Big Data applications in Food Safety

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• Brief Introduction to Nestlé Research
• The Changing Reality Framing Food Safety
• What does success looks like?
• Data analysis for a New Game
• Summary
Nestlé in Figures

Nutrition & Healthcare
11%

Pet Care
12%

Confectionery
11%

Nestlé Waters
8%

Milk Products & Ice Cream
20%

Prep. Dishes & Cooking aids
16%

Powdered & Liquid Beverages
22%

Turnover 2014: CHF 91.6 billion

>330’000 employees in 150 countries

>440 factories in 86 countries

>2,000 brands

OVER 1 BILLION PRODUCTS SOLD EVERY DAY
The Changing Reality Framing Food Safety

Science & Technology
- Scientific advances
- Agri-food technology
- Safety testing tools
- «Big Data»
- Analytical technology

Environmental
- Water
- Climate
- Dwindling bio-resources
- Soil integrity
- Contamination

Social & Cultural
- More foodborne disease
- Distrust
- Consumer expectations
- Consumption patterns
- Media and Social Media
- NGOs
- Crowdfunding/sourcing
- Food Ethics

Business
- Increasing food & water crises
- Food Fraud
- Complexity
- Costs

Regulatory
- Lack of harmonization
- Increasing complexity
- Increased product monitoring
- Limited understanding of complex food systems
Food Safety: What does success look like?

**Science & Technology**
- Anticipation of new advances
- Science $\Rightarrow$ superior products
- Lower uncertainty
- Data sharing

**Social & Cultural**
- Decrease in foodborne disease
- Food industry trusted
- High confidence in safety
- Innovations welcomed
- Food data accessible

**Environmental**
- Sustainable practices
- Adaptation to climate change
- Increased efficiency
- Reduced waste

**Consumer Health, Trust & Confidence**

**Regulatory**
- Internationally harmonized
- Secure international food trade
- Systems approach
- Targeted risk management
- Fewer crises and incidents

**Business**
- Fewer recalls
- Few food crises
- Minimal food fraud
- Innovation driven business
First Rule: Get on top of the data technology revolution!

DATA

→

INFORMATION, UNDERSTANDING

«Data» is not information!
«Information is not knowledge!» (Einstein)
Knowledge is not action!

Caveats!

If a man’s knowledge is not in order, the more of it he has the greater will be his confusion
Herbert Spencer

The illusion of understanding, or how everyone thinks he knows what is going on in a world that is more complicated (or random) than they realise
Nassim Nicholas Taleb
Challenge: Explosion of literature data

2X: Annual growth in worldwide data creation
8 Zettabytes: Estimated worldwide data creation in 2015
28,100: English language peer-reviewed journals
2.5 million: Papers per year (~5 per minute)
3.5-5%: Annual increase in published papers
2.5 billion: Full-text downloads per year
270: Articles read by average scientist per year
30 minutes: Average reading time per article (down from ~45 minutes in the mid-90s)

+ Peer-review process malfunctioning
  Increase in retraction rate
  ↓
  Acute effect on multidisciplinary sciences like food safety

Nestlé Research
Big Data: Food Safety & Integrity Applications

- Food safety early warning systems
- Search engine queries to detect disease outbreaks
- Whole genome sequencing data from environmental, food and clinical pathogen isolates
- Metagenomics data from food and environmental samples
- Non-target fingerprint data sets for food authenticity and adulteration
- Satellite imaging data to detect illegal fishing
- Meteorological data to predict mycotoxin risks in crops
- GIS data to detect food fraud
- Social media analysis to understand consumer concerns and preferences
- Traceability and RM/ingredient data
- Image analysis and automated processes
- Computational microbiology, chemistry and toxicology
A change in focus is necessary

- Scientific / technical
- Product quality control
- Detection of defects
- Reactive

- Consumer centric
- Quality management, entire supply chain, TQM
- Interpretation, understanding, foresee, prevent
- Proactive using foresight and early warning systems
Early Warning Approach

Early Warning Principles

Food safety challenges continue to increase and must be addressed through multiple competencies.
Anticipating food safety issues: Early Warning System

Early Warning Expert Network
- Global reach
- 150 people
- Multi-disciplinary
- R&D and Operations experts

Webscouting
- 8000 websites per day
- 300,000 articles scouted per year
- 10,000 articles kept in a database for knowledge building
- 1000 RSS food safety flashes
- 12 Issue Round Table presentations
Trend analysis based on contaminant surveillance data

- Trend analysis of data on contaminants in food raw materials
- Detect abnormal trends
- Root cause analysis to find the right actions

- 26 big laboratories
- 1000 people
- 3.3 million of data/year
Example: abnormal trends for arsenic in rice in Malaysia

**THE PROBLEM**
- Arsenic level in rice were getting higher in Malaysia
- We use rice to produce baby food
- Levels would potential have exceeded safe levels if we did nothing

**THE ANALYSIS AND SOLUTION**
- Root cause analysis
  - Correlation between the yield improvement made by farmers (they wanted to go from 2000 tons/hectar to 8000 tons/hectar and increasing levels of arsenic in rice)
  - The main cause was identified to be the fertilizers
- Working with farmers allowed to still increase the yield while lowering the level of arsenic in rice by optimizing the usage of fertilizers
FISH
Seafood fraud

• One in five fish eaten in the world is caught illegally
• USD 10-23 Billion
• Seafood fraud: 25-70%
• Potential for food safety implications
• Fish stocks are depleted
• Waste associated with non-target catch: ~1 million tonnes pa; >USD 1 billion.
• Preventive approaches based on «big data» applications
• New analytical tools show promise

Sources: Oceana, Pew Charitable Trusts, BBC, Satellite Applications Catapult, UK
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Fish DNA Barcoding is based on PCR and DNA sequencing.
DNA Barcoding derives from the iBOL project

Initiated in 2003 by taxonomists to create a genetic database of all living organisms

Sponsored by 25 nations
- National Institutes
- Museums
- Universities

~ 100000 species recorded

~ 10000 fish species
Data enables the application of Systems Thinking to prevent food contamination and fraud

- Recent crises highlighted the **complexity** of food supply networks
- **International food trade** increases the possibility of food fraud

Understand and map vulnerabilities

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<th>Fish</th>
<th>Fillet</th>
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<td>Low</td>
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Detection of food adulteration: Don’t forget to start with visual inspection!

It worked for the Ale Conner!
THANK YOU!