Grain Test Weight Deception

Test weight is used as an indicator of general grain quality and is a measure of grain bulk density. Test weight, but not overall grain weight, normally increases during drying. Erroneous calculations using test weights can incorrectly infer that drying systems that increase test weight also increase the number of bushels that can be sold. This bulletin explains the use of test weight in the grain industry, how it can be used to determine grain value, and why some calculations involving test weight can be deceptive.

Background

When grain is traded, samples are usually tested for quality, and test weight is one of the tests carried out. Test weight is actually bulk density, measured under specific conditions. The USDA-approved manual test weight apparatus (Figure 1) consists of a hopper equipped with a slide gate supported above a one quart container called a kettle.

Figure 1.
USDA test weight apparatus

Grain for testing is placed in the hopper. When the gate is opened, grain drops into the kettle, fills it and flows over the sides. The operator strikes off the top of the kettle with a leveling stick and weighs it. Weight of grain in the kettle is measured in pounds and this value is multiplied by 32 (the number of quarts in a volume or Winchester bushel) to obtain the grain test weight in units of pounds per bushel.

For an official USDA test weight determination, the apparatus and procedure must meet USDA requirements. There is one instrument on the market that can perform an official USDA test weight determination automatically within the instrument, but usually test weight is determined manually. Some moisture meters measure test weight, but these units are not official; their use in trade is regulated by individual states. Iowa does not regulate test weight devices at elevators or processors, where official inspection rarely is used.

Grain test weight in units of pounds per bushel specifies the weight of a "volume" bushel, which is 32 quarts or 1.2445 ft^3 of grain. The "weight" bushel in units of pounds is used for the basis of payment for grain. By law, a "weight" bushel of corn is exactly 56 pounds, a soybean bushel is 60 pounds and a wheat bushel is 60 pounds, regardless of the test weight.

Test weight is a general indicator of grain quality and higher test weight normally means higher quality grain. Test weights decrease as grain deteriorates. Test weights have been a part of U.S. grain grades since the United States Grain Standards Act was passed by Congress in 1916. U.S. grades for most grains specify test weight minimums for each grade level. Test weight minimums for various USDA grades for corn, soybeans, and wheat are listed in Table 1. The principles discussed here also apply to grains other than corn.

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Table 1.
Test weight minimums for U.S. grain grades[a]

U.S. Grade	Corn (lb/bu)	Hard Red Spring Wheat (lb/bu)
U.S. No. 1	56	58
U.S. No. 2	54[b]	57
U.S. No. 3	52	55
U.S. No. 4	49	53
U.S. No. 5	46	50

[a] Test weight is no longer part of the U.S. grades for soybeans as of 2007, although it is routinely measured and included in discount schedules at local elevators.
[b] The levels for No. 2 corn normally are used as standards by country elevators.

Elevator purchase policies specify price penalties for grain with test weights below a specified minimum lb/bushel value. A common discount policy for corn test weight in Iowa is $0.01 per bushel for each lb/bu below 54 lb/bu to 52 lb/bu, $0.02 per bushel for each lb/bu below 52 lb/bu to 50 lb/bu, and $0.03 per bushel for each lb/bu below 50 lb/bu. For example, corn with a test weight of 51.4 lb/bu would incur a penalty of:

$$\left(\frac{\$0.01}{\text{bu per lb/bu}} \times \frac{2.0\text{ lb}}{\text{bu}}\right) + \left(\frac{\$0.02}{\text{bu per lb/bu}} \times \frac{.6\text{ lb}}{\text{bu}}\right)$$

$$= \$0.032/\text{bu}$$

Effects of Drying on Test Weights

Grain test weights normally increase during drying. For example, when corn is dried from 24 percent moisture to 15.5 percent moisture, the test weight likely increases between two and five pounds per bushel. There are many reasons for this increase. One reason is that dry matter in the corn kernel is denser than water, so bulk density of the kernel goes up as the portion of water in the kernels goes down. (The specific gravity of water is 1.0. The specific gravity of corn dry-matter, or corn at 0 percent moisture, is about 1.5.) Although the reason is not clear, research has shown that slow drying with natural air or with little addition of heat results in greater test weight increases than those occurring with fast, high temperature drying. Drying methods often are compared by the test weight increase that they cause and the claim of greater test weight increases is used during sales of dryers.

Deceptive Calculations

Differences in test weight increases among dryers do occur. Deception occurs when the claim is made that a test weight increase results in an increase in the weight of grain that can be sold. An example illustrates how this is done. This type of question is included in advertisements for some grain dryers:

Just think: What is the value of preserving five pounds of test weight on 20,000 bushels of corn over 20 years, if the average price of corn is $4.00/bushel? Answer: $142,857

Here is the calculation the reader makes in order to obtain the answer given:

$$\frac{5\ lb}{bu} \times \frac{20{,}000\ bu}{yr} \times 20\ yr \times \frac{bu}{56\ lb} \times \frac{\$4.00}{\text{bu}}$$

$$= \$142{,}857$$

This calculation assumes that if the corn dried in the advertised dryer has a test weight that is five pounds per bushel higher than that of other corn, the weight of every bushel of corn sold will increase by five pounds. This is not true. The increased test weight simply means the corn occupies less total volume because of greater bulk density. At sale, one bushel is 56 lb regardless of test weight.

The weight of corn for which the seller is paid is not affected by test weight. The price the seller receives for a given weight of corn, however, can be affected by test weight. The following example calculations

Table 2. Example calculations of corn value, with varying test weight.			
	Load #1	Load #2	Load #3
Weight (lbs)	20,000	20,000	20,000
Number of bushels to be sold[a] (= weight/56)	357.14	357.14	357.14
Moisture content[b]	14.5%	14.5%	14.5%
Test weight (lb/bu)	54.0	59.0	51.0
Volume (ft^3)	461	422	488
Price ($/bu)	4.00	4.00	4.00-.04=3.96[c]
Calculation of value	357.14 bu x $\frac{4.00}{bu}$	357.14 bu x $\frac{4.00}{bu}$	357.14 bu x $\frac{3.96}{bu}$
Value ($)	$1,428.57	$1,428.57	$1,414.27

[a] By law, 1 bushel = 56 lbs.
[b] Moisture discounts and drying charges usually apply when the moisture content exceeds 15%. There are no moisture discounts or drying charges in this example.
[c] Includes a test weight discount of $0.04 per bu calculated by the policy stated under Table 1.

provide further illustration. Assume three 20,000-lb loads of corn are delivered for sale (Table 2). The values of Loads 1 and 2 are the same even though the test weight of Load 2 is 5 lb/bu higher than that of Load 1. At sale, one bushel of corn is defined as 56 lb, regardless of its test weight. Load 2 will occupy about 9 percent less volume, so the truck box will not be as full as for Load 1. Corn test weight is not used in the computation of the value (that is, the price paid to the seller) of these two loads.

The test weight of corn in Load 3 is abnormally low, and the wagon or truck delivering the corn will be fuller than for Load 1 or Load 2 (the bulk corn in Load 3 is less dense). In the case of Load 3, the low corn test weight causes a price penalty of $0.04 per bushel. When this penalty is subtracted from the original load value calculated, the final load value decreases by approximately $14.

In instances when corn has an abnormally low test weight at harvest due to drought, disease, or other environmental influence, the drying process might raise test weight and thereby reduce test weight penalties. Also, occasionally corn buyers may pay a premium for corn with a high test weight. It is, therefore, possible for a drying process to cause corn value to increase. However, such increases are never due to increases in the weight of corn sold.

Summary

Grain test weight is an indicator of general grain quality and grain test weight normally increases as grain is dried. Increases in test weight during drying vary among dryers and drying methods. Increases in grain test weight during drying do not result in increases in weight of grain sold, and such claims are deceptive.

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