Sources of variability in measuring aflatoxin and the role of sampling

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Sampling

Laboratory

Reagents

Analyst

Sources of Variability

Sample reduction

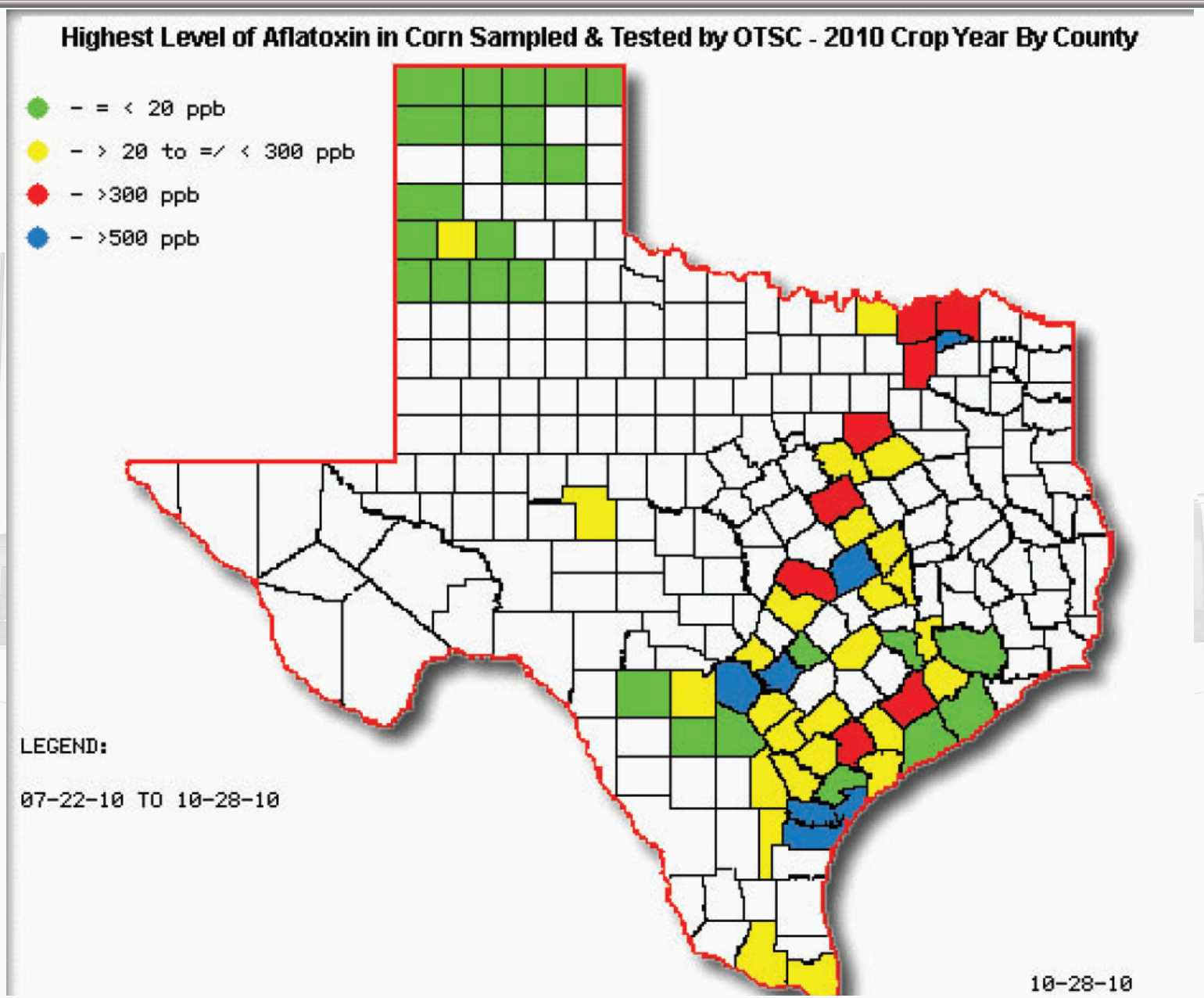
Testing platform

Sub-sample measurement

Scale

Detection

Sample matrix


Highest Level of Aflatoxin in Corn Sampled & Tested by OTSC - 2010 Crop Year By County
- = < 20 ppb
- > 20 to =/ < 300 ppb
- >300 ppb
- >500 ppb
LEGEND:
07-22-10 TO 10-28-10
10-28-10

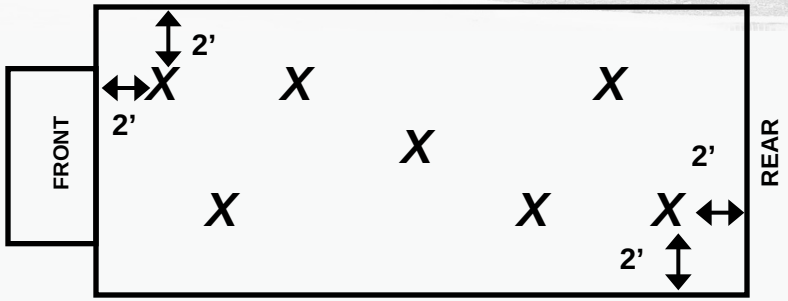
One-Sample Strategy Program Components

- Standardized methods
- Standardized training
- Verification of employee performance
- Documented program outcomes
- Monitoring & corrective actions
- Reduced market and food safety risk

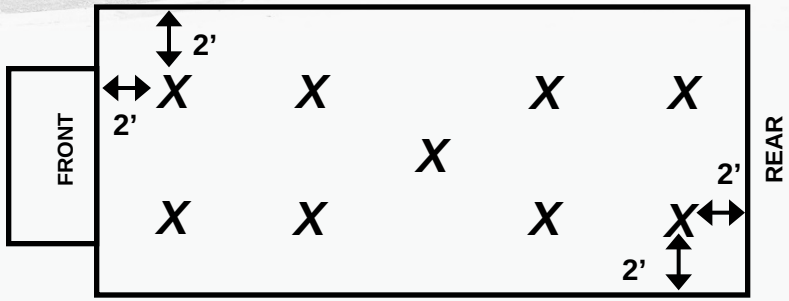
Criteria: Sampling

- Minimum 5-pound sample collected from each incoming truck or trailer
- USDA representative sampling patterns
- 6’ spiral hand probe

PATTERN 1: 7 probes for trucks or trailers loaded with grain more than 4 feet deep



PATTERN 2: 9 probes for trucks or trailers loaded with grain less than 4 feet deep

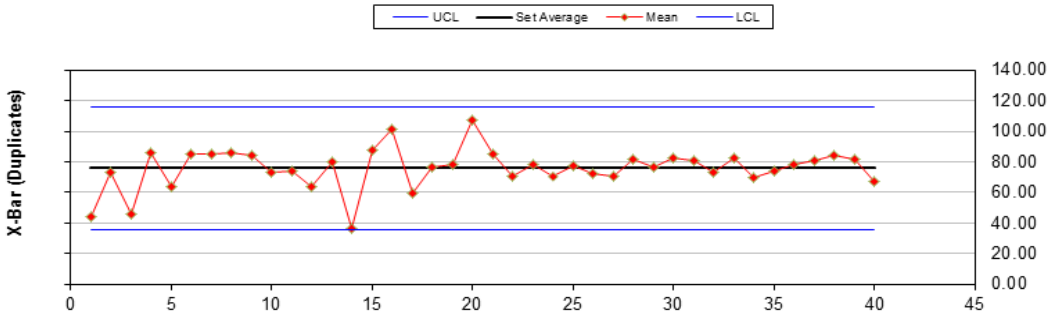


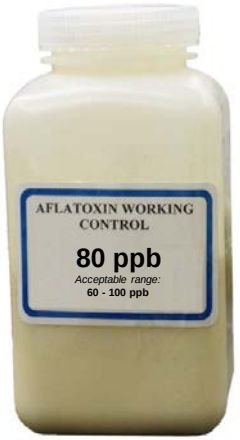
Criteria: Grinding

- Grind the entire sample
- Collect at least 500 grams of the ground sample
- 70% of the particles pass through a 20 mesh sieve after grinding

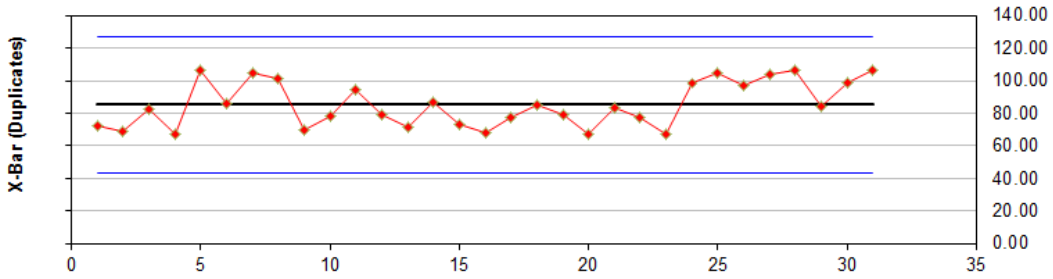
Control Chart

Company A



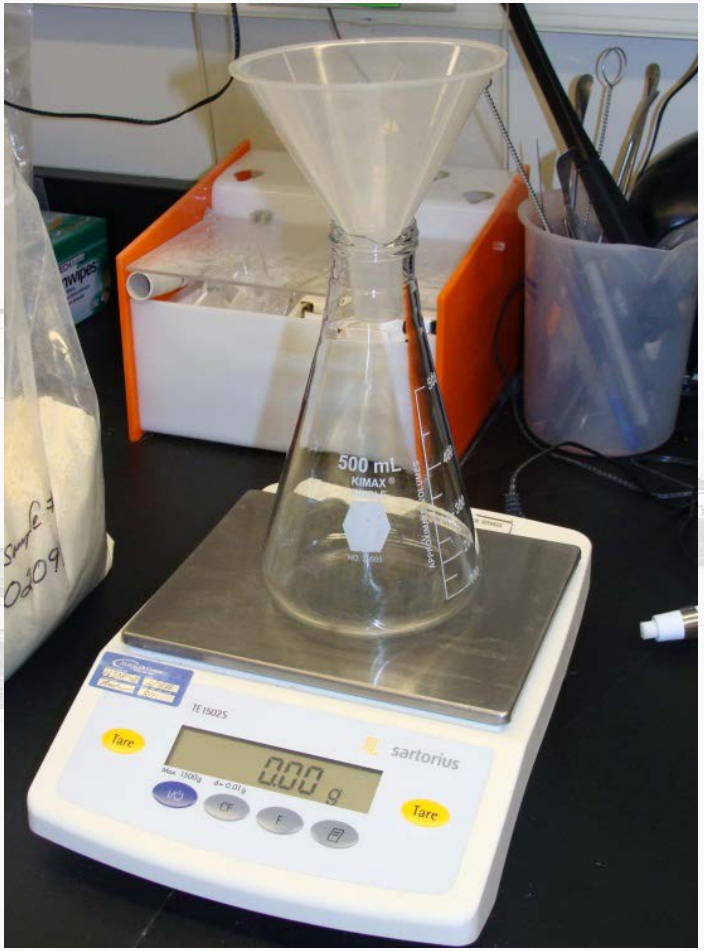


Company B

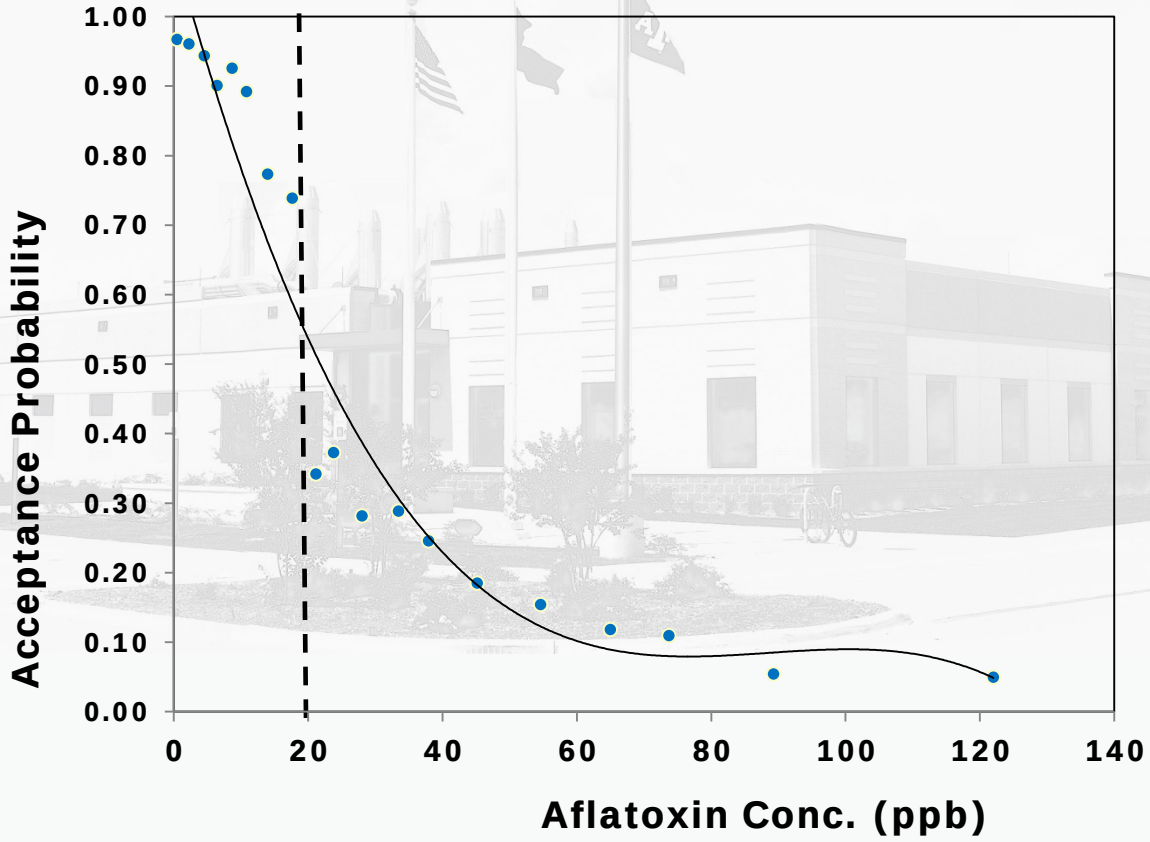


OTSC Monitoring

- Employee performance
- Equipment performance
  - Grinder check
  - Lab scale check
- Control standard record
- Retained sample analysis in an ISO 17025 accredited lab



Performance curve for 2013-2015



Inference about the population

SAMPLING

Variance Structure of Aflatoxin Contaminated Maize in Commercial Grain Elevators and Transporters

Variance Source	Percent of Total Variance
Facility	1.9
Bin	65.8
Truck	9.1
Sampling and Testing Error	23.2

Herrman et al. JRS 1(1):23-31

Variance Structure of Aflatoxin Contaminated Maize in Commercial Maize Mills in Kenya

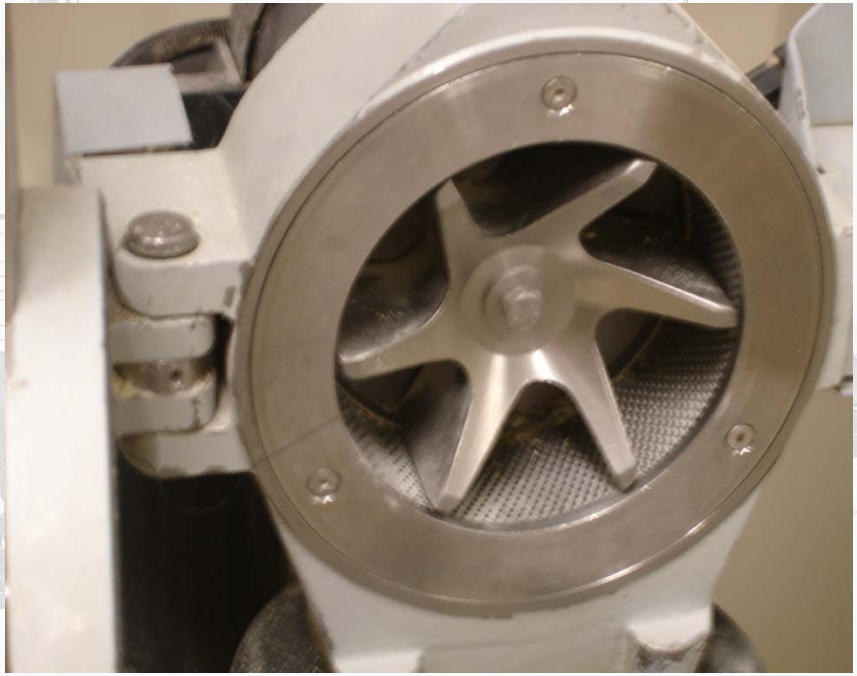
Variance Source	Percent of Total Variance
Mill	0
Truck	7.8
Bag	33.3
Within bag	50.1
Analytical	3.4
Error	5.4

Retaining the representative property of the sample

GRINDING

Sample Grinding

Sample Grinding

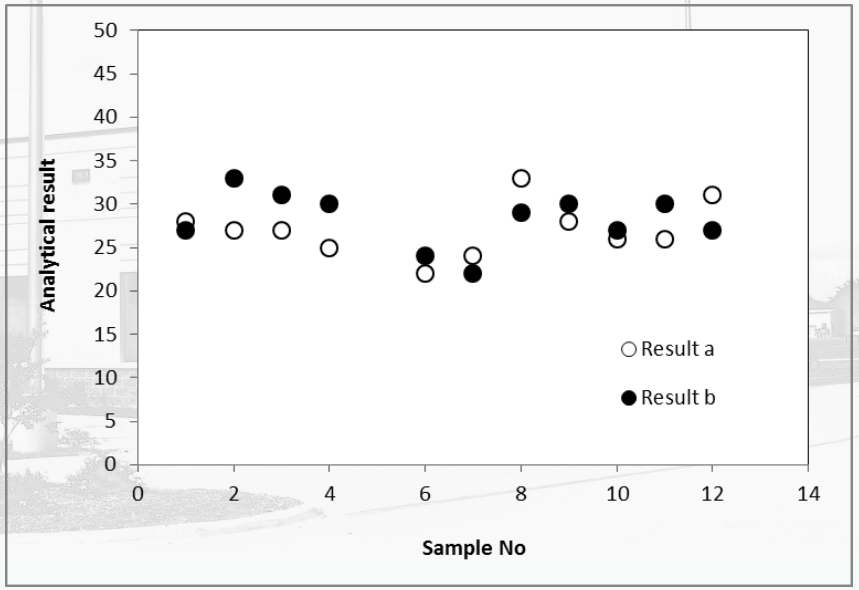


Developing uniform working controls

REFERENCE MATERIAL

Recommendation 9: Sufficient Homogeneity

In testing for sufficient homogeneity, duplicate results from a single distribution unit should be deleted before the analysis of variance if they are shown to be significantly different from each other by Cochran's test at the 99% level of confidence



Sufficient stability

Changes in test material are inconsequential

Period in question is the interval between preparation of the material and the deadline for return of the results

5 samples will be analyzed after the proficiency test

Laboratory uncertainty

UNCERTAINTY & VARIABILITY

Uncertainty

ISO 17025 5.4.6.2

- Testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement…
- Reasonable estimation shall be based on knowledge of the performance of the method and on the measurement scope and shall make use of, for example, previous experience and validation data

Uncertainty Budget

- List all potential factors affecting variability in measurements –make table
- Determine the standard uncertainty for each factor including distribution
- Perform root sum squares for all factors to create the combined or standard uncertainty

$$S_I = \sqrt{S_a{}^2 + S_b{}^2 \ldots S_x{}^2}$$

- Multiply by coverage factor: 2

OTSC Uncertainty Measurement Estimation

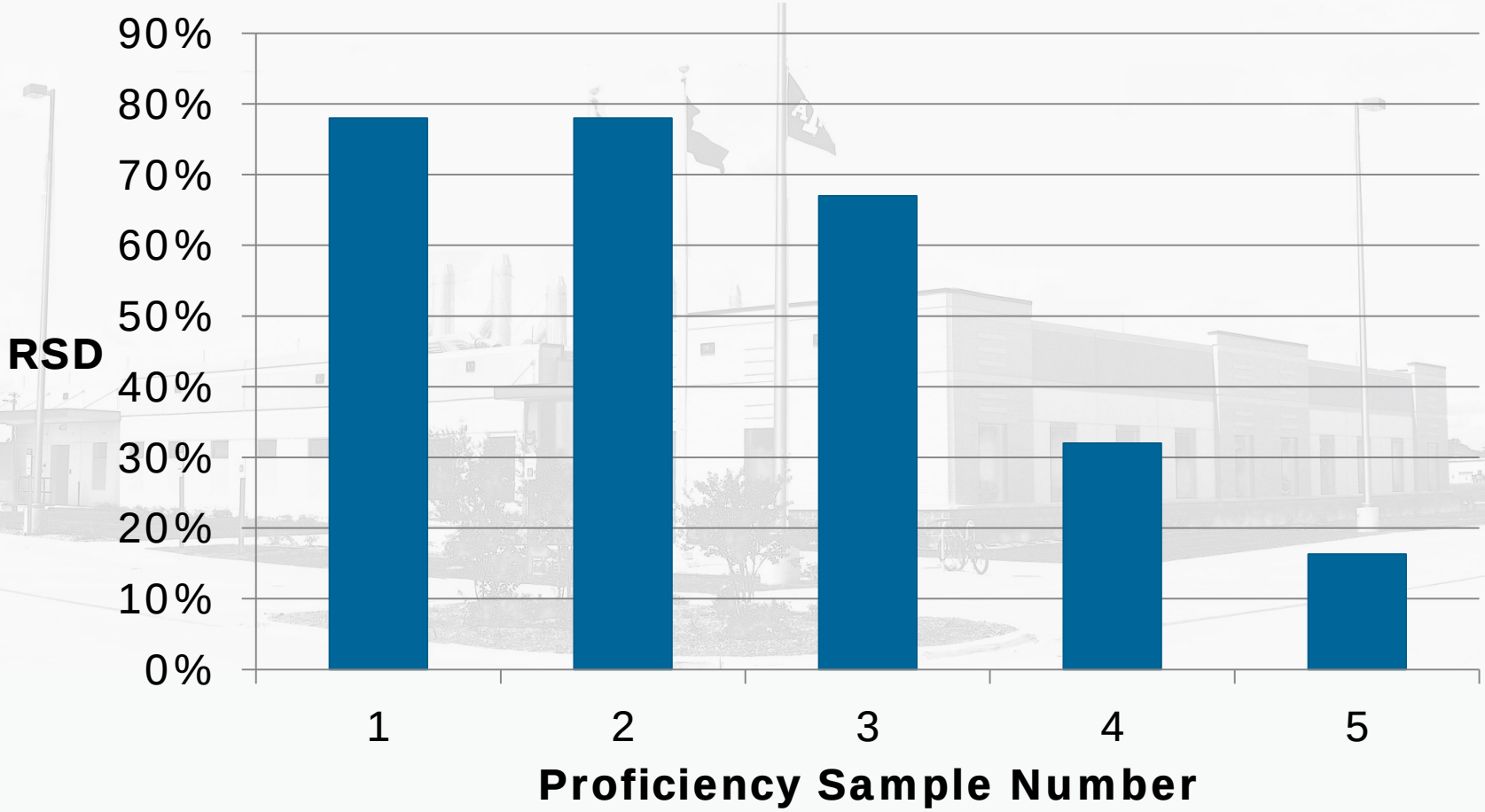
Analyte	Procedure	Mean	Std. Dev.	CV	Uncertainty
Aflatoxin	HPLC	21.6	2.2	10.1	20.2
Aflatoxin	ELISA	24.6	3.7	15.1	30.3
Aflatoxin	LC/MS/MS	22.7	3.0	13.4	26.8
Aflatoxin	UHPLC	21.8	3.3	15.0	30.1
Aflatoxin	Fluoroquant	22.5	3.2	14.0	28.0
Fumonisin	LC/MS/MS	7.8	0.08	8.8	17.7

One of the Big Three

PROFICIENCY TEST RESULTS


APTECA Proficiency Testing Program
Corn Meal Sample #4

Proficiency Testing Performance



APTECA group qualification exercises

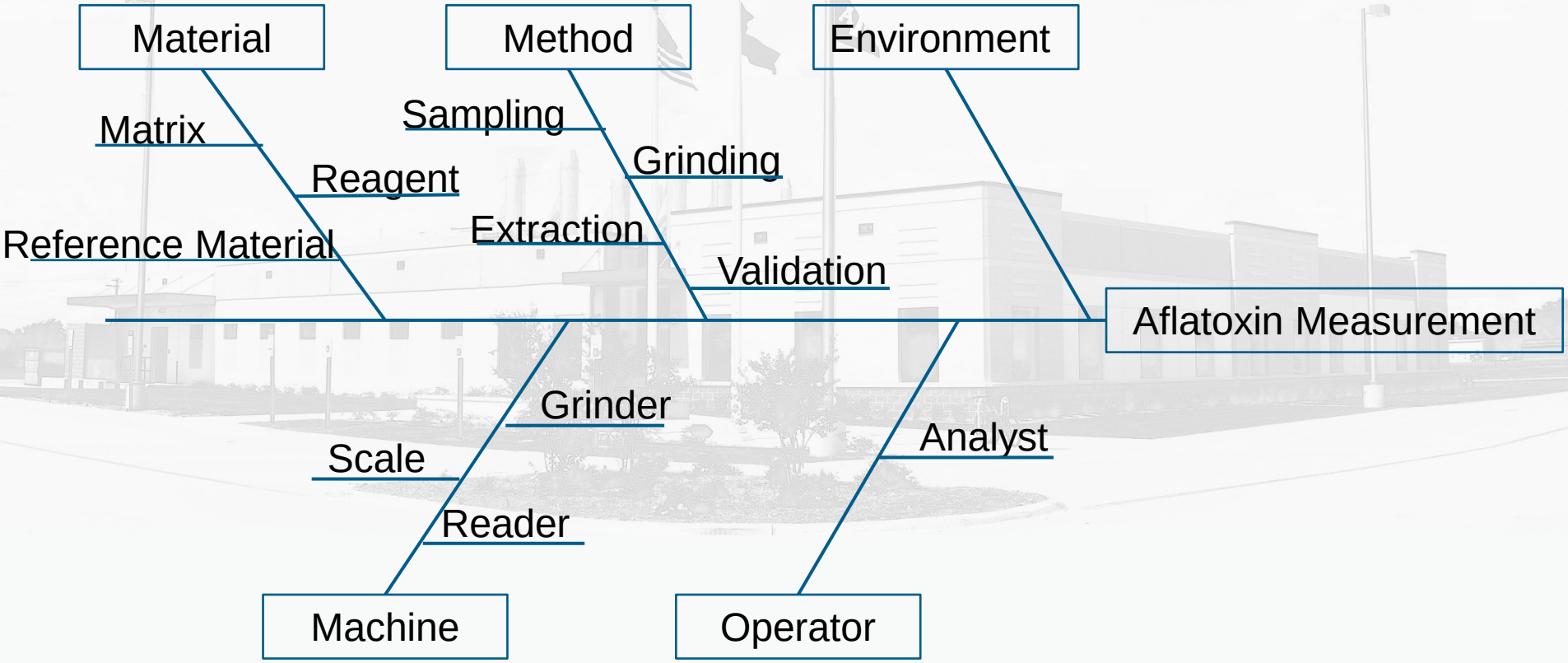
LABORATORY ENVIRONMENT


NILE GOLD
BEYOND AN ORDINARY MALT.

Sources of Variability

SUMMARY

Cause and Effect Diagram



Uncertainty Budget for Total Variability

Sources of Variability

- Sampling CV = 82%
- Test method CV = 46%
- Analyst CV = 32%

Uncertainty Budget

Worse Case

$$S_I = \sqrt{S_a{}^2 + S_b{}^2 \ldots S_x{}^2}$$

$$S_I = \sqrt{82_a{}^2 + 46_b{}^2 + 32_c{}^2}$$

$$S = 99\%$$

Uncertainty Budget for Total Variability

Sources of Variability

- Sampling CV = 23%
- Test method CV = 16%
- Analyst CV = 16%

Best Case

Uncertainty Budget

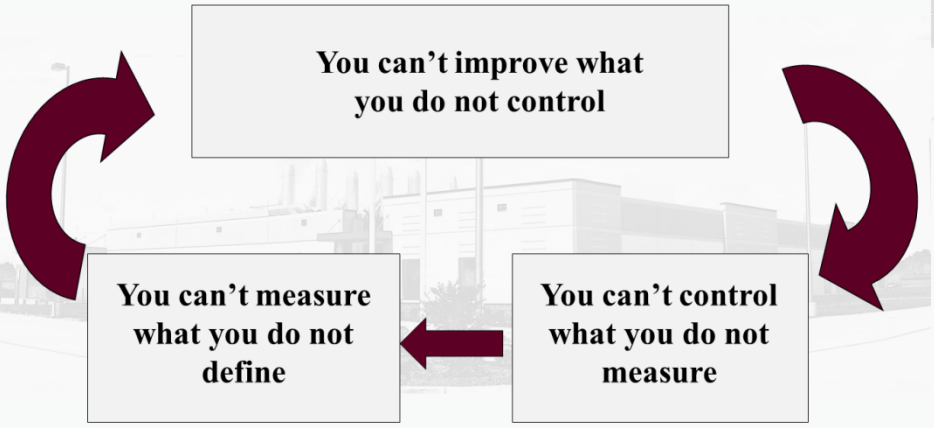
$$S_I = \sqrt{S_a{}^2 + S_b{}^2 \ldots S_x{}^2}$$

$$S_I = \sqrt{23_a{}^2 + 16_b{}^2 + 16_c{}^2}$$

$$S = 32\%$$

SOURCES OF VARIABILITY IN MEASURING AFLATOXIN AND THE ROLE OF SAMPLING

A continuous improvement approach to define, measure, and control aflatoxin helped reduce food safety risk.



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