GOAL

AQUACULTURE INNOVATION 2019 =AWARD=

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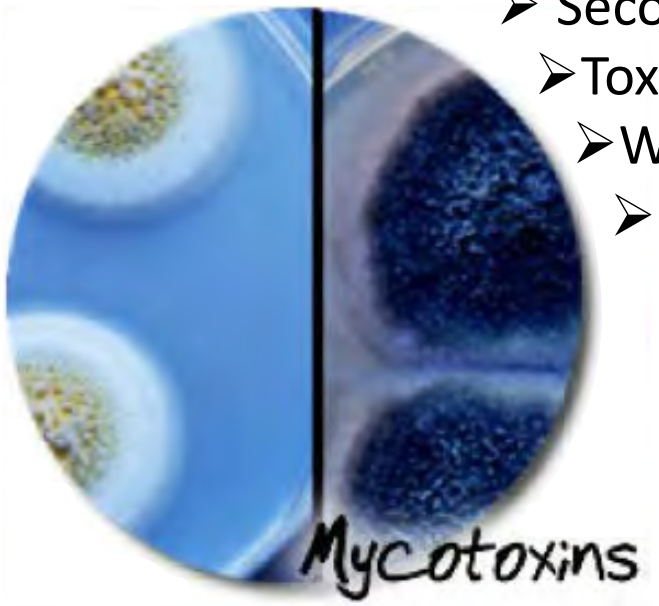
PEGASUS SCIENCE

Mycotoxins risk management by NIR

DMV. Dr. Adriano O. Mallmann – Technical Director

Chennai, 23rd Oct 2019

Mycotoxins: what they are and where they occur



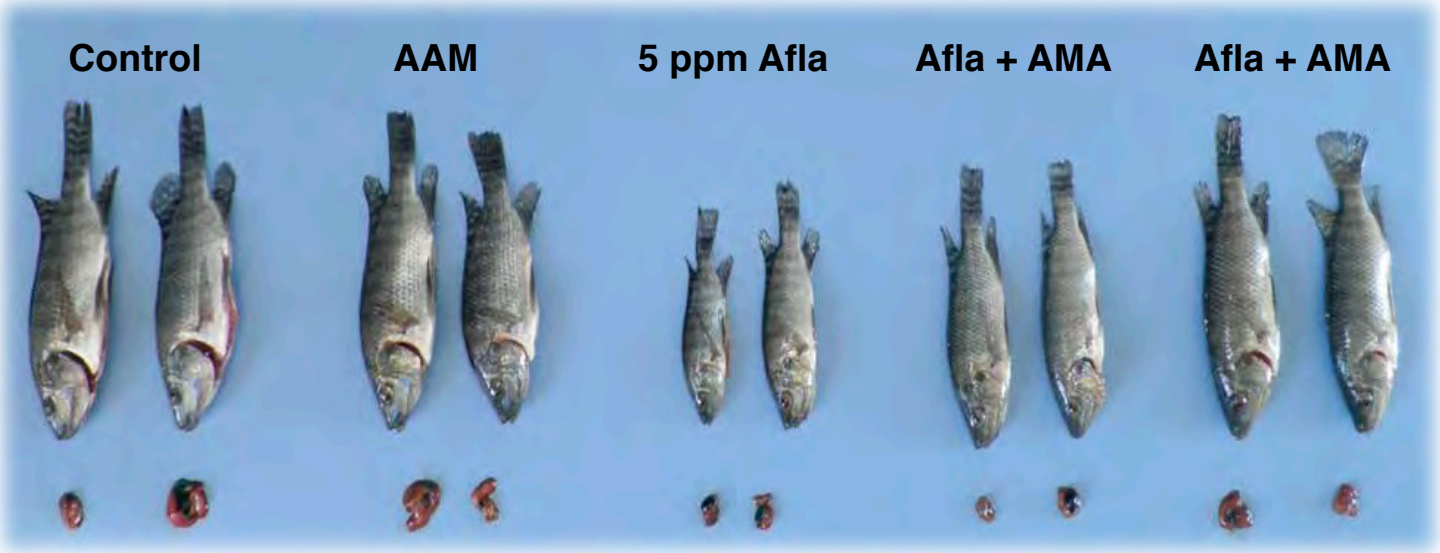
- Secondary methabolites produced by fungus
- Toxic effects to animals and humans
- Worldwide occurrence
- Cereals more affected are corn and wheat

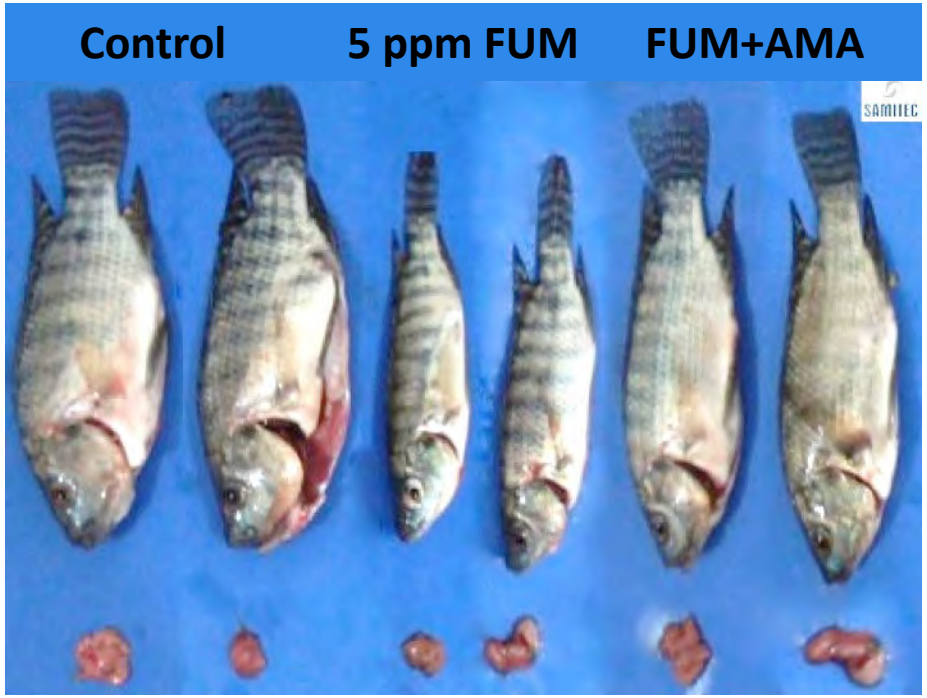

Aspergillus sp.

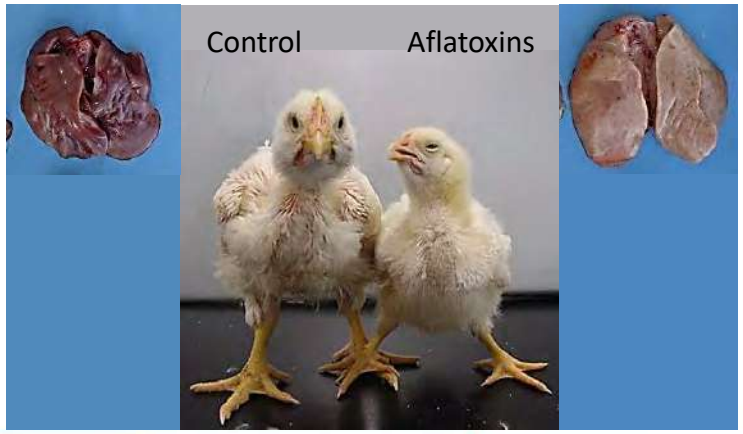

Fusarium sp.


Penicillium sp.

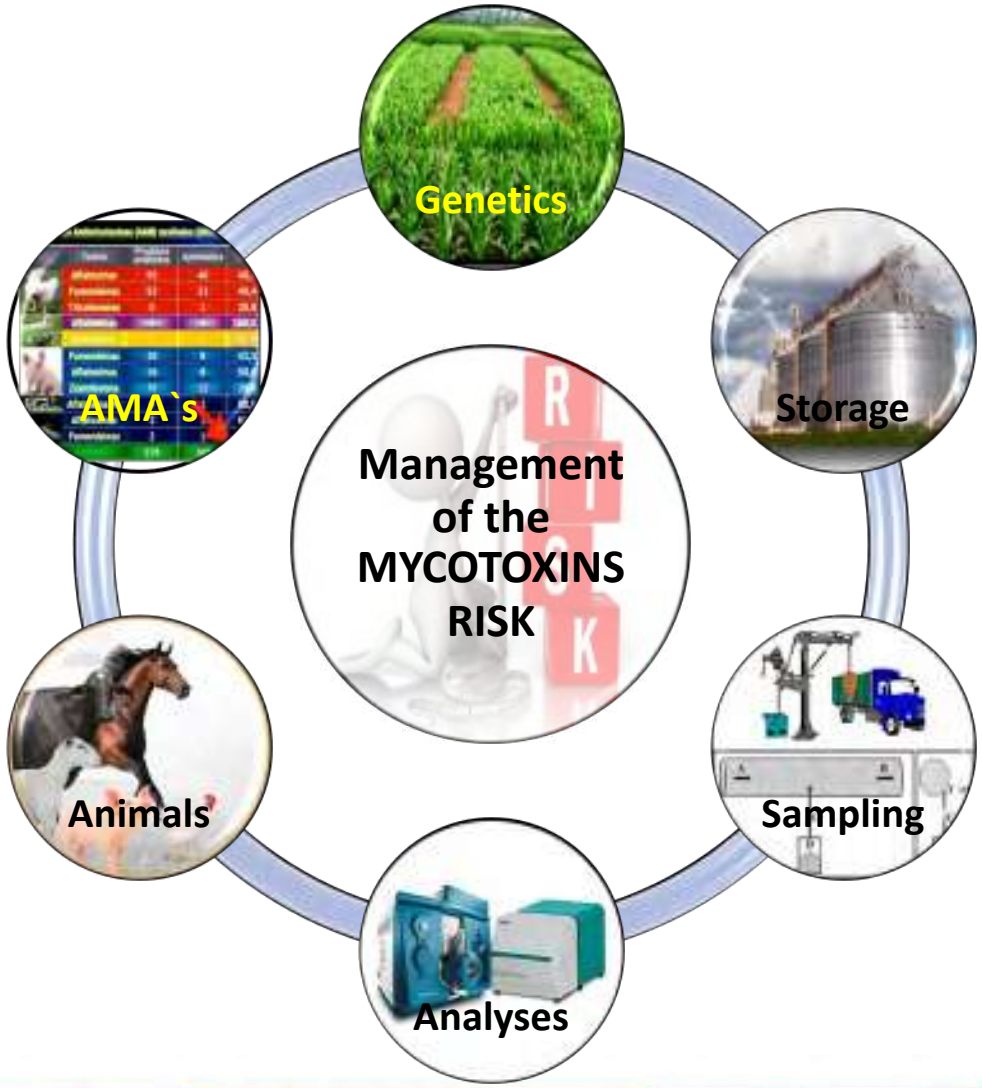
Effects of mycotoxins





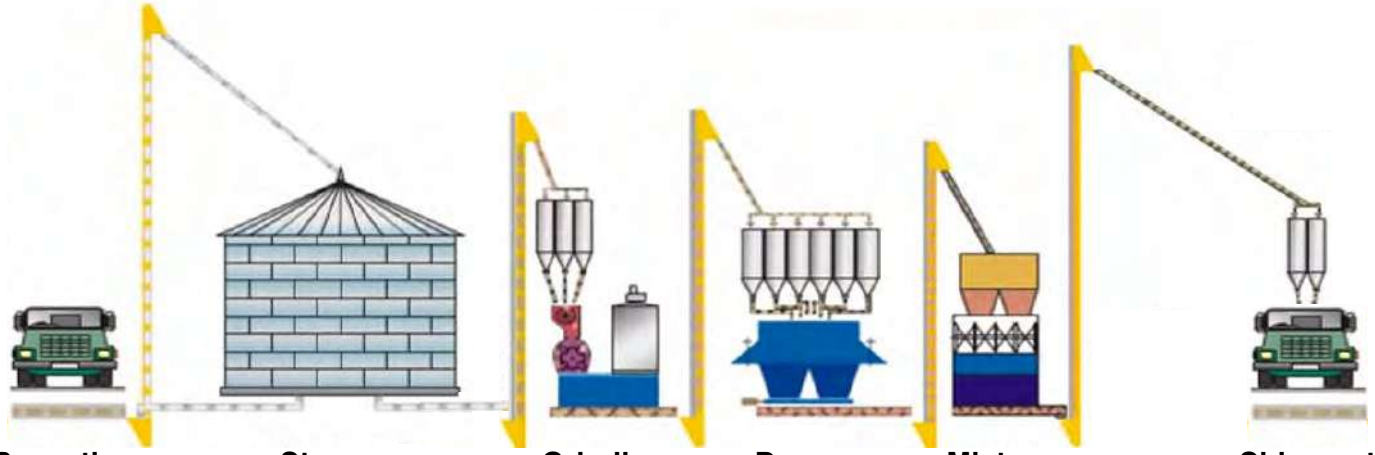


Controlling mycotoxins



- Sampling
- Analysis
- Result interpretation
- Decision making:
  - Segregate raw materials
  - Inclusion of Anti-mycotoxin Additive

Sampling plan for mycotoxin analysis



Mycotoxin analysis

Lateral flow

http://www.nirco.com/web/upload/productes/307_2.jpg

ELISA

https://huaanmagnech.en.ec21.com/Toxin_Fast_Mycotoxin_ELISA_Test--9007552.html

NIR

http://www.directindustry.com/pt/prod/metrohm/product-15372-1253883.html

http://www.businesswire.com/news/home/20050601005266/en/Agilent-Technologies-Introduces-Industry-First-GCMS-System-Allowing

GC-MS

https://gmi-inc.com/media/product/f47/agilent-1100-hplc-system-vwd-with-quaternary-pump-949.jpg

HPLC

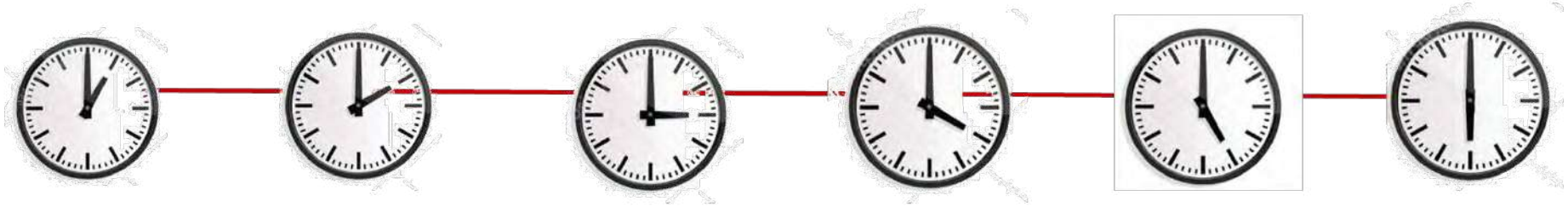
https://images.sciex.com/products/mass_spec/triple_quad/triplequad-6500_share.jpg

LC-MS/MS

Mycotoxin analysis

What do we need?

Analysis | Results typing | Checking results | Graphic tab | Share results | Decision-making



Decision-making depends on analysis result!

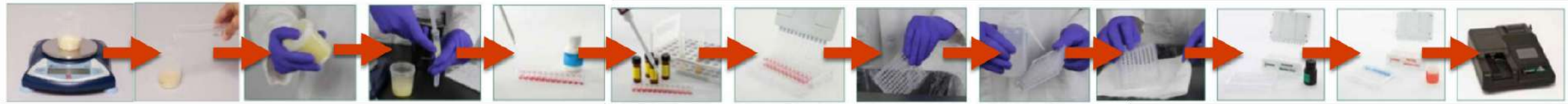
Mycotoxins risk management by NIR

NIR

- Aflatoxins
- Fumonisins
- Don and Zea

One spectrum → **8 min**

ELISA



https://www.slideshare.net/francoisstepman/aflatoxin-test-kits-65475348

4 hours

LC-MS/MS

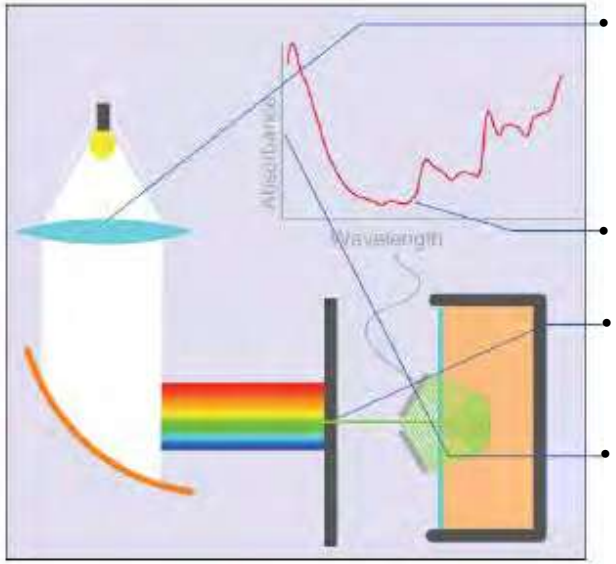
Days...

LC-MS/MS

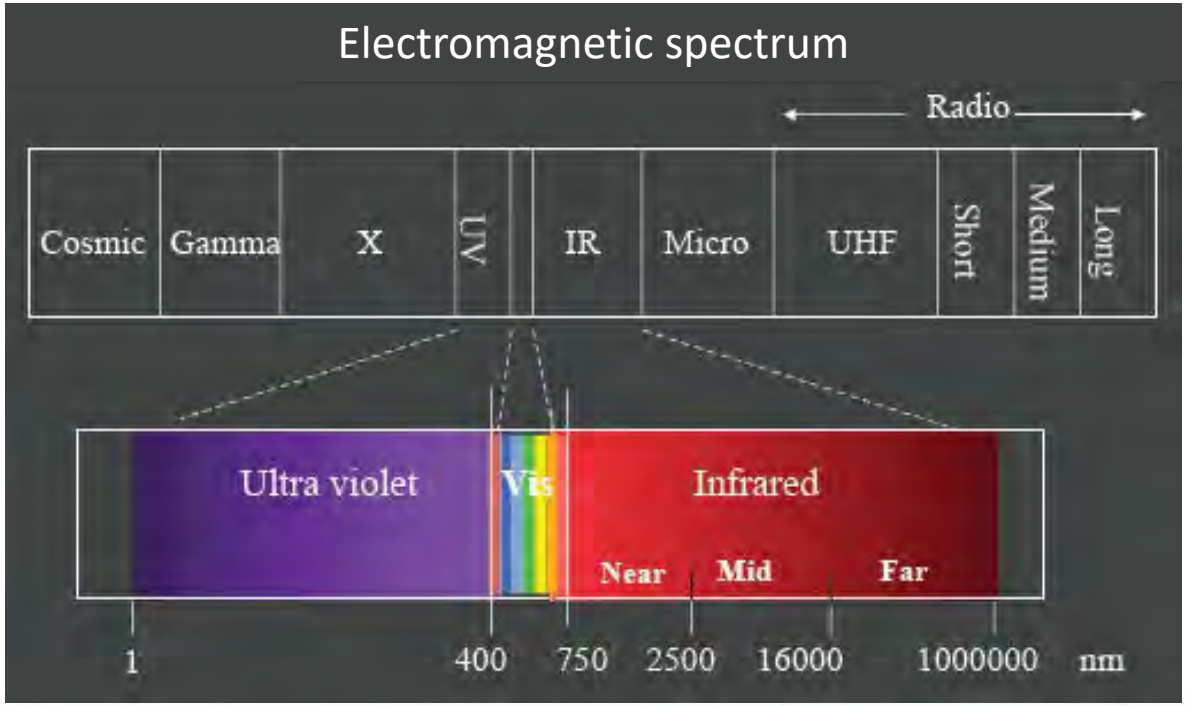
Aflatoxins	209 minutes (3.5 hours)
Fumonisins	202 minutes (3.4 hours)
Don and Zea	301 minutes (5 hours)

→ **12 hours**

Near Infrared (NIR) Spectroscopy



- Infrared light reach the concave mirror that behaves like a prism, separating radiation according to wavelength.
- Spectrum: Abs x Wavelength.
- The radiation passes through a window and penetrates the sample, exciting molecules with electric bipoles.
- The NIR measures the light absorbed or reflected by polar molecules at each wavelength.



Development of mycotoxins analysis through NIR

Reference method

- Two official laboratories (ISO 17.025)
- Methodology: LC/MS-MS
- Samples naturally contaminated
- Analyses in duplicate

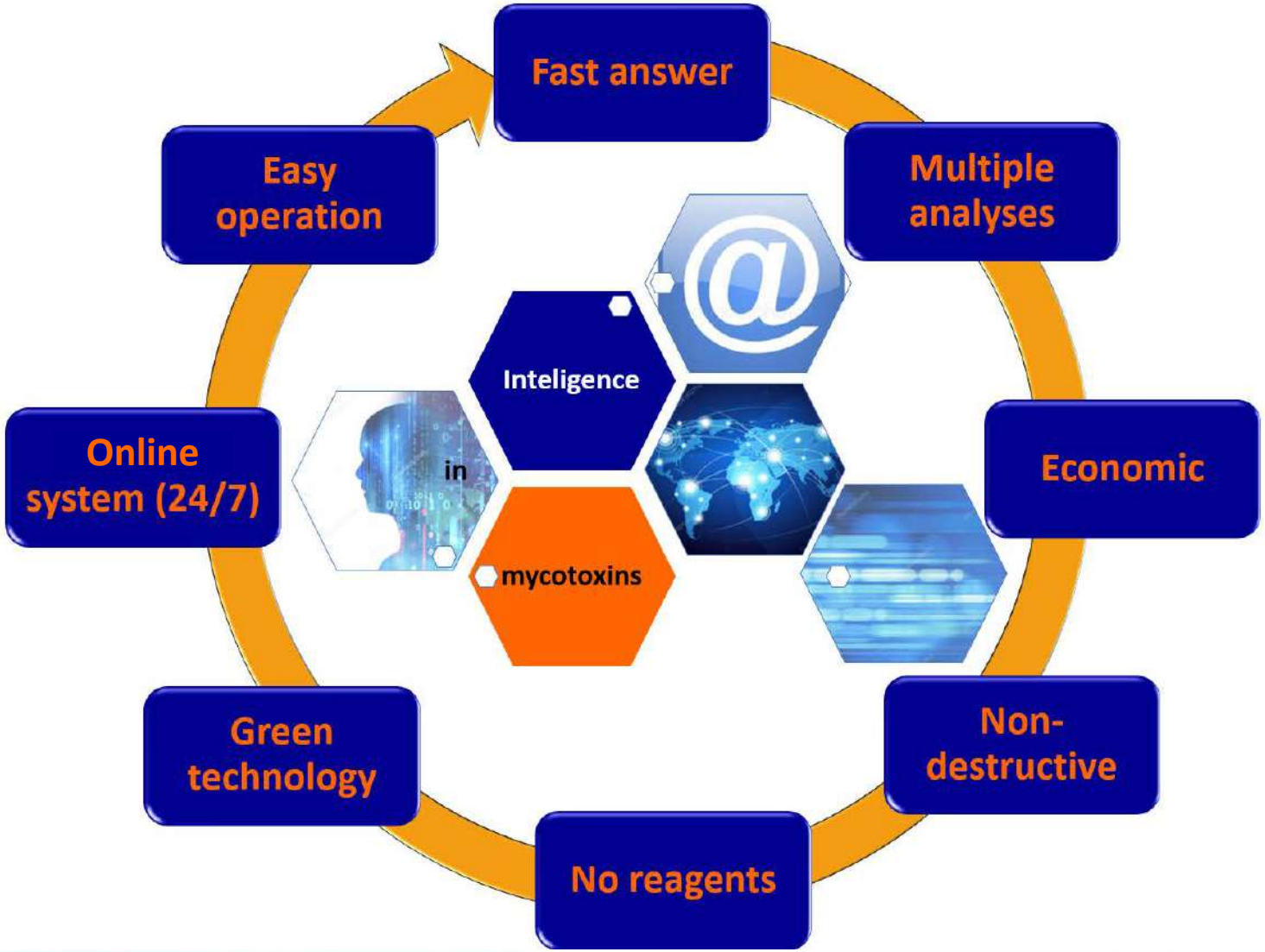
Calibration

- Granulometry: 1 mm
- Equipment "master":

  Foss - XDS: 400-2500 nm

  Bruker - MPA: 780-2600 nm

Benefits

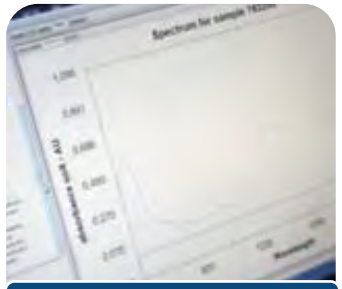

Fast answer
Multiple analyses
Economic
Non-destructive
No reagents
Green technology
Online system (24/7)
Easy operation
Inteligence
in
mycotoxins

Online platform: results in real time


Sampling


Grind the sample


Spectrum reading

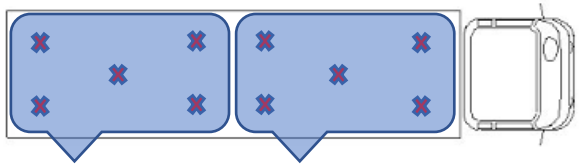

Spectrum exporting


Spectrum sending


Manage the results

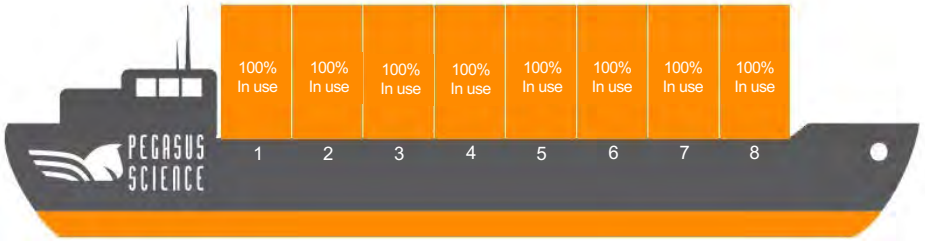
Trucks and trains

- Mean of 2 samples = result / truckload



Ships

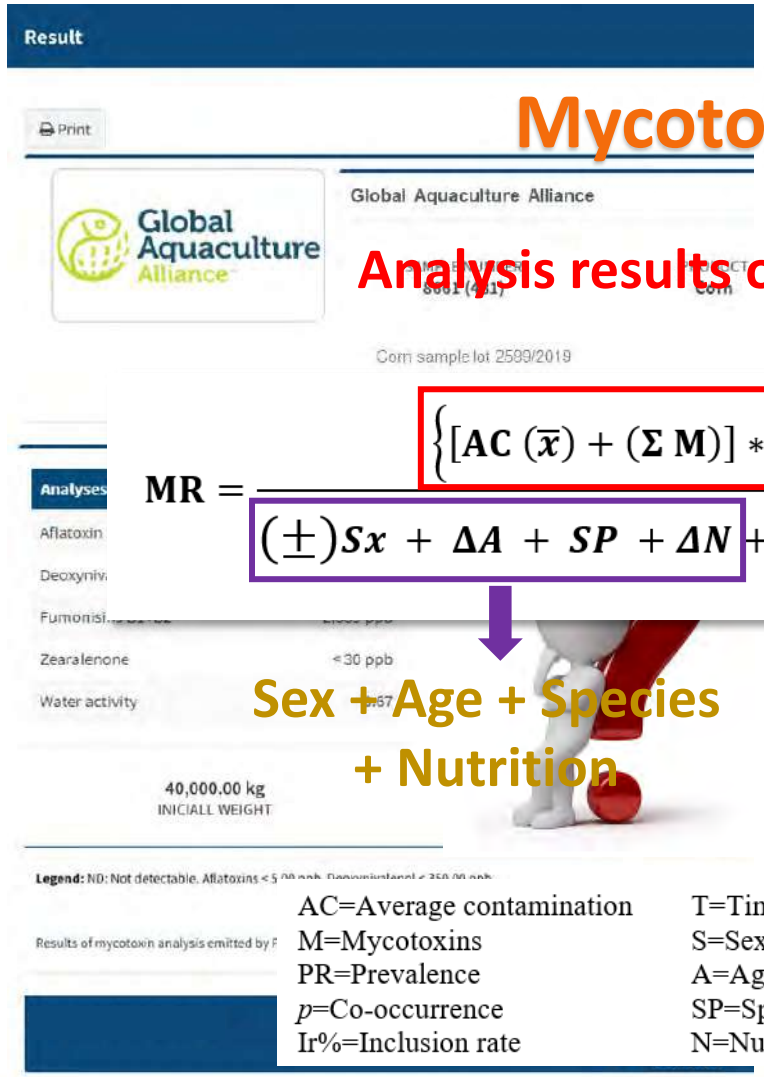
- Mean and positivity per compartment
- Mean and positivity of the ship



Silos and warehouses

- Mean and positivity

Results interpretation and decision making



Mycotoxins Risk Algorithm

Analysis results of each ingredient of the feed

$$MR = \frac{\left\{[AC\ (\bar{x}) + (\Sigma\ M)] * PR\ \left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

Sex + Age + Species + Nutrition

Environment + Health + Genetic

AC=Average contamination	T=Time	E=Environment	RD=Respiratory diseases
M=Mycotoxins	S=Sex	T°=Temperature	VAC=Vaccinations
PR=Prevalence	A=Age	B=Bedding usage	IH=Intestinal health
p=Co-occurrence	SP=Species	NH3=Ammonia	G=Genetics
Ir%=Inclusion rate	N=Nutrition	H=Health	

Mycotoxins Risk Algorithm

$$MR = \frac{\left\{[AC\,(\bar{x}) + (\Sigma\,M)] * PR\left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

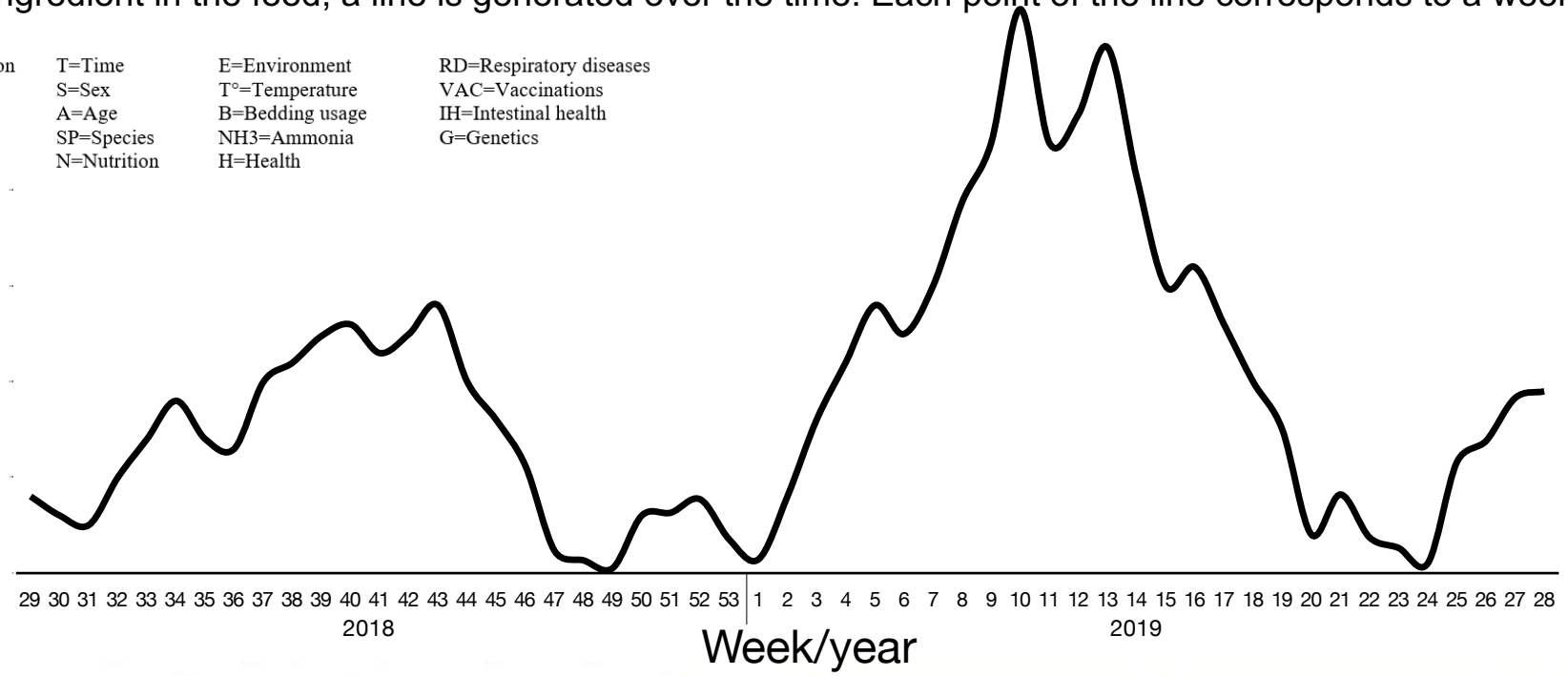
Based on the historical monitoring of each mycotoxin, by the mean of concentration, positivity, mycotoxin coocurrency and inclusion rate of each ingredient in the feed, a line is generated over the time. Each point of the line corresponds to a week:

AC=Average contamination
M=Mycotoxins
PR=Prevalence
p=Co-occurrence
Ir%=Inclusion rate

T=Time
S=Sex
A=Age
SP=Species
N=Nutrition

E=Environment
T°=Temperature
B=Bedding usage
NH3=Ammonia
H=Health

RD=Respiratory diseases
VAC=Vaccinations
IH=Intestinal health
G=Genetics



Mycotoxins Risk Algorithm

$$MR = \frac{\left\{[AC\ (\bar{x}) + (\Sigma\ M)] * PR\ \left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

Based on factors that determine susceptibility for each mycotoxin as sex, age and animal species, the risk ranges (sensitivity ranges) are established:

AC=Average contamination	T=Time	E=Environment	RD=Respiratory diseases
M=Mycotoxins	S=Sex	T°=Temperature	VAC=Vaccinations
PR=Prevalence	A=Age	B=Bedding usage	IH=Intestinal health
p=Co-occurrence	SP=Species	NH3=Ammonia	G=Genetics
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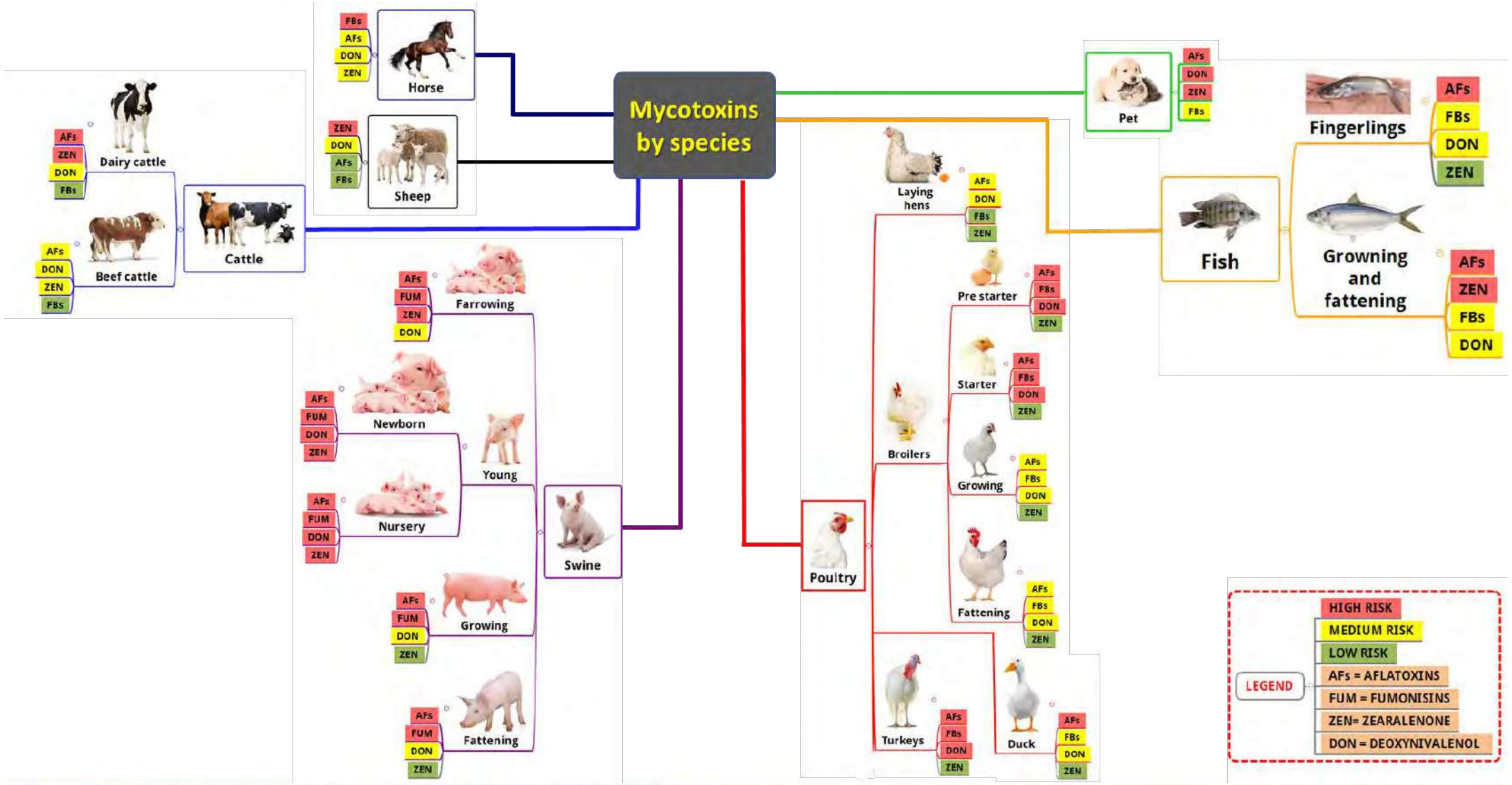
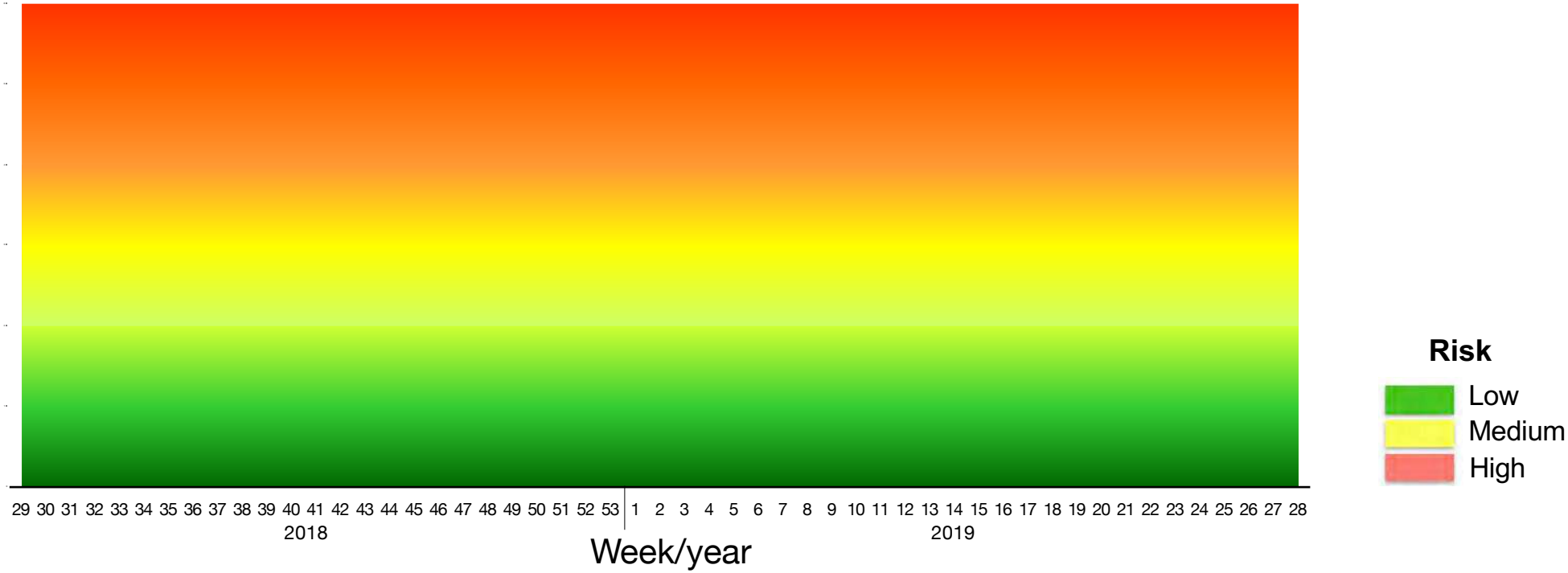
Sensitivity to mycotoxins



Mycotoxins Risk Algorithm

$$MR = \frac{\left\{[AC\ (\bar{x}) + (\Sigma\ M)] * PR\ \left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

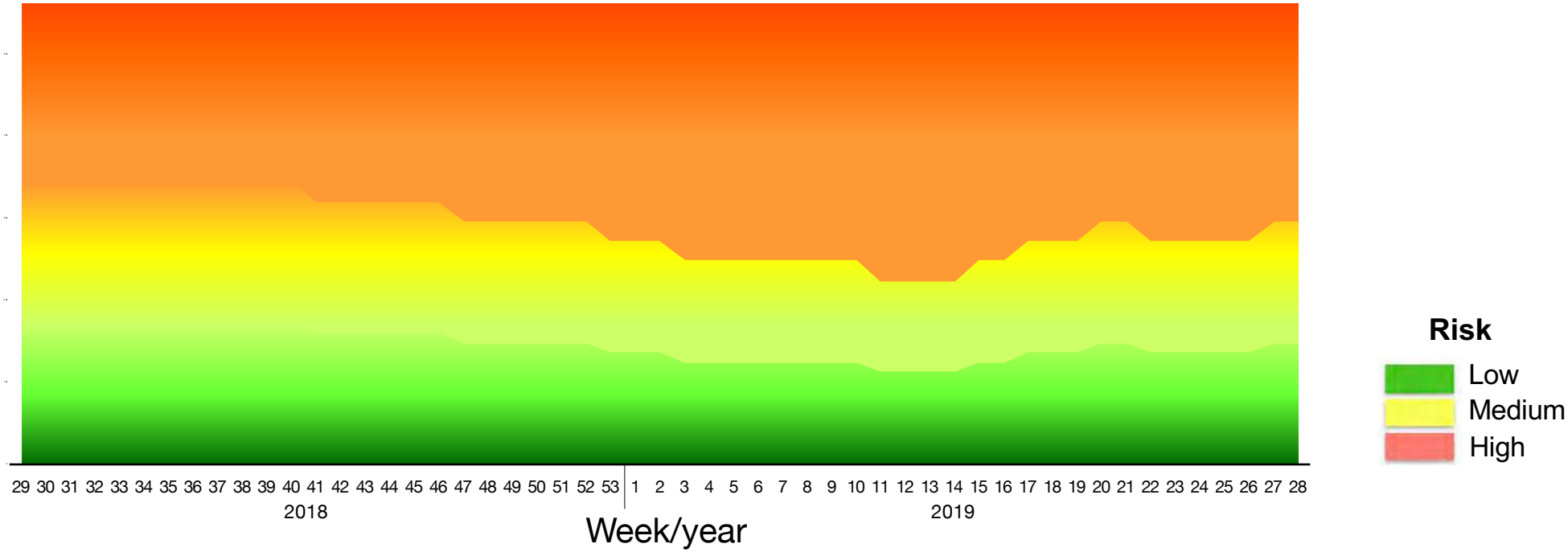
Based on factors that determine susceptibility for each mycotoxin as sex, age and animal species, the risk ranges (sensitivity ranges) are established:



Mycotoxins Risk Algorithm

$$MR = \frac{\left\{[AC\ (\bar{x}) + (\Sigma\ M)] * PR\ \left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

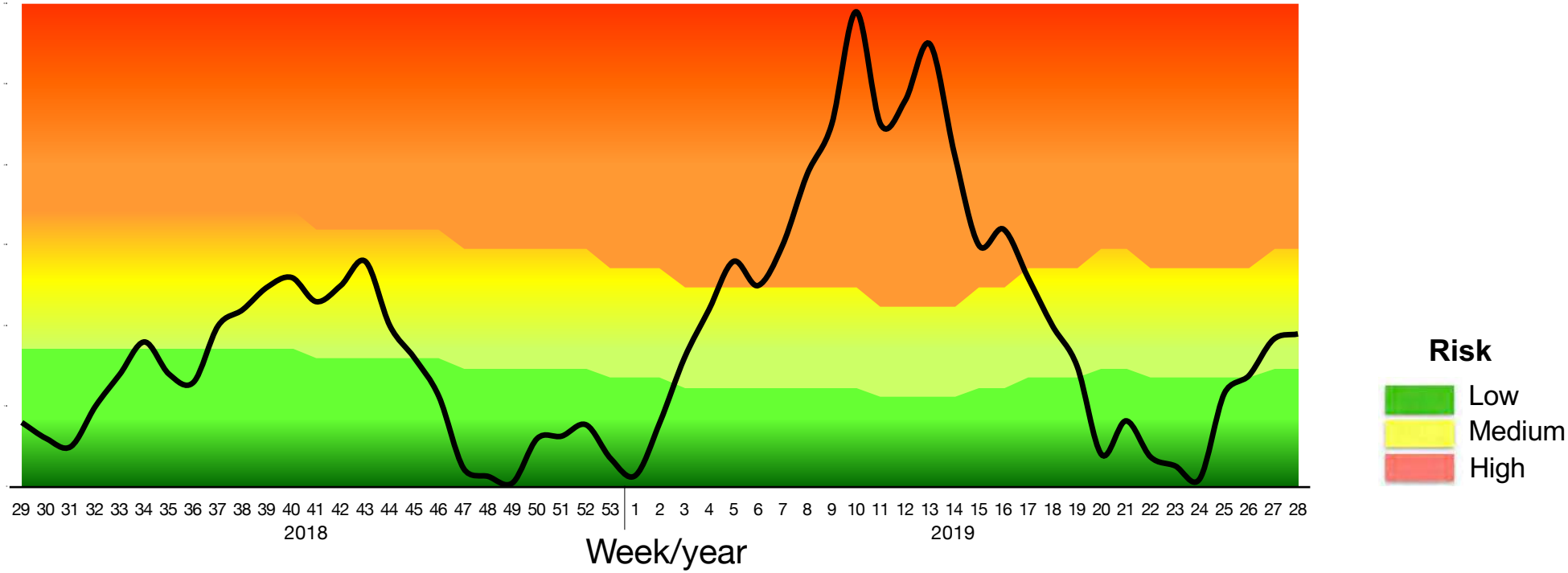
Based on factors that determine susceptibility for each mycotoxin as sex, age and animal species, in addition to nutritional, environmental, health and genetic factors, the risk ranges (variable sensitivity ranges per week) are established:



Mycotoxins Risk Algorithm

$$MR = \frac{\left\{[AC\ (\bar{x}) + (\Sigma\ M)] * PR\left(\% = \frac{(\Sigma n+) * (p\Sigma)}{\Sigma n}\right)\right\} * Ir\% * \Delta T}{(\pm)Sx + \Delta A + SP + \Delta N + \Sigma\left[\left(E\begin{bmatrix} T^{\circ} & NH3 \\ B & \dots \end{bmatrix}\right) + H\begin{bmatrix} RD & IH \\ VAC & \dots \end{bmatrix} + \Delta Gn\right]}$$

The line is plotted on the risk ranges:



Changing the future in mycotoxins risk control

- Minimal environmental impact
- Greater agility in decision making
- Protection of the most sensitive animal species
- Use of specific AMA
- Higher productivity and animal welfare

Acknowledgements

Universidade Federal de Santa Maria 1960 UFSM
LAMIC
INSTITUTO SAMITEC

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