

Commercial Implementation of NIR Testing Methodology for Ethanol Yield Potential in Corn Grain to Establish Input Process Control and Market Data Feedback

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Pioneer Hi-Bred

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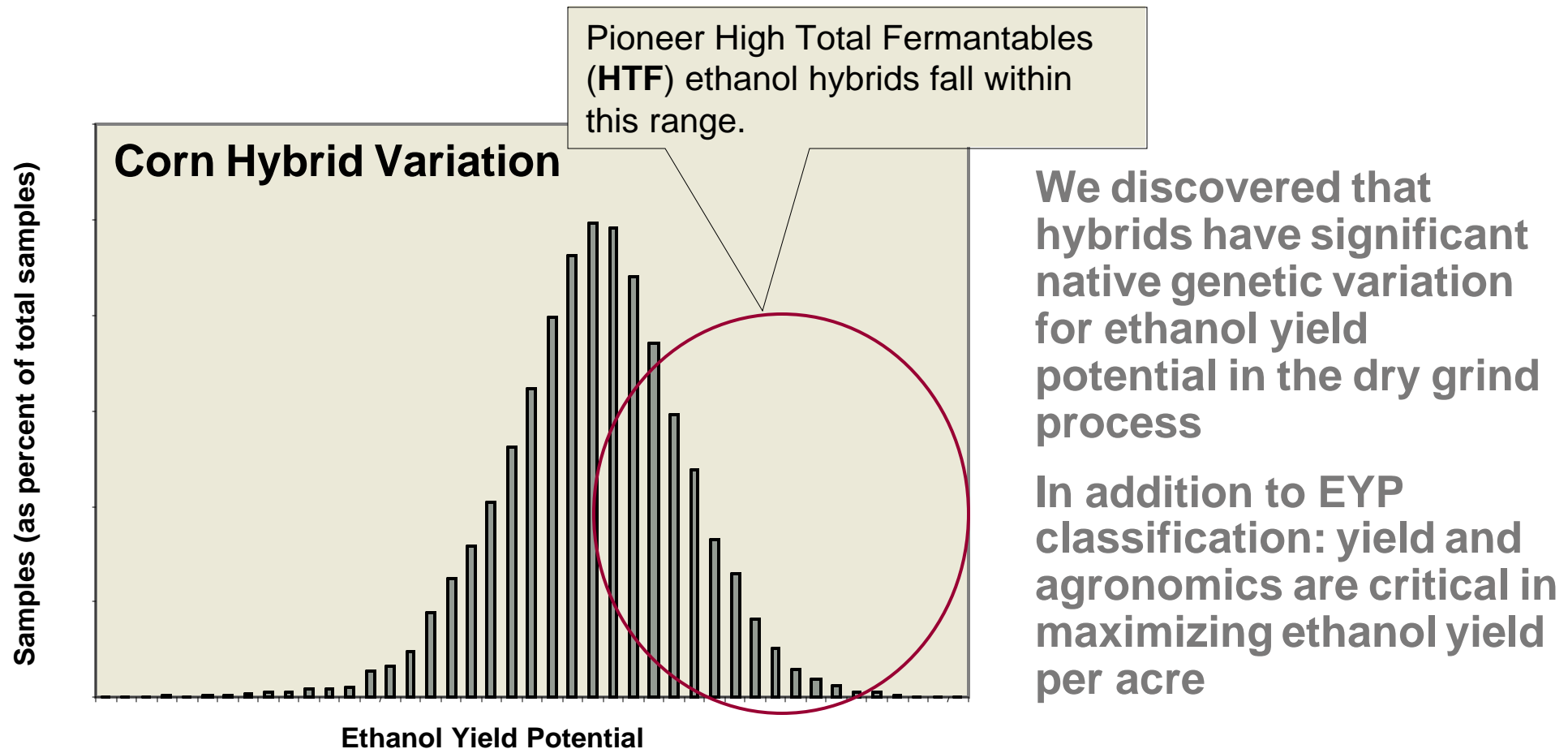
International Fuel Ethanol Workshop

St. Louis, Missouri



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Corn Hybrids Differ for Ethanol Yield Potential



Other Factors to consider:

- ***Changes in processing technologies***
- ***Crop environment, farming practices***

Develop a Rapid Test for Fermentation Yield

1. Choose robust platform to meet needs - NIR
2. Lab-scale fermentations with conditions set to identify substrate limitation and mimic industry practice
3. Quantify: CO₂ production by mass; other analytes by HPLC-RI and immobilized enzyme (YSI)
4. Replication, inclusion of standards in each procedure, and statistical techniques to make accurate comparisons across analyses
5. Derive an NIR calibration
6. Verify with commercial testing

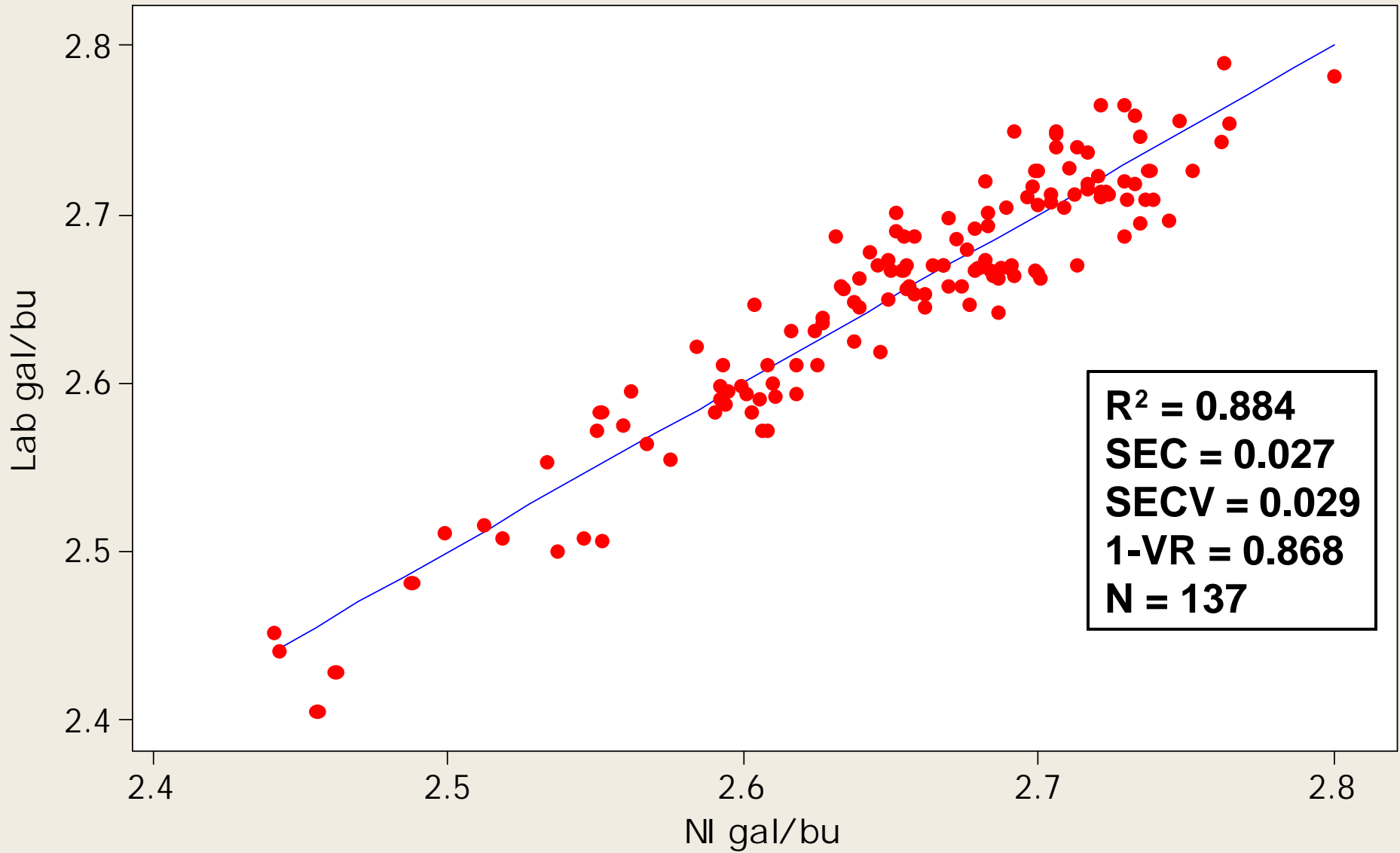
Significant variation:

Genotype – 6-7%

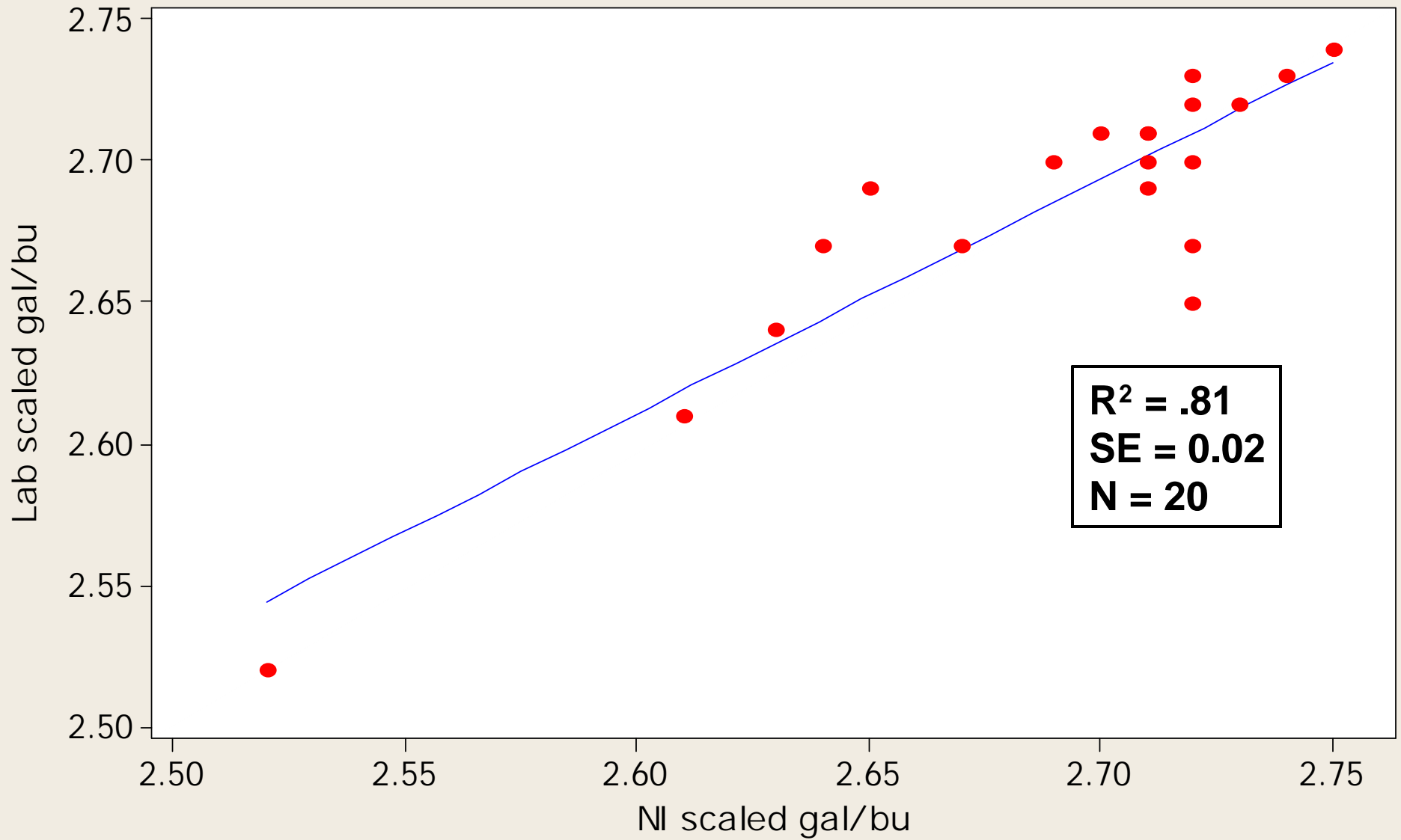
Sample - 15%



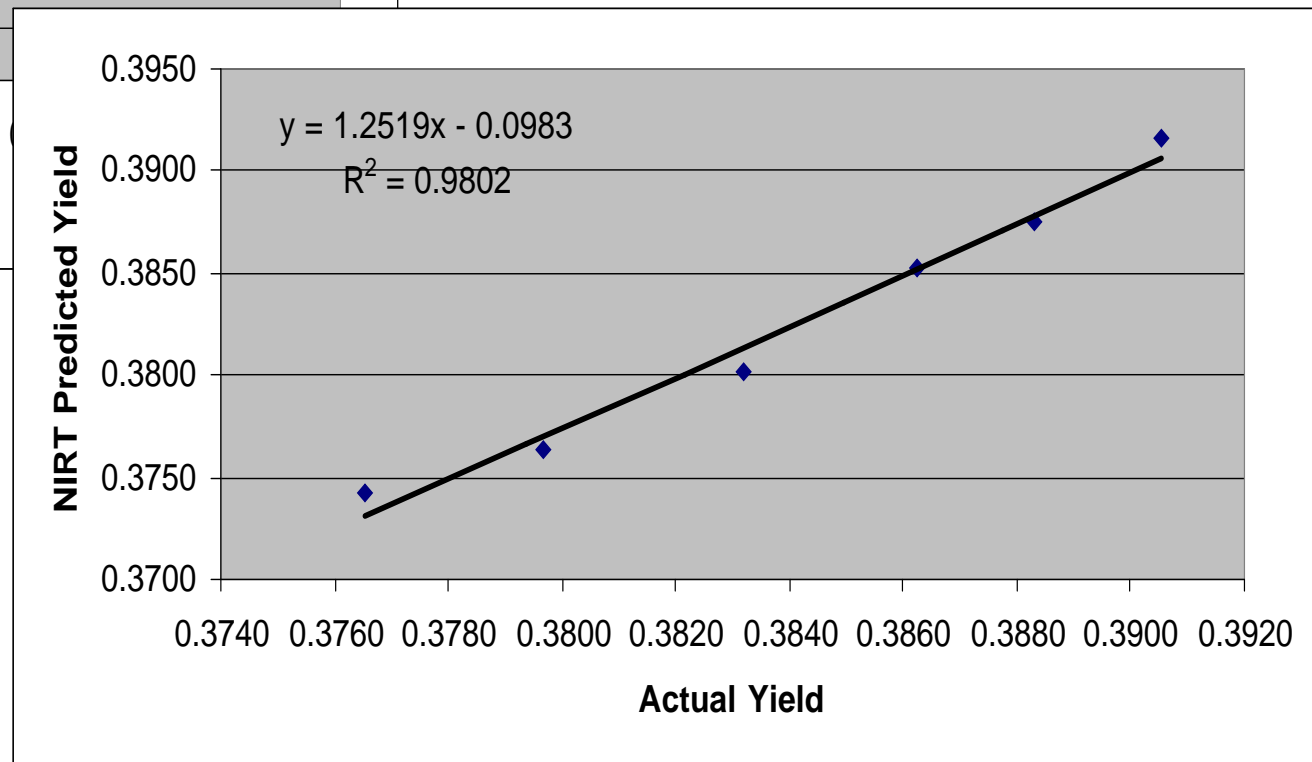
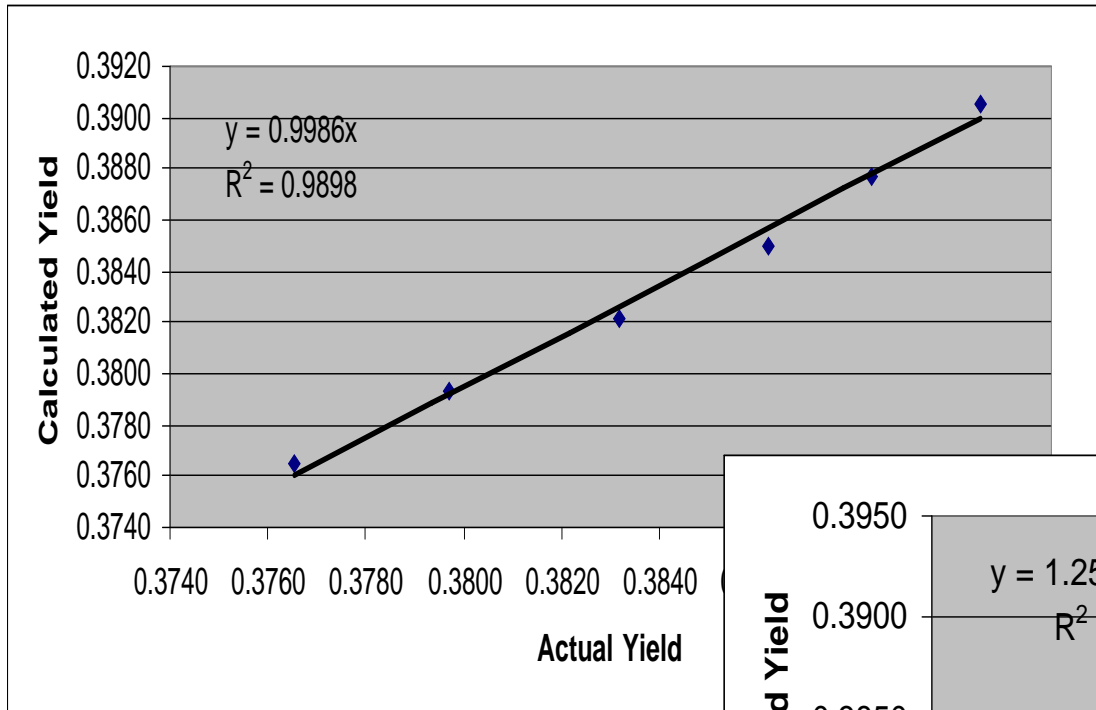
Lab gal/bu versus NI Predicted gal/bu (scaled)



Independant Validation Samples



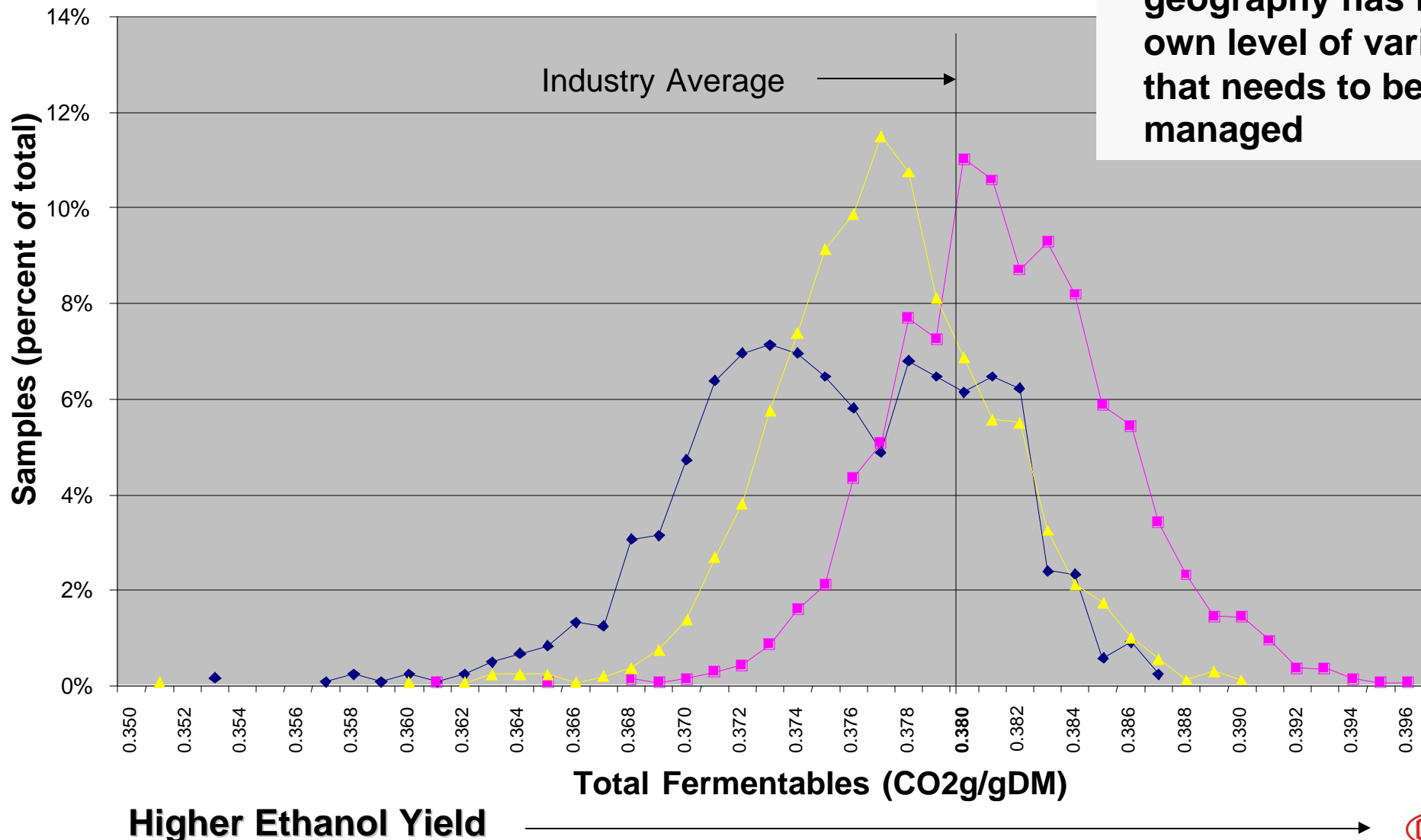
Proportional Inclusion of HTF Grain – Calculated, Actual, and NIR Predicted Fermentation Yields (CO₂ g/100g DM)



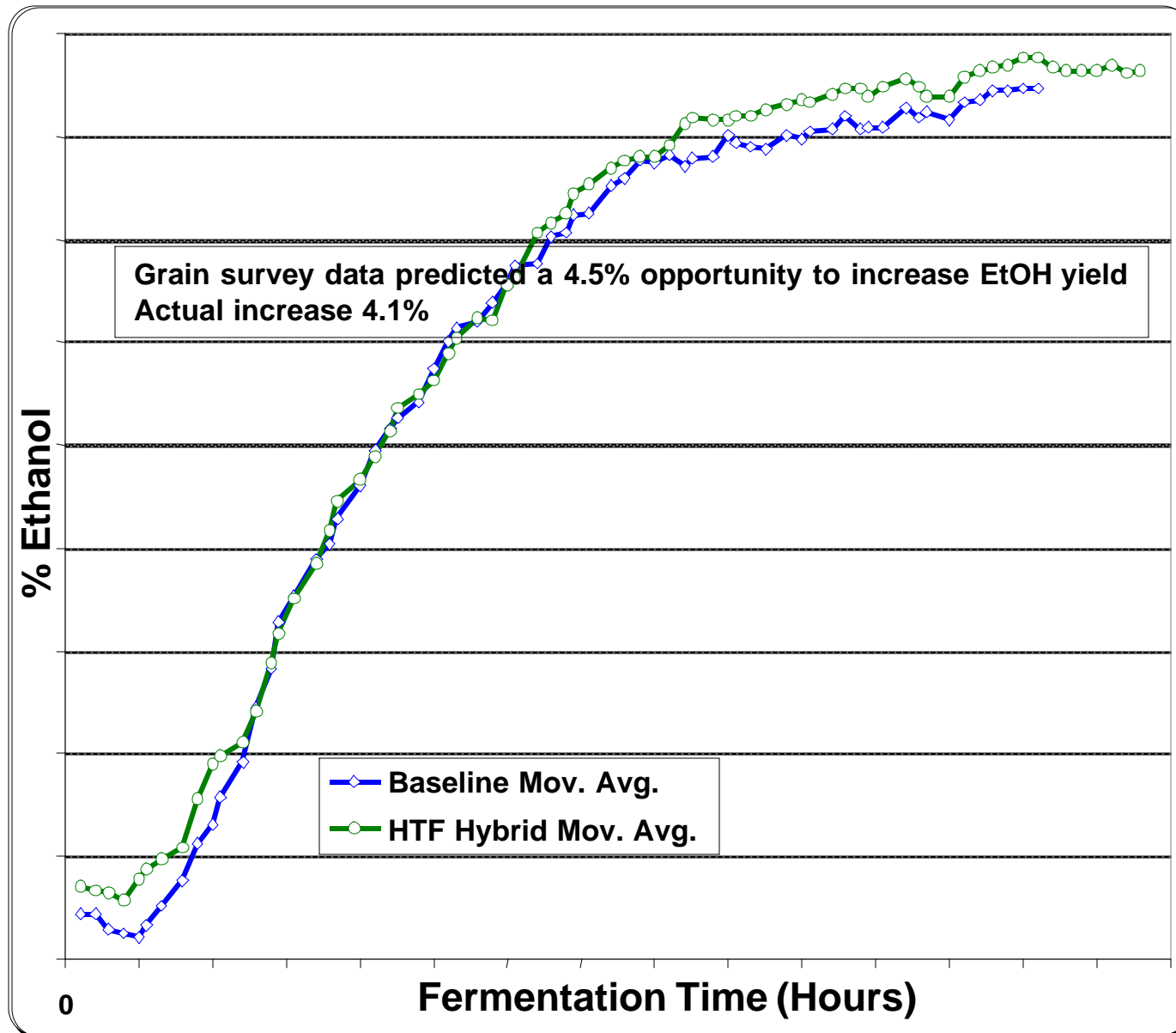
Distribution of EYP in 3 plant locations (4200 samples)

Key Point:

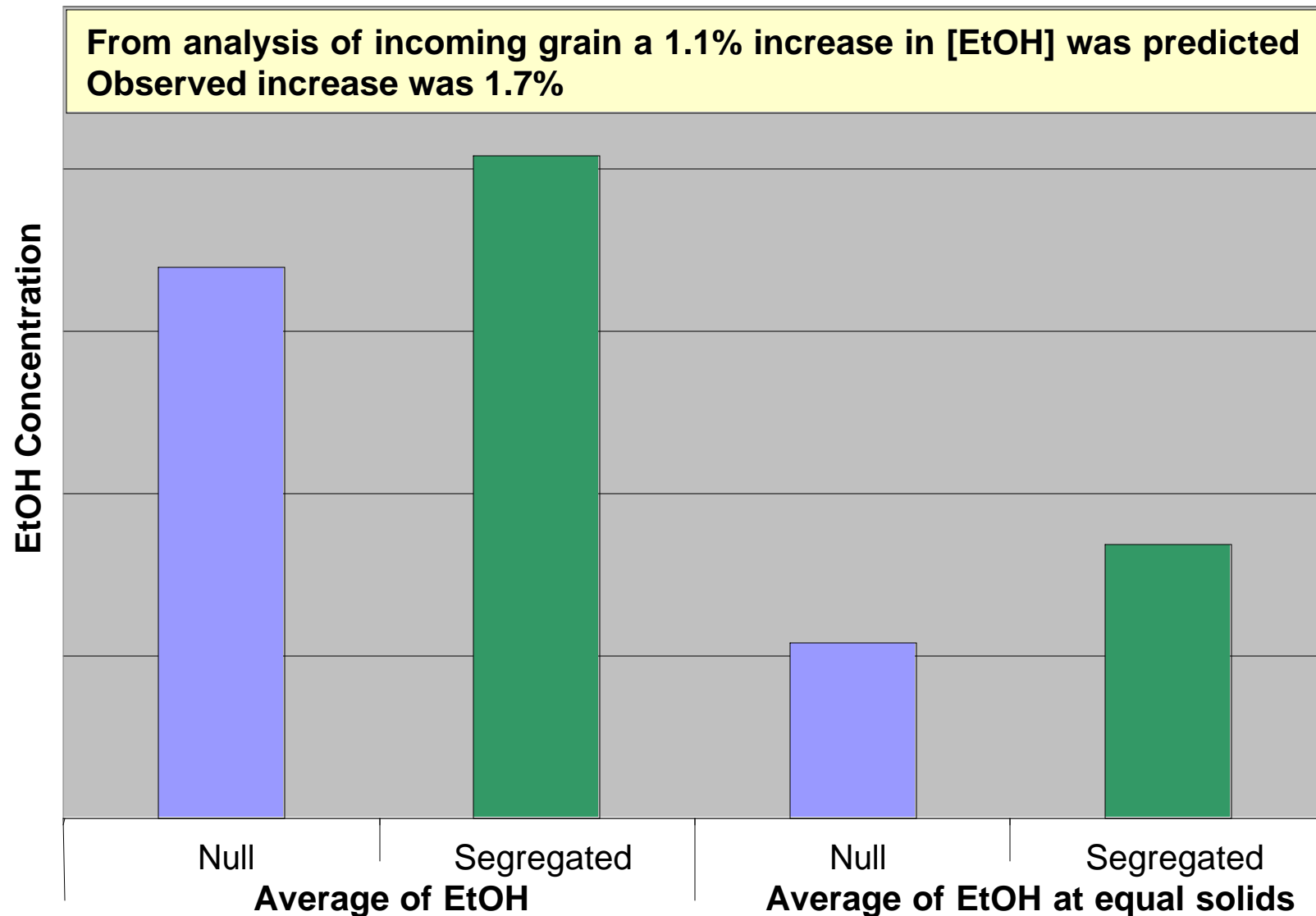
- Each local origination geography has its own level of variation that needs to be managed



Commercial Validation: HTF Hybrid Grain Versus Normal Purchases



Commercial Validation – Grain Segregated for EYP using NIR at Receiving



The Opportunity

- Every local grain originator is faced with the same problem. They must buy all of their corn within a modest origination radius of their plant (usually 20 to 30 miles).
- Ethanol plants present a new market for corn growers.
 - More corn is now consumed locally
 - Ethanol plants have introduced a new use for corn, with different functional needs
 - Grain purchase specifications that drive Ethanol Yield are needed
- In order to change quality characteristics for grain you must change habits of corn growers in your origination area.
 - Corn growers must be introduced to, and trained to recognize new Ethanol Yield standards for corn that will drive efficiency and profitability in the chain

Ethanol Yield (EYP) Data Feedback Objectives

- 1. Use NIR measurement tool to provide real-time EYP information for corn at delivery**
 1. Data access, transparency, and communication
- 2. Use consistent data feedback to corn vendors to increase awareness and drive change in key farmer behaviors that will improve EYP of grain**
- 3. Enable process management procedures for corn EYP at the plant level**
- 4. Enable development of market valuation systems based on EYP**

Main Implementation Elements

- 1. Deployment of NIR measurement system**
 - i. Once a trait can be measured it can be managed
 - ii. Must fit into grain receiving process
 - i. depends on robust equipment, calibration, and integration with grain accounting software
- 2. Direct data feedback to vendors on how their delivered grain ranks relative to plant specifications**
 - i. Feedback is delivered by the plant and Pioneer supports data processing
- 3. Focused promotion of hybrids and management practices that will help corn growers improve the plants ethanol yield**

Direct Data Feedback to Growers

- 1. All loads of corn delivered to plant will be analyzed for EYP**
 - i. Time to analyze is ~ 45 to 60 seconds
 - ii. Data stored in grain accounting software for on demand use by plant
- 2. EYP analyses are included on vendor receiving tickets as a grade field**
- 3. Data are summarized and reported back to vendors to show how their corn quality compares for EYP to global plant receipts**

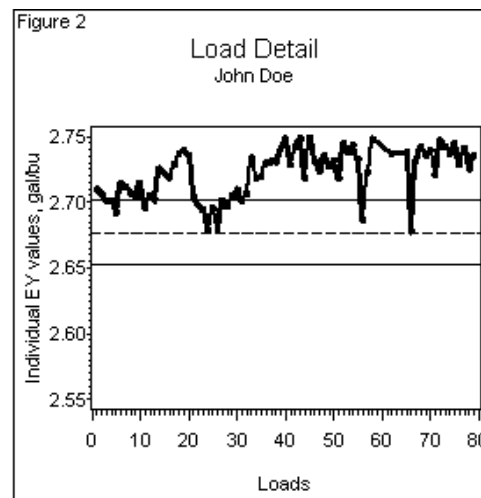
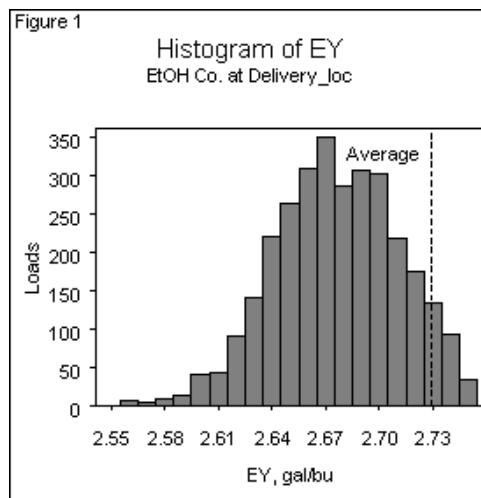
Feedback to Vendors – Influencing Behavior

This report summarizes ethanol yield (EY) potential of the corn grain that you delivered to Delivery_loc between 09/01/06 and 10/31/06. Ethanol yield is expressed as gallons absolute ethanol/bushel at 15% moisture basis and is related to the Total Fermentable characteristics of corn hybrids. This report supplements information you received on your scale receipts when you delivered each shipment and summarizes the EY information of your corn deliveries during this period.

Total number of shipments delivered:	79
Weighted Average EY:	2.729 gal/bu 85% dry basis
EY Percentile ranking versus all vendors:	96

Figure 1 below illustrates the EY distribution characteristics of all grain delivered to Delivery_loc during this period. The grand average EY for all corn delivered to Delivery_loc during the period was 2.676. The dotted vertical line on figure 1 indicates the average EY of your deliveries compared to all grain delivered to us during the period.

Figure 2 is a load detail summary for your deliveries. The horizontal dotted line is the Delivery_loc location EY average. Points above the top solid horizontal line are in the upper 25th percentile of EY, points below the bottom solid line are in the bottom 25th percentile for EY. Figure 2 provides insight into the variation in EY concentration that occurred in your deliveries relative to key benchmarks.



- Pioneer is working in cooperation with plants that are using NIR testing to implement a data feedback system for Ethanol Yield (EY) Potential.
- EY data is printed on receiving ticket for immediate feedback
- Twice per year a summary report is generated.
 1. Vendors weighted average EY
 2. Percentile ranking
 3. Overall location distribution
 4. Load-by-load run chart

Advantages for Ethanol Plants

1. Improved knowledge about a key functional trait of your feedstock that is directly related to plant yield
 - Potential to manage feedstock for more consistent, plant performance
 - Potential to communicate directly with vendors on a trait that matters to you, and that they can influence
 - Opportunity to engage vested supply chain partners

Thank You!



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