Sorting for Aflatoxin: The Needle in the Haystack

california almonds
Almond Board of California

Session Speakers

Tim Birmingham, ABC

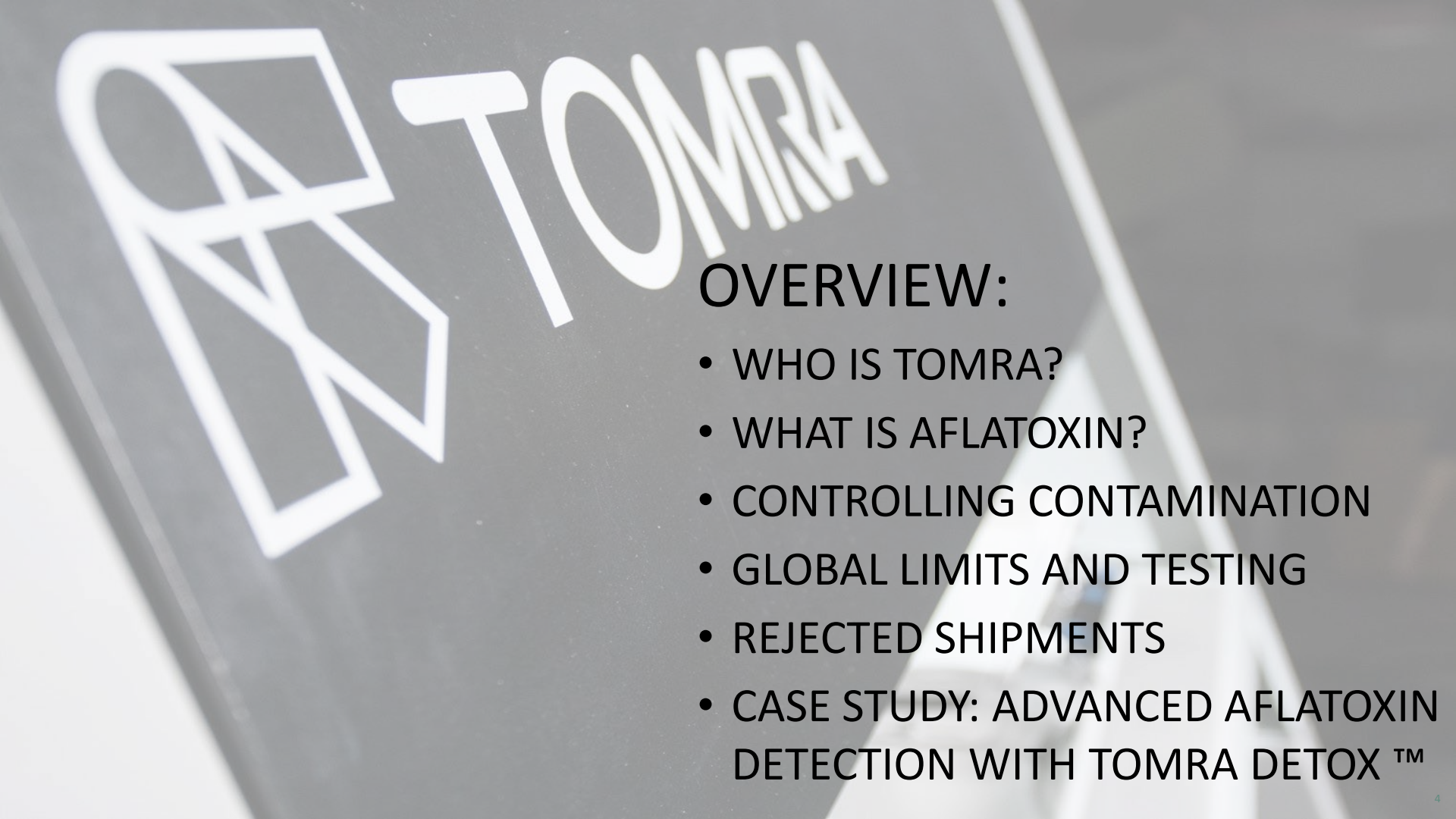
Brendan O’Donnell, TOMRA Sorting Solutions

Jared Morse, MPA Solutions

TOMRA: SORTING FOR AFLATOXIN

TOMRA

Brendan O'Donnell
Almond Conference Sacramento
Dec 12 2019



OVERVIEW:

- WHO IS TOMRA?
- WHAT IS AFLATOXIN?
- CONTROLLING CONTAMINATION
- GLOBAL LIMITS AND TESTING
- REJECTED SHIPMENTS
- CASE STUDY: ADVANCED AFLATOXIN DETECTION WITH TOMRA DETOX ™

TOMRA AT A GLANCE

4000+
EMPLOYEES GLOBALLY

Publicly listed on Oslo Stock Exchange (OSEBX: TOM)

8.6
BILLION NOK REVENUES IN 2018

TOMRA

TOMRA SORTING SOLUTIONS

FOOD | RECYCLING | MINING

TOMRA COLLECTION SOLUTIONS

REVERSE VENDING | MATERIAL RECOVERY

INSTALLED BASE WORLDWIDE

TOMRA COLLECTION SOLUTIONS

REVERSE VENDING	
Nordic	~15,100
Germany	~30,000
Other Europe	~14,600
North America	~16,000
Rest of the world	~7,400
TOTAL	**~83,100**

TOMRA SORTING SOLUTIONS

RECYCLING	
EMEA	~4,250
Americas	~865
Asia	~820
Other	~25
TOTAL	**~5,960**

MINING	
Europe	~28
US / Canada	~41
Australia	~12
South Africa	~37
Other	~35
TOTAL	**~153**

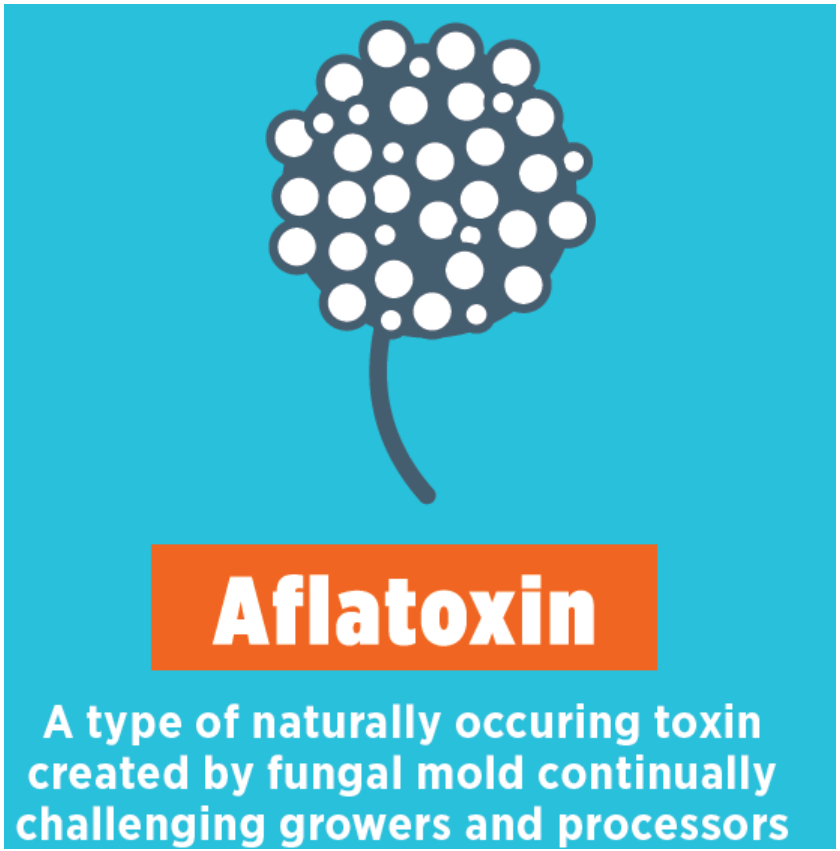
FOOD BULK	
EMEA	~3,250
Americas	~2,950
Asia	~675
TOTAL	**~6,875**

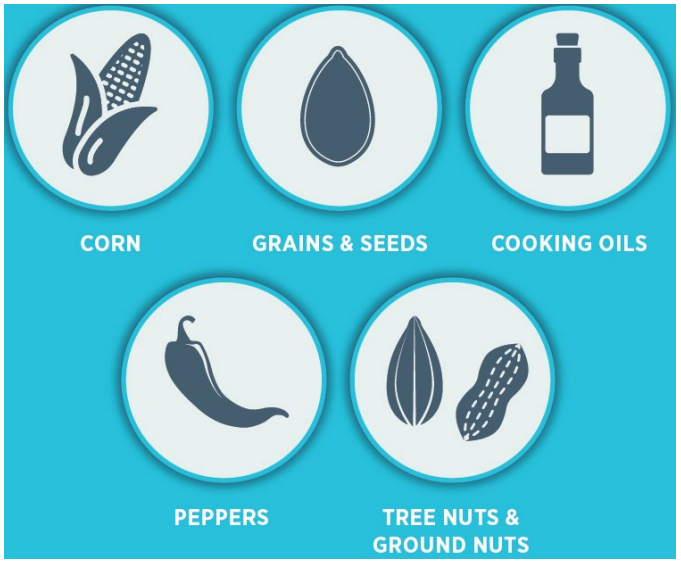
FOOD LANE	
EMEA	~790
Americas	~1,705
APAC	~840
TOTAL	**~3,335**

Food Lane includes Compac and BBC

WHAT IS AFLATOXIN?

WHAT IS AFLATOXIN

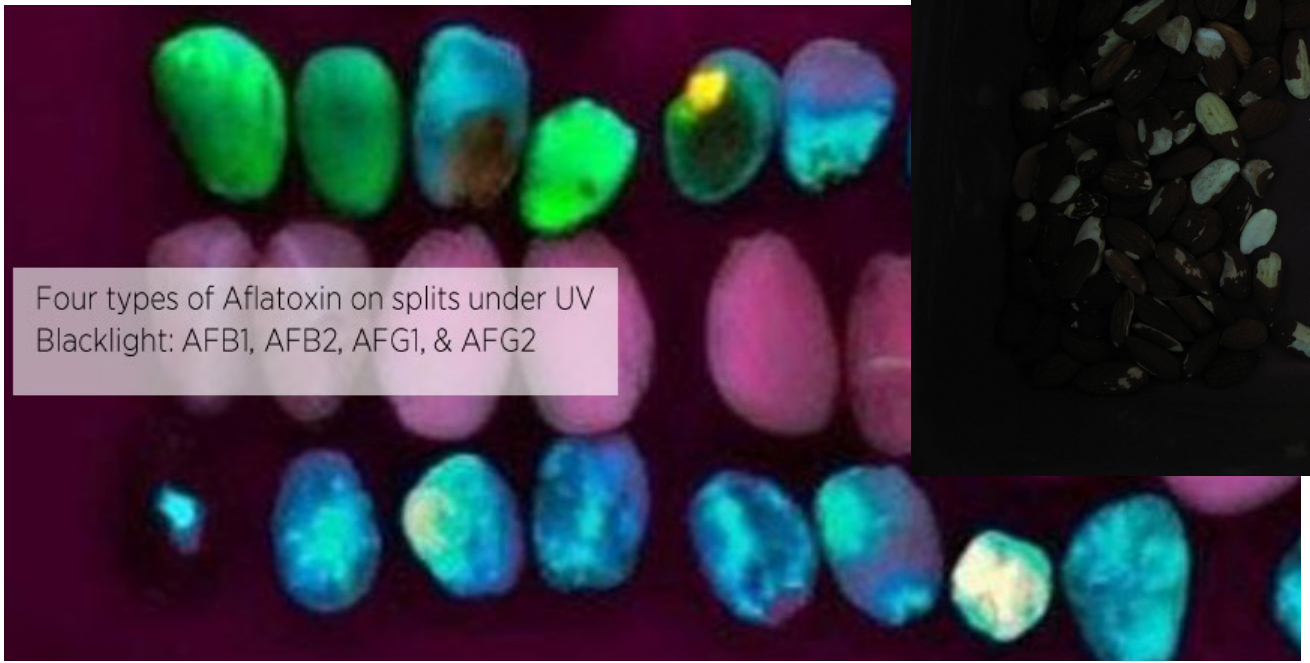




TYPES OF AFLATOXIN

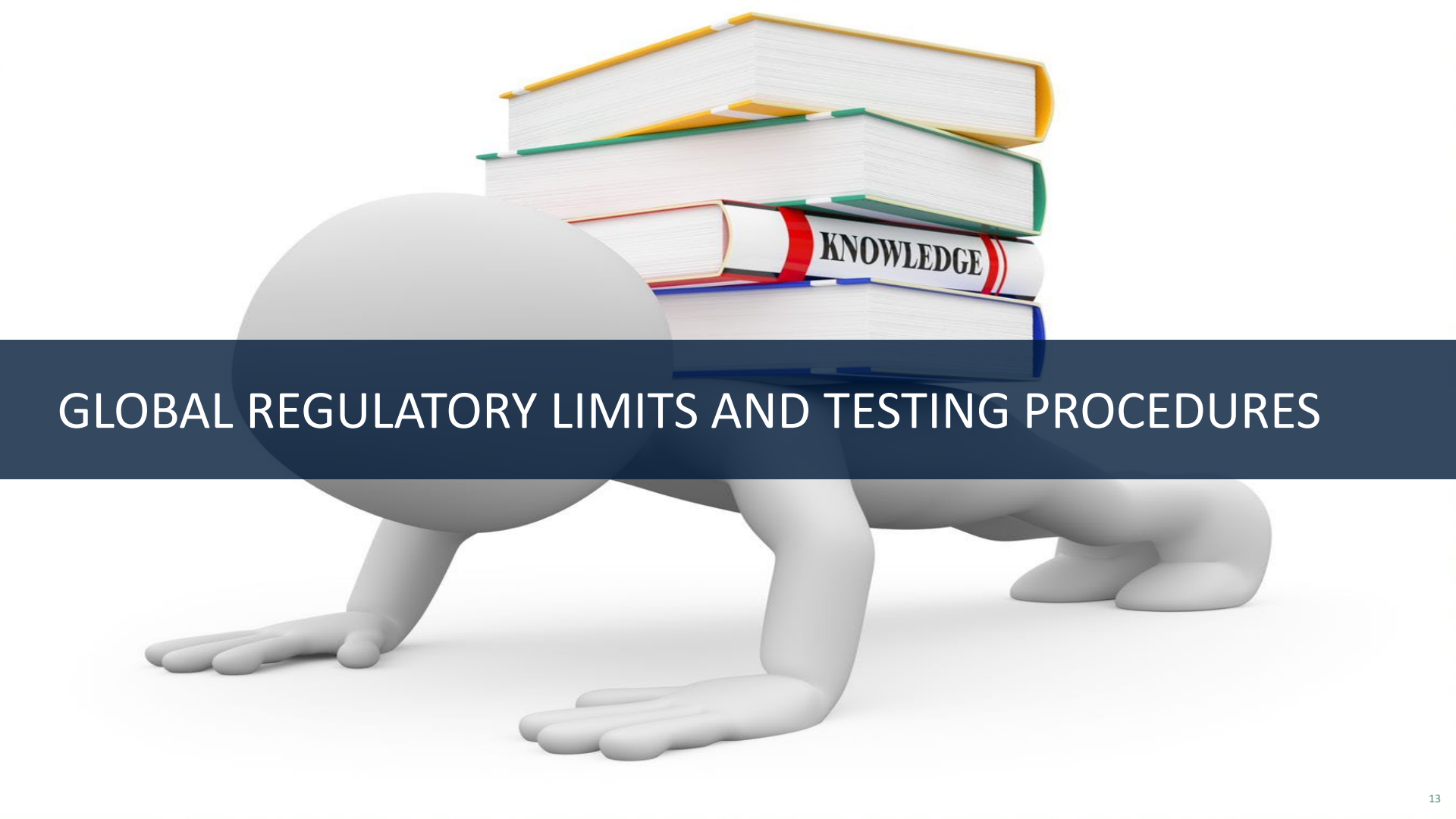
B1 / B2 named for blue fluorescence

G1, G2, Y named for the green and yellow fluorescence



AFLATOXIN IN BRAZIL NUTS

AFLATOXIN IN FIGS

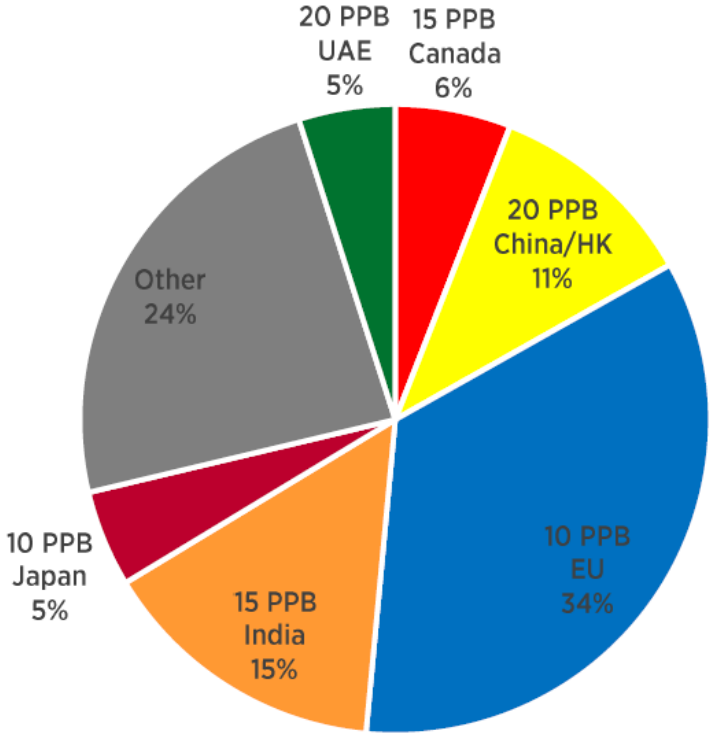


GLOBAL REGULATORY LIMITS AND TESTING PROCEDURES

EVERY COUNTRY HAS THEIR OWN LIMITS

USA LIMIT: 20 PPB

Maximum Aflatoxin Levels (PPB) for Top Importers
(by % of California Almond Exports)

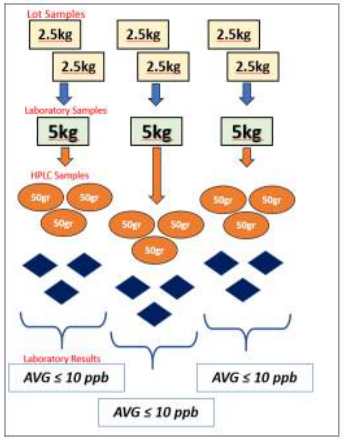


Between EU and Japan alone, nearly 40% of California's almond exports must be less than 10 ppb

EVERY COUNTRY TESTS DIFFERENTLY

- Different quantities sampled
- Different sample locations
- Different number of samples
- Test samples separately vs. blend samples

Japan Aflatoxin Testing Protocol



NOTE: Korea has initiated mandatory import testing due to Japanese violations

- **<u>The bottom line:</u>**
- No uniform globally agreed sampling and testing method creates uncertainty

REJECTED SHIPMENTS

THE PAIN OF REJECTION

- Ocean Freight x2
- Cleaning Cost
- Re-Packaging Cost
- TIME
- Brand Reputation

THE PAIN OF REJECTION

- Ocean Freight x2: ($6,000-$10,000)
- Cleaning Cost: ($5,000-$10,000)
- Re-Packaging Cost: ($4,000-$5,000)
- TIME: ($5,000-$20,000)
- Brand Reputation:
- **TOTAL: ($20,000-$45,000)**
- NOT accounting for damage to reputation

THE PAIN OF REJECTION

- What if it's a domestic rejection?

PepsiCo recalls peanuts because of aflatoxin levels

Kenya: Govt. agency recalls Jetlak Food's Nuteez peanut butter after it tests positive for cancer-linked aflatoxin; company comments

Author: Business Daily (Kenya), Published on: 4 February 2019

Cargill Expands Previously Announced Voluntary Recall of Select Southern States® Feed Due to High/Excessive/or Elevated Aflatoxin Levels

Dog food recall underscores toxic danger in drought-hit U.S. corn

- **TOTAL: $130,000- $1,000,000**
- Likely a legal battle as well- who is responsible?

CONTROLLING CONTAMINATION

CONTROLLING CONTAMINATION

Proper Irrigation:
Stressed trees more susceptible to fungal growth

Clean, Dry, Cool Storage

Control Insect Damage:
Exposed meats
promote fungal growth

Get the
Mummies!

TOMRA DETOX ™ SORTING

CASE STUDY: AFLATOXIN DETECTION WITH TOMRA DETOX ™

CASE STUDY

- Prominent California almond packer had a load rejected from Japan for Aflatoxin
    - (This was very clean J-Spec product with less than 1% Insect Damage)

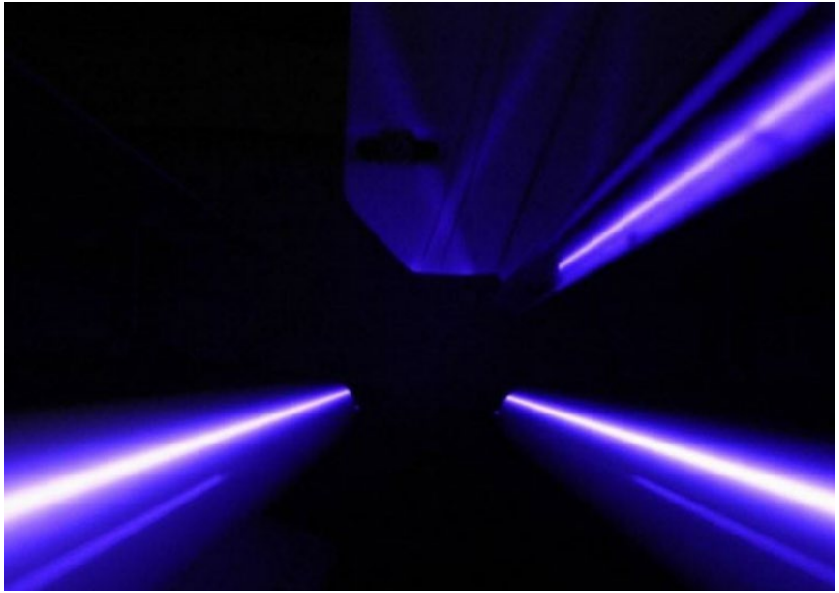
- Full 20’ load, 36,000 lbs. run through TOMRA DETOX ™ equipment

- ABC involved as a non-biased third party monitoring testing and sampling

- Method:
- 3 samples from incoming product (6 tests total)
- 3 Samples post TOMRA DETOX ™ sorting (6 Tests Total)
- 3 samples from TOMRA DETOX ™ sorter reject stream (6 tests total)

EQUIPMENT USED

TOMRA Nimbus 640 with double Laser in DETOX ™ Configuration



CASE STUDY

First samples tested: Incoming product after rejection

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

All incoming samples tested min. levels for aflatoxin

This is after the load was rejected from Japan…

CASE STUDY

Second samples tested: Output, clean product after TOMRA Detox ™ Sorter

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

Total Aflatoxin Subsample 1	<	0.4 ppb
Aflatoxin B1 Subsample 1	<	0.1 ppb
Aflatoxin B2 Subsample 1	<	0.1 ppb
Aflatoxin G1 Subsample 1	<	0.1 ppb
Aflatoxin G2 Subsample 1	<	0.1 ppb
Total Aflatoxin Subsample 2	<	0.4 ppb
Aflatoxin B1 Subsample 2	<	0.1 ppb
Aflatoxin B2 Subsample 2	<	0.1 ppb
Aflatoxin G1 Subsample 2	<	0.1 ppb
Aflatoxin G2 Subsample 2	<	0.1 ppb

All outgoing samples tested min. levels for aflatoxin

This is after the load was run through TOMRA DETOX ™

CASE STUDY

Third samples tested: Rejected product from TOMRA Detox ™

Total Aflatoxin Subsample 1	114 ppb
Aflatoxin B1 Subsample 1	88.4 ppb
Aflatoxin B2 Subsample 1	12.0 ppb
Aflatoxin G1 Subsample 1	9.7 ppb
Aflatoxin G2 Subsample 1	3.8 ppb
Total Aflatoxin Subsample 2	27.9 ppb
Aflatoxin B1 Subsample 2	19.1 ppb
Aflatoxin B2 Subsample 2	2.0 ppb
Aflatoxin G1 Subsample 2	5.9 ppb
Aflatoxin G2 Subsample 2	0.9 ppb

Total Aflatoxin Subsample 1	139 ppb
Aflatoxin B1 Subsample 1	91.1 ppb
Aflatoxin B2 Subsample 1	10.3 ppb
Aflatoxin G1 Subsample 1	30.5 ppb
Aflatoxin G2 Subsample 1	7.3 ppb
Total Aflatoxin Subsample 2	98.5 ppb
Aflatoxin B1 Subsample 2	54.4 ppb
Aflatoxin B2 Subsample 2	8.3 ppb
Aflatoxin G1 Subsample 2	31.1 ppb
Aflatoxin G2 Subsample 2	4.7 ppb

Total Aflatoxin Subsample 1	49.9 ppb
Aflatoxin B1 Subsample 1	26.1 ppb
Aflatoxin B2 Subsample 1	3.1 ppb
Aflatoxin G1 Subsample 1	17.8 ppb
Aflatoxin G2 Subsample 1	2.9 ppb
Total Aflatoxin Subsample 2	84.8 ppb
Aflatoxin B1 Subsample 2	47.2 ppb
Aflatoxin B2 Subsample 2	10.9 ppb
Aflatoxin G1 Subsample 2	21.8 ppb
Aflatoxin G2 Subsample 2	4.9 ppb

All reject samples tested very high in aflatoxin

Average **<u>54.38 ppb B1</u>** and **<u>85.68 ppb total</u>**

*** Important to note***

The total reject from 36,000 lbs. was 54 lbs. **(0.15%)**

SUMMARY

When it comes to **total cost**, damage to your **brand reputation**, damage to the **industry reputation**, we must use **every tool** at our disposal!

- Orchard Management
  - Winter Sanitation, proper irrigation, pest control program
- Storage Management / Stockpile Management
- Sorting for Serious Damage (correlation vs. causation)
- TOMRA Detox™ Sorting (final safeguard)

WE ARE LOCAL - CALIFORNIA BASED SERVICE AND SALES SUPPORT

Northern California (San Joaquin North)
Bob MacKie
Bob.Mackie@tomra.com
(916) 388-3918

Central/Southern California (Stanislaus South)
John Duwe
John.Duwe@tomra.com
(916) 365-6722

www.tomra.com

THANK YOU

PLEASE VISIT US AT BOOTH 335

optimum SORTING

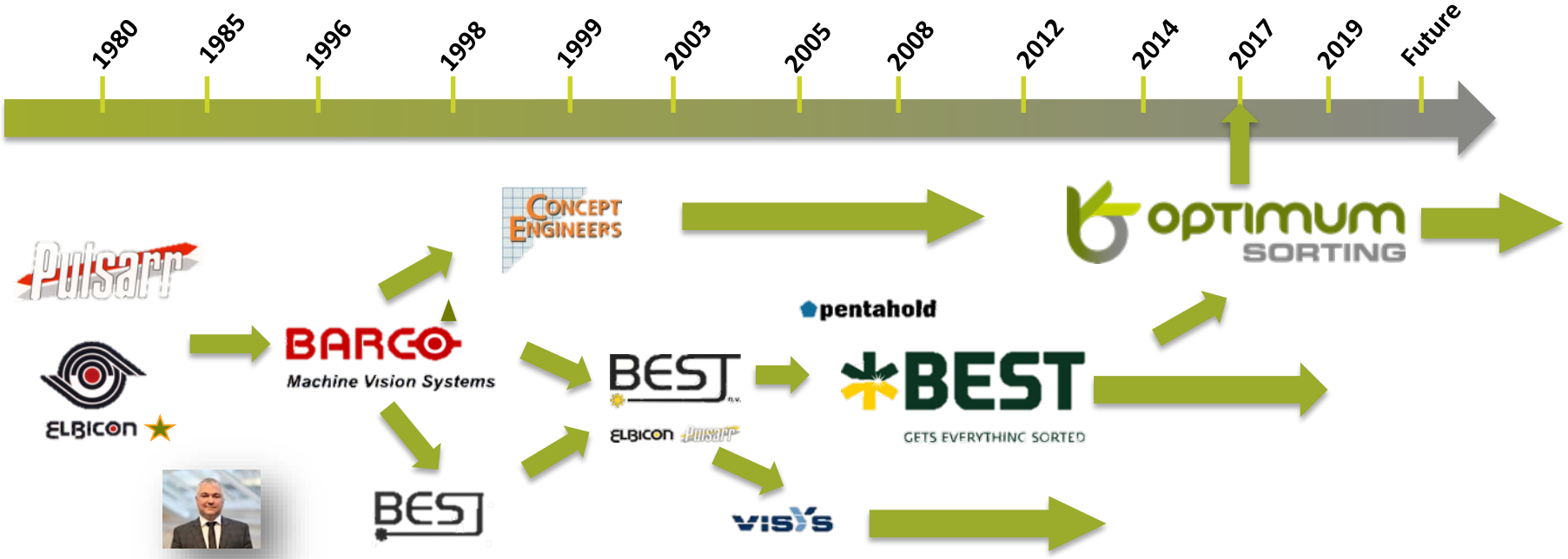
MPA SOLUTIONS
MACHINE PROCESS AND AUTOMATION SOLUTIONS

Almond Sorting - Aflatoxins

Industry challenges and our approach to providing solutions to the food industry

california almonds
Almond Board of California

Optimum Sorting – who are we?



Experience

- Our leadership team has over 200 years experience in food sorting – our only focus is sorting!


Frans

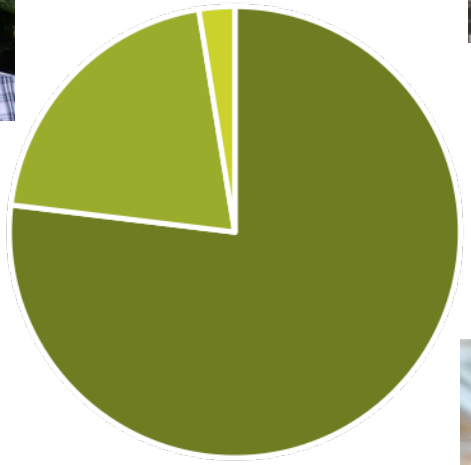

Erik


Steve


Jan


Geert


Bernie



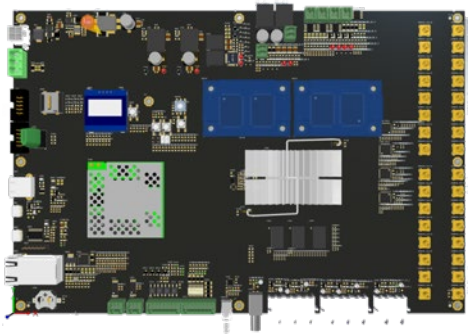

Karel

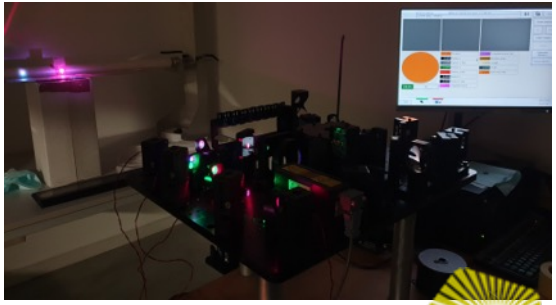
pentahold
where industry meets finance


Geert


Paul

Focus on research and development



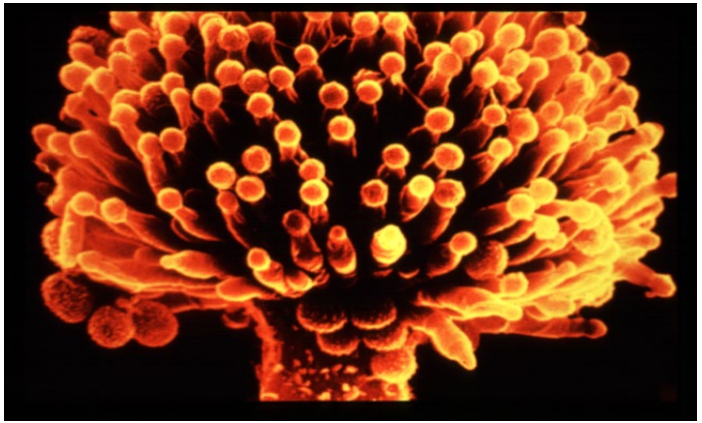


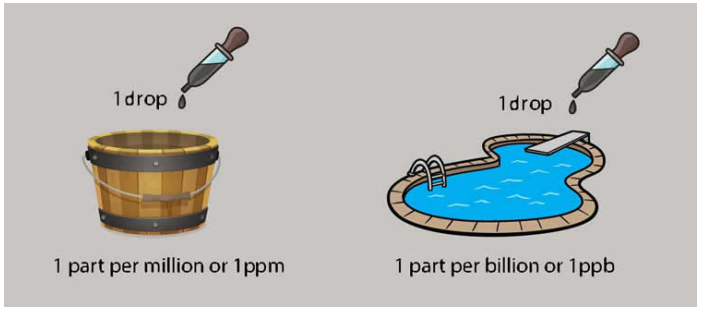
B-PHOT
BRUSSELS
PHOTONICS
TEAM

- We invest more then 15% of the total sales revenues back into R&D
- Our team of 15+ R&D employees work continuously on improvements and the next generation of sorters
- Partnerships with local universities and institutions to help speed up development

Aflatoxin in Almonds

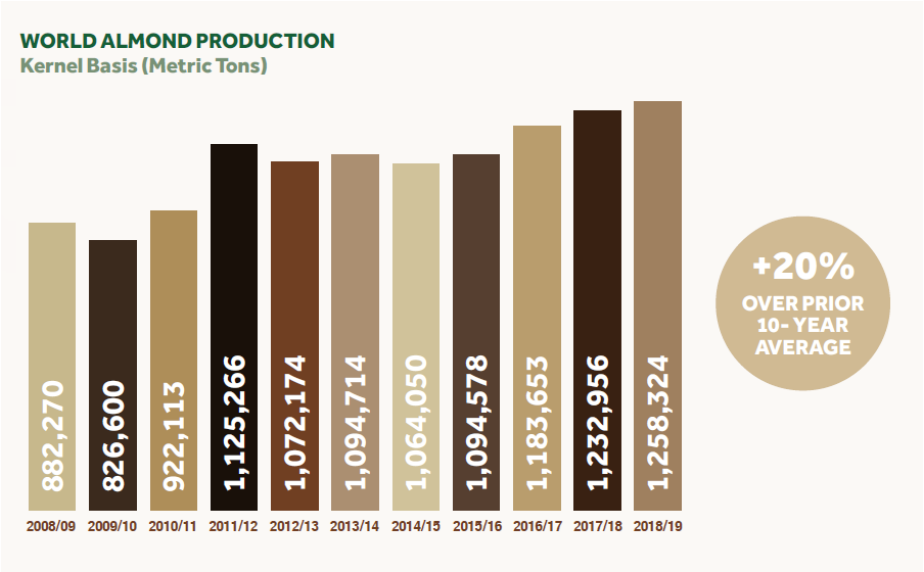
- Number of *Aspergillus* (Fungi) species present in the environment
- Aspergillus flavus and *Aspergillus parasiticus* are two species commonly found in almond orchards
  - Given right conditions, and a host, they can grow and produce a chemical compound known as aflatoxin
  - Aflatoxin is a secondary metabolite
- Aflatoxin is a potent carcinogen
- Widely regulated given its prevalence in various crops grown around the world
  - EU is particular vigilant when in regards to aflatoxin
- Aflatoxin is measured in parts per billion
  - PPB equivalent to:
    - 1 drop in an Olympic size pool
    - A pinch of salt to a 10 ton bag of potato chips

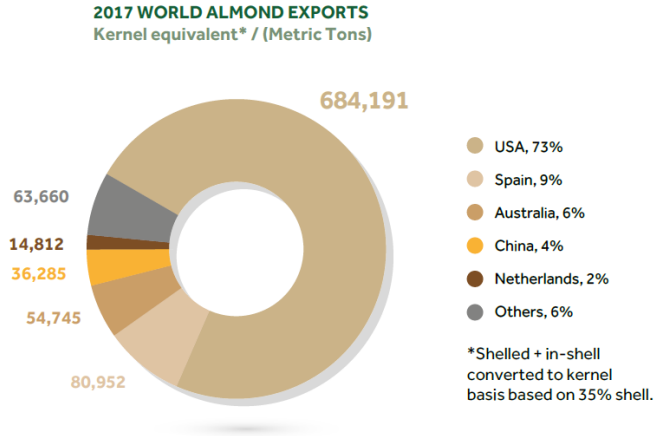




So why is the focus on aflatoxin so important

- The outlook for industry growth is very good but the risk to the manufacturers are also growing





Almond Process Flow

- Example of the current process flow with a final pass for reducing aflatoxins

How companies currently control aflatoxin

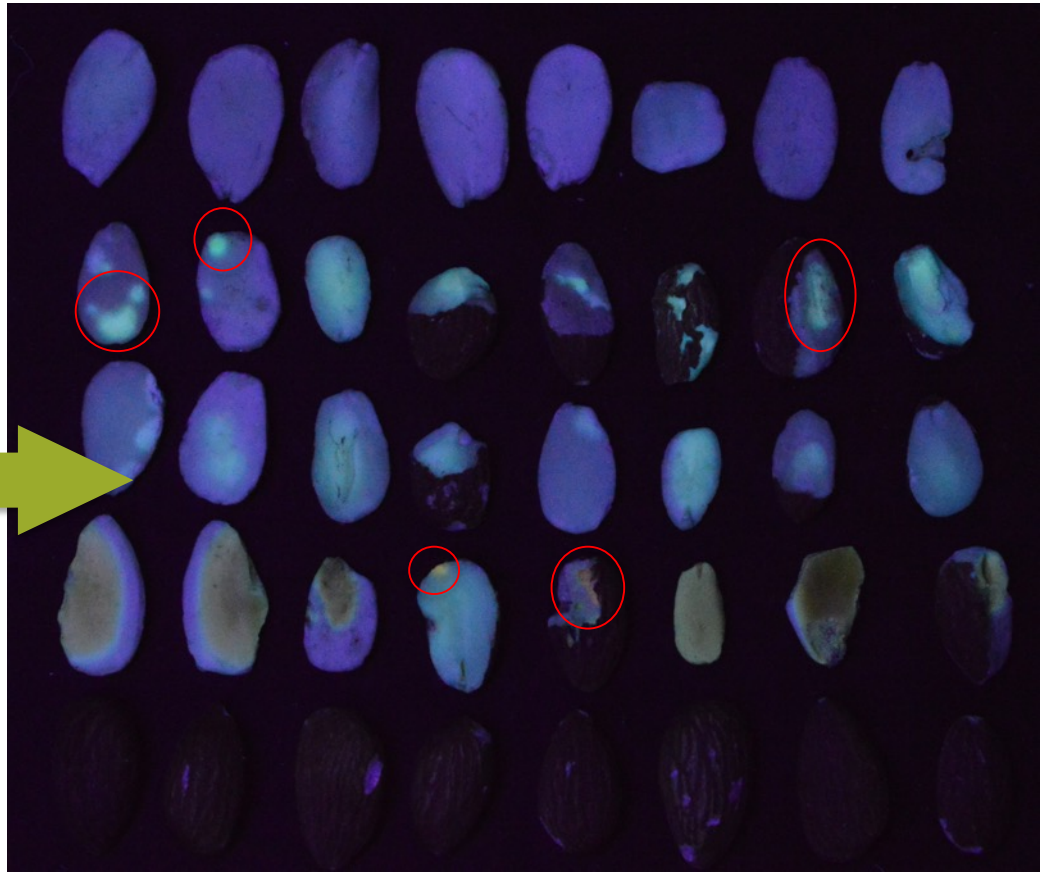
- While we cannot see the aflatoxin it can be associated and reduced by targeting other defects:
  - Molds and decay
  - Insect damage
  - Shrivel

- However – Aflatoxins are still present on nuts that look good to the human eye. Other sorters removing visible damage (molds and insect damage) will not see all of the defects and the manufacturer will remain vulnerable to failing an aflatoxin test.

What if we could see the invisible

- It is known that some residues from aflatoxin fluoresce
- Using a UV laser light source, we can stimulate fluorescence
- Our laser technology is extremely sensitive and can pick up the slightest amount of fluorescence
- So it does not detect the aflatoxin itself, but the fluorescing “by product”
- By removing all the fluorescing kernels, we reduce the amount of Aflatoxin drastically
- This can be done with almost no false rejects and at high throughput on our VENTUS 1800
- **The good almonds are “invisible” to the technology**

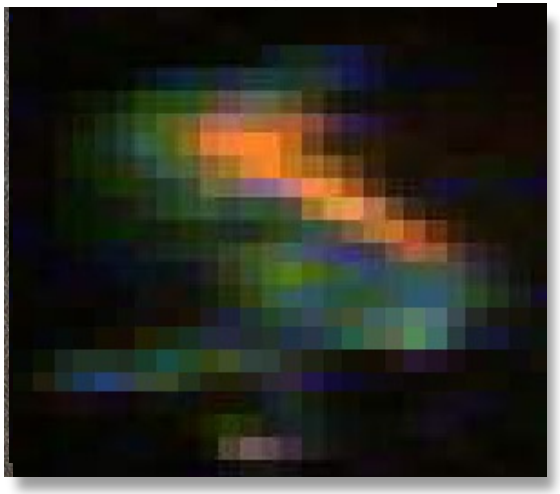
AflaSort



AflaSort

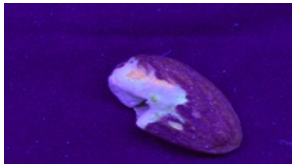
- AflaSort is an option on our VENTUS platform (600 – 900 – 1200 – 1800) with capacities of up to 25,000 lb/hr.
- It sorts based on Biological Characteristics
- Defects to be detected are invisible to the human eye, but are believed to be carcinogenic
- Examples ;
  - Aflatoxin on peanuts, tree nuts, dried fruits, spices, cereals, figs, …
  - Ochratoxin on coffee

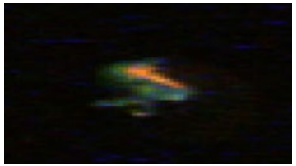
AflaSort – Detection



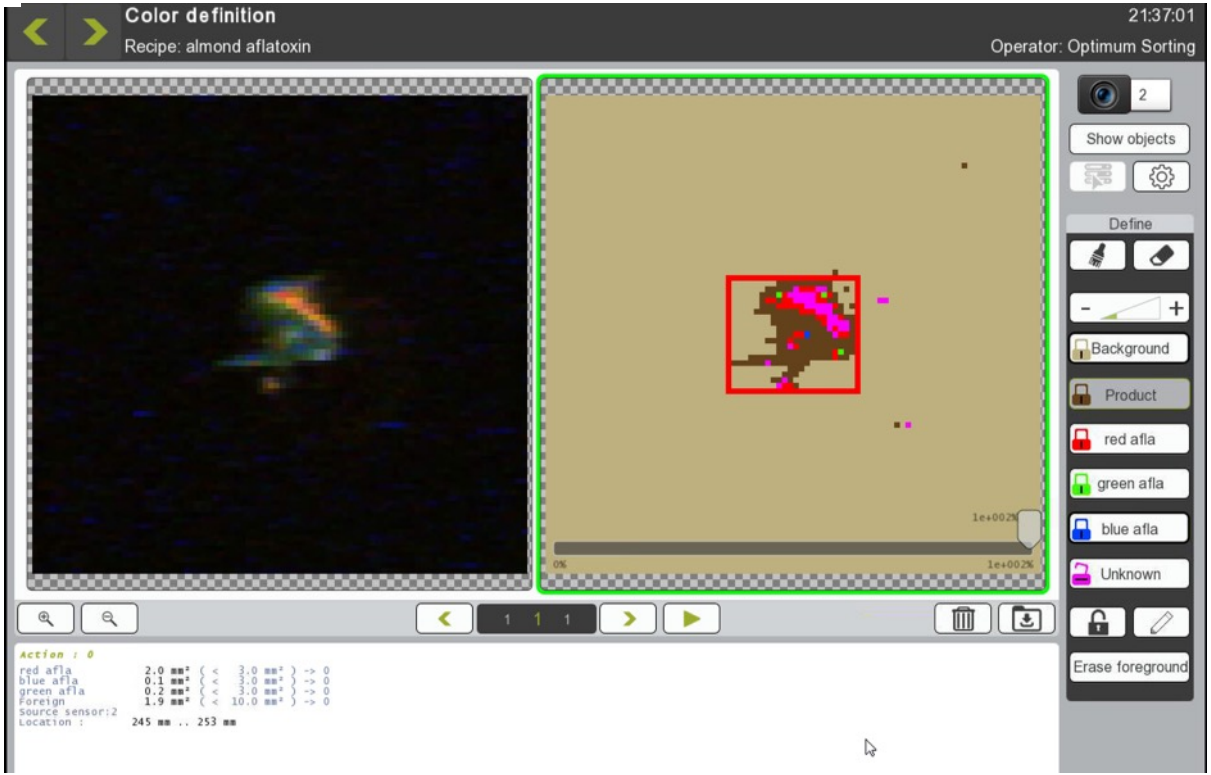
More than 30 pixels!

- A picture of a damaged nut.
- A picture of the same nut under Blacklight
- A picture as seen by the VENTUS AflaSort
- This picture shows the fluorescence of the infected nut as seen by the VENTUS
- Due to the high resolution of the VENTUS, this small sized defect shows up as many pixels….
- Count the pixels!!!! Better than 0,3mm resolution

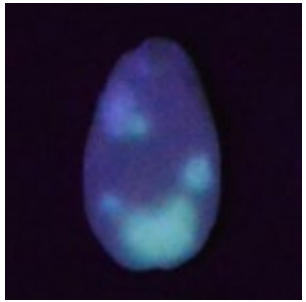


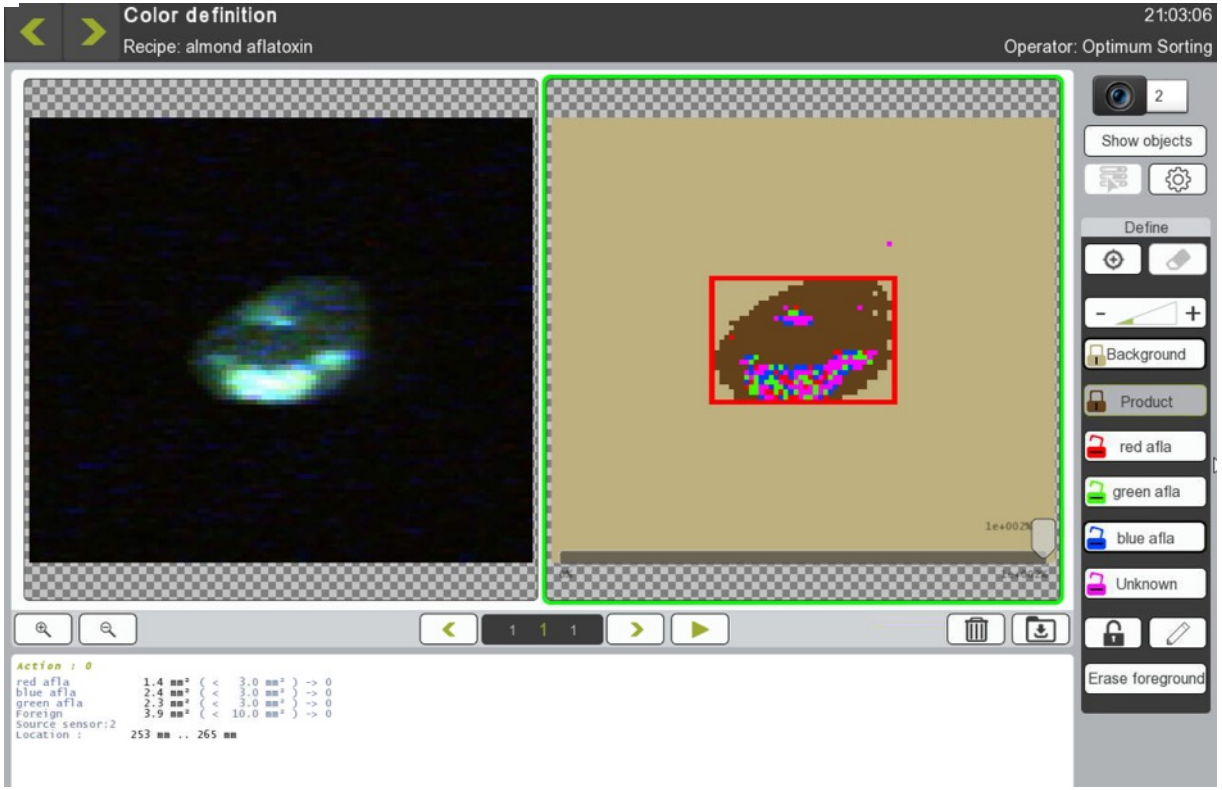


AflaSort – Detection



AflaSort – Detection

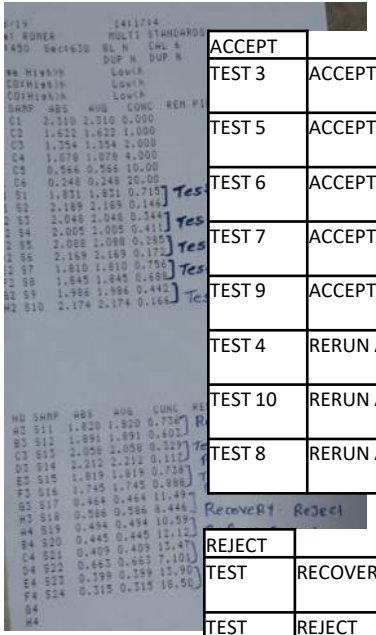




AflaSort - Test results on Aflatoxin

- The test was performed on a “normal” batch of products
- We received this print-out from a customer who analyzed samples in his own lab after sorting on the Ventus

- Our laser technology is extremely sensitive and can pick up the slightest amount of fluorescence
- The product was sorted and accept was collected (first 5 samples on the sheet) : significant reduction below required levels
- The reject was resorted and split again into “rerun accept” and “reject”
- Even the rerun accept was clean
- The Reject has high concentration



ACCEPT			PPB
TEST 3	ACCEPT	SAMPLE 1	0,715
		SAMPLE 2	0,146
TEST 5	ACCEPT	SAMPLE 1	0,344
		SAMPLE 2	0,411
TEST 6	ACCEPT	SAMPLE 1	0,285
		SAMPLE 2	0,172
TEST 7	ACCEPT	SAMPLE 1	0,756
		SAMPLE 2	0,688
TEST 9	ACCEPT	SAMPLE 1	0,442
		SAMPLE 2	0,166
TEST 4	RERUN ACCEPT	SAMPLE 1	0,736
		SAMPLE 2	0,603
TEST 10	RERUN ACCEPT	SAMPLE 1	0,329
		SAMPLE 2	0,117
TEST 8	RERUN ACCEPT	SAMPLE 1	0,738
		SAMPLE 2	0,888

REJECT			PPB
TEST	RECOVERY REJECT	SAMPLE 1	77,49
		SAMPLE 2	8,446
TEST	REJECT	SAMPLE 1	10,59
		SAMPLE 2	12,12
TEST	REJECT	SAMPLE 1	13,47
		SAMPLE 2	7,1
TEST	REJECT	SAMPLE 1	13,9
		SAMPLE 2	18,5

Challenges to the manufacturers

- While “new technologies” have been introduced to detect the presence of aflatoxins, the industry still has many challenges to overcome.
  - Now that you have a solution to help reduce your chances of a positive test, how and where do you implement the solution?
  - Validation: how can the operator ensure the sorter is working properly before production is started
  - Verification once the line is operational, how can the operator be sure that it is still working
  - Preventing good product loss (we don’t want you to lose thousands of pounds of almonds just to find 40 lb of infected)

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What the future brings

- We have come a long way in helping increase the safety of our food supply and the future is looking promising.
- We will only achieve our goals by working together with industry partners like the attendees at this conference including:
  - Food manufacturers
  - Technology and sensor based companies
  - Labs
  - The Almond Board and other industry boards
- We need to work to set global standards on testing so that manufacturers have a clear path to reducing their risks
- Sorters are unique machines that have the ability to see and calculate every single object that go through their sensors. We need to work with the manufacturers to collect and utilize any necessary data so that we can take actionable steps to resolving the issues that they are facing.

We welcome industry partners to join in our efforts
Please visit MPA Solutions at booth #105 to learn more

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Sorting for Aflatoxin: The Needle in the Haystack

california almonds
Almond Board of California

Upcoming Sessions at 10:45 a.m.

- Almond Food Safety: Past, Present and Future (Room 1)
- Europe: Playing a Pivotal Role in Almonds' Future (Room 2)
- Alternatives for Managing Replant Pests and Problematic Weeds (Room 3)

Visit the Exhibit Halls and Participate in the Passport Game

· 3P Partners	#2206	· K·Coe Isom	#707
· ABC Booth	#526	· Lincoln Agribusiness Services	#733
· AC Horn	#421	· Napasol	#2205
· Ag Spray Equipment	#2203	· NETZSCH Premier Technologies	#218
· Bayer CropScience	#127	· Satake	#521
· Best Drayage	#2112	· Suterra, LLC	#1638
· Bird Gard, LLC	#1812	· TOMRA Sorting Solutions	#335
· Borrell USA	#327	· Trécé, Inc	#516
· Cablevey Conveyors	#217	· Valent U.S.A.	#621
· Central Life Sciences	#917	· Westbridge Agricultural Products	#1534
· JAX, Inc.	#413	· Wilkey Industries	#320
· JKB Energy	#635	· Yara North America	#627

The first 500 attendees to turn in a completed passport card to the ABC booth (#526) will receive a hat and will be entered to win one of seven amazing prizes!

Lunch: Pushing Your Personal Limits

Featuring John Stenderup

Sponsored by:

FARM CREDIT

Doors open at 12:15 p.m. in Building C

You must have already purchased a ticket to attend luncheon

Food Truck Village

Food Truck Village is located next to Building D

Open on Tuesday and Wednesday from 11:00 a.m. – 2:30 p.m.

Cash and credit cards are accepted

Almond Food Truck

Wednesday, December 12

- 9 am to Noon
- Donation-Only (all proceeds to benefit California FFA)
- Outside the Registration Tent

California FFA

California FFA members will be on-site selling CalAg License Plates

Valent U.S.A. is proud to partner with the California FFA Foundation and support the CalAgPlate program.

VALENT®

Shuttle Schedule

Shuttle service will be provided by The Almond Conference from the downtown hotels to Cal Expo daily.

- Downtown Pickup Location: Hyatt Sacramento Front Drive
- Cal Expo Pickup and Drop-Off Location: Blue Gate

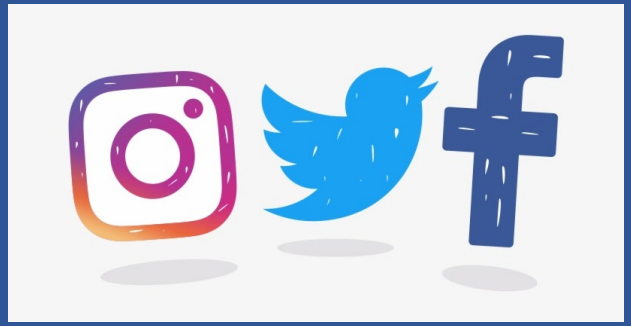
Shuttle Schedule:

- Tuesday, Dec. 10
  - 6:45 a.m. – 6:30 p.m.
- Wednesday, Dec. 11
  - 6:45 a.m. – 6:30 p.m.
- Thursday, Dec. 12
  - 6:45 a.m. – 1:30 p.m.

2019 Research Update

Pick up a copy at the ABC booth #526

Join the Conversation!



Use #AlmondConf to share highlights from The Almond Conference

Dedicated Trade Show Time

4:30 p.m. – 6:00 p.m.

Social Reception Sponsored by:

Join Tonight's Social Reception

Come and Sample:
ALMOND BROWN ALE

Stop by:
The Almond Board Lounge in Building D.

Sample:
Almond brown ale during the Tuesday and Wednesday receptions.

This almond beverage is the result of a special project from Dominique Camou and Lucas Schmidt in collaboration with **Temblor Brewing Company**.

Industry members and attendees are welcome to stop by and have a taste.

When:
Tuesday and Wednesday evening reception from 4:30–6:00 p.m.

4:30 p.m. – 6:00 p.m. - Pavilion + Building D

CALIFORNIA ALMOND SUSTAINABILITY PROGRAM

10 YEARS OF PROGRESS

JOIN THE JOURNEY

It's all there at

SustainableAlmondGrowing.org

Thank you!