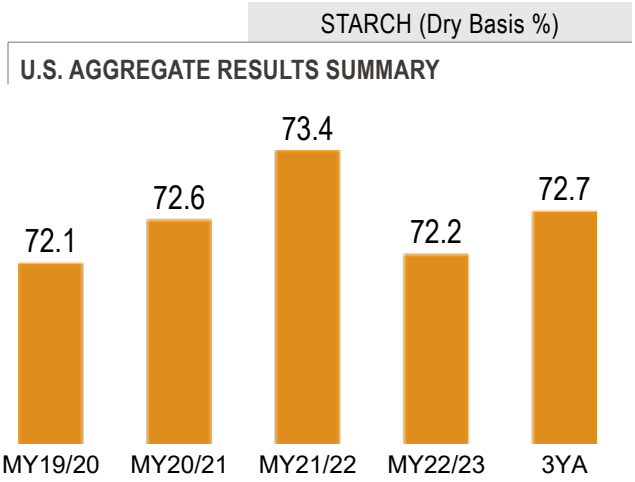
- Average: **11.0%**, lower than 2021/2022 (11.3%) but the same as the 3YA
- Standard deviation: **0.64%**, lower than 2021/2022 (0.89%) and the 3YA (0.81%)



STARCH

Starch is related to metabolizable energy for livestock and poultry. High starch concentration is often indicative of good kernel maturation/filling conditions and reasonably moderate kernel densities. Results are reported on a dry basis. The average and standard deviation for the 2022/2023 samples were the following:

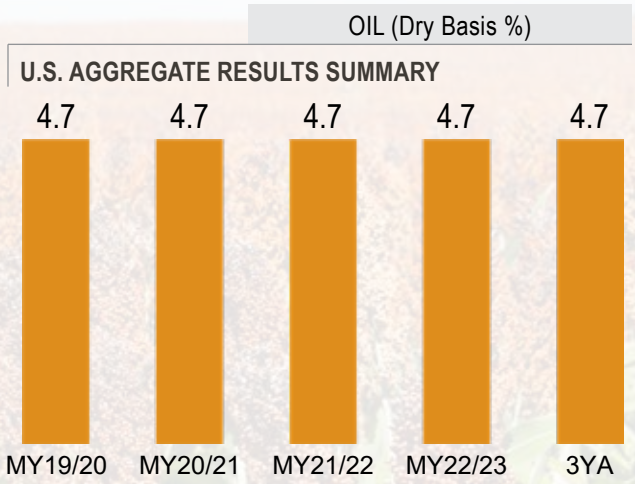
- Average: **72.2%**, lower than 2021/2022 (73.4%) and the 3YA (72.7%)
- Standard deviation: **1.11%**, higher than 2021/2022 (0.97%) and the 3YA (1.06%)



OIL

Oil is an essential component of poultry and livestock rations. It serves as an energy source, enables fat-soluble vitamins to be utilized and provides certain essential fatty acids. Oil may also be an important co-product of sorghum value-added processing. Results are reported on a dry basis. The average and standard deviation for the 2022/2023 samples were the following:

- Average: **4.7%**, the same as 2021/2022, 2020/2021 and 2019/2020
- Standard deviation: **0.19%**, lower than 2021/2022 (0.32%) and the 3YA (0.26%)



D. PHYSICAL FACTORS

Physical factors include other quality attributes that are neither grading factors nor chemical composition. Tests for physical factors provide additional information about the processing characteristics of sorghum for various uses, as well as its storability and potential for breakage in handling.

SUMMARY: PHYSICAL FACTORS

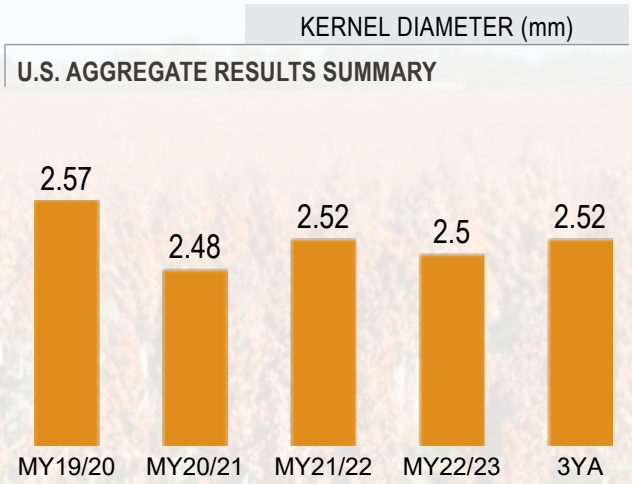
	2022/2023					2021/2022					2020/2021				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate						U.S. Aggregate					U.S. Aggregate				
Kernel Diameter (mm)	97	2.50	0.14	2.03	2.81	97	2.52	0.15	1.98	2.94	108	2.48	0.13	2.20	2.85
1000-Kernel Weight (g)	97	24.76	3.14	15.14	36.92	97	25.23	3.08	16.70	32.60	108	25.02	2.72	19.09	31.71
Kernel Hardness Index	97	68.8	9.4	34.7	85.4	97	67.8	4.8	53.9	79.9	108	67.1	5.6	48.1	83.7

KERNEL DIAMETER

Kernel diameter directly correlates with kernel volume, affects material handling practices and may indicate the maturity of kernels.

Kernel diameter is measured using a Perten Single Kernel Characterization System (SKCS 4100). The instrument records the individual diameter of 300 seeds and calculates the average seed diameter in millimeters (mm). The average and standard deviation for the 2022/2023 samples were the following:

- Average: **2.50 mm**, lower than 2021/2022 and the 3YA (both 2.52 mm)
- Standard deviation: **0.14 mm**, lower than 2021/2022 (0.15 mm) but higher than the 3YA (0.13 mm)

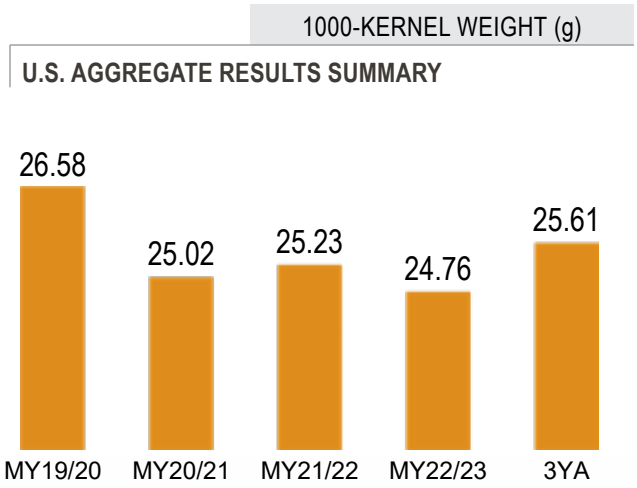


1000-KERNEL WEIGHT

1000-kernel weight (commonly referred to as TKW) is the weight for a fixed number of kernels and is reported in grams. Kernel volume (or size) can be inferred from TKW. As TKW increases or decreases, kernel volume will proportionally increase or decrease.

The TKW is determined from the average weight of 300 individual kernel replicates using the SKCS 4100. The instrument weighs each seed to the nearest 0.01 mg and automatically calculates the TKW based on the average weight of the 300 individual seeds. The average TKW is reported in grams. The average and standard deviation for the 2022/2023 samples were the following:

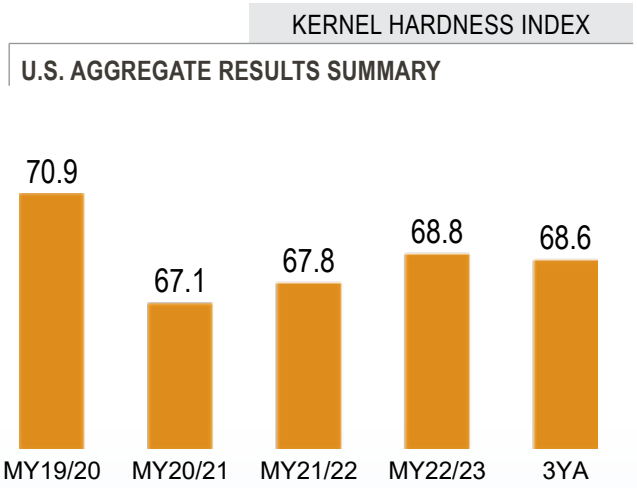
- Average: **24.76 g**, lower than 2021/2022 (25.23 g) and the 3YA (25.61 g)
- Standard deviation: **3.14 g**, higher than 2021/2022 (3.08 g) and the 3YA (2.64 g)



KERNEL HARDNESS INDEX

Kernel hardness affects mold and insect resistance, size reduction behavior and sorghum end-use. Grain hardness was measured using the SKCS 4100. The SKCS 4100 automatically selects individual kernels, weighs them, and then crushes them between a toothed rotor and a progressively narrowing crescent gap. As a kernel is crushed, the force between the rotor and crescent is measured. About 50 g of clean, externally intact seed is introduced into the instrument hopper. The instrument then automatically characterizes 300 individual seeds. The data are reported as average kernel hardness index, based on the 300 individual seeds. Samples are also classified as hard, mixed, or soft, depending on the average hardness index value and hardness distribution among the 300 seeds. Kernel hardness index values can range from 20 to 120. The average and standard deviation for the 2022/2023 samples were the following:

- Average: **68.8**, higher than 2021/2022 (67.8) and the 3YA (68.6)
- Standard deviation: **9.4**, higher than 2021/2022 (4.8) and the 3YA (5.5)



U.S. SORGHUM GRADES AND GRADE REQUIREMENTS

Grade	Minimum Test Weight per Bushel (Pounds)	Maximum Limits of: Damaged Kernels: Heat Damaged (Percent)	Damaged Kernels: Total (Percent)	Broken Kernels and Foreign Material: Foreign Material (part of total) (Percent)	Broken Kernels and Foreign Material: Total (Percent)
U.S. No. 1	57.0	0.2	2.0	1.0	3.0
U.S. No. 2	55.0	0.5	5.0	2.0	6.0
U.S. No. 3[1]	53.0	1.0	10.0	3.0	8.0
U.S. No. 4	51.0	3.0	15.0	4.0	10.0

U.S. Sample Grade is sorghum that:

(a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, or 4; or

(b) Contains 8 or more stones which have an aggregate weight in excess of 0.2 percent of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria spp.*), 2 or more castor beans (*Ricinus communis L.*), 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), 8 or more cocklebur (*Xanthium spp.*) or similar seeds singly or in combination, 10 or more rodent pellets, bird droppings, or an equivalent quantity of other animal filth in 1,000 grams of sorghum, 11 or more pieces of other material from any combination of animal filth, castor beans, crotalaria seeds, glass, stones, unknown foreign substances, and cockleburs; or

(c) Has a musty, sour, or commercially objectionable foreign odor (except smut odor); or

(d) Is badly weathered, heating or otherwise of distinctly low quality.

[1]*Sorghum which is distinctly discolored shall not grade any higher than U.S. No. 3.*

Source: Code of Federal Regulations, Title 7, Part 810, Subpart D, United States Standards for Sorghum

U.S. AND METRIC CONVERSIONS

Sorghum Equivalents		Metric Equivalents	
1 bushel =	56 pounds (25.40 kilograms)	1 pound =	0.4536 kg
39.368 bushels =	1 metric ton	1 hundredweight =	100 pounds or 45.36 kg
15.93 bushels/acre =	1 metric ton/hectare	1 metric ton =	2204.6 lbs
1 bushel/acre =	62.77 kilograms/hectare	1 metric ton =	1000 kg
1 bushel/acre =	0.6277 quintals/hectare	1 metric ton =	10 quintals
56 lbs/bushel =	72.08 kg/hectoliter	1 quintal =	100 kg
		1 hectare =	2.47 acres

U.S. GRAINS COUNCIL

A global network of professionals building worldwide demand and developing markets for U.S. grains and ethanol.

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