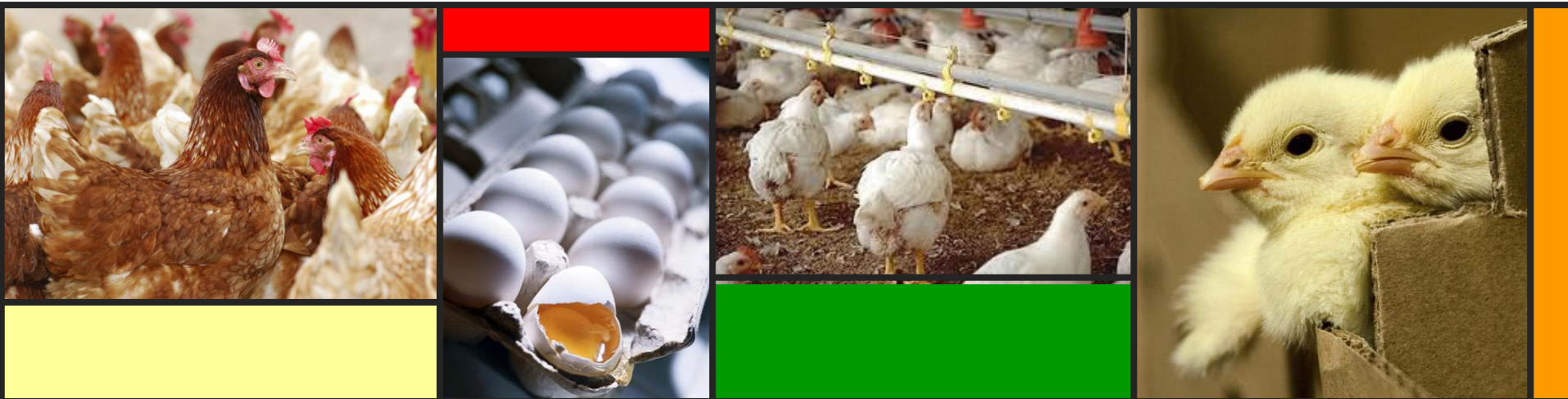


Mycotoxins in the Poultry Industry



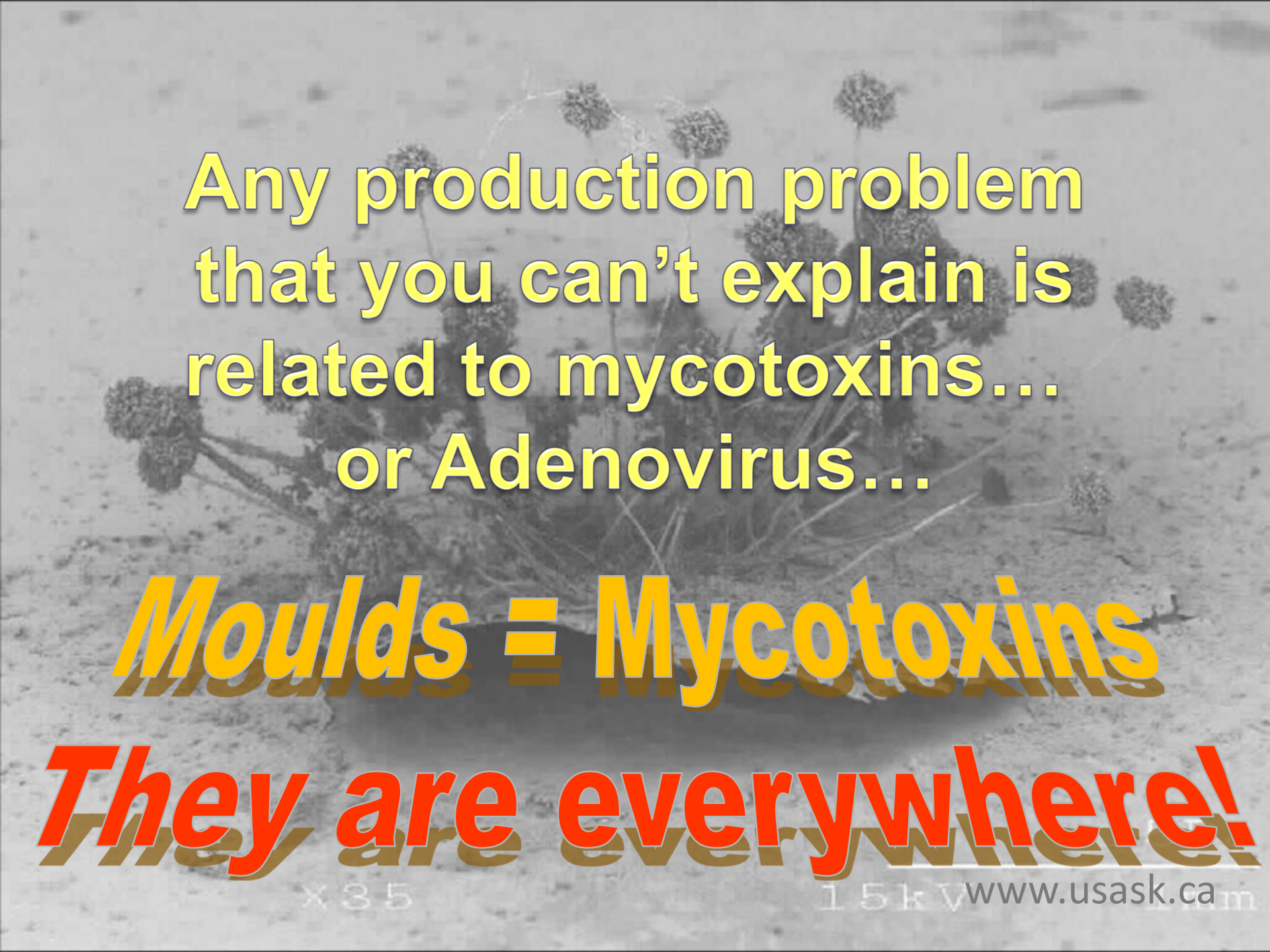
Tom A. Scott, Ph. D.

Research Chair in Feed Processing technology

Coll.: Michael Kautzman, M. Sc. Candidate, Toxicology

University of Saskatchewan

www.usask.ca



Any production problem
that you can't explain is
related to mycotoxins...
or Adenovirus...

Moulds = Mycotoxins

They are everywhere!

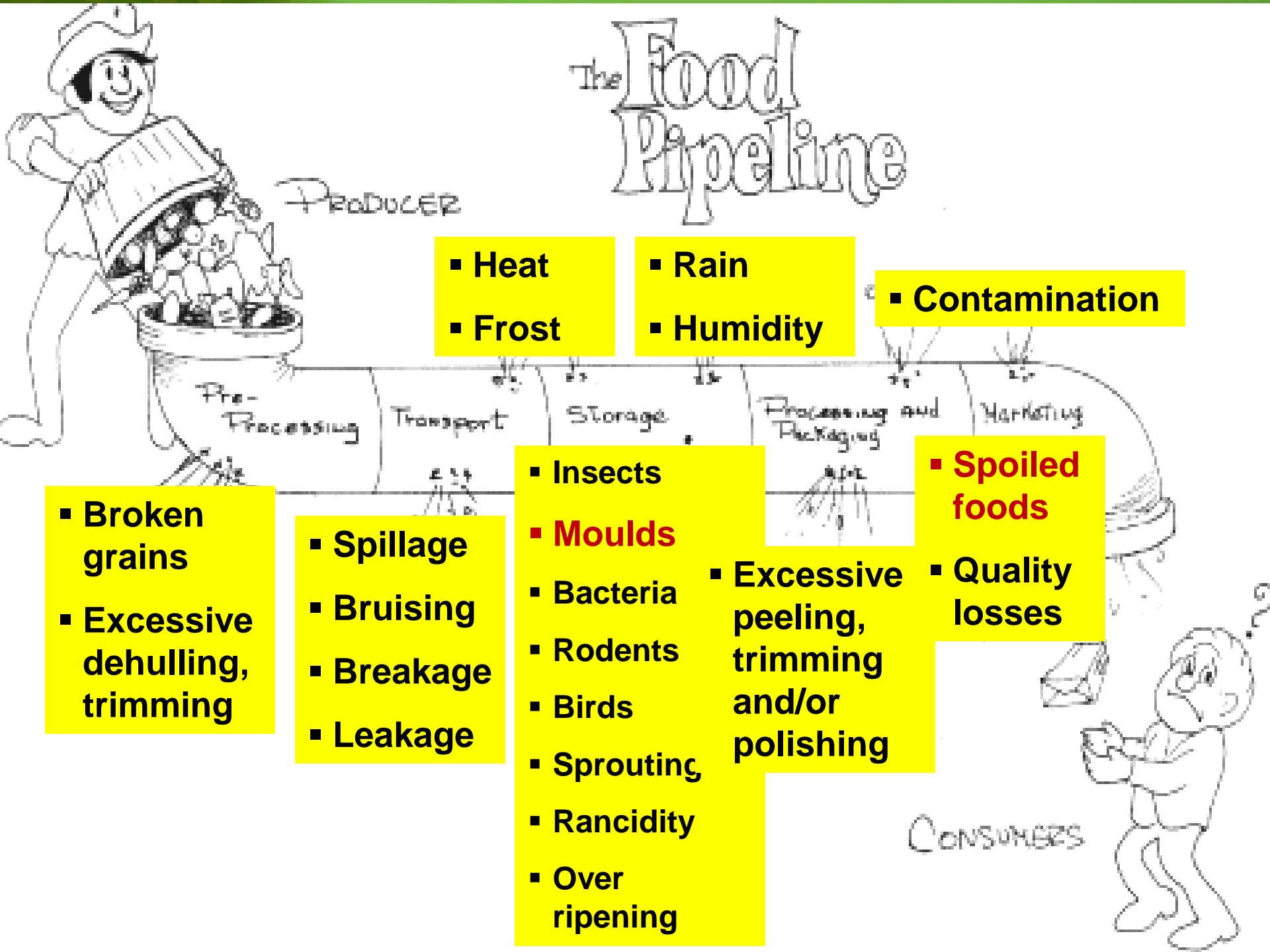
x35

1.5k V

www.usask.ca

**FAO estimates that
20 - 40% of Food
is WASTED**

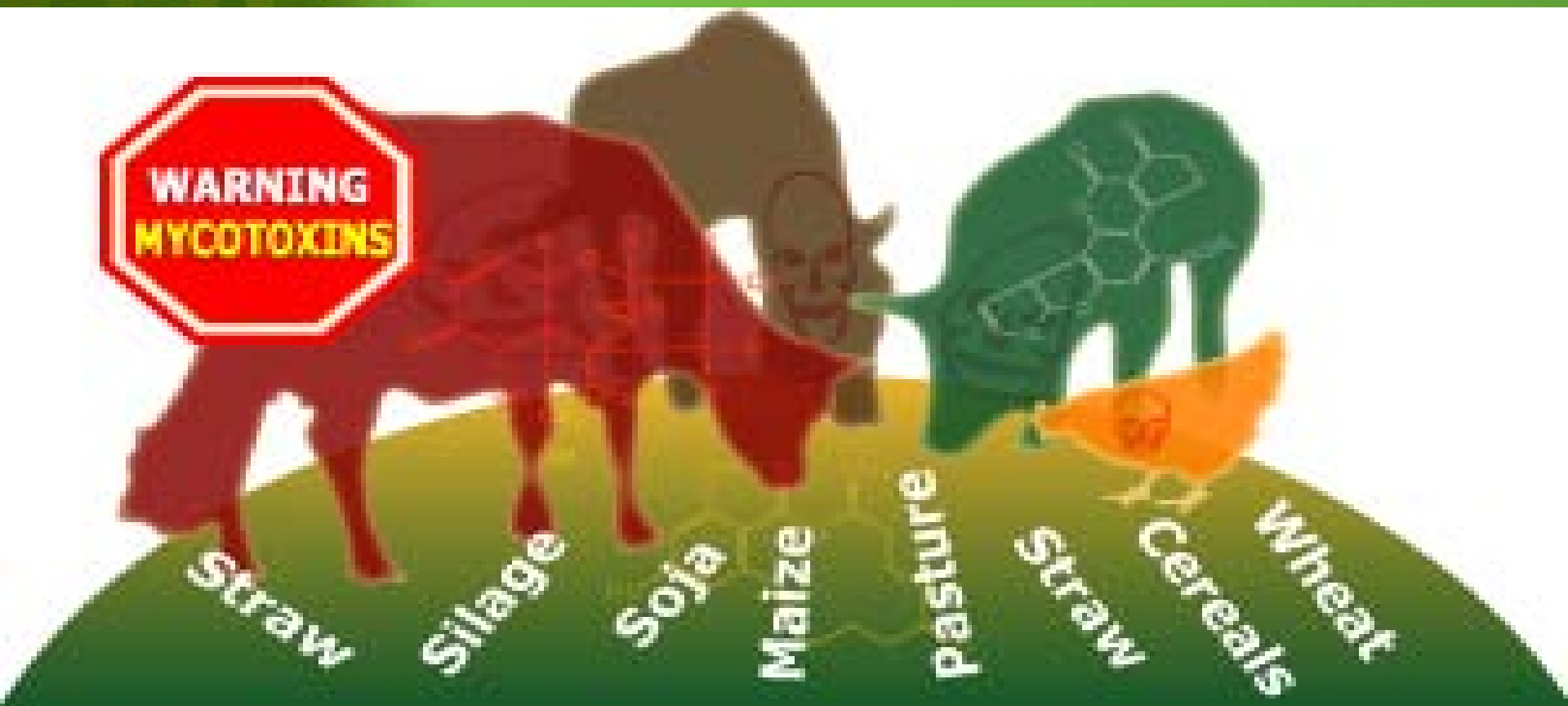
The Food Pipeline



Effectively, this means:

- 20 - 40% of energy / fuel used to grow and make food is wasted
- 20 - 40% of land base used to grow food is wasted
- 20 - 40% of the water is wasted
- 20 - 40% of the labour / handling is wasted

**What does this cost the animal industry and
can we better utilise animals to reduce these losses?**



Losses of ingredients and feeds associated with mycotoxins must be minimised to reduce **WASTE**

Devegowda and Murthy (2005)

“Under practical conditions, no poultry feed is completely free of mycotoxins.

Additionally, no feed can be expected to contain only one mycotoxin.

The adverse effects of mycotoxins on poultry are many fold indicating a clear and persistent danger.”



Meta-analytical analysis (Andretta et al., 2011)

98 papers (1980-2009):

- >1400 diets
- >37,000 birds

Three criteria:

1. Intoxication with mycotoxins
2. Commercial broilers
3. Measured performance and/or organ weights

Variables:

- Challenge period, mycotoxin type and concentration, age, BW and sex
- Data 1401 rows x 189 columns

Younger birds more affected

Mycotoxin presence:

- ⬇ Feed intake 12%
- ⬇ Body weight 14%
 - Ochratoxins and aflatoxins most severe
- ⬆ Mortality
 - DON - 8.8 x greater
 - Aflatoxins - 2.8 x greater
- ⬆ Organ weights
 - Liver 15%
 - Kidneys 11%
 - Lungs 9%
 - Gizzard 3%

Meta-analysis

Magnitude of toxicity varied with:

- Mycotoxin type
- Mycotoxin concentration
- Young >> older
- Nutritional factors

✓ Aflatoxin negative effects lower in birds consuming:

- Higher protein
- Higher methionine
- May relate to Met and Cys as part of the oxidative stress control

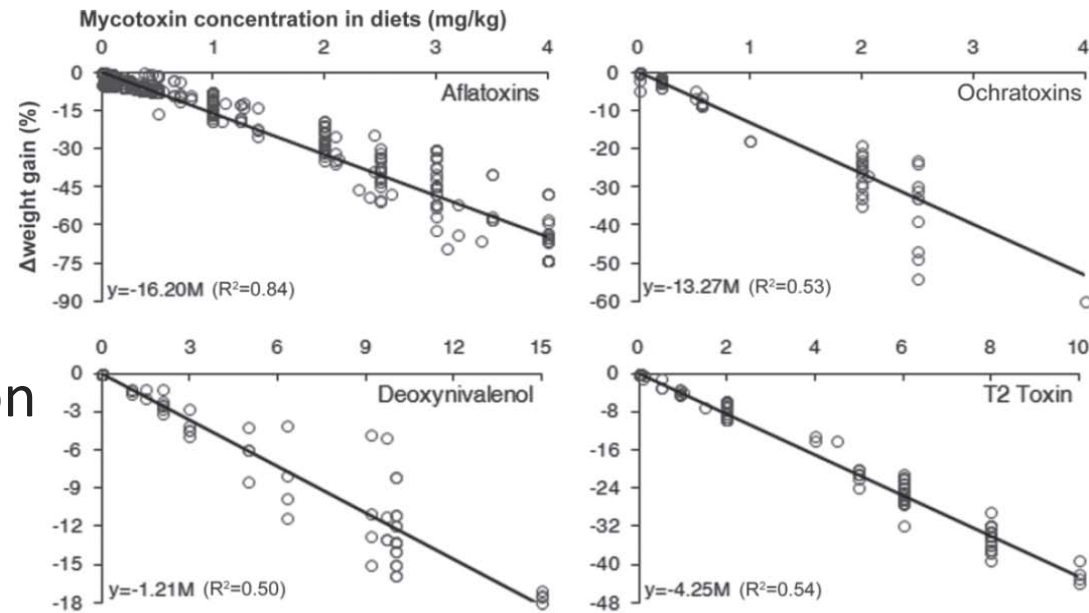


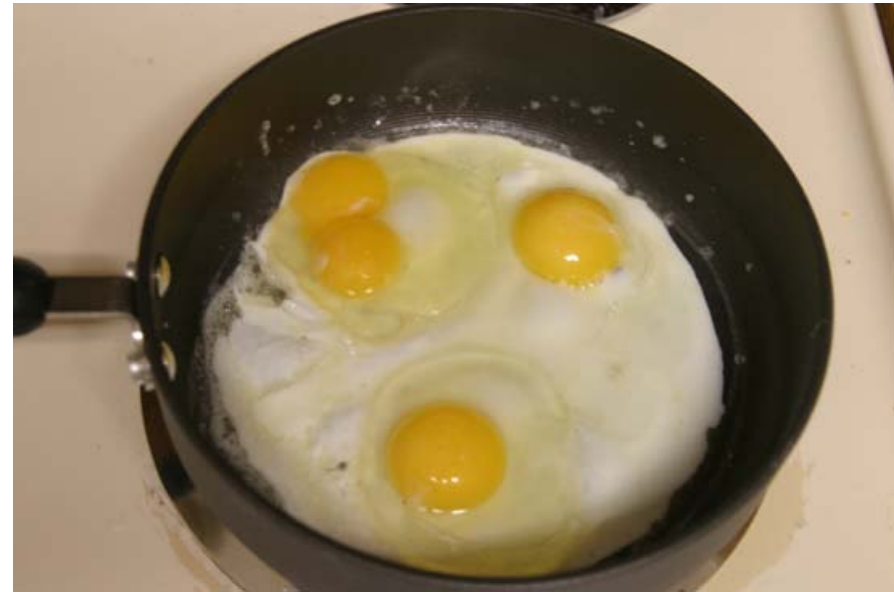
Figure 1. Reduction in average daily weight gain, obtained through variance-covariance analysis, in broilers challenged by aflatoxins, ochratoxins, deoxynivalenol, or T2 toxin relative to mycotoxin concentration in diets.

Andretta et al. (2011)

Now we need a meta-analysis to evaluate the efficacy of control treatments!

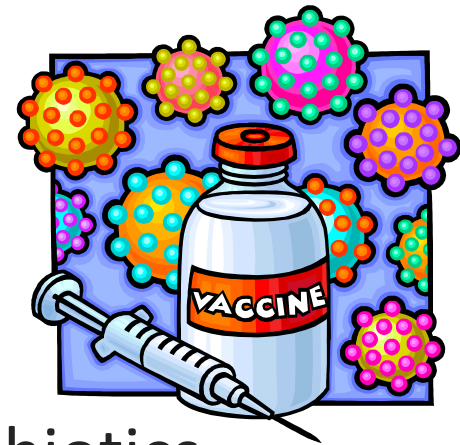
Impact of mycotoxins

- Direct health challenges
 - ✓ Reduced immune response (vaccinations)
 - ✓ Toxicity
 - ✓ Skeletal health
- Reduced feed intake
- Reduced nutrient absorption
 - ✓ Excretion of lipids
 - ✓ MALABSORPTION SYNDROME
- Residues in meat / **Eggs**
- Condemnations / Downgrading
 - ✓ Bruising
 - ✓ Loss of salable product (i.e.: liver, gizzard erosion)
- Reproduction (loss in fertility & hatchability)



Impact of aflatoxins on the immune system

- Reduction in size of bursa of Fabricius and thymus
- Reduction in T-lymphocyte, B-lymphocyte and white blood cell counts
- Reduction in total serum proteins and immunoglobulins
- Reduction in antibody titers
- Reduction in serum concentration of antibiotics



(Devegowda and Murthy, 2005)

Balancing oxidative stress

“Mycotoxins are considered to be among the most important feed-borne stress factors” (Surai and Dvorska, 2005)

- Must balance pro-oxidants / Antioxidants
 - ✓ Minimize free radical / Lipid peroxidation
 - ✓ Optimize free radical scavenging
 - Some antioxidants can also be pro-oxidants (e.g. Vit E)
 - Cell signaling relies heavily on free radicals
 - If these are neutralized by antioxidants the animal will fail

Do mycotoxins stimulate lipid peroxidation? Or do they make tissues more susceptible due to a compromised antioxidant system? Or both?

Co-contamination of mycotoxins in poultry

- Multiple mycotoxins can be produced by one fungi
- Multiple mycotoxins can be combined from different sources of contamination, the most common are:
 - ✓ Aflatoxins and ochratoxin
 - ✓ Aflatoxins and T-2 toxin
 - ✓ T-2 toxin and diacetoxyscirpenol
 - ✓ Ochratoxin and citrinin
 - ✓ Deoxynivalenol and fusaric acid
 - ✓ “The number of possible combinations is vast”
- Effects can be additive or synergistic

(Devegowda and Murthy, 2005)

Safe / permissible levels of mycotoxins in poultry feeds

- What is a safe level?
 - ✓ “There is no safe level”
 - ✓ Impact of levels may be different between farms
- Can a contaminated grain source be fed safely to other animals if not poultry?
- What will be the economic impact of a given level of contamination?



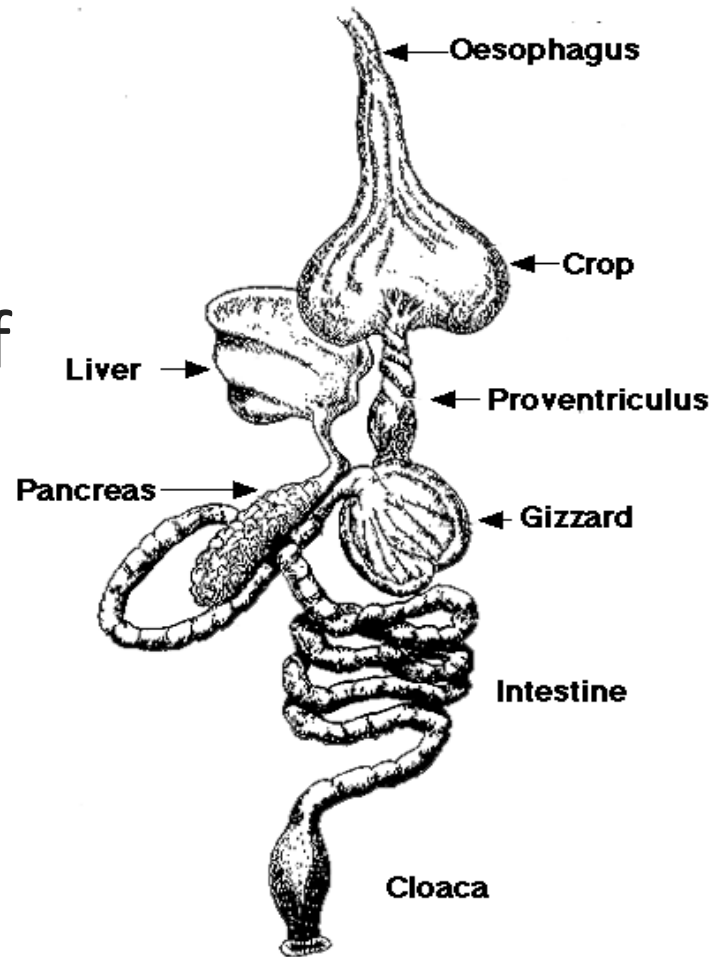


CONTROL OF THE ADVERSE EFFECTS OF MYCOTOXINS

Detoxification / Decontamination

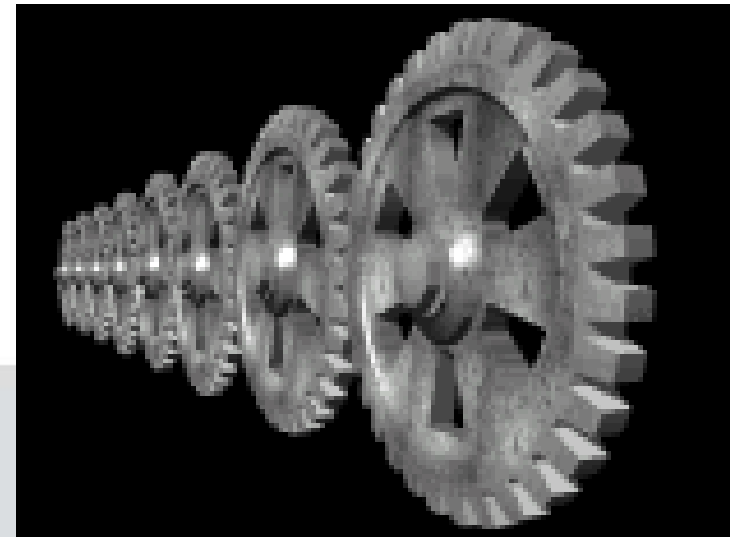
MUST act quickly in the gut

- Rapid transit / Rapid absorption
- Mycotoxin levels must be reduced within 30 minutes of digesta becoming solubilised
- Is activity possible in dry dietary form?
 - ✓ Combating 2ndary effects may be by different routes after absorption of mycotoxin



Decontamination of ingredients

- Dilution with sound grain
- Washing – Dehulling – Polishing
- Separation (by screens, blowers, sieves)
- Heat treatment (autoclaving, roasting, microwave heating)
 - ✓ Some mycotoxins can withstand temperatures $> 400\text{ C}$
- Density segregation – Flotation
- Electronic color sorting
- Solvent extraction
- UV radiation



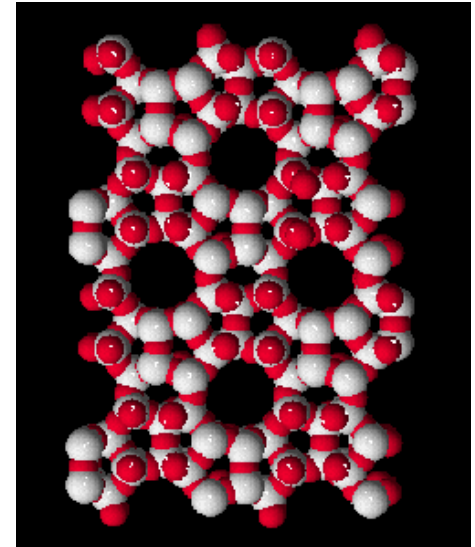
Mycotoxin adsorbents

Factors to be considered

- Able to adsorb a wide range of mycotoxins
- Low inclusion rate
 - ✓ Reduce cost, dilution effect, but harder to mix evenly
- Easy to mix uniformly
- Heat and storage stability
- No affinity for vitamins, minerals, etc.
- Functional under pH ranging from 2-7
- Biodegradability after excretion
- Safe for animals and humans
- Palatability
- No potential for other sources of contaminants

Adsorbents: Mineral clays

- Many products available
 - ✓ Bentonites
 - (used as a pellet binder, but require >4%)
 - ✓ Zeolites
 - ✓ Aluminosilicates
 - ✓ Hydrated sodium calcium aluminosilicate (HSCAS)
 - ✓ Activated charcoal
- Adsorption depends on the chemical structure
 - ✓ Capacity can vary from 0 to 87%



(Devegowda and Murthy, 2005)

Adsorbents: Mineral clays

- Mostly effective for aflatoxins, but little efficacy for:
 - ✓ Zearalenone
 - ✓ T-2 toxin
 - ✓ Ochratoxin
 - ✓ Diacetoxyscirpenol
 - ✓ Fescue Toxin
- Mineral clays reduce the utilization of Mn, Zn, Mg, Cl, Cu and Na

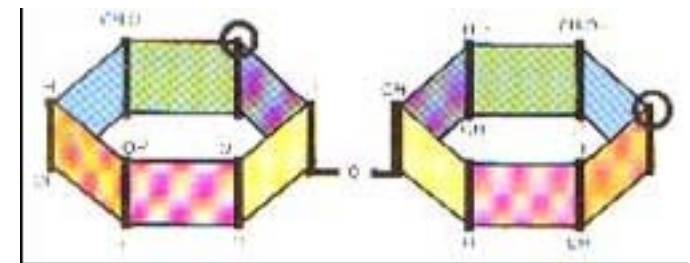


Adsorbents: Yeast cell wall

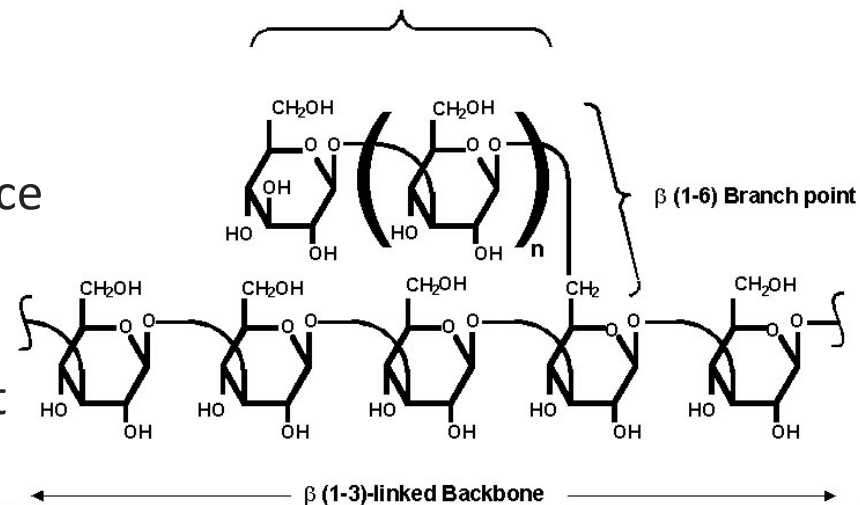
- Yeast cell wall derived and/or modified glucomannan (Mycosorb / Alltech Inc)
- Biorigin (Brazil)
- Biomin (Germany)
- Pros and Cons
 - ✓ Lower inclusion levels than clays (1 vs 40kg / MT)
 - Costs/MT similar, but less dilution of diet
 - ✓ Broader claims for different types of mycotoxins
 - ✓ Efficacy often variable

Yeast cell wall

- *Saccharomyces cerevisiae* is a yeast species which has been domesticated for at least 3,000 years
- Not live yeast, rather the yeast cell wall
 - ✓ Manno-oligo saccharides
 - It is alternative attachment place
 - ✓ 1-3, 1-6 β glucans
 - Diverse molecule
 - Strong immune stimulator effect



β (1-3)-linked Branch



Ultimate
Toxin
Prevention
Program



UTPP - 5	UTPP Spl	UTPP Biotech
HSCAS	HSCAS	HSCAS
Buff. Org. acids	Buff. Org. acids	Buff. Org. acids
	MOS	MOS
		Act. Charcoal
		Oxine copper
		Lipotropic agents
2.5 - 5 kg / ton	1 kg / ton	1 kg / ton

The New line of Mycotoxin Binder - Nutron Alimentos



T1

T2

T3

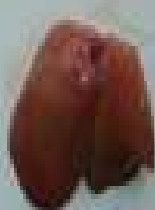
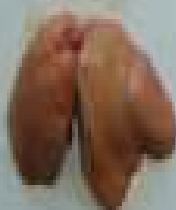
T4

T5

T6

T7

T8



Positive

Negative

Adsorb

Vugel

Sanofix

Micofix

Vetcare

Providet

12 11 2007

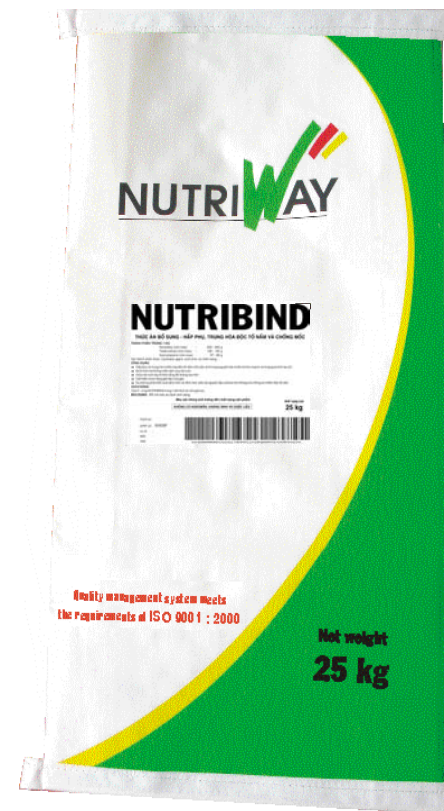
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NUTRIBIND

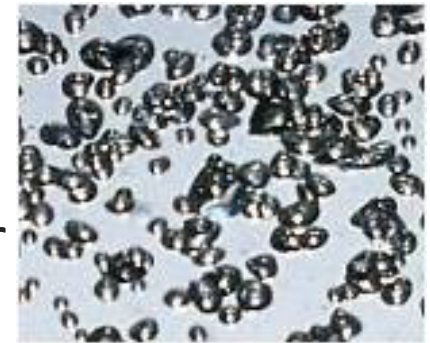
A multifunctional product:

1. Mould inhibition
2. Toxin absorption
3. Immune stimulation
4. Liver protection



Smectite: *a living mineral*

- **Pelleting aid:** Since the start of commercial poultry farming
- **Growth promoter:** Since the 70s, due to the beneficial effect on performance
 - ✓ Weight gain
 - ✓ Increased egg production
- Increases wool growth in sheep
- Decreases moisture level in droppings –dry litter
- Aids liver regeneration
- As toxin binder: Since the 80s
 - ✓ Mycotoxin
 - ✓ Bacterial endotoxin



Hydrated Bentonite



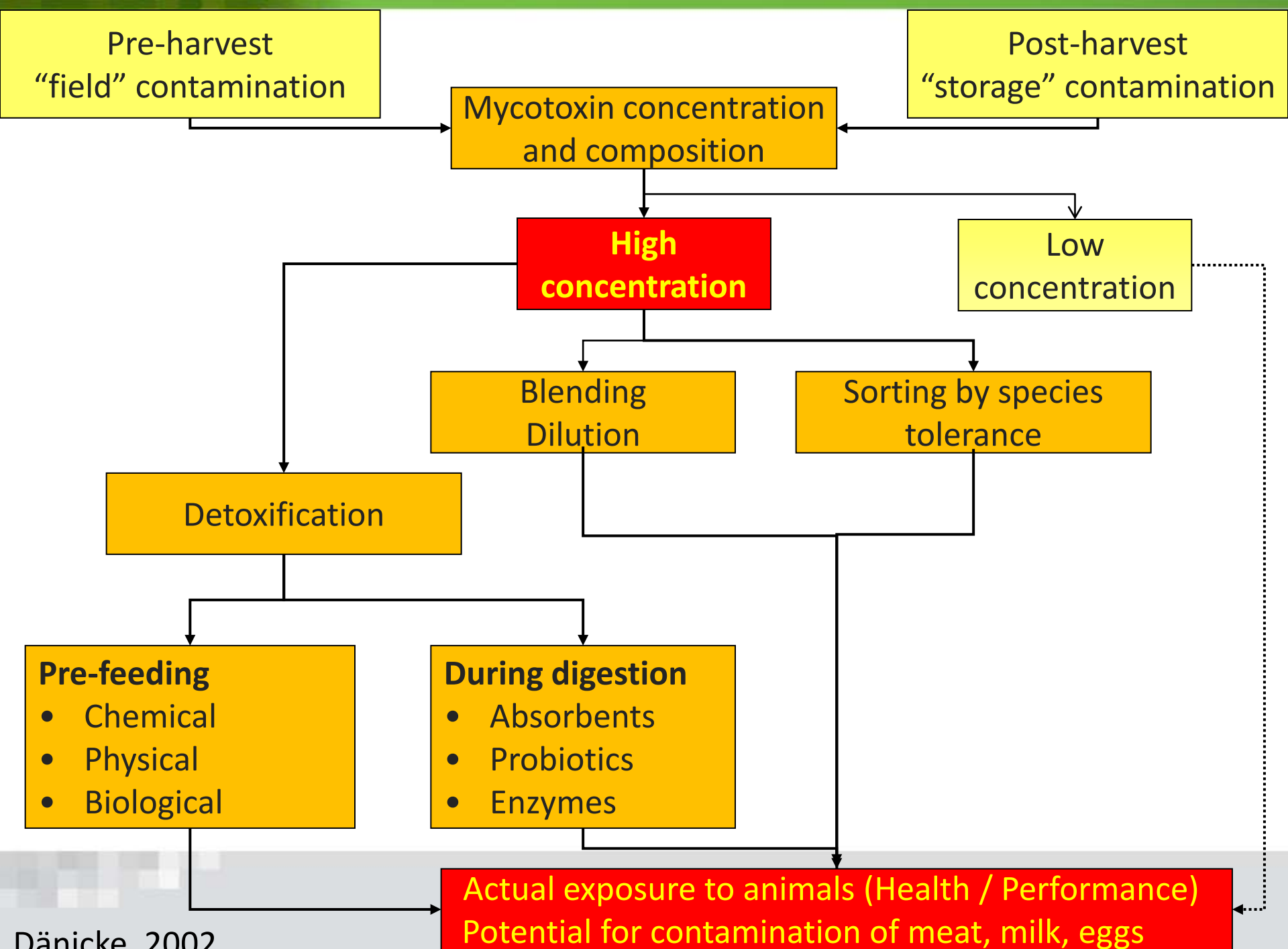
Sausages,
political agreements and
adsorbents *in vitro* tests
Do not ask how
they are made!

Chemical detoxification

- Detoxify or inactivate mycotoxins
 - ✓ Ozone
 - ✓ Ammonia, ammonia hydroxide
 - ✓ Sodium bisulfite
 - ✓ Peroxide acids
 - ✓ Formaldehyde
 - ✓ Bases, calcium hydroxide
- Issues with
 - ✓ Safety
 - ✓ Palatability
 - ✓ Efficacy

Ducks more
susceptible

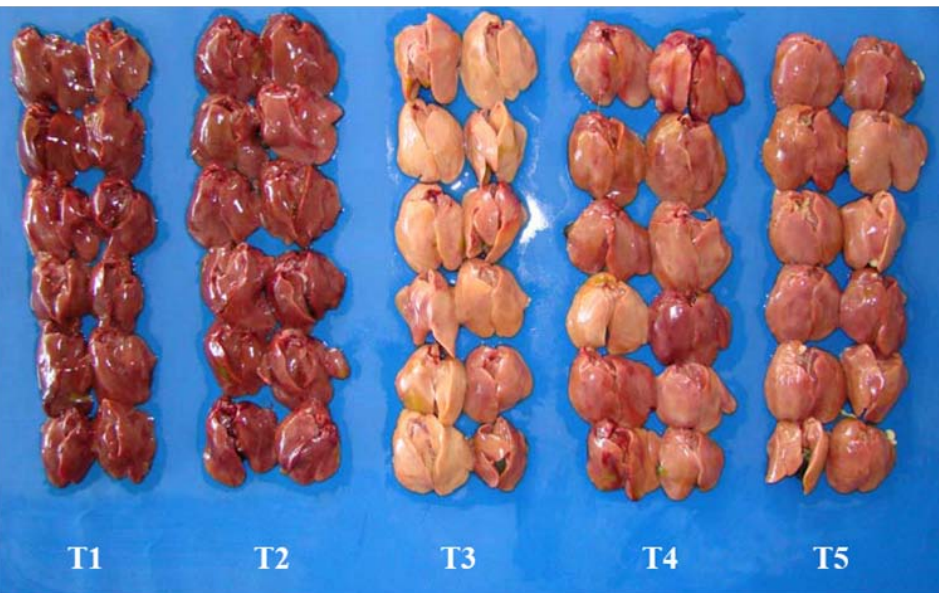




Efficacy of control measures:

Physical treatments

- Uncertain results
- Often connected with high feed losses
- Limited practical application

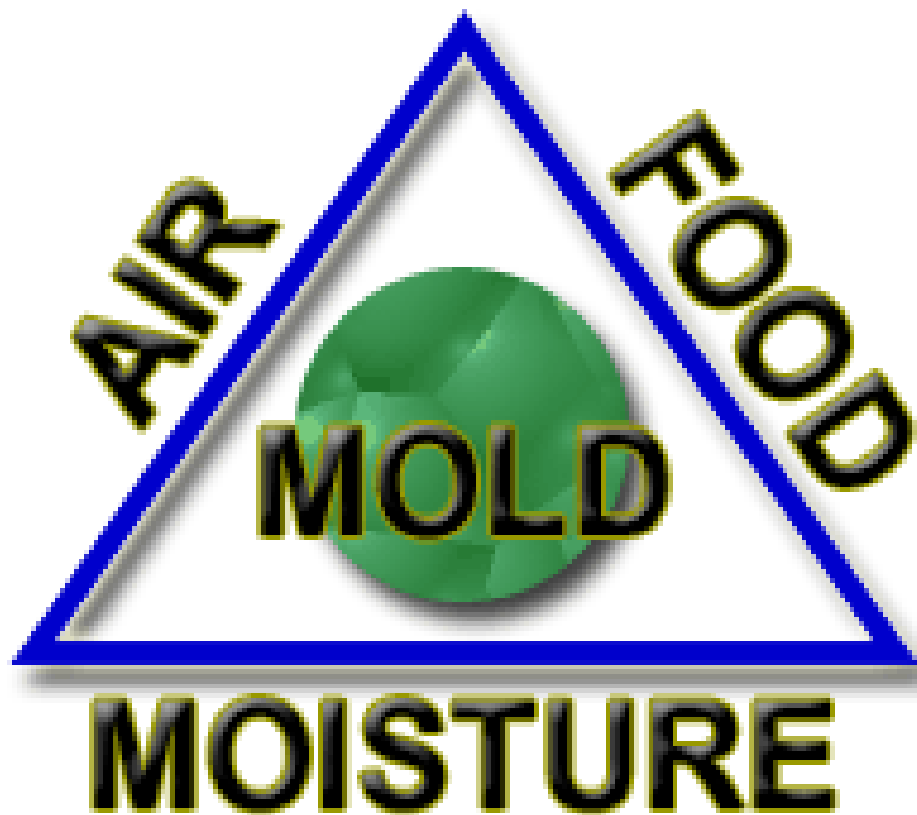


Chemical treatments

- Expensive and time consuming
- Changes in palatability / Feed intake
- Dilution or destruction of nutrients
- Decreased feed quality
- Regulatory
- No practical application

Nutritional Modifications

- Fortify diets (counter oxidative stress)
 - ✓ Methionine
 - ✓ Selenium
 - ✓ Vitamins (possibly to account for binding)
 - ✓ Fat source (polyunsaturated fatty acids (PUFA) in cell membranes more susceptible)
- Supplements
 - ✓ Antioxidants
 - Polyphenols
 - Peptides
 - Ethoxyquin



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