

## Fate of *Fusarium* Mycotoxins in Cereal Food Chain



**Fusarium Forum**  
**13<sup>th</sup> Jan 06**

Dr Clare Hazel



### Agenda



#### Project Overview

- Objectives
- Funding
- Participants
- Timescales

#### Workstreams

- Progress to date

#### Summary



Better foods for a better life

## Project Background

UK recognised that:

- *Fusarium* mycotoxins do occur in UK and imported cereals
- Prevention of occurrence would be the best scenario but very difficult with “field origin” mycotoxins
- Significant gaps in our knowledge e.g.
  - Fate in full scale commercial processing
  - Breakdown products, hidden metabolites and toxicological significance

Better foods for a better life

## Overall Project Aim

- To assist UK Industry in the management of key mycotoxins in the cereal processing chain so as to best comply with future regulation and reduce the exposure of consumers to these contaminants

Better foods for a better life



•UK Government supporting the studies of the factors that affect toxin levels at each process stage in laboratory and pilot scale studies and analytical determination of mycotoxins

•Industry assisting by sampling and managing processes from raw cereal to the end product.

Better foods for a better life

- To determine the fate of key mycotoxins during commercial UK processing
- To predict fate of toxins based on chemistry of mycotoxin and process conditions
- To determine breakdown products or bound mycotoxins
- To consider any toxicological implications of findings
- To make recommendations for potential process changes to reduce toxins in food fractions
- To assess the influence of fungal contamination patterns on toxin profile and fate during processing
- To provide validation of available rapid test formats

Better foods for a better life

## Key Scientific Advances

### New Information

- Fungal contamination and effect on toxin profile in grain and processing
- Extrusion and effect of inclusions
- Fate of toxins during fermentation in bread/role of yeast/*Lactobacilli*
- Breakdown products, bound toxins and likely toxicological significance
- Data on occurrence

Better foods for a better life

## *Fusarium* Mycotoxins

### ▪ Focus on:

#### – *Fusarium* toxins

- Trichothecenes DON/NIV/T2/HT2  
Possibly acetylated DON derivatives
- Zearalenone (ZON)
- Fumonisin (maize only)

Better foods for a better life

## Processes

▪ Focus on:

- Breakfast cereals
- Flour and bread
- Oat processing
- Snacks
- whole wheat cornflakes
- wheat maize

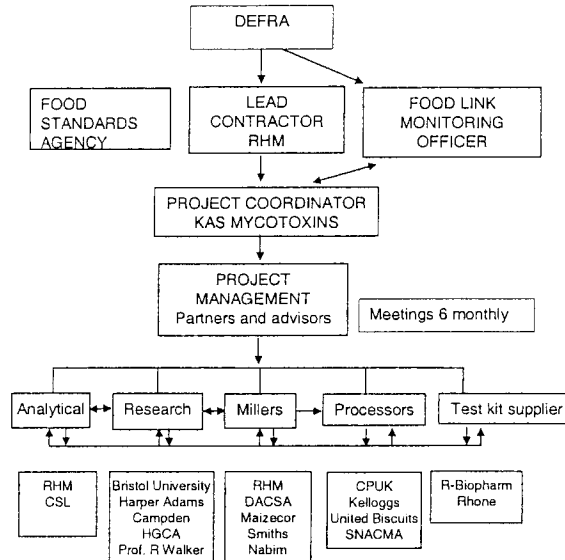
Better foods for a better life

## Timescales

- Project began late 2004
- Schedule to run for just over three years
- Covers multiple harvest years allowing differences in levels and nature of *Fusarium* infection to be studied
- Interim results will be available Sept 2006

Better foods for a better life

## Project Management



Better foods for a better life

## Accuracy of Results



Two analytical labs participating  
Must ensure all results are comparable

### CONSIDERATIONS

Standard quantification	Sample treatment at the laboratory to achieve homogeneity -grinding/particle size -mixing
Extraction -solvent -time	Clean-Up
End determination technique	Method performance parameters
Accreditation status	Proficiency testing

Better foods for a better life

## Workstreams

Task A	To establish the fate of <i>Fusarium</i> mycotoxins in full scale commercial processing
Task B	To identify process reaction products –Breakdown products –Metabolites
Task C	Identify the influence of processing parameters on <i>Fusarium</i> mycotoxin levels –Extrusion –Bread baking – <i>Fusarium</i> infection patterns and fungicide treatments
Task D	Assess the impact of processing on the risk from <i>Fusarium</i> mycotoxins

Better foods for a better life

## Progress : Task A

Task A	To establish the fate of <i>Fusarium</i> mycotoxins in full scale commercial processing of:	
	Maize	Breakfast cereals Snacks
	Wheat	Breakfast cereals Snacks Flour and bread
	Oats	Breakfast cereals and other foods

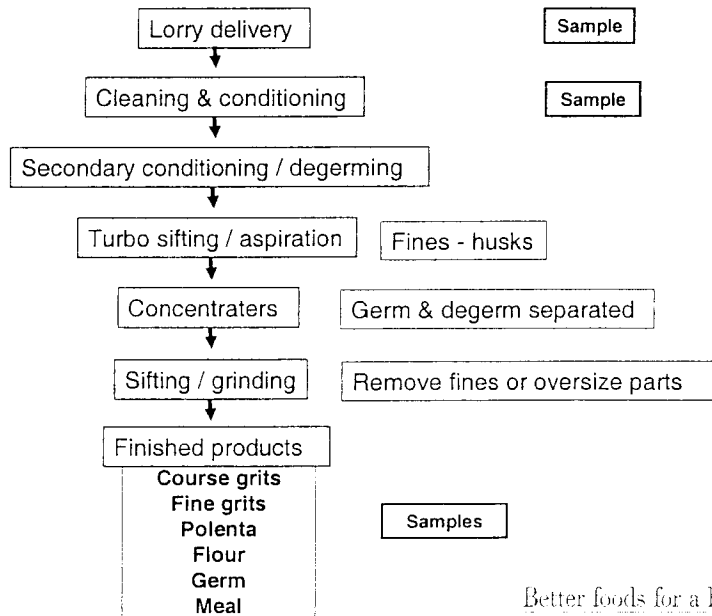
Better foods for a better life

## Progress : Task A

Task A	<p>To establish the fate of <i>Fusarium</i> mycotoxins in full scale commercial processing:</p> <p>SAMPLING and TRACEABILITY</p> <p>a) that the samples taken for mycotoxin determination are representative of the lot being processed</p> <p>b) raw material lot can be traced through the process</p> <p>Sampling plans agreed with the UK FSA for each process.</p> <p>These are as close as possible to EU sampling plans</p> <ul style="list-style-type: none"> <li>-Where to sample, based on chemical and physical processes that may effect mycotoxins</li> <li>-Sample sizes</li> <li>-First sets of samples collected and analysed</li> </ul>
--------	--

Better foods for a better life

## Maize Milling



Better foods for a better life

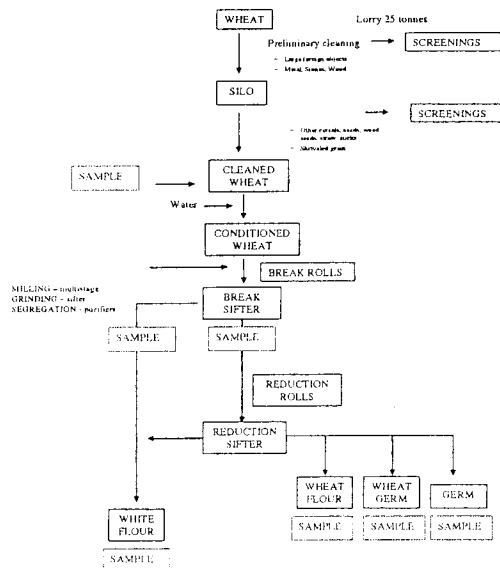


Distribution of mycotoxins in maize fractions, specimen set

Fraction	DON ( $\mu\text{g}/\text{kg}$ )	ZON ( $\mu\text{g}/\text{kg}$ )	Fumonisin B1 ( $\mu\text{g}/\text{kg}$ )
Maize	519	74	418
Cleaned	502	46	310
Coarse grits	108	10	110
Fine grits	142	13	89
Med. Polenta	147	17	134
Flour	221	24	187
Germ	1217	166	907
Meal	1728	181	1716

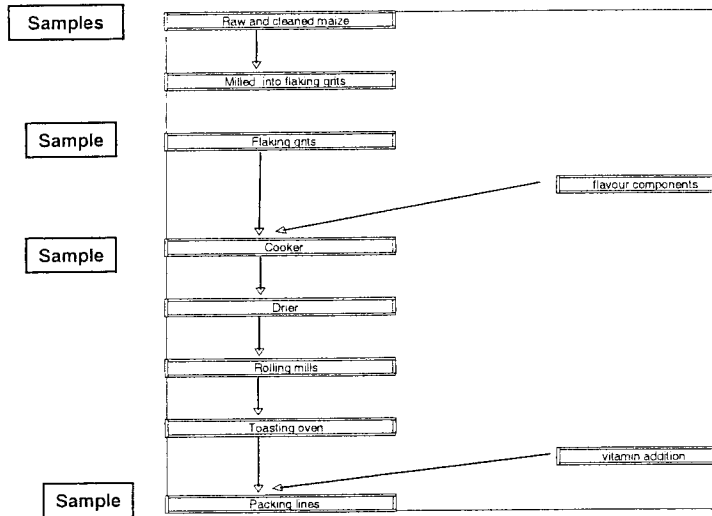
Better foods for a better life

Wheat Milling



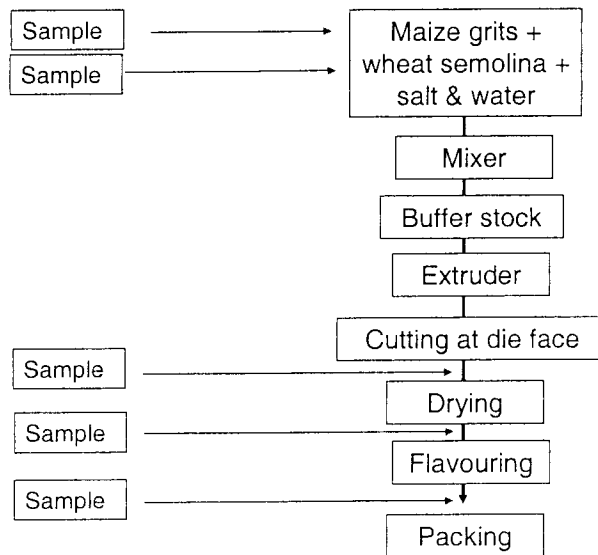
Better foods for a better life

## Cornflake Production



Better foods for a better life

## Extrusion



Better foods for a better life

## Progress : Task A

Task A	<p>To establish the fate of <i>Fusarium</i> mycotoxins in full scale commercial processing:</p> <p><b>ON SITE ANALYSIS</b> Assess the reliability and accuracy of rapid test kits at production sites</p> <p>Planned:</p> <ul style="list-style-type: none"><li>Deoxynivalenol</li><li>Fumonisin</li></ul> <p>Blind testing by non specialist staff Compare to conventional analytical methods</p>
--------	--

Better foods for a better life

## Progress : Task B

Task B	<p>To identify process reaction products</p> <ul style="list-style-type: none"><li>-Breakdown products</li><li>-Metabolites</li></ul> <p>▪Plan to produce radiolabelled <i>Fusarium</i> mycotoxins</p> <p>▪Likely degradation and binding routes will be identified based on chemical properties of the toxins and the physical processes being studied</p> <p>▪Pilot scale processing with radiolabelled mycotoxins will be carried out and fate of radiolabelled entities traced.</p> <p>Initial focus on obtaining <i>Fusarium</i> strains that can produce high levels of toxins to produce radiolabelled materials for studies</p>
--------	---

Better foods for a better life

## Progress : Task C

Task C	<p>Identify the influence of processing parameters on <i>Fusarium</i> mycotoxin levels</p> <ul style="list-style-type: none"> <li>-Extrusion Snacks</li> <li>-Bread baking</li> <li>-<i>Fusarium</i> infection patterns (wheat) and fungicide treatments             <ul style="list-style-type: none"> <li>2004 harvest infection pattern for DON within kernel identified</li> <li>2005 harvest doing comparison</li> </ul> </li> </ul>
--------	---

Better foods for a better life

## Progress : Task C

Task C	<p>Identify the influence of processing parameters on <i>Fusarium</i> mycotoxin levels</p> <p><b>Effects of Extrusion</b></p> <p><b>Plant and pilot scale extrusion processing studied</b></p> <p><b>Maize is the major cereal used in snacks</b></p> <p>Plan to look at</p> <ul style="list-style-type: none"> <li>-maize grits in direct expansion</li> <li>- maize flour in pellets</li> </ul> <p><b>Wheat may have most of its contamination in the bran and will be more severely tested in direct expansion</b></p> <ul style="list-style-type: none"> <li>•wholemeal in direct expansion</li> </ul> <p><b>Processing conditions</b></p> <p><b>Moisture levels, temperatures, salt inclusion</b></p>
--------	--

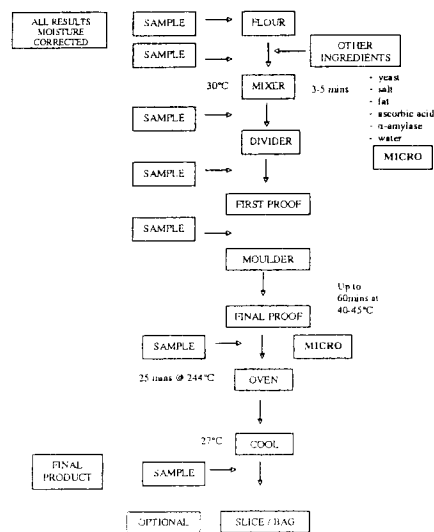
Better foods for a better life

## Bread Baking

- Conflicting data in the literature on effect of bread production on trichothecene levels in final product
- Use naturally contaminated flours
- Bake UK plant bread (white and brown) using commercial formulations
- Perform full mass balance for toxins across the process
- Determine microbial flora of the dough
- Determine the physical, chemical and microbial effectors on *Fusarium* toxins

Better foods for a better life

## Bread Baking



Better foods for a better life

## Progress : Task D

Task D	<p>Assess the impact of processing on the risk from <i>Fusarium</i> mycotoxins.</p> <p>Completed an assessment of published information on known breakdown products of <i>Fusarium</i> mycotoxins and the available toxicology</p>
--------	--

Better foods for a better life

## Summary

- Industrial scale approach
- Interdisciplinary collaboration
- Understanding of fate of *Fusarium* toxins
  - Identification of metabolites
  - Controlling factors
- Reduction of consumer risk
- Wide industry support
- UK, European and world impact

Better foods for a better life