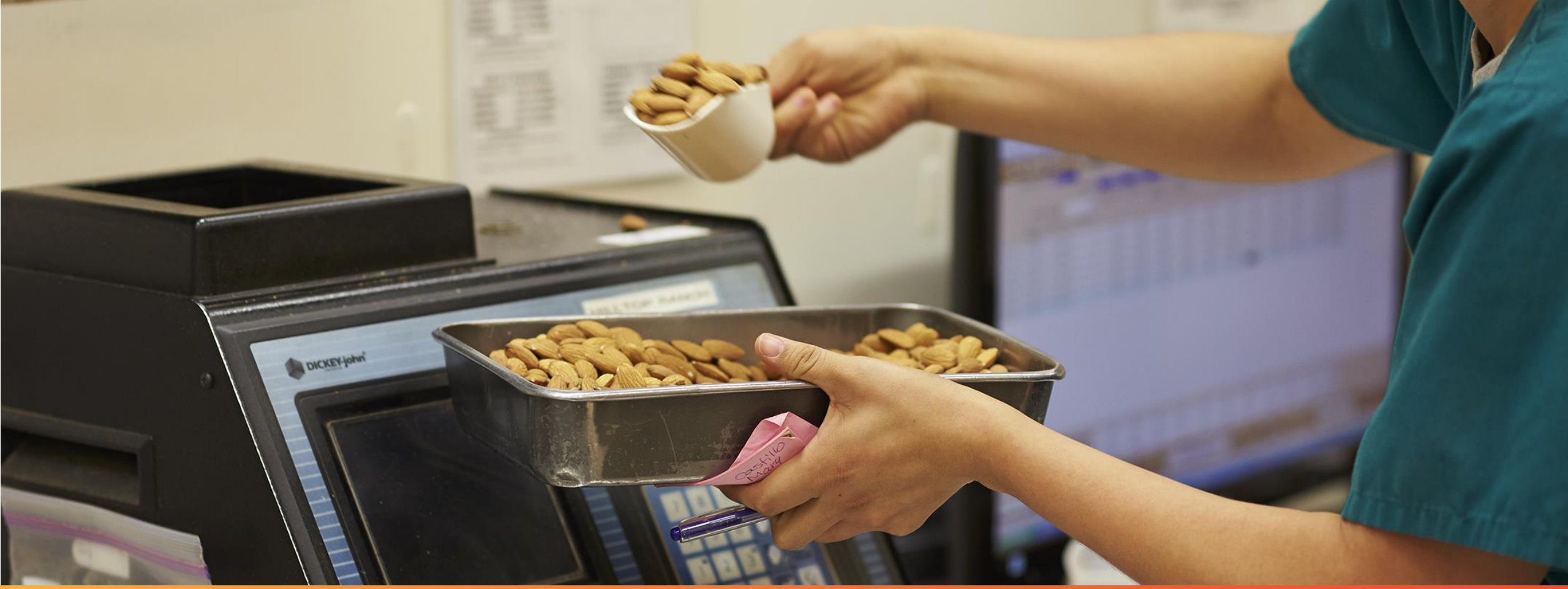


2018 | THE ALMOND CONFERENCE

THE ALMOND AFLATOXIN MENACE: ADDRESSING IT HEAD ON

ROOM 306-307 | DECEMBER 4, 2018

california almonds
Almond Board of California

growing ADVANTAGE
The Almond Conference

AGENDA

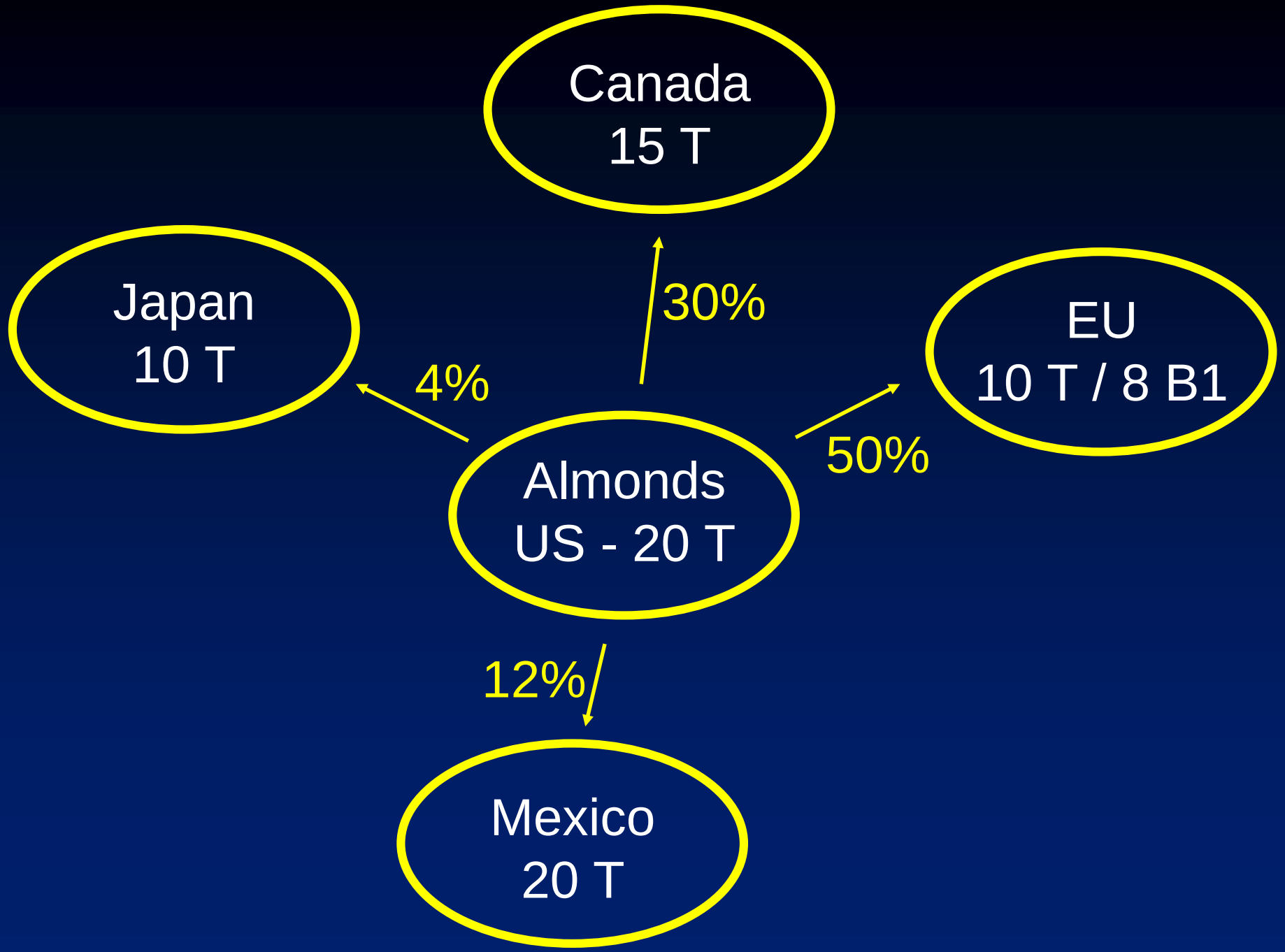
- **Tim Birmingham**, Almond Board of California, moderator
- **Tom Whitaker**, NC State / USDA

The Aflatoxin Menace
- Addressing Head on -

Tom Whitaker
USDA/ARS Retired
Professor Emeritus
NC State University

Aspergillus flavus

4


Canada
15 T
30%
Japan
10 T
4%
EU
10 T / 8 B1
50%
Almonds
US - 20 T
12%
Mexico
20 T

US Exporter

Customer Importer

Aflatoxin Concentration = ?

ABC Staff & Industry Have Been Proactive in Developing Programs that Produce Information to Better Manage Aflatoxin

Aflatoxin Studies

1) Aflatoxin Risk Categories
2) Sorting Efficiency
3) Sample Accuracy and Precision
4) Codex Aflatoxin Standard MLs/Samp Plans/Tree nut
5) B1/Total Aflatoxins Ratio
6) VASP/PEC – EU
7) Aflatoxin by Product Category
8) Method to Reduce Lots Rejected at Destination

Aflatoxin Risk Categories

Where is the Aflatoxin?

- Poor vs good quality nuts
- Grade factors

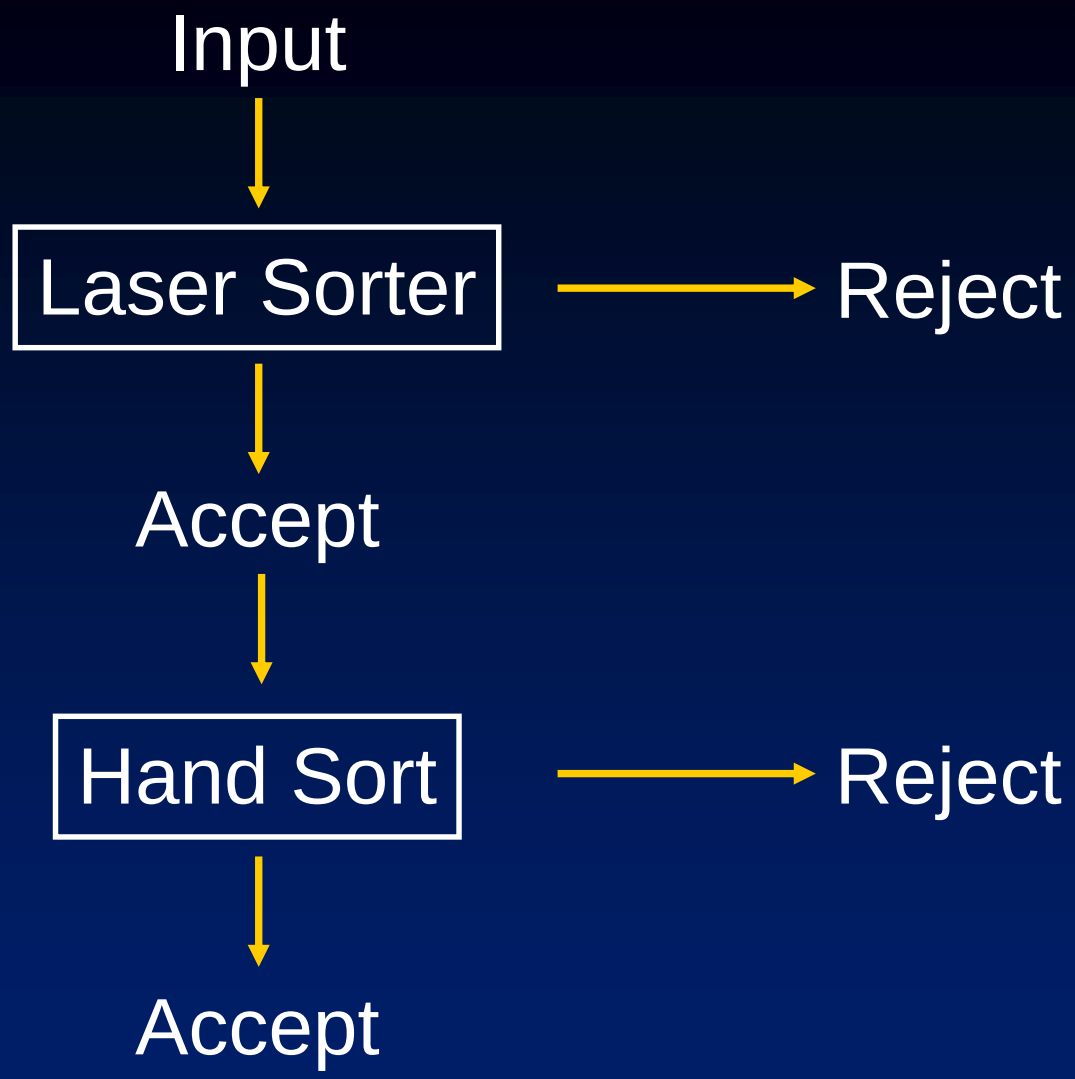
Average of 50 Lots

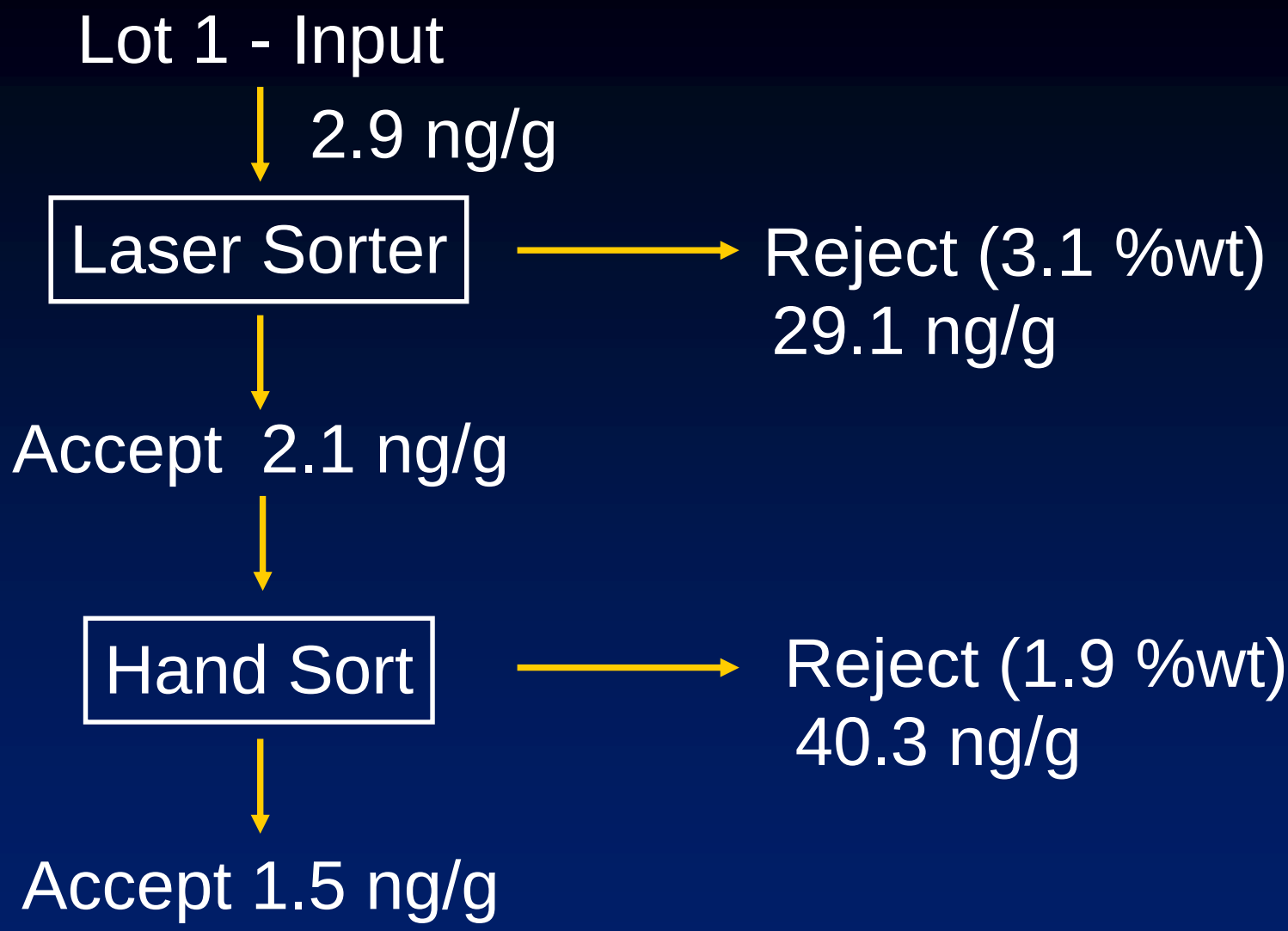
Grade Category	Weight (%)	Aflatoxin (%)
High Quality	83.7	3.2
Mechanical	7.4	7.9
Insect	7.2	76.3
Other defect	1.5	11.8
Mold	0.2	0.8
Total	100.0	100.0

Average of 50 Lots

Grade Category	Weight (%)	Aflatoxin (%)
High Quality	83.7	3.2
Poor Quality	16.3	96.8
Total	100.0	100.0

Efficiency of Electronic and Hand Sorting at Removing Aflatoxin Contaminated Almonds


Input
Laser Sorter
Reject
Accept
Hand Sort
Reject
Accept


Lot 1 - Input
2.9 ng/g
Laser Sorter
Reject (3.1 %wt)
29.1 ng/g
Accept 2.1 ng/g
Hand Sort
Reject (1.9 %wt)
40.3 ng/g
Accept 1.5 ng/g

Avg Aflat. In Lots Exiting Handler

Crop Year	Lots Tested	Aflat. (ppb)
2007	15,022	0.48
2008	13,208	0.45
2009	10,007	0.59
2010	12,611	0.32
2011	13,580	0.27
2012	13,700	0.38
2013	15,028	0.33

VASP/PEC

Industry-wide export aflatoxin sampling program to reduce the number of U.S. lots rejected by the EU

US Export Aflatoxin Sampling Plan (VASP) RTE Almond Lots

Year	U.S. Plan	EU Limit
2007-10	3x5 kg ≤ 2T	2B1/4T

EU Plan before March 2010 - 3x10 kg ≤ 2B1/4T

Codex Standard for Tree Nuts
ML & Sampling Plan (2010)

RTE: 2x10kg<10 ppb T
DFP: 1x20kg<15 ppb T

T=Total aflatoxins - No B1

EU adds B1 ML to Codex Std

Ratio B1/Total Aflatoxin
Total=B1+B2+G1+G2

B1/Total Ratio

- Samples Tested – 2,656 (T >0.5 ppb)
- Mean Ratio (%) - 86.4
- Median Ratio (%) - 100.0
- Distribution - Negatively Skewed

US Export Aflatoxin Sampling Plan (VASP) RTE Almond Lots

Year	U.S. Plan	EU Limit
< 2010	3x5 kg ≤ 2T	2B1/4T
>2010	2x10 kg ≤ 8B1/10T	8B1/10T

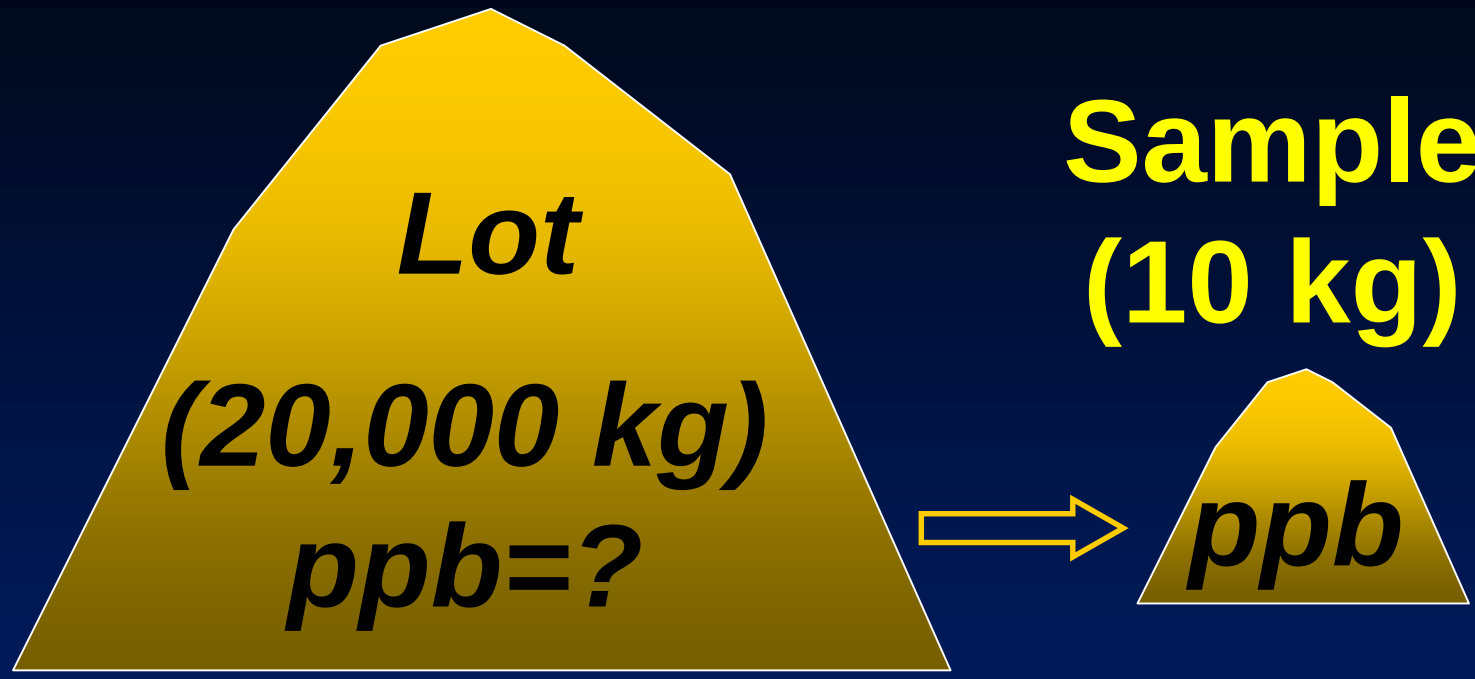
EU Before March 2010 - 3x10 kg ≤ 2B1/4T
EU After March 2010 - 2x10 kg ≤ 8B1/10T

VASP % Lots Accepted & Rejected

Crop Year	Lots Tested	Accept (%)	Reject (%)
2007	15,022	94.77	5.23
2008	13,208	95.33	4.67
2009	10,007	94.87	5.13
2010	**12,611**	**98.72**	**1.29**
2011	**13,580**	**98.88**	**1.12**
2012	**13,700**	**98.41**	**1.59**
2013	**15,028**	**98.76**	**1.24**

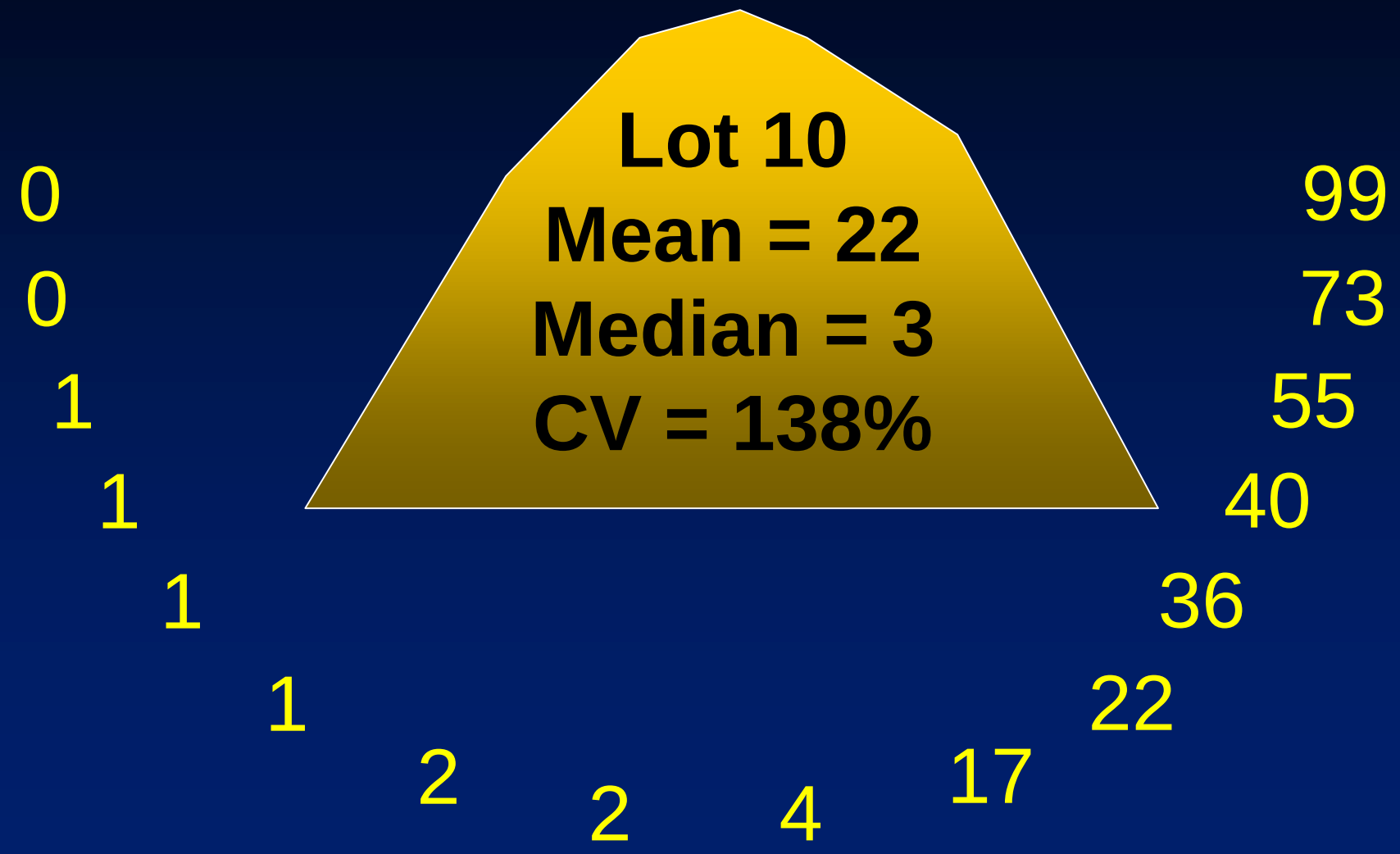
Sampling Studies

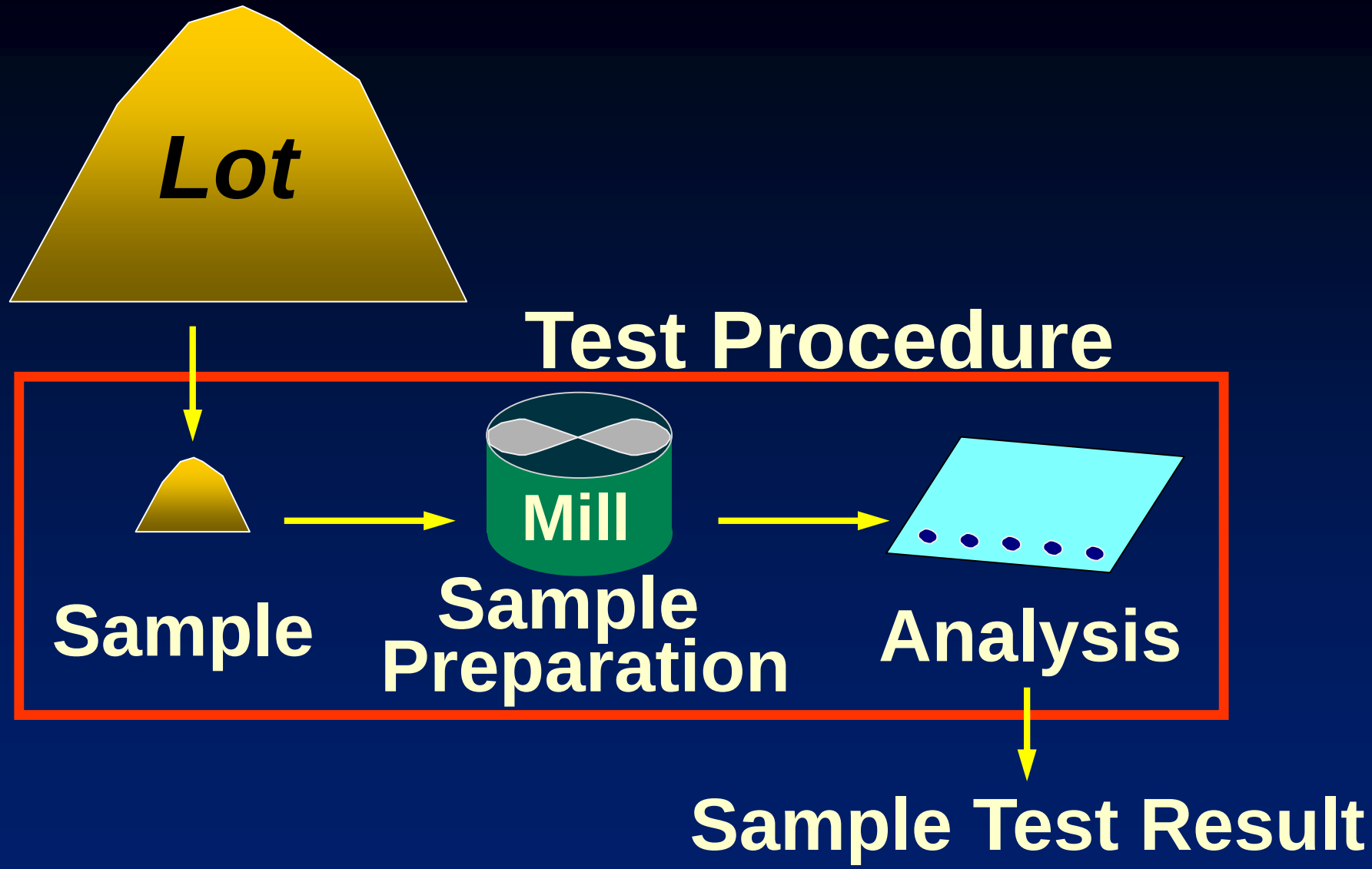
How accurately and precisely does sample ppb estimate the true lot ppb?



- **Lot ppb = Sample ppb ?**
- **Sample ppb ≤ Regulatory Limit**

16x10 kg Almonds Samples




Lot
Test Procedure
Mill
Sample
Sample Preparation
Analysis
Sample Test Result

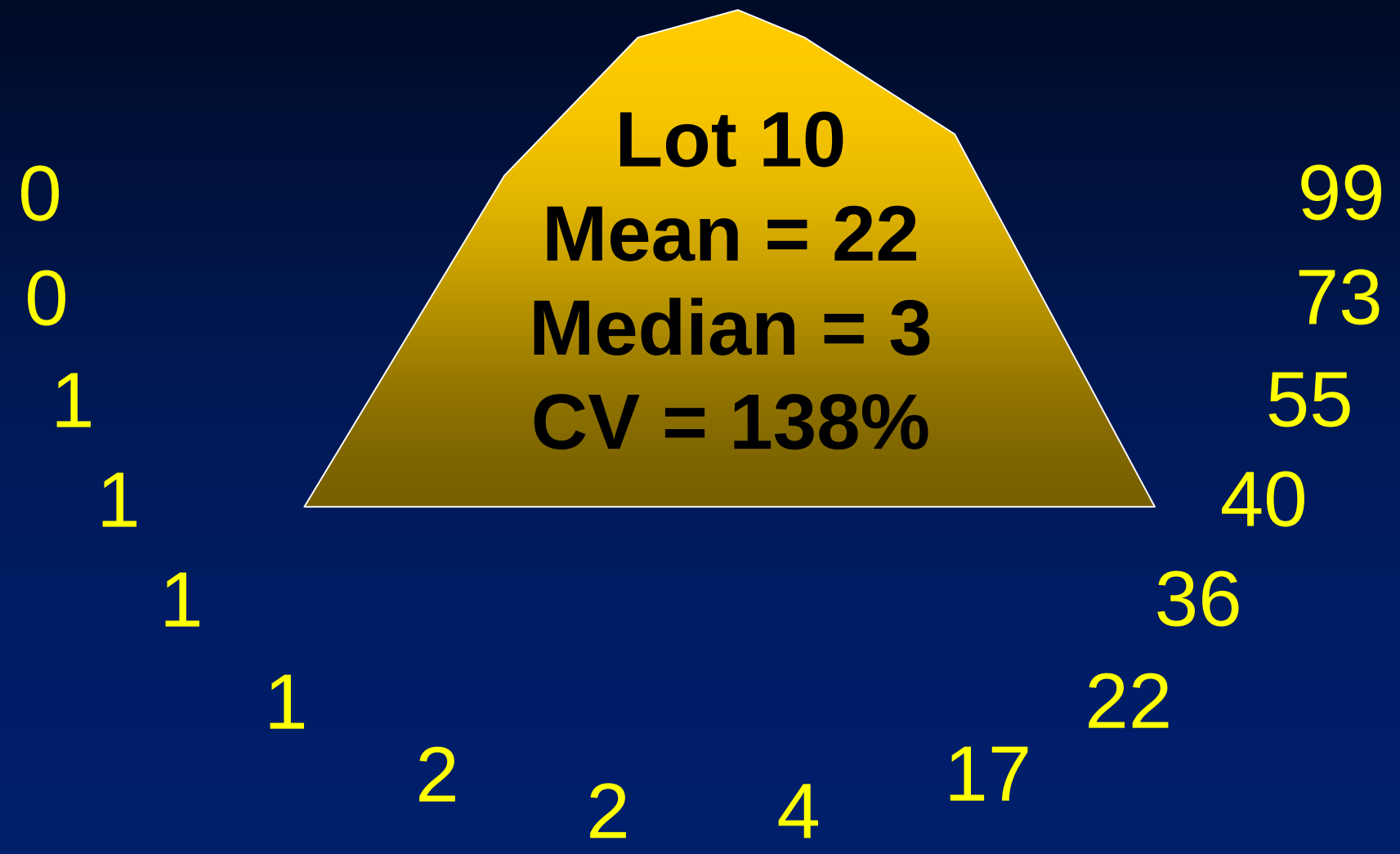
Almond Lot Aflatoxin = 10 ppb

Test Procedure	Size	Variance	Ratio (%)
Sample-kg	10	209.6	94.4
Test Port.-g	100	12.0	5.4
HPLC-Aliq	1	0.4	0.2
Total		222.0	100.0

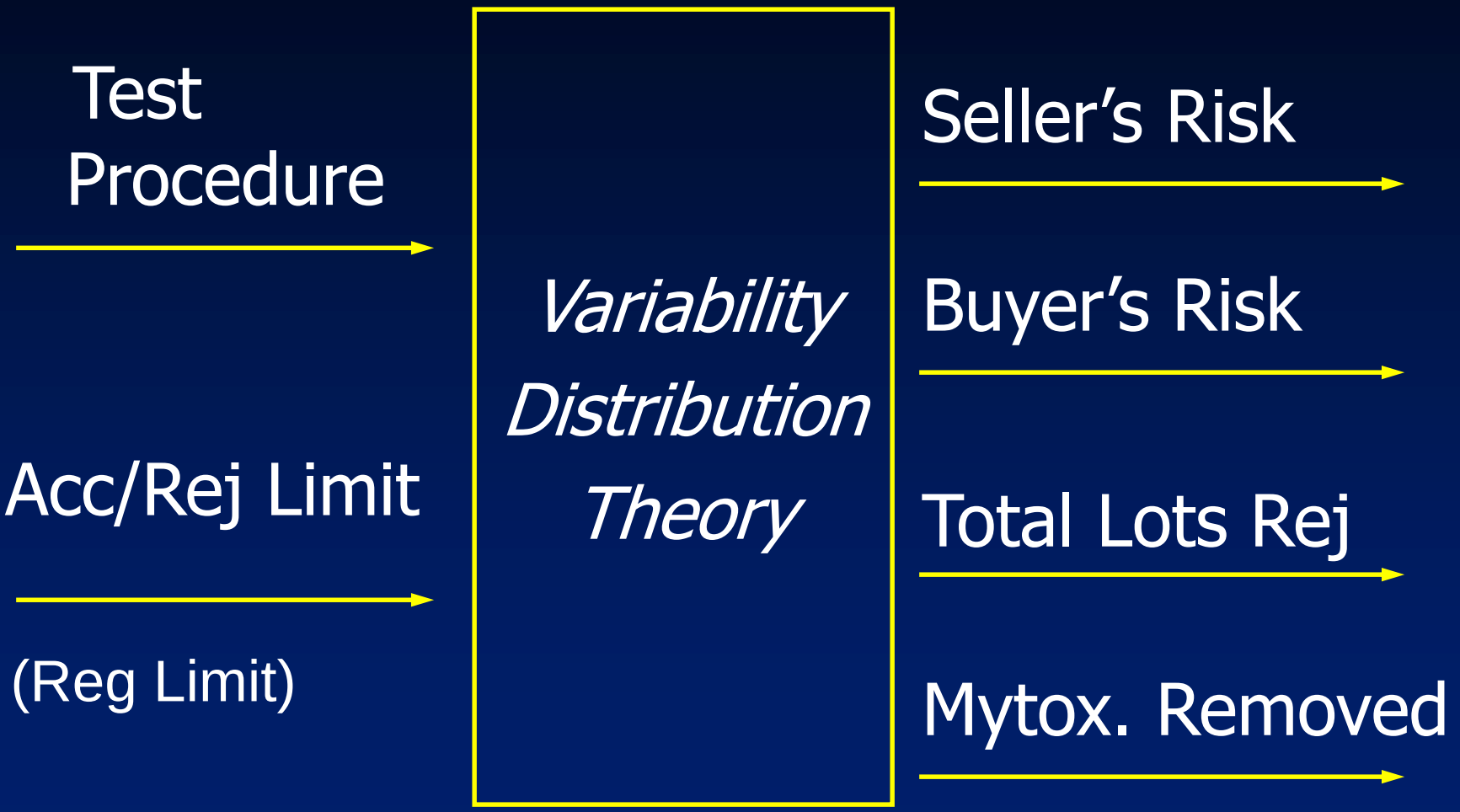
Variability Leads to Misclassification of Lots

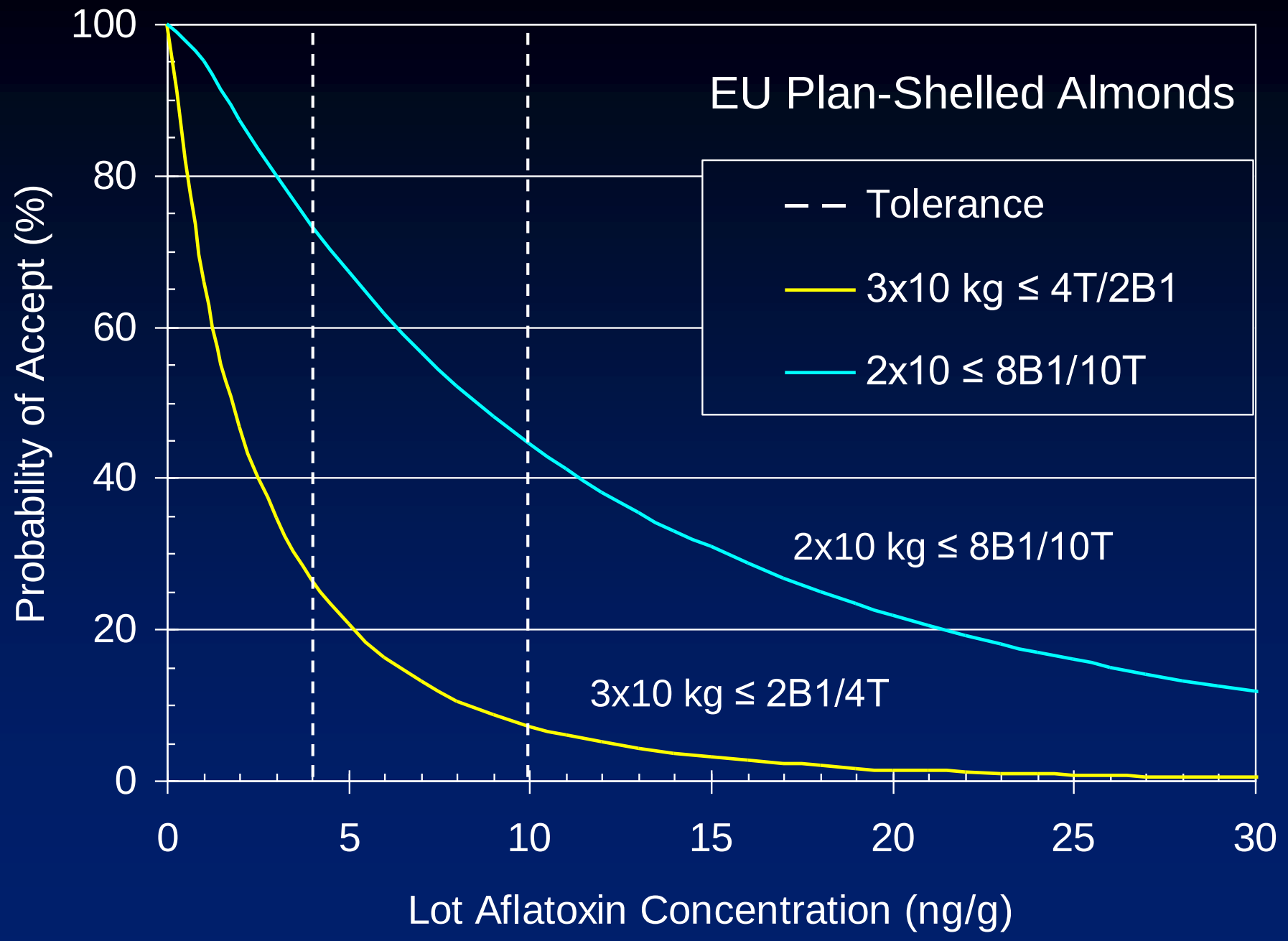
- Good lots rejected
  - (Exporter's risk)
- Bad lots accepted
  - (Importer's risk)

16x10 kg Almonds Samples



Sampling Plan Evaluation Method (OC Development)




EU Plan-Shelled Almonds
Tolerance
3x10 kg ≤ 4T/2B1
2x10 ≤ 8B1/10T
2x10 kg ≤ 8B1/10T
3x10 kg ≤ 2B1/4T
Probability of Accept (%)
100
80
60
40
20
0
0
5
10
15
20
25
30
Lot Aflatoxin Concentration (ng/g)

FAO Mycotoxin Sampling Tool (Food Safety Risk Analysis Tools)

http://www.fstools.org/mycotoxins/

*Based upon USDA/ARS Model

Develop a method to predict the number of U.S. almond lots rejected by the EU at destination

Rejects reflect:

1) Aflatoxin level in lots tested in US

2) Design of US export sampling plan

3) Design of EU import sampling plan

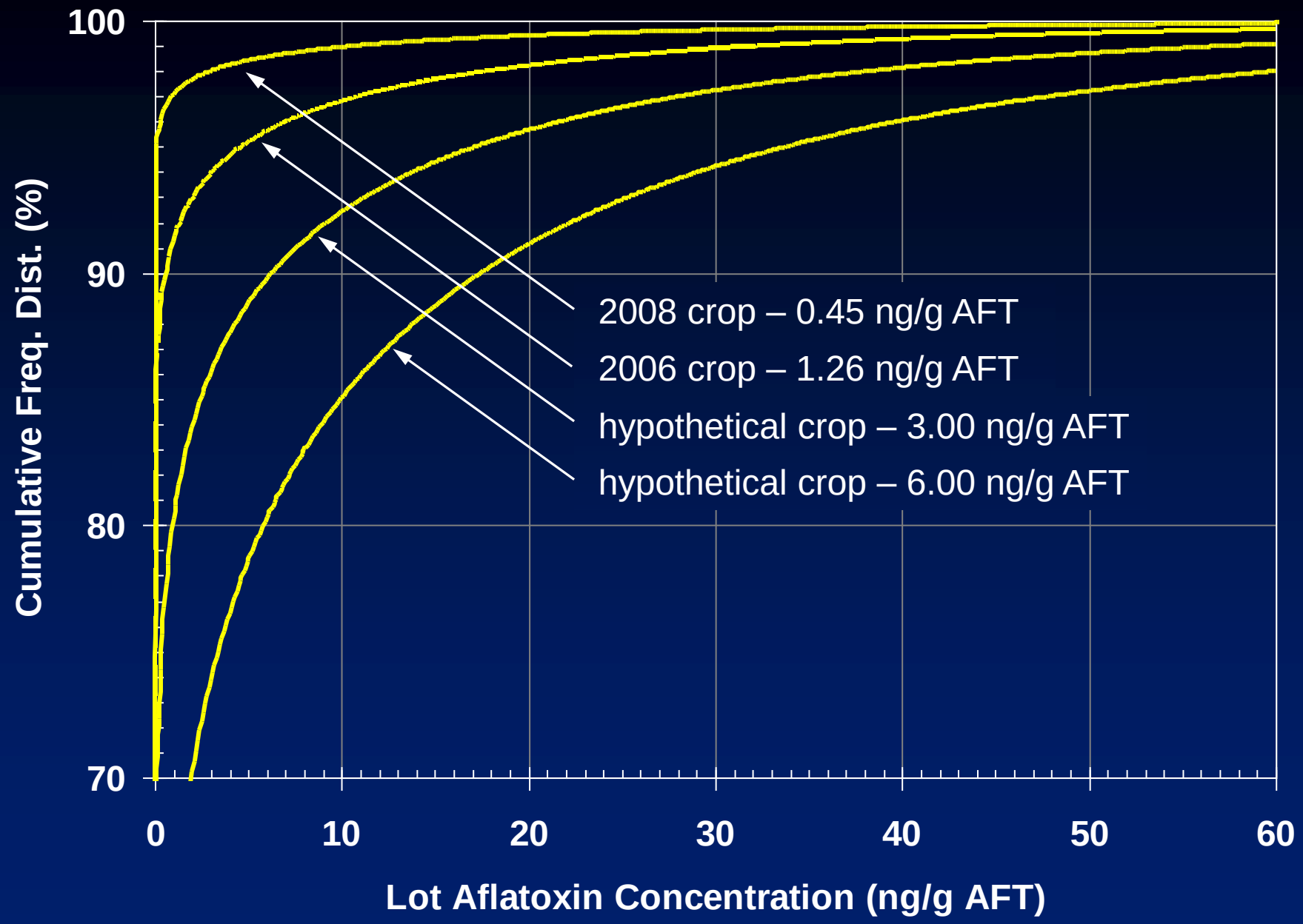
Objectives

1) Determine effect of U.S. aflatoxin levels and PEC sampling plan on lot rejected in the EU

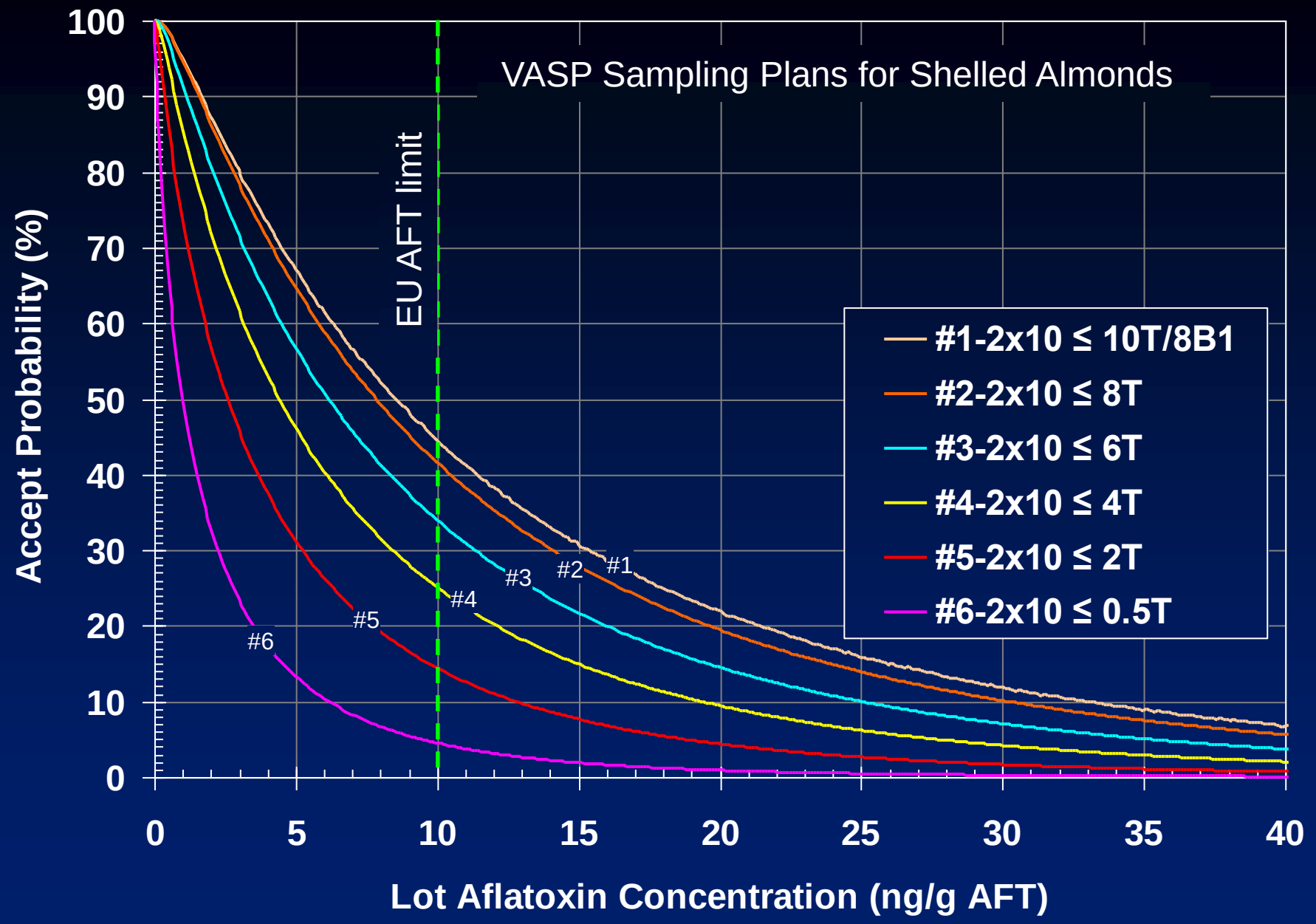
2) Using PEC sample test results, predict at time of U.S. testing the % US lots that will be rejected at a later date in the EU

3) Modify PEC sampling plan to keep U.S. lots rejected in the EU to acceptable levels


A
Aflatoxin Distribution Among Lots
At Origin
B
U.S. Aflatoxin Export
Sampling Plan (100%)
F
Lots Rejected
At Origin
C
Lots Accepted for Export
To EU
D
EU Aflatoxin Sampling Plan
(1-10% Testing Rate)
G
Lots Rejected
At Destination
E
Lots Accepted
At Destination

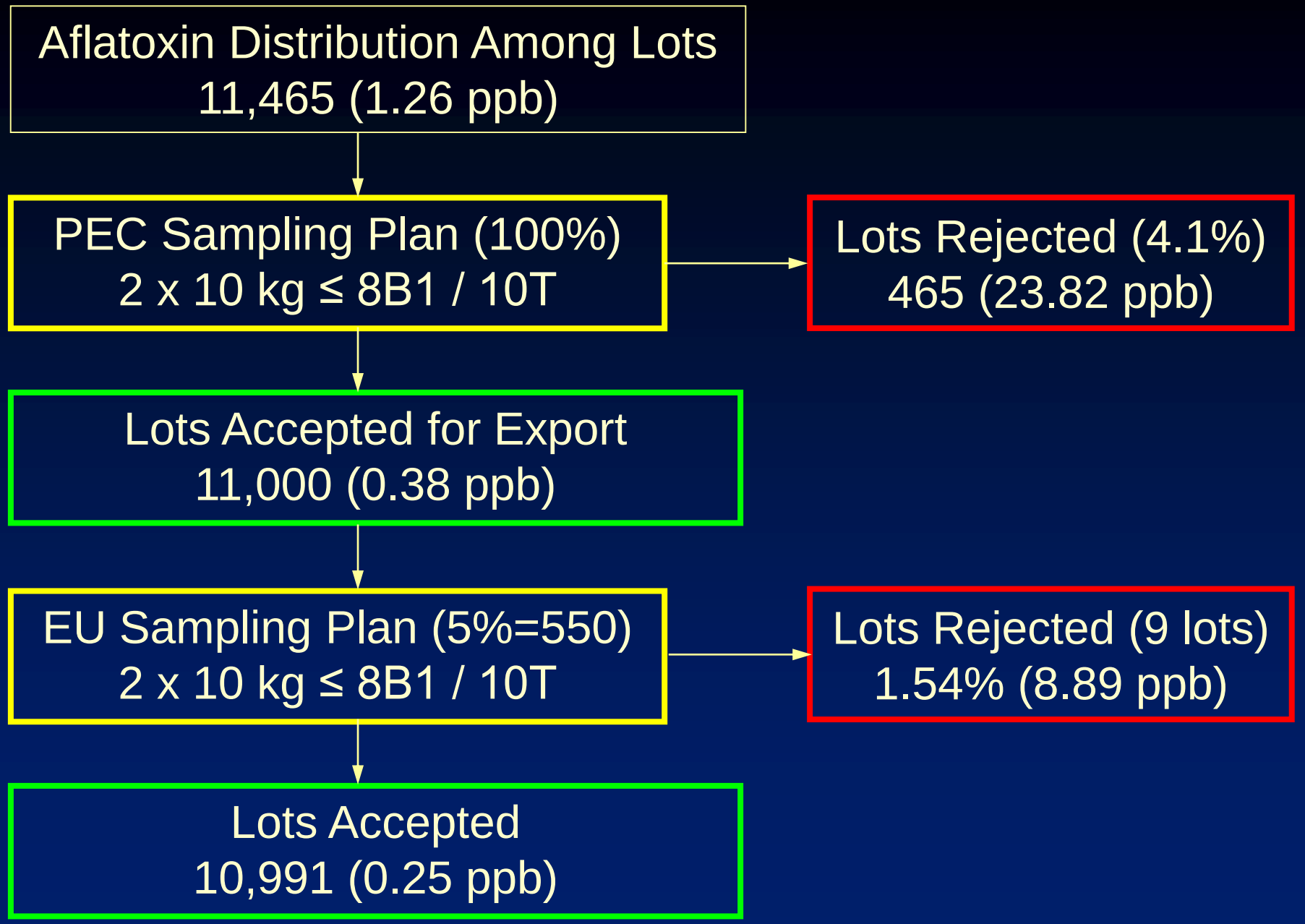

100
90
80
70
Cumulative Freq. Dist. (%)
0
10
20
30
40
50
60
Lot Aflatoxin Concentration (ng/g AFT)
2008 crop – 0.45 ng/g AFT
2006 crop – 1.26 ng/g AFT
hypothetical crop – 3.00 ng/g AFT
hypothetical crop – 6.00 ng/g AFT

US1/EU	2x10 kg ≤ 8B1/10T
US2	2x10 kg ≤ 8T
US3	2x10 kg ≤ 6T
US4	2x10 kg ≤ 4T
US5	2x10 kg ≤ 2T
US6	2x10 kg ≤ 0.5T

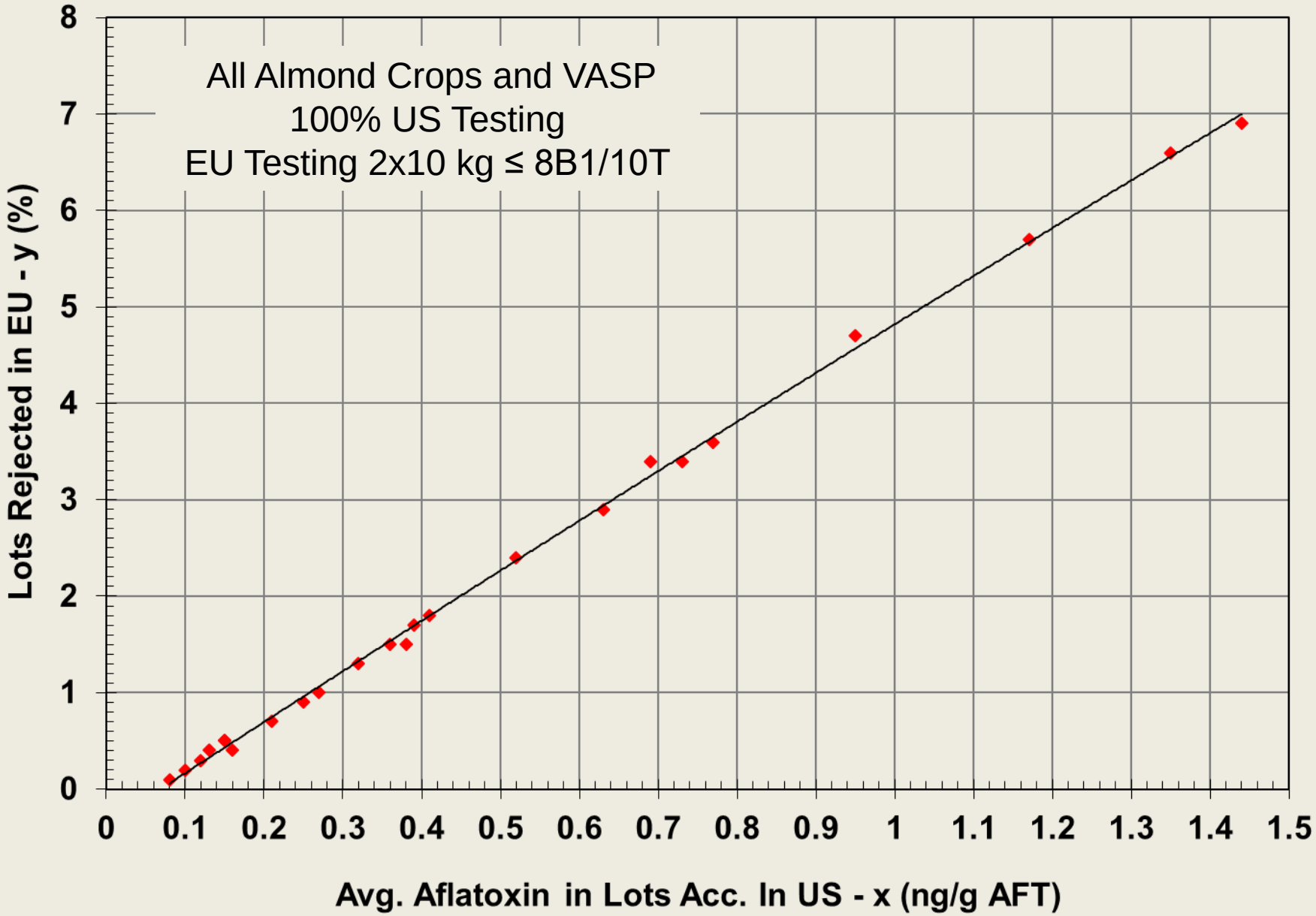

VASP Sampling Plans for Shelled Almonds
EU AFT limit
Accept Probability (%)
Lot Aflatoxin Concentration (ng/g AFT)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
#1-2x10 ≤ 10T/8B1
#2-2x10 ≤ 8T
#3-2x10 ≤ 6T
#4-2x10 ≤ 4T
#5-2x10 ≤ 2T
#6-2x10 ≤ 0.5T
#1
#2
#3
#4
#5
#6

US Plans 2x10 kg	US Lot Contamination (ppb)			
	0.42	1.26	3.00	6.00
8B1 / 10T				
8T				
6T				
4T				
2T				
0.5T				

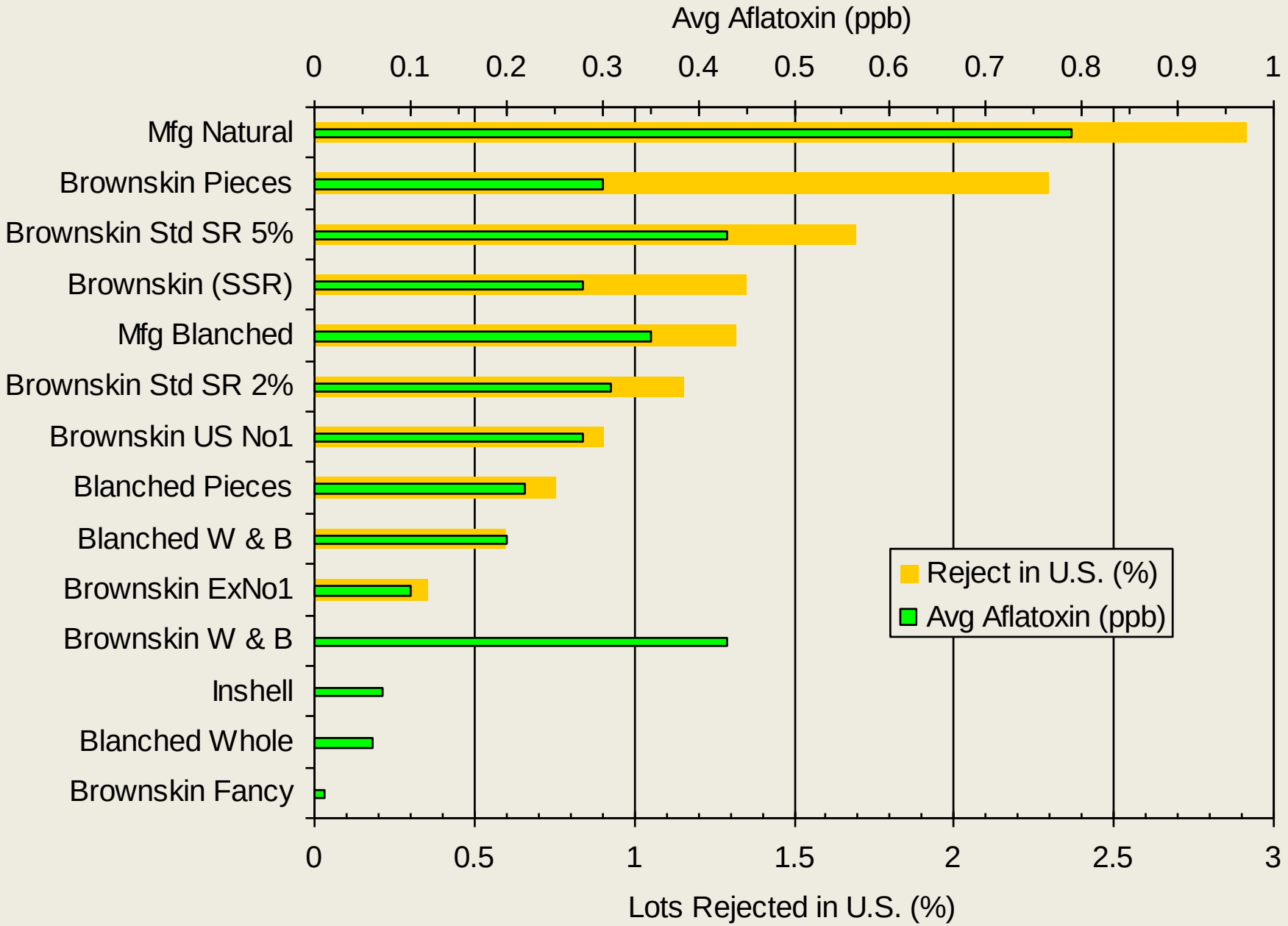
- % lots acc/rej in US
- Avg. AFT in acc/rej lots in US
- % lots acc/rej in EU
- Avg. AF in acc/rej lots in EU


Aflatoxin Distribution Among Lots
11,465 (1.26 ppb)
PEC Sampling Plan (100%)
2 x 10 kg ≤ 8B1 / 10T
Lots Rejected (4.1%)
465 (23.82 ppb)
Lots Accepted for Export
11,000 (0.38 ppb)
EU Sampling Plan (5%=550)
2 x 10 kg ≤ 8B1 / 10T
Lots Rejected (9 lots)
1.54% (8.89 ppb)
Lots Accepted
10,991 (0.25 ppb)

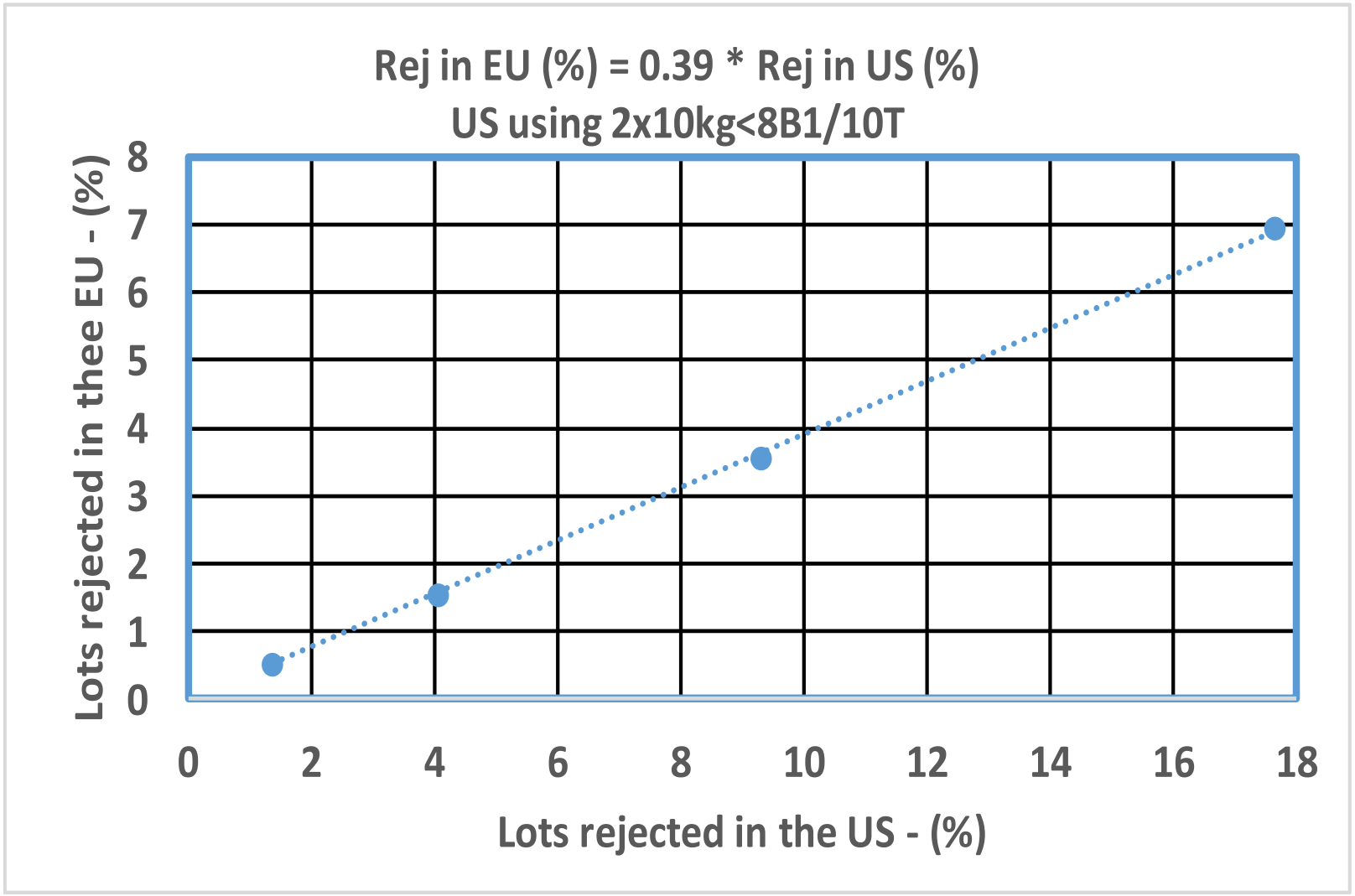
US Aflat Level (ppb)	US Rej (%)	Avg Aflat in Exports (ppb)	Rej in EU (%)
0.42	1.36	0.15	0.51
1.26	4.06	0.38	1.54
3.00	9.31	0.77	3.56
6.00	17.66	1.44	6.94
US=2x10kg<8B1/10T			


All Almond Crops and VASP
100% US Testing
EU Testing 2x10 kg ≤ 8B1/10T
Lots Rejected in EU - y (%)
0
1
2
3
4
5
6
7
8
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
Avg. Aflatoxin in Lots Acc. In US - x (ng/g AFT)

2010 Crop Contamination By Product Category



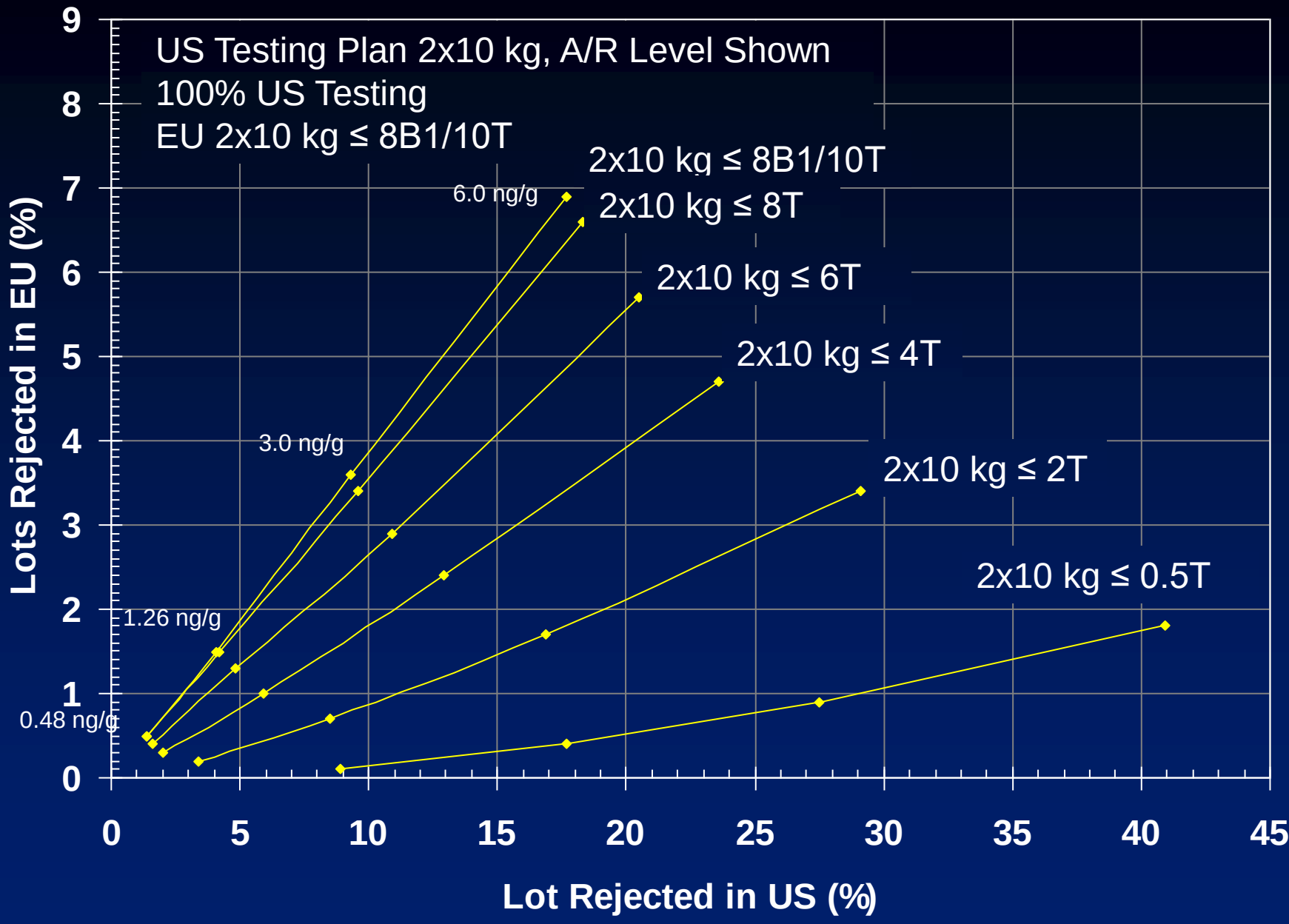
US Aflat Level (ppb)	US Rej (%)	Avg Aflat in Exports (ppb)	Rej in EU (%)
0.42	1.36	0.15	0.51
1.26	4.06	0.38	1.54
3.00	9.31	0.77	3.56
6.00	17.66	1.44	6.94
US=2x10kg<8B1/10T			


Rej in EU (%) = 0.39 * Rej in US (%)
US using 2x10kg<8B1/10T
Lots rejected in thee EU - (%)
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
14
16
18
Lots rejected in the US - (%)

US Lots Rejected in EU (%)

US Plans 2x10 kg	US Lot Contamination (ng/g)			
	0.42	1.26	3.00	6.00
8B1 / 10T	0.51	1.54	3.56	6.94
8T	0.48	1.46	3.38	6.54
6T	0.42	1.26	2.92	5.74
4T	0.34	1.03	2.38	4.71
2T	0.24	0.73	1.69	3.37
0.5T	0.13	0.40	0.91	1.85


A
Aflatoxin Distribution Among Lots
At Origin
B
U.S. Aflatoxin Export
Sampling Plan (100%)
F
Lots Rejected
At Origin
C
Lots Accepted for Export
To EU
D
EU Aflatoxin Sampling Plan
2x10 kg ≤ 8B1/10T
G
Lots Rejected
At Destination-RAFF
E
Lots Accepted
At Destination


US Testing Plan 2x10 kg, A/R Level Shown
100% US Testing
EU 2x10 kg ≤ 8B1/10T
2x10 kg ≤ 8B1/10T
2x10 kg ≤ 8T
2x10 kg ≤ 6T
2x10 kg ≤ 4T
2x10 kg ≤ 2T
2x10 kg ≤ 0.5T
6.0 ng/g
3.0 ng/g
1.26 ng/g
0.48 ng/g
Lots Rejected in EU (%)
Lot Rejected in US (%)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
45

Crop (CY)	# Lots Tested	# Lots Accepted	# Lots Failed	% Failed	% Accept	Aflatoxin Levels (PPB			% Insect Damage
						Avg. Afla (all lots tested	Avg. Afla (Failed Lots)	Avg. Afla (Accepted Lots)	
2015 (15/16)	13870	13644	226	1.63%	98.37%	0.63	19.89	0.24	1.30%
2016 (16/17)	14648	14387	261	1.78%	98.22%	0.59	17.68	0.24	1.20%
2017 (17/18)	15224	14263	961	6.31%	93.69%	1.48	17.73	0.35	2.40%
2018 (18/19)	1499	1409	90	6.00%	94.00%	1.05	13.09	0.29	1.70%

2015 to 2017 –> 2x10kg<8B1/10T

2018 -> 2x10kg<5T

US Aflat Level (ppb)	US Rej (%)	Avg Aflat in Exports (ppb)	Rej in EU (%)
0.42	1.36	0.15	0.51
1.26	4.06	0.38	1.54
3.00	9.31	0.77	3.56
6.00	17.66	1.44	6.94
US=2x10kg<8B1/10T			

Thank you!


california
almonds
Almond Board of California


growing
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The Almond Conference