MARCH 2007

The Economic Impact of Errors in Moisture Measurements Part 2, Grain Moisture Meter Series

By G. Diane Lee

Grain is an essential source of the world's human and animal food supply. According to the Agricultural Statistics Board 2006 Crop Values Summary, the production value of major grains (corn, wheat and soybeans) in the United States is approximately $61 billion (U.S.D.) of the $13.3 trillion U.S. gross domestic product. Inaccurate grain moisture measurements can have a large economic impact on the grain market, which means that weights and measures inspectors have an important role in the inspection of commercial grain moisture meters to ensure these meters are accurate and comply with NIST Handbook 44 requirements. Although few in numbers compared to other commercial devices, grain moisture meters have a high monetary impact per device. This is the second article in a series of articles on grain moisture meters. This article will give examples of possible monetary losses due to inaccurate moisture meter measurements. For simplicity, this article will include examples based on corn.

The measurement of moisture in grain is critical because the amount of moisture in grain affects its storage and weight. A grain moisture meter measures the percent moisture of grain as percent wet basis. When an elevator purchases grain, it measures the moisture content to determine if it is higher than the limits for safe storage. If the moisture is higher than the set limits, the elevator must dry the grain before storage. Grains must be dried because there is an increase in microorganism growth in high moisture grain and high moisture grains will spoil. Higher moisture grains also attract more insects and can cause chemical and physical property changes in the grain. The grain elevator's (typically the buyer's) cost for drying the grain is typically a cost passed on to the farmer (typically the seller). Also, when grain is dried, moisture is lost and the weight of the grain is lowered. Grain is bought and sold based on weight. Therefore, the elevator must recover costs for drying the grain and for the reduction in weight. To recover these costs, the elevator will reduce the quantity using shrink factors, reduce the price the farmer receives using discounts, and assess drying charges or some combination of these approaches. Many of these changes and discounts are based on the moisture content of the grain. To evaluate possible monetary loss due to moisture, the various charges and discounts for grains must be considered.

- *Charges and Discounts*

There are a number of charges and discounts assessed by the buyer of grain that reduces the price per bushel. These charges and discounts include drying, shrinkage, test weight, damage, and foreign material. These charges and discounts may vary depending on the grain type and are set by the buyer. The buyer of grain will also set purchasing factors or set limits for grain, and grains not meeting these limits or factors may be rejected. Descriptions of the various charges and discounts noted above are listed below with examples.

- *Drying.* This is a charge to the seller for drying the grain and may be subject to change depending on fuel prices. In reviewing several posted drying charges, drying may be charged to the farmer for each percentage of moisture above a set moisture limit or the charge can be based on a moisture range and then discounted from a set price per bushel the farmer receives for the grain. Consider the example of a drying charge based on moisture for corn that is 4 cents for each 1 % moisture over a set moisture limit of 15 % and a stated price per bushel of $2.50. If the grain received is at 16 % moisture, the price per bushel of grain would be discounted by $0.040 per bushel of grain and the farmer would receive only $2.46 per bushel. Examples of a drying charge based on a moisture "range" for corn is 4.2 cents for a percent moisture of corn ranging from 15.1 to 15.5 (i.e., the price per bushel of grain would be discounted by $0.042 per bushel or $2.458 ~ $2.46 per bushel); 7.2 cents for percent moisture of corn ranging from 15.6 to 16.0 (i.e., the price per bushel of grain would be reduced by $0.072 per bushel or $2.428 ~ $2.43 per bushel).

- *Shrinkage.* This is a percentage of the price per bushel charged per increments of moisture lost during storage. Grain placed into storage with aeration may shrink. An example of a set charge for shrinkage for corn is 1.5 % of the price per bushel for every 0.5 % of moisture over 15 %. If the corn received is 16 % moisture and the price per bushel for corn is $2.50 per bushel, the price per bushel would be discounted by (0.015 x $2.50 x 2) or 0.075 cents per bushel. The resulting price is thus, $2.425 ~ $2.42 per bushel.

- *Test Weight.* A discount for test weight is a reduction in cost for each pound per bushel under a target pound per bushel. An example of a discount for test weight is 2 cents per pound per bushel under 54 pounds per bushel. If the starting price per bushel for corn is $2.50 and the corn received is 53 pounds per bushel, then the price per bushel would be discounted by $0.02. The resulting price per bushel paid would be $2.48.

- *Damage.* This is a charge assessed based on the percentage of damaged kernels above a set percentage. The charge for damaged kernels may be 1 cent per percentage of damage kernels above 5.0 % (e.g., if corn has 8 % damaged kernels, and the price per bushel for corn is $2.50, then the price per bushel is discounted by $0.03 or the price per bushel is $2.47).

- *Foreign material.* This is a charge assessed based on the amount of foreign material above a set percentage. An example of a charge for foreign material is 3 cents per percentage of foreign material above 3 percent (e.g., if corn has 7 % foreign material and the price per bushel of corn is $2.50, then the price per bushel is
discounted by $0.12 and the price per bushel paid is reduced to $2.38).

The Monetary Impact of Errors in Moisture Measurements

As noted earlier the production value of major grains (corn, wheat and soybeans) in the United States is significant at approximately $61 billion. The following examples are illustrations of corn, which alone has a production value of approximately $33 billion. To appreciate the magnitude of the impact of moisture measurement errors, consider the

following examples in which an elevator receives 10 truckloads of corn a day. (See table on page 4.) In 1996, an NCWM survey reported a total of 8937 commercial grain elevators in the United States which buy and sell grain. While the exact number of elevators has likely changed since that time, we can use it in our examples to help illustrate the potential impact of errors in moisture measurement. Calculations in these examples are made using the same methods for discounting described earlier in this article.

Examples of Possible Monetary Losses Due to Inaccurate Moisture Measurements for Corn

Example 1 – Drying **Grain:** Corn **Price per Bushel:** $3.20 **Actual % moisture of grain:** 15 % **Drying Charge:** 4 cents for each 1 % moisture over 15 % **Truck Load:** 547 bushels	**Percent moisture** (meter reading)	**Moisture error** (meter error)	**Price per bushel discounted by**	**Discounted price per bushel**	**Loss per truck load (547 bushels)**
	17 %	+ 2 %	$0.08 ($0.04 x 2)	$3.12 ($3.20 – $0.08)	$43.76 ($3.20 - $3.12) x 547 bushels
	Loss per elevator per day (10 trucks per day)	**Loss per elevator per year 260 days per year (5d week)**	**Loss for <u>all</u> elevators (8, 937) per day**	**Loss for all elevators (8, 937) per year**	
	$437.60	$113,776.00 (260 x $437.60)	$3,910,831.20	$1,016,816,112.00	
Example 2 – Shrinkage **Grain:** Corn **Price per Bushel:** $3.20 **Actual % moisture of grain:** 15 % **Shrinkage Charge:** 1.5 % of the price per bushel for every 0.5 % of moisture over 15 %	**Percent Moisture** (meter reading)	**Moisture error** (meter error)	**Price per bushel discounted by**	**Discounted price per bushel**	**Loss per truck load (547 bushels)**
	17 %	+ 2 %	$0.19 (0.015 x 3.20) x 4	$3.01 ($3.20 - $0.19)	$103.93 ($3.20 - $3.01) x 547 bushels
	Loss per elevator per day (10 trucks per day)	**Loss per elevator per year 260 days per year (5d week)**	**Loss for <u>all</u> elevators (8, 937) per day**	**Loss for all elevators (8, 937) per year**	
	$1039.30	$270,218.00 (260 x $1039.30)	$9,288,224.10	$2,414,938,266.00	

When examining the possible monetary losses per day and per year of just one grain type and the various charges associated with the buying and selling of grain, it is clear to see the economic impact of moisture measurement errors in the grain industry. It is also clear that weights and measures inspection and evaluation of these meters are extremely

important to ensure moisture measurement accuracy and compliance with NIST Handbook 44.

The next article, Part 3 of the grain moisture meter series, will address near infrared grain moisture meter measurement technology.

If there are any questions, you may contact Diane Lee of the NIST WMD by e-mail at diane.lee@nist.gov, by fax at 301-975-8091 or by phone at 301-975-4405.