# Disease mitigation and GHG emissions

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# Today’s talk

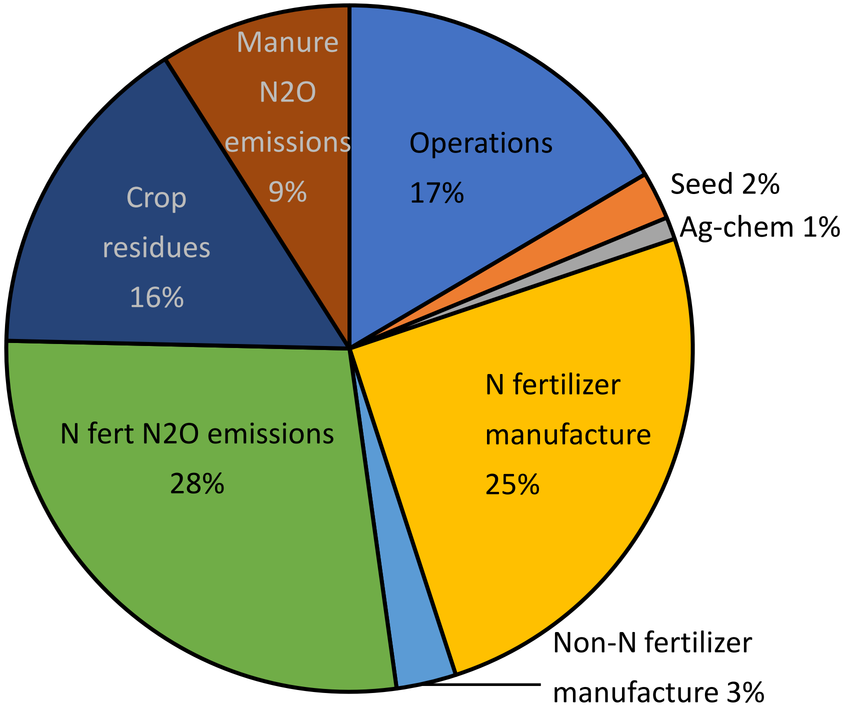
- GHG emissions explained
- How to calculate GHG emissions
- Indirect land use change (ILUC)
- Cost of disease on GHG emissions

# Main sources of direct GHG emissions

Segregated the C footprint into 8 categories

Emissions originate from three divisions:

1. Embedded emissions
    - Seed
    - Ag-chemical manufacture
    - Nitrogen fertiliser manufacture
    - Non-N fertiliser manufacture
2. Energy
    - Operations
3. Direct and indirect $N_2O$ emissions
    - Nitrogen fertiliser application
    - Manure application
    - Crop residue decay




*C footprint of YEN Zero 2021 and 2022 winter wheat (feed and seed) crops n=157*

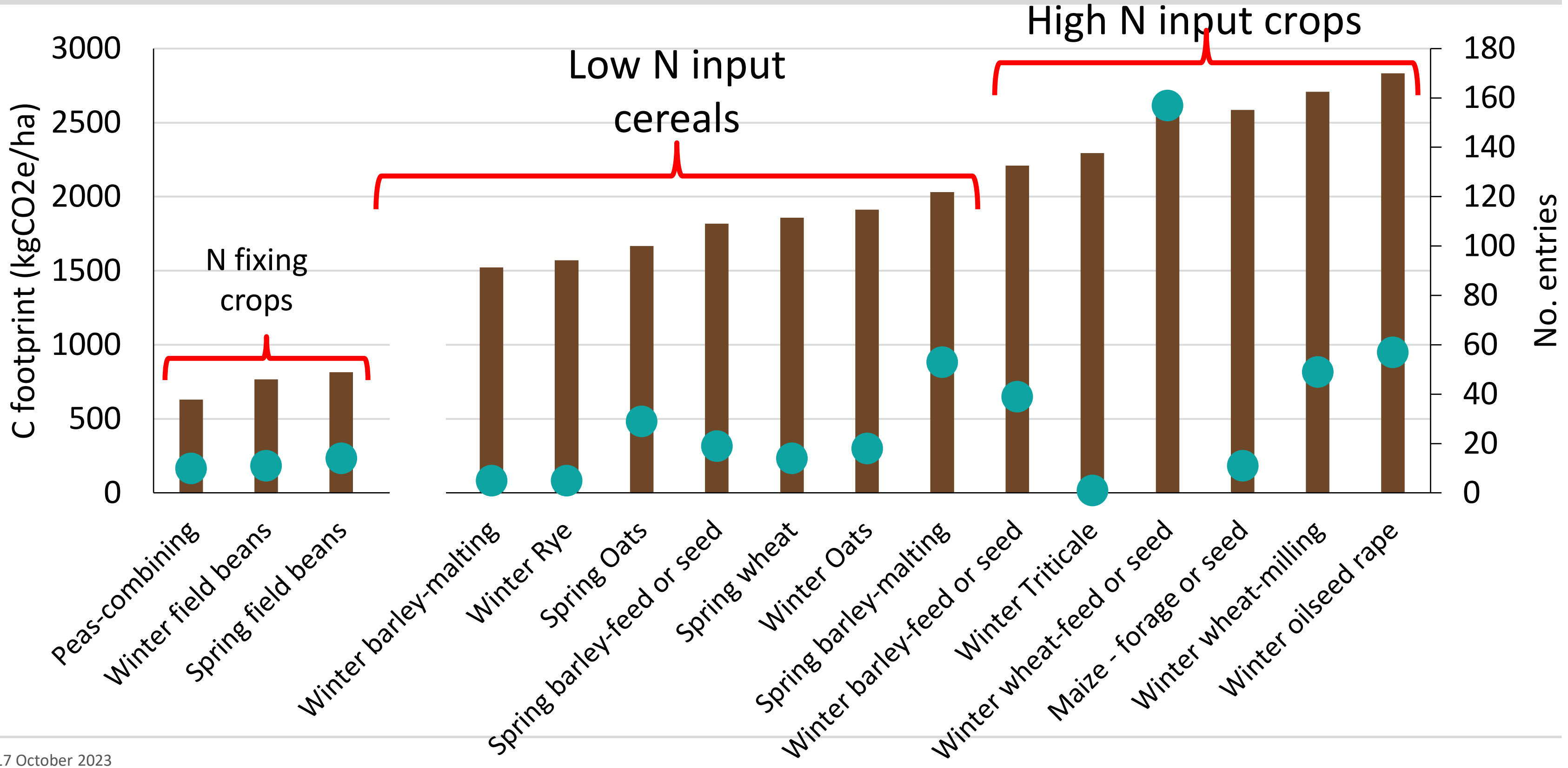
# Calculating GHG emissions

**Activity** x **Emission Factor** = **Greenhouse gas emissions**

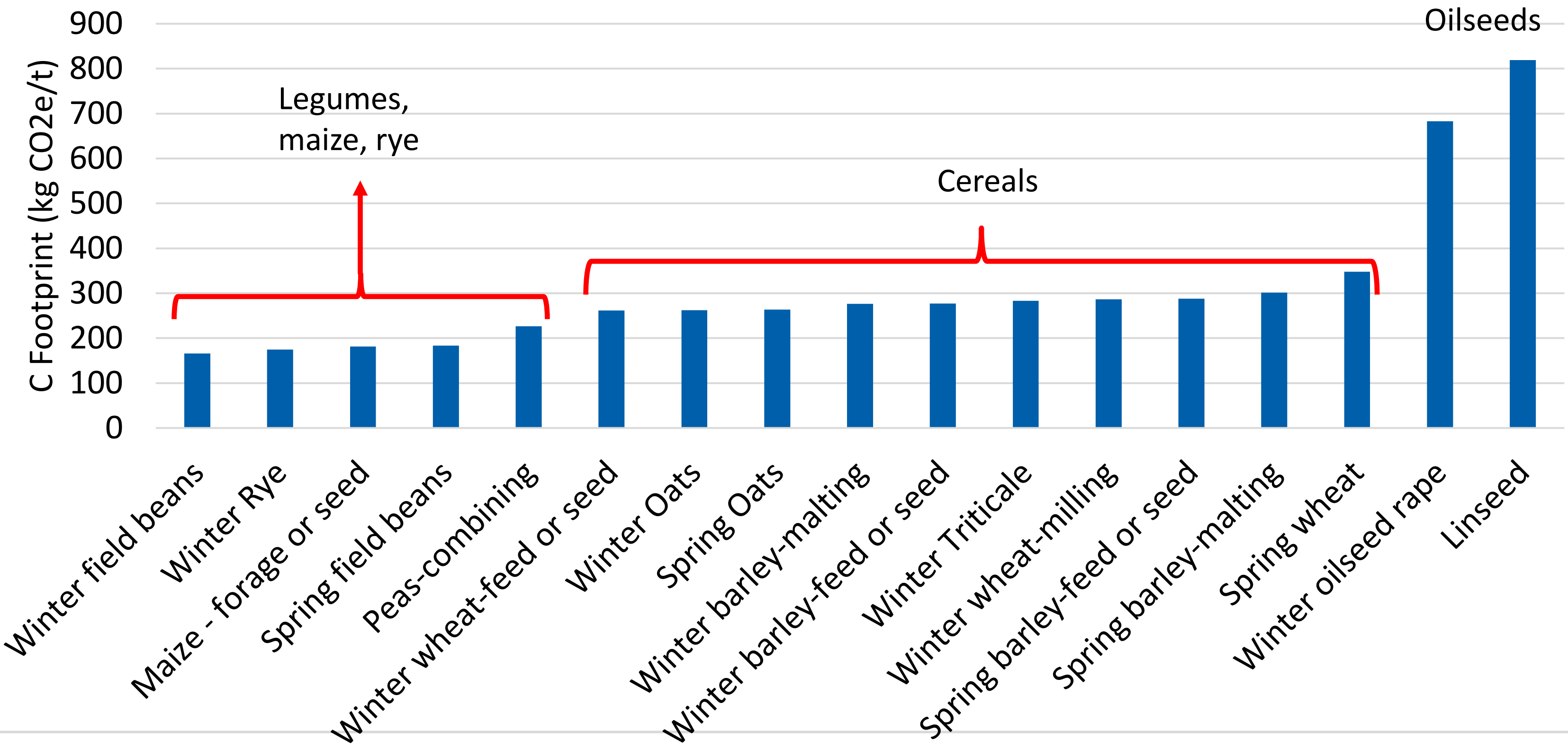
**Greenhouse gas emissions** x **Global Warming Potential** = **kg $CO_2$eq**

- Rate of ag-chemicals based on kg of active substance applied per ha
- Emission factors for ag-chemicals sourced from Green et al. (1987)

# YEN Zero Crop C footprints, per hectare



# YEN Zero Crop C footprints, per tonne

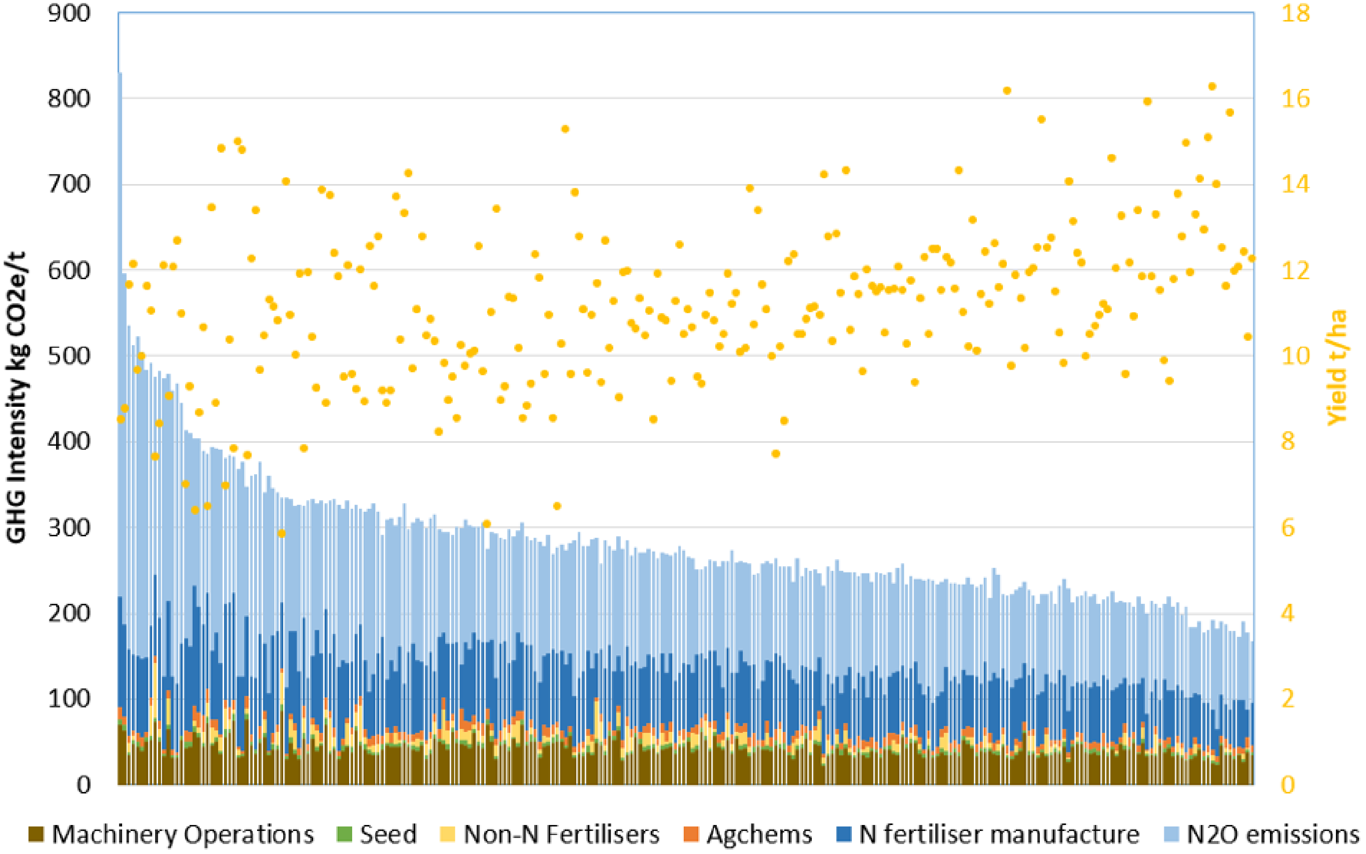


# Lots of variation

Analysis of GHG intensities for past Cereal YEN crops

N fertiliser and $N_2O$ dominant

Can we better understand what's driving this variation?



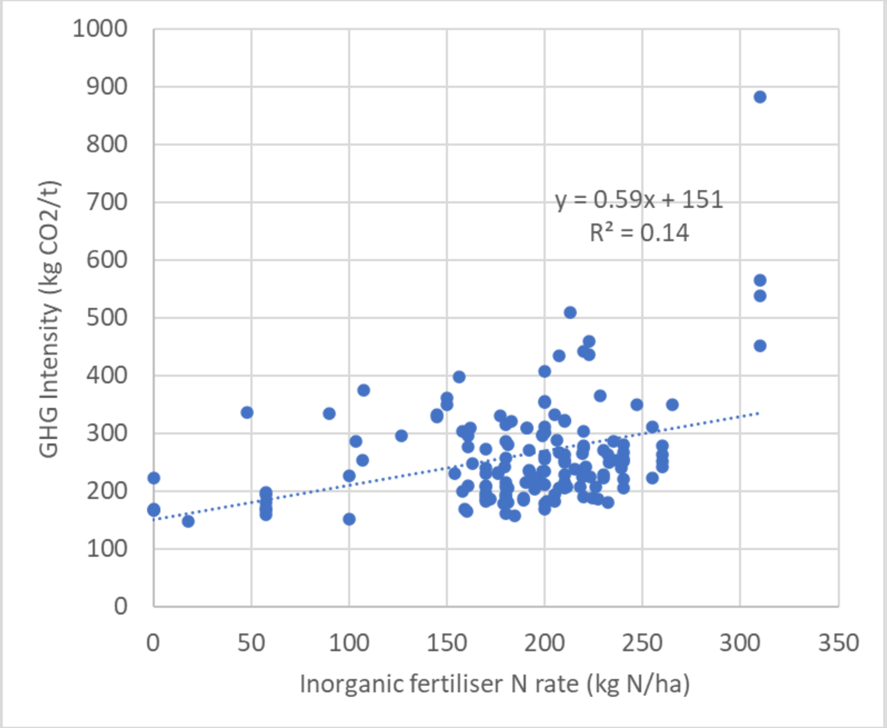
# Factors associated with low C intensity (Feed wheat)

**Higher yield** associated with lower C intensity

Extra 1 t/ha ≈ reducing C intensity by 15 kg $CO_2$/t

**Lower N rate** associated with lower C intensity

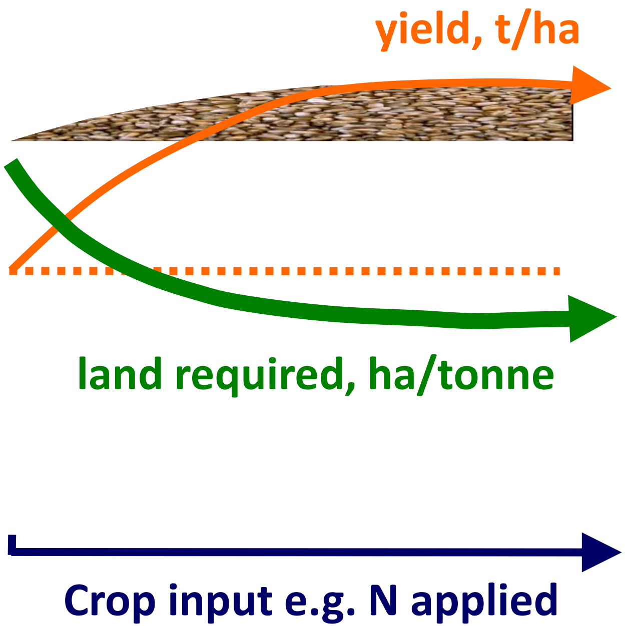
Reducing by 30 kg N/ha ≈ reducing C intensity by 18 kg $CO_2$/t



# Crops with low GHG emissions

- High yields
- Low rate of synthetic N fertiliser, greater use of fertiliser efficiency products
- Wheat more often following non-cereal break crops
- Less intensive cultivations, less grain drying (wheat)
- Less manures and P, K fertiliser
  - but these may be applied elsewhere in rotation

# Effect of Land use change (LUC)



# Effect of Land use change (LUC)

| Ecosystem type | IPCC (t $CO_2$/ha) (1997) | Searchinger *et al.* (2008) (t $CO_2$/ha) |
| --- | --- | --- |
| **Tropical Forest** | 553-824 | 604-824 |
| **Temperate forest** | 297-627 | 688-770 |
| **Tropical grassland and savannah** | 189-214 | 75-305 |
| **Temperate grasslands** | 139-242 | 111-200 |
| **Wetlands** | 748 | 1146 |

Figures are calculated over a 30 year period

# Land Use Change (LUC)

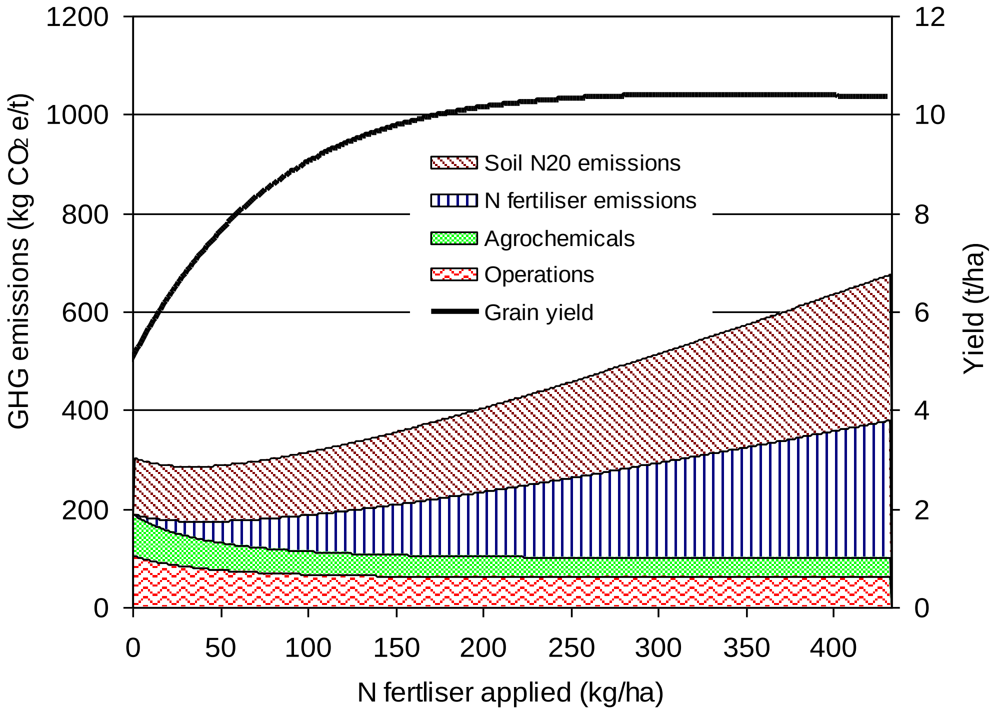
Many scenarios possible

Large variation in GHG emissions associated with LUC

*LUC scenario*

- Calculate yield foregone at crop management intensity below that required for economically optimum yield
- Calculate additional land area required to produce foregone yield
- Extra land is converted from another land use type
  - E.g. temperate grassland or tropical forest
- Grassland conversion emits 6000 kg $CO_2$ e/ha per year

# Impact of LUC using N fertiliser as an example






Kindred *et al.* (2008) *Aspects of Applied Biol.* 88

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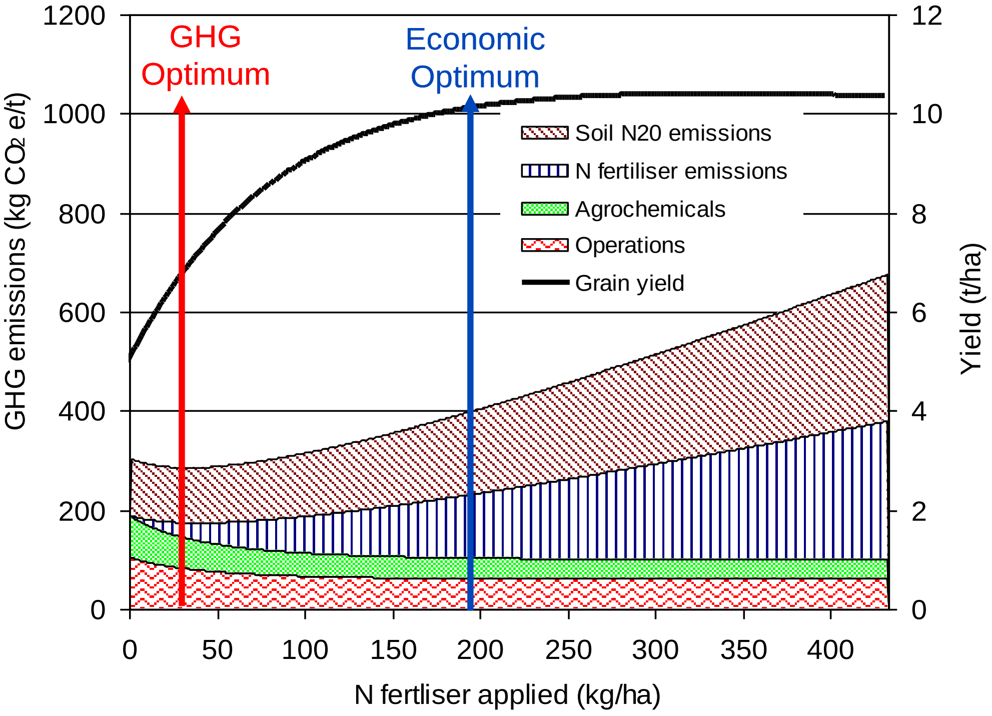




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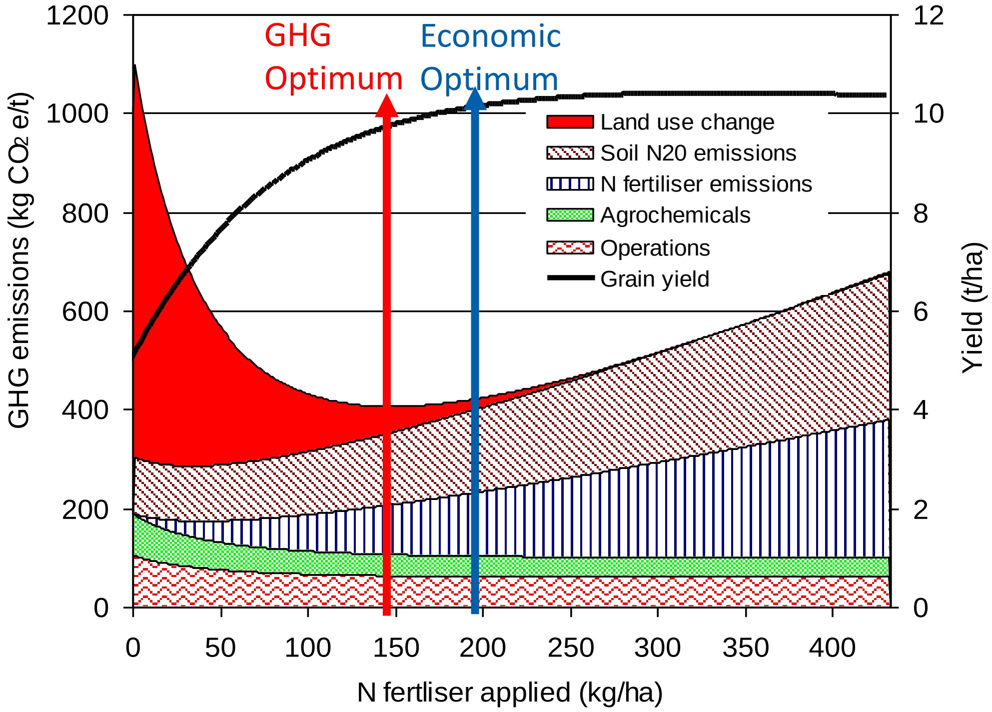




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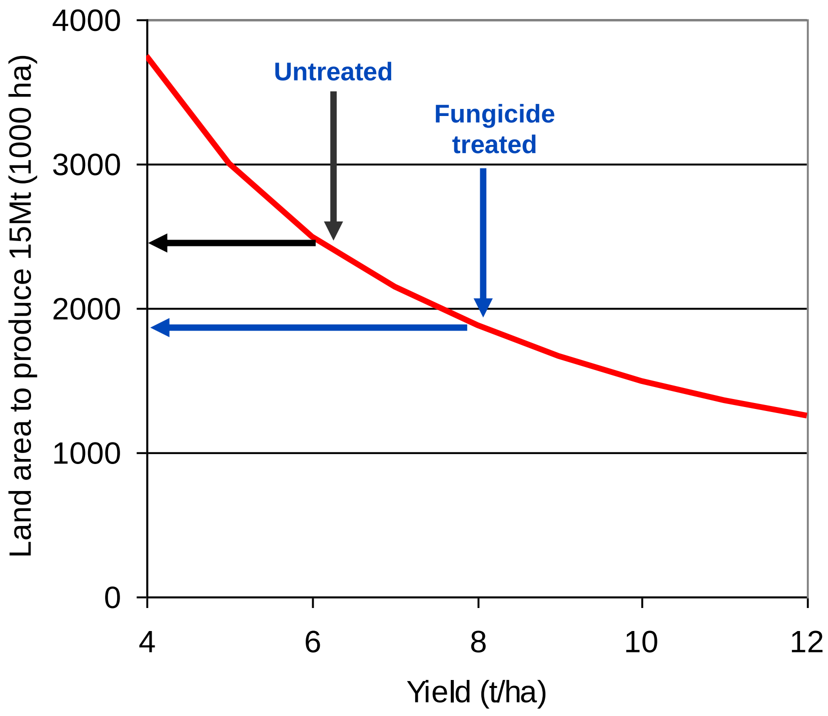
# Disease and its effect on GHG emissions

## Quantifying the effects of fungicides and disease resistance on greenhouse gas emissions associated with wheat production

P. M. Berry[a*], D. R. Kindred[b] and N. D. Paveley[a]

[a]*ADAS High Mowthorpe, Duggleby, Malton, North Yorkshire YO17 8BP; and* [b]*ADAS Boxworth, Battlegate Road, Boxworth, Cambridgeshire CB3 8NN, UK*

# Land use (UK wheat scenario)




- Fungicides increase UK wheat yield by 21%
- Reduce wheat area to produce 15Mt by 0.5M ha



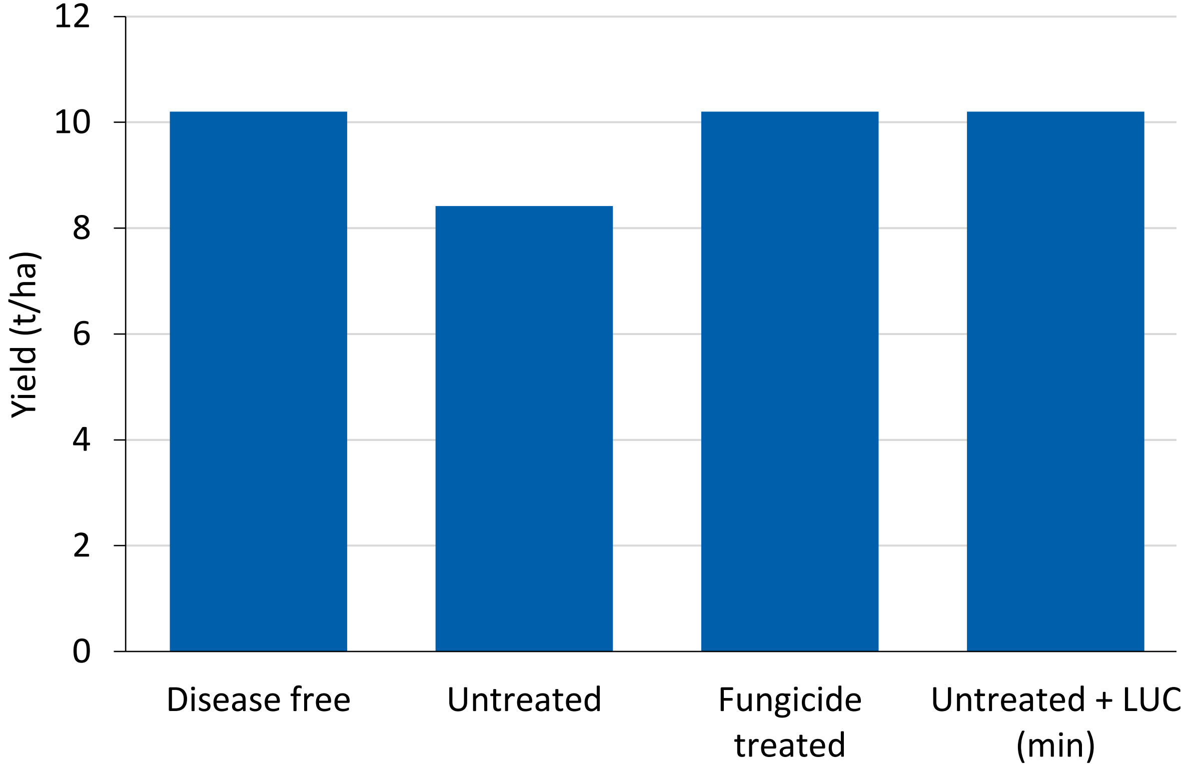
Berry *et al.* (2008) *Plant Pathology* 57, 1000-1009

# Disease and its effect on GHG emissions (in 2008)

Reduction in wheat growing area means less GHG emissions to produce 15 Mt grain

| Scenario | GHG emissions (Mt $CO_2$ eq. per year) |
|---|---|
| Disease free | 4.70 |
| Fungicide treated | 4.91 |
| Untreated (2008 cultivars) | 5.84 |
| Untreated (2008 cultivars with Septoria leaf blotch resistance increased by one point) | 5.59 |
| Controlling wheat disease completely can save up to | 1.14 |

# Different yields and GHG emissions



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# Varietal resistance

- Reduction in fungicide input
- Lower GHG emissions when ILUC taken into account

Each unit increase in resistance rating (1–9 scale) to Septoria leaf blotch reduced disease-induced yield loss by 0·31 t $ha^{-1}$.

# Main findings

- Approximately 70% of total GHG emissions in wheat production are associated with N fertiliser
- Disease interferes with green area and thus with yield
- Less grain produced means more land is needed for the same amount of grain

- On average disease reduces yield from 10.20 t/ha to 8.42 t/ha

  Increasing the net GHG emissions 59 kg $CO_2$eq./t

  A need to convert land elsewhere to obtain the same yields would result in an increase in GHG emissions of 277 kg $CO_2$eq./t

# Thank you