What is test weight?

Test weight is the measure of bulk density, or the weight of a specified volume of corn. It is just one of the quality tests run on corn that can have an effect on premiums or discounts received at sale. Corn in the United States is sold on a weight basis in a 56 pound block called a ‘bushel’. Historically, a bushel is a measure of volume, not weight, equivalent to 32 quarts or 1.2445 cubic feet. However, because the logistics of selling by weight make more sense than by volume, a standard was set that each 56 pound measure of corn would be considered a bushel.

So, how does test weight come into the picture? Test weight helps to quantify differences in grain density that may result from differences in environmental conditions or production practices. Since test weight is the measure of the weight of a specified volume, it takes into account the density of each kernel as well as the density with which they are packed together in the measurement vessel. Test weight is measured by filling a standardized one quart vessel with corn until spilling over. The tester then levels the corn and measures the weight. There are 32 quarts in one volume bushel, so the result is multiplied by 32 to convert from pounds per quart to pounds per bushel.

In 1916, the United States Grain Standards Act was passed by Congress specifying grades and grade requirements, including test weight minimums for each grade of corn. These are shown in Table 1. Price penalties vary for grain with test weights below the minimum lb/bu value. The minimum test weight for U.S. No. 1 grade corn is 56 pounds, thus the 56-pound bushel measurement.

<table>
<thead>
<tr>
<th>U.S. Grade</th>
<th>Minimum Test Weight (lb/bu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. No. 1</td>
<td>56.0</td>
</tr>
<tr>
<td>U.S. No. 2</td>
<td>54.0</td>
</tr>
<tr>
<td>U.S. No. 3</td>
<td>52.0</td>
</tr>
<tr>
<td>U.S. No. 4</td>
<td>49.0</td>
</tr>
<tr>
<td>U.S. No. 5</td>
<td>46.0</td>
</tr>
</tbody>
</table>


What factors influence the test weight of corn?

Corn test weights can range from 45 – 60 pounds per bushel. Various physical factors can influence test weight, but the primary one is moisture. Because kernel dry matter is more dense than water, proportionally as the amount of water decreases, the bulk density of the kernel increases. Therefore, there is an inverse relationship between test weight and moisture; test weight increases as moisture level decreases.

Test weight, however, is not only a function of density. When density reaches a certain point, other factors determine test weight: how well kernels fit together (size and shape), how slippery the seedcoats are, and other physical characteristics. In some cases, seeds that fill a little longer and get heavier can actually lose test weight due to shape changes. Drying from 28% to 20% moisture content generally results in an increase in test weight because seeds shrink and get denser. A change from 20% to 15%, however, can actually decrease test weight in some cases because kernels can lose moisture weight without a change in size or shape.

How much the test weight increases upon drying varies based on the corn product, grain condition, and drying temperature. Although the cause is not fully understood, studies have shown that slow drying with natural or low-heat air can result in greater increases of test weight than fast drying with high heat. Test weight can also be a good indicator of storability, as it generally decreases as grain deteriorates. Corn below 54 pounds per bushel after drying should not be stored into warm weather and should be dried to less than 15% moisture content for any type of storage.

Corn products will vary in test weight due to their unique endosperm makeup. This variability does not necessarily correspond to differences in genetic yield potential. Test weight for a given corn product may vary by location or season, but does not necessarily correspond to the yield level of an environment. Test weights of corn products that differ greatly in kernel moisture percentage should not be compared.
to one another, because the drier product has an unfair advantage in that comparison. In order to learn more about test weights in your fields or for help choosing corn products, consult with your Channel Seedsman.

What are the implications of high versus low test weight?

High test weight corn is more desirable in quality because it means the kernels are a higher percentage of hard endosperm; whereas lower test weight usually indicates that the crop did not mature entirely or was subjected to stresses. When it comes to the logistics of grain handling, it also makes sense as to why higher test weight corn is more desirable. Transportation and storage of low test weight grain is more expensive per pound, thus it is often discounted by buyers. Higher weight in a smaller volume is advantageous in handling and storage as well as during harvest because more weight bushels will fit in the truck, bin, or grain tank of the combine.

Occasionally, there is confusion regarding how drying your grain can increase its value. Sometimes claims are made implying that drying (resulting in test weight increase) can increase the weight of grain that can be sold. At sale, 56 pounds is 56 pounds, regardless of the test weight. Higher test weight corn just takes up less volume because it is denser and packs more tightly. Price paid is impacted when test weight is low enough to incur a price penalty per bushel (Table 2, Load 3). In some cases, a premium may be paid for a higher test weight. An increase in price is never due to an increase in the weight of corn sold.

What are the causes of low test weight?

As previously stated, there is an inverse relationship between grain moisture and test weight. Test weight increases naturally as kernel moisture content drops as long as the kernel remains intact. As moisture is shed (to a certain point), volume shrinks and drier grain is slicker which results in better packing. When corn comes out of the field at higher moisture contents, it makes sense that test weights may be less than ideal. This is the one cause of low test weight that can be remedied to a certain extent by drying.

Other factors contributing to lower test weights include any plant stresses that impact the movement of nutrients to the kernel during grain fill or degrade the integrity of the kernel once it is filled. Plant diseases, insects, soil fertility, and environmental conditions can all ultimately influence test weight. Stress that slows or halts grain fill can result in kernels with low density endosperm which results in low test weight. The types of stresses affecting test weight include:

- Drought stress, late-season folar diseases, and low fall temperatures can all cause a reduction of photosynthetic production. This can result in less than optimum starch deposition in kernels and may even prevent plants from completing grain fill.
- Early frost or freeze that results in leaf or whole plant death ends grain filling, essentially having the same effect.
- Ear rots that cause kernel damage can result in lightweight chaffy grain, as well as broken kernels, and excess foreign material (this low test weight grain has other overarching problems aside from just low test weight).

Research was done at the University of Minnesota to assess the effect on test weight of plant death at different stages of development prior to natural black layer formation. It was found that test weight will vary based on the stage corn had reached before grain fill was ended. Immature ears were taken at various stages from soft dough through full maturity and dried at 80 and 120 °F. The study showed that those kernels that had reached soft dough and early dent actually decreased test weight after drying, whereas there was an expected increase at all other stages. Increase in test weight will depend on stage of development, kernel moisture and grain quality, and drying temperature. The general result of this study found that if corn is well dented or beyond in maturity, some increase in test weight should occur with drying.