# Overview of Significance of Residues and Chemical Contaminants in Milk

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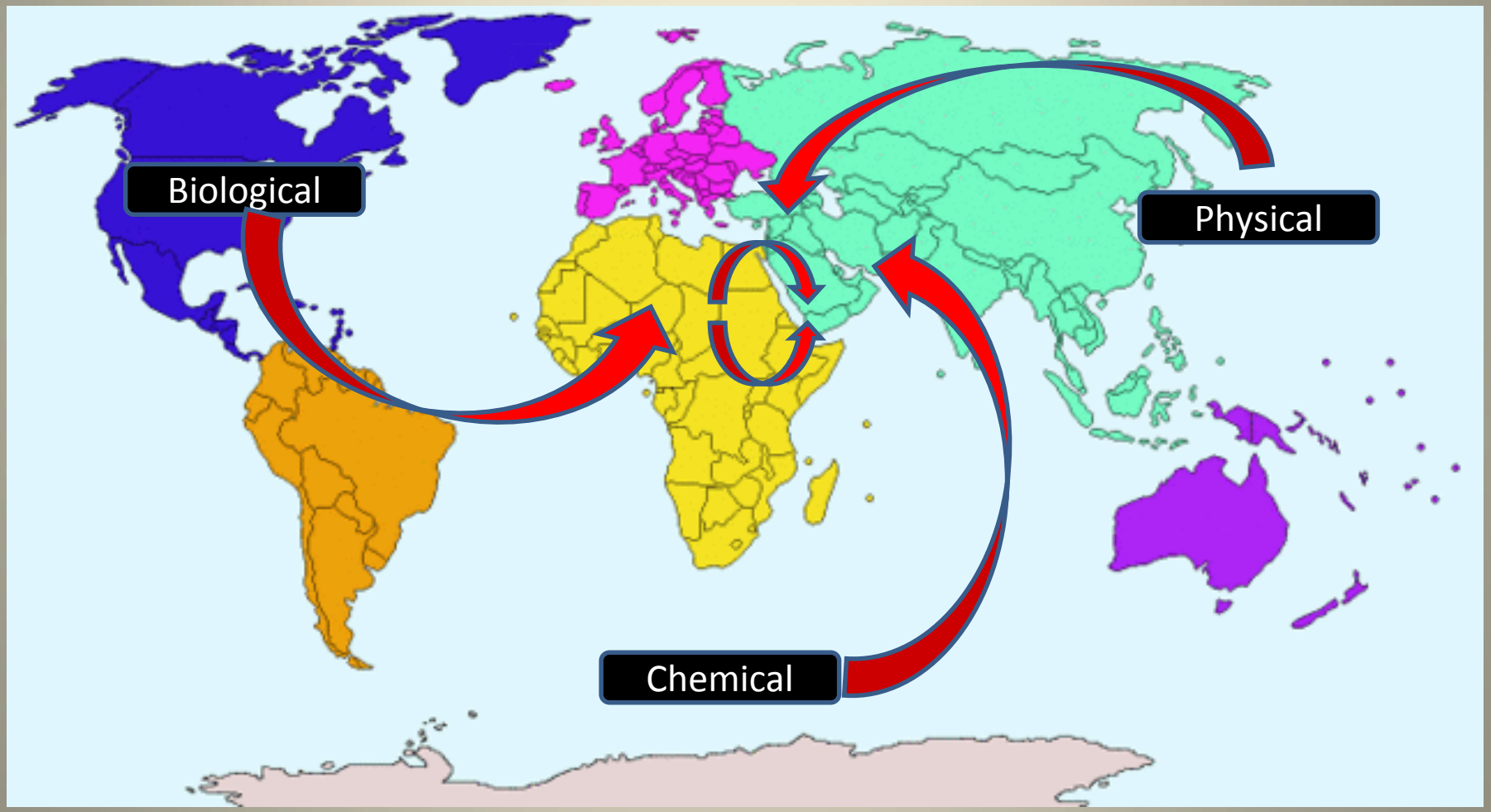
# Types of Residues and Contaminants found in Foods



# Contaminant or Residue?

**For the purposes of this presentation**

## Contaminants:

**Substances that are found in food, as a result of entering at any stage of the food chain. Usually they may enter food unintentionally – but occasionally due to being intentionally added with fraudulent intent.**

## Residues:

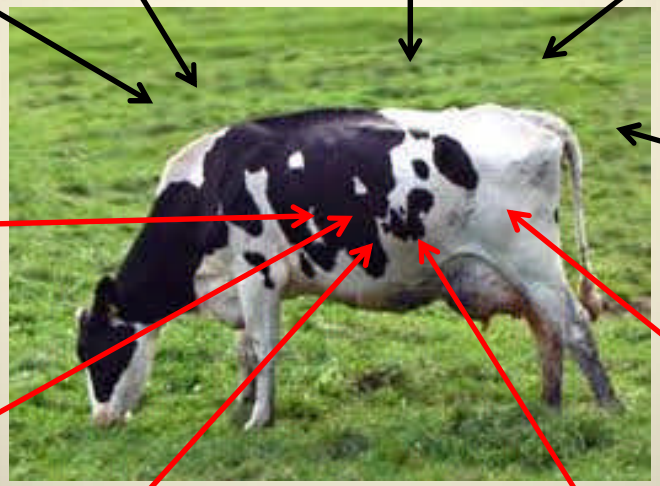
**Substances that are found (or remain) in food as an unintended consequence of using phytosanitary products (pesticides) or veterinary drugs.**

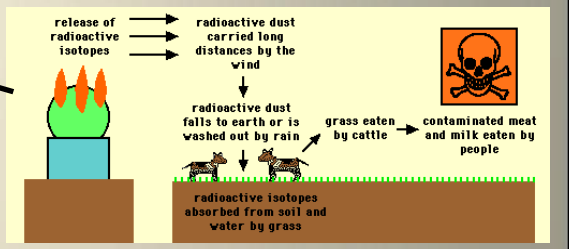
# Simple Dairy Farm to Fork Chain

# Potential Contamination Sources
## - the Raw Material Source


Direct →

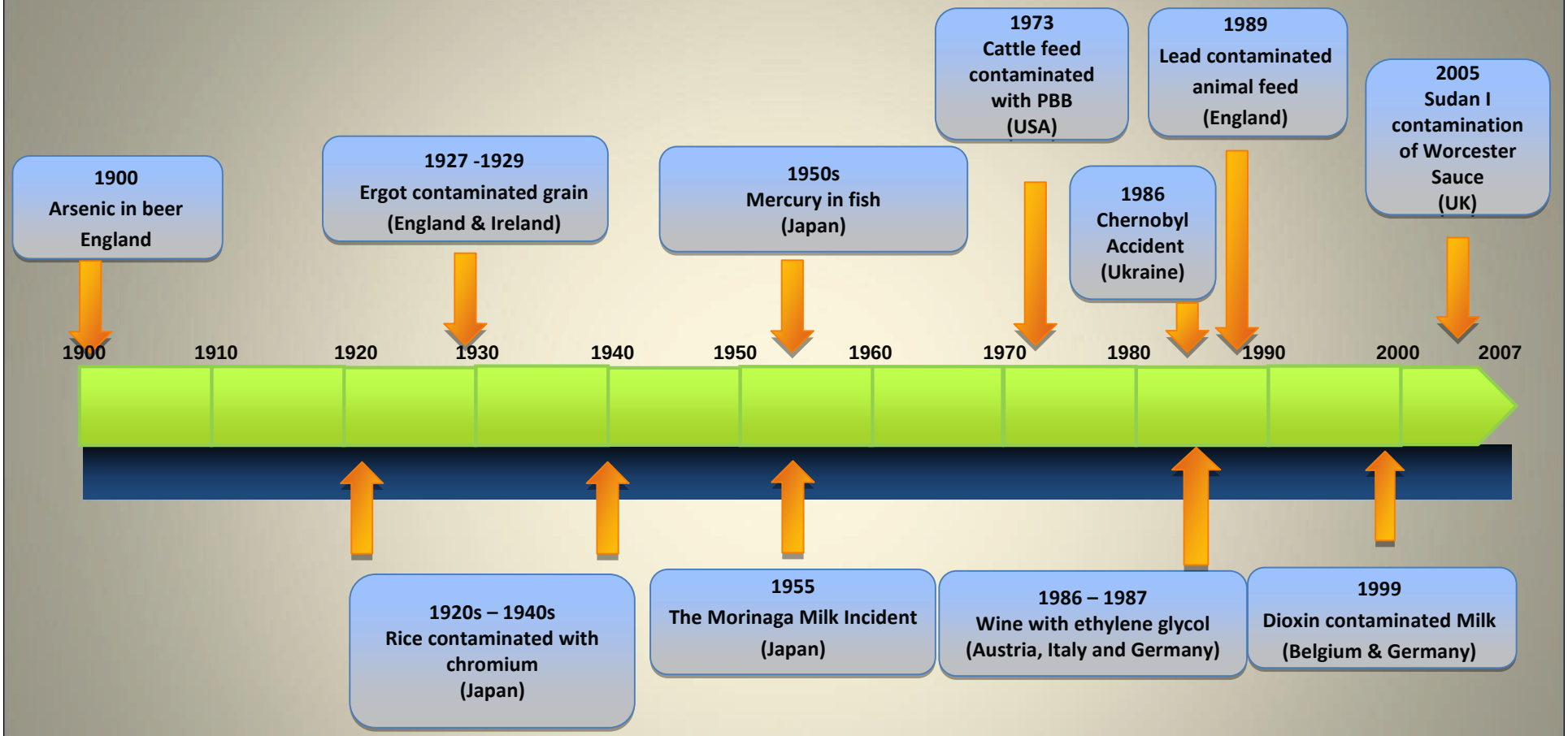
Indirect →







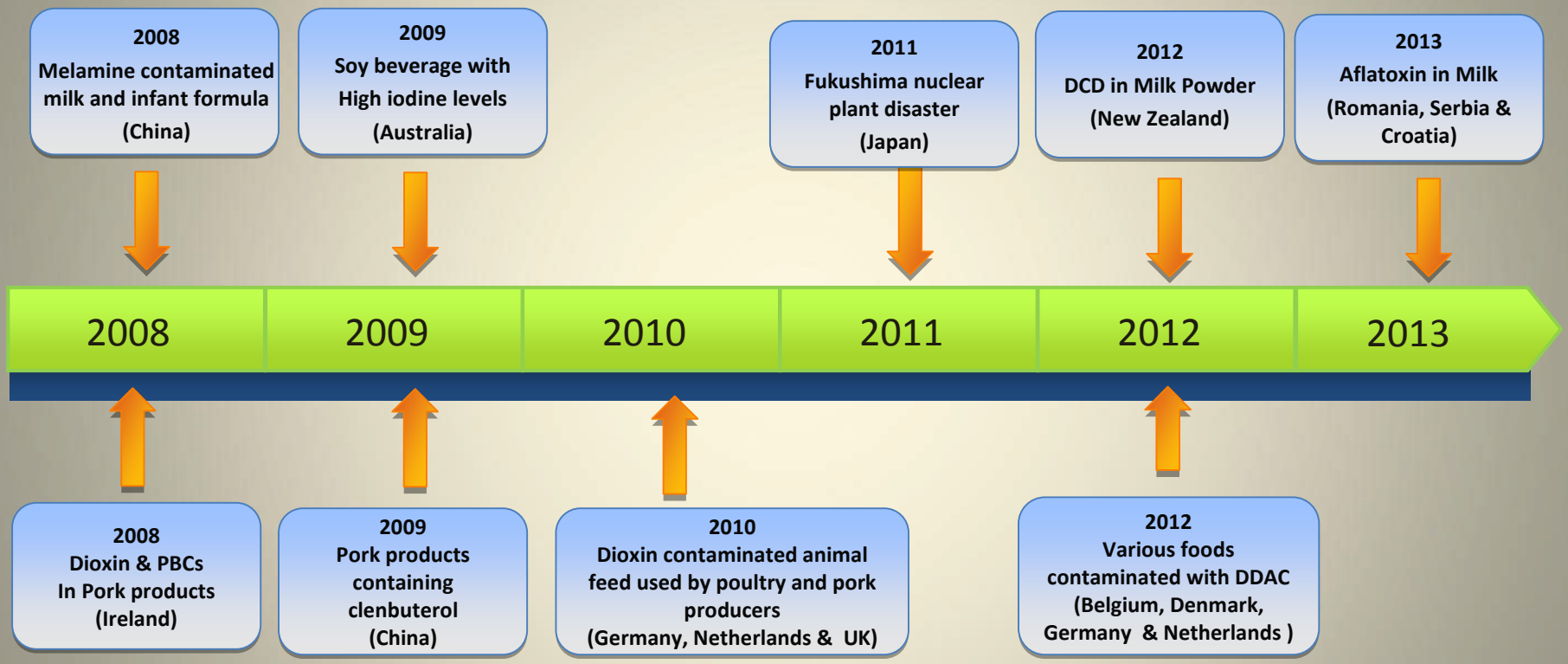
# Some examples of contamination (1900 – 2007)




**Morinaga Incident – recombined milk contaminated with sodium arsenate which had inadvertently contaminated a permitted food additive disodium phosphate**

**PBB - polybrominated biphenyl (a flame retardant)**

# Some examples of contamination (2008 – 2013)

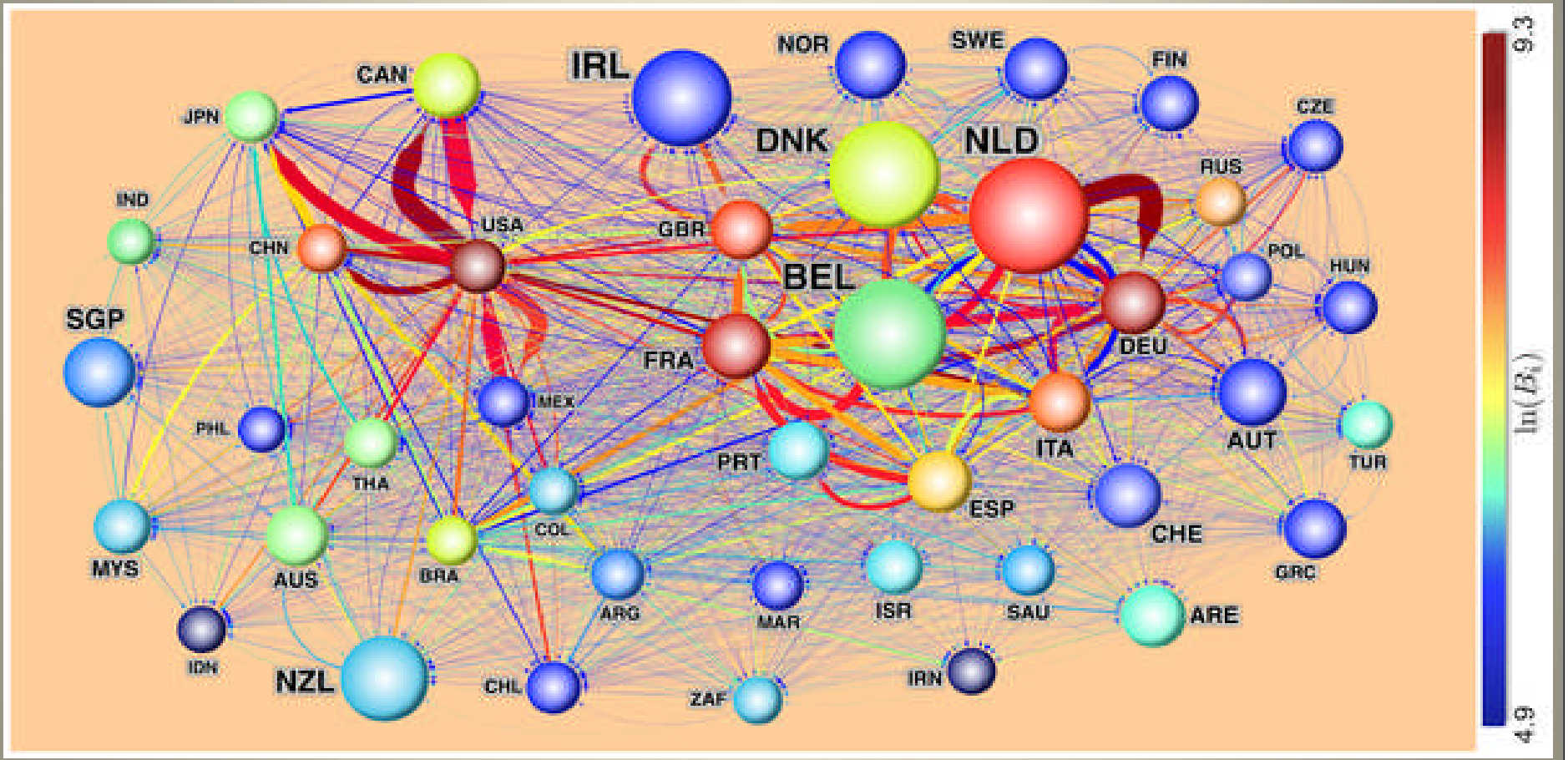



DCD – Dicyandiamide – a nitrification inhibitor that may be added to fertilizer

DDAC – Didecyldimethylammonium chloride – a Quaternary Ammonium Compound [QAC] – was authorized in EU as an active substance in plant protection products (exclusively for indoor uses for ornamental plants) – approval now withdrawn (by Implementing Reg. No 175/2013 )

# The EU Dioxin Case 2010

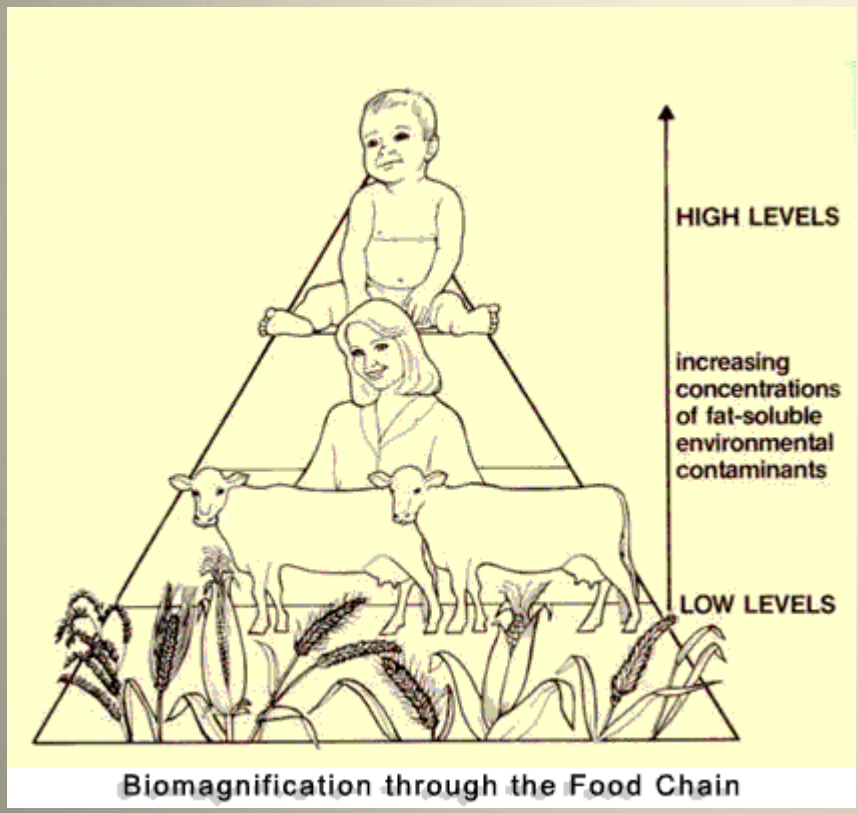
# The International Agri-Food Trade Network (IAFN Dataset 2007)




Ercsey-Ravasz M, Toroczkai Z, Lakner Z, Baranyi J (2012) Complexity of the International Agro-Food Trade Network and Its Impact on Food Safety. PLoS ONE 7(5): e37810. doi:10.1371/journal.pone.0037810
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0037810

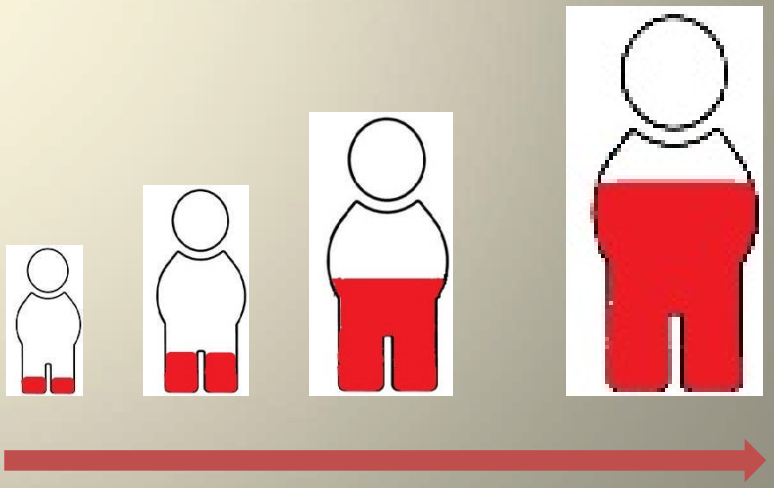
# Bioconcentration
# Biomagnification & Bioaccumulation

Biomagnification



Biomagnification through the Food Chain

Bioaccumulation



Age

# POPS
# The Original "Dirty Dozen" (2001)[1]

| | |
|---|---|
| Pesticides | Aldrin<br>Chlordane<br>Dichloro-diphenyl-trichloroethane (DDT)<br>Dieldrin<br>Endrin<br>Heptachlor<br>Hexachlorobenzene (HCB)<br>Mirex<br>Toxaphene |
| Unintended by-products | Dioxins<br>Furans |
| Industrial chemicals | Polychlorinated biphenyls (PCBs) |

POPs = Persistent Organic Pollutants – all are polyhalogenated hydrocarbons

[1] Under the Stockholm Convention on Persistent Organic Pollutants - 22 May 2001

# The 10 new POPS

| | |
|---|---|
| Pesticide by-products | Chlordecone<br>beta-Hexachlorocyclohexane (alpha-HCH)<br>beta-Hexachlorocyclohexane (beta-HCH)<br>Lindane (gamma-HCH)<br>Endosulfan and related isomers |
| Industrial Chemicals<br>(e.g. Flame Retardants) | Hexabromobiphenyl (HBB)<br>Hexabromodiphenyl ether and heptabromodiphenyl ether<br>Pentachlorobenzene (PeCB) (also a Pesticide)<br>Perfluorooctane sulfonates and perfluorooctane sulfonyl fluoride (PFOS)<br>Tetrabromodiphenyl ether and pentabromodiphenyl ether |

# Elements of Risk Analysis

World Health Organization

Food and Agriculture Organization of the United Nations

# The Scientific Basic of Codex

Vet. Drugs

Pesticides

Contaminants

Natural Toxins

## International Risk Assessment

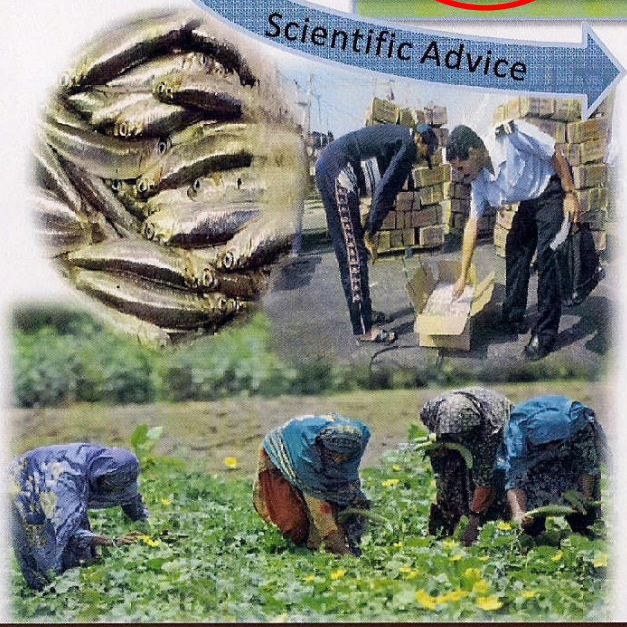
Request

Scientific Advice

| JMPR | JECFA | JEMNU | JEMRA | Ad Hoc Expert Meetings |
|---|---|---|---|---|
| Joint Meeting on Pesticide Residues | Joint Expert Committee on Food Additives | Joint Expert Meeting on Nutrition | Joint Expert Meeting on Microbiological Risk Assessment | |

Scientific Advice

Output

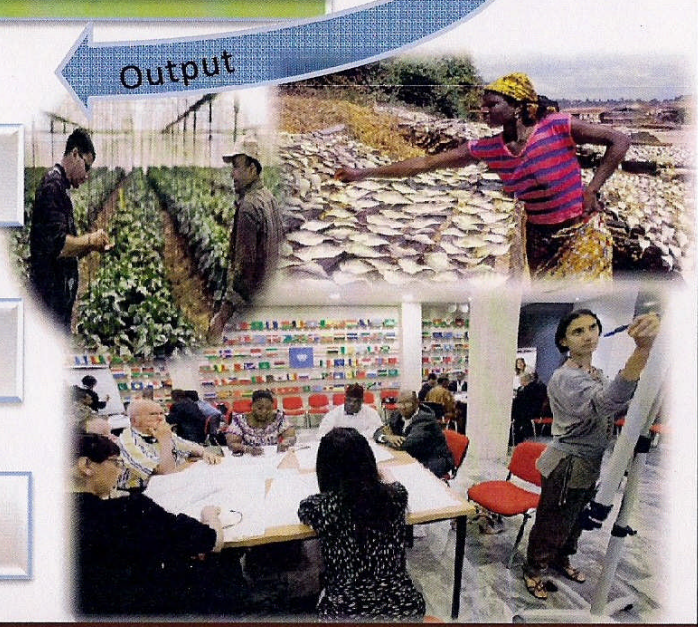


## CODEX Committees

CODEX ALIMENTARIUS COMMISSION

International Food Standards

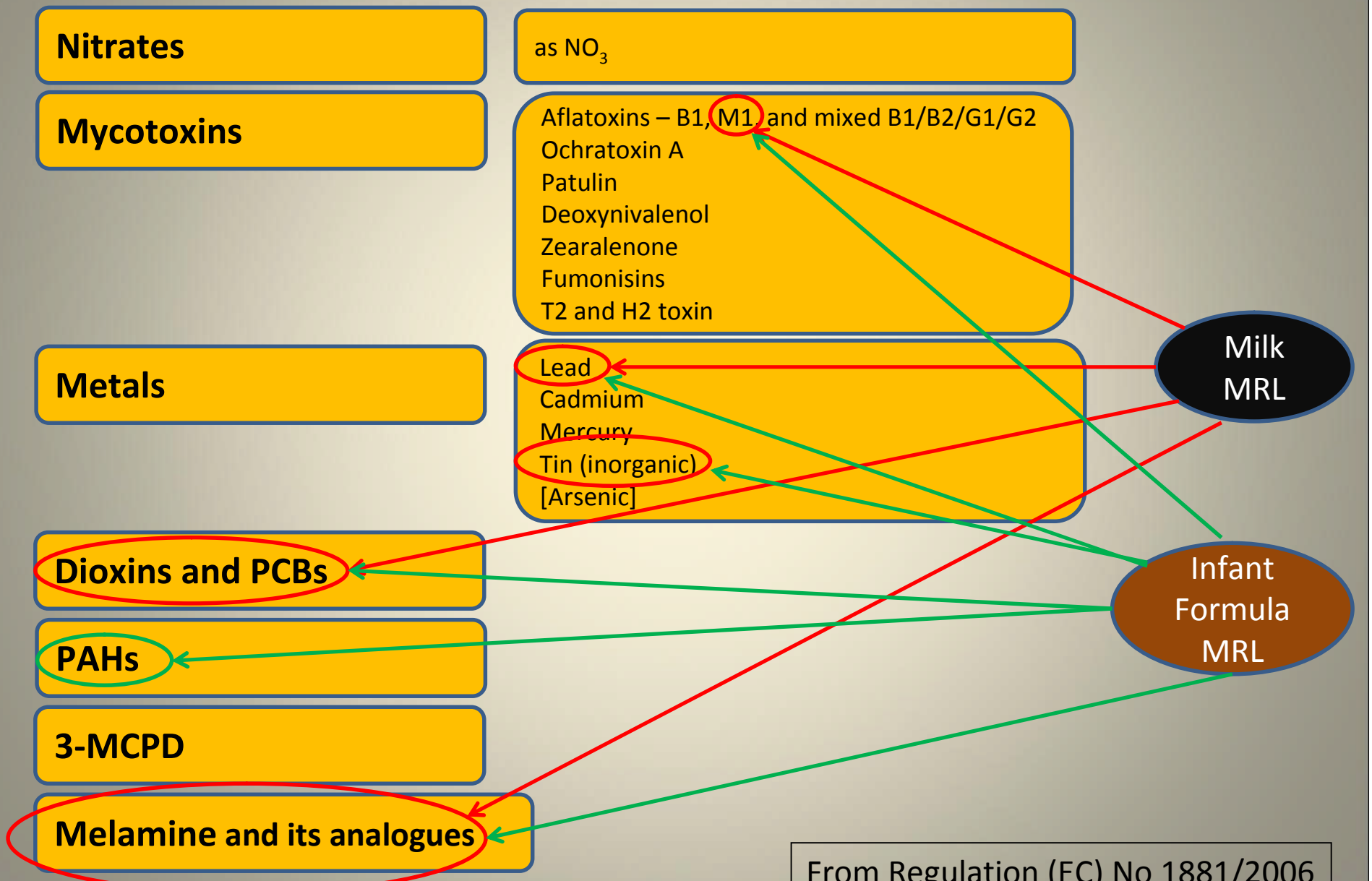
Consumer Protection and Fair Trade Practices



**WHO**
www.who.int/foodsafety/en/
www.who.int/nutrition/en/

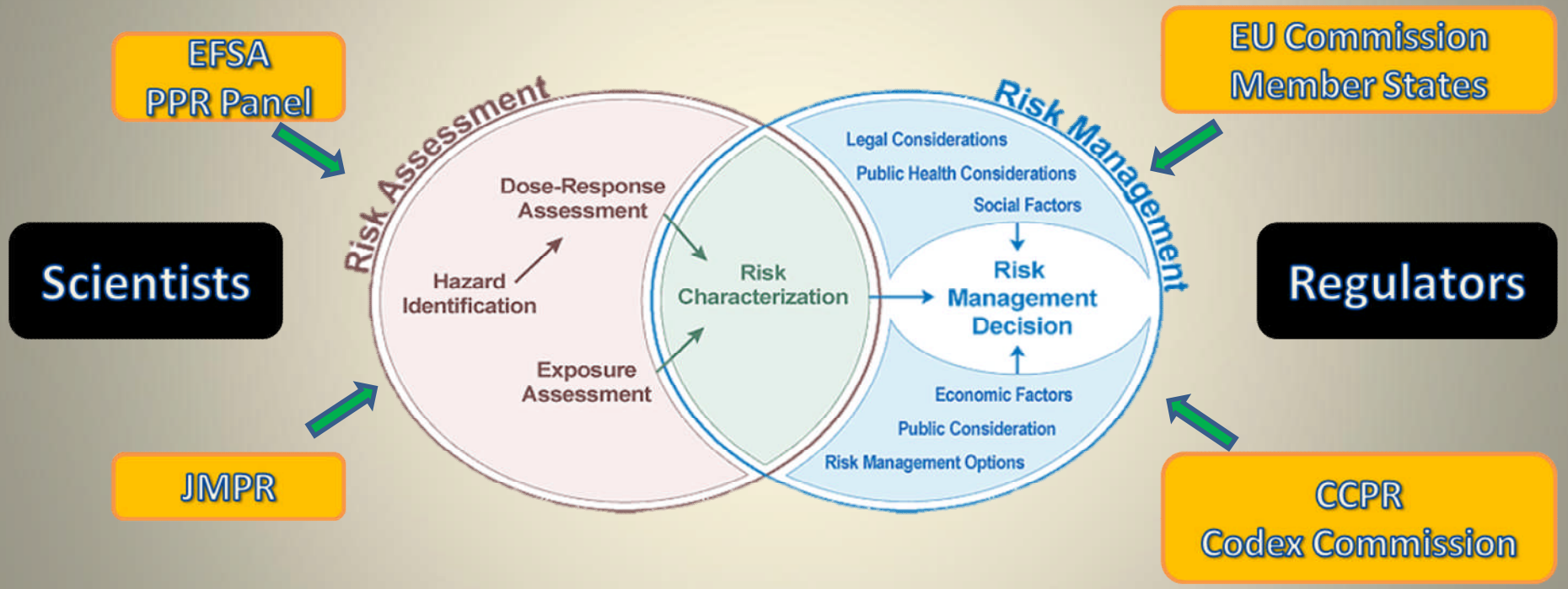
**FAO**
http://www.fao.org/food/food-safety-quality
http://www.fao.org/agriculture/crops/core-themes/theme/pests/jmpr
http://www.fao.org/food/en/

# Chemical Contaminants in Food - EU



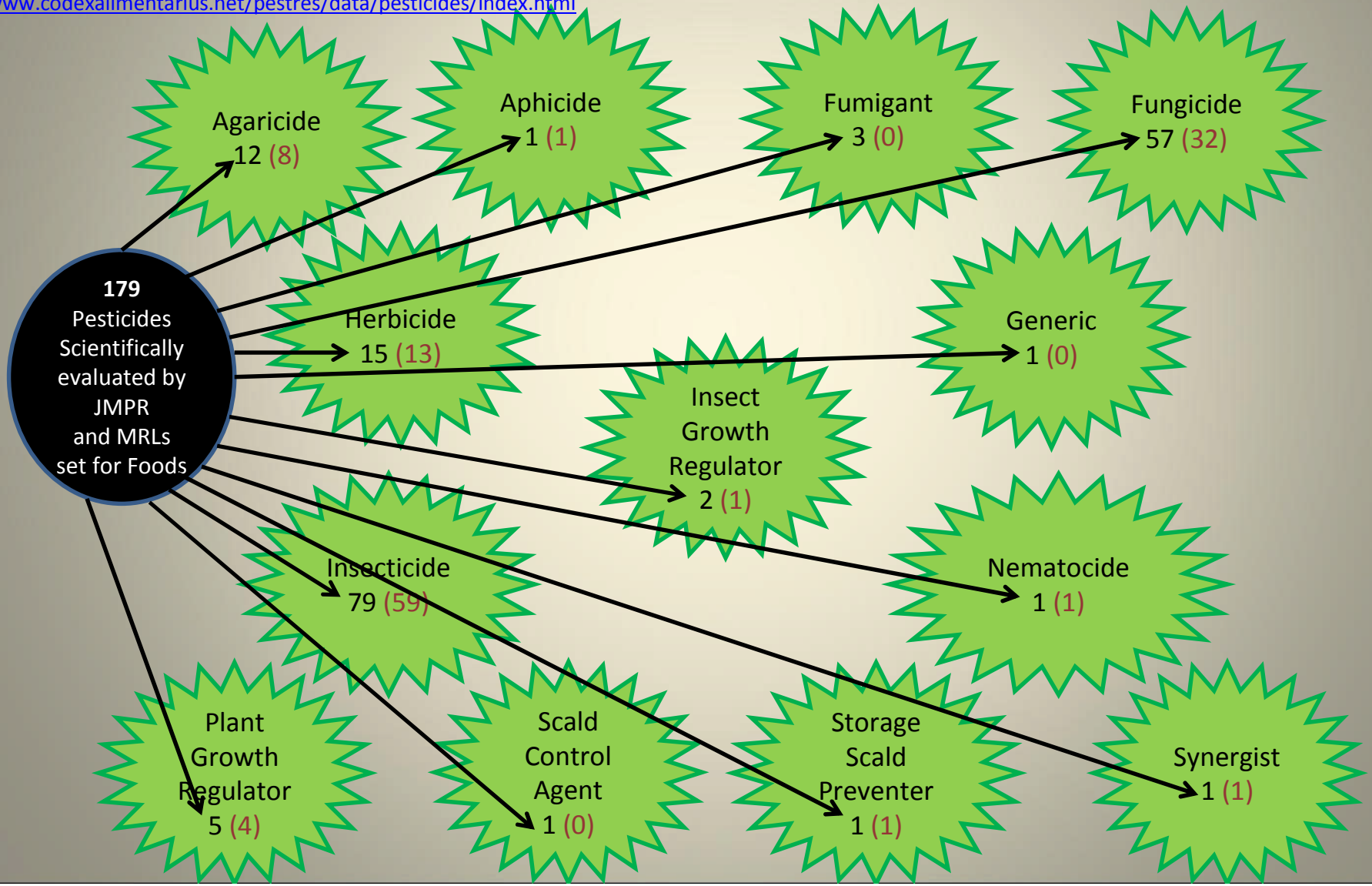

From Regulation (EC) No 1881/2006

# Pesticide Residue Risk Analysis



# Pesticide Functional Classes (CODEX)

www.codexalimentarius.net/pestres/data/pesticides/index.html



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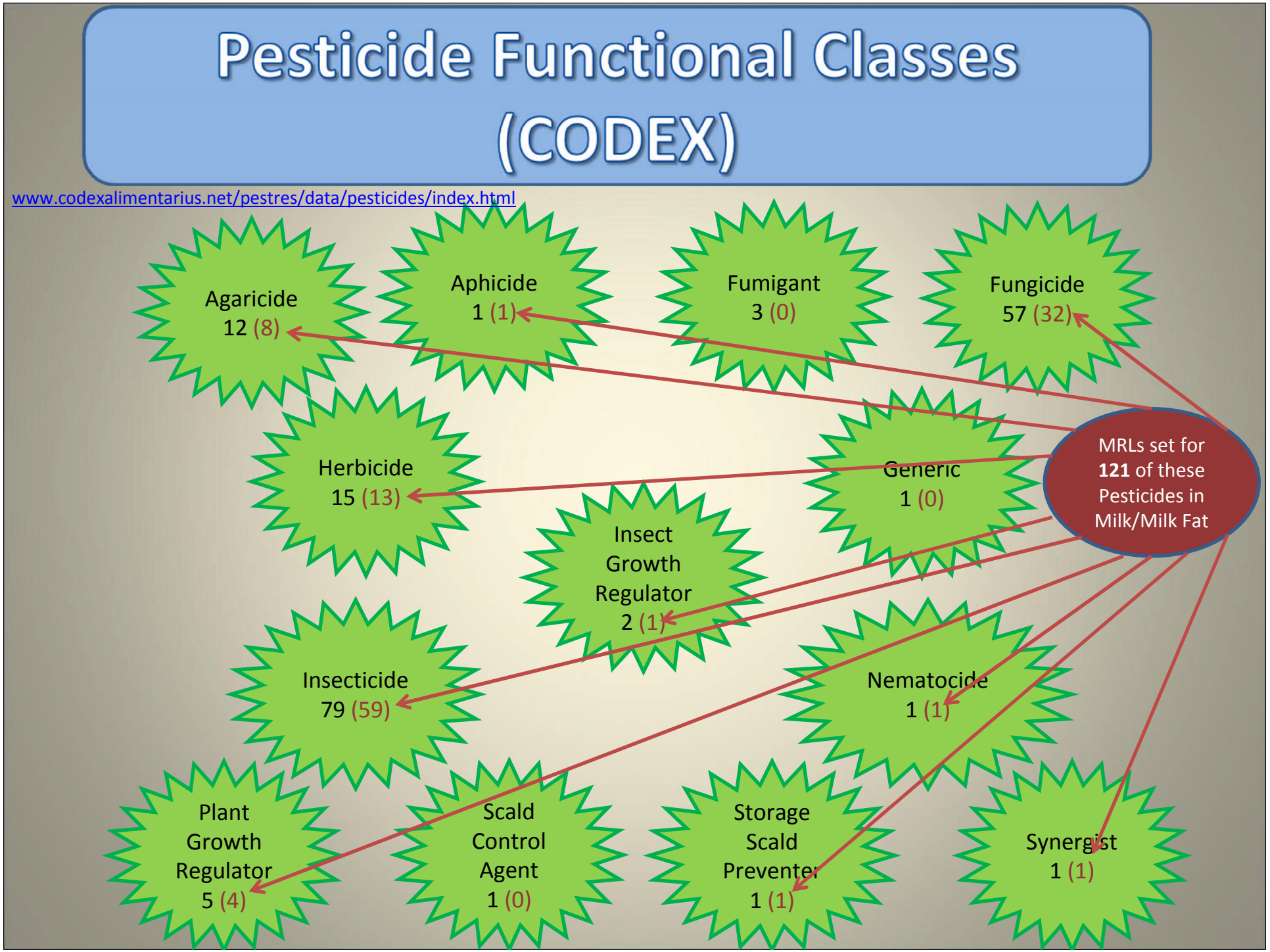
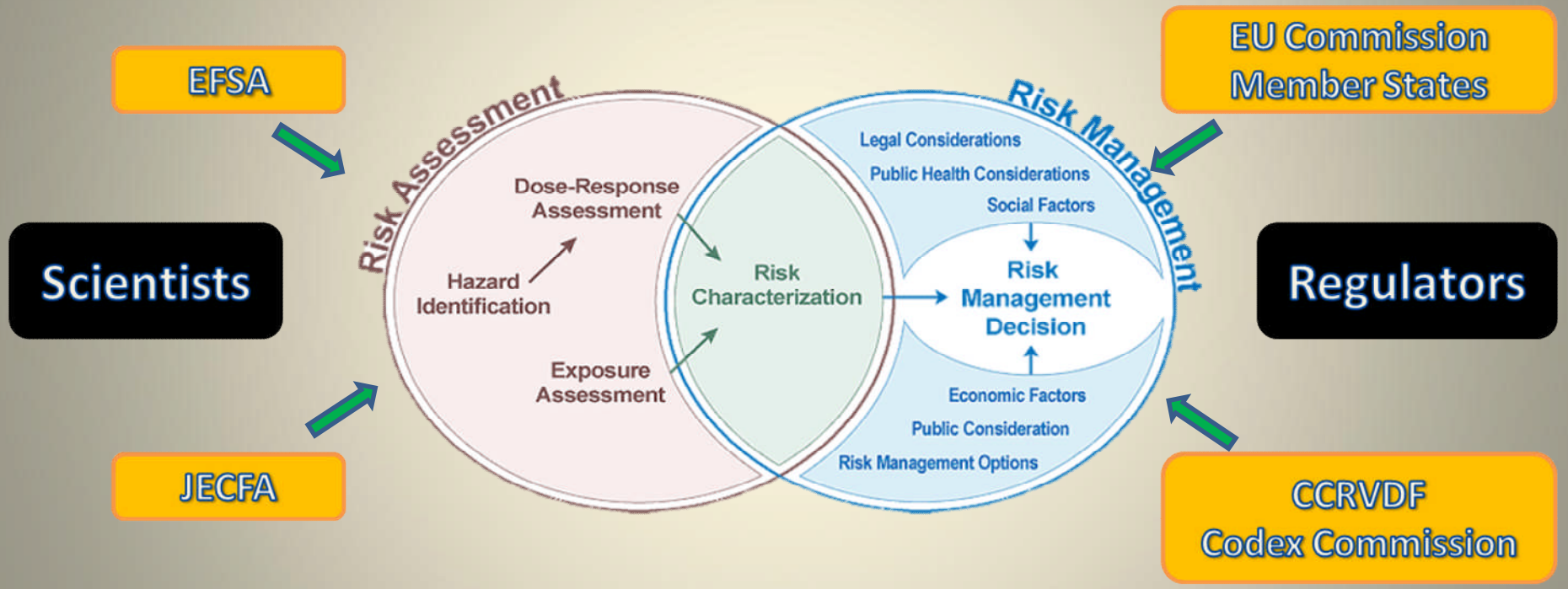
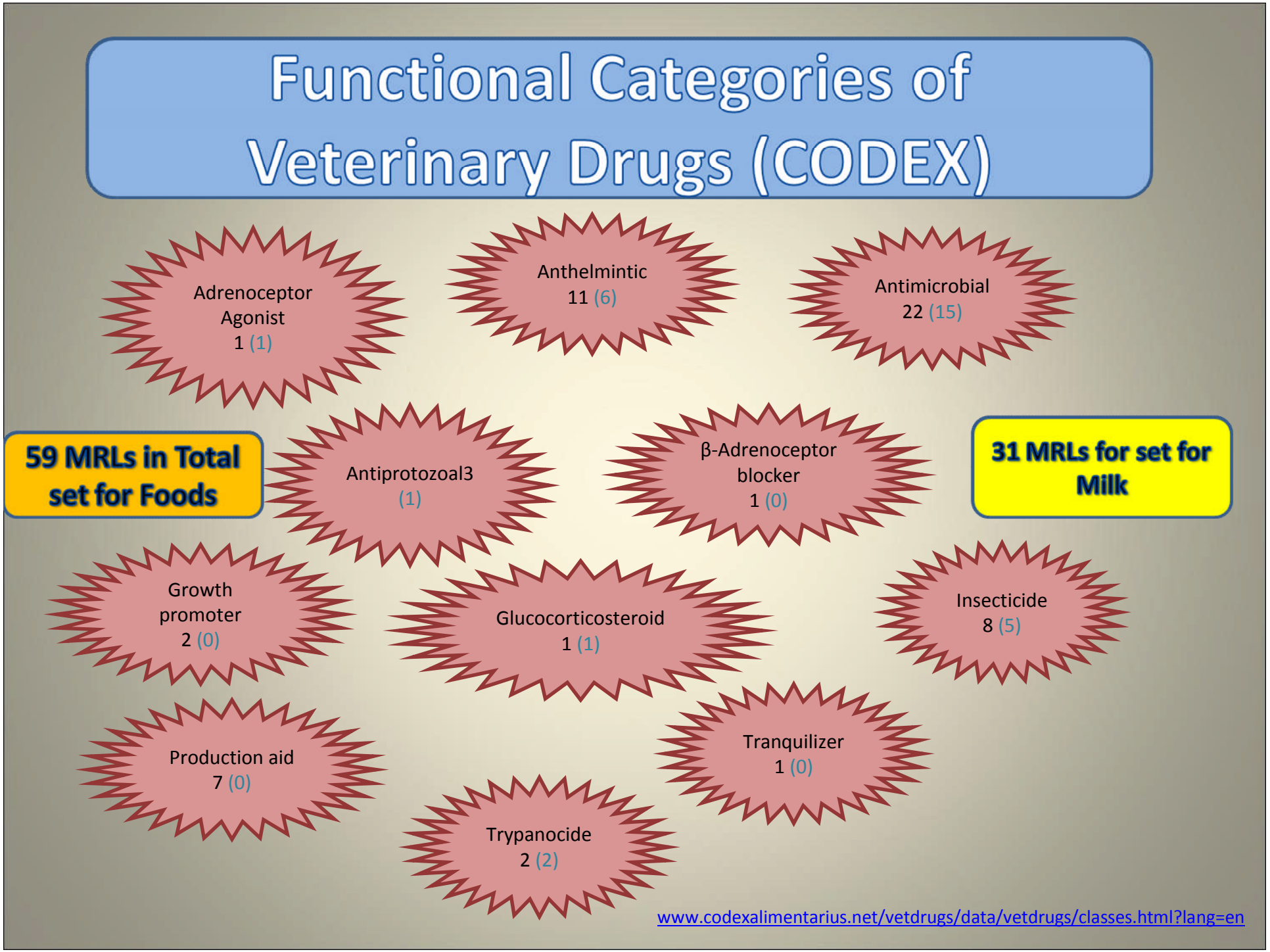


# Veterinary Drug Residue Risk Analysis



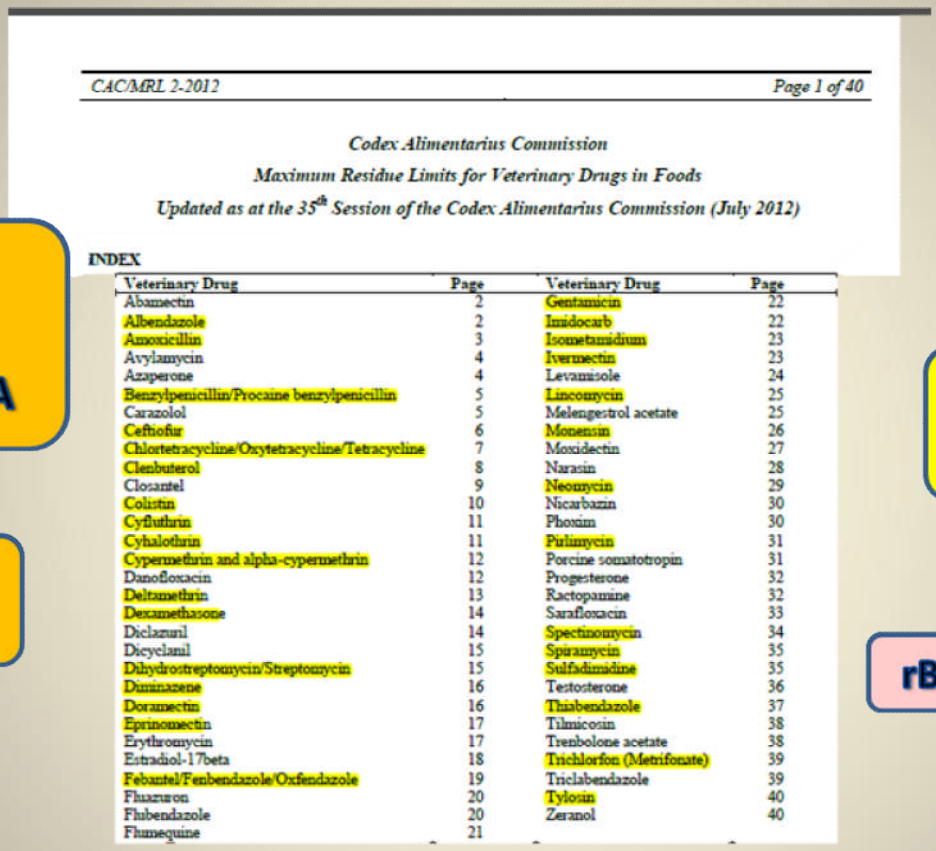
# Functional Categories of Veterinary Drugs (CODEX)




www.codexalimentarius.net/vetdrugs/data/vetdrugs/classes.html?lang=en

**Residues of ~ 90 Veterinary Drugs evaluated by JECFA**

**59 MRLs in Total set for Foods**





*Codex Alimentarius Commission*

*Maximum Residue Limits for Veterinary Drugs in Foods*

*Updated as at the 35th Session of the Codex Alimentarius Commission (July 2012)*

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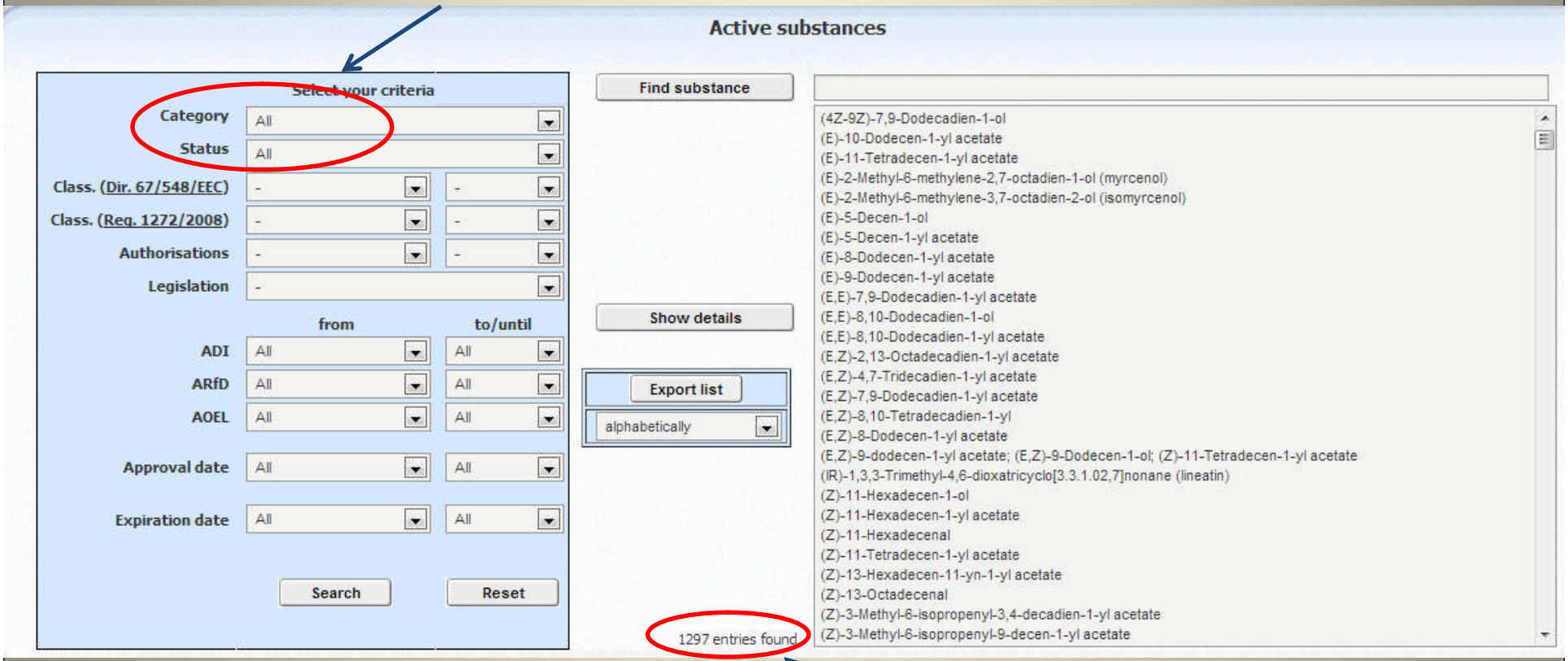
**31 MRLs for set for Milk**

**rBST not included (yet!)**

# EU Pesticides Database

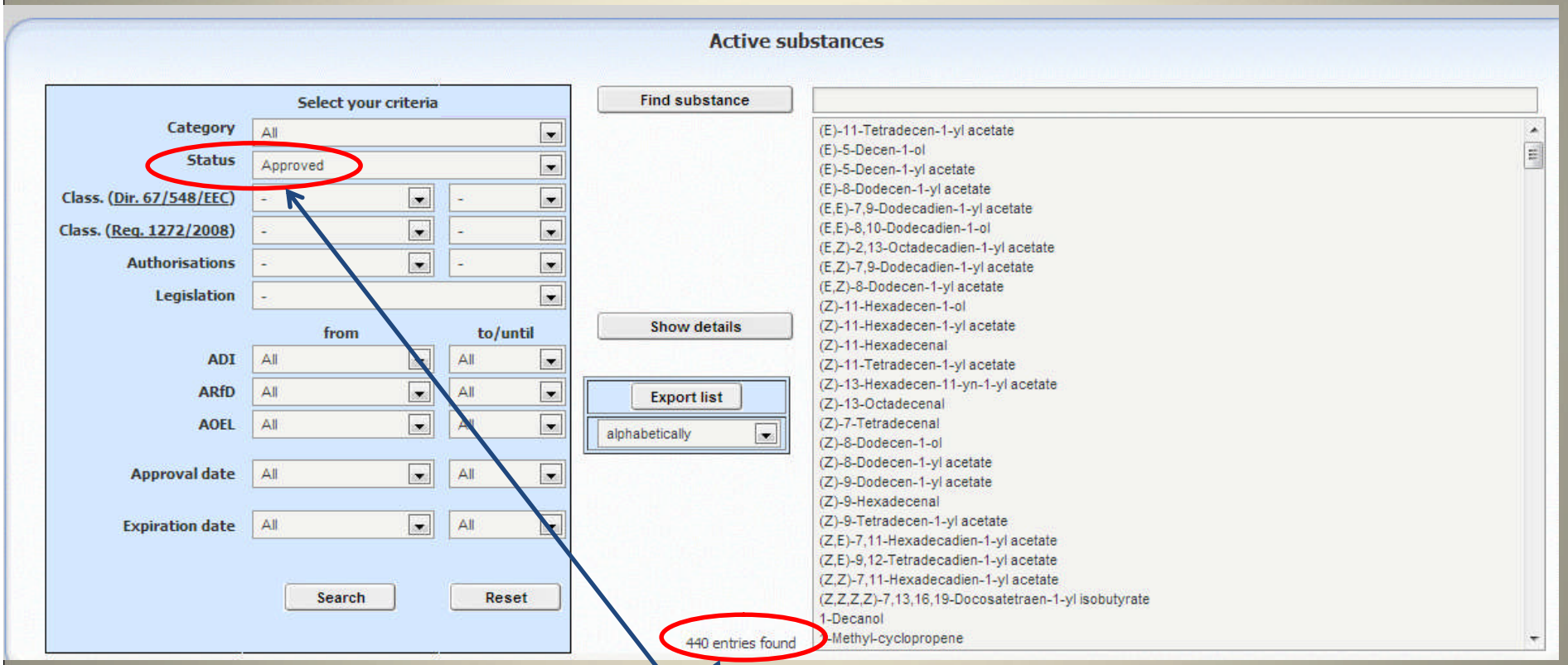
Includes Approved, Non-approved, Pending and substances that are not plant protection products




Total of 1297 Substances

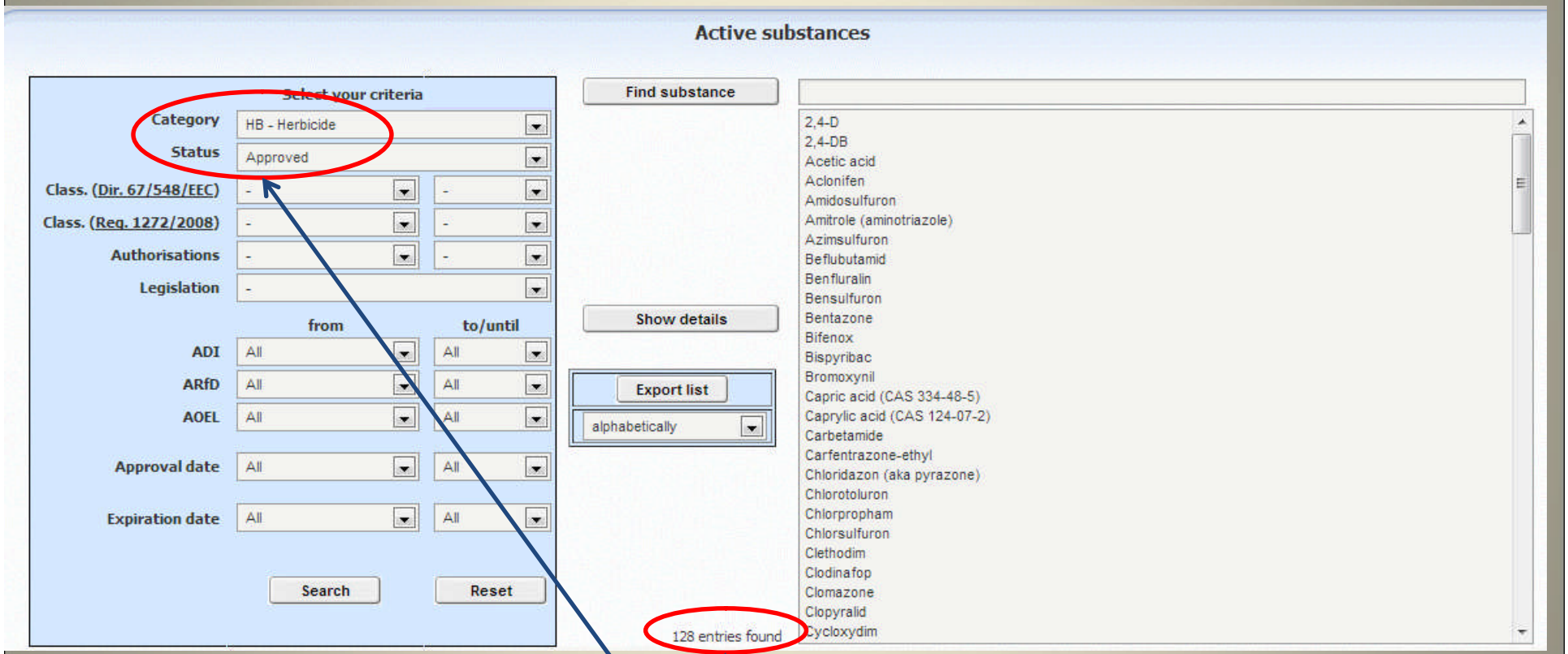
http://ec.europa.eu/sanco_pesticides/public/?event=activesubstance.selection

# EU Pesticides Database




Total of just 440 APPROVED Substances

# EU Pesticides Database




128 APPROVED Herbicide Substances

# Targeted Sampling Approach
## The National Residue Plan

**Aimed at:-**

Detecting of the illegal use of prohibited substances.

Monitoring compliance with the specified MRLs for veterinary drugs, pesticides, mycotoxins, heavy metals etc.

Monitoring levels of environmental contaminants.

**Sampling focus:-**
Most samples (c. 80%) are taken in accordance with criteria designed to target animals or products, which are more likely to contain illegal residues

However sampling may also be conducted in specific cases where the presence of illegal residues was suspected

# National Residue Plan (Ireland)
## for Milk

| GROUP A – Substances having anabolic effect and unauthorised substances | | Milk |
|---|---|---|
| A1 | Stilbenes and derivatives | |
| A2 | Antithyroid agents | |
| A3 | Steroids (natural and synthetic) | |
| A4 | Resorcylic acid lactones (incl. zeranol) | |
| A5 | Beta-agonists | |
| A6 | Compounds in Annex IV of Reg. 2377/90 (e.g. chloramphenicol, nitrofurans etc.) | ✓ |
| **GROUP B – Veterinary Drugs and Contaminants** | | |
| B1 | Antibacterial substances, incl. sulphonamides, quinolones, tetracyclines. | ✓ |
| B2a | Anthelmetics (parasitic worms/helminths) | ✓ |
| B2b | Anticoccidals | |
| B2c | Carbamates and pyrethroids | |
| B2d | Sedatives | |
| B2e | Non-steroidal anti-inflammatory drugs (NSAIDs) | ✓ |
| B2f | Other pharmacologically active substances (e.g. teflubenzuron, diflubenzuron | |
| B3a | Organochloride compounds (incl. PCBs) | ✓ |
| B3b | Organophosphorus compounds | ✓ |
| B3c | Chemical elements (lead, cadmium, mercury, arsenic) | ✓ |
| B3d | Mycotoxins | ✓ |
| B3e | Dyes (e.g. malachite green) | |
| B3f | Others (brominated flame retardants, PAHs) | |

Ref: National Food Residue Database Report 2010/11. M. Danagher & J. Rae,J.
see http://nfrd.teagasc.ie/pdf/NFRD_Annual_Report_2011.pdf

# Analysis Challenges

g $10^{0}$

mg $10^{-3}$

µg $10^{-6}$

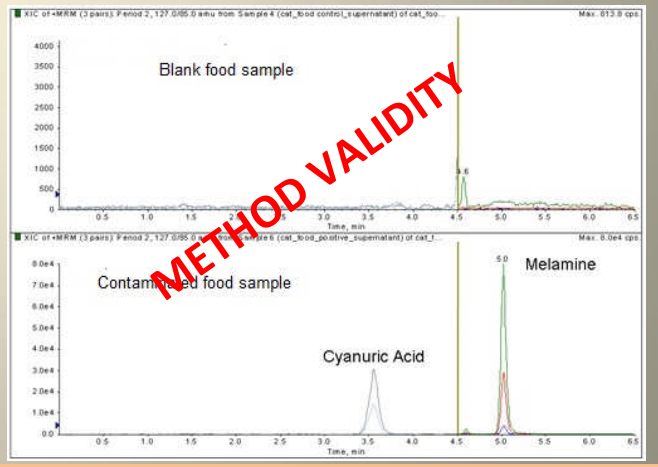
ng $10^{-9}$

pg $10^{-12}$

fg $10^{-15}$


The Level of Contamination


Food matrix complexity




Verification and validation

# Biomarker Methodology

Requires demonstration of a quantitative relationship between intake of a substance and the amount of the substance or a metabolite in the body tissue or fluid of an animal - e.g., in blood, adipose tissue, urine, or milk

**BioCop Project (2005 – 2009)**[1] detecting chemical contaminants in food

- Involved measuring of the effect of the contaminant(s) rather than the more traditional single target compound concentrations
- Developed using rapid and efficient transcriptomics, proteomics and biosensor-based technologies
- Examples include detection of:-
  - Pesticides
  - Mycotoxins such as produced by fungi
  - Therapeutic drugs (growth promoters, quinolone antimicrobials)
  - Endocrine disrupters (phytoestrogens)

[1] For more see http://www.teagasc.ie/publications/2009/1075/biocop_detecting_chemical_contaminants_in_food_5442.pdf or ftp://ftp.cordis.europa.eu/pub/food/docs/elliot.pdf

# Acknowledgement

Some concepts and illustrations used herein are based on a presentation entitled
FOOD SAFETY MANAGEMENT SYSTEM FOR CONTAMINANTS AND DRUG RESIDUES IN THE DAIRY PRODUCTS
by Prof. Dr. Bruno LE BIZEC, École Nationale Vétérinaire, Agroalimentaire et de l'Alimentation Nantes-Atlantique given at the **2013 IDF World Dairy Summit** in Yokohama, Japan.

However, the views and opinions expressed herein are my own and should not be taken as being those of Dr. LE BIZEC and his co-workers.

# THANK YOU