Maintaining Control in Quality Control:

Problem Solving Common Mistakes and Misconceptions in Food Manufacturing NIR Networks

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My Background

- Studied Food Science at the University of Manitoba
  - *Studying wheat protein quality*
- Applications Specialist at Perten Instruments Canada
  - *Working with academia, government and industry primarily with many different rheology and NIRS applications*

Presentation Overview

- NIRS in food quality control applications
- Common mistakes in the food manufacturing QC
- Proper implementation of NIRS in the food industry

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Market Segments

Grain collection and Trade

Flour milling

Dairy

Oilseed processing

Meat and meat products

Seed breeding

Snackfoods and baked goods

Petfood

Starch production

Feed milling

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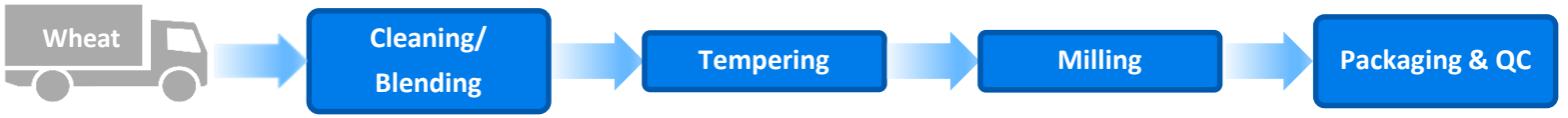
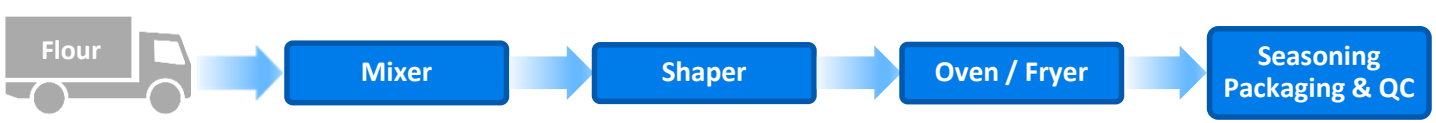
Food Quality Control

Flour Milling



Dough Snackfood Products



Oilseed Processing

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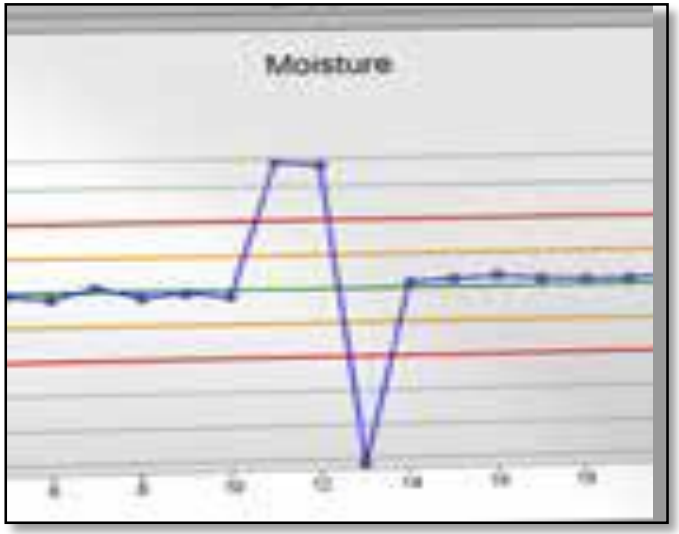
NIRS in Food Quality Control Applications: Why NIRS?

- Simple, quick feedback
- Non-destructive
- Works well for many parameters in food quality control



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NIRS in Food Quality Control Applications: How Can NIR Help?

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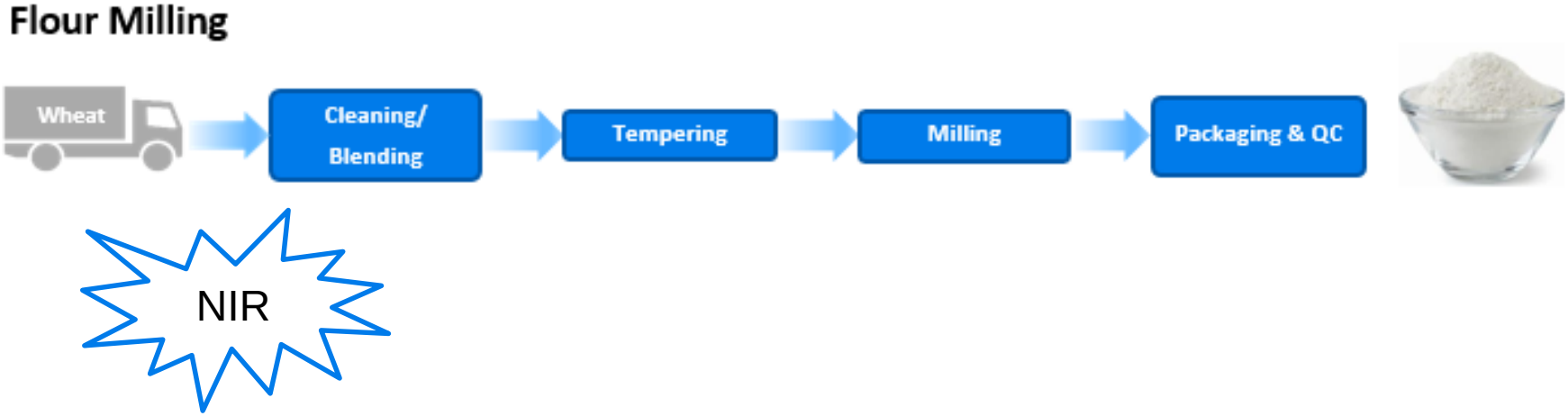

Check incoming materials

- Purchasing / Binning / Claims
- Optimize use of expensive ingredients - formulation
- Rejection

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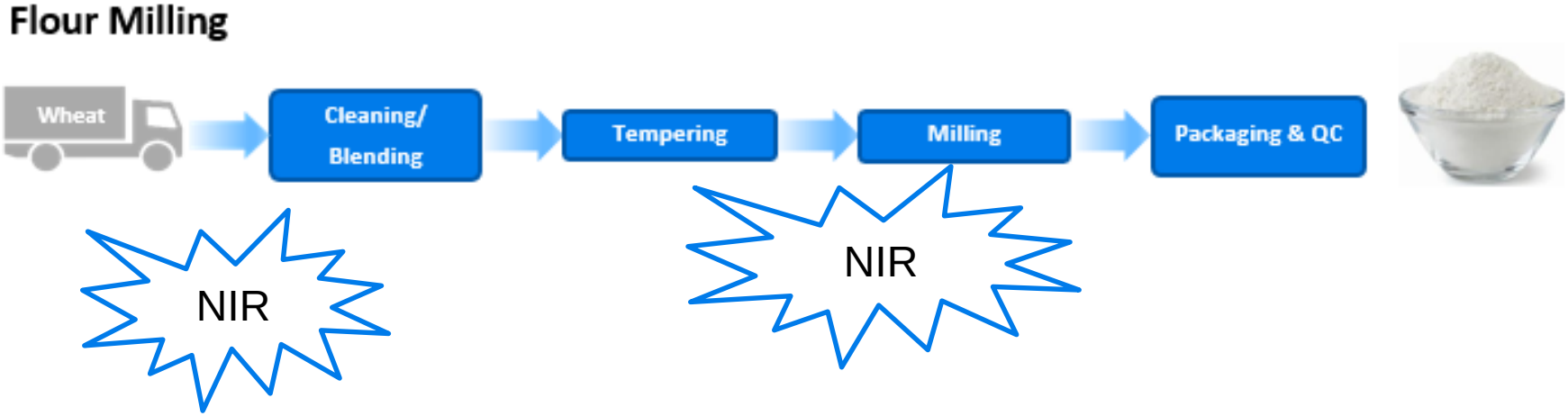
NIRS in Food Quality Control Applications: How Can NIR Help?



Measurement of in-process products

- Process control
  - Valves on/off, Increase/decrease residence time, Speed/slow belts
- Reduce re-work or scrap product

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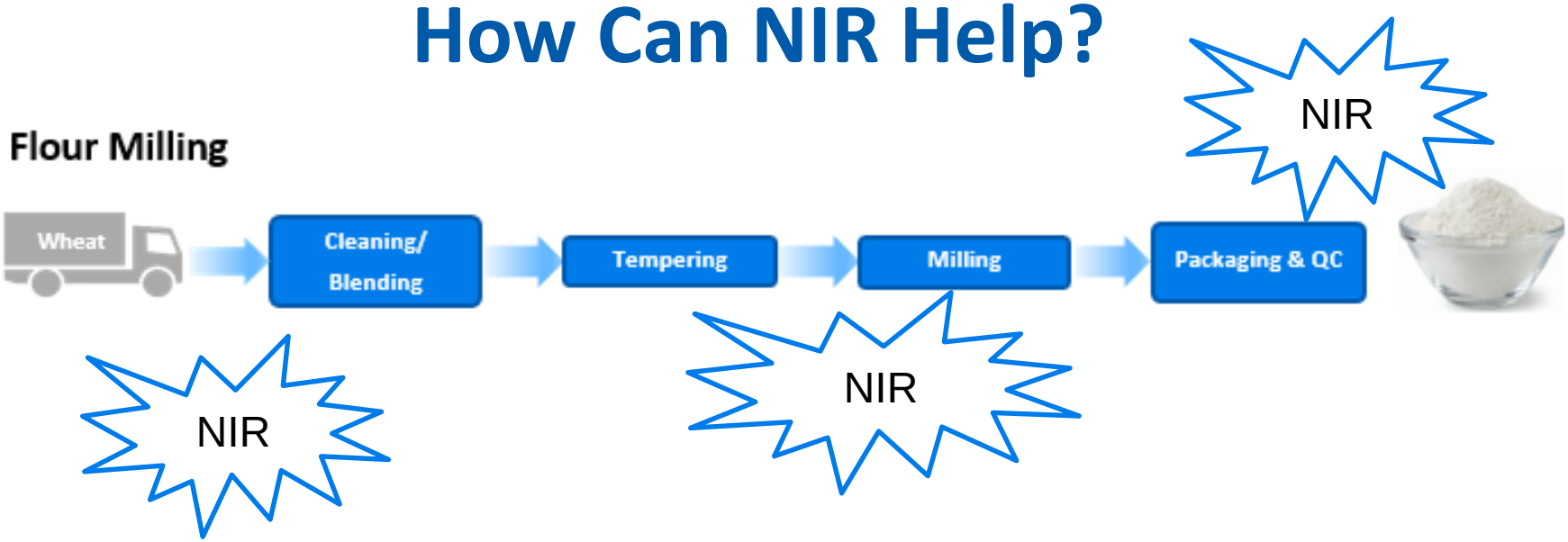
NIRS in Food Quality Control Applications: How Can NIR Help?



Final product testing

- Quality control
- Avoid “bad” deliveries

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Who is Using NIRS?

- Widely used in the food industry
  - *Quick feedback that saves time and money at each processing step*
  - *NIR technology is designed to be simple and user friendly*
- Many operators do not have a technical background in NIRS
- In reality NIR technology is advanced technology that needs to be properly maintained, calibrated and validated to give accurate, reliable results

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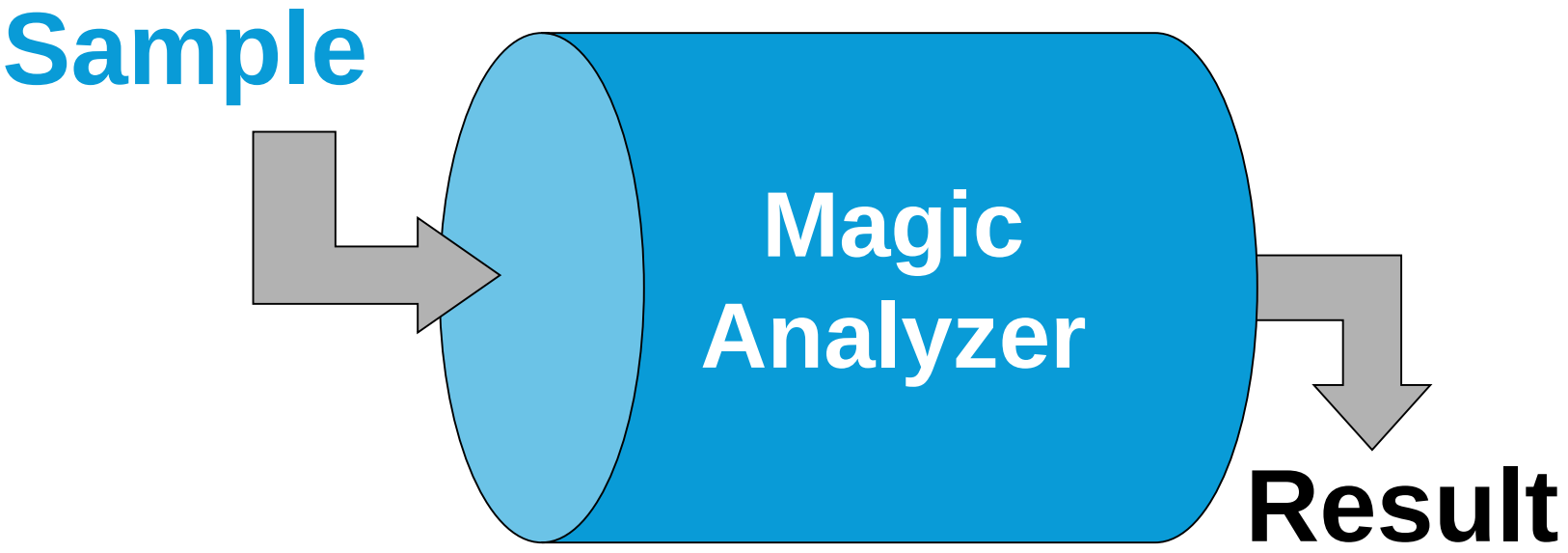
The Magic Analyzer Misconception



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Common Mistakes in Food Quality Control
NIRS Applications

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Calibration Validation

- NIR is a secondary technique that is calibrated to a reference method
- Biases may appear with slight differences in manufacturing or with slight differences in the product itself
- Calibrations should be validated to check for a bias and determine how much error how expect to see in your measurements
- Validation should be done with a representative sample set with good lab data

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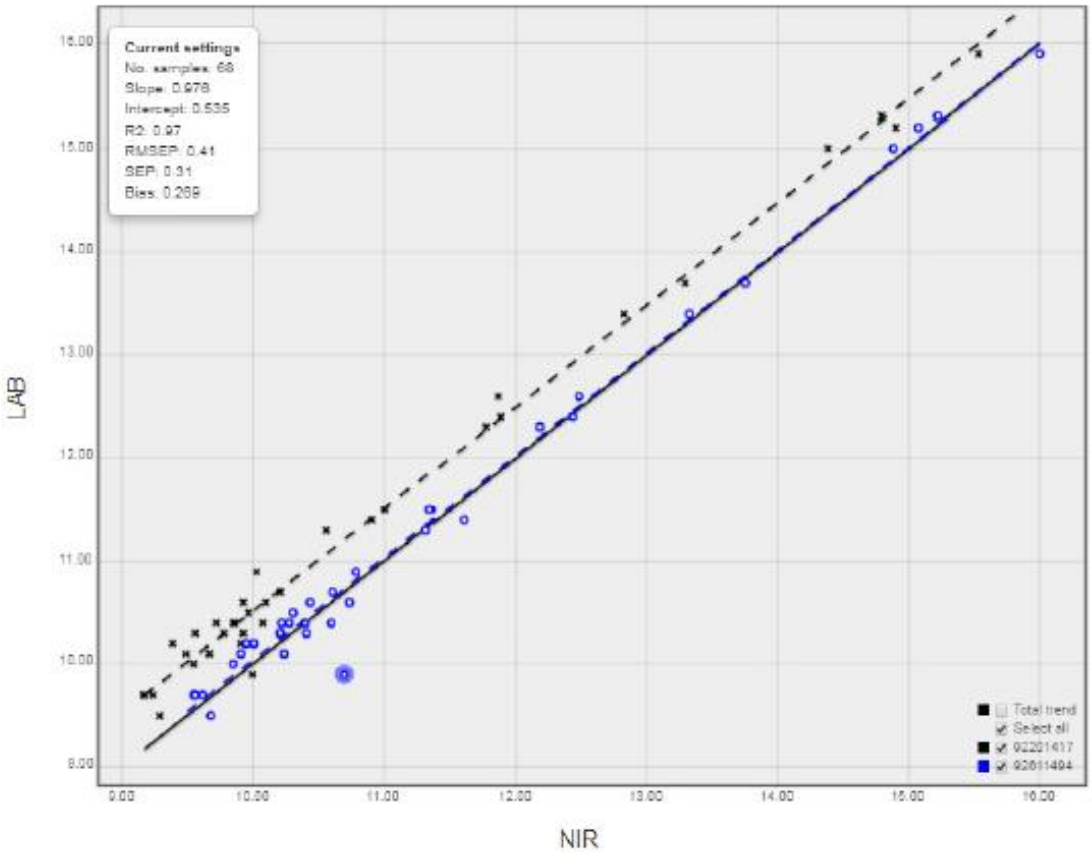
Calibration Validation



- Without a bias adjustment; RMSEP 0.54, RMSEP 0.14
- With bias adjustment; RMSEP 0.18, RMSEP 0.13

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Mistake 1: No Validation

- Multiple plant locations all using NIR independently
- QC of parameters including total solids and fat to maintain a consistent product across all locations

"Ooooh the solids is reading higher than on our old instrument. The operations department is going to love this!"

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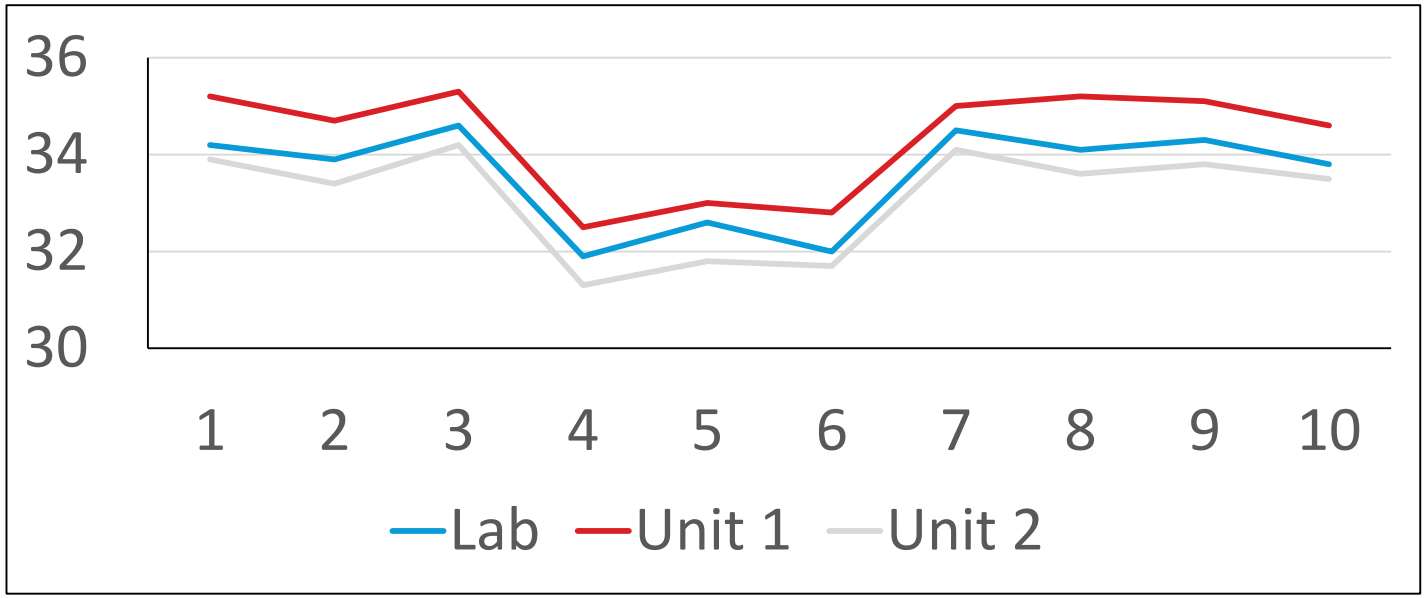
Mistake 1: No Validation



- Accuracy
  - If there is a instrument bias in total solids that is not accounted for, there are real world effects on the product
- Consistency
  - If there are different biases between sites the product will not be consistent across all locations

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Mistake 2: Wrong Calibrations + No Validation

- Multiple units at multiple sites used to monitor incoming ingredients, processing and quality of the final product
- They reported seeing differences of up to 1% in the same sample between units and also poor repeatability

"Our instruments are not working. They're all giving us different numbers. How can we trust the numbers when each unit is telling us something different?"

- They were running different milled products under white wheat flour calibrations, none of which were validated

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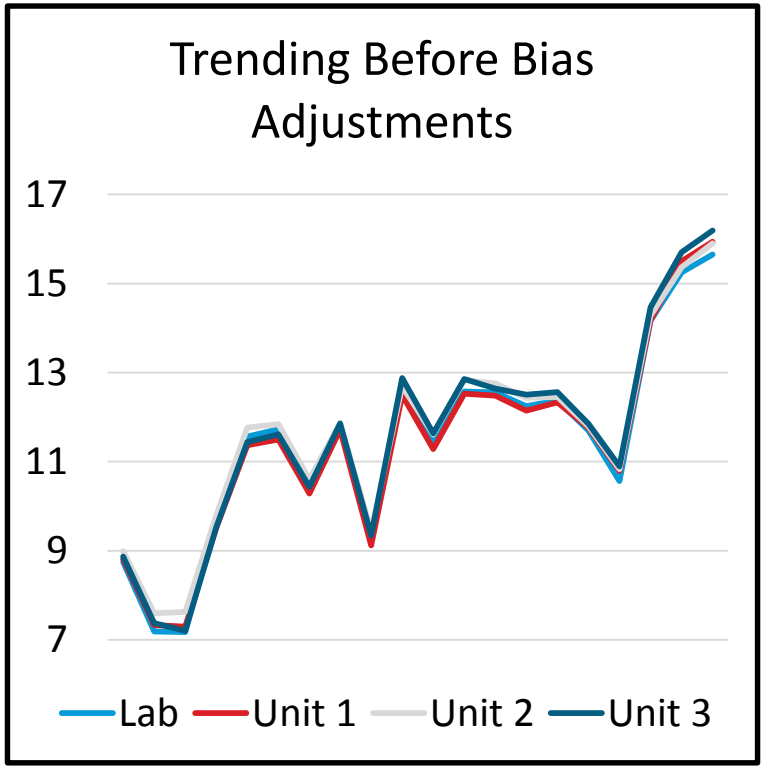
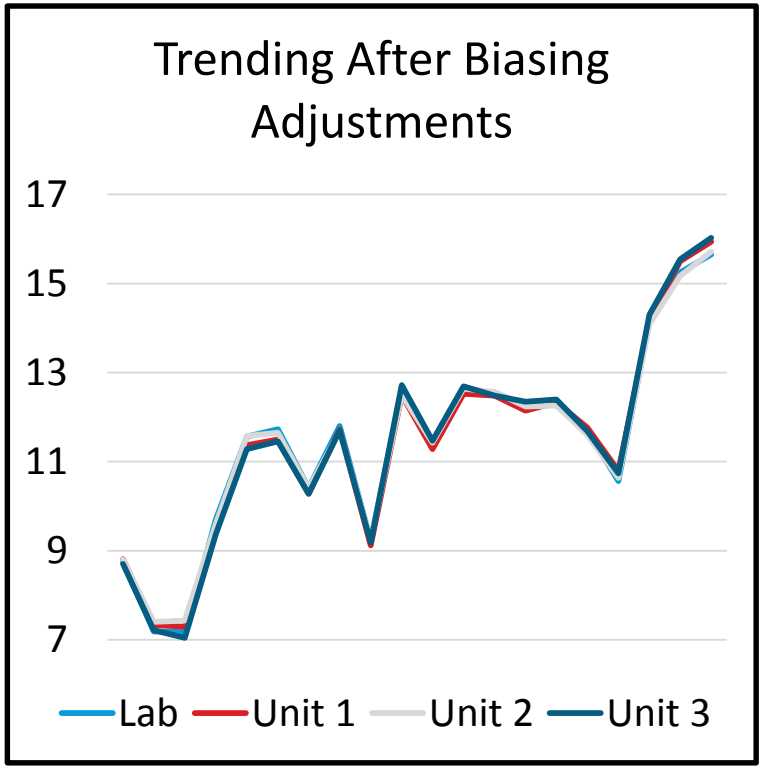
Mistake 2: Wrong Calibrations + No Validation

- You should only be testing the products that the calibration has been taught to recognize
- You should validate each product on each unit





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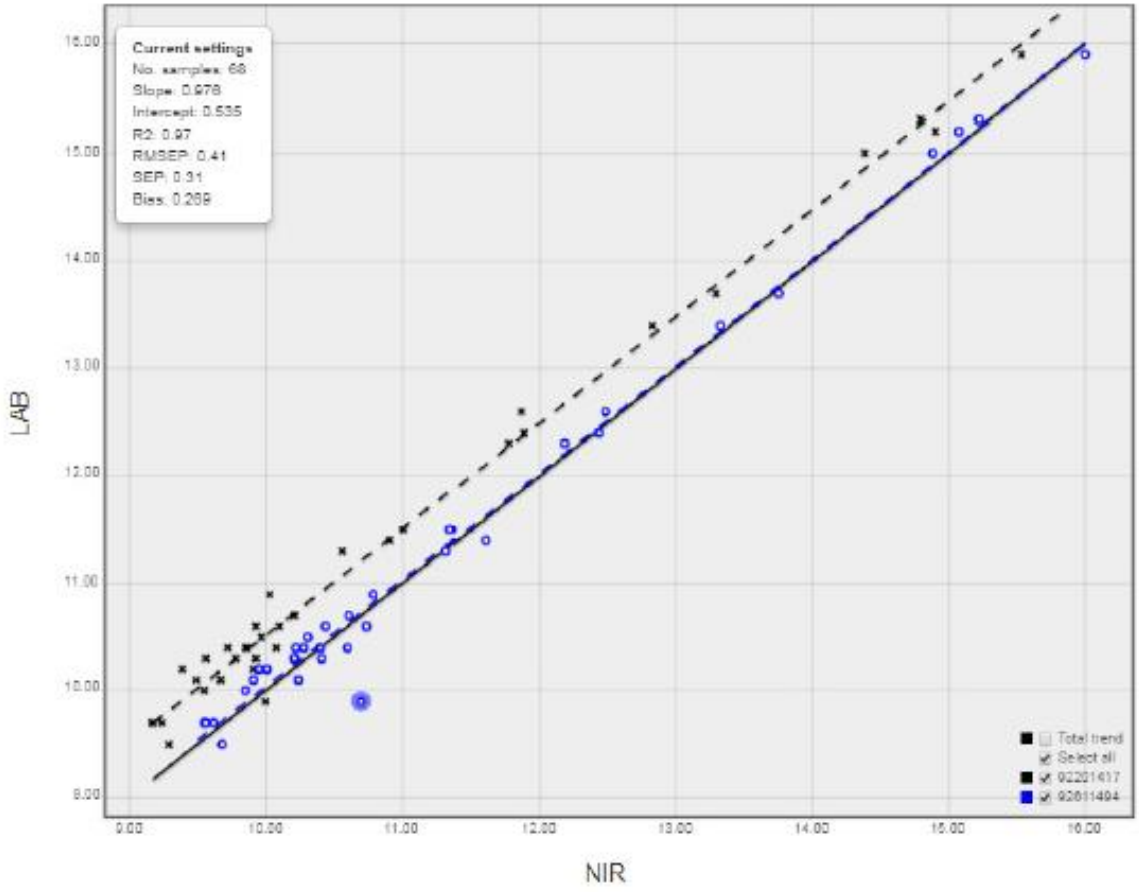
Mistake 3: Chasing Your Tail with Biasing

- Bias-happy users constantly check and adjust the bias without properly determining the true bias



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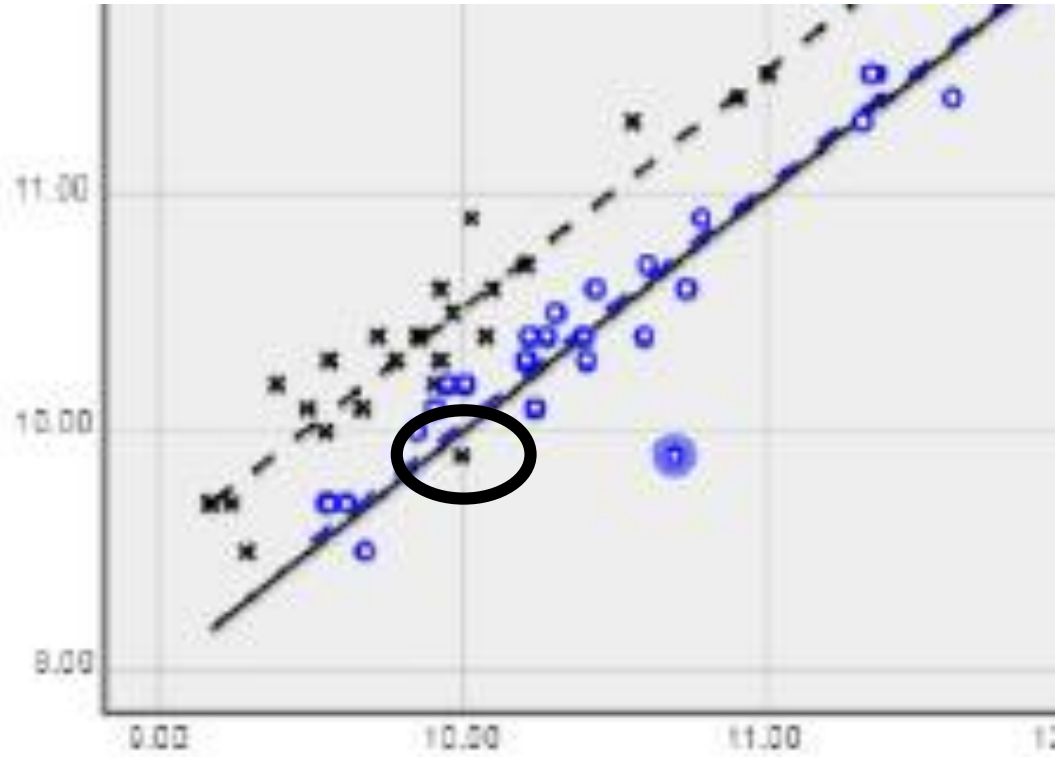

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Mistake 3: Biasing By Chasing Your Tail

Representative sample set is needed that reflects the all the variation you expect to see in that product

- *Varieties, growing regions, recipes, ingredient suppliers, temperatures*
- *Span the full range of each parameter you are measuring*
- *20+ samples*

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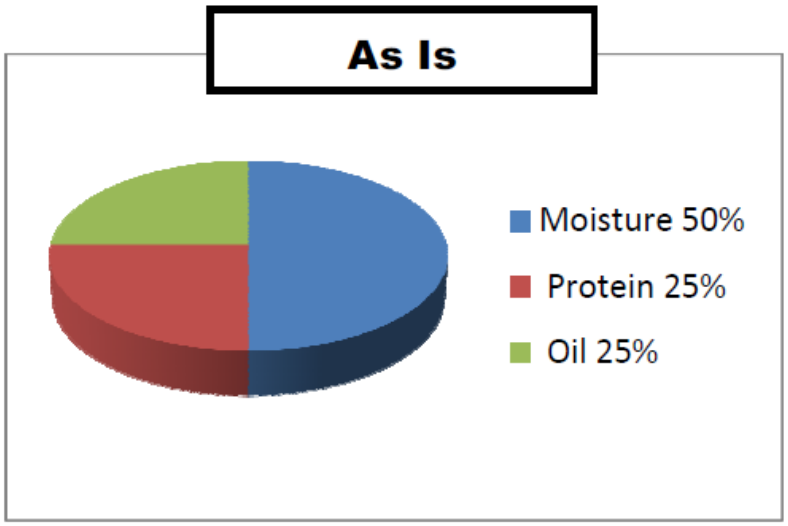
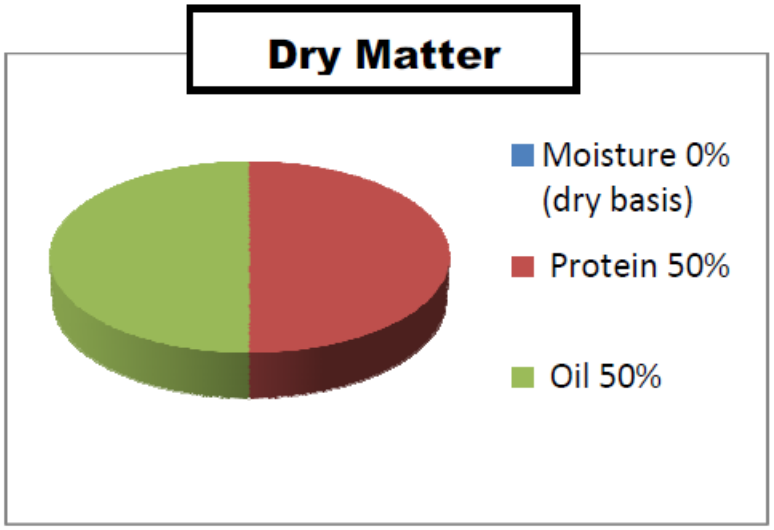
Mistake 4: Validating or Comparing NIR Results on the Wrong Moisture Basis

Moisture Basis: A raw or mathematically-weighted percentage used to express the dry matter composition of a sample.





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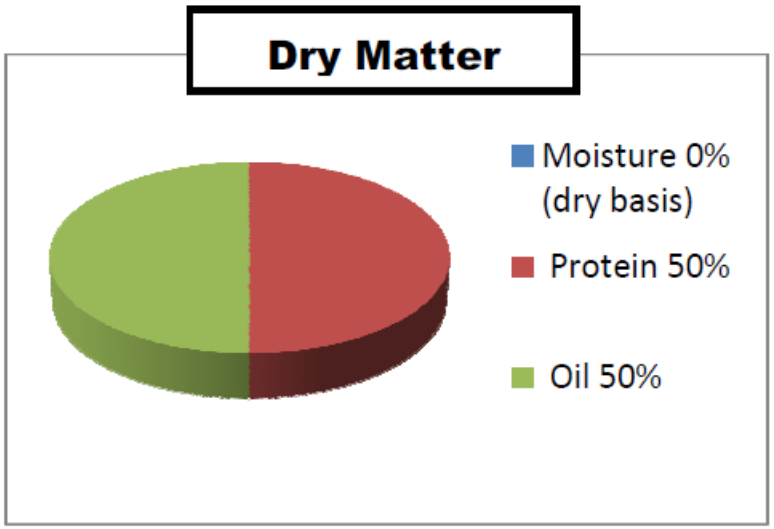
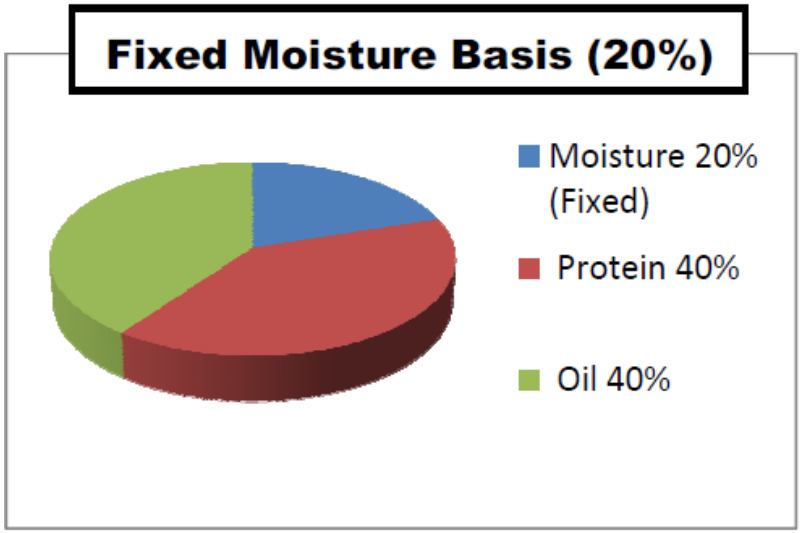
Mistake 4: Validating or Comparing NIR Results on the Wrong Moisture Basis





- **Fixed Moisture Basis:** A fixed percentage (ex. 12% for US wheat) is mathematically assumed to be the moisture content. When reported on a 12% fixed moisture basis, the protein and oil results are reported as if the sample was truly at 12% moisture.
- The actual moisture content is still reported and is not necessarily 12%

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Mistake 4: Validating or Comparing NIR Results on the Wrong Moisture Basis

Moisture	Protein As Is	Protein Fixed 12% mb	Protein Dry Basis
13.7	7.9	8.0	9.1
11.2	9.1	9.0	10.2
9.7	10.1	9.8	11.2
14.5	11.8	12.2	13.9
14.0	12.4	12.7	14.4
11.5	13.7	13.6	15.4
12.6	14.5	14.6	16.6

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Mistake 4: Validating or Comparing NIR Results on the Wrong Moisture Basis

"Our protein machine is not working and the malfunctions have cost us $10,000CAD."

- Biased the calibrations using "As is" protein measurements on "Dry Basis" calibrations
- Reported the results without specifying "Dry Basis" to a customer who buys on a "13.5% Fixed moisture basis"
- Paid a penalty because the true protein content on a 13.5% moisture basis was lower than what they reported

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Mistake 5: Validation with Poor Lab Data

"The error is way too high on our instrument. Why isn't it working?"

- The error on the reference results was poor
- In some cases, the lab was also using NIR rather than the primary method

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Mistake 5: Validation with Poor Lab Data

Be sure to use reliable sources to validate calibrations

"You know, I don't need your approval.
I can have all my crackpot opinions
validated on the internet!"

CartoonStock.com

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Mistake 6: Ignoring the Warning Signs

Most NIR technologies have software that will notify you when:

- The spectra looks different from the spectra in the calibration
- The prediction is outside the calibration range

Typical causes:

- Failure to update calibrations when samples are changing (raw ingredients change, recipes change, process changes which changes the nature of the final product)
- Testing the product under the wrong calibrations
- Outlier limits are set too restrictively

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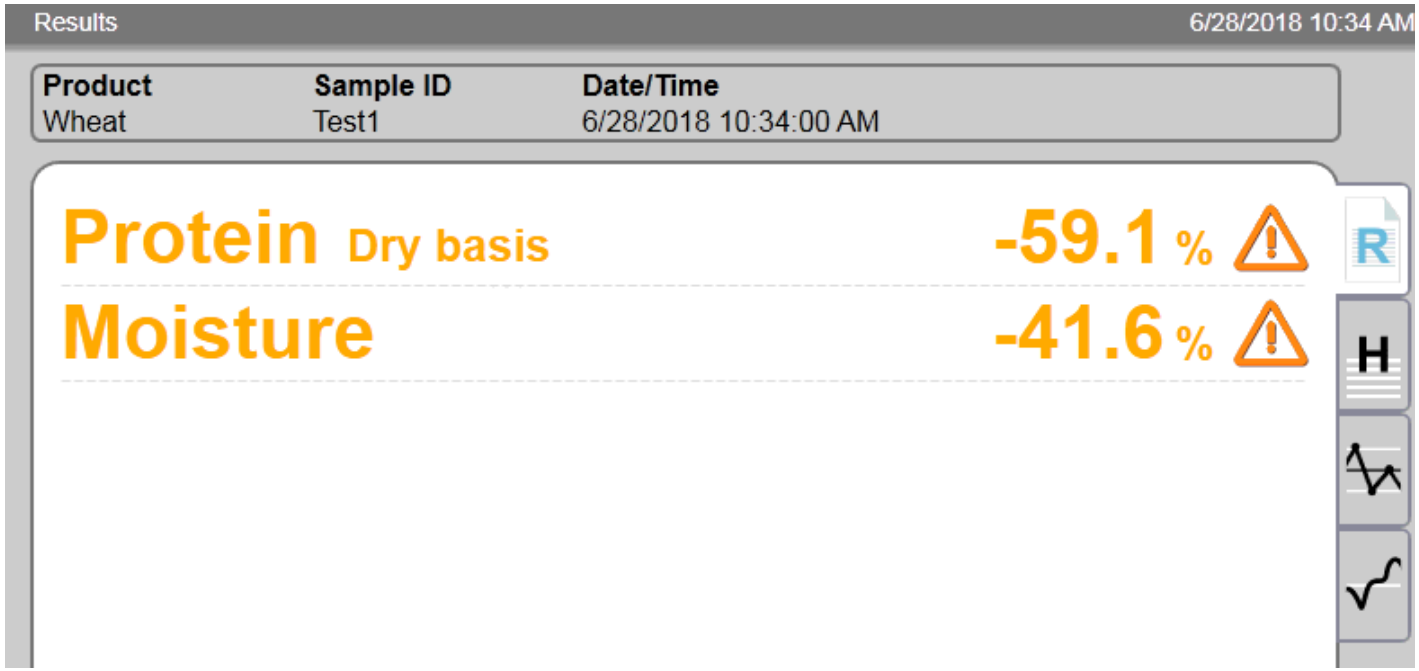
Mistake 6: Ignoring the Warning Signs



Outliers should be tested in the lab to determine their true value and used to update the calibrations

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Proper Use of NIR in Food Quality Control

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Proper Use of NIR in Quality Control

- Designate a person/group to monitor calibrations
- Proper calibration validation
- Proper use of calibrations
- Set outlier warnings appropriately
- Understand the level of error in each measurement
- Educate operators on proper sampling
- Use external check samples to monitor instrument performance

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Questions?

Thank You

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