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Crop Production in Ireland -  
the role for science & innovation in addressing  
environmental challenges





# Competitive Reality

- We need access to the latest technology to remain competitive – Irish Agriculture worth over €20 Billion - €9 Billion Exported annually
- Environmental Issues very important but are often greatly exaggerated but we must not be complacent
- We need to strive for an acceptable balance between
  - Technical efficiency
  - Food Cost
  - Food Quality
  - Conservation of the environment



# Ireland Has Good Yields

- ***Very suitable climate for high yields***
  - Adequate rainfall distributed throughout the season
  - Relatively mild winter and long growing season
  - Summers not hot
  - Fertile, deep, moisture retentive, free-draining soils
- ***Disadvantages***
  - Relatively small scale production units
  - Climate leads to high disease levels incurring high fungicide costs

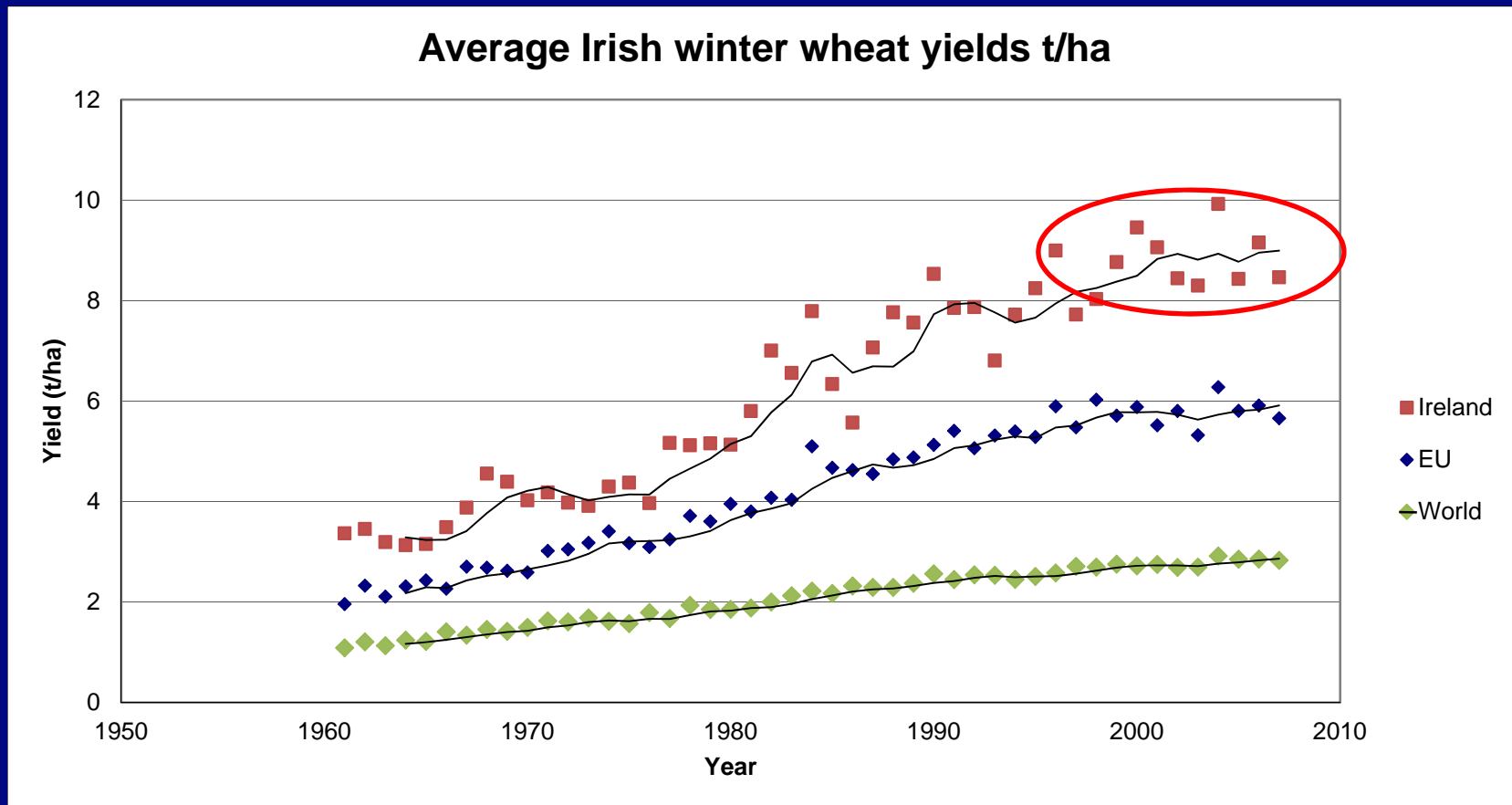
# Yield potential and Ireland

- Yield achievable in the absence of: water, nutrient, disease, and weed competition.



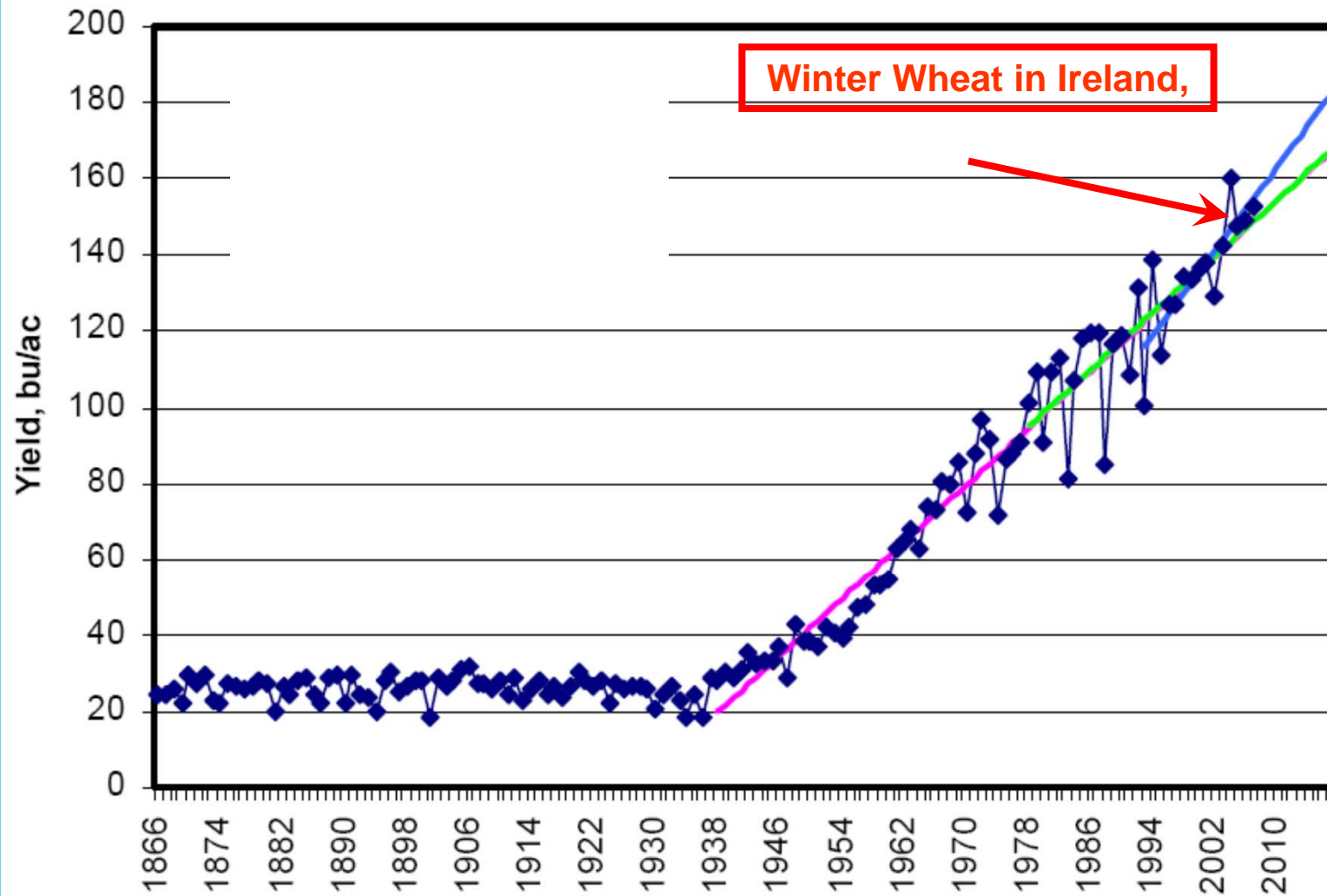
- It is yield limited by solar radiation, temperature.
- We receive enough solar radiation to produce **19.8 t/ha winter wheat (dry)** (Burke *et al.*, 2011)

**Lower growth in grain yields** –World yields grew at 2.1 % in 1980s, but at < 1.0 % per annum in 1990s - yields plateauing



Source: CSO, FAO

## U.S. Corn Yield -- Actual and Predicted



Source: *Ethanol Industry – Impact on Corn and DGS Production*, Dhuyvetter et al.

## What about increasing grain yields significantly?

- We are going to have to use all of our tools (germplasm, genomics, mutations (TILLING), transgenics, and phenotyping /statistics/bioinformatics) on a scale that has not been seen before.
- Reassess the role for hybrids.
- We will have to look at traits/cultivars/hybrids that are environmentally “flexible”
- More emphasis on accurate phenotyping in plant breeding (expanding our tool kit).



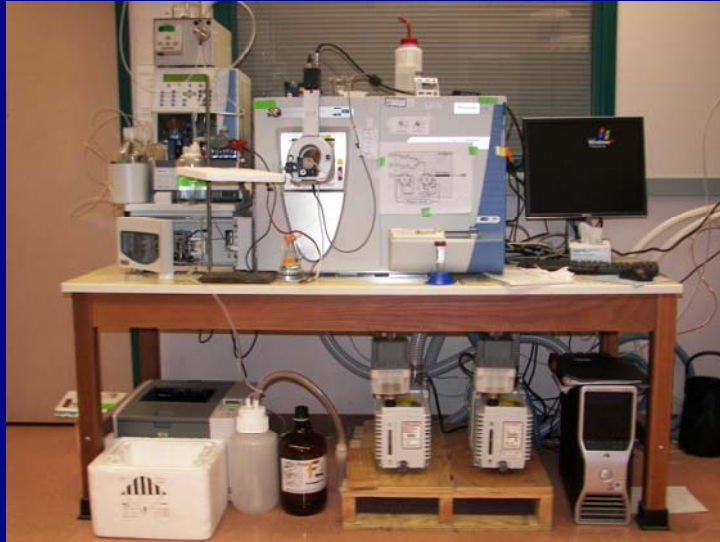
# The Need for Phenotyping:

- Effective selection.
- Effective use of tying molecular markers (which have become very cost effective) to phenotypes.

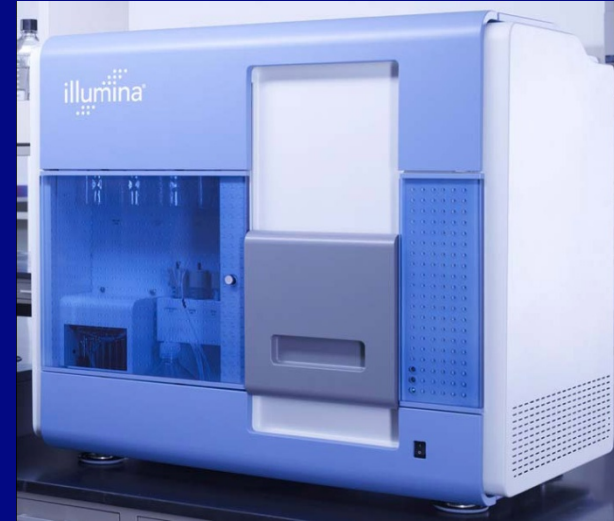
*Note this also increases the number of lines that require phenotyping and possibly the number of traits that need to be phenotyped to gain the understanding that is needed of the underlying genetics.*

- Need automation and interpretation

# Experimental System for Systems Biology



HPLC-MS/MS Analysis



Illumina Genome Analyzer

Shot-gun Proteomics

Plant Interactome

Genomics and Transcriptomics



High-throughput  
Modeling and Gene  
Discovery

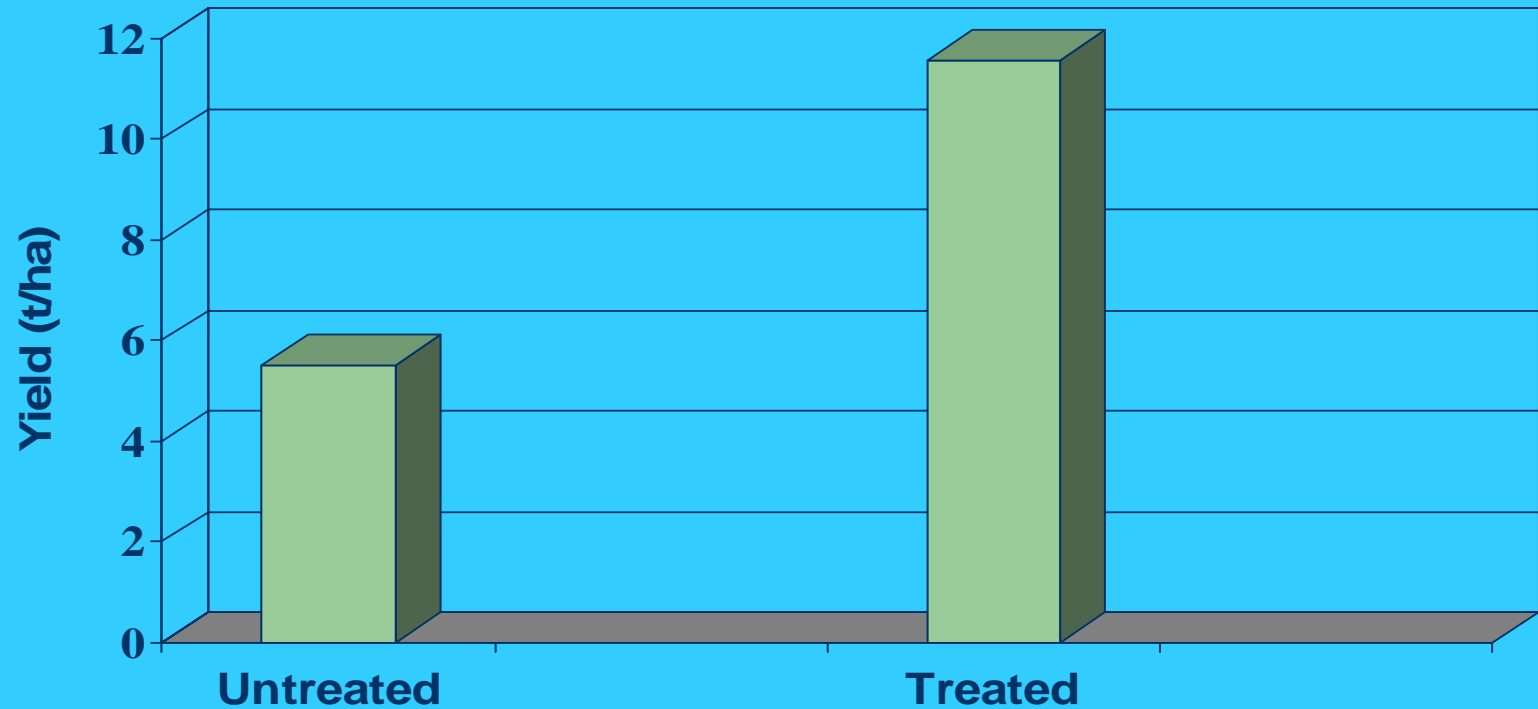




# Septoria



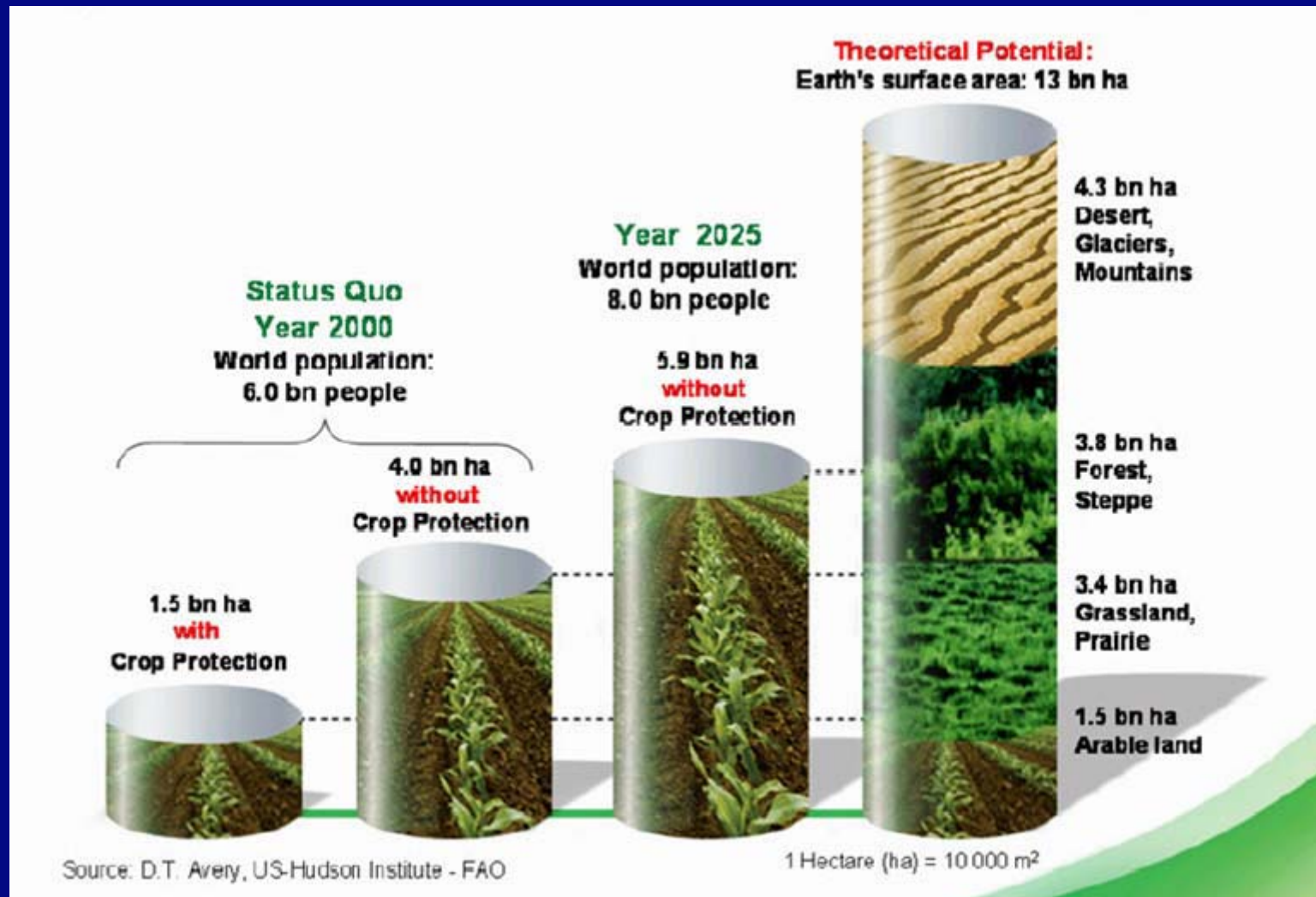
# Typical yield response to fungicide (high disease)





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- Lower Yields resulting from poor pest and disease control is bad from our Carbon emissions point of view
  - Eg Cereal farmers achieving grain yields of 12 t/ha currently would only receive 9 T/ha (at best) if crop protection products are restricted

# The global significance of crop loss due to diseases, pests and weeds.



# Sustainable Use of Pesticides Directive

- Some of the objectives are laudable
  - Training of Users
  - Inspection of Application Equipment
  - Safe Handling of Pesticides *but*

***Others could have serious effects of Irish Agriculture***

# Sustainable Use of Pesticides Directive

- Blanket reduction not the way forward
- Amounts to be applied must be based on a crop by crop basis
- Integrated Pest Management can play a significant role in sustainable use of pesticides



# Integrated Pest Management (IPM)

- Avoid the problem if possible
- Assess action required
- Apply appropriate dose of correct pesticide

# Key Components:

- **Rotation**
- **Genetics**
- **Cultural**
- **Pesticides**
  - *Appropriate dose*
  - *DSS*
  - *Weather*
  - *Likely damage*

## Pest & Disease Management

- **Understanding the relationship between, disease, yield & environmental sustainability**
- **Combating pathogens using less pesticides**
- **Evaluate alternative control strategies where product withdrawals will limit production**

# Identifying sources of genetic resistance to diseases in wheat.





## Model Species

- New model: *Brachypodium distachyon*.
- More closely related to grasses.
- Similar qualities to *Arabidopsis*.

*Arabidopsis* (left), *Brachypodium*  
(centre), wheat (right)

- *Brachypodium* has been found to be a host for *Septoria* at UCD



# Future for Biocontrol ?

In field crops:

biopesticides combined with the best synthetic chemicals in a season-long disease, weed or insect control program



In animal production:

the replacement of antibiotics with probiotics

# Mycotoxins

## *Toxic substances of Fungal Origin*

- ◆ Field fungi
  - ↗ Fuzarium spp.
  - ↗ other
- ◆ Field fungi in storage
- ◆ Storage fungi

# Effects of aflatoxins

Low chronic dose	- reduced liver function - lowered immune system
More/longer	- hepatitis susceptibility
Higher/longer	- liver cancer/death
Acute	- death

"4.5 billion people in developing countries are exposed to uncontrolled amounts"

Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions

Williams et al - Am J Clin Nutr 80:1106 -22, 2004

## Future Crop Production

High output with minimum impact on environment:

- Improved Farming Systems
- Precision Agriculture
- Sustainability practices
- Utilise new cutting edge technology



# More food by 2050, using...



**75 million**

*more people each year added  
to global population*

About the number of people in Germany



# What needs to be done:

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- **IMPROVED PRODUCTIVITY AND INCOME** - Restore higher annual genetic gains to increase crop productivity, enhance quality
- **PROTECT BIODIVERSITY** - Double crop production on same area of land - save the forests/biodiversity, 13m ha loss/year
- **ENVIRONMENTAL IMPACT** - Reduce need for external inputs – pesticides - fertilizers - conservation of soil & water -sustainability
- **YIELD STABILITY** - Increase stability of yield through better control of abiotic and biotic stresses - drought - the major cause of past famines
- **SOCIAL BENEFITS** - Alleviation of poverty, improved environment & health





Thank You for  
Your Attention