



MARS

Chemical Hazards in Foods –
Dioxins and Pesticides

Dubai Food Safety Conference

24th February 2010

So, why should we produce safe food?

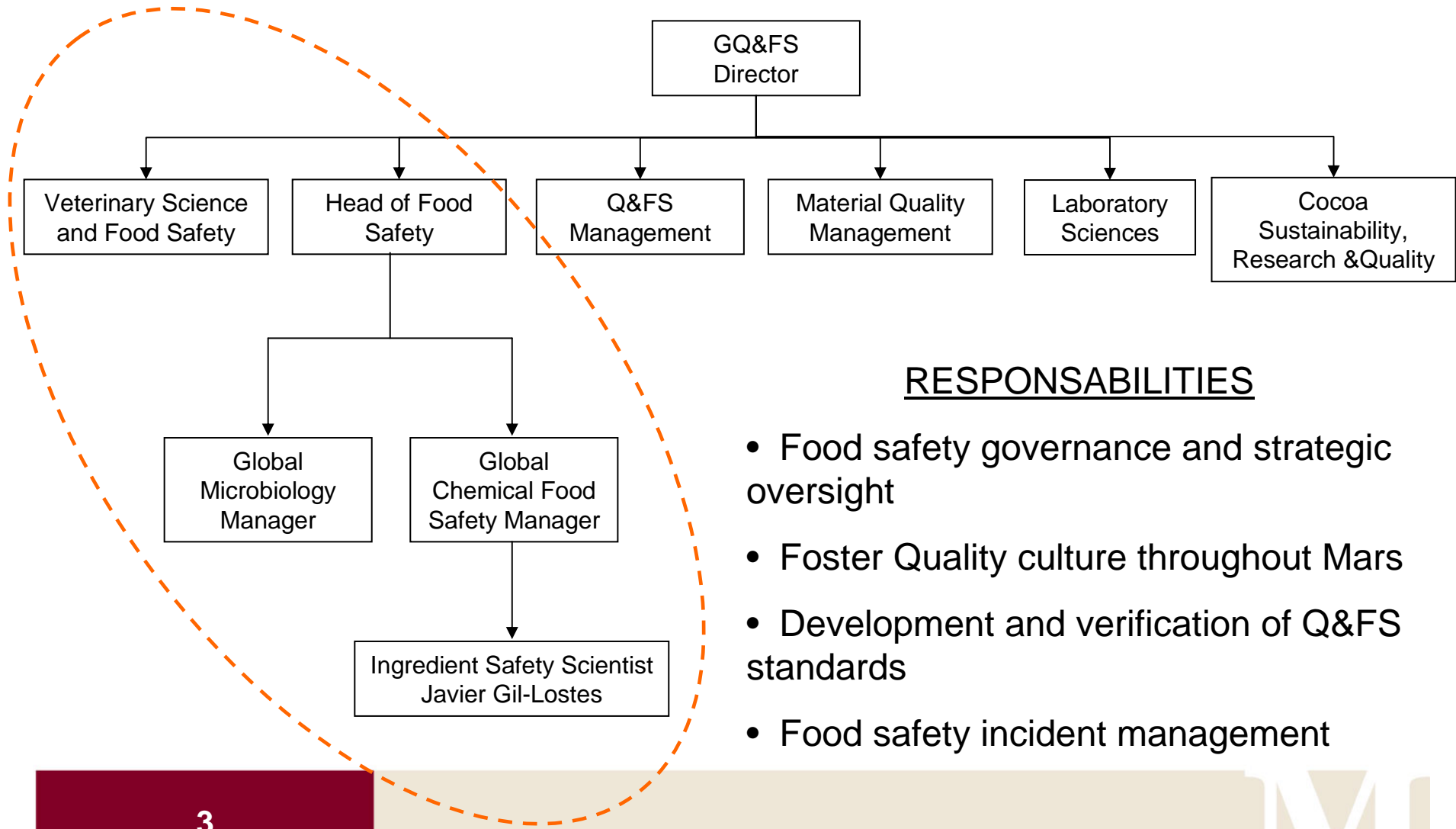
Quality is the first of our principles. Excellence in Food Safety Management sits at the heart of that

and

- The consumer takes it for granted
- Mars reputation demands it
- Legal obligations and
- Unsafe food might result in illness or death



Food Safety at Mars – Global Quality and Food Safety Group



RESPONSABILITIES

- Food safety governance and strategic oversight
- Foster Quality culture throughout Mars
- Development and verification of Q&FS standards
- Food safety incident management





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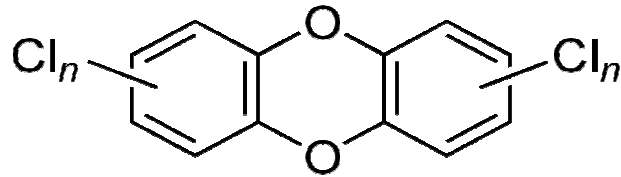
Dioxins and
dioxin-like PCBs

Food Safety Incidents – Dioxins

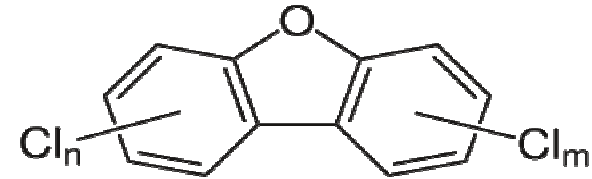
Year	Country	Commodity	Contaminant	Exposure Assessment	Outcome
1968	Japan (Yusho)	Rice Oil	PCBs, PCDFs	10 mg/kg BW (PCBs) 58 µg/kg BW (PCDFs)	1700 victims
1979	Taiwan (Tucheng)	Rice Oil	PCBs, PCDFs	17 mg/kg BW (PCBs) 63 µg/kg BW (PCDFs)	2000 victims
1999	Belgium	Animal Feed	PCBs and dioxins	25 µg/kg BW (PCBs, estimated) 500 pg/kg BW (dioxins, estimated)	Recall all meat products >25% fat content
2007	Switzerland	Guar Gum	Dioxins and pentachlorophenol	406 pg WHO-TEQ/g product (PCDD/F) 4 mg/kg product (PCP)	Recalls of guar gum and foodstuffs (esp. fruit, dairy) in at least 16 EC member states.
2008	Ireland	Pork	Dioxins	Up to 200 pg WHO-TEQ/g fat	Withdrawn all pork products from Irish Republic and Northern Ireland



Dioxins and dioxin-like PCBs



Polychlorinated dibenzodioxins (PCDDs)

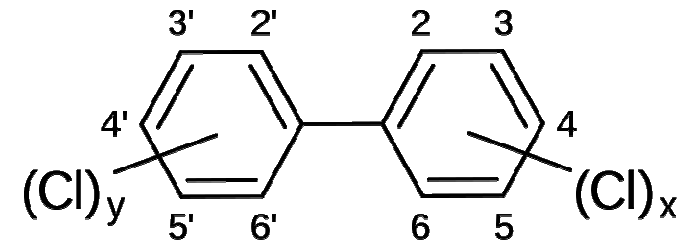


Polychlorinated dibenzofurans (PCDFs)

Dioxin

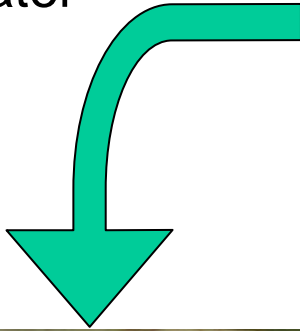
2,3,7,8-tetrachlorodibenzodioxin
(2,3,7,8-TCDD or TCDD)

Polychlorinated biphenyls (PCBs)

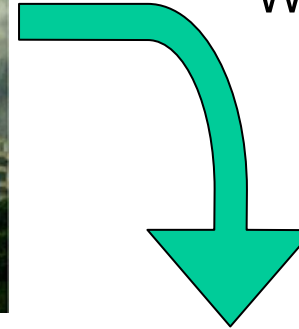


Dioxin contamination in food

Soil
Water

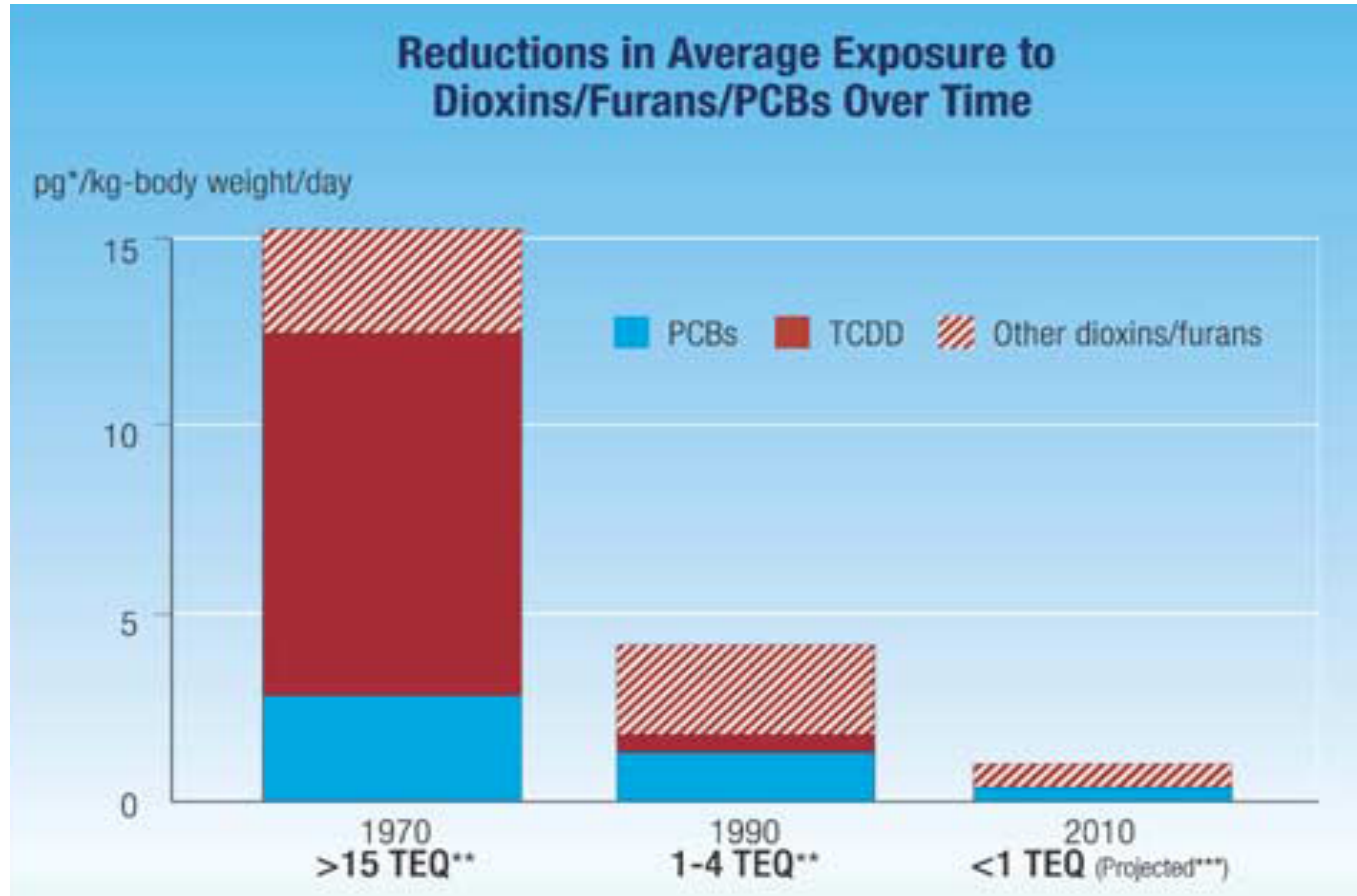


Soil
Water



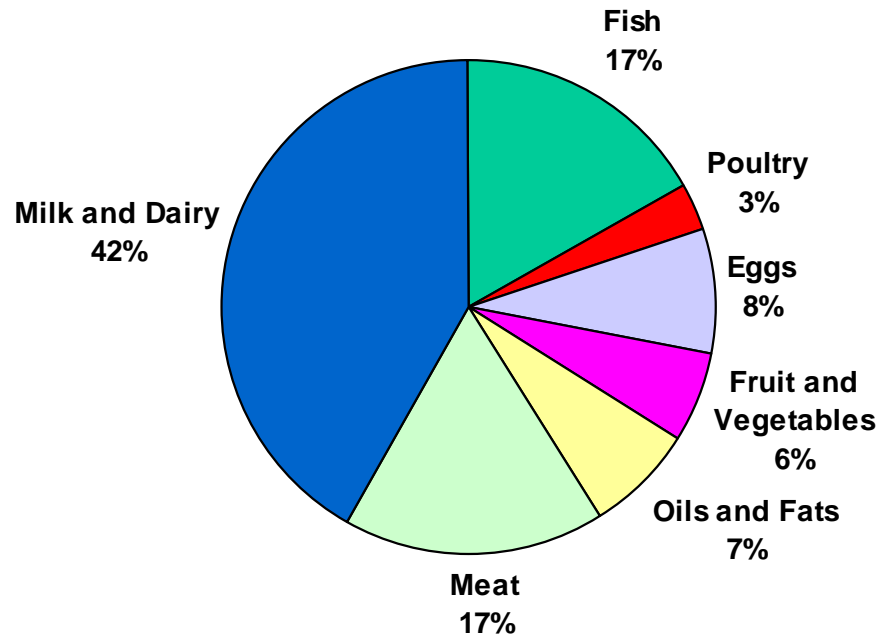
- Dioxins are not intentionally added to food or created during food processing
- By-products of waste incinerators (especially in the past), household heating, traffic, forest fires, and metal, pulp and paper industry
- In US, human body burden of TCDD and dioxin TEQ decreased 10-fold and 4- to 5- fold respectively between 70's and 1999, leading to a decrease of exposure >95%

Dioxin and dioxin-like PCB exposure levels over time

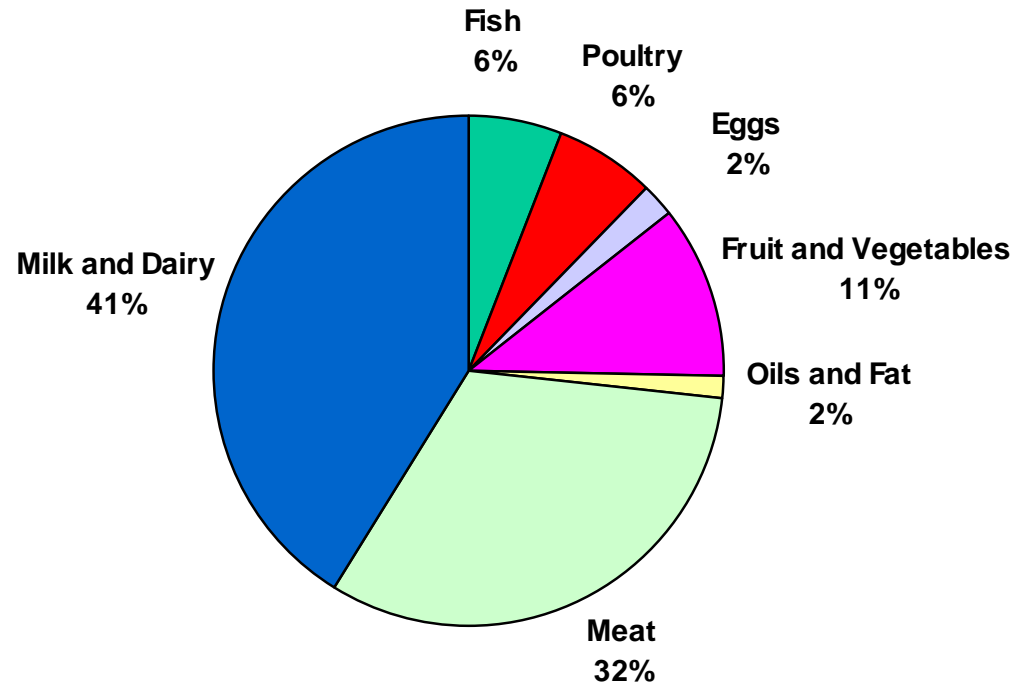


Contribution of different food commodities to dioxin exposure levels in humans

Germany



USA



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Congener toxic potency expressed relative to that of a reference compound, i.e. TCDD. Arbitrary $TEF_{TCDD} = 1$

WHO criteria for including a dioxin-like PCB compound in the TEF scheme

- show a structural relationship to the PCDDs and PCDFs
- bind to the Ah receptor
- elicit Ah receptor-mediated biochemical and toxic responses, and
- be persistent and accumulate in the food chain

Toxic Equivalency Factor (TEF)

PDDDs	TEF	'Non-ortho' PCBs	TEF
TCDD	1	3,3',4,4'-TCB	0.0001
1,2,3,7,8-PeCDD	1	3,4,4',5-TCB	0.0003
1,2,3,4,7,8-HxCDD	0.1	3,3',4,4',5-PeCB	0.1
1,2,3,6,7,8-HxCDD	0.1	3,3',4,4',5,5'-HxCB	0.03
1,2,3,7,8,9-HxCDD	0.1		
1,2,3,4,6,7,8-HpCDD	0.01		
OCDD	0.0003		
PCDFs	TEF	'Mono-ortho' PCBs	TEF
2,3,7,8-TCDF	0.1	2,3,3',4,4'-PeCB	0.00003
1,2,3,7,8-PeCDF	0.03	2,3,4,4',5-PeCB	0.00003
2,3,4,7,8-PeCDF	0.3	2,3',4,4',5-PeCB	0.00003
1,2,3,4,7,8-HxCDF	0.1	2',3,4,4',5'-PeCB	0.00003
1,2,3,6,7,8-HxCDF	0.1	2,3,3',4,4',5-HxCB	0.00003
1,2,3,7,8,9-HxCDF	0.1	2,3,3',4,4',5'-HxCB	0.00003
2,3,4,6,7,8-HxCDF	0.1	2,3',4,4',5,5'-HxCB	0.00003
1,2,3,4,6,7,8-HpCDF	0.01	2,3,3',4,4',5,5'-HpCB	0.00003
1,2,3,4,7,8,9-HpCDF	0.01		
OCDF	0.0003		



TEFs are based on toxicological evaluations of dose–response relationships between external exposure, i.e. the levels of intake of congeners, and toxicity in organs.

$$\text{TEQ} = C_1\text{TEF}_1 + C_2\text{TEF}_2 + C_i\text{TEF}_i + \dots$$

TEQ = Toxic Equivalent of the mixture.

TEF_i = Toxic Equivalency Factor for dioxin or dioxin-like PCB “i”

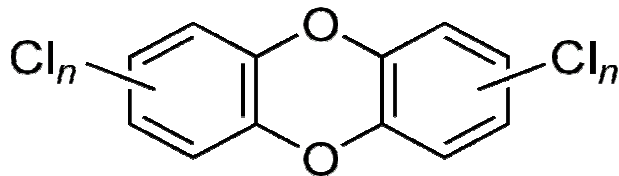
C_i = Level of intake of Dioxin or dioxin-like PCB “i” in the mixture.

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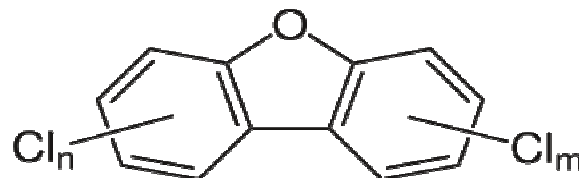


- Sweden, exposure estimates exceed TDI, high consumption of fish in the diet
- Belgium, breastfed babies, dioxin intake $> 20 \times$ TDI. First-3-months intake 6% lifetime dioxin intake
- US, exposure data indicates that children might exceed the WHO-TEQ limit
- Germany, breastfed babies, dioxin intake $> 60 \times$ TDI. 6-y old children, 50% dioxin body burden via breastfeeding

Dioxins and dioxin-like PCBs



Polychlorinated dibenzodioxins (PCDDs)

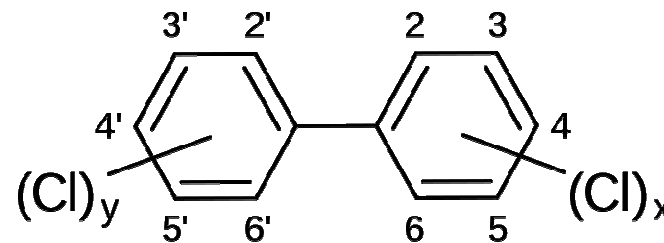


Polychlorinated dibenzofurans (PCDFs)

Dioxin

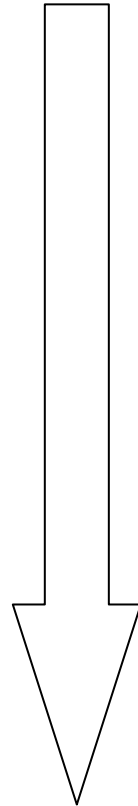
2,3,7,8-tetrachlorodibenzodioxin
(2,3,7,8-TCDD or TCDD)

Polychlorinated biphenyls (PCBs)



- Wasting syndrome
- Impairment of immune responses
- Chloracne and related dermal lesions
- Reproductive Toxicity
- Carcinogenicity
- Teratogenicity
- Death

Acute



Chronic



Ukraine President Viktor Yushchenko



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Pesticides

Food Safety Incidents - Pesticides

Year	Country	Commodity	Pesticide	Route of Contamin.	Exposure Time	Outcome
1958	India	Flour	Parathion	Transport	1-2 months	360 people ill and 102 deaths
1971	Iraq	Wheat and Bread	Methyl mercury	Accidental use	6 months	6500 people ill and 459 deaths
1983	Senegal	Oil	Parathion	Unsafe use	1 day	25 people ill and 18 deaths
1985	USA	Watermelon	Aldicarb	Unsafe use	3 month	1350 people ill and no deaths
1989	Taiwan	Flour	Barium carbonate	Accidental use	1 day	13 people ill and 1 death
1997	India	Meal ingredients	Malathion	Unsafe use	1 day	60 people ill and 1 death



MARS | Pesticides

- Pesticide is any substance, preparation or organism prepared or used for controlling any pest
- Maximum Residue Level (MRL), maximum concentration of a pesticide residue permitted in or on food and feed
- MRLs, Good Agricultural Practice check
- MRLs are NOT safety limits. Exposure to residues in excess of an MRL does not imply a hazard to health → Acceptable Daily Intake (ADI)



MRLs in food commodities

Pesticide	Citrus fruit (orange)*	Tree Nuts (almonds)*	Root and tuber vegetables (potatoes)*	Bulb vegetables (garlic)*	Leaf vegetables and fresh herbs (lettuce)*	ADI**
HCB	0.01	0.01	0.01	0.01	0.01	Withdrawn
Dichlorvos	0.01	0.01	0.01	0.01	0.01	0.00008
Diazinon	0.01	0.01-0.05	0.01-0.1	0.01-0.05	0.01	0.0002
Aldicarb	0.02	0.02	0.02	0.05	0.02	0.003
Endosulfan	0.05	0.1	0.05	0.05	0.05	0.006
Alachlor	0.05	0.05	0.05-0.1	0.1	0.1	N/A

* mg/kg commodity

** mg/kg BW/d

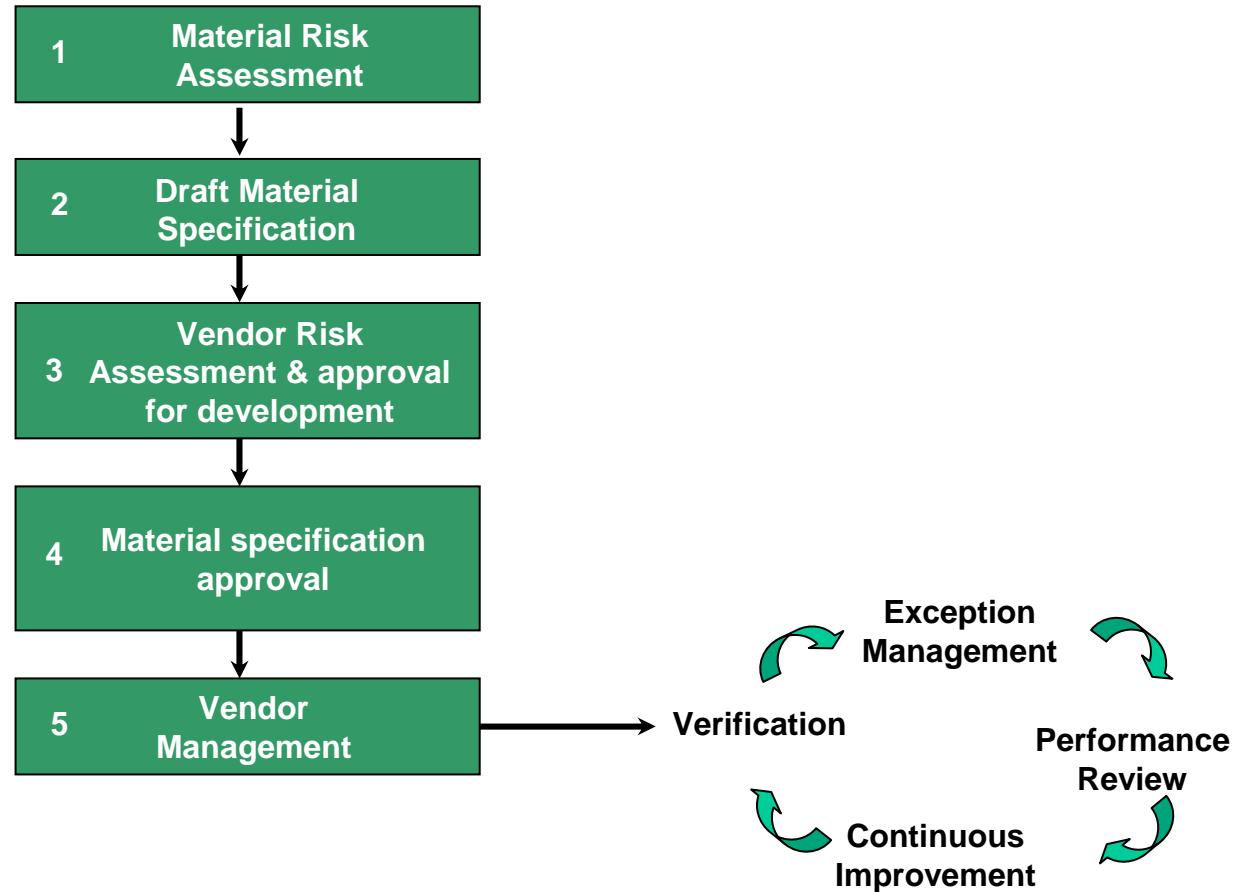


- Pesticide residues, MRLs, in food.
- Pesticides currently or formerly used in agriculture in or outside the EU (~1100)
- MRLs for fresh products (315), MRLs already in force before September 2008 (~45,000), harmonised MRLs previously set by the Member States (~100,000)
- A list of low risk substances for which MRLs are not necessary.
- EFSA, peer review programme, 1993, safety assessment of all active substances used in plant protection products.

- Fungicides - Low toxicity, irritating to skin, eyes, respiratory tract
- Herbicides - Low toxicity, irritating to skin, eyes, respiratory tract, diarrhea, vomiting
- Insecticides - Nervous system disorders, gastric symptoms, headache, dizziness, muscle weakness, coma and death

	Class I	Class II	Class III	Class IV
Oral LD₅₀ (mg/kg BW)	≤ 50	50-500	500-5000	>5000
Inhalation LC₅₀ (mg/l)	≤0.2	0.2-2	2-20	>20
Dermal LD₅₀ (mg/kg BW)	≤200	200-2000	2000-20000	>20000
Ocular effects	Corrosive corneal opacity not reversible within 7 days	Corneal Opacity reversible within 7 days; irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation
Dermal effects	Corrosive	Severe irritation at 72 h.	Moderate irritation at 72 h.	Middle or slight irritation at 72 h.

Material Quality Management Process



Material Risk Assessment (MRA) – How to manage risks?

- The first step in the Mars Inc. Material Quality Management (MQM) standard.
- Identify inherent hazards related to a material
- Determine “severity of Effect” vs “Likelihood of Occurrence” => High / Medium / Low risk

Assess supplier controls vs own controls

- what must be controlled at the supplier
- what will be controlled at own site
- relationship between Supplier and own HACCP

- What is the hazard? Chemical, Physical, Biological
- What does the supplier do to mitigate the risk?
- What do MARS do to mitigate the risk?
- Residual risk?

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Thank you!



Bergkvist C., Öberg M., Appelgren M., Becker W., Aune M., Ankarberg E. H., Berglund M., Håkansson H.. Exposure to dioxin-like pollutants via different food commodities in Swedish children and young adults. Food and Chemical Toxicology, 46 (2008) 3360-3367

Charnley G., Doull J., Human exposure to dioxins from food, 1999–2002, Food and Chemical Toxicology 43 (2005) 671–679

Chaudhry R., Lall S. B., Mishra B., Dhawan B., A foodborne outbreak of organophosphate poisoning, BMJ. 317(7153) (1998) 268–269.

Commission Regulation(EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs

EFSA (2008) Statement of EFSA on the risks for public health due to the presence of dioxins in pork from Ireland. The EFSA Journal (2008) 911, 1-15

EFSA Scientific Report (2006) 77, 1-43, Conclusion on the peer review of dichlorvos

EFSA Scientific Report (2006) 85, 1-73, Conclusion on the peer review of diazinon

Electronic Code of Federal Regulations 40 CFR 156.62 <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;rgn=div5;view=text;node=40%3A23.0.1.1.7;idno=40;sid=48302bcda20b542dd44746b6e576f543;cc=ecfr#40:23.0.1.1.7.3.1.2> (last accessed February 11th 2010)

EU Pesticides Database http://ec.europa.eu/sanco_pesticides/public/index.cfm (last accessed February 11th 2010)



MARS | References

European Commission, Health & Consumer Protection Directorate-General, Scientific Committee on Food (2001). Opinion of the SFC on the risk assessment of dioxins and dioxin-like PCBs in food. [Update based on new scientific information available since the adoption of the the SCF opinion of 22nd November 2000. Adopted 30 May 2001]

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
http://www.bmu.de/english/food_safety/consumer_protection_eu/doc/41969.php

Ferrer A., Cabral R., Recent epidemics of poisoning by pesticides, Toxicology Letters 82/83 (1995) 55-63

Health Canada, Environmental Health Directorate, Health Protection Branch (1996). Health-based tolerable daily intakes/concentrations and tumorigenic doses/concentrations for priority substances.

Johansson, N., Hanberg, A. (2000). Report from a Nordic meeting on the 1998 WHO consultation on assessment of the health risks of dioxins; re-evaluation of the tolerable daily intake (TDI). Organohalogen Compounds, 48, 252-5.

Joint Meeting on Pesticide Residues (JMPR) (1998) Evaluations Part II Toxicological, 950. Endosulfan

Joint Meeting on Pesticide Residues (JMPR) (2006). Inventory of IPCS and other WHO pesticide evaluations and summary of toxicological evaluations performed by the Joint Meeting on Pesticide Residues (JMPR)

Ministerial Council on Dioxin Policy of Japan (1999)

National Health & Medical Research Council (2002) Dioxins: Recommendation for a Tolerable Monthly Intake for Australians

Rapid Alert System for Food and Feed (RASFF) -Notification detail - 2007.0499. https://webgate.ec.europa.eu/rasff-window/portal/index.cfm?event=notificationDetail&NOTIF_REFERENCE=2007.0499



The Chlorine Chemistry Council (2002) A Comparison of Dioxin Risk Characterizations.

US ATSDR (1998). Toxicological profile for chlorinated dibenzo-p-dioxins. US EPA

Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson. The 2005 World Health Organization reevaluation of human and Mammalian toxic equivalency factors for dioxins and dioxin-like compounds. *Toxicological Sciences* 93(2) (2006) 223-241

Van Larebeke N., Hens L., Schepens P., Covaci A., Baeyens J., Everaert K., Bernheim J. L., Vlietinck R., De Poorter G., The Belgian PCB and Dioxin Incident of January–June 1999: Exposure Data and Potential Impact on Health. *Environmental Health Perspectives* 109 (2001) 265–273.

Wittsiepe J., Fürst P., Schreya P., Lemma F., Kraft M., Eberweind G., Winneke G., Wilhelma M., PCDD/F and dioxin-like PCB in human blood and milk from German mothers *Chemosphere* 67 (2007) S286-294

World Health Organization (1991) *Environmental Health Criteria* 121, Aldicarb.

World Health Organization (1996) WHO-Coordinated Exposure Study: Levels of PCBs, PCDDs and PCDFs in Human Milk. *Environmental Health in Europe* No. 3 Bilthoven: World Health Organization, European Center for Environment and Health.

World Health Organization (2001) Joint FAO/WHO Expert Committee on Food Additives, 57th Meeting, WHO Food Additives Series No 48. Safety Evaluation of Certain Food Additives and Contaminants. Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls

