Update on USDA’s Transition to New Official Moisture Technology

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United States Department of Agriculture
Grain Inspection, Packers and Stockyards Administration
Federal Grain Inspection Service
Mission of Federal Grain Inspection Service (FGIS)

• The mission of the Federal Grain Inspection Service is twofold:
  – Promote the marketing of high-quality grain to domestic and international buyers
  – Maintain objective standards for grain to certify its quality as accurately as possible

• In administering and enforcing the U.S. Grain Standards Act, FGIS establishes methods and procedures and approves equipment for the official inspection and weighing of grain.
GIPSA’s Technology and Science Division

• GIPSA's reference methods and laboratories are integral components of the official inspection system

• The data from these labs are used to calibrate field instruments and/or methods to internationally recognized reference methods, which encourages worldwide confidence in our official inspection results

• GIPSA maintains reference methods for moisture, protein, oil, starch, mycotoxins, and fatty acid composition.
History of Official Moisture Meters

• 1960 - Motomco Model 919 Moisture Meter approved for use
• 1998 - GAC 2100 manufactured by Dickey-john Corporation replaced the Motomco meter
• On April 11, 2012, GIPSA announced its approval of two UGMA-Compatible moisture meters, the DICKEY-john GAC 2500UGMA, and the Perten AM 5200-A.
New Generation Official Moisture Meter

• Dr. David B. Funk led a 10-year research and development initiative to develop a new generation of instruments to measure moisture in grain. The result was the Unified Grain Moisture Algorithm (UGMA).

• GIPSA made Dr. Funk's work freely available as a public algorithm to facilitate adoption by multiple manufacturers.
What is GIPSA’s Unified Grain Moisture Algorithm (UGMA)?

- Very accurate dielectric-type moisture method
- Higher measurement frequency (about 150 MHz)
- Based on a defined physical parameter—Dielectric Constant
- Excellent density correction
- Three “unifying parameters” per grain group
- A single calibration “curve” for all grain types
- Precise, wide-range temperature correction
- Calibrated to GIPSA’s standard Air Oven method
- “Open”—Available to any manufacturer
UGMA Master System

Agilent E4991A Impedance Analyzer

Master Test
Why change to UGMA?
Improved Accuracy for All Grain Types

2011 Corn Crop

GAC 2100

UGMA
Improved Accuracy of UGMA

The diagram shows variability (SDD % Moisture) for different crops compared to GAC 2100 vs. Air Oven and UGMA Master vs. Air Oven. The crops include Corn, Soybeans, Sorghum, Sunflower, Rice, Long Rough, and Rice, Medium Rough.
Improved Accuracy of UGMA
Improved Year-to-Year Calibration Stability
Soft Red Winter Wheat

GAC 2100

UGMA

1 yr
3 yr
Long Grain Rough Rice

GAC 2100

UGMA


Graph showing the performance of GAC 2100 and UGMA over the years 1998 to 2006.
Drastically Improved Accuracy on High and Low Test Weight Corn
GAC 2100 Corn Results—Density Issue
Accuracy for 2007-2009 Crops

A. Plot of GAC2100 Accuracy vs. USDA Air Oven Moisture,
Corn Temperature Data Only

For range: 10-36% M
Samples: 686
Std. Dev. of Diff: 0.70% M

Low TW samples yielded low moisture results.
The drastic change in test weight with moisture for normal corn presents special challenges for density correction of corn moisture measurements.
Secondary Density Correction
Corn Results for UGMA

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Wider Sample Temperature Ranges

GAC 2100

- 32 °F
- 0 °F
- 103 °F

UGMA

- 0 °F
- 113 °F
“Green” Grain Effects Reduced

Long Grain Rough Rice Rebound

Moisture Error due to Rapid Drying (%)

Moisture Content of the Dried Sample, M%
“Green” Grain Effects Reduced

LGRR Mixture Effects

Error due to Mixture of Wet and Dry Rice (%) vs. Moisture Content of the Wet Component, M%
“Green” Grain Effects Reduced

Effects of Mixtures of Wet and Dry Soybeans

Moisture Error due to Mixture (%)

Moisture of Wet Component of Mixture (%)
GIPSA-Certified UGMA-Compatible Moisture Meters

Dickey-john GAC 2500UGMA

Perten AM 5200-A
GIPSA’s Basic Definition of Equivalency

• Same technology
• Very close agreement among types as well as units of a type
• Same calibrations and standardization processes
UGMA-Compatibility Criteria (1)

- NTEP Certification
- Documented & stable production processes
- Measurement frequency
- Standardized test cell design
- Standardized loading method
- Standardized measurements
  - Sample dielectric constant
  - Sample mass
  - Sample temperature
UGMA-Compatibility Criteria (2)

• Tight tolerances specified for individual subsystems as well as moisture results
• Must use specified mathematics
• Units’ agreement with FGIS Master system must meet tolerances in FGIS Regulations
  – +/- 0.05% M for Headquarters Standard units
  – +/- 0.15% M for other Official units
  – Mean difference on medium-moisture HRWW
UGMA-Compatibility Criteria (3)

- All UGMA-Compatible models must be able to use the same check testing process.
- A simple check testing process must ensure performance on all grains over full moisture ranges.
- Instruments must provide for efficient means of entering calibrations.
- Instruments must provide standardized output data stream for printing or networking.
Excellent Agreement Between UGMA Models

![Bar chart showing variability (SDD % Moisture) for different crops: Corn, Soybeans, Sorghum, Sunflower, Rice, Long Rough, and Rice, Medium Rough. The chart compares GAC2500 vs. AM5200 and UGMA Unit to Unit.](image)
Excellent Agreement Between UGMA Models

Check Testing Tolerance for Official Moisture Meters

Variability (SDD % Moisture)

Wheat, Hard, Red, Winter
Wheat, Hard, Red, Spring
Wheat, Hard, White, Winter
Wheat, Soft Red, Winter
Wheat, Soft, White
Durum
Barley
Oats

GAC2500 vs AM5200

UGMA Unit to Unit
Far Better Agreement Than Between Different Technologies
Far Better Agreement Than Between Different Technologies
Anticipated Moisture Changes with Transition to UGMA

• GAC 2100 and new UGMA –based meters are all calibrated to agree with GIPSA’s air oven method as closely as possible.

• Do not expect significant average differences between GAC 2100 and new UGMA-based meters—except:

• Low test weight corn moisture values will generally increase:
  – GAC 2100 reads lower than UGMA by 0.2% per pound per bushel below 57 lb/bu

• High test weight corn moisture values will generally decrease:
  – GAC 2100 reads higher than UGMA by 0.2% per pound per bushel above 57 lb/bu