Summary

Fusarium ear blight (*Fusarium* spp.) is seen as an increasing problem in many parts of Europe. The disease is of major concern due to the production of mycotoxins by the fungi involved. It is a disease which is highly linked to crop rotation and tillage methods. The risk is particularly high in regions where maize is a widely grown crop in the rotation and reduced or minimum tillage is practiced.

Genetic resistance is available with effective levels of control available in some cultivars. Application of good agricultural practices can help significantly to keep the disease and mycotoxin levels low. In seasons with high rainfall levels during flowering combined with high risk situations (normally maize and minimal tillage) specific fungicide programmes need to be applied during flowering.

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About ENDURE

ENDURE is the European Network for the Durable Exploitation of Crop Protection Strategies. ENDURE is a Network of Excellence (NoE) with two key objectives: restructuring European research and development on the use of plant protection products, and establishing ENDURE as a world leader in the development and implementation of sustainable pest control strategies through:

> Building a lasting crop protection research community

> Providing end-users with a broader range of short-term solutions

> Developing a holistic approach to sustainable pest management

> Taking stock of and informing plant protection policy changes.

Eighteen organisations in 10 European countries are committed to ENDURE for four years (2007-2010), with financial support from the European Commission's Sixth Framework Programme, priority 5: Food Quality and Security.

Website and ENDURE Information Centre

www.endure-network.eu

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From Science to Field
Wheat Case Study – Guide Number 2

Strategies to Control *Fusarium* Ear Blight and Mycotoxin Production in Wheat

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diversifying crop protection

Food Quality and Safety
SIXTH FRAMEWORK PROGRAMME

Strategies to Control *Fusarium* Ear blight and Mycotoxin Production in Wheat

Fusarium ear blight is an increasing problem in many parts of Europe, and understanding the factors which influence the severity of the attack is key

Fusarium ear blight (*Fusarium* spp.) is seen as an increasing problem in many parts of Europe, including Germany, France, Denmark, Italy and Hungary. The disease is of major concern due to the production of several mycotoxins by the fungi involved which pose a threat to the health of both humans and animals.

There are several species of *Fusarium* that affect wheat, the main species being *F. avenaceum, F.culmorum, F. graminearum, F. poae* and *F. langsethiae*. *Microdochium nivale* and *M.majus* also affect wheat and may cause ear blight. However, *Microdochium* species do not produce mycotoxins; they are the main cause of seedling blight. Often several species can infect the same ear and the severity of attack depends mainly on weather conditions during flowering and a combination of agricultural factors.

Manipulating the agricultural factors can contribute strongly to reducing this risk, without the need for fungicides. Fungicides applied to the ear during flowering can reduce the incidence and severity of *Fusarium* ear blight but in high-risk seasons high levels of control are unlikely.

Typical symptoms of infection by *F. graminearum* and *F. culmorum*
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Fusarium mycotoxins

Fusarium mycotoxins are toxic chemicals produced by some species of *Fusarium* which attack the ears of wheat and other cereal crops. *Fusarium* mycotoxins are produced in the field as part of the fungal colonisation of the ear and rarely increase after harvest.

Infection of ears by *Fusarium* species occurs when the weather conditions during flowering are warm and wet. Wheat crops infected at flowering often have individual bleached spikelets or partially bleached ears, resulting in pink or chalky-white shrivelled grains at harvest.

Levels of ear blight seen in the field do not always correlate with mycotoxin occurrence. Legal limits exist for *Fusarium* mycotoxins (deoxynivalenol (DON) and zearalenone) in wheat intended for human consumption (see table 1) and there are guidance limits for grain for feed (see table 2).

Table 1: Legal limits for mycotoxins (ppb) in grain intended for human consumption.

	DON	Zearalenone
Unprocessed soft wheat and barley	1250	100
Unprocessed durum wheat and oats	1750	100
Flour	750	75
Finished products	500	50
Infant food	200	20

Table 2: European Union guidance on mycotoxin levels (ppb) in grain intended for animal feed.

	DON	Zearalenone
Feed grains	8000	2000
Complete feedstuffs for - Pigs - Calves, Lambs and Kids	 900 2000	 250 (100*) 500

* Feed intended for piglets or gilts

Reducing the risk of *Fusarium* by management

The risk from *Fusarium* is strongly linked to crop rotation and tillage methods. The risk is particularly high in regions where maize is a widely grown crop in the rotation. Direct drilling and reduced tillage leaving debris on the surface as a source of inoculum at field level also increase the risk of fusarium ear blight.

Figure 1 (overleaf) illustrates that maize as the preceding crop strongly increases the risk of DON-contamination in the following wheat crop. Minimal or reduced tillage increases this risk still further. Conversely, ploughing can significantly reduce the risk, even when maize is the previous crop. In some countries wheat after wheat in combination with minimal tillage has also been found to increase the risk of *Fusarium* ear blight.

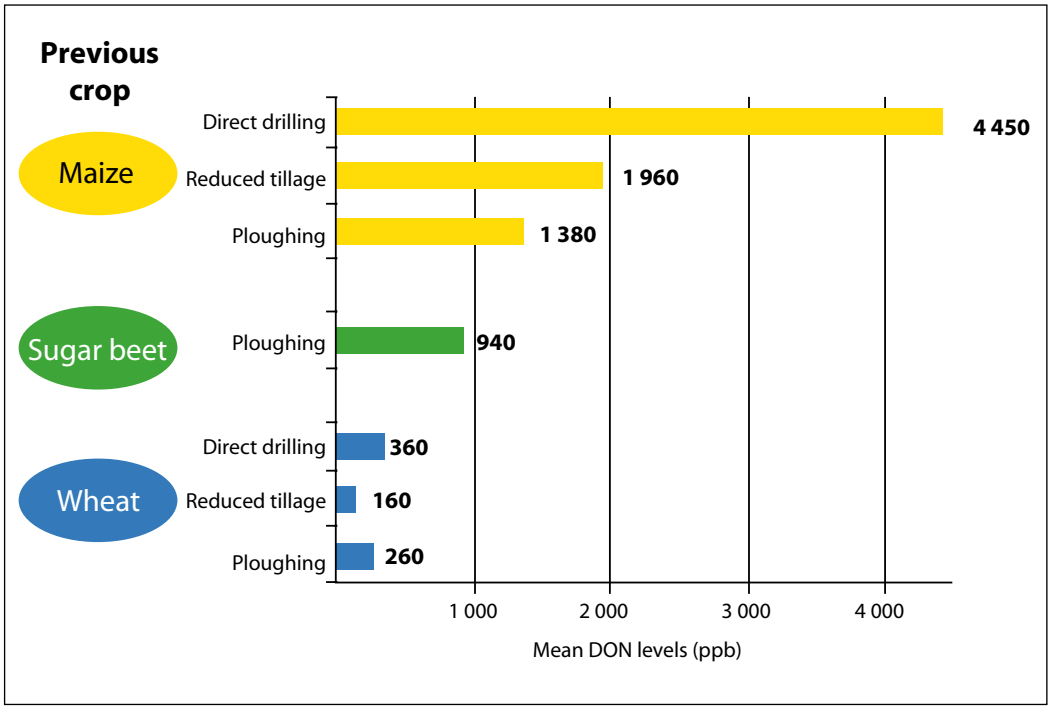

Figure 1: Mean DON levels for different preceding crops and tillage practices in Boigneville, France, from 1999-2004. (Source: Arvalis, France)

Reducing the risk of *Fusarium* by choice of cultivar

No cultivar gives 100% control of *Fusarium* ear blight but cultivars with high levels of resistance are available. So cultivar resistance to *Fusarium* ear blight is a key factor when trying to minimise the risk of mycotoxins in grain. DON levels from the most susceptible to the most resistant cultivar can be reduced by a factor of three (see figure 2). Several countries rank each year the relevant cultivars for susceptibility to *Fusarium* ear blight (see figure 3).

Resistant cultivars may become infected in situations with high disease pressure and even where fungicides are applied to the ear, infection can still result. Thus, under high disease pressure (crop following maize, minimum tillage, wet weather during flowering) resistant cultivars will not be sufficient to give high levels of control. Equally, under similar conditions, fungicides alone will not give high levels of control.

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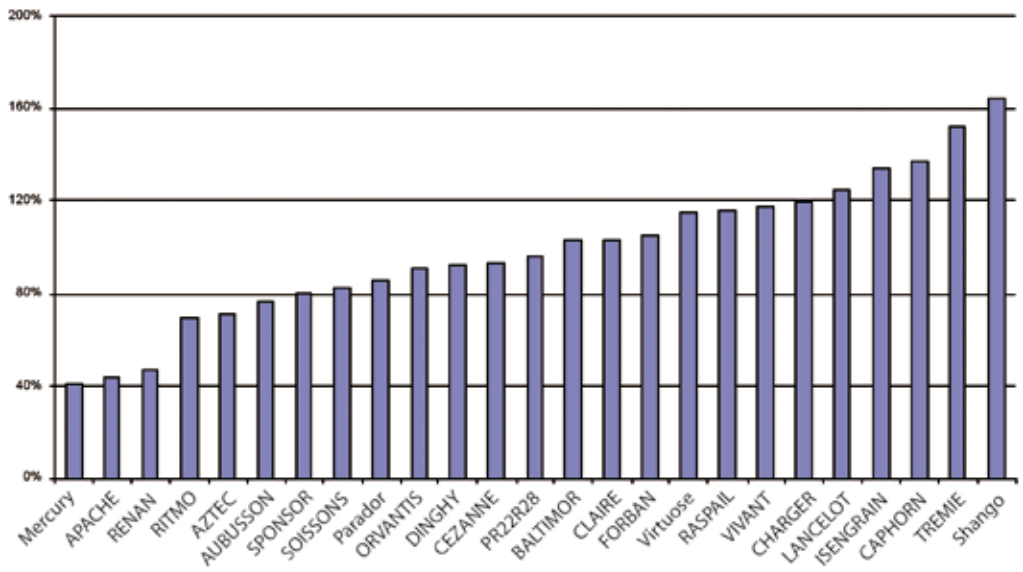

Figure 2: Mean levels (over six trials, 2001-2004) of DON accumulation in cultivars as % of the median value (Source: Arvalis, France).

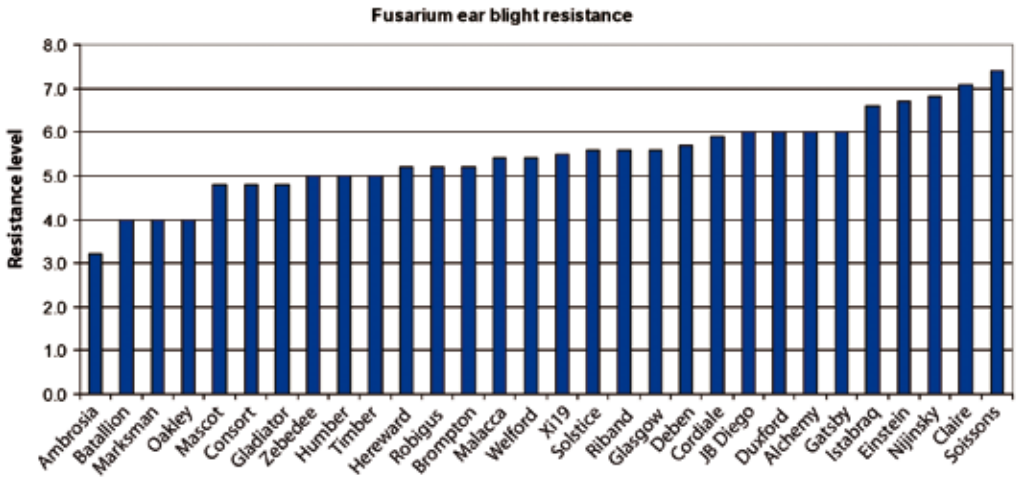

Figure 3: Resistance to *Fusarium* ear blight. A high figure equates to low levels of disease. (Source: HGCA Recommended List 2008, UK).

Decision key for *Fusarium* risk assessment

The risk of *Fusarium* ear blight and mycotoxin production can be estimated in a number of ways and several published risk tools exist in different European countries. The common high–risk factors in each of these risk tools are the inclusion of maize in the rotation, particularly as the preceding crop, reduced or minimal tillage and rainfall during flowering.

The risk of *Fusarium* ear blight can normally be reduced by adjusting crop rotation, tillage methods and choice of resistant cultivars. If for various reasons these factors cannot be adjusted there can be a need for fungicide treatment to minimise disease levels. Application of fungicides are most effective during flowering but even at high doses they generally give only 50-60% control.

An example of a decision key in evaluating the risk level for DON in a given field is given in figure 4. In this example we can see that a combination of agricultural practices can drastically reduce the DON risk without the use of fungicides. The quantification of these risk levels is represented in figure 5. In some European countries wheat after wheat in combination with no ploughing also gives rise to an increase risk of *Fusarium* ear blight.

DON risk assessment grid on wheat ARVALIS-Institut du végétal 2008

Previous crop	Tillage	Varietal susceptibility	Risk category						
Cereals, oilseed rape, flax, peas, beans, sunflowers	Ploughing	Low susceptibility	1						
		Medium susceptibility	1						
		Susceptible			2b				
	No ploughing	Low susceptibility		2a					
		Medium susceptibility		2a					
		Susceptible			2b				
Sugar beet, potatoes, soya, others	Ploughing	Low susceptibility		2a					
		Medium susceptibility		2a					
		Susceptible			2b				
	No ploughing	Low susceptibility		2a					
		Medium susceptibility		2a					
		Susceptible				3			
Grain maize, sorghum *(forage maize)*	Ploughing	Low susceptibility		2a					
		Medium susceptibility		(2a)	2b				
		Susceptible				3			
	No ploughing	Low susceptibility				(3)	4		
		Medium susceptibility					(4)	5	
		Susceptible						(5)	6

Figure 4: Decision key for DON risk (Source: Arvalis, France)

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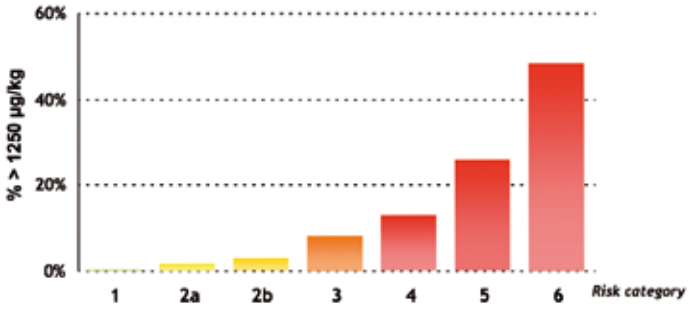

Figure 5: Risk percentage of exceeding the DON legal limit for each risk category (1902 fields surveyed from 2001 to 2008). (Source: Arvalis, France)

Grain sampling procedures for testing

It is good practice to sample every trailer load coming into a store, taking samples of at least 1kg. Composite samples, representing a given bulk, can be obtained by thoroughly mixing individual samples. Such samples are used for a range of purposes including moisture and quality assessments.

Effective sampling for mycotoxins is essential as the distribution is not likely to be uniform within a stored bulk. If composite samples were not obtained as the store was loaded, it is important to take as many sub-samples of the bulk as possible to obtain a representative aggregate sample. For official control purposes, one hundred incremental 100g sub-samples are taken from any lot exceeding 50 tonnes (Commission Regulation 401/2006).

Typical life cycle of *Fusarium* species in wheat.