

Towards an efficient management of *Fusarium*-toxins from field to silo: synthesis of Arvalis experiments

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Introduction

- ✿ **DON** : the most common Fusarium-toxin found in cereals produced in France and Europe
- ✿ **Zearalenon and fumonisines** : also in maize
- ✿ **Fusarium-toxins** : maximum levels will come into force on 1st july 2006 for human consumption
- ✿ Being under maximum levels = a new condition to accede to the market
- ✿ **Mycotoxins** : very stable compounds not degraded during processing
- ✿ **PREVENTION IS BETTER THAN CURE !**

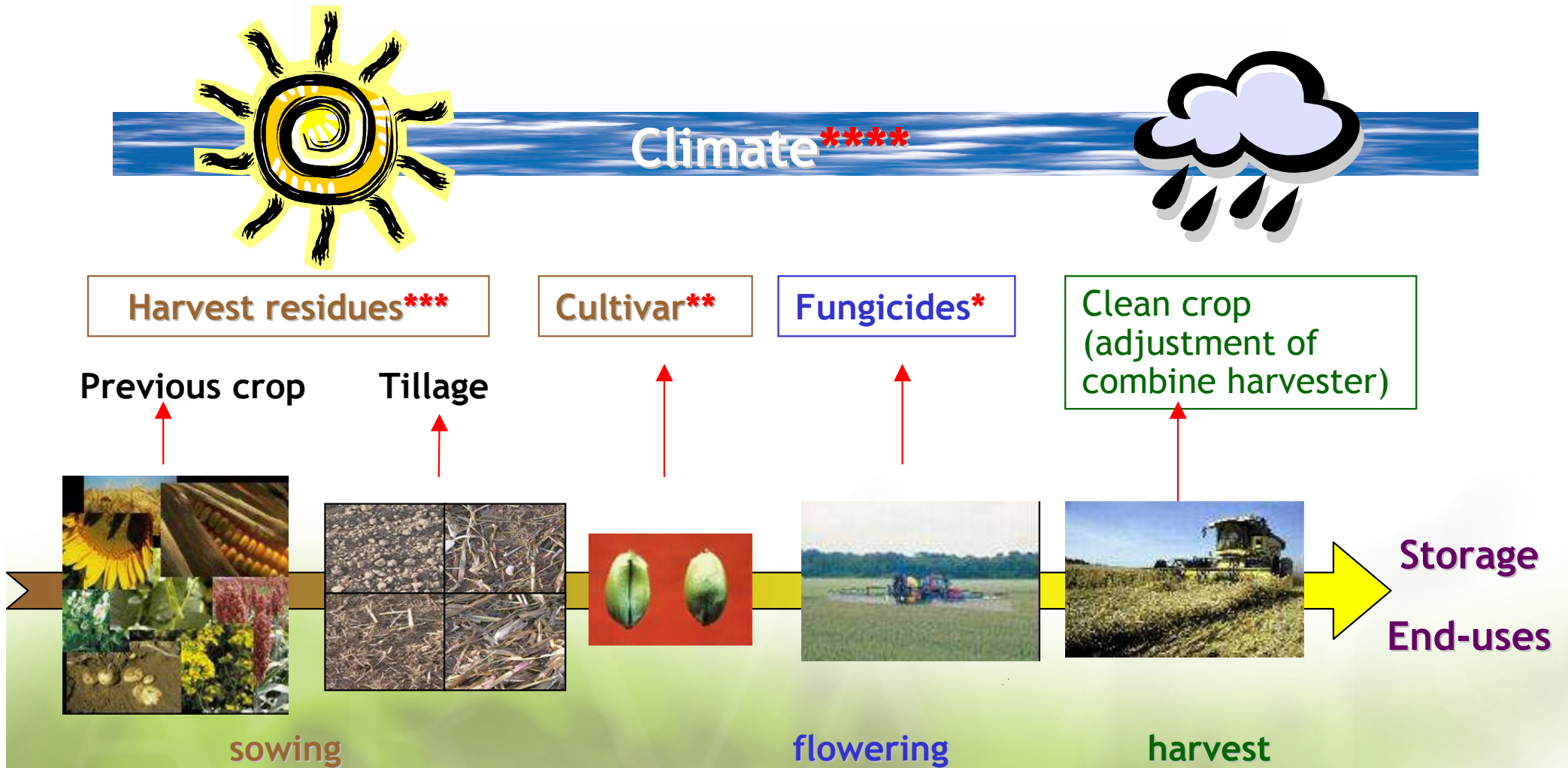
DON content ($\mu\text{g}/\text{kg}$) found in cereals in Europe

Barleys	N	% > 1000 $\mu\text{g}/\text{kg}$
Overall (EU)	627	0.0
Wheat	N	% > 1000 $\mu\text{g}/\text{kg}$
Overall (EU)	4753	4.3
Durum wheat	N	% > 1500 $\mu\text{g}/\text{kg}^*$
Overall (EU)	150	8.3
Maize	N	% > 1500 $\mu\text{g}/\text{kg}^*$
Overall (EU)	539	14.1

* estimated

SCOOP (2003)

DON contamination in wheat is plurifactorial

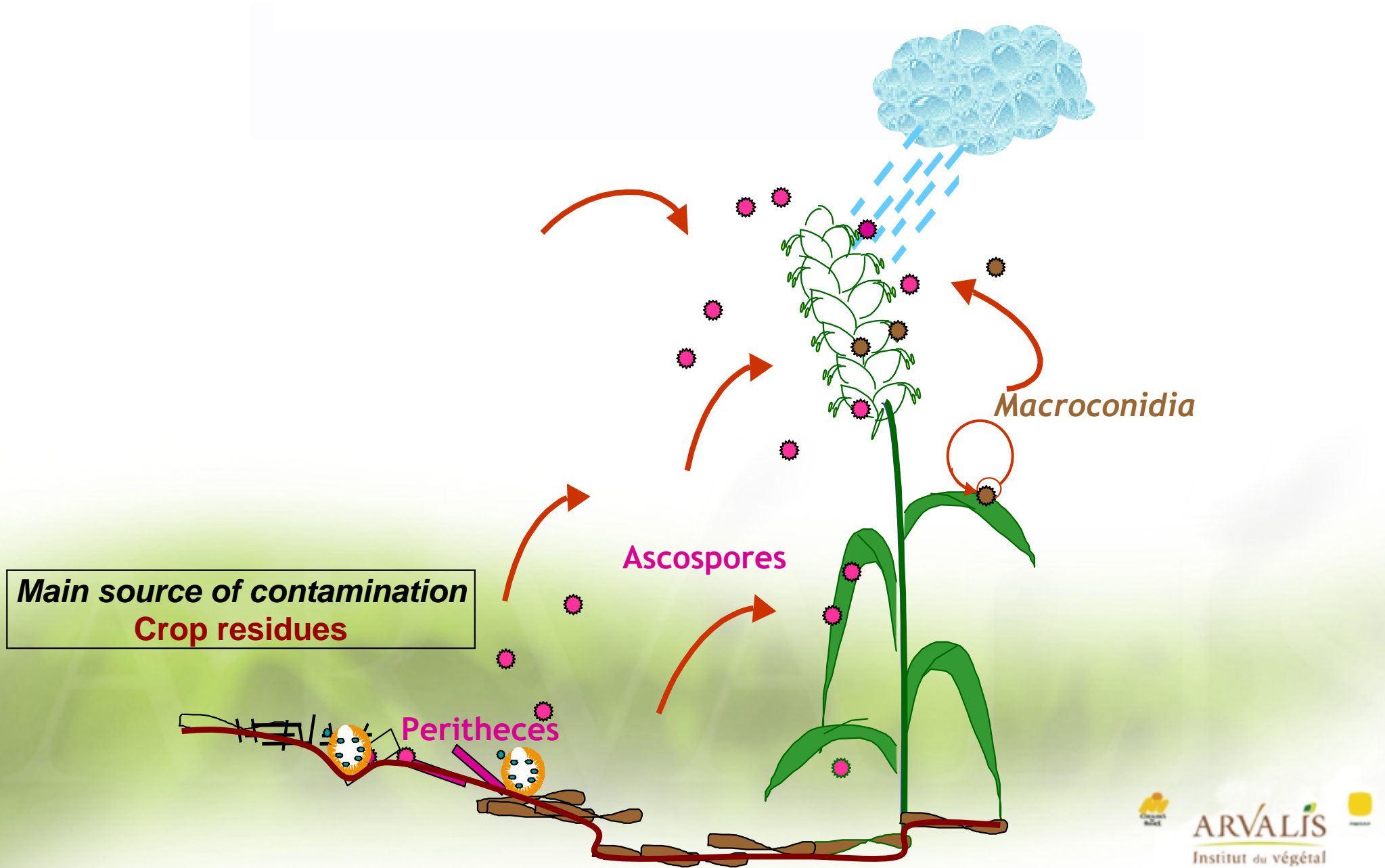


*Factors : from the highest (****) to the lowest (*) of importance*

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Crop residues are the main source of contamination

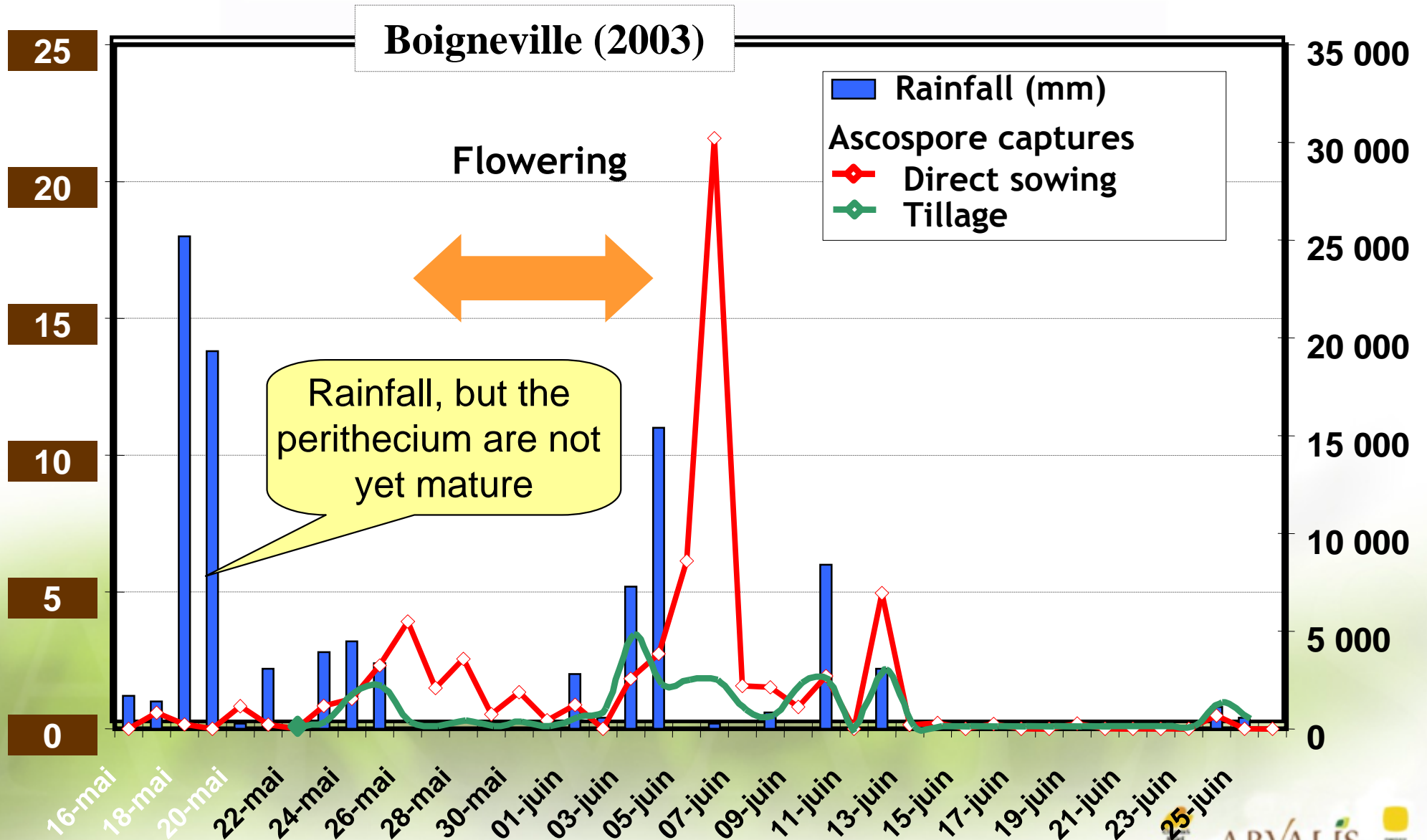


Collecting ascospores near heads

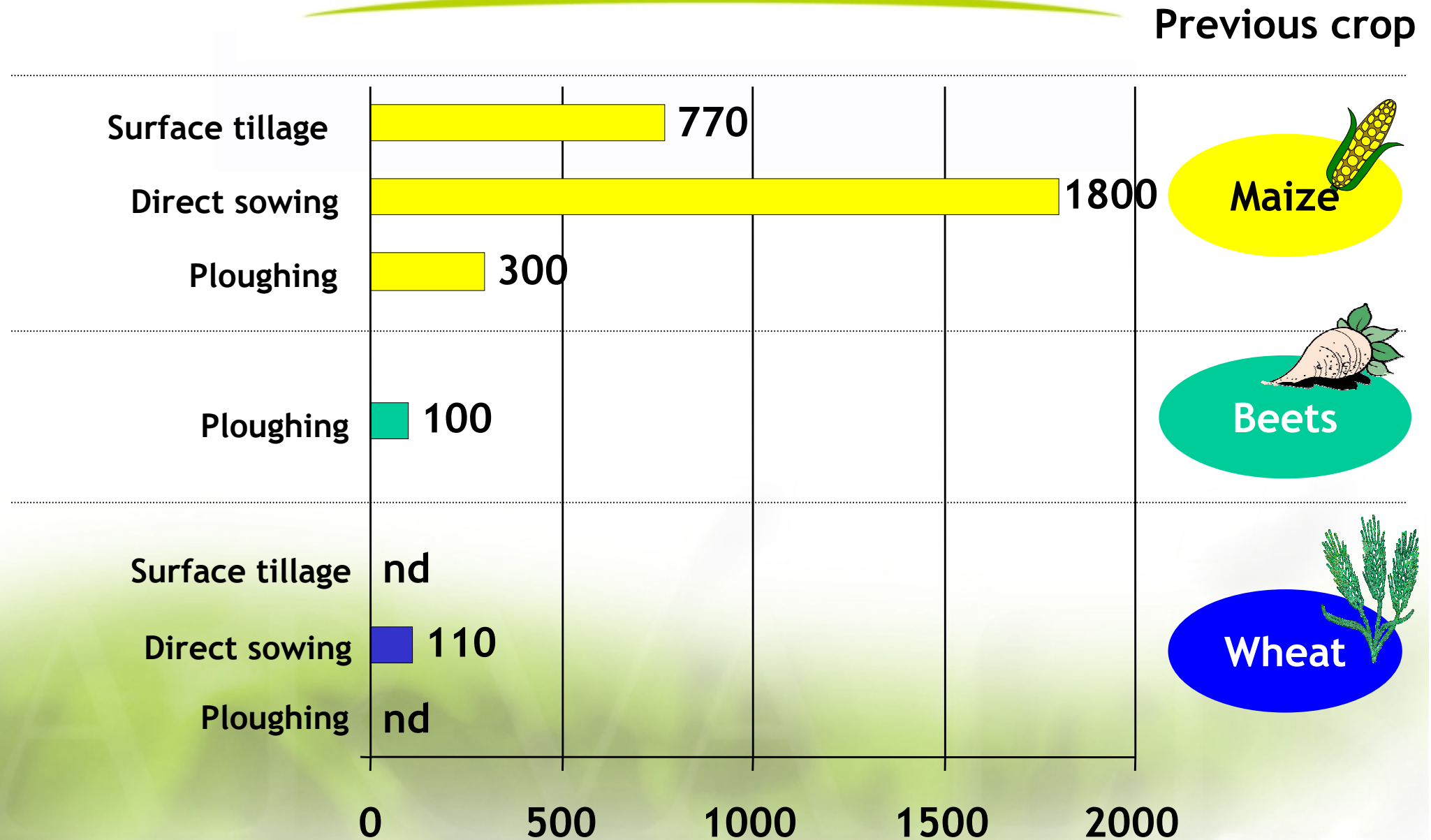


Ascospore captures in 2003 according to soil cultivation

Wheat - previous crop maize

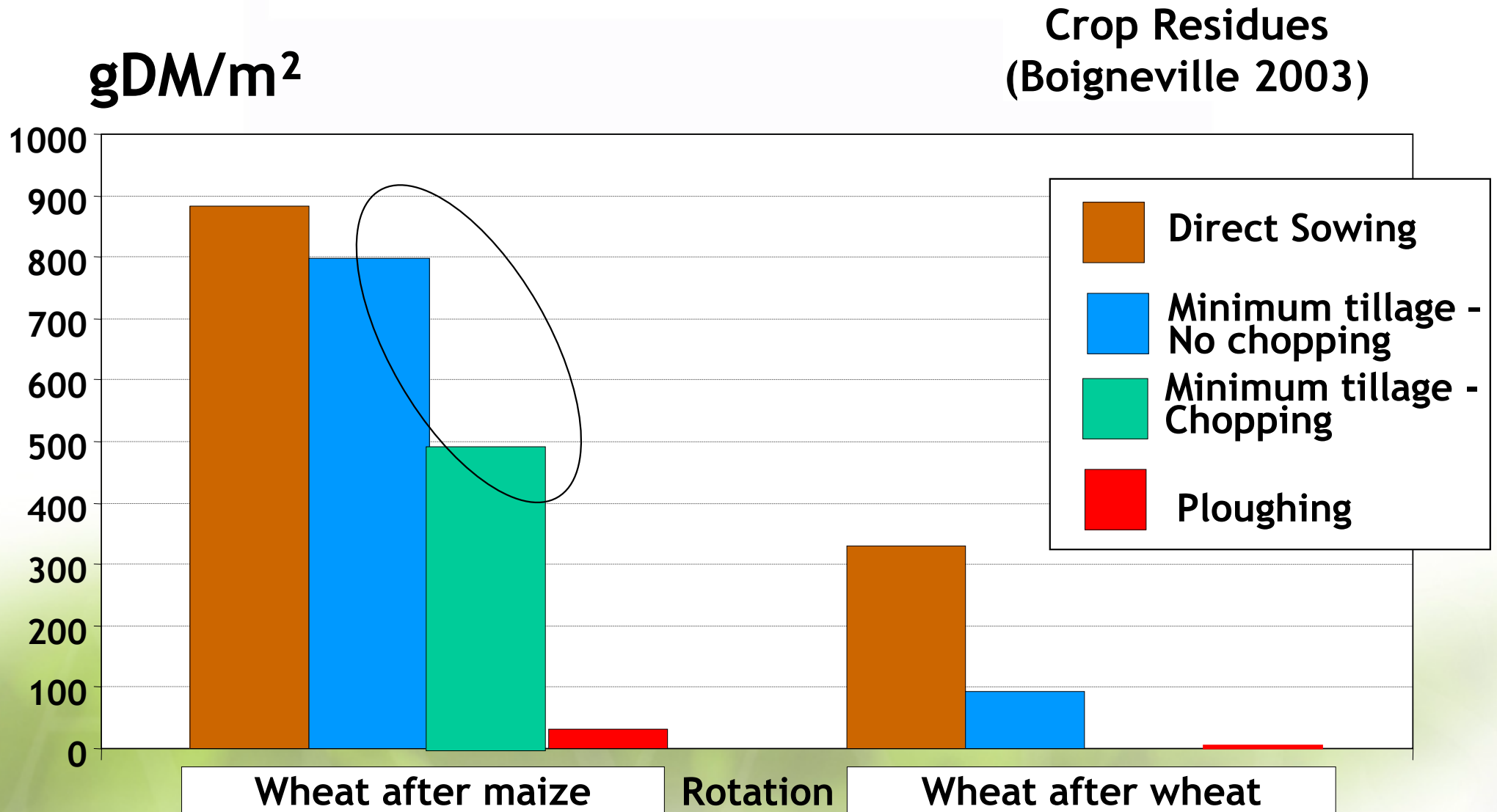


DON content ($\mu\text{g}/\text{kg}$) according to soil cultivation in wheat



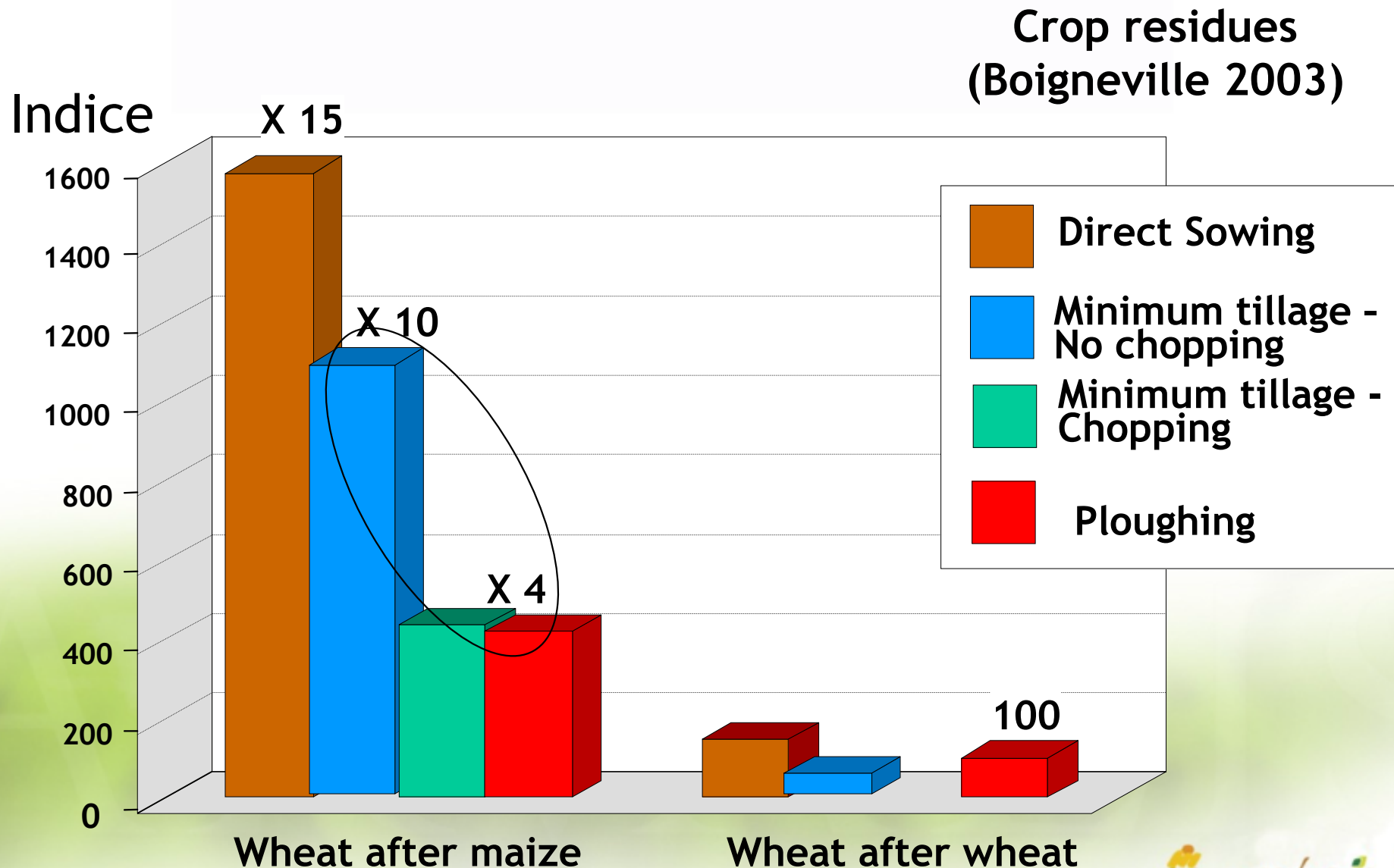
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Residues significance depending of the previous crop and the soil management



ARVALIS-Institut du végétal, 2003

DON content ($\mu\text{g}/\text{kg}$) depending of the previous crop and the soil management



ARVALIS-Institut du végétal, 2003

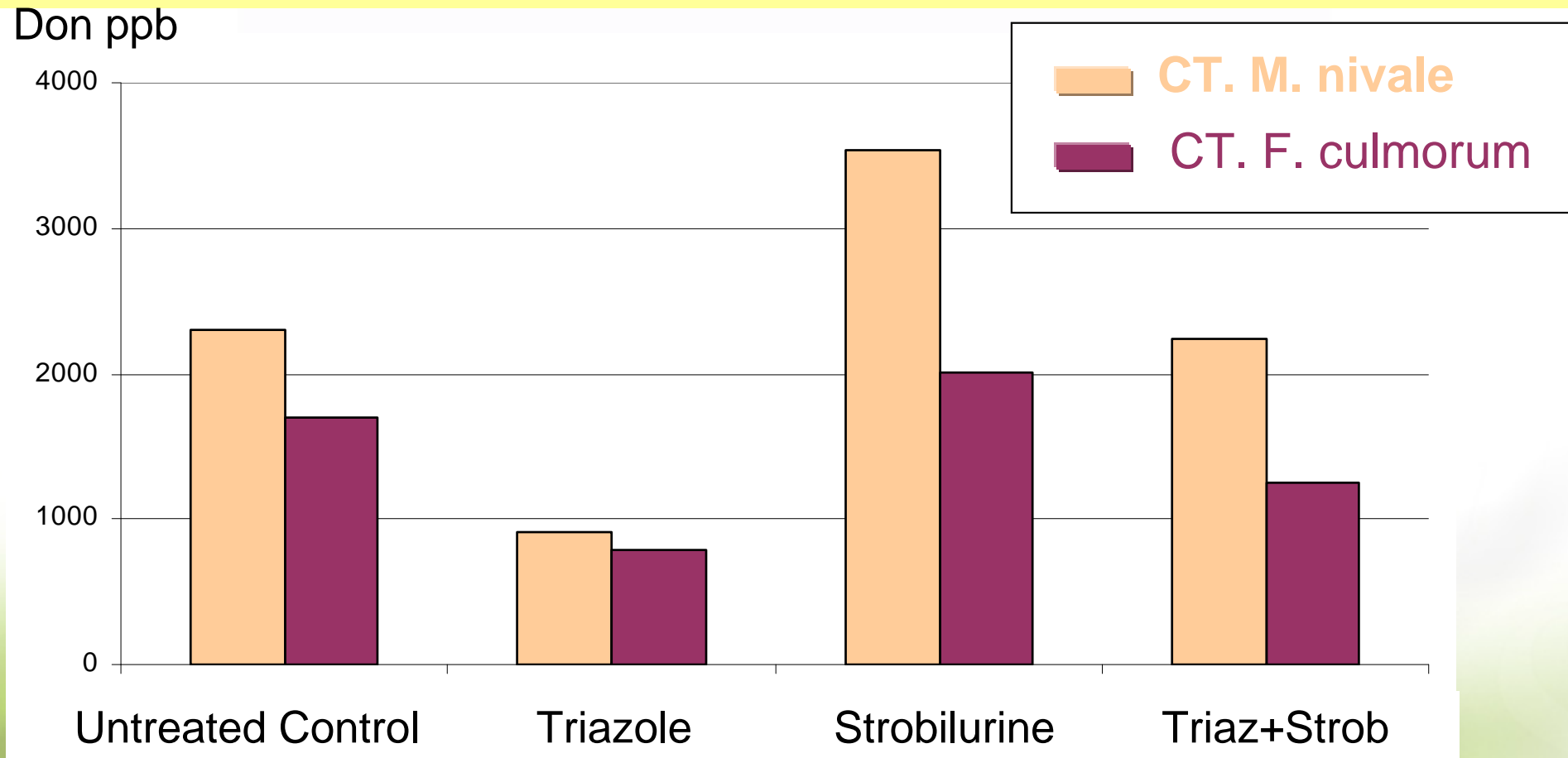


Susceptibility of wheat varieties to Fusarium head blight

Low susceptibility	7	MERCURY (HYNO-ESTA)				
		APACHE HYNO-QUINTA	COCKPIT (EPHOROS)	PARADOR (HYBRED)	RENAN	ORNICAR
Medium susceptibility	5	ANDALOU	ASTRAKAN	CATALAN	RUNAL*	SOISSONS*
		SPONSOR* (PERFECTOR)	(BOSTON*)	(AZIMUT)	(BALTIMOR)	(LIMES)
		CEZANNE	AZTEC	PYTAGOR		
		ALTRIA* RASPAIL* (ATTLASS) (QUEBON)	ORATORIO* (ACIENDA) (HYXO) (ROSARIO)	PR22R28* (ALCAZAR) (MELKIOR) (SANKARA)	FORBAN* (ALLISTER) (MENDEL) (SCORPION 25)	VIRTUOSE* (ASTUCE) (NIRVANA)
High susceptibility	3	CHARGER	EVEIL	PR22R20	QUATUOR	
		AUTAN* RECITAL* (EQUILIBRE)	CAPHORN* SEMAFOR* (INOUI)	ISENGRAIN* SHANGO* (TOISON D OR)	LANCELOT* (BASTIDE)* (VIVANT)	ORVANTIS* (TAPIDOR*)
		TREMIE*	ROYSSAC			

Effect of phytosanitary protection : triazole Triazole Fusarium/strobilurine

The use of strobilurines solo can increase the DON content



(3 trials with artificial contamination *M.nivale* and 5 trials with artificial contamination *F.culmorum*)

Agronomic factors and DON risk in wheat



Cereals,
rapeseed, flax,
pea, fababean,
sunflower



Beet, potato
soya, others



Maize, sorghum

Previous crop	Soil cultivation	Cultivar susceptibility	Risk and Recommendation
Cereals, rapeseed, flax, pea, fababean, sunflower	Ploughing	Low	1
		Middle	
		High	
Beet, potato soya, others	No Ploughing	Low	2
		Middle	
		High	
Maize, sorghum	Ploughing	Low	2
		Middle	
		High	3
Maize, sorghum	No ploughing	Low	4
		Middle	5
		High	6

Part of samples (%) above maximum levels for Fusarium-toxins in maize grain

DON - Maize	% > 1500 µg/kg*	% > 2000 µg/kg
OVERALL MEAN (EU)	14.1	6.3
Zearalenon - Maize	% > 200 µg/kg	
OVERALL MEAN (EU)	13.8	
Fumonisin - Maize	% > 2000 µg/kg	
OVERALL MEAN (EU)	4.1	

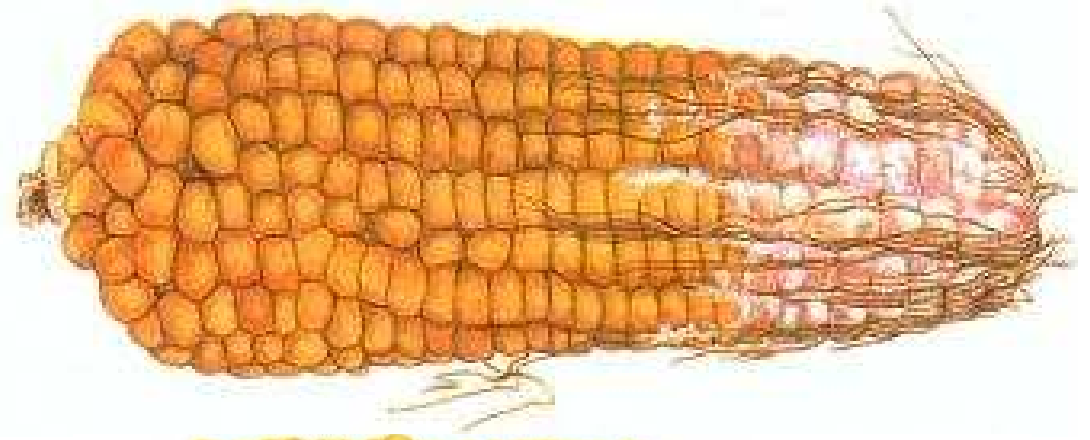
* estimated

From SCOOP report (2003)

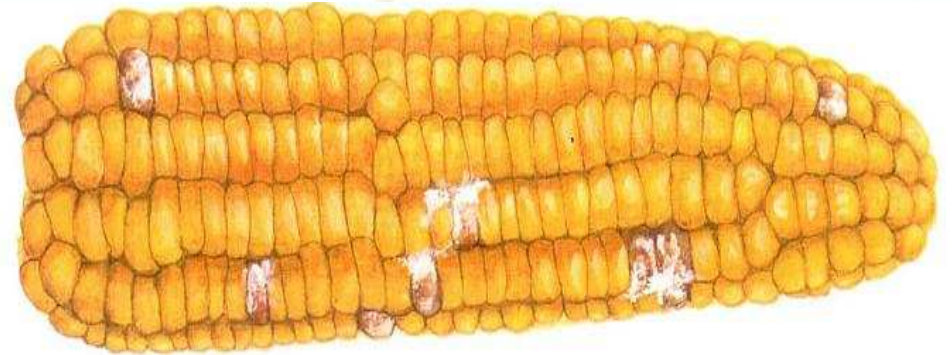
Data before 2003...

The two main Fusarium on maize ears

- *Fusarium graminearum*



- *Fusarium moniliforme*



- *Different contamination pathways*

- *Different developement conditions*

- *Competitiveness between the two Fusarium*

Contamination by insects

**European
Corn borer**
(2nd génération)



**SouthWest
Corn borer**



Héliothis



**Infection by
conidia
through
wounds
+
Spore-
carrying**



Risk factors of mycotoxin accumulation in maize



Cultivar :

- Adapted to local area
- Susceptibility

Rainfall at appearance of silks

Aim: harvest in October

Crop residues



European and SouthWest corn borer larvae

Harvesting / drying management



Storage
End-uses

Clean crop

Sowing

Flowering

Harvest

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Fusarium-toxin contamination on maize is plurifactorial



In addition of the factors identified on wheat:

- Climate
- Residues on soil (previous crops and tillage)
- Cultivar (susceptibility + adapted to local climate)



Supplementary factors:

- Insect larvae attacks
- Harvesting time
- Time between harvesting and drying

A network of farm field surveys in France

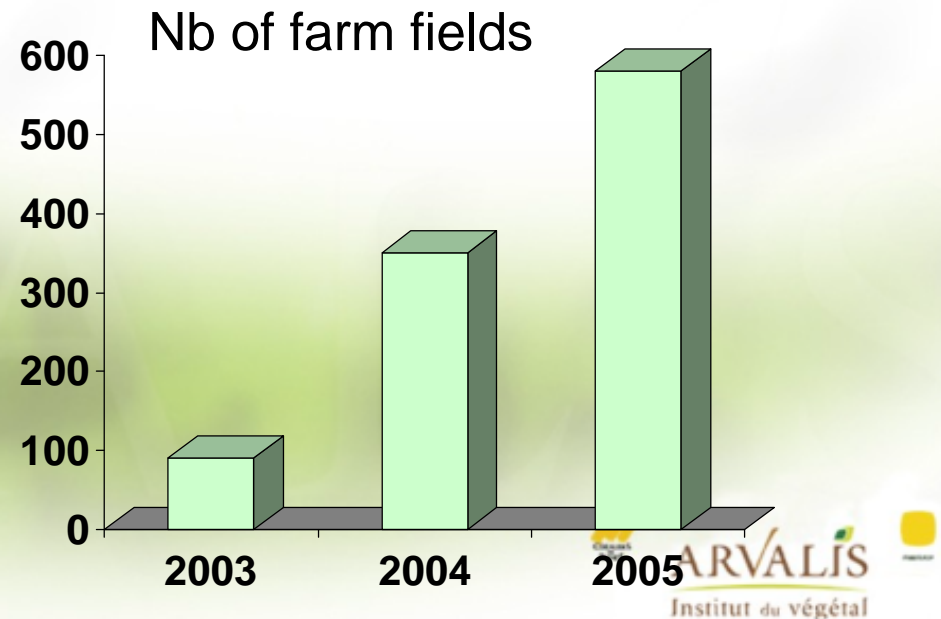
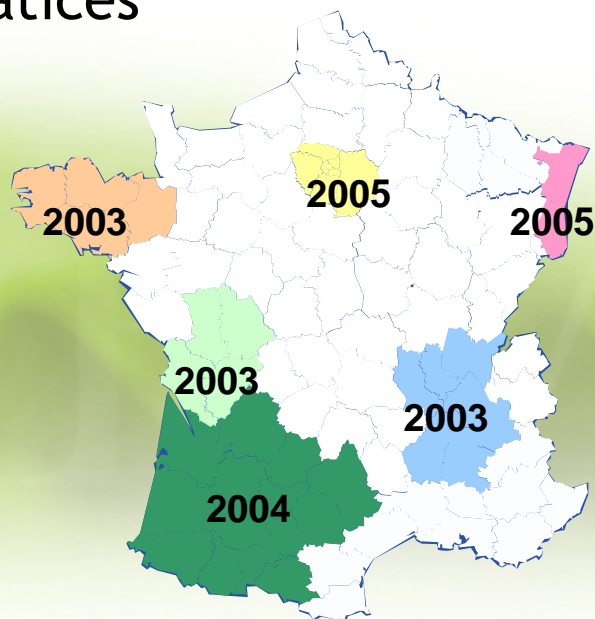
✿ Aims

Characterize the Fusarium-toxins contents (DON, fumonisins and zearalenone) of maize in collaboration with cooperatives and traders

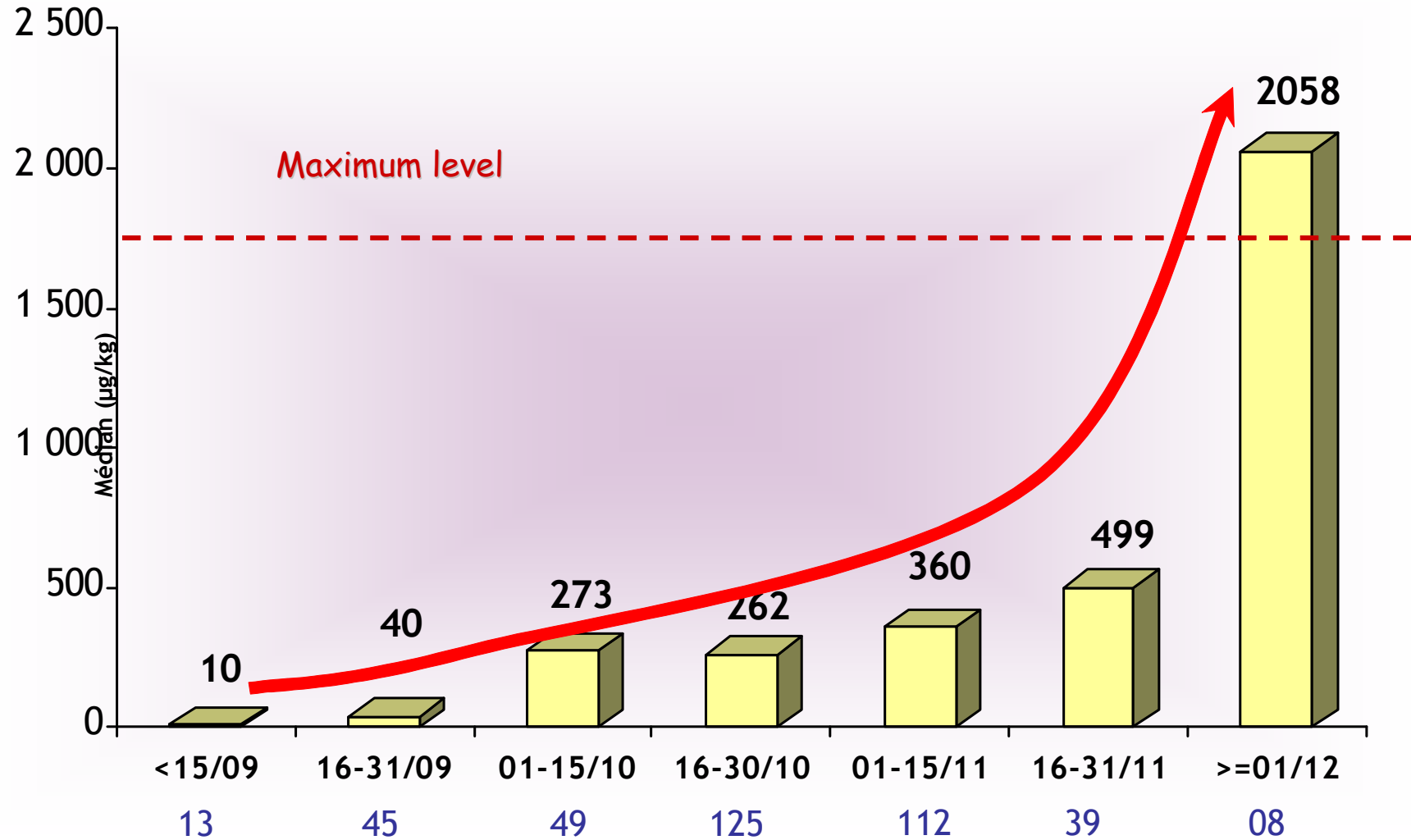
Analyse the situation of each region

Identify involved factors, weight these factors and study the interactions

Improve knowledge, identify the actions of prevention and disseminate good practices

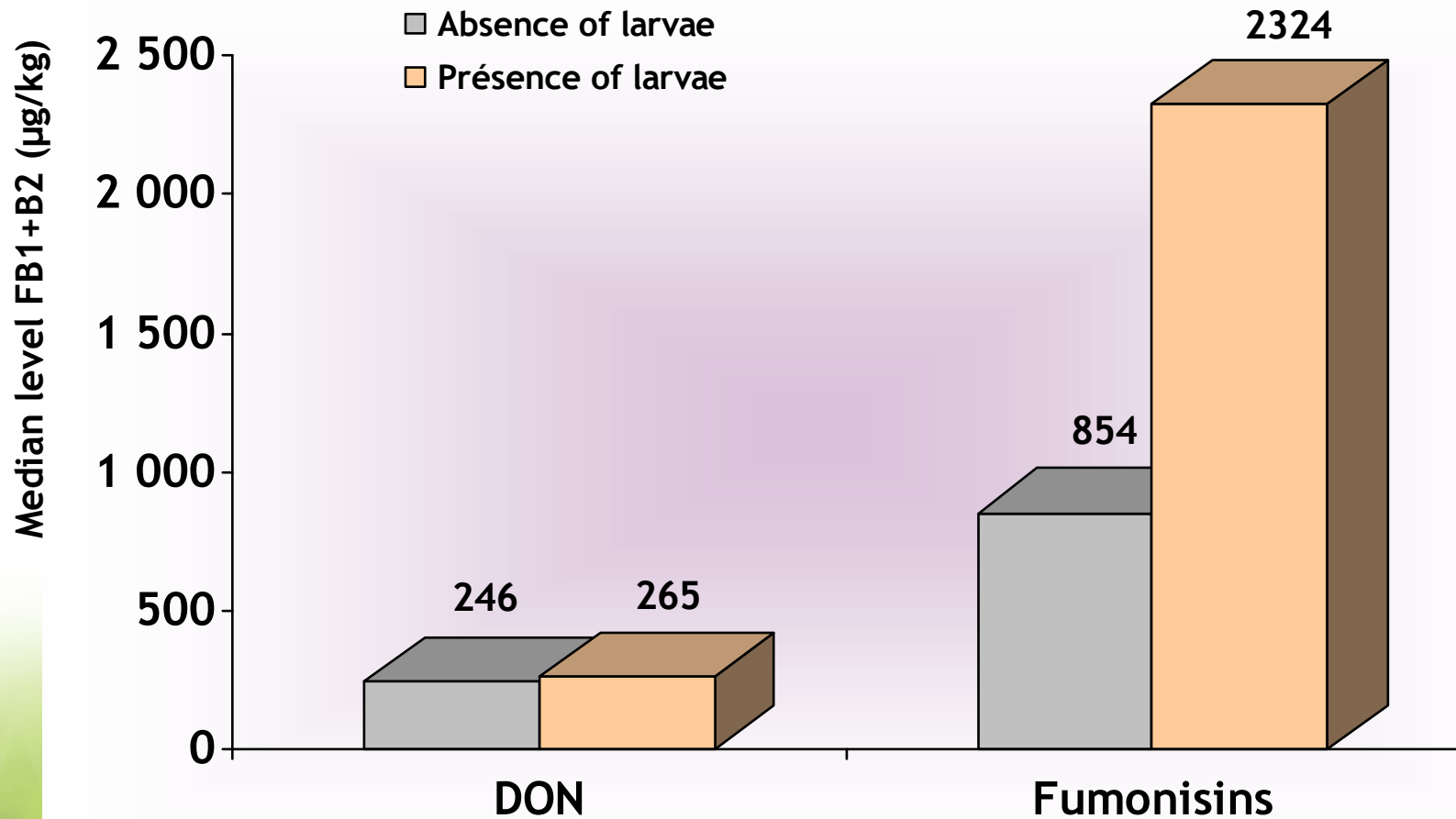


Effect of harvesting time on DON



From Arvalis field surveys – 391 data

Influence of European corn borer on fumonisins

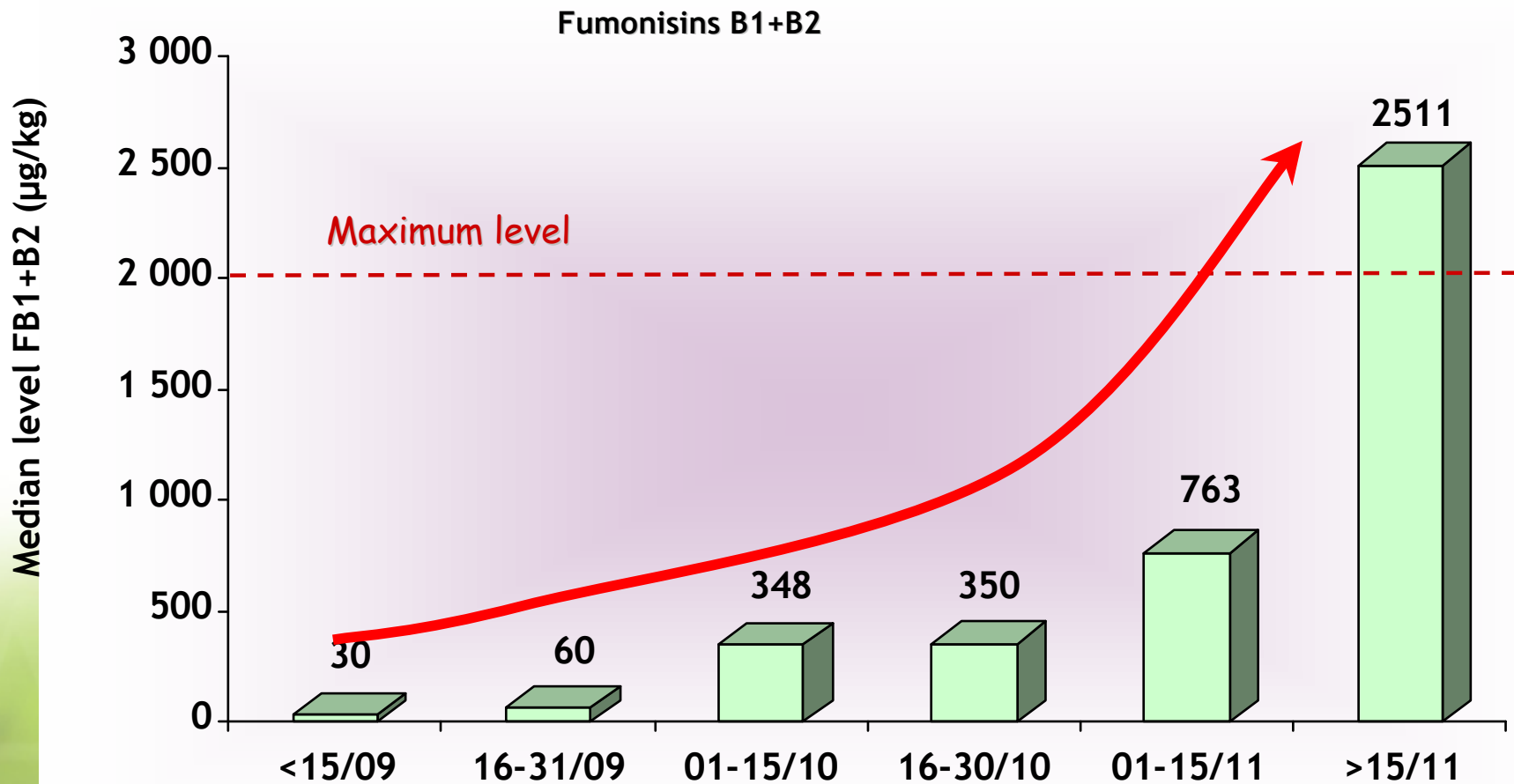


From ARVALIS-Institut du végétal 2004 field surveys –

122 data

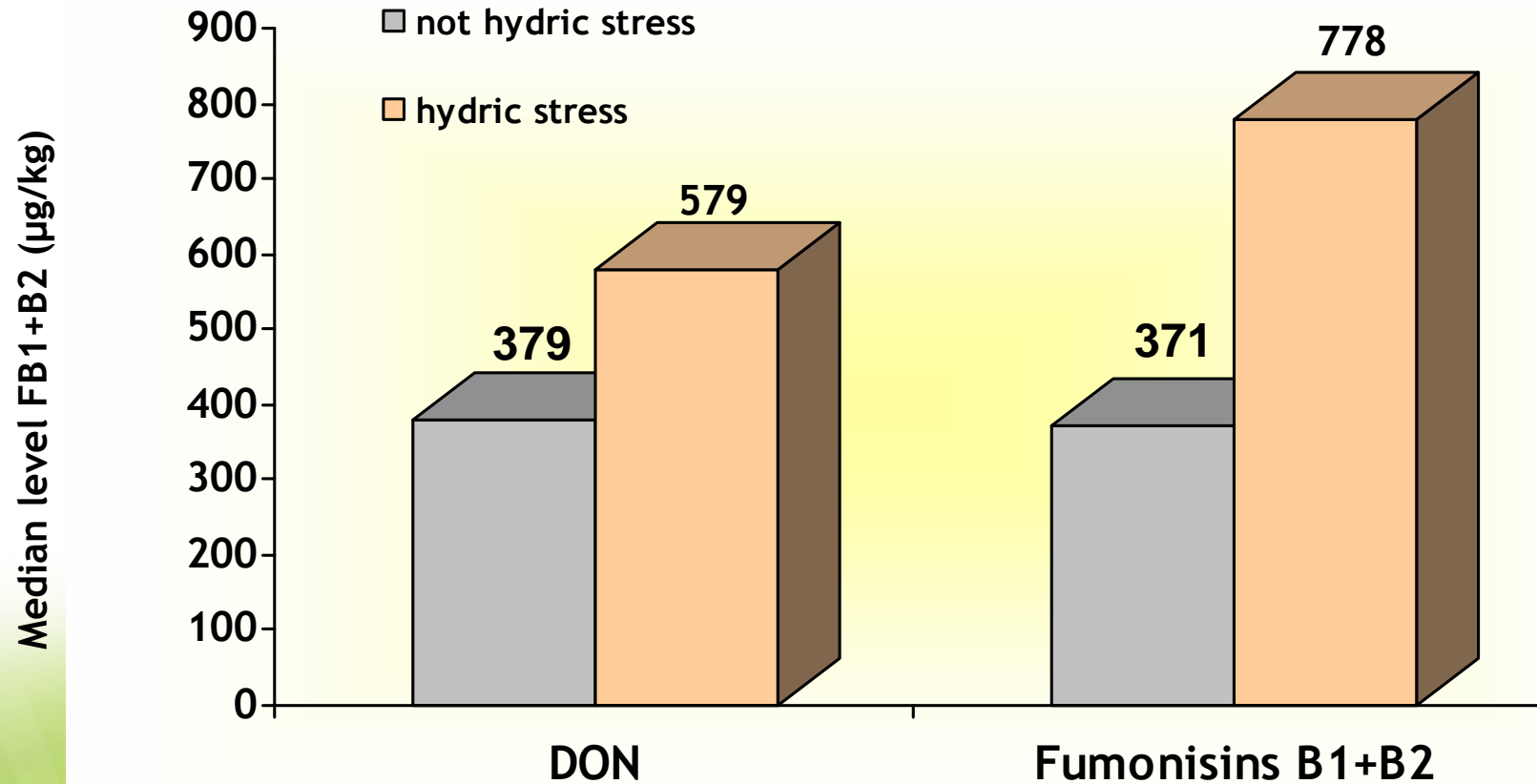


Effect of harvesting time on fumonisins (absence of borer larvae)



From ARVALIS-Institut du végétal 2004 field surveys – 105 data

Hydric stress of maize and mycotoxins



ARVALIS-Institut du végétal 2004 field surveys – 124 data

Identification and weight of different factors

■ DON

■ Fumonisins

+++

Harvesting time

Insects
(European Corn borer)

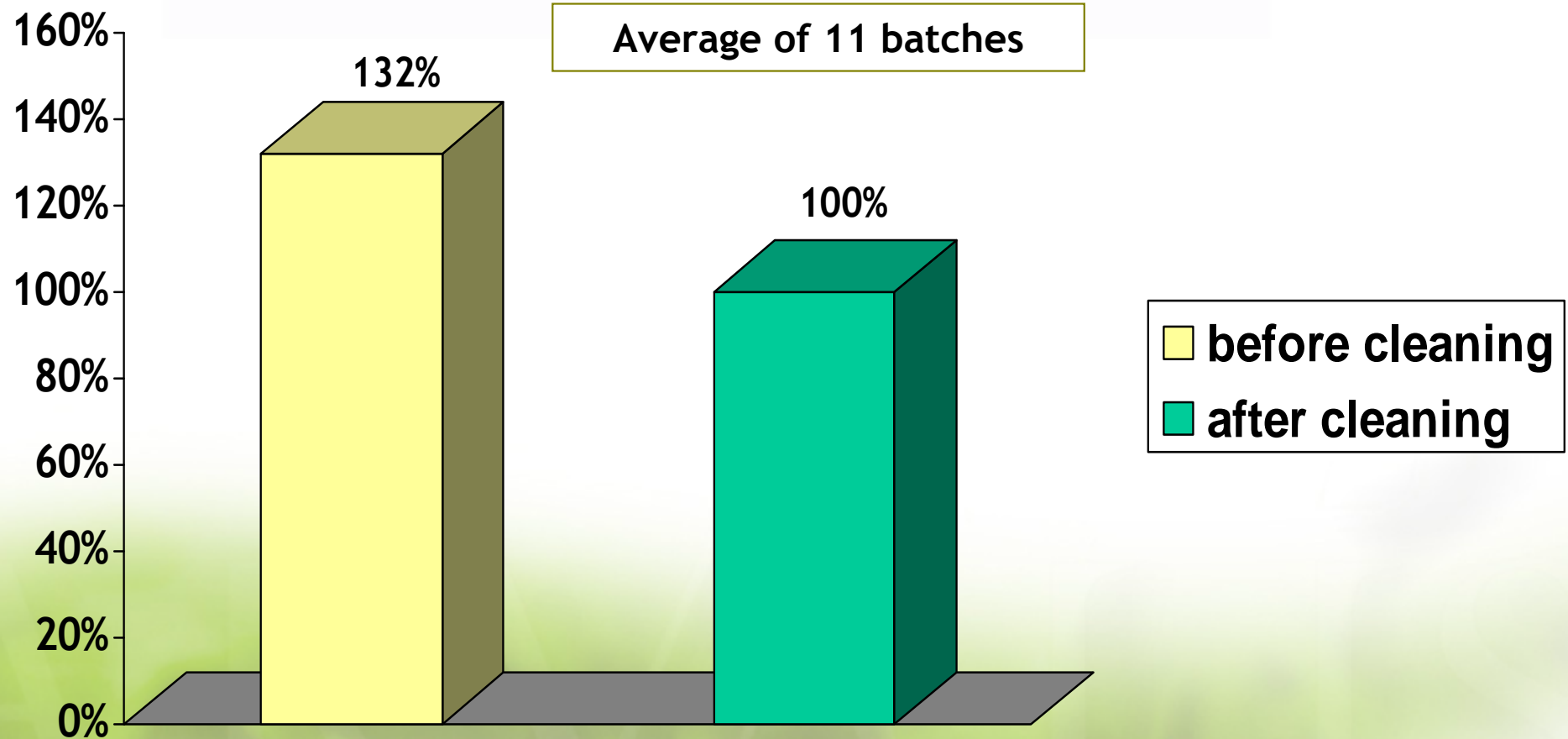
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Harvest residues processing
Cultivar susceptibility

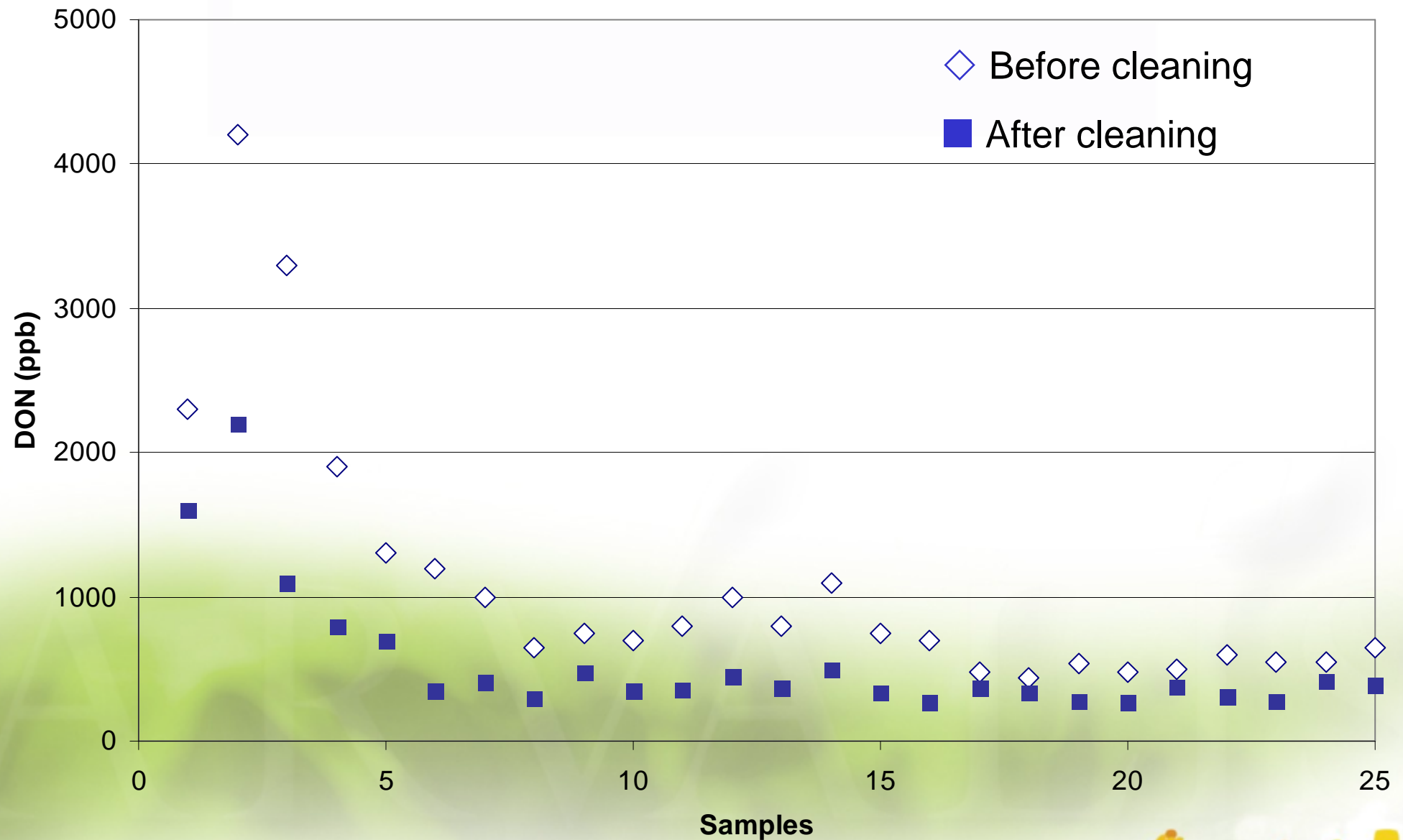
Harvesting time
Hydric stress
Harvest residues processing

Very difficult to control them...

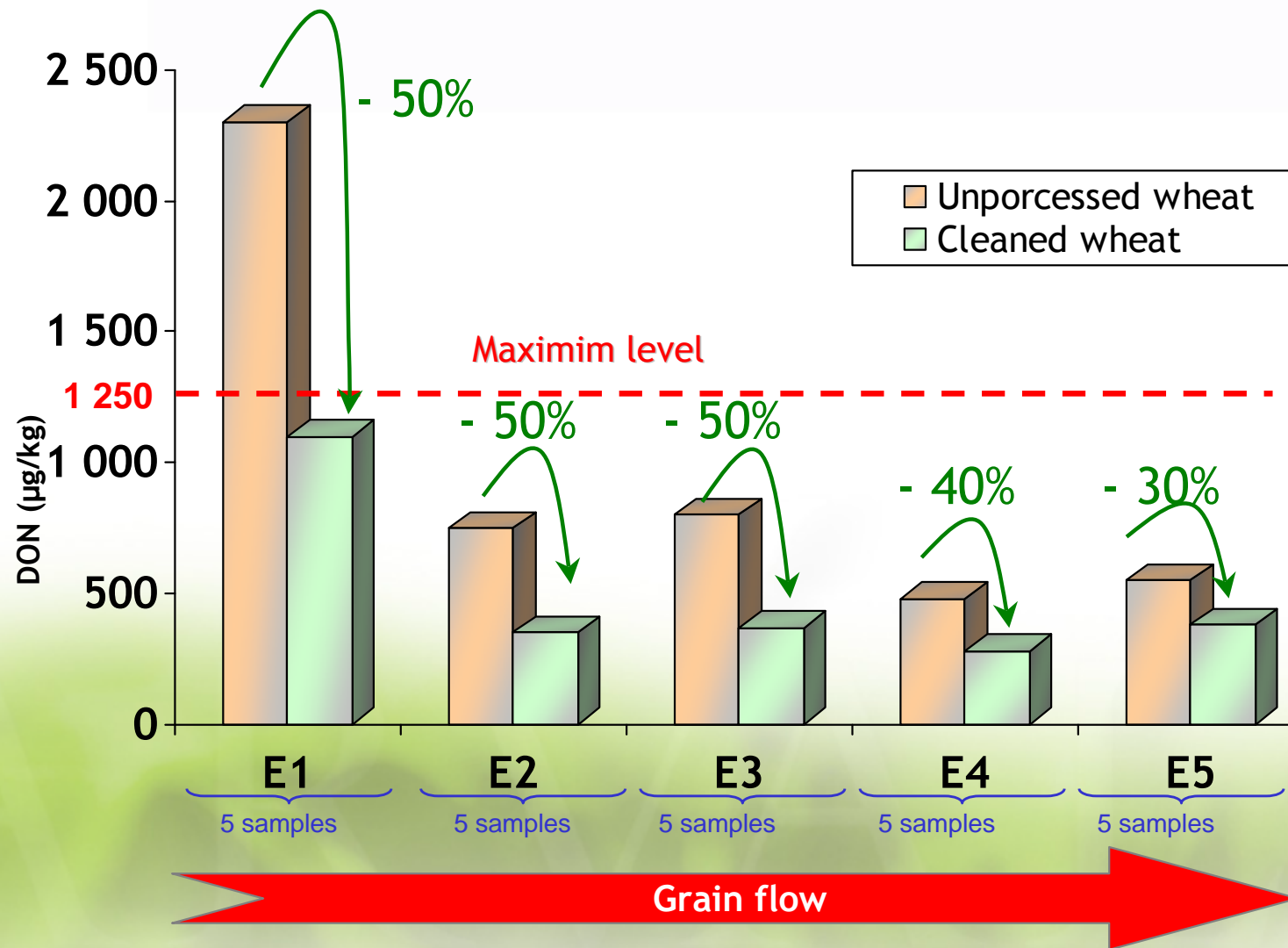
Effect of cleaning on DON content in wheat



Influence of cleaning on DON content (2 x 25 samples)



The higher the contamination the higher the efficacy of cleaning



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Conclusions

- ✿ The question of Fusarium-toxins remains complex. Necessity of an integrated approach. Avoid accumulation of several risk factors
- ✿ Influence of climate is essential. The first agro-climatic models proposed for wheat will enable to assess DON contamination before harvest
- ✿ Situation is more complex for maize, with 3 toxins, supplementary factors involved, fewer data available, and incomplete solutions
- ✿ Resolve apparent conflicts between advices (annual ploughing vs minimum tillage for environmental considerations...)
- ✿ Reinforce communication addressed to farmers