Making Sense of Corn Test Weight and Drydown Rates

Corn test weight is a term that is often misunderstood. Some confusion exists that high test weight corn contributes to yield potential and provides an economic benefit. Both of these perceptions are incorrect. Choosing the corn moisture content for harvest is often a economic decision.

Test weight is a measurement of bulk density or weight of a unit volume of grain (bu/lb). Iowa State University reports that corn test weight values can range from 45 lbs/bu to over 60 lbs/bu.[1] The United States Department of Agriculture established the standard test weight of a bushel of corn as 56 lbs/bu based on 15.5% moisture content. Table 1 lists different test weights of corn needed to equal one bushel of No. 2 shelled corn at 15.5% moisture when corn is harvested at various moisture levels.[2] For some specialty food corn, test weight is used as an indicator of grain characteristics which are favorable for processing.

Today in the United States, grain yield is still referenced in bushels per acre, but it is actually traded and sold on a weight basis. Test weight is still measured when grain is sold. Grain price can be affected by test weight in certain areas such as those that have premiums for high test weight or when selling in the whole food grade market. However, in most cases, only test weights that are below the minimum for No. 2 yellow corn (< 54 lbs/bu) would result in a discount.[3]

Table 1. Test weight (lbs) of corn needed to equal one bushel of No. 2 shelled corn (at 15.5% moisture) when corn is harvested at various moisture levels.

% Moisture in corn	Test weight (lbs) of corn needed to equal one bushel
14	55.02
15	56.67
15.5	56.00
16	56.33
17	57.01
18	57.71

Source: Lauer, J. 2002. Methods for calculating corn yield. University of Wisconsin. Field Crops 28.47-33. http://corn.agronomy.wisc.edu/

Is yield influenced by test weight? Any stress that prematurely stops or reduces grain fill and/or interferes with photosynthesis could lower yield potential as well as test weight. Grain yield is determined by the number of kernels per acre along with the weight per kernel, which is shown in the equation below:

Corn Yield (bu/acre) = # of kernels per acre x weight per kernel @15.5% moisture

56 lb/bu (standard weight of a bushel)

In comparison, test weight measures the weight of corn in pounds that will fit into a bushel. Yield is a direct measure of kernel weight and kernel number. However, test weight is not a direct factor of grain yield. Test weight is only partially related to kernel weight because there is also the volume component associated with the measurement. Factors that affect test weight, but not corn yield, are those that influence how kernels fit or pack together. These may include slipperiness of the seed coat as well as kernel shape or size. Due to the volume component, test weight will influence how many bushels can fit into a bin, wagon or truck, but not yield per acre.

Is there a correlation between yield and test weight? There has been some that think yield will always be lower if test weight is lower and vice versa. If this were true, corn products with high test weight grain would regularly out yield corn products with average test weight grain. Yield can be high and test weight can be low. For example, if the time for grain fill is shortened the seed size may be smaller but the density of the individual seeds remains unchanged.

Conversely, yield can be low and test weight can be high. Popcorn is a good example of this as it is more dense than field corn and has a relatively high standard test weight of 65 lbs/bu compared to field corn at 56 lbs/bu. Yet, average popcorn yields are half as much as field corn.[4,5,6]

In some instances, corn test weights may be lower than expected due to changes in kernel weight from stresses during kernel fill. Lower kernel weight can also result in lower yield and therefore, the test weight can be low as well. It is important to remember that changes in yield and test weight are not always proportional or correlated.

Corn yield is about the accumulation of dry matter in the kernel and the number of kernels produced per acre. Controlled by the limitations of the environment and corn product yield potential, the maximum amount of dry matter possible will be accumulated within that acre. If corn is grown in an environment that will support the production of 12,320 lbs of dry matter (220 bu) per acre and two different corn products yield similarly but one has higher test weight than the other, the higher test weight corn product has produced the same amount of dry matter but with less volume per unit of grain. However, the end result of equivalent yield has been reached.

Corn product selection impacting test weight: In addition to environmental stresses impacting test weight, corn product selection may also influence test weight results. This is a result of corn products with higher vitreous (hard or flinty) endosperm having higher test weights than ones with floury (soft or dent) endosperm. Hard kernels can have higher densities. However, this potential difference in endosperm content does not necessarily correlate to differences in genetic yield potential.

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Corn Drydown Rates

Choosing the corn moisture content for harvest is often an economic decision that weighs excess harvest losses against the energy costs for drying corn. Other factors, such as stalk strength or the presence of ear rots, should also be considered when determining the target harvest date. Harvesting early may be a good practice since field losses can increase when harvest is delayed, as well as when the crop dries down after maturity.

Corn Maturity and Drydown: When corn reaches physiological maturity or black layer, it is around 30% moisture. There are many factors that can affect how quickly corn dries down in the field after reaching maturity. Warm, dry weather can speed up the drying rate, whereas wet and cool weather can slow it down. Additionally, late-planted and full-season corn products tend to dry more slowly.

After reaching maturity, typical drying rates may range from 0.4% to 0.8% loss of moisture content per day. Rates of drydown vary depending on temperature and moisture levels and can be as low as 0.3% or greater than 1%. Typically, the rate of moisture content loss continues to decrease as temperatures cool and days get shorter. Corn maturing at the beginning of September is expected to dry down faster than corn maturing at the beginning of October.

After physiological maturity (black layer), moisture content of the kernel is influenced by the atmosphere surrounding the kernel and physical characteristics of the ear and husks that influence the atmosphere surrounding the kernel. The moisture difference between the kernel itself and the surrounding air leads to moisture movement out of the kernel until an equilibrium is reached. A year with wet weather and delays in planting may result in slower field drying of corn. Other factors may also come into play if harvest is delayed. For example, corn could have developed a shallow root system because of the early-season moisture. In addition, conditions may have been conducive for the development of stalk rots and stalk cannibalization in corn. These factors could lead to higher than normal harvest losses because of an increased risk for stalk lodging in corn this fall.

Germplasm Characteristics: Ear and husk characteristics of different corn germplasm can affect the rate of drydown. These characteristics have the largest effect when weather conditions are unfavorable for rapid grain drying:

- Number and Thickness of Husk Leaves - Fewer husk leaves and thinner leaves can lead to faster moisture loss.
- Dieback of Husk Leaves - Earlier dieback of husk leaves can lead to more rapid grain drying.
- Husk Coverage of the Ear - Husks that are open at the tip of the ear may provide for quicker grain moisture loss.
- Tightness of Husk Leaves - Looser fitting husks on the ear can lead to faster grain drying.

Table 2. Example calculations of corn value, with varying test weights.

	Load #1	Load #2	Load #3
Weight (lbs)	20,000	20,000	20,000
# of bu to be sold (= weight/56)[a]	357.14	357.14	357.14
Moisture content[b]	14.50%	14.50%	14.50%
Test weight (lb/bu)	54	59	51
Volume (ft^3)	461	422	488
Price ($/bu)	$3.25	$3.25	$3.25 - .04 = $3.21[c]
Calculation of value	357.14 bu X $3.25/bu	357.14 bu X $3.25/bu	357.14 bu X $3.21/bu
Value ($)	$1,160.71	$1,160.71	$1,146.42

[a] 56 lbs/bu is the standard weight of a bushel established by USDA.
[b] Moisture discounts and drying charges can occur when the moisture content exceeds 15%. This example has no moisture discount or drying charges.
[c] Includes a test weight discount of $0.04/bu due to a test weight below 54 lbs/bu.

Modified From: Bern, C. and Brumm, T. 2009. Grain test weight deception. Iowa State University Extension. PMR 1005. http://lib.dr.iastate.edu/

- Ear Angle - Ears that droop from an upright position after maturity tend to lose moisture more quickly. Upright ears can capture additional moisture from rainfall.
- Properties of Kernel Pericarp - Thinner pericarps (outer layer covering a corn kernel) have been associated with faster drying rates in the field.

Harvest Loss: The optimum harvest moisture content for corn is approximately 23% to 25%. At this moisture level, kernels shell easily and stalks generally stand better, which can make harvesting more efficient. A normal harvest loss level of a timely and efficient harvest is about 1 to 2%.

Delaying harvest until corn dries down to 17% to 19% moisture content can save on artificial drying cost. However, as corn dries down in the field there is greater potential for excess harvest losses from stalk lodging and ear drop. Most harvest losses are mechanical, caused by kernel shattering or corn never getting into the combine. Allowing corn to drydown in the field could result in excess harvest losses, as much as 2 to 8% above normal level with a timely and efficient harvest.

If stalk lodging or ear drop problems are observed, harvest timing will be more critical to maximize yield potential. Time should be taken to watch crop condition in the field in an effort to balance field drydown with harvest loss.

Sources:
[1] Hurburgh, C. and Elmore, R. 2008. Corn quality issues in 2008 – moisture and test weight. Iowa State University Extension. Integrated Crop News. http://www.extension.iastate.edu/ .
[2] Lauer, J. 2002. Methods for calculating corn yield. University of Wisconsin. Field Crops 28.47-33. http://corn.agronomy.wisc.edu/.
[3] Bern, C. and Brumm, T. 2009. Grain test weight deception. Iowa State University Extension. PMR 1005. http://lib.dr.iastate.edu/
[4] Carter, P.R., Hicks, J.D., Doll, E.E., Shuler, R., and Holmes, B. Popcorn. University of Wisconsin and University of Minnesota. Alternative Field Crops Manual. http://www.hort.purdue.edu/.
[5] Duffy, M. and Calvert, J. 2010. Enterprise budget: popcorn. Iowa State University Extension and The Leopold Center. BFC 16. https://www.leopold.iastate.edu/.
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