



**Pesticide residues and food safety:  
the case of strawberries**

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## Content

- Pests and diseases in strawberries
- Pesticide use in strawberries
- Pesticide residues in strawberries
- Trends in pesticide use and consequences
- Food safety and pesticide residues
- Environmental aspects and pesticide use in strawberries

## Situation

- Strawberry market in Belgium ca. 45.000 ton
- Strawberries are one of the highest value per-acre crops
- Management of pests and diseases on strawberries is crucial having important economic effects
  - fungal diseases -> fungicides
  - insect injury -> insecticides
  - weed competition -> herbicides
- Strawberries is a crop with a potential problem of the presence of pesticide residues
- This problem holds for the crop all over the world and the Belgian situation is only an example

## Diseases and Pests

Mildew (*Podosphaera aphanis*)  
 Red root rot (*Phytophthora fragariae*)  
 Crown and root rot (*Phytophthora cactorum*)  
 Grey mold (*Botrytis cinerea*)  
 Antracnose (*Colletotrichum acutatum*)  
 Black leaf spot (*Alternaria alternata*)  
 Leaf scorch (*Diplocarpon earlianum*)  
 Wilt (*Verticillium* spp.)

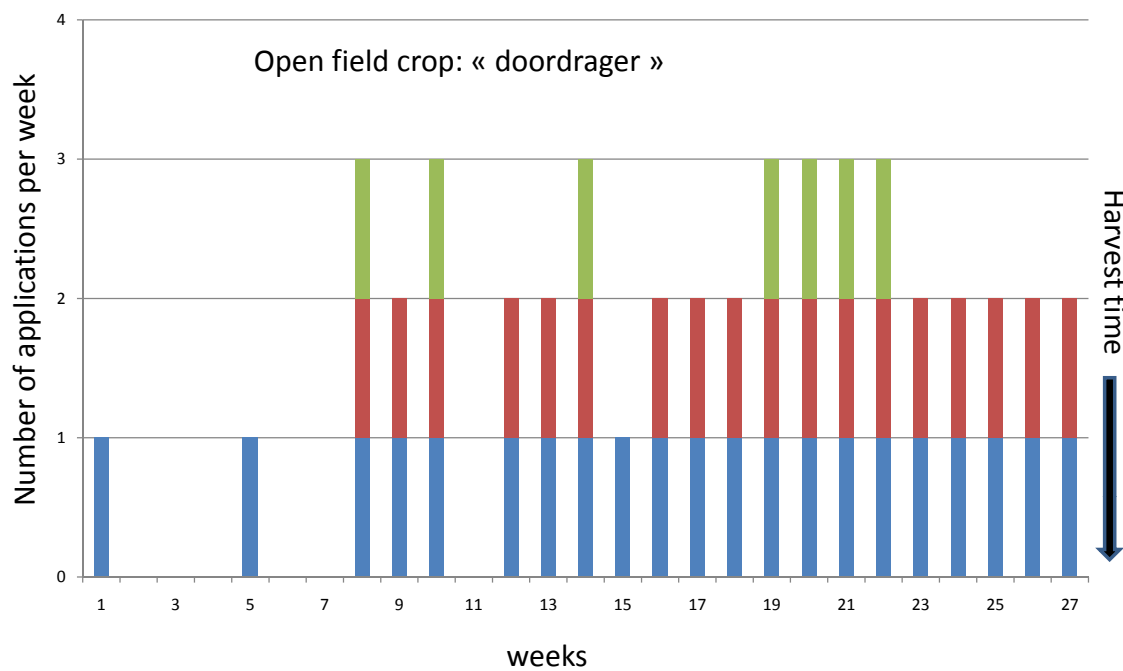
Also post-harvest infections  
 can cause considerable losses

*Tarsonemus fragariae*  
 Spider mites (Tetranychidae)  
 Thrips (Thysanoptera)  
 Aphids (Aphididae)  
 White fly (Trialeurodes)  
 Agrotis, Tipula  
 Melonontha  
 Agriotes  
 Miridae

Over 200 species of arthropod pests  
 have been reported on strawberries












# Consequence: intensive use of PPPs



A. Demeyere, 2006

## Consequence: intensive use of PPPs

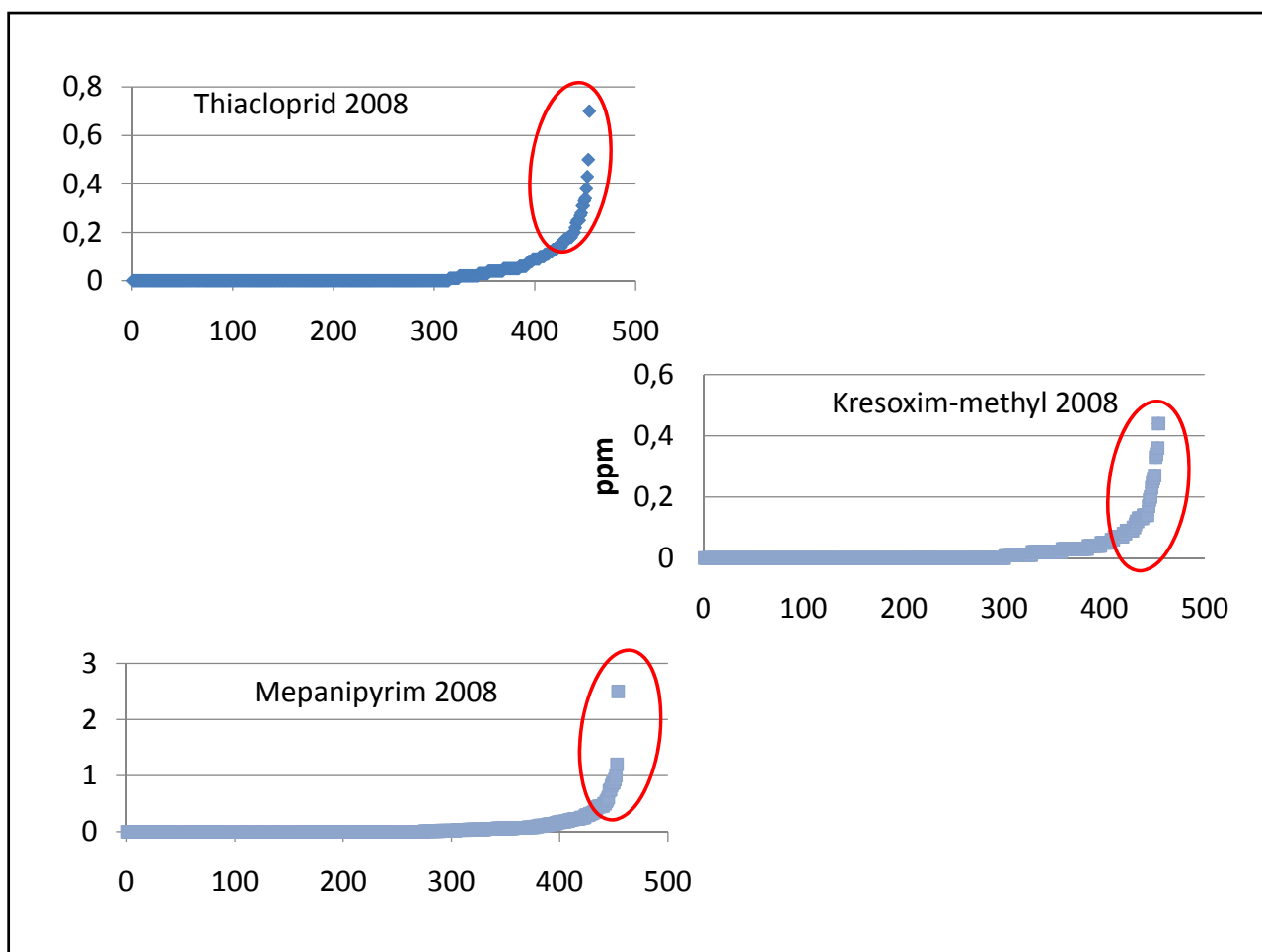
 <b>BASF</b> The Chemical Company		AARDBEISCHEMA 2010								
		SPUITSHEMA BASF AARDBEI								
										
	planten	rajaar		begin bloei	bloei	bloei	voorooft	oogst	oogst	oogst
Onkruidbestrijding			Stomp* (+ contact- middel)							
Phytophthora Stengelbasisrot	Paraat* (direct na planten)									
Botrytis				Scala* + TMTD *	Rovra* WG + TMTD *	Signum*	Scala* + TMTD *		Signum*	
Colletotrichum						Signum*			Signum*	
Witziekte		Candit*		Candit*		Signum*			Signum*	
Spint		Nissorun* Masai*		Nissorun* Masai*						

## Registered PPPs in Belgium:

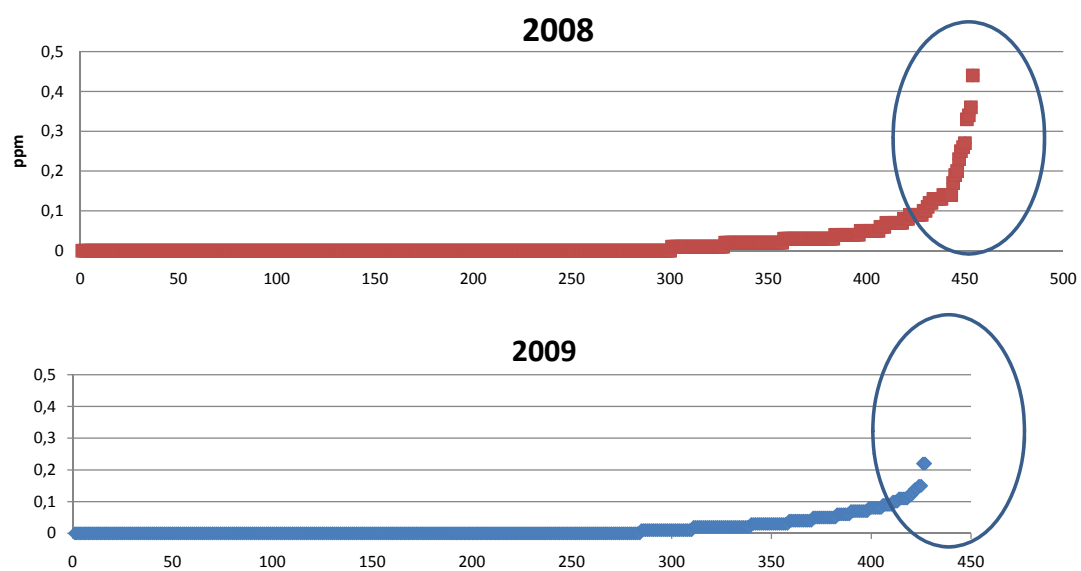
Abamectin	Sulfur	Fenmedifam
Bacillus thuringiensis	Fenamidon	Quinalofop-ethyl
Clofentezin	Phosethyl-Al	Isoxaben
Bifenthrin	Quinoxifen	Clopyralid
Pyrethrins	Mepanipyrin	Napropamide
Spinosad	Boscalid	Pendimethalin
Chlorpyrifos	Pyroclostrobin	
Spirodicofen	Myclobutanil	
Lambda cyhalothrin	Diethomorph	
Hexythiazox	Penconazole	
Bifenazate	Thiofanate methyl	
Pyridaben	Laminarine	
Fipronil	Carbendazim	
Imidacloprid	Thiabendazol	
Thiacloprod	Kresoxim-methyl	
Thiamethoxam	Fenhexamid	
	Prochloraz	
	Captan	
	Pyrimethanil	
	Iprodion	

## Results monitoring

2008		2009	
37 different a.i.		47 different a.i.	
> 95% of samples with residues		> 96% of samples with residues	
7% > MRL (fenmedifam, procymidon, dimethomorph, thiacloprid, mepanipyrin, mevinfos, cyhalothrin)		3% > MRL (dimethomorph, fenmedifam, thiabendazol, spinosad, dimethoate, dichlorvos)	
<b>Top 10</b>		<b>Top 10</b>	
boscalid	1	pyroclostrobin	
fenhexamid	2	boscalid	
cyprodinyl	3	cyprodinyl	
fludioxonil	4	fludioxonil	
mepanipyrin	5	mepanipyrin	
kresoxim-methyl	6	fenhexamid	
thiacloprid	7	kresoxim-methyl	
iprodion	8	thiacloprid	
penconazole	9	myclobutanil	
quinoxafen	10	penconazole	



## Kresoxim 2008 versus 09



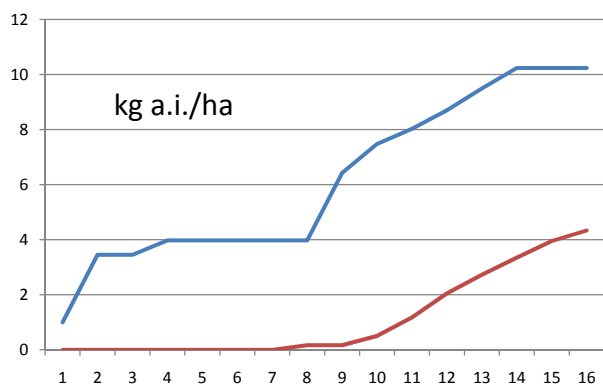
## Important milestones

- **1991**: Dir 91/414/EEC: regulation of PPPs
- **2000-** : voluntary initiatives
  - Labels: Flandria, ...
  - Global GAP
- **2008**: Regulation (EC) No 396/2005: maximum residue levels of pesticides in food
- **2009**: Regulation (EC) 1107/2009 replacing 91/414
- **2009**: Extra criteria from retailers and NGOs
  - Lower MRLs
  - Limitation of the number of a.i. on one sample
- **2010**: Dir 2009/128/EC: sustainable use of PPPs

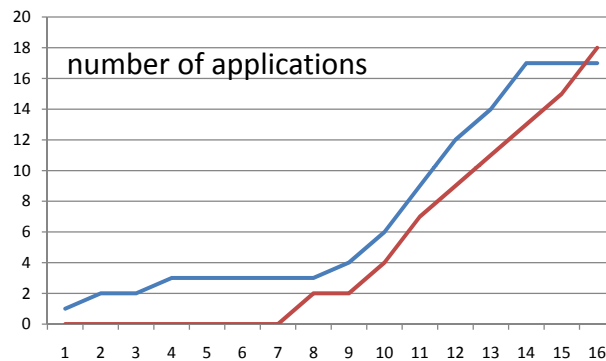
## Consequences of new regulations

- limitation of number of a.i.'s
- a.i. with low dosage = lower residues
- fractionated dosage = higher number of treatments
- more selective a.i.'s = **more treatments**
- resistance management = alternation and combination of a.i. with different mode of action
- **consequence: multiple residues at lower levels !**

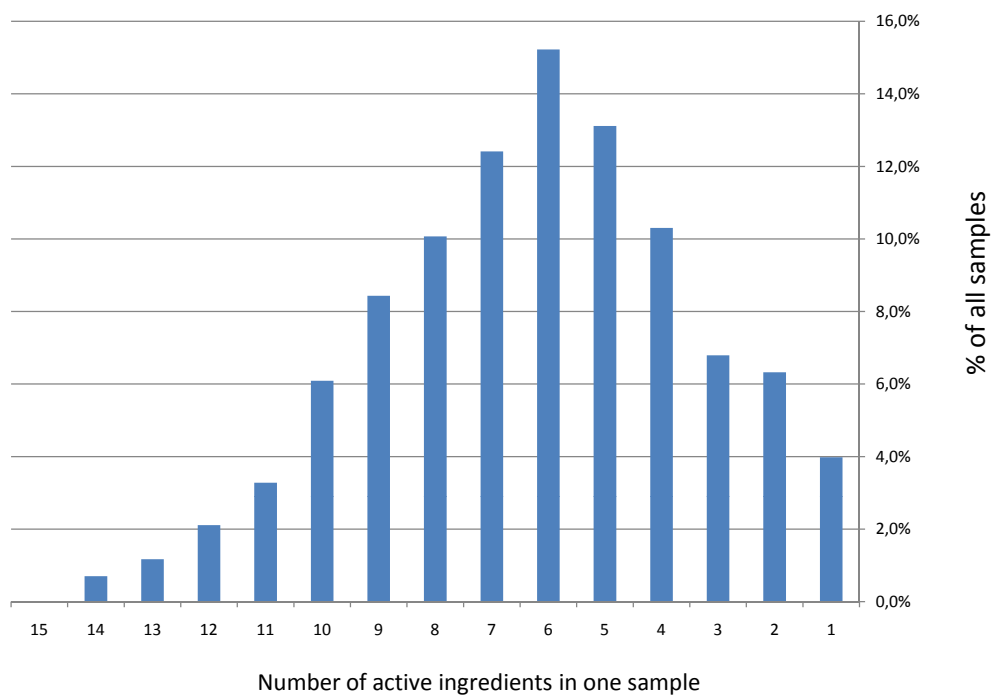
# Open air



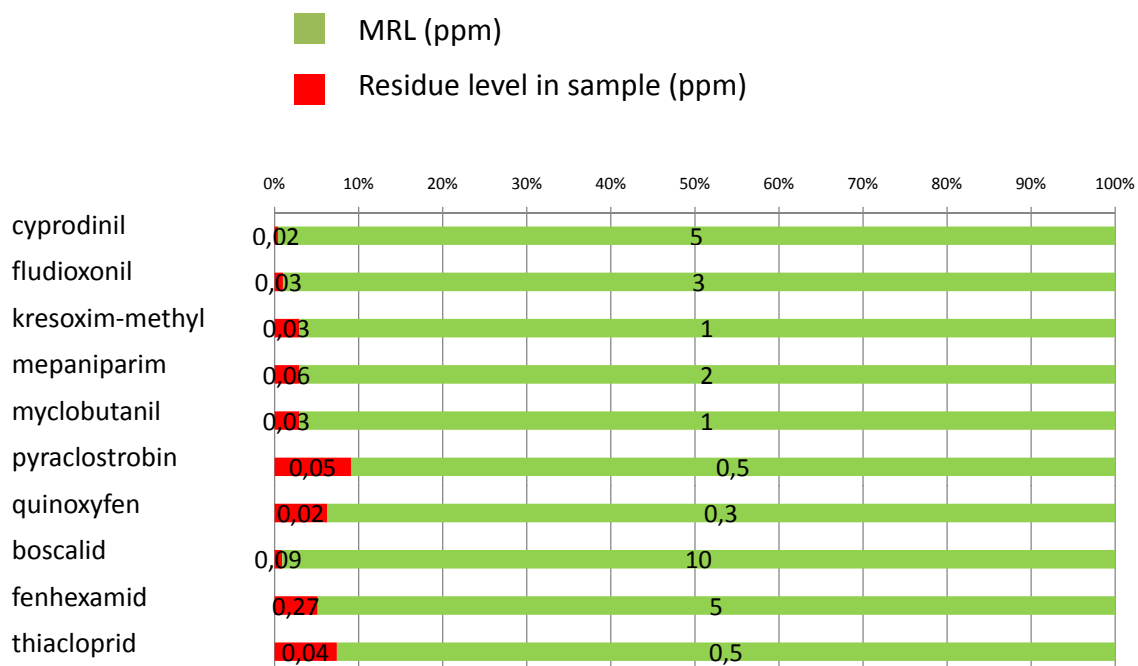
— 2000  
— 2005



## Multiple residue samples (2009) > LOD (limit of detection)



## Multiple residues : an example



## Retailers: extra legal restrains

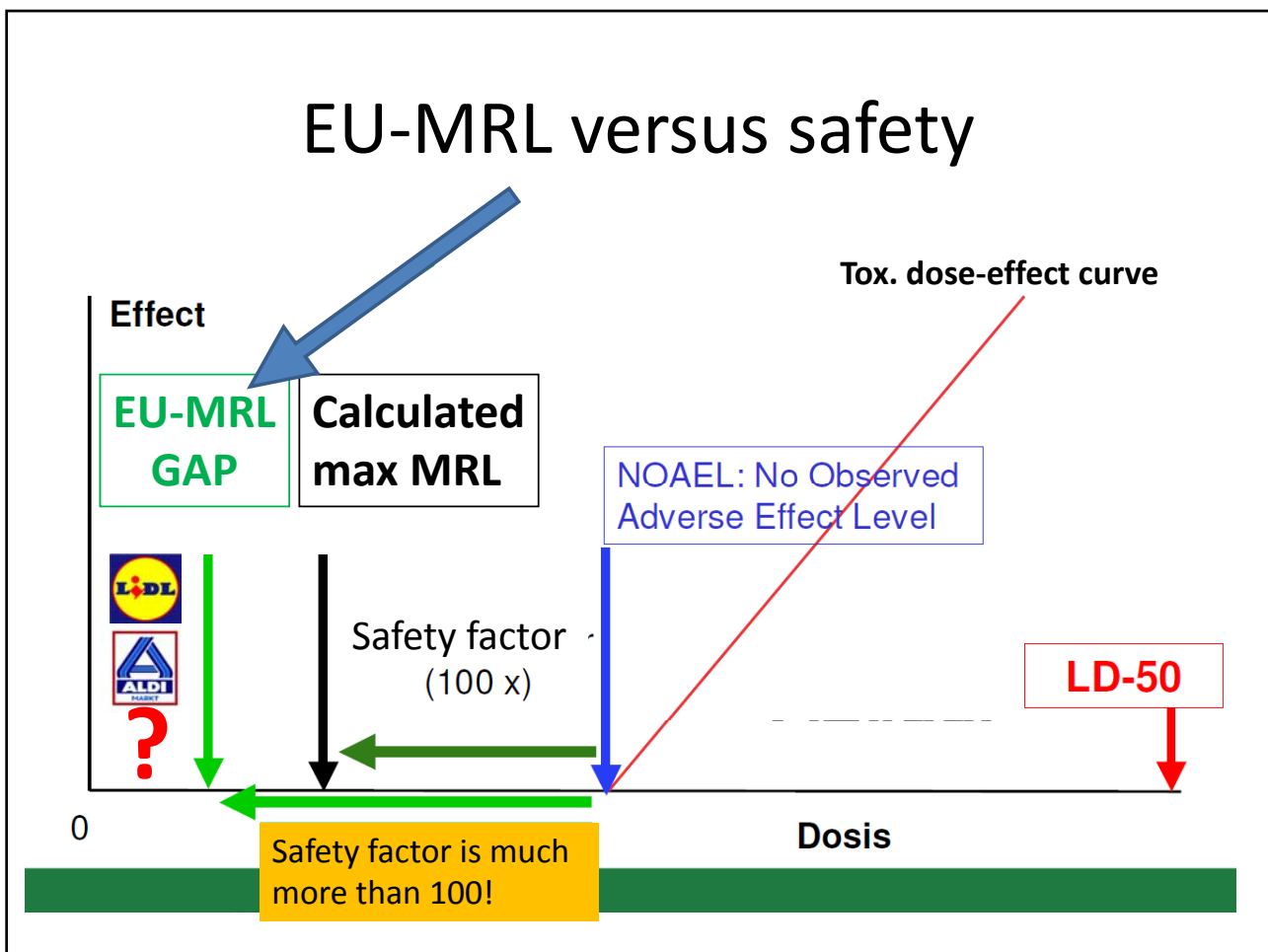


- residu < 1/3 MRL
- $\sum \text{ARfD} < 100\%$



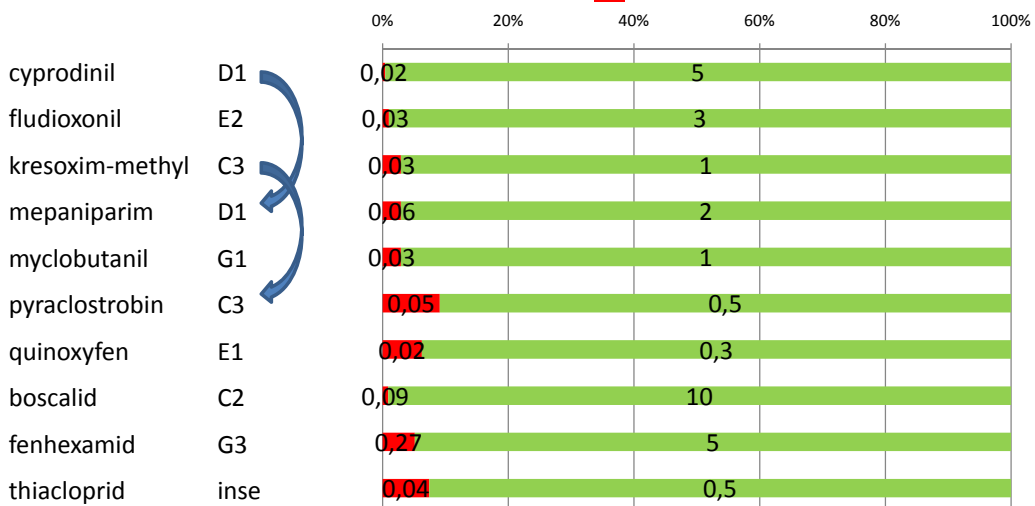
- residu < 70% of MRL
- $\sum \text{ARfD} < 80\%$
- ARfD each a.i. < 70% MRL
- $n < 5$

# EU-MRL versus safety



# Total confusion: an example

■ MRL (ppm)  
■ Residue level in sample (ppm)

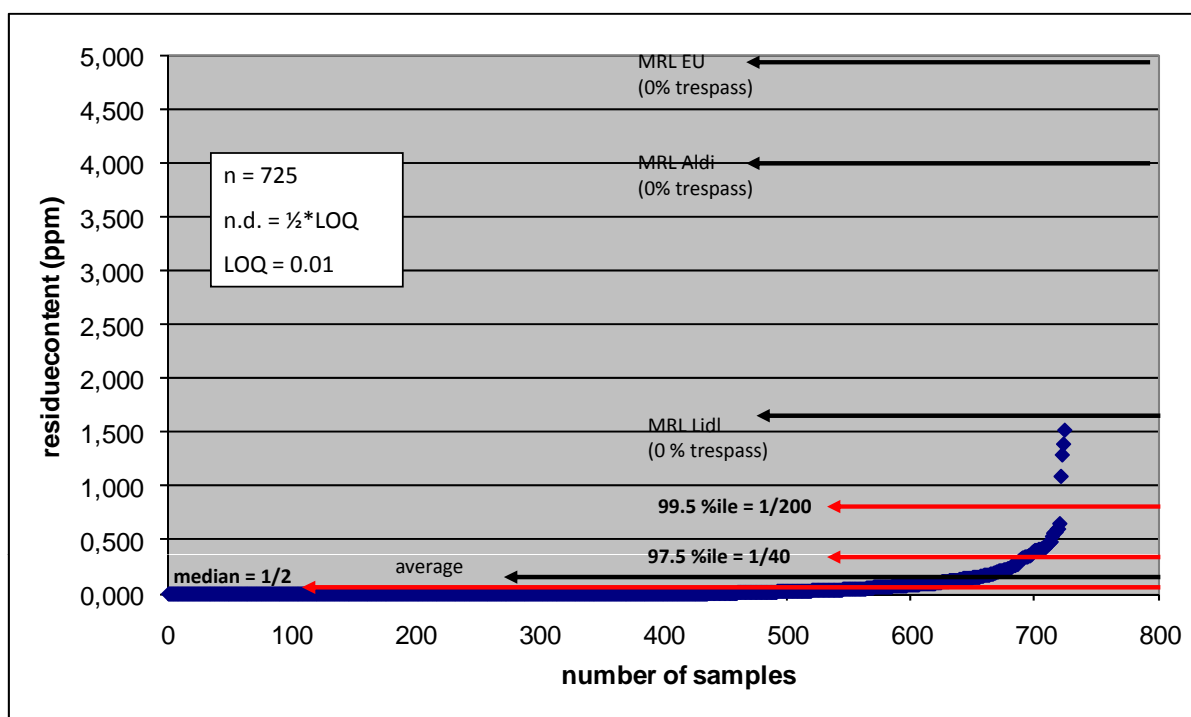


➔ Sample is compliant to current legal MRL requirements

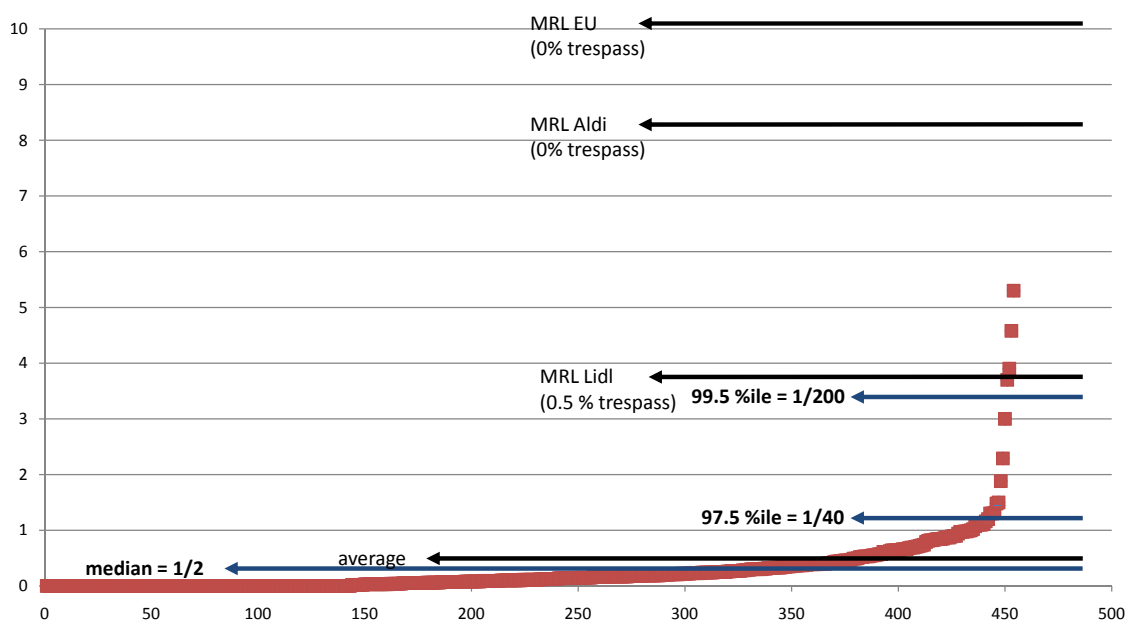
Ref. Univeg calculator

	MRL % per AB	MRL % Sum	ARFD % per AB	ARFD % Sum	Number of AB	Black List ?	Specs met ?
ALDI/ Hofer	ok	ok	---	ok	> 5	---	no
LIDL	ok	---	ok	---	---	---	yes
REWE	ok	---	ok	---	---	ok	yes
Kaufland	ok	---	ok	---	---	---	yes
PLUS	ok	ok	ok	ok	> 5	---	no
METRO	ok	---	ok	---	---	---	yes
GLOBUS	ok	---	ok	---	> 5	ok	no
NORMA	---	ok	---	ok	> 5	---	yes
EDEKA	ok	---	---	---	---	---	yes
Global2000	ok	ok	ok	---	---	---	yes

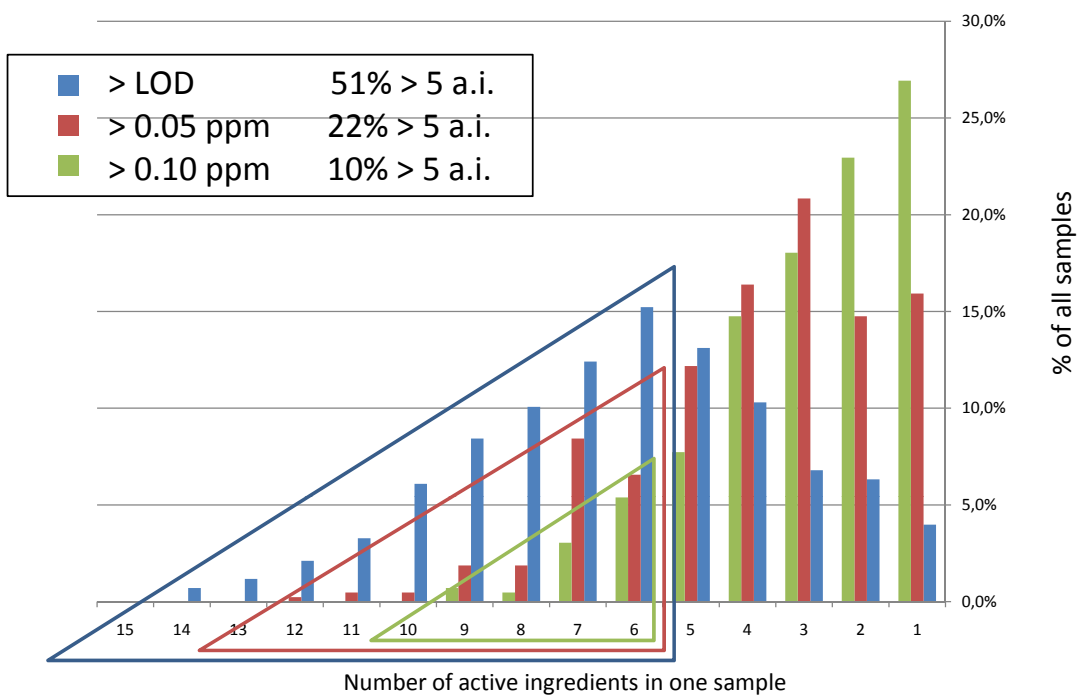
### Cyprodinil on strawberry



# Boscalid 2008



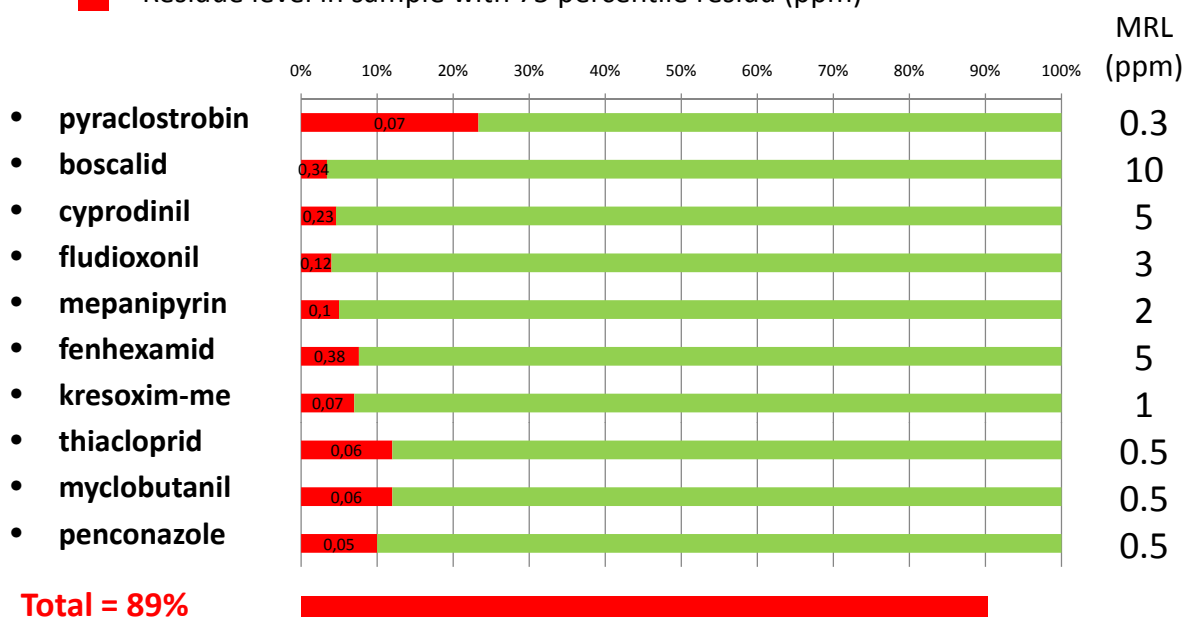
# Multiple residue samples (2009)



## Worst case scenario (75 percentile of top 10)

■ MRL (ppm)

■ Residue level in sample with 75 percentile residu (ppm)

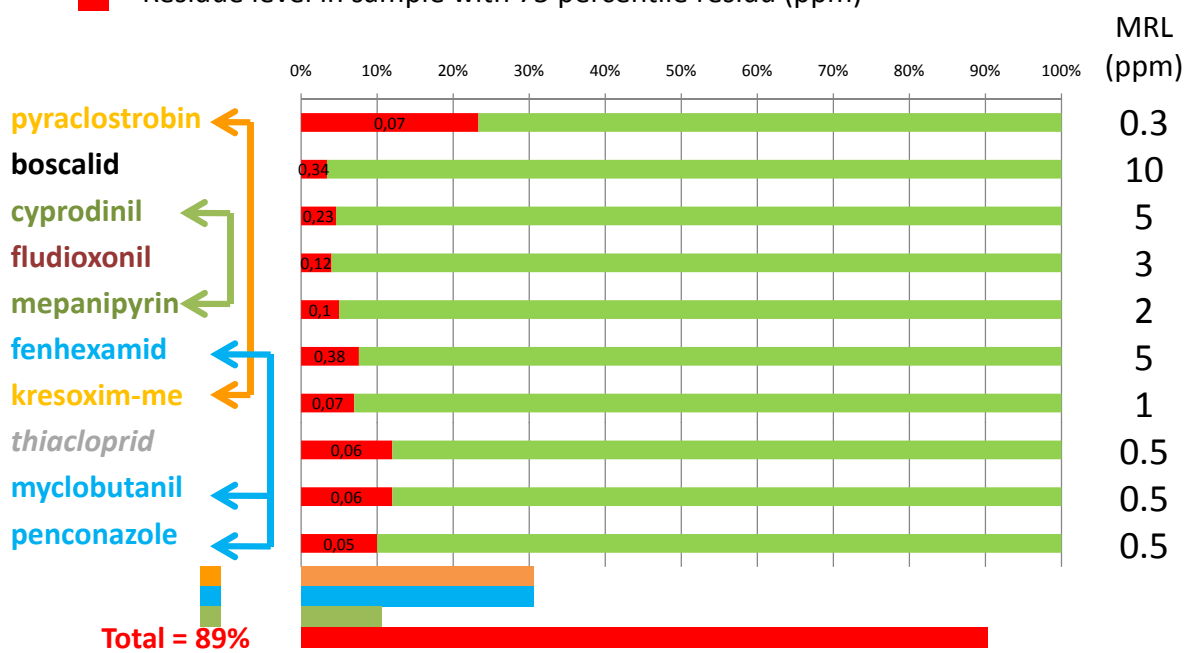


## Fungicide classification according mode of action (FRAC)

Nucleic acids synthesis inhibition	bupurimate, ethirimol
Mitosis and cell division disruption	carbendazim, thiophanate-methyl, thiabendazol
Succinate dehydrogenase inhibitor	boscalid
Cytochrome bc1 inhibitor	fenamidone, kresoxim-methyl, pyraclostrobin, trifloxystrobin
Protein synthesis inhibitor	cyprodinil, mepanipyryn, pyrimethanil
Signal transduction	fludioxonil, iprodion, procymidon, quinoxafen, vinclozolin
Lipids synthesis inhibitor	dimethomorph
Sterol biosynthesis inhibitor	imazalil, myclobutanil, penconazole, propiconazole, fenpropimorph, fenhexamid
Multi-site contact activity	tolyfluanide, sulfur
Host plant defence inductor	laminarine

## Worst case scenario (75 percentiel of top 10)

- MRL (ppm)
- Residue level in sample with 75 percentile residu (ppm)



## Indicator POCER : Pesticide Risk

- 10 components
  - risk for **exposure**:
    - pesticide applicator
    - field worker
    - bystander
  - **Environmental** risk:
    - persistence
    - ground water
    - aquatic organisms
    - birds
    - earth worms
  - risk for **beneficial organisms (IPM)**:
    - bees
    - beneficial arthropods



## POCER-indicator: principe

PIAS: Pesticide Impact Assessment System



- **RI = PEC / NEC**
  - RI = risk index
  - PEC = exposure concentration  
(« predicted environmental concentration »)
  - NEC = no effect concentration
- RI varies from 0 (zero risk) tot 1 (real risk)

## Impact assessment

	Tunnel		Open air		Year round	
	2000	→ 2005	2000	→ 2005	2000	→ 2005
Total amount applied (kg/ha)	10.7	3.0 (-78%)	10.2	4.3 (-58%)	28.0	3.8 (-86%)
Number of applications	14	7	17	18	45	28
Average dose (kg/ha)	0.77	0.43 (-44%)	0.60	0.24 (-60%)	0.62	0.14 (-78%)
POCER soil organisms	-82%		-98%		-75%	
POCER groundwater	-76%		-97%		-95%	
POCER surface water	+55%		-81%		-89%	
POCER birds	-78%		-97%		-99%	
POCER bees	+127%		+61%		-18%	
POCER Consumer	-98%		-99%		-97%	
POCER applicator	-78%		-99%		-82%	



## Conclusions



- Strawberries is a very sensitive crop for pests and diseases
- Therefore the crop is frequently treated with fungicides and insecticides, also close to harvest time
- This results in the presence of residues
- The residue levels are generally below the MRLs
- For sustainable use (prevention of resistance) it is advised to alternate and/or combine different active ingredients
- This results in the presence of multiple residues albeit at low levels
- The human and environmental impact of pesticide use is decreasing during last decade
- Risk assessment of the potential problem of accumulative risk due to the presence of residues of a high number of active ingredients is not clear yet (EFSA opinion)
- The extra safety standards from voluntary initiatives (labels of NGOs and the retail sector) has only a very limited extra safety margin and is a risk management decision without scientific support