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Creating Opportunities for American Farmers and Businesses

Federal Grain Inspection Service
Technology and Science Division Overview and Updates

Timothy Norden, Acting Director

Technology and Science Division

Grain Inspection Advisory Committee Meeting

September 5, 2018

Technology and Science Division Overview

- FGIS – Technology and Science Division (TSD) is responsible for developing, improving, and supporting all official grain inspection methods
- **Organization**: Four branches plus administrative support
    - Analytical Chemistry Branch
    - Biotechnology and Analytical Services Branch
    - Inspection Instrumentation Branch
    - Board of Appeals and Review Branch
    - Office of the Director
        - Administrative Support Team
        - Digital Media Team
- **Current employees**: 60 with 15 vacancies = 75 total

Analytical Chemistry Branch (ACB)

- Develops and evaluates new or improved chemical and physicochemical methods for food safety and end-use quality factors
- Provides centralized official inspection and quality assurance services
- **Key programs**:
    - mycotoxins, pesticide residue, falling number and wheat varietal identification

Biotechnology and Analytical Services (BASB)

- Develops and provides cutting-edge technology for determining genetic, nutritional, and intrinsic quality factors in grain and grain products
- Provides research, harmonization, and centralized testing services
- **Key programs**:
  - biotechnology and commodities testing; moisture, protein, and oil reference methods

Inspection Instrumentation Branch (IIB)

- Develops and maintains calibrations and procedures for approved inspection instruments
- Administers instrument evaluation and quality control programs
- **Key programs**:
  - Moisture meter, near infrared (NIRT) protein, oil and starch; and nuclear magnetic resonance (NMR) oil

Board of Appeals and Review (BAR)

- Directs and oversees the integrity and alignment of all visual inspections throughout the nation
- Provides procedures and centralized quality assurance services for inspection equipment
- **Key programs**:
  - Subjective Testing and Evaluation Process (STEP), training and licensing, Board Appeals, and equipment check testing

TSD Branch Updates

- Brian Adam
  - Chairman, Board of Appeals and Review
- Cathleen Brenner
  - Chief, Inspection Instrumentation Branch
- Tom Weber
  - Chief, Analytical Chemistry Branch
- Tandace Bell
  - Chief, Biotechnology and Analytical Services Branch

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Determining HVAC in Durum Wheat

Brian Adam, Chief
Board of Appeals and Review Branch

Grain Inspection Advisory Committee Meeting
September 5, 2018

Hard and Vitreous Kernels of Amber Color (HVAC)

- **HVAC (100% Hard and Vitreous of Amber Color)** - Vitreous is the characteristic which gives the wheat kernels a hard, glossy appearance
- **NON-HVAC –** Soft durum kernels that lack the hard vitreous characteristic, or semi-hard kernels that contain soft chalky spots
- **How HVAC is Determined -** Visual inspection on a 15 gram portion cut out from the representative sample

SUBCLASS

Durum wheat is divided into three sub-classes based on the percentage of HVAC in the representative lot.

Hard Amber Durum Wheat *Durum wheat with 75 percent or more of hard and vitreous kernels of amber color*

Amber Durum Wheat *Durum wheat with 60 percent or more, but less than 75 percent of hard and vitreous kernels of amber color*

Durum Wheat *Durum wheat with less than 60 percent of hard and vitreous kernels of amber color*

Even though durum is certified by subclass, contracts may dictate specific limits to be met or penalties may be assessed.

- Durum has many uses, the most common being pasta which is made from durum
- Semolina is durum wheat ground into a coarse granular product
- Semolina content determines the end use. The amount of flour in the blend affects the color of the product

Vitreous and Non-Vitreous Kernels

HVAC

Non-HVAC or Soft

Non-HVAC Kernels with Soft Spots

Readily Identifiable HVAC Samples


Hard Amber Durum


Easy to detect soft kernels

Challenges with HVAC Inspection

- Time constraints lead to inconsistency between online inspectors, and industry keeps pushing to load faster

- If adequate time is not given to online inspection personnel to analyze this highly subjective factor, accuracy may be compromised

- Growing conditions can mask the appearance of the true kernel characteristics making HVAC determinations very difficult

Difficult HVAC sample

- Weather-affected kernels
- Require more time and possibly cross-sectioning of kernels
- Samples of this appearance are more subjective and can result in more inconsistencies

Board of Appeals and Review and Field Office Monitoring Programs

- Monitoring programs are in place for inspectors and Quality Assurance Specialists (QAS)
- Referee samples used to assess inspector and QAS ability
- Conduct annual grain grading seminars for QASs
- Provide on-site training for inspectors and elevator personnel
- Conduct research on alternative methods for HVAC determination

QAS Alignment to the BAR
FY18 to Date

- Durum HVAC 96%
- HRS DHV 93%

Subjective Testing Evaluation Process (STEP) is a monitoring program used to align QASs to the BAR

Natural vs Conditioned

Natural

Bleached
w/ Potassium Hydroxide (KOH)

Potential Benefits of Bleaching

- Produces a bright vibrant kernel
- Makes difficult weather-affected kernels easier to separate
- Potentially minimizes inspector variation and increases accuracy and consistency
- Collaborating with the Inspection Instrumentation Branch (IIB) to explore using the bleach method with imaging technology

Questions?

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Inspection Instrumentation Branch Updates

Cathy Brenner, Chief
Inspection Instrumentation Branch

Grain Inspection Advisory Committee Meeting
September 5, 2018

LED Study

May 2016 Resolution –

The Advisory Committee commends FGIS for its work with updating inspection laboratory lighting standards; and recommends **continued work on lighting advancements and testing for grain inspection**. The committee would also like to encourage FGIS to **review how other governmental or industry groups** involved in human-sorting-of objects **are utilizing** new technologies in **LED lighting** for inspection purposes.

FGIS Specifications

Fluorescent Emitter Specifications

Lamp Radiation	Specifications
2000 to 2499 Lumens	Color Rendering Index > 92
	Color Temperature 7500 °K
	Rated Average Life > 15,000 Hours
Or	
>= 2500 Lumens	Color Rendering Index > 87
	Color Temperature 7500 °K
	Rated Average Life >12,000 Hours

Lighting Research

https://www.nist.gov/image/composite-color-preferencepng

Illuminating Engineering Society Task Group
National Institute of Standards and Technology
Office of Energy Efficiency & Renewable Energy, Department of Energy

Study Design

- 30 Training Boxes

Soybean Mold Damage Training Box

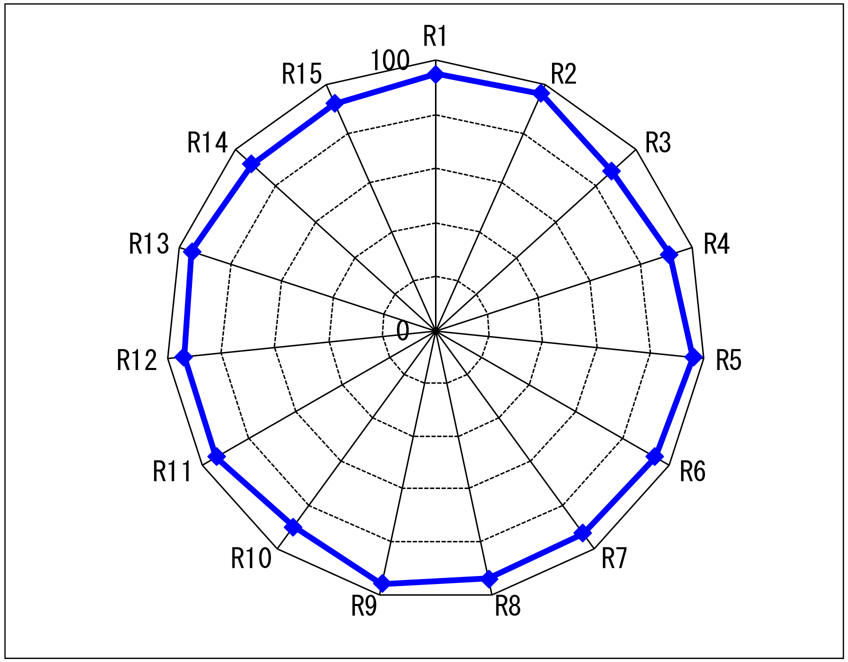
- 4 Test Lights
- 3 pairs of BAR Inspectors
- Number of kernels that changed determination

Results – Difference between Test Light and approved Fluorescent Light

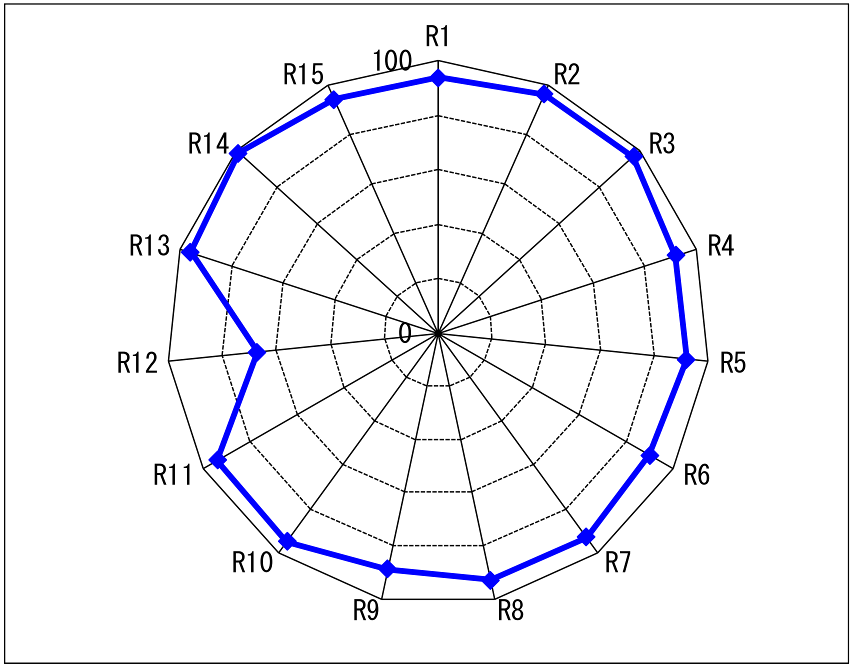
	Test Light A		Test Light B		Test Light C		Office Light	
Inspector	1	2	5	6	3	4	1	2
Chi-square	0.10	1.66	6.80	7.62	15.89	16.23	19.97	10.00
p-value	0.75	0.20	0.01	0.01	< 0.001	< 0.001	< 0.001	0.002

Chi-Square < 3.84 and p-value > 0.05 results are not significantly different at the 95% confidence level.

Light Color Composition



Approved Fluorescent, CRI = 93



Light A, CRI = 93

Conclusions

- LED can be used for official inspection
    - Task Light only commercially available light that is not significantly different.

- Variations observed in the R9 (red) and R12 (blue) for all LEDs tested warrant further investigation for developing LED specifications.

Next Steps

- Review Training Boxes with final selection
- Test Lights for new study
    - Review commercially available
    - Canadian Grain Commission approved LED
- Establish study timeline with BAR

- Completed by December 2018

NIR Equivalency Field Study

Previous Studies

- 2015 Cooperative Agreement with Iowa State University (ISU)
  - 3 National Type Evaluation Program (NTEP) Approved models and calibrations
  - Not equivalent
  - FGIS field benchmark was almost twice the lab reproducibility for wheat protein on the approved instrument

- 2016 Cooperative Agreement with ISU
  - Common sample set for wheat protein
  - Updated calibrations improved reproducibility

October 2016 Resolution –

The Advisory Committee recommends that new equipment must be equal to or better than the old equipment in precision and repeatability in order to be approved as official. **Performance of equivalent** instruments should **match or exceed** that of the **existing approved instrument in the same field environment**. The Advisory Committee recommends GIPSA continue work with NIR Equivalence by continuing focus on improving performance in test instrument field studies. GIPSA should also consider including **all NTEP approved instruments in** the **field studies to determine equivalency**.

Study Design

- 4 NTEP Approved Models
  - Barley, Corn, Soybeans, and Wheat
- 3 - 5 Specified Service Points per grain type
- Minimum 50 samples per location per grain type plus Standard Reference Samples

Status

- FOSS Infratec Nova approved as equivalent September 2017
- One participating manufacturer developed process to match raw instrument data to FOSS Infratec 1241.
  - Not achievable in a field setting
- Report in review process

Next Step

- Final report to be completed by December 2018

FGIS Approval Process

For Equipment, Instruments, and Test Kits

U.S. Grain Standards Act

§ 79b – Testing of equipment

- Periodic testing of all equipment used in inspection
- Ensure accuracy and integrity of equipment
- Prohibits use of non-approved equipment for grain inspecting

Regulations under USGSA

§800.215 (c) (4) – "…proposed equipment is tested to determine whether the equipment will improve the performance of activities under the Act."

§800.217 (d) – Testing may occur when:

(1) At request of interested party with concurrence of Administrator

(2) Upon determination of need by the Service

FGIS Current Process

- Evaluate benefit to grain inspection
- Develop performance specifications and criteria (as needed)
- Assign resources and evaluate

Questions?

Moisture Meter Performance

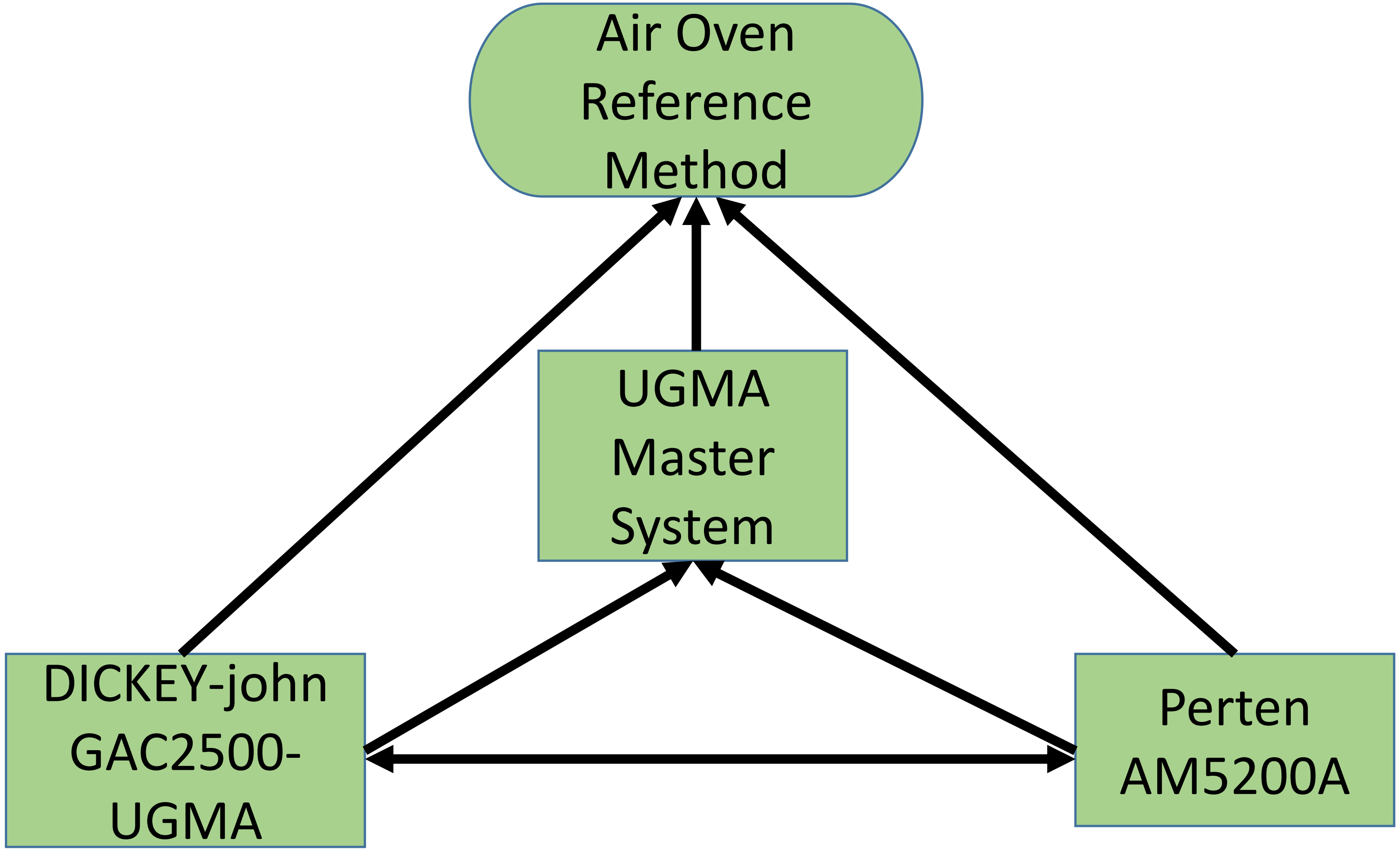
Request for information to assure industry that official moisture results are consistent and accurate.

Moisture Meter Models

- Do not directly measure moisture
    - Dielectric characteristics closely related to moisture content

- Requires calibration
    - Based on historical data

Annual Moisture Calibration Process

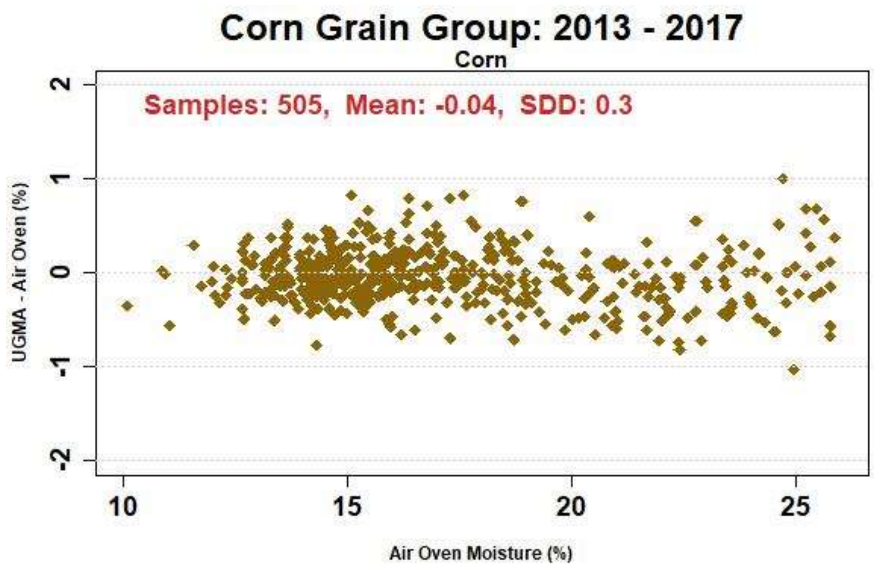


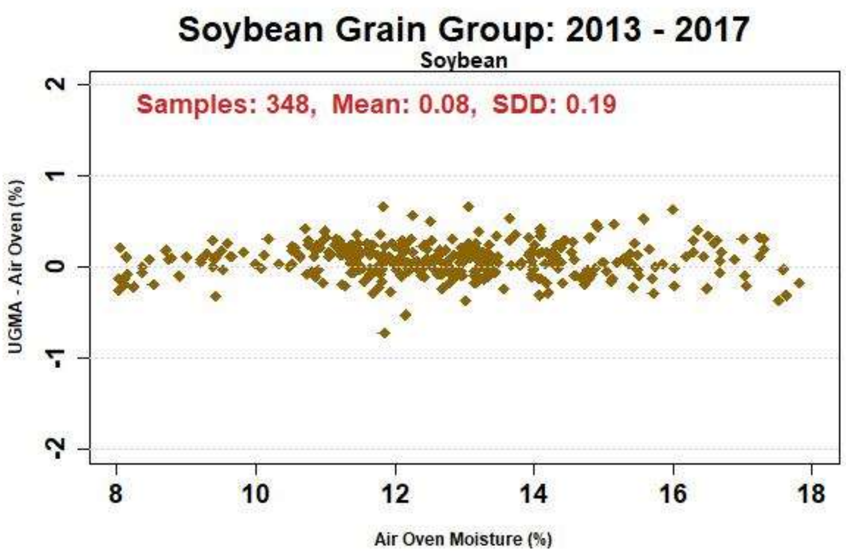
Calibration Implementation Dates

- May 1 for Spring/Summer crops
- August 1 for Fall crops

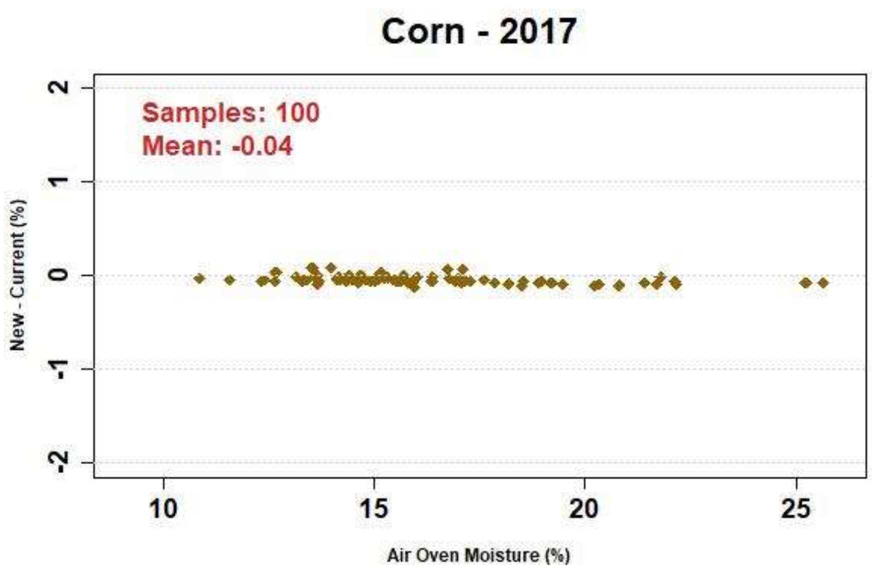
- https://www.gipsa.usda.gov/fgis/moisture.aspx
  - 5 year performance
  - Explanatory Notes of impact for any updates
  - Calibration bundles

Performance Data





Impact of Change (Explanatory Notes)



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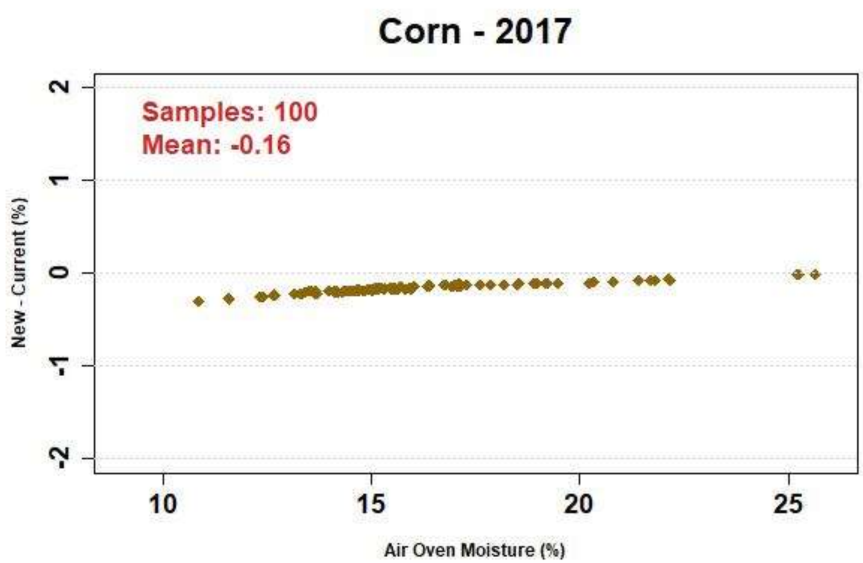
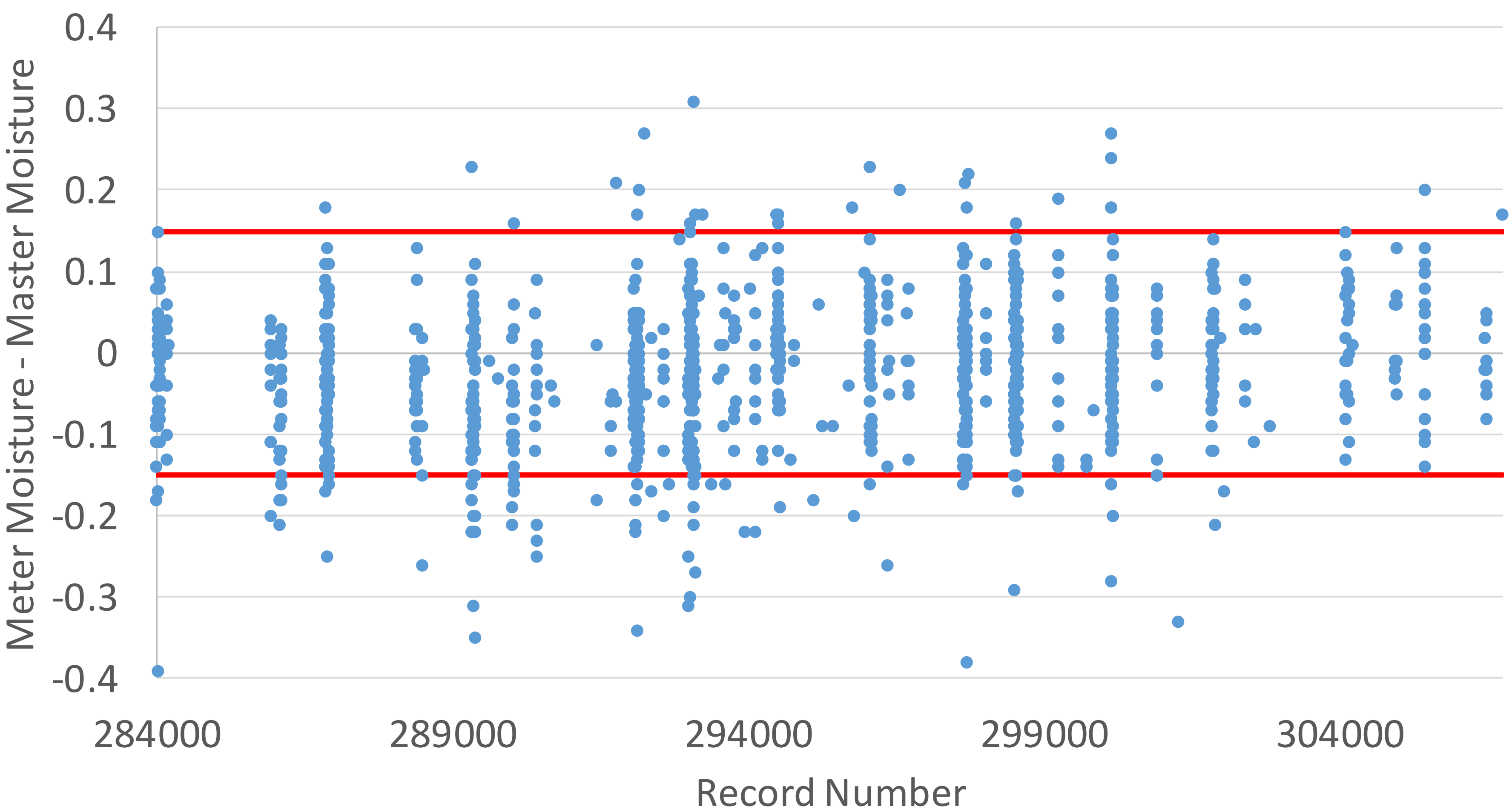


Quality Control – Checktest

- Twice a year
- Scale Tolerances
  - Accuracy = ± 0.5 grams
  - Range = 1.0 grams
- Moisture Tolerances
  - Accuracy = ± 0.15 % moisture
  - Range = 0.26 % moisture

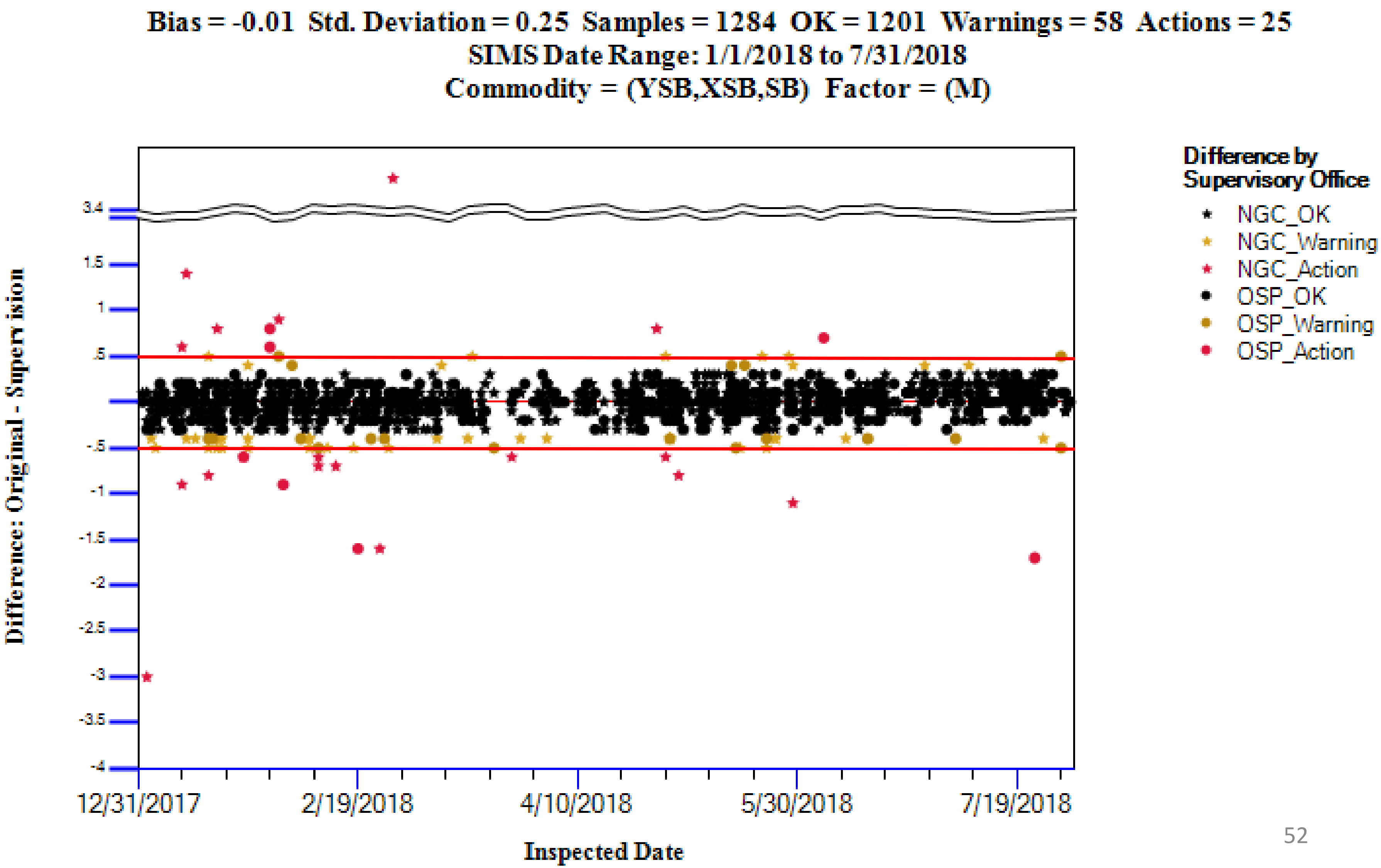
Moisture Checktest - Average Moisture
January - July 2018



Quality Control – Sample Inspection & Monitoring System (SIMS)

- Tolerances by grain and/or moisture
- Selected from file samples
- Domestic Inspection Operations Office
- Quality Assurance & Compliance Division

Soybean SIMS Difference Graph



July 2014 Resolution –

The Advisory Committee recommends the GIPSA **review and update all quality assurance tolerances utilized in the official system**. Specifically, the Advisory Committee recommends that the **first to be** reviewed reflect the Unified Grain Moisture Algorithm (UGMA) technology for **moisture** measurement.

April 2015 Resolution –

The Advisory Committee commends FGIS for its work in implementing and testing of UGMA moisture meters; and recommends that for the Sample Information Monitoring System (**SIMS**) that **FGIS provide on their website** a listing **by grains for** the approved UGMA **moisture** meters the following information: the moisture **standard deviation, ± warning limit, ± action limit, and the moisture range** for which these limits are applicable.

Commercial Rice Mill Study

October 2015 Resolution –

The Advisory Committee encourages FGIS to initiate a **study with rough rice to determine the effectiveness of the Grainman Miller No. 65 for predicting commercial rice milling yield**. Factors to consider in addition to **milling yield** are total broken kernels, whiteness and chalkiness. Newer rice hybrids along with their harvest and drying history should be included in the study.

Objective

- To evaluate the consistency of milling yield results between the official FGIS laboratory mill and commercial milling operations.

Cooperative Agreement

- University of California, Davis
  - California Agri Inspection Co., Ltd
  - 2 Participating Mills in Arkansas
  - 1 Participating Mill in California
  - 1 Participating Mill in Louisiana

- Completed first year of planned 2 year study

Commercial mill sample collection

Mill	Location	Rice Types (Variety Type)		
M1	California	**Long** (Pure)	**Medium** (Pure & Mixed)	**Short** (Pure & Mixed)
M2	Arkansas	**Long** (Pure & Hybrid)	**Medium** (Pure & Mixed)	
M3	Louisiana	**Long** (Pure & Mixed)	**Medium** (Pure & Mixed)	
M4	Arkansas	**Long** (Hybrid & Mixed)		

FGIS Milling Procedures

Type of rice	Milling cycle	Duration	Brushing cycle	Duration
Long-grain	2 pounds	30 sec	0 pounds	30 sec
Medium-grain	7 pounds	30 sec	0 pounds	30 sec
Short-grain	10 pounds for Western production 12 pounds for Southern production	30 sec	2 pounds for Western production 0 pounds for Southern production	30 sec

Milling Yield

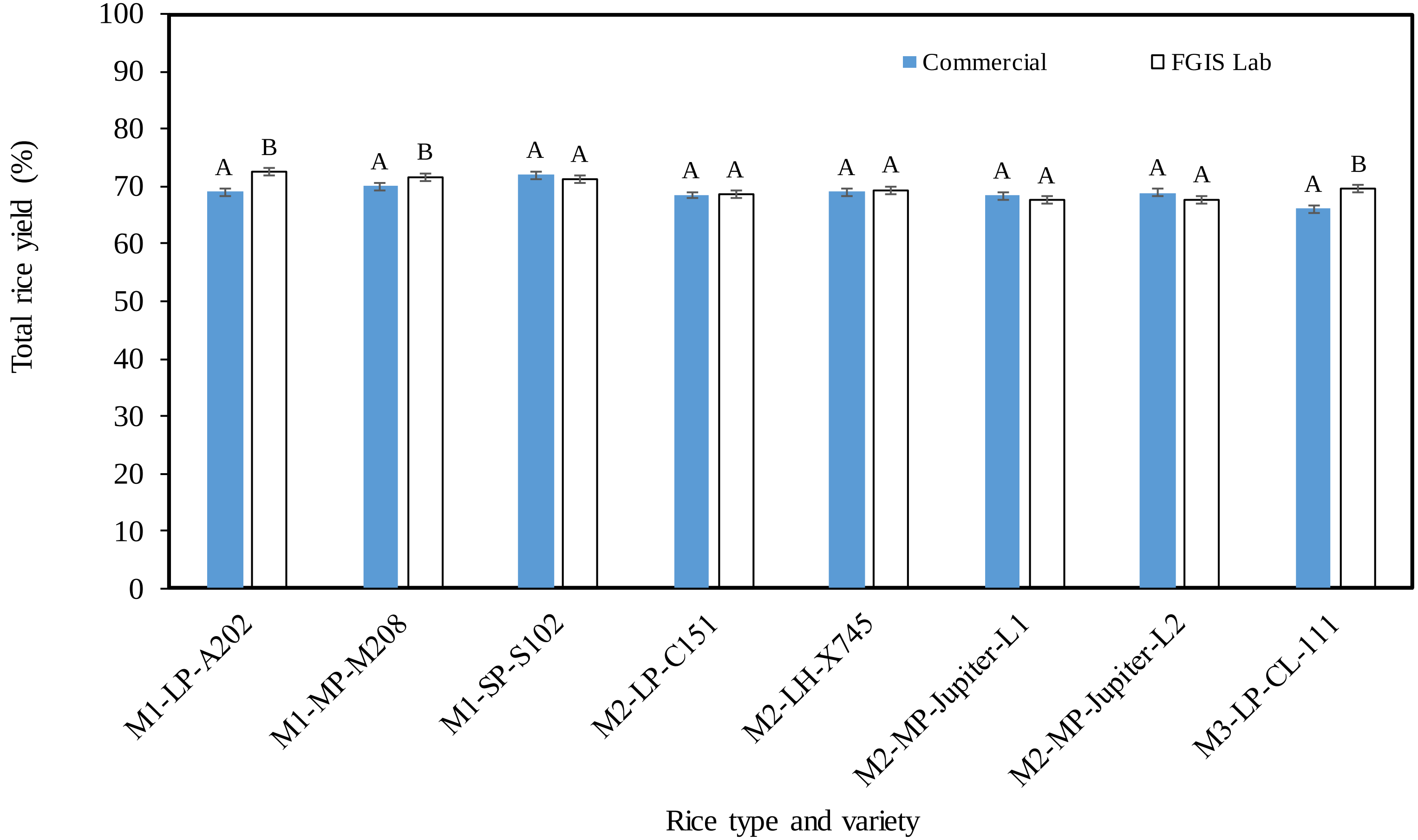
Total rice yield (TRY) or Total Rice (TR) and head rice yield (HRY) or percent whole kernels (WK)

Results from First Year

Category	No Significant Difference	FGIS Less Than Commercial	FGIS Greater Than Commercial
TRY	29%	29%	42%
HRY	35%	16%	49%

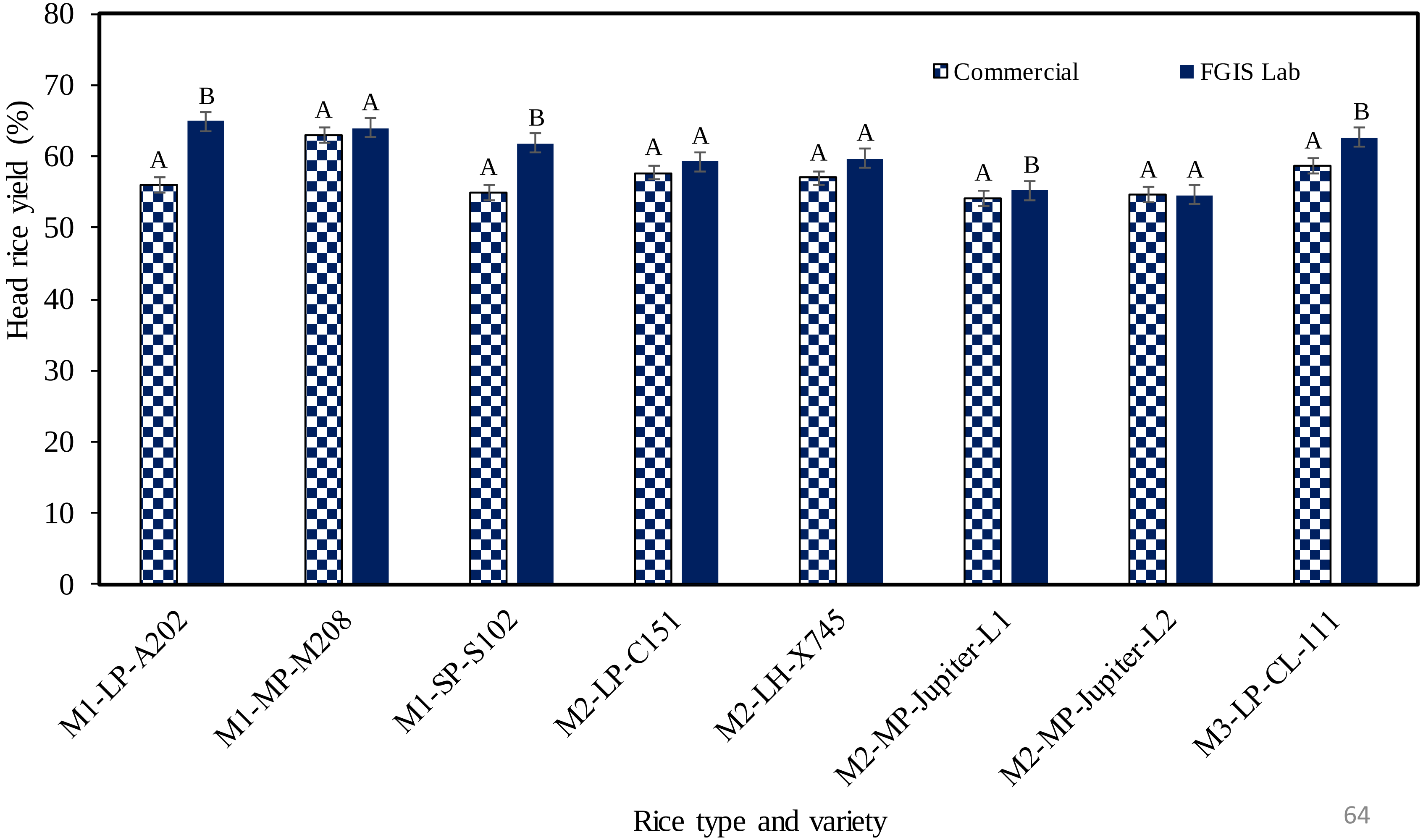
Results

Milling yield – Total rice yield (TRY)- Fourth quarter



Results

Milling yield – Head rice yield (HRY)- Fourth quarter



Conclusion

- The first year data shows no consistent trend in the difference in the milling yield between the FGIS lab and commercial mills.

Next Steps

- Final (second) year sample collection in process
  - Determine if the findings from first year are seen in the second year
  - Make conclusive statements with high confidence about the agreement between FGIS and commercial mills

- Final Report due April 2019

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Questions?

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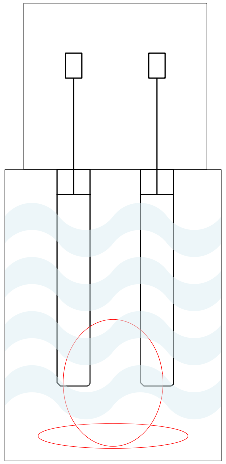
Falling Number and Mycotoxin Testing

Tom Weber, Chief
Analytical Chemistry Branch

Grain Inspection Advisory Committee Meeting
September 5, 2018

Falling Number (FN) Method

- Indirect measurement of alpha-amylase activity
- Alpha-amylase breaks down starch
- High activity adversely effects end-use quality
- Important factor in domestic and international trade of wheat
- Internationally standardized and most widely accepted method
- FN is the time required to mix and drop rod through heated wheat meal / water slurry
- FN inversely proportional to alpha-amylase activity



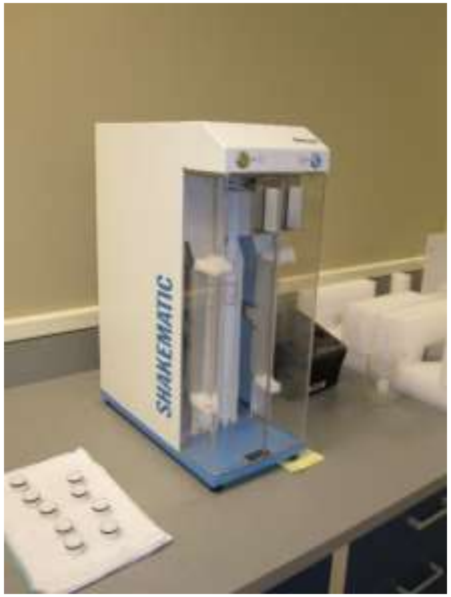
Pacific Northwest 2016

- Low falling number values
  - 44% soft white, 42% club wheat samples < 300 sec*
  - High frequency of discounts applied
  - Complaints that FN test too variable
- October 2016 Advisory Committee Resolution
  - FGIS should continue its efforts to reduce FN testing variation and increase oversight and training of official service providers

*M. Weaver. Capital Press. 8/2/2018

Two Opportunities to Reduce Variation

1. Implement new correction based on barometric pressure
2. Require use of Shakematic

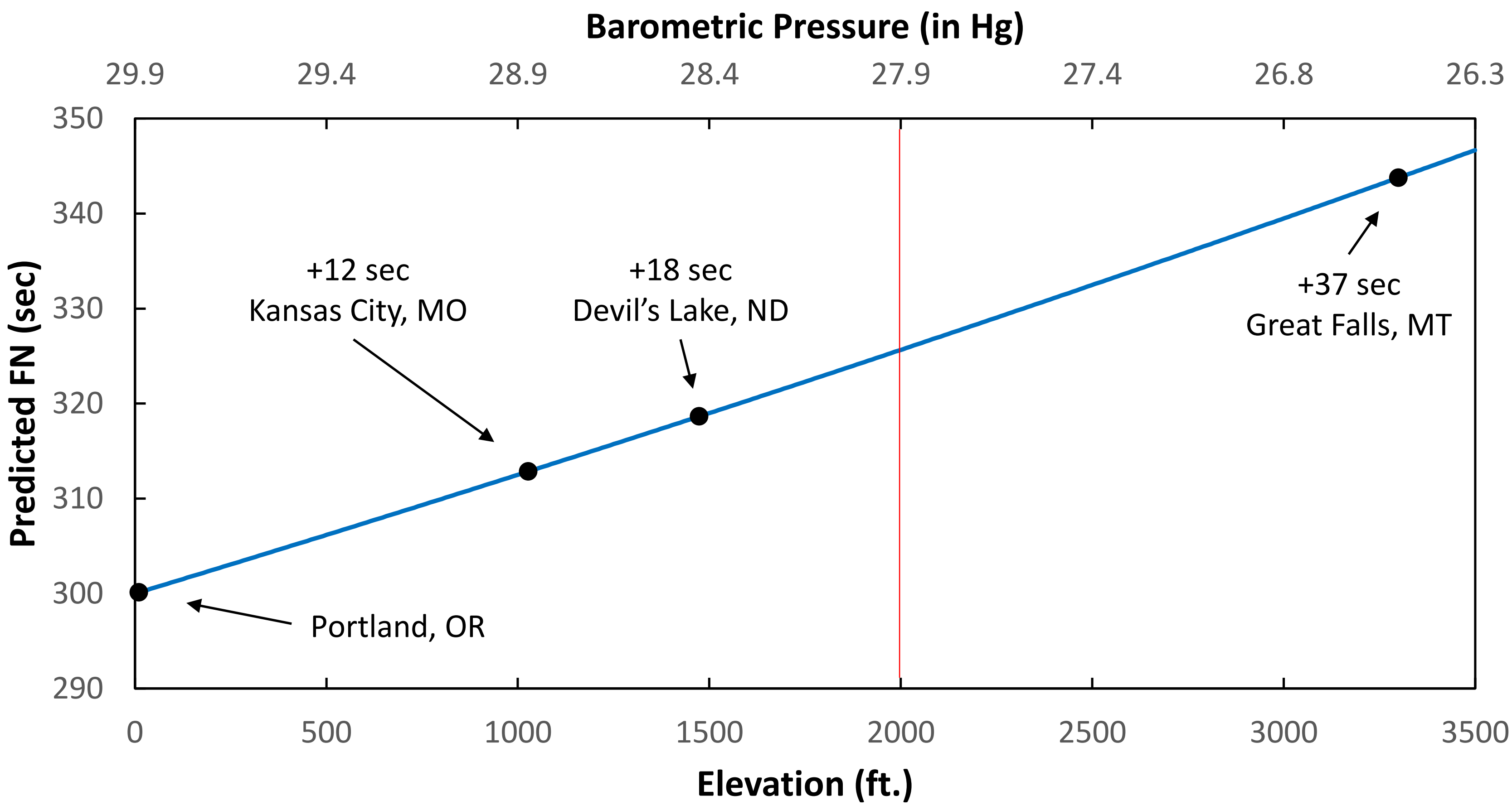


Correcting FN to Sea Level

- Increase elevation leads to increase in FN
- Current FGIS procedure
  - Correct to sea level at locations 2000 ft. and above
  - Cereal Chem. **1994**,71(3), 269–271
  - Correction needed below 2000 ft. to remove bias
- New FGIS procedure
  - FGIS engaged USDA Agricultural Research Service
  - Correct to sea level using barometric pressure
  - Cereal Chem. **2018**, 00, 1–8

Effect of Elevation on Falling Number

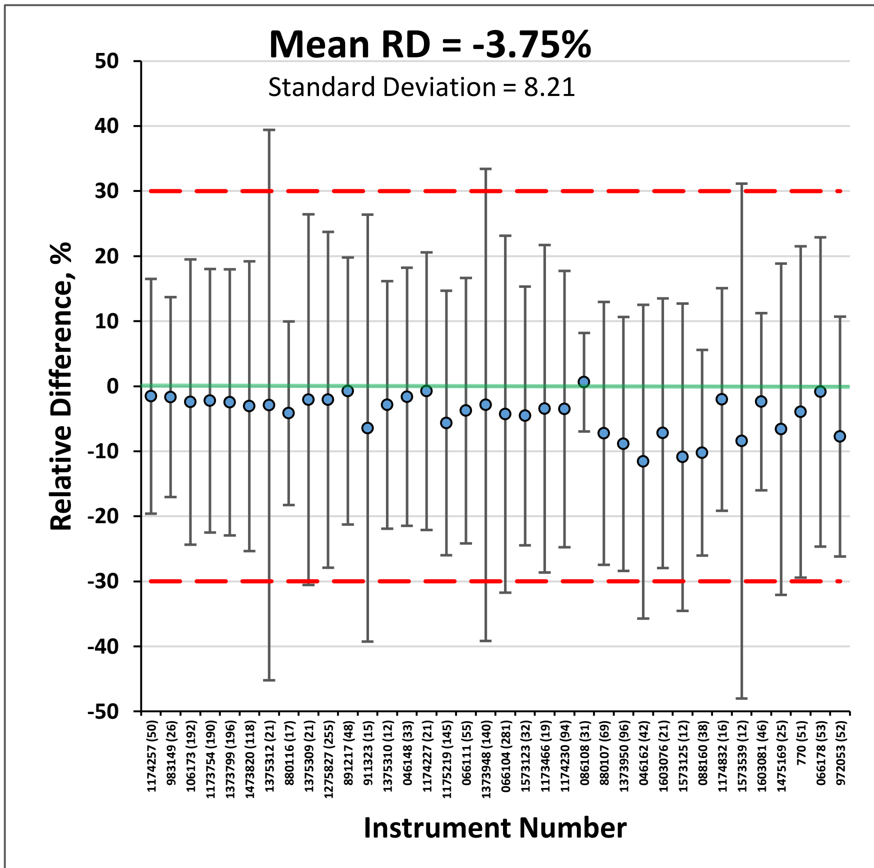
Example: FN = 300 sec at sea level



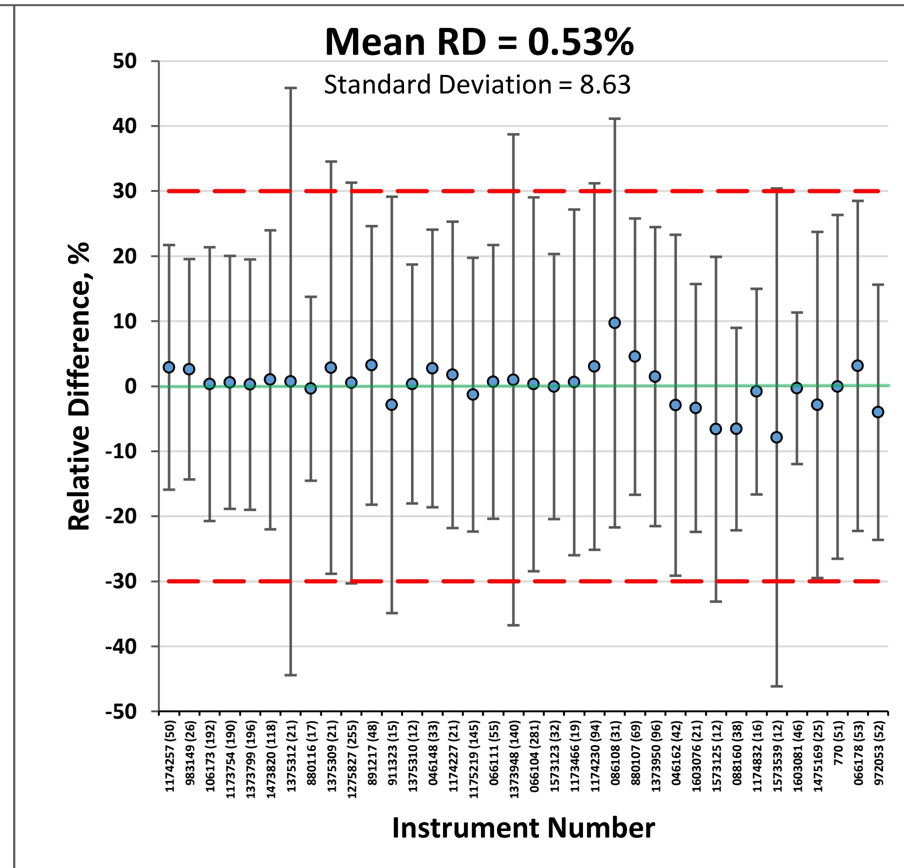
Comparison of Correction Procedures

2,545 Inspection Monitoring Results

Current Correction



New Correction



Error bars represent +/- 3 standard deviations

Impact of Implementing New Correction

- Reduced variation that promotes fair trade
- Allow tighter tolerances in inspection monitoring
- Lower FN for locations below 2000 ft.
- Higher FN for locations at 2000 ft. and above
- Magnitude of change depends on elevation and falling number

Sample Shaking Method

- Sample / water homogenization required
- FGIS allows shaking by hand or Shakematic
- FGIS compared the two shaking methods
  - Shakematic gives 3–5% lower FN results
- FGIS recommends requiring Shakematic
  - Eliminates fatigue
  - Provides more consistent mixing
  - Most official service providers use Shakematic

Recommendations

- Implement barometric pressure correction
- Require use of Shakematic
- Implementation Plan
  - Fall 2018 – notify stakeholders
  - Update FGIS Program Directive 9180.38
  - Target effective date of May 1, 2019
    - Allow time for industry to prepare
    - Ready for start of 2019 crop harvest

Mycotoxin Testing

Topics of Concern

- What is the expected variation between official labs?
- Why not use one test kit for all official agencies?
- Are uniform procedures established?
- Are procedures are available to industry?

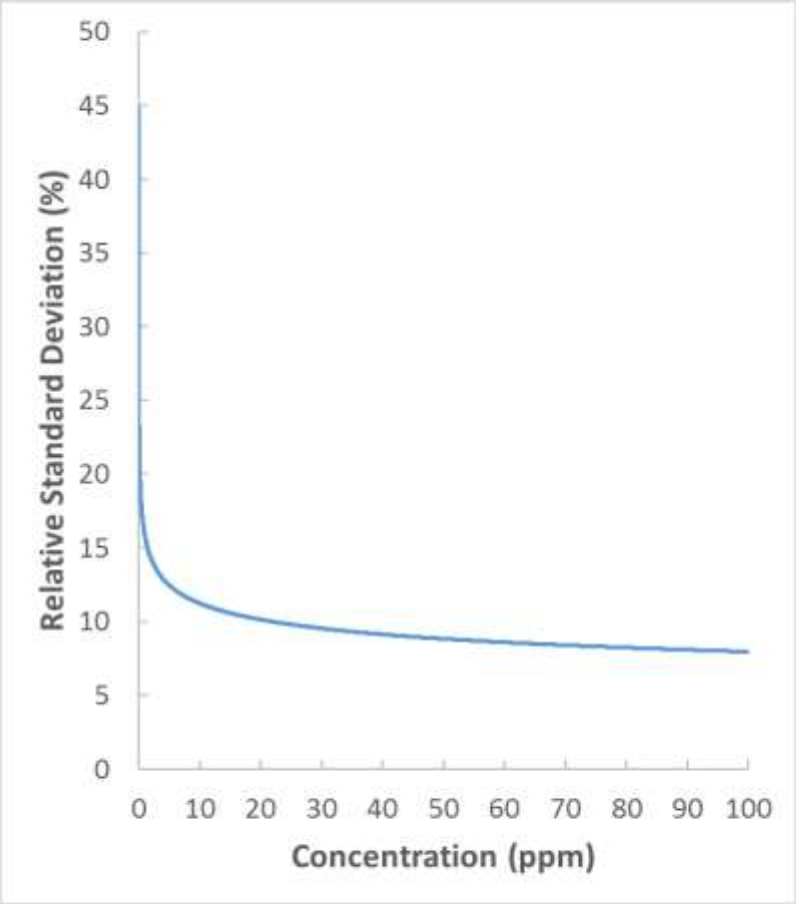
Variation in Measurements

- Some variation is expected
- More variables lead to more variation
- Variation also dependent on concentration

Conditions for Smaller Variation	Conditions for Larger Variation
One analyst	Multiple analysts
One lab	Multiple labs
One method	Multiple methods
One ground sample	Multiple whole grain samples
High concentration	Low concentration

Prediction of Variation

- Horwitz function*
  - Internationally-accepted method
  - Between-lab variation
  - Used in FGIS inspection monitoring to flag erroneous results



*Horwitz, W. *et al.* *J. AOAC.* **1984**, 63, 1344 – 1354

Agreement between Labs

- Use predicted variation to determine acceptable range
- Example: Labs A and B analyze same ground sample
  - A = 1.2 ppm DON; B = 2.5 ppm DON
  - Mean = 1.85 ppm
  - Predicted RSD = 14.49%; SD = 0.27 ppm
  - Results should be 1.85 ± 0.54 ppm (i.e., 1.31 – 2.39 ppm) 95% of the time
  - Results from Labs A and B are outside this range

Test Kit Selection

- Official agencies can use any FGIS-certified test kit
- Mycotoxin Test Kit Evaluation Program
  - Performance-based approval of test kits
  - Test kit must meet FGIS accuracy requirements

Use and Availability of Procedures

- Official, written instructions issued by FGIS
- All official service providers are required to follow these official instructions
- Training and licensing is required
- Procedures available to industry on FGIS website

October 2016 Advisory Committee Resolution

"The Advisory Committee recommends looking into and addressing what could be the root cause of variances in testing results i.e., particle size, test kit performance, sample splitting, etc."

- Investigated contributors to unexpected variation
- Developing a plan to minimize overall variation

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