



Food safety risk analysis Conference Ceremony

10 June 2010, Osijek, Croatia

Impact of climate change on food safety



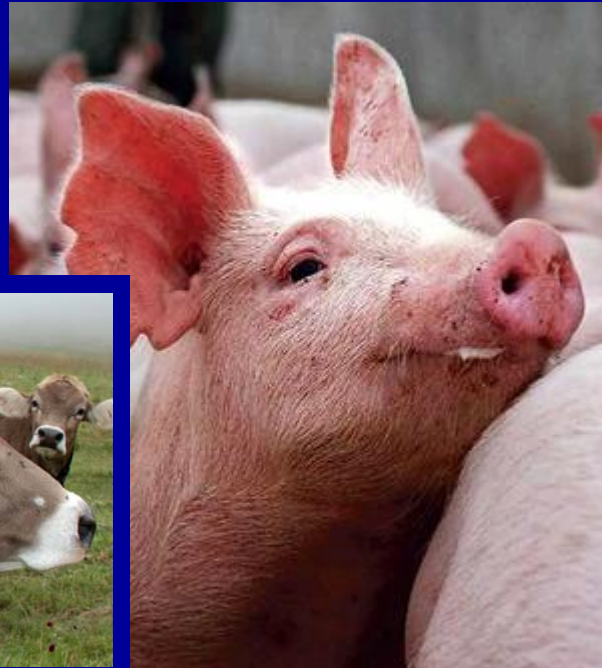
Paola Battilani
Università Cattolica del Sacro Cuore



Food



Feed & food



Rating health risks from food

Acute

Chronic

Microbiological

Phycotoxins

Some phytotoxins

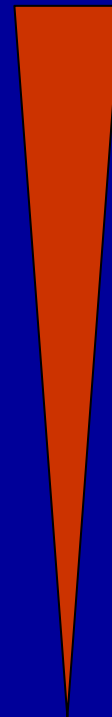
Mycotoxins

Antropogenic contaminants

Pesticide residues

Food additives

High



Low

Mycotoxins

Antropogenic contaminants

Some phytotoxins

Unbalanced diet

Phycotoxins

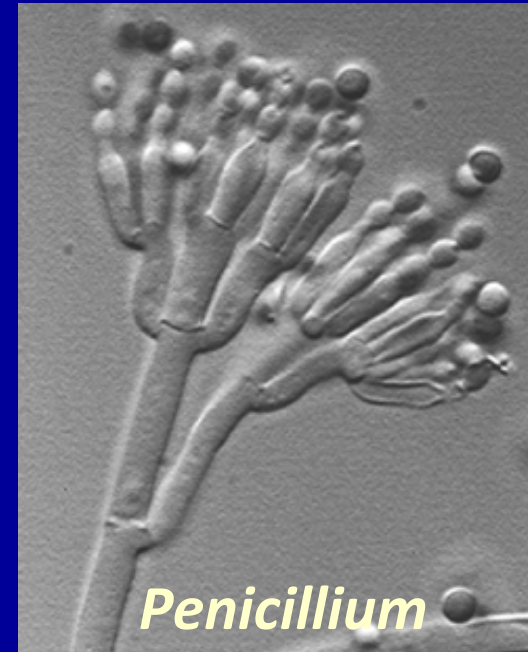
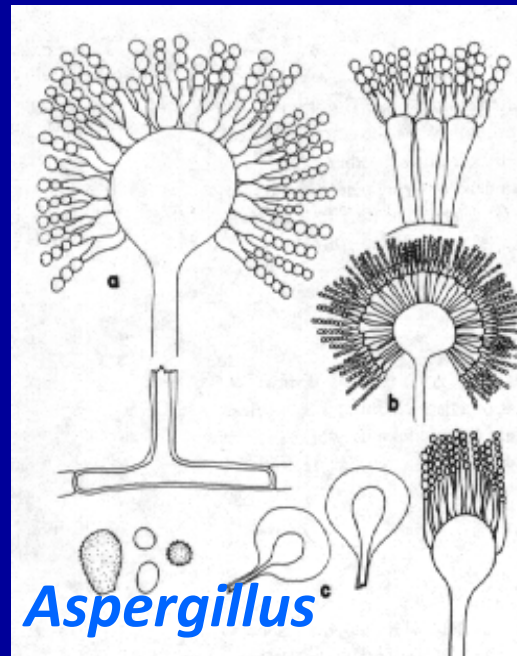
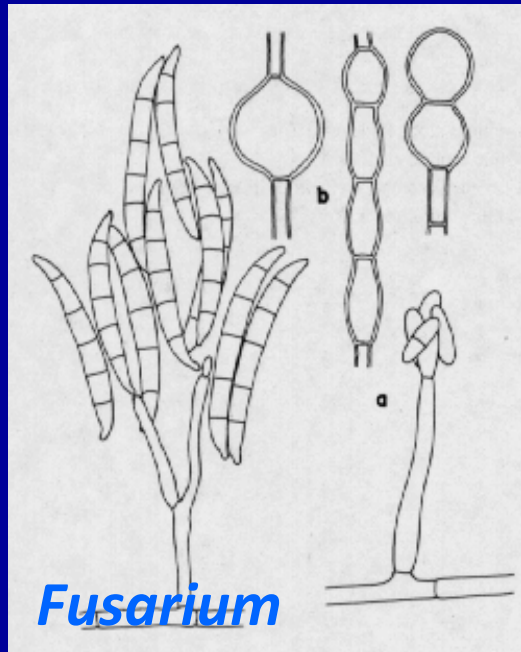
Food additives

Pesticide residues

Microbiological

Mycotoxins

- Secondary metabolites, produced by fungi, mainly in field



Mycotoxin producing fungi

- Weak parasite
- **Very susceptible to ecological conditions**
- Opt conditions differ for growth & tox
- **Mycotoxins production elicited by stress**

Fungi – ecology & geographic distribution

Wheat - FHB

F. avenaceum
F. poae
F. sporotrichioides
F. culmorum

F. culmorum
F. graminearum
F. avenaceum
F. poae

F. graminearum
F. culmorum
F. avenaceum
F. cerealis

Nivalenol
T-2 + derivatives
Diacetoxyscirpenol

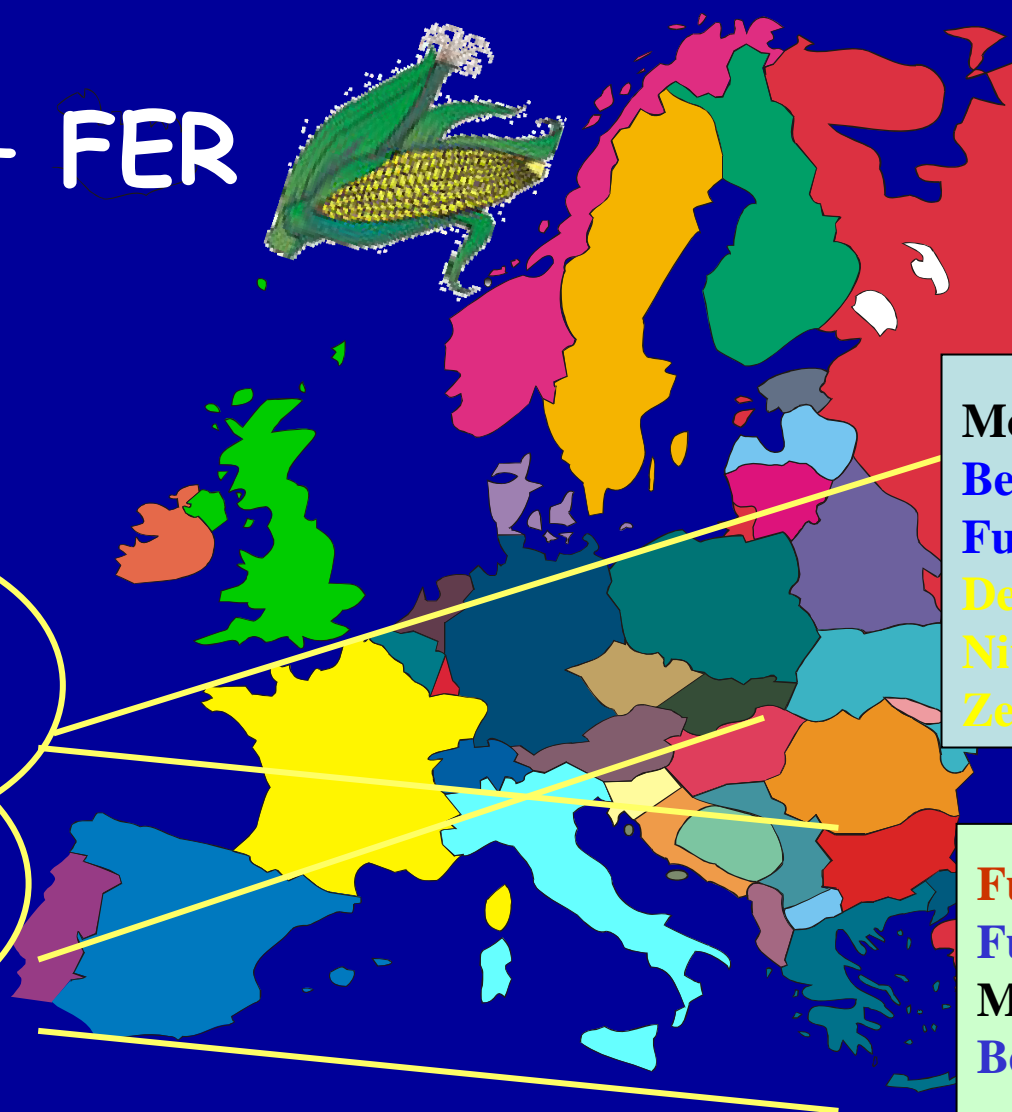
Moniliformin
Beauvericin
Enniatins

Deoxynivalenol (DON)
3-AcDON
15-AcDON
Nivalenol
Zearalenone
Zearalenols



Fungi - ecology & geographic distribution

Maize - FER



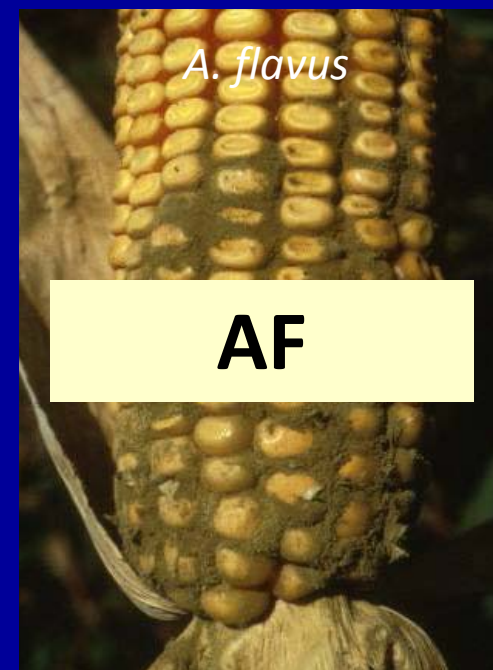
F. subglutinans
F. poae
F. graminearum
F. verticillioides

F. verticillioides
F. proliferatum

Moniliformin
Beauvericin
Fusaproliferin
Deoxynivalenol
Nivalenol
Zearalenone

Fumonisin
Fusaproliferin
Moniliformin
Beauvericin

Fungi - ecology & geographic distribution



Temp

25°

30°

35°

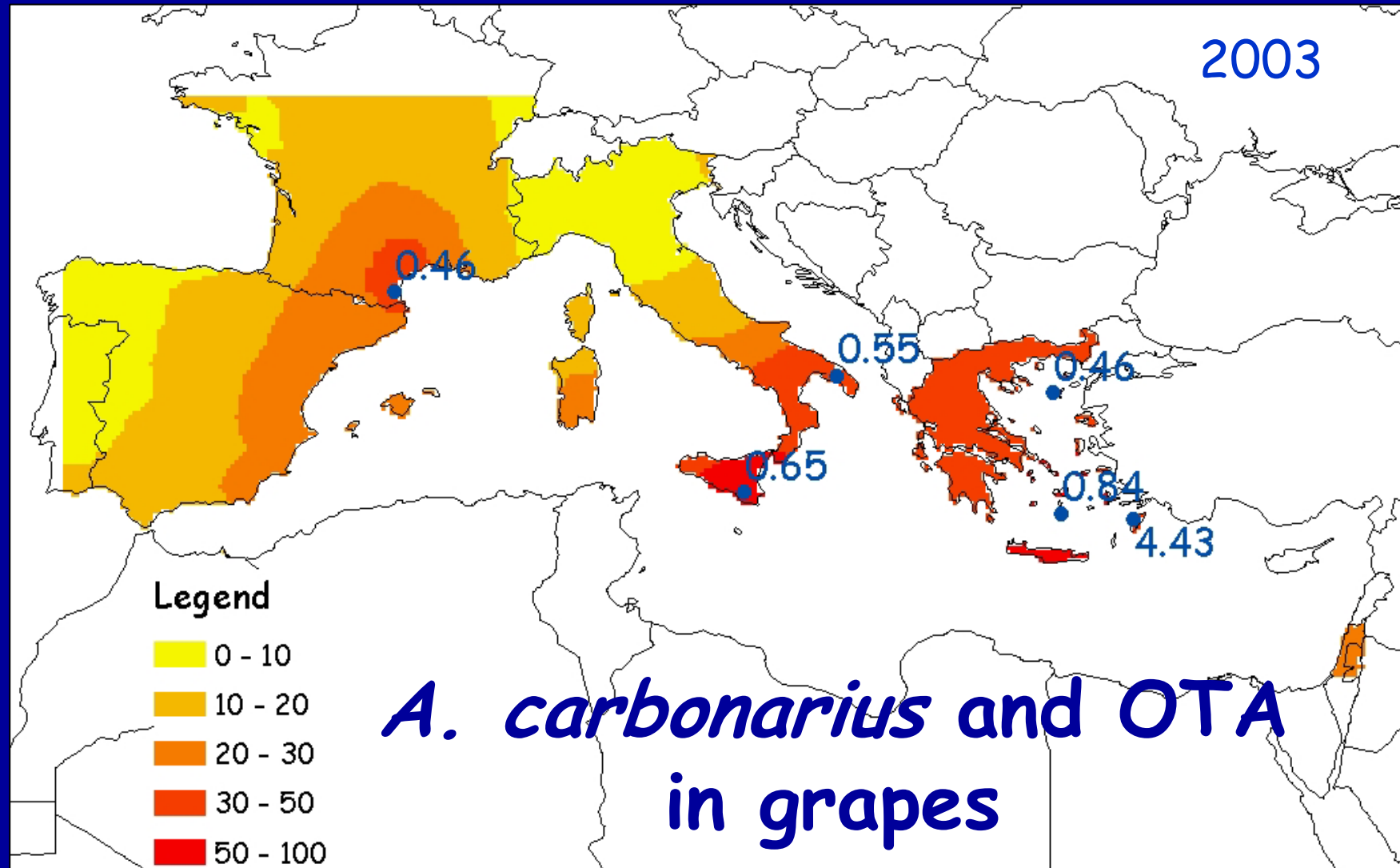
0.98

0.96

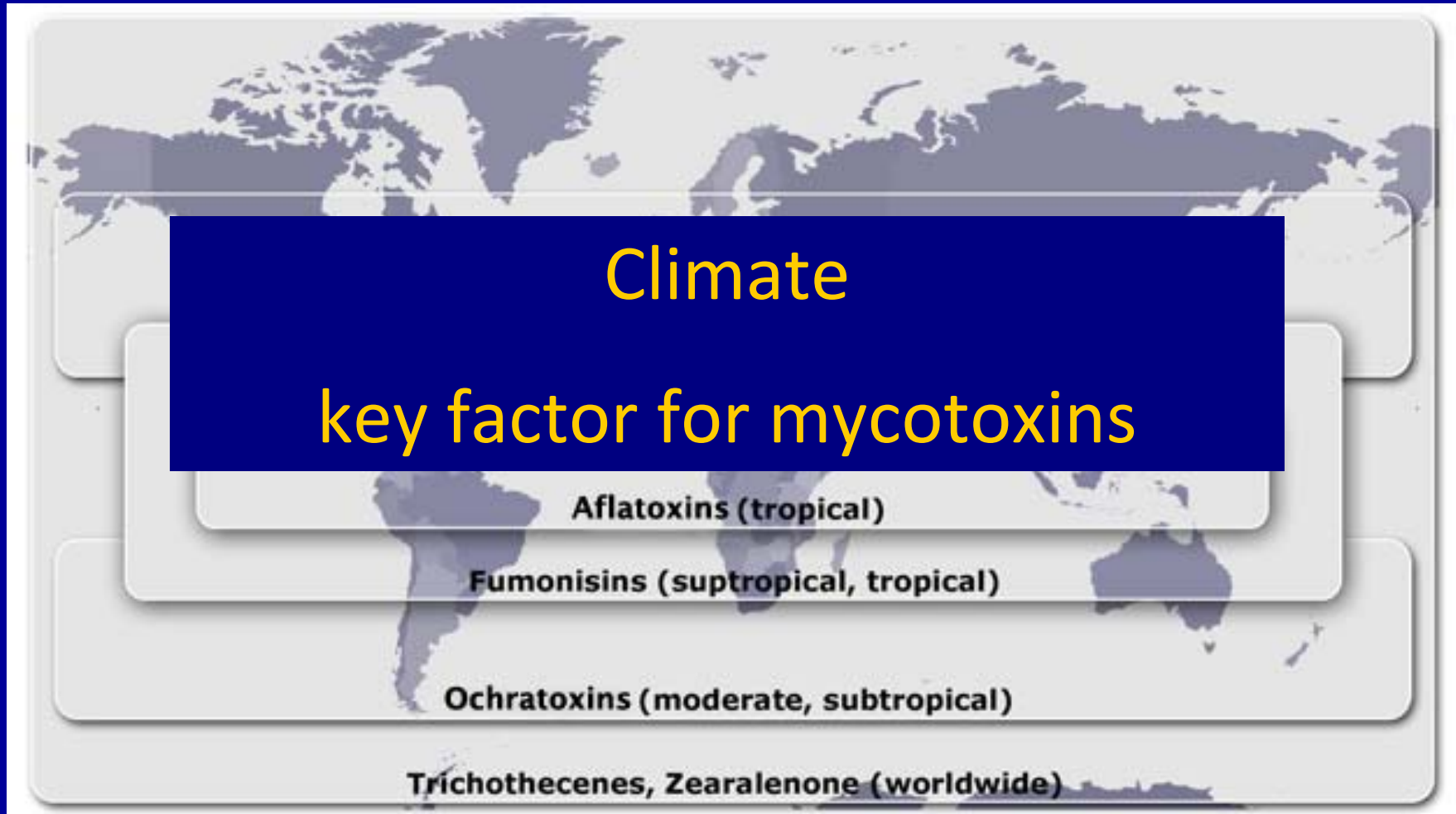
0.78

aw

Fungi - ecology & geographic distribution



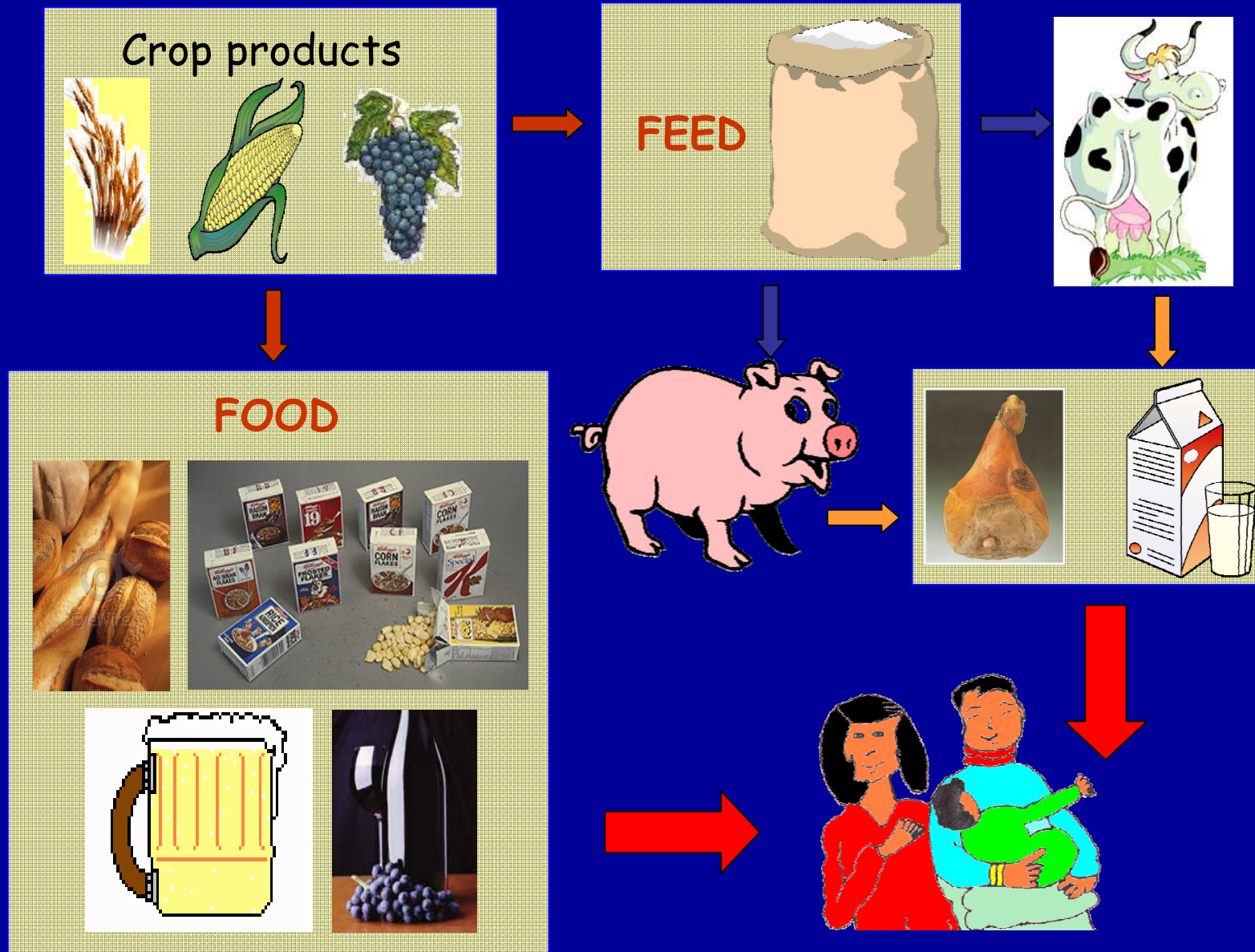
Mycotoxins around the world



Mycotoxins in Europe

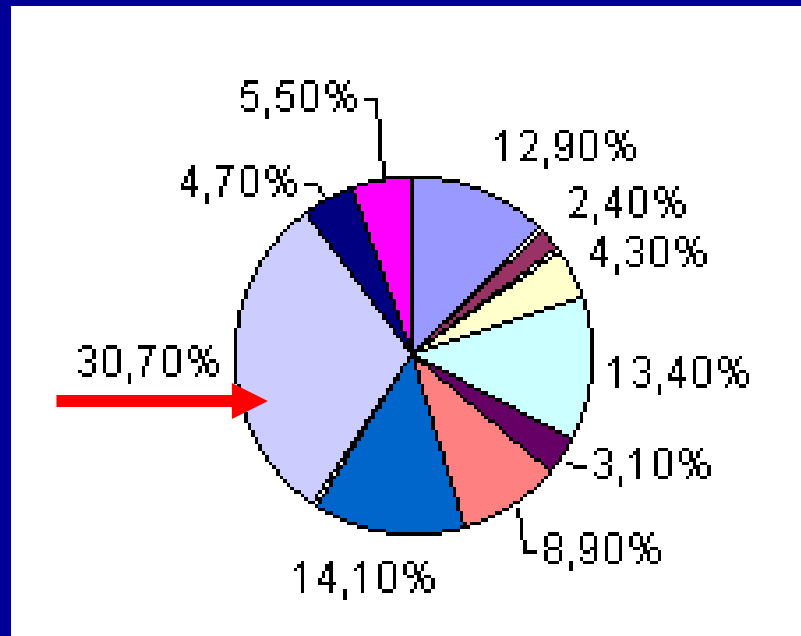
Toxins	Commodities affected
Fumonisin	Maize
Trichothecenes	Wheat, barley, maize
Ochratoxin A	Grapes, wheat
Aflatoxins	Maize
Zearalenone	Maize, wheat

Mycotoxins in the food chain

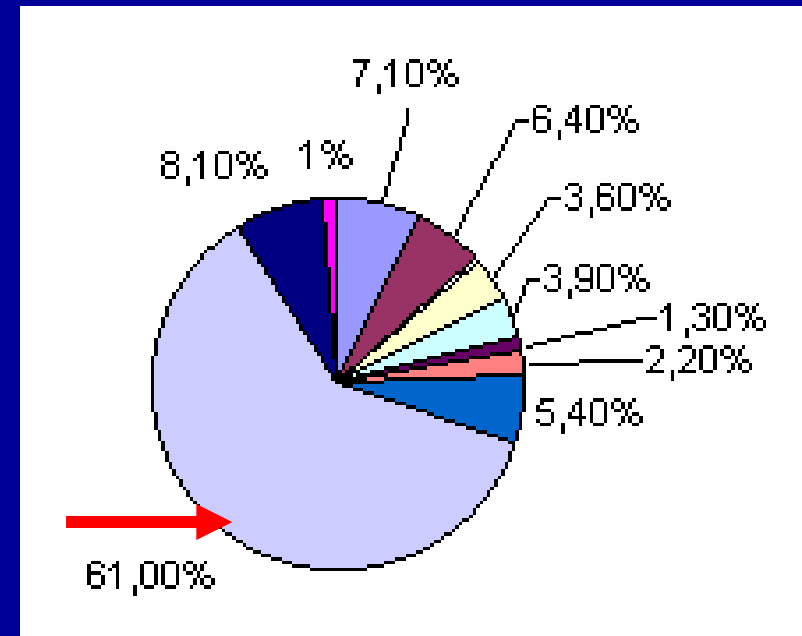












Human exposure - Feed habits

Industrialised countries



Emerging economies



- | | | | |
|---|--------------------|---|---------------|
|  | sugar |  | milk |
|  | seeds, nuts |  | oils, fats |
|  | fruits, vegetables |  | cereals |
|  | meat |  | roots, tubers |
|  | eggs, fish |  | other |

Human exposure – contamination level

Fumonisin B

Maize

FB ($\mu\text{g/g}$)	Maize intake (g/60 kg person/day)						
	10	50	100	150	200	400	500
0.2	0	0.2	0.3	0.5	0.7	1.4	1.7
0.5	0.1	0.4	0.8	1.3	1.7	3.4	4.2
1	0.2	0.8	1.7	2.5	3.3	6.6	8.3
2	0.3	1.7	1.3	5.0	6.7	13	17
3	0.5	2.5	5.0	7.5	10	20	25
4	0.7	3.3	6.7	10	13	27	33
5	0.8	4.2	8.3	13	17	33	43
10	1.7	8.3	17	25	33	67	83
12	2	10	20	30	40	80	100

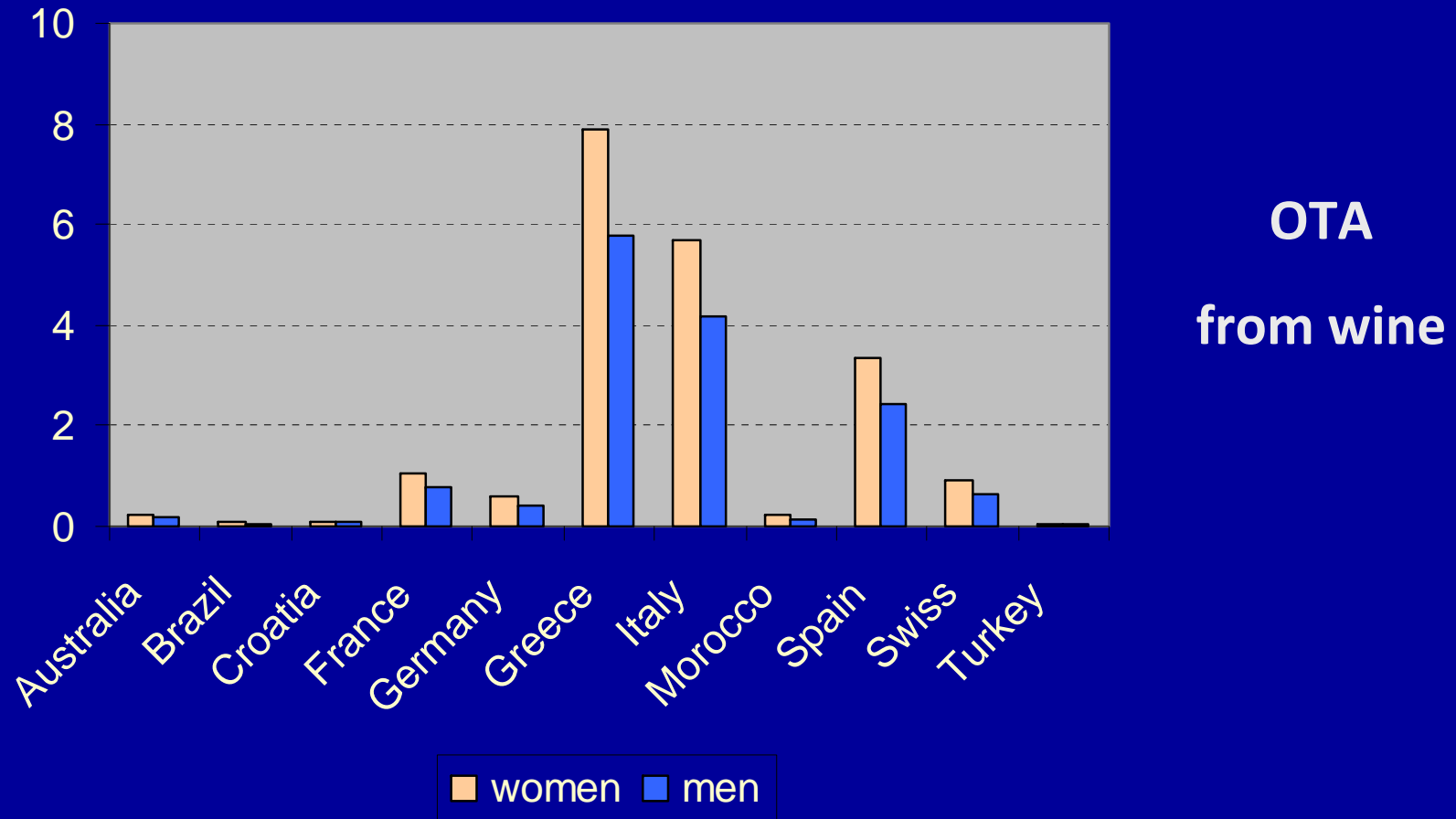
PMTDI = Provisional Maximum Tolerable Daily Intake

White = within PMTDI

Black = above PMTDI

Marasas et al., 2008

Human exposure – OTA intake



Mycotoxins management

2 MAIN LINES have been tracked to manage mycotoxin problems

➤ **definition of legal limits**

➤ **development of guidelines for crop management**

EU Legislation

- Reg. 100/2003 AF feed
- Reg. 1881/2006 All contaminants
- Reg. 1126/2007 Fusaria toxins
- Reg. 165/2010 Aflatoxins
- Reg. 401/2006 Sampling
- Racc. 506/2006 Other tox Feed

Products/mycotoxins

	Wheat	Maize	Nuts	Grapes*	Coffee	Cocoa	Apple*	Spices
Aflatoxins								
Ochratoxin A								
Patulin								
DON								
ZEA								
Fumonisin								

* Processed products

Limit defined

Limit not defined

Limit not planned/applicable

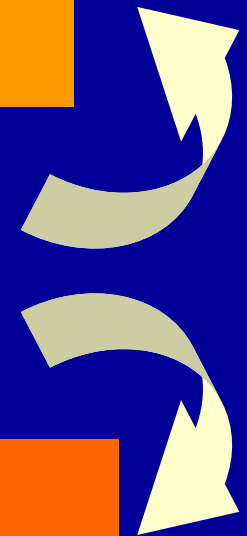
Guidelines – GAP & GMP

Storage

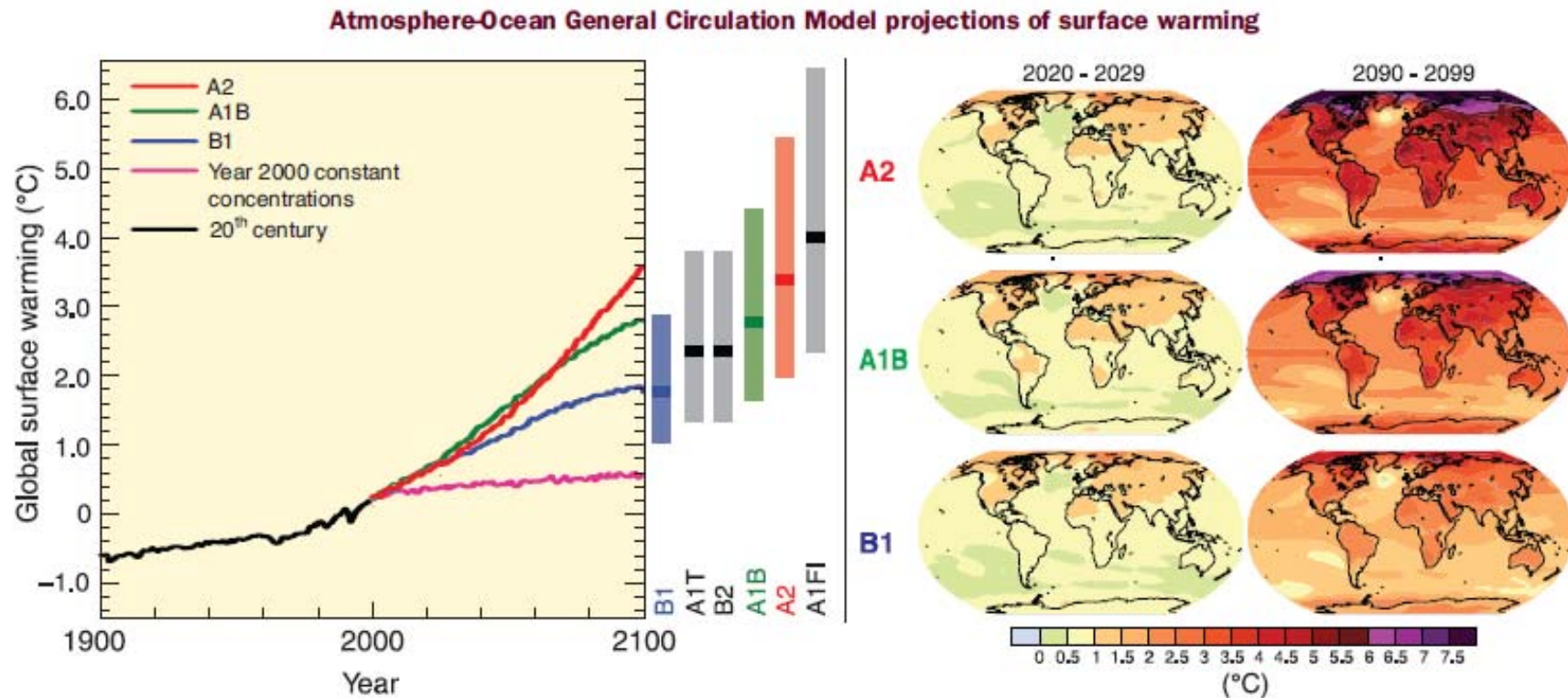
Cropping system

Harvest

Processing



Climate change scenario - T



More drought events

Climate change scenario - R

Multi-model projected patterns of precipitation changes

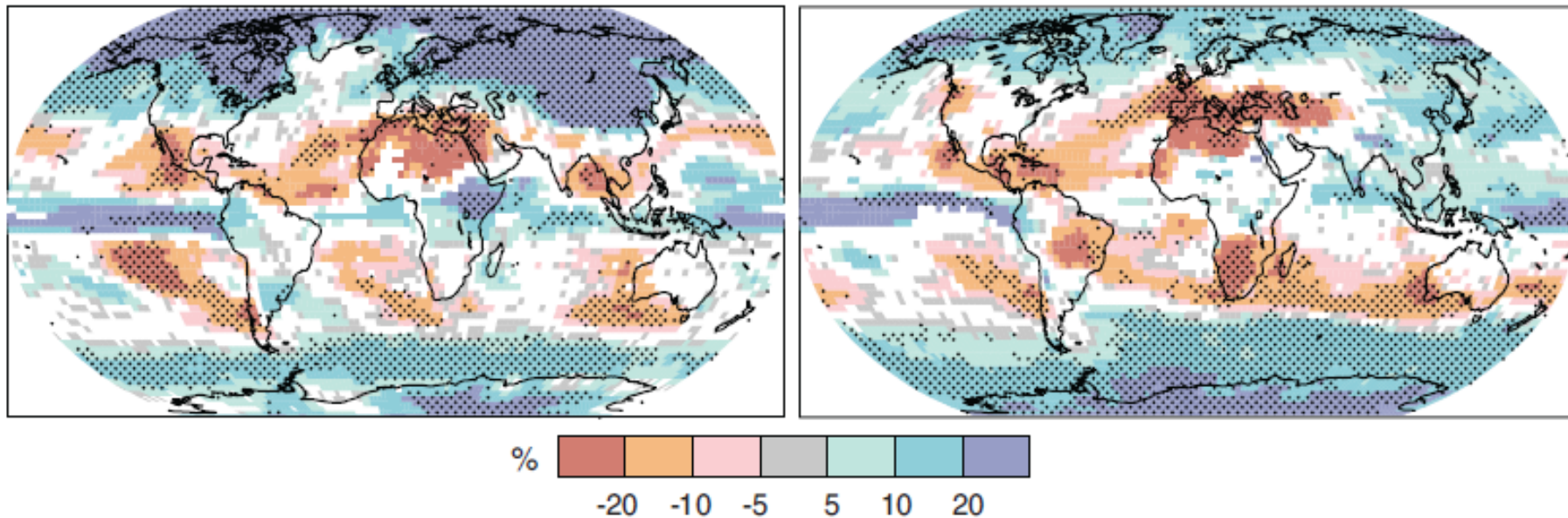


Figure 3.3. Relative changes in precipitation (in percent) for the period 2090-2099, relative to 1980-1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. [WGI Figure 10.9, SPM]

More extreme rainfall

Table 3.1. Projected global average surface warming and sea level rise at the end of the 21st century. (WGI 10.5, 10.6, Table 10.7, Table SPM.3)

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) ^{a, d}		Sea level rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	Likely range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations ^b	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Notes:

- These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity, and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs) as well as observational constraints.
- Year 2000 constant composition is derived from AOGCMs only.
- All scenarios above are six SRES marker scenarios. Approximate CO₂-eq concentrations corresponding to the computed radiative forcing due to anthropogenic GHGs and aerosols in 2100 (see p. 823 of the WGI TAR) for the SRES B1, A1T, B2, A1B, A2 and A1FI illustrative marker scenarios are about 600, 700, 800, 850, 1250 and 1550ppm, respectively.
- Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899 add 0.5°C.

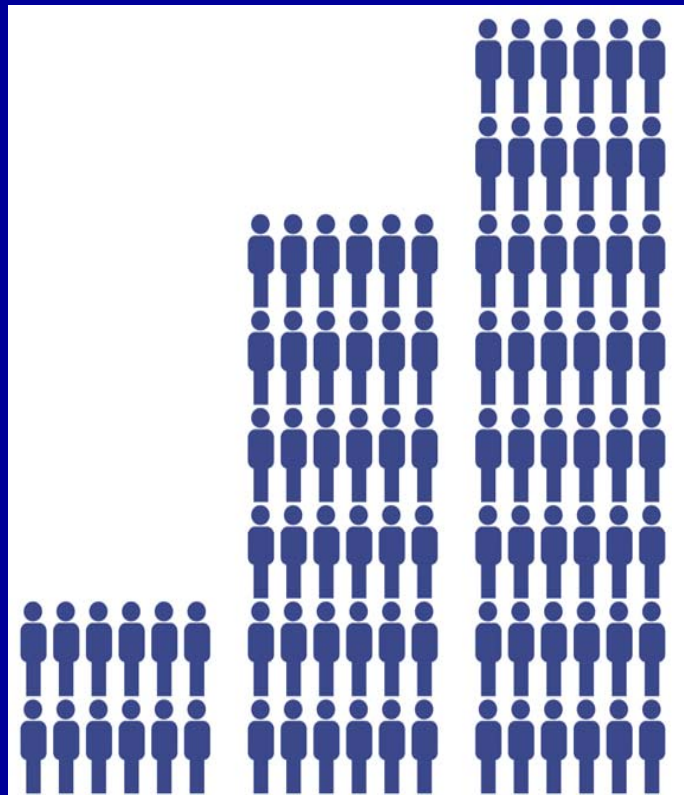
Effect of climate change

- Modification of the biogeographic scenarios of crop cultivation
- Variation in geographic distribution of fungal species
- Increase of plant and fungi stress
- Increase of contamination at harvest

Old problems, new challenges

The challenge – world people feed

World population

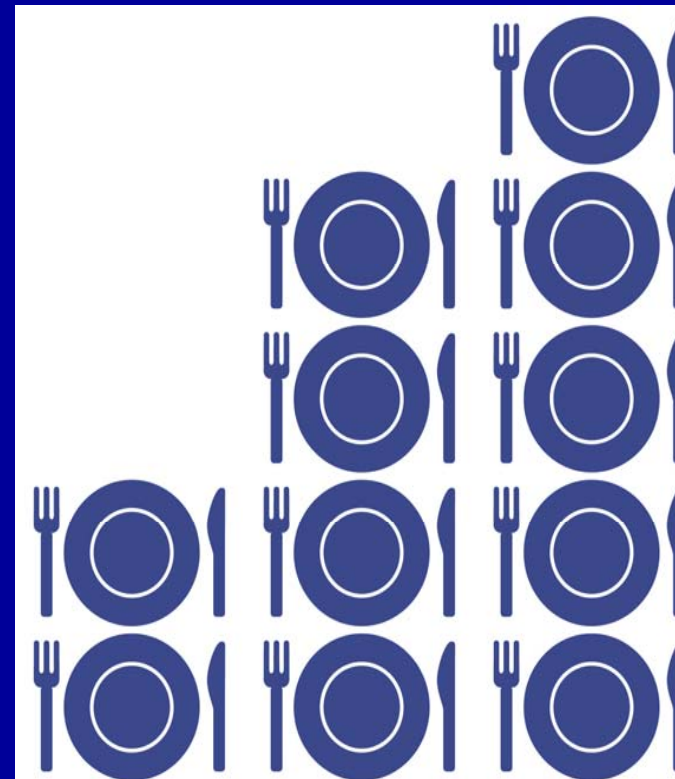


1950
2,5 billion

2005
6,5 billion

2030
> 8 billion

People feed/hectare



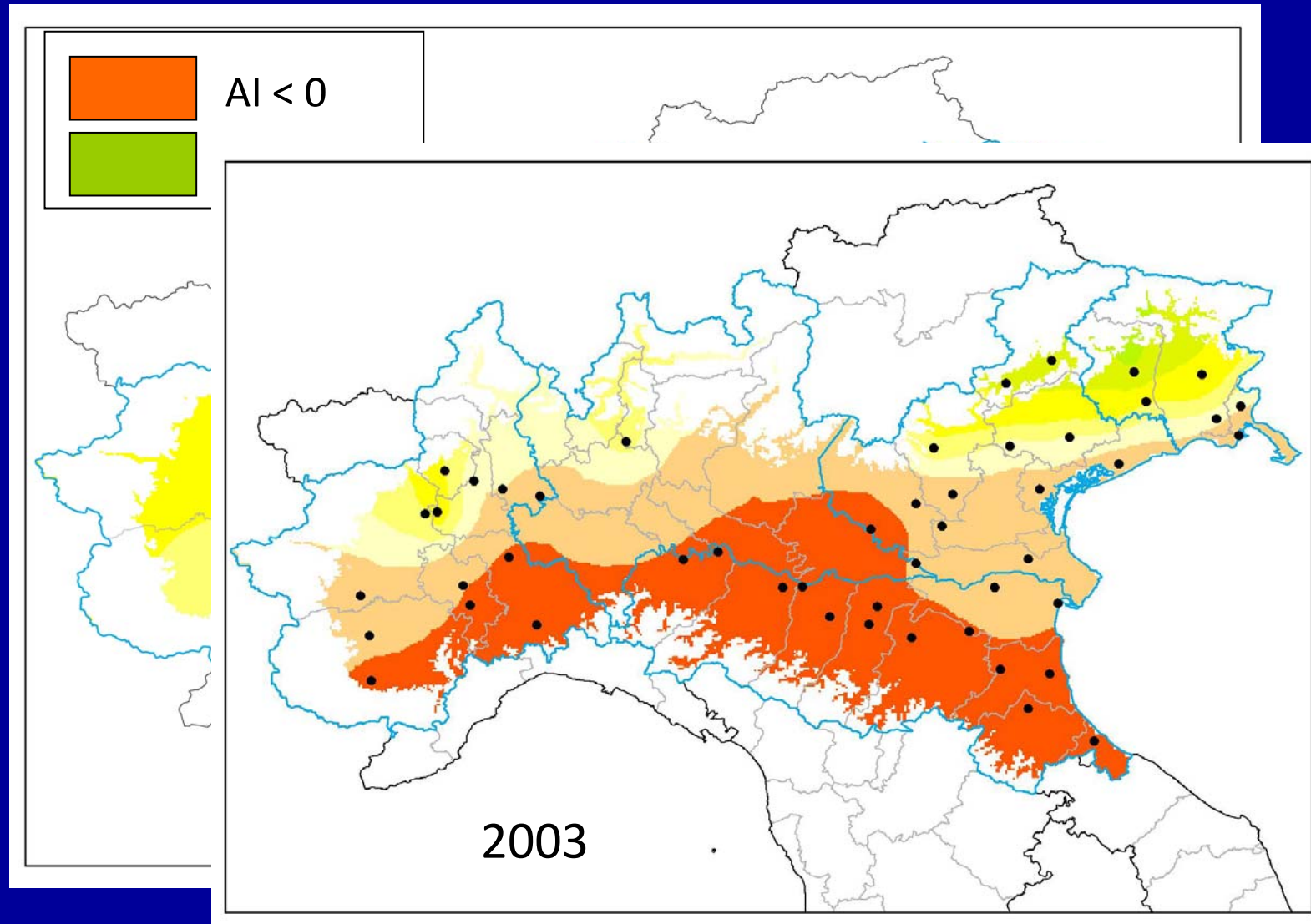
1960
2 people

2005
>4 people

2030
>5 people

Source: FAO

Italy 2003 – unusual situation



High public attention

POLENTA AT RISK OF CONTAMINATION

Tons of milk unusable

Milk and cheese contaminated by AFM₁ - a carcinogenic substance

Contamination is caused by corn, due to high temperature and drought

Why AFs problems in 2003 ???

- Unpredictable situation (aridity)
- Difficult to promptly act on the first steps of the food chain
 - Consumers protected
 - Farmers struck

Italy 2003 – reaction

AFLARID (National Project)

Over-all objective: To decrease the amount of aflatoxins in milk and derived products with the aid of a Decision Support System for the management of the maize-milk-cheese chain

- **Dynamic of aflatoxins carry over**
- **Prediction of maize contamination at harvest**

EU PROJECTS

WINE-UCHRA RISK

(EU Project R&D; www.ochra-wine.com)

Over-all objective: Assessment of risk of ochratoxin A (OTA) in grapes and wine in Europe and protection of consumers' health by decreasing the amount of toxins with the aid of integrated management of production and processing

MYCOGLOBE

(EU Project, SSA; <http://mycoglobe.ispa.cnr.it/>)

Over-all objective: Implement the outcome of a wide range of European research projects in the area of mycotoxins and toxigenic fungi by the participation and co-operation with countries all over the world

Learn from the past

- Draw future scenario
- Develop and apply validated predictive models
- Involve all the actors of the food chain
 - Take advantage of their feedbacks
 - Build their trust

Plan for the future

- Predict biogeographic distribution of crops
- Predict mycotoxin contamination at harvest
- Map new risks scenarios

Key words:

knowledge, prediction, involvement,
worldwide vision, dissemination

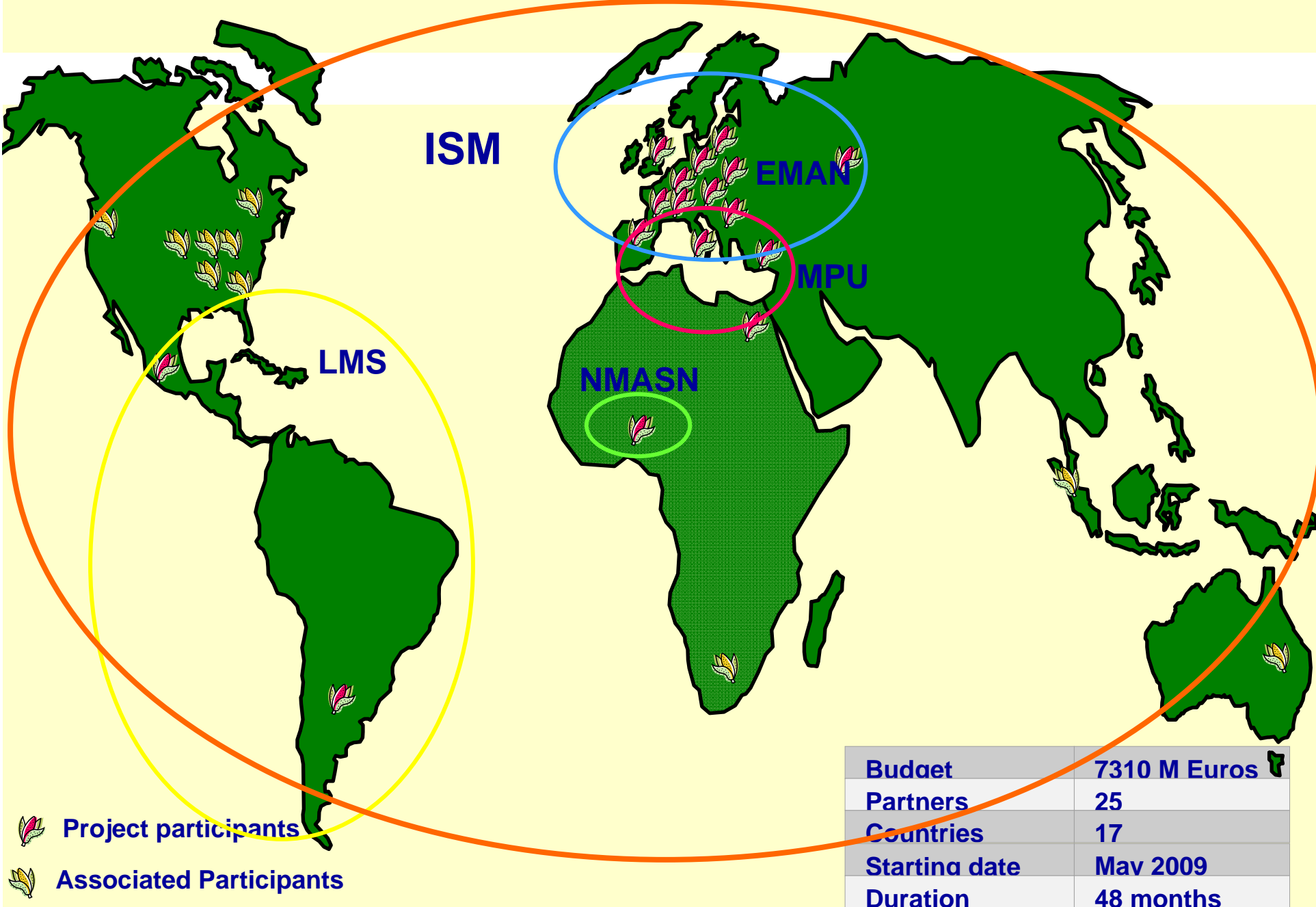


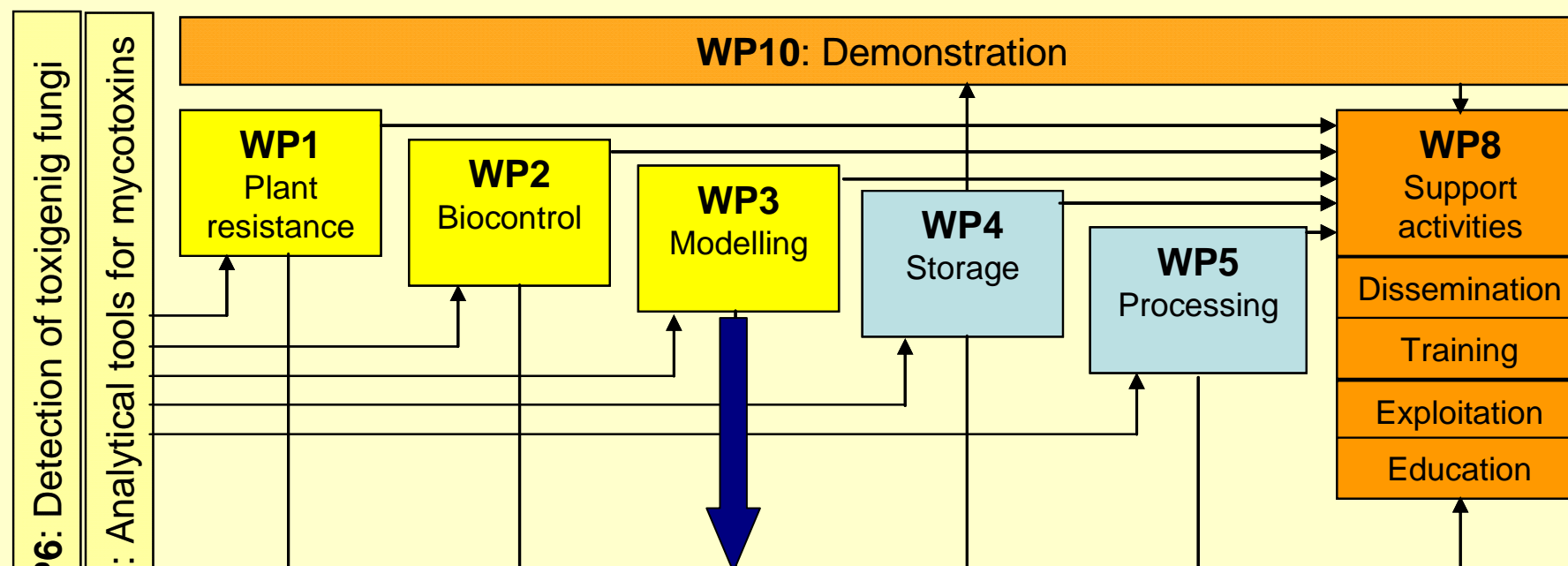
Novel, multidisciplinary and integrated strategies to reduce mycotoxin contamination in the food and feed chain worldwide

Overall objectives:

- to develop novel solution driven methodologies and handling procedures to reduce both pre- and post-harvest contamination in selected feed and food chains
- to generate and disseminate information and education strategies to reduce mycotoxin risks at a global level

The Consortium





WP3 - Modelling and development of Decision Support Systems

Key crops: small grain, maize, grapes, nuts

Modelling, predicting and mapping the emergence of aflatoxins in cereals in the EU due to climate change

MODMAP

Overall objectives:

- Develop predictive models for *A. flavus* and *A. parasiticus* and AFs production in maize, wheat and rice
- Identify data on climate change and generate climate change scenarios
- **Draw maps describing scenarios of fungal and AFs contamination in the selected crops in EU**



Thanks for your attention