Crop yields and opportunities for their increase in Europe – with a focus on management

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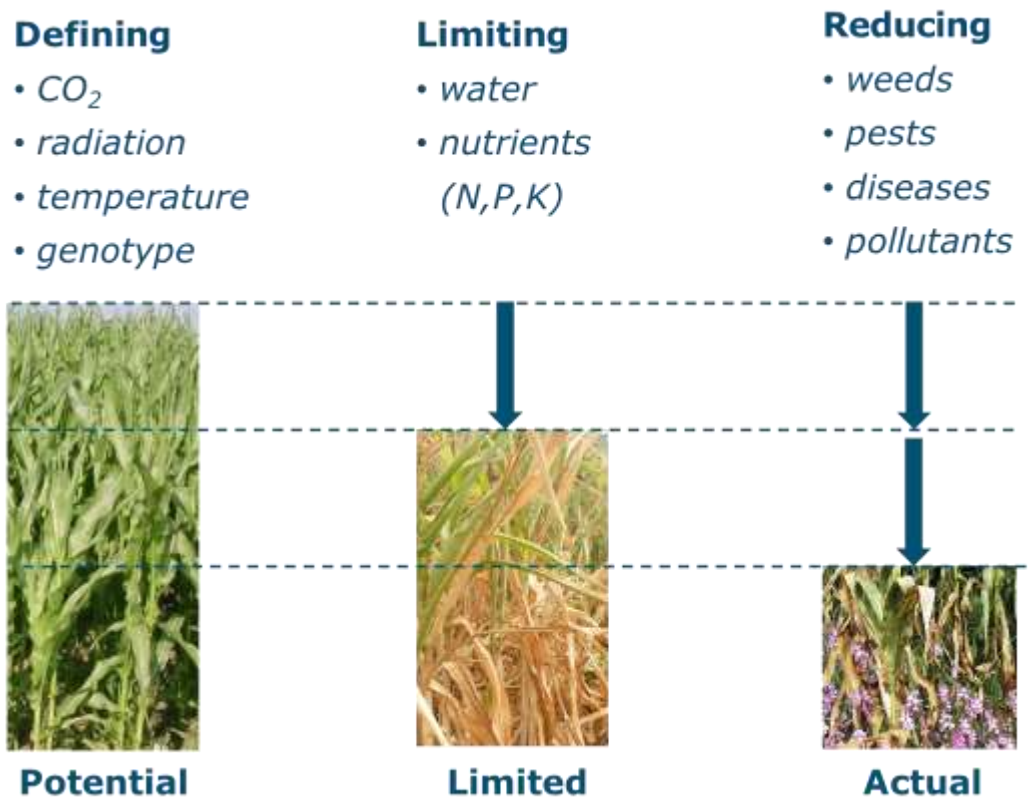
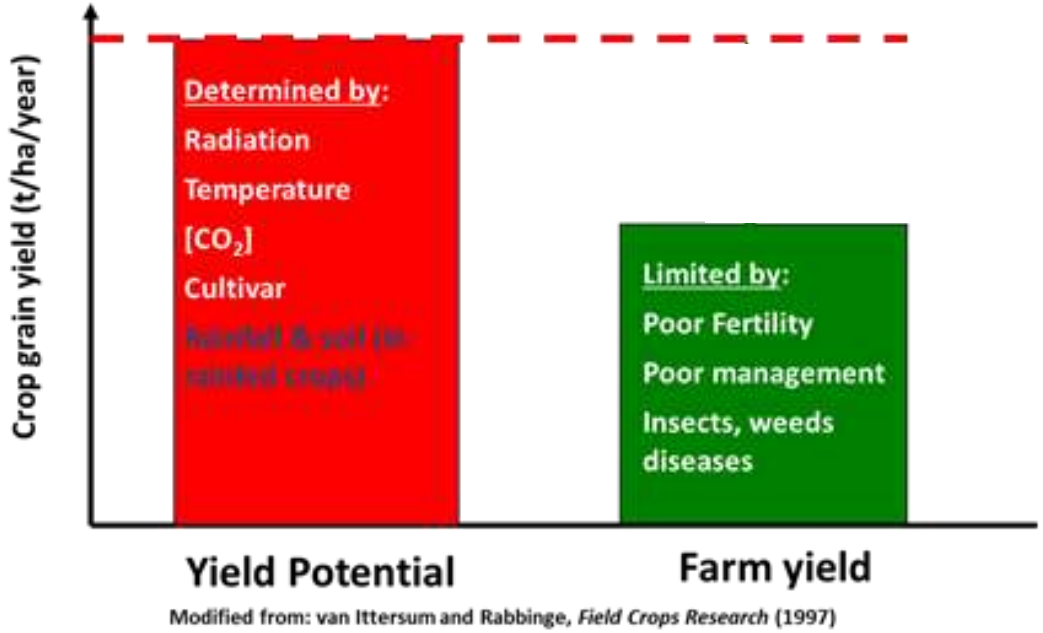


After Van Ittersum and Rabbinge (1997) Field Crops Research; Evans (1993)

Simplified

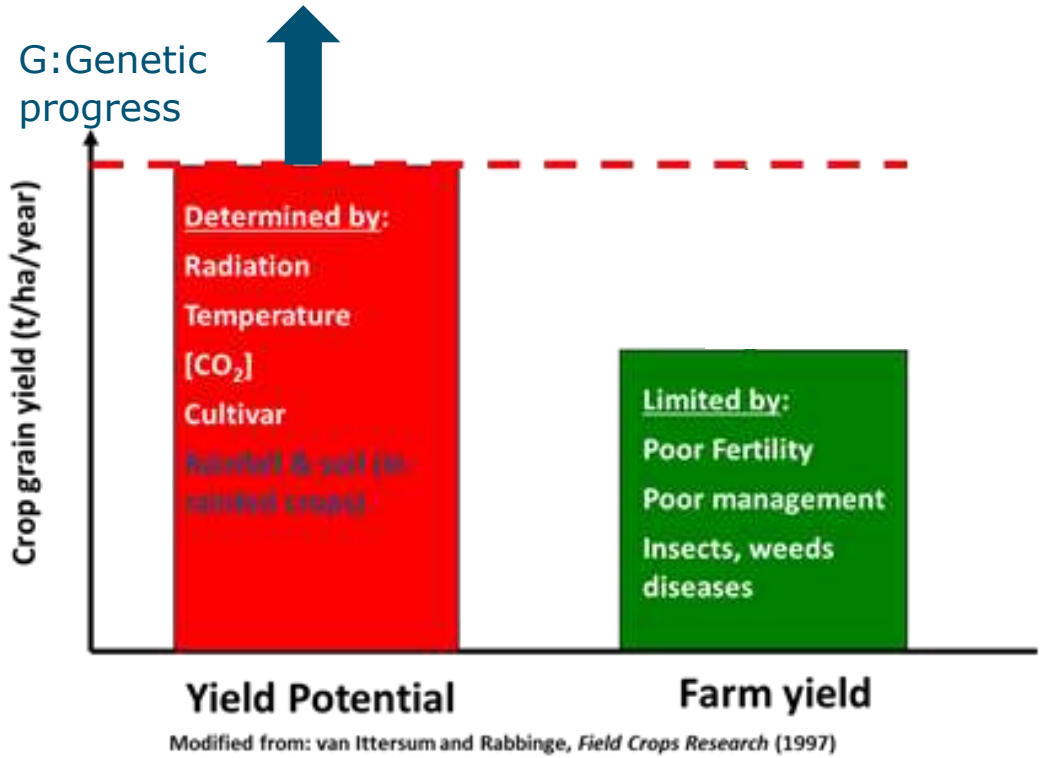


Modified from: van Ittersum and Rabbinge, *Field Crops Research* (1997)

Crop yields are a function of G x E x M

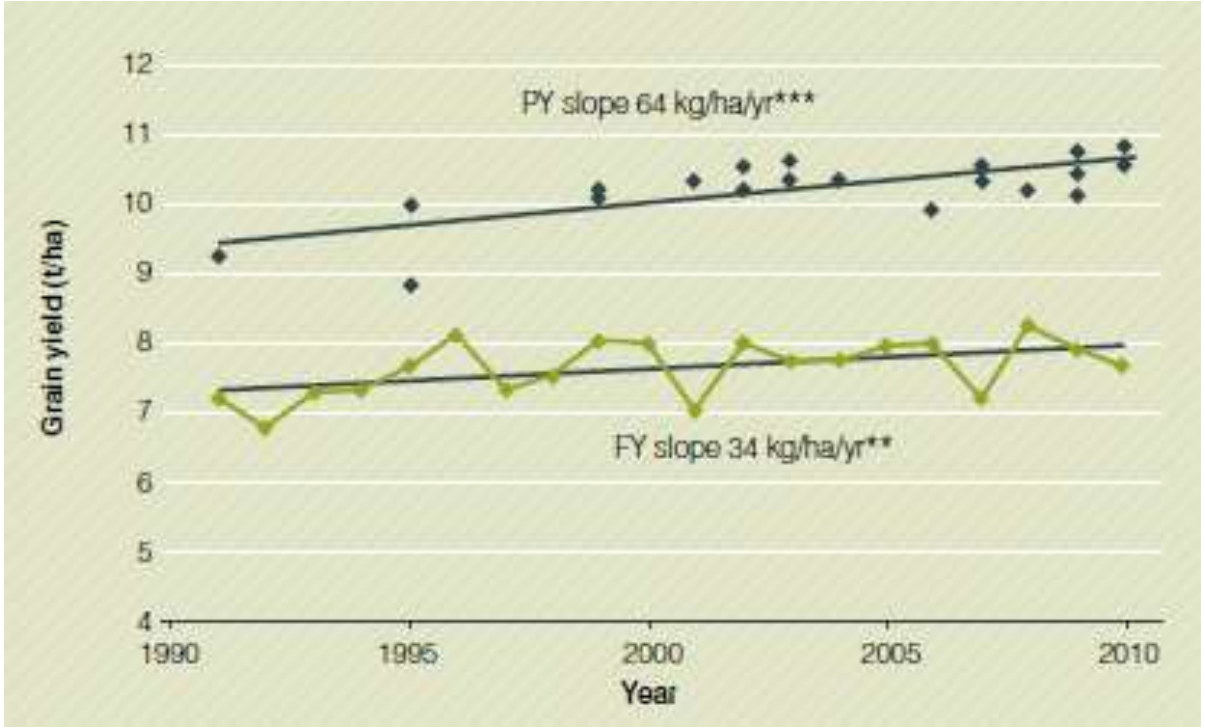
- G: Genetics
- E: Environment
- M: Management

G: Genetic progress (of potential yield)



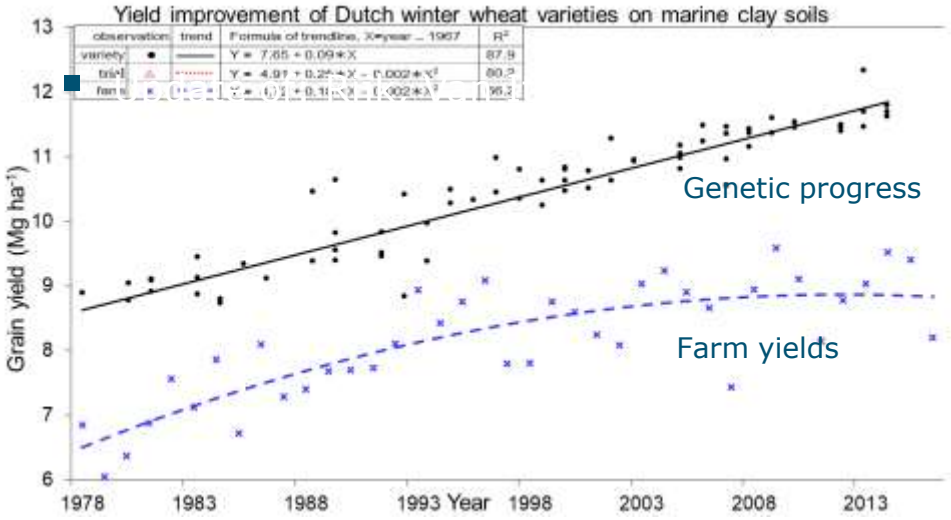
Modified from: van Ittersum and Rabbinge, *Field Crops Research* (1997)

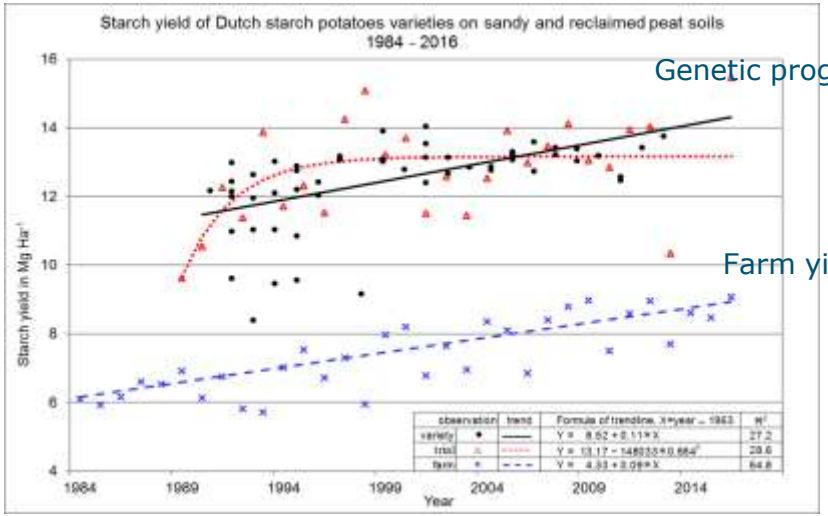
Yield progress UK wheat varieties



Fischer, Byerlee, Edmeades (2014)

Yield progress Dutch winter wheat and starch potato varieties





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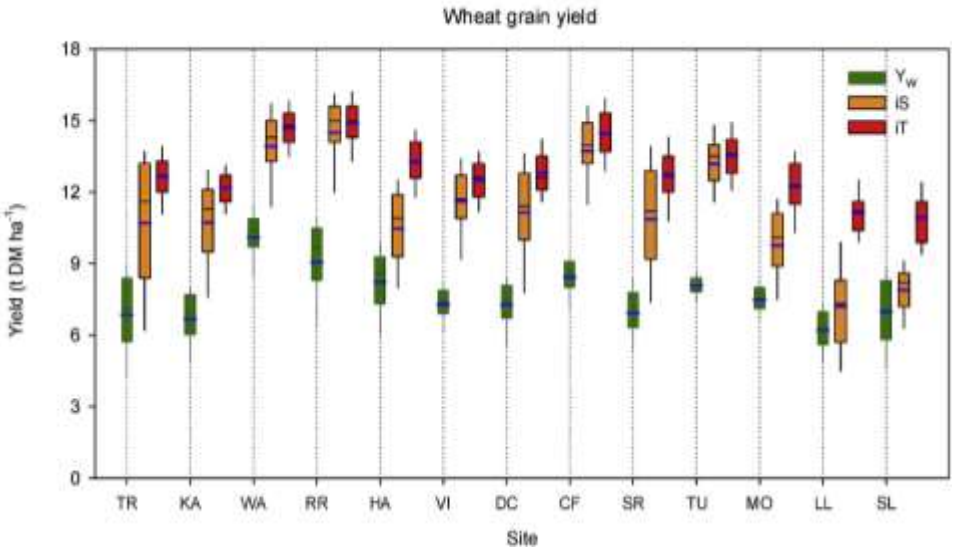
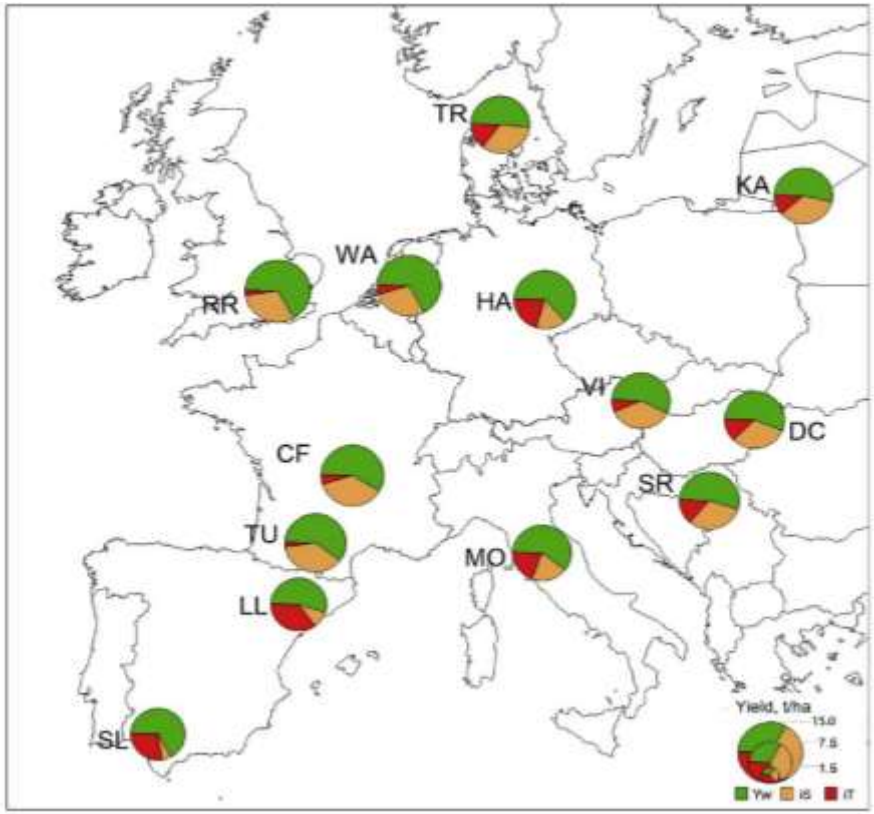
Update of: Rijk, Van Ittersum, Withagen (2013) Field Crops Research

G: Genetics: genetic yield gaps

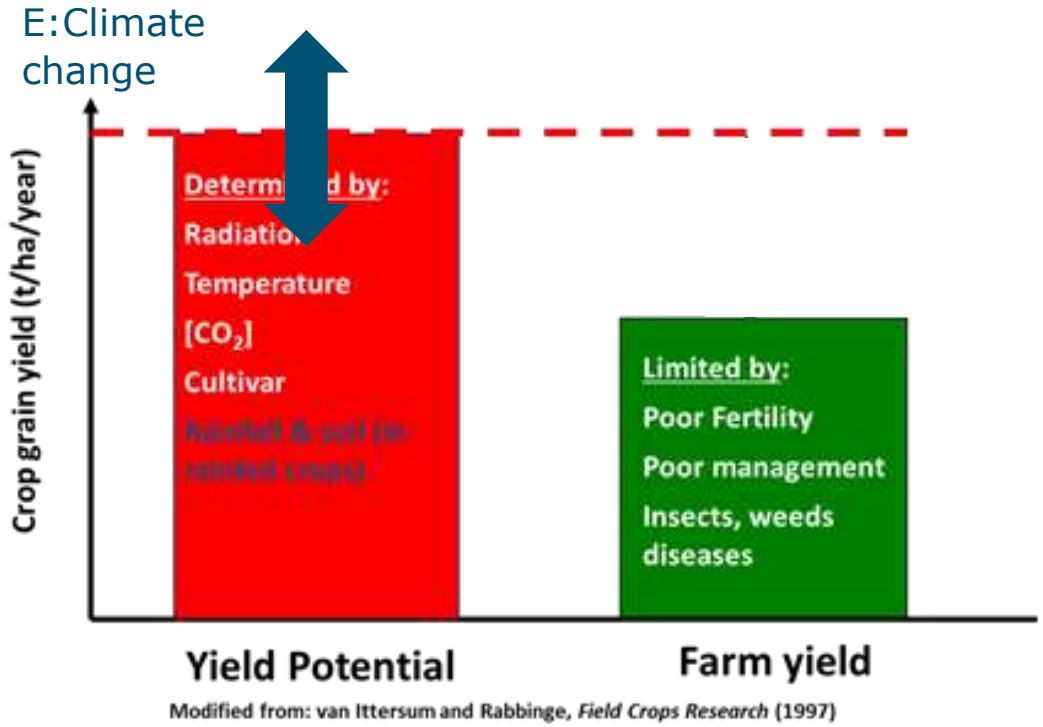




Green: Yw: current climate in rainfed condition
Orange: iS: ideotypes, heat and drought sensitive
Red: iT: ideotypes, tolerant to heat and drought

Senapati and Semenov (2020) Global Food Security

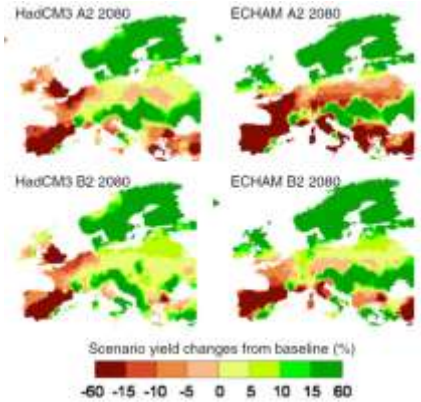
E: effects of climate change



Modified from: van Ittersum and Rabbinge, *Field Crops Research* (1997)

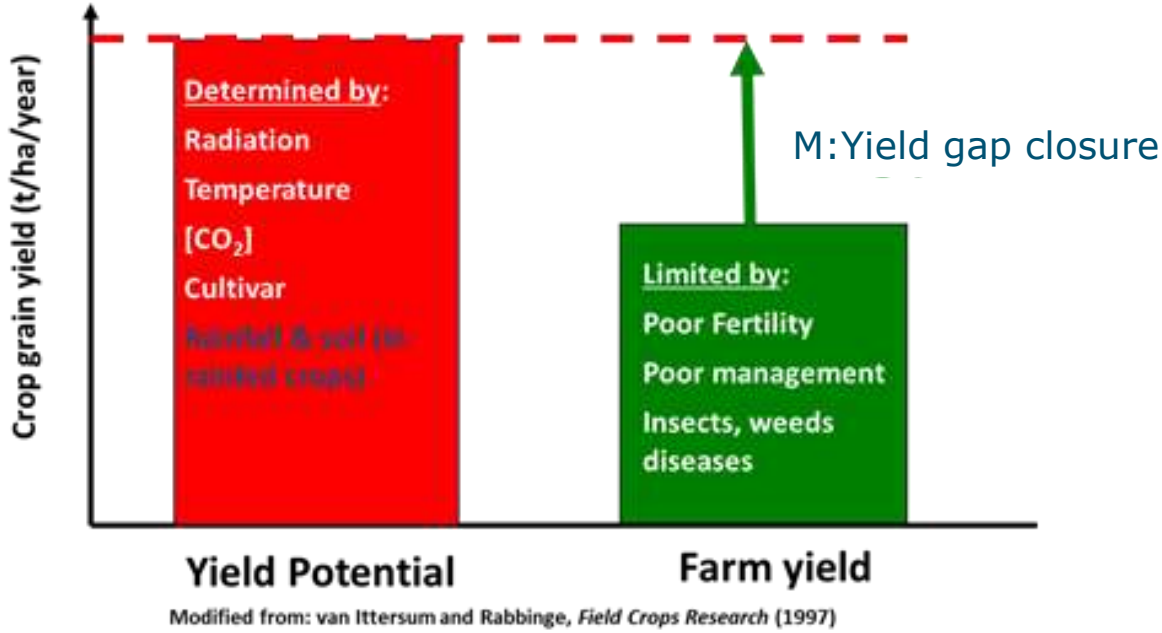
Effects of climate change (E)

- T and precipitation: can account for ca. 10% of current stagnation in European wheat and barley yields (Moore and Lobell, 2015), partly confirmed by Ray et al. (2019)
- T, precipitation and CO2: positive effects on future yields:
    - 2050: +8%, but large regional and crop differences (Knox et al., 2016);
    - longer term (2080): positive effects in Northern Europe and (strong) negative effects elsewhere (Iglesias et al., 2012)



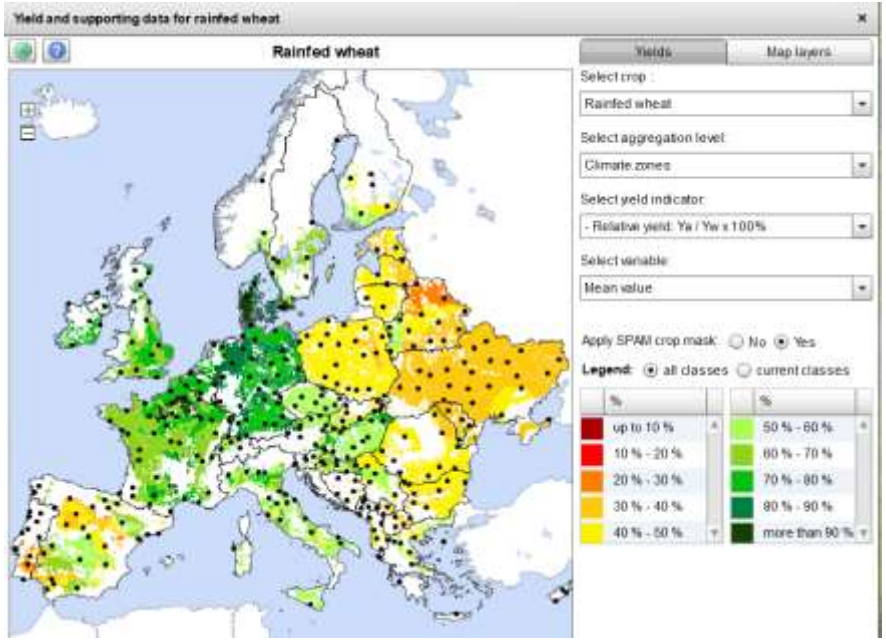
Iglesias et al., 2012 (Climatic Change)

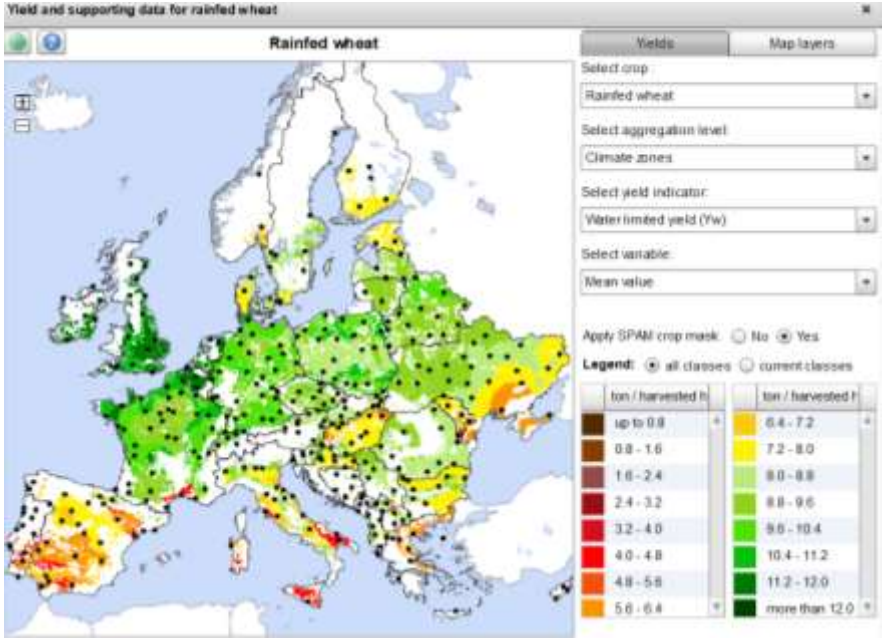
M: Management – yield gap closure

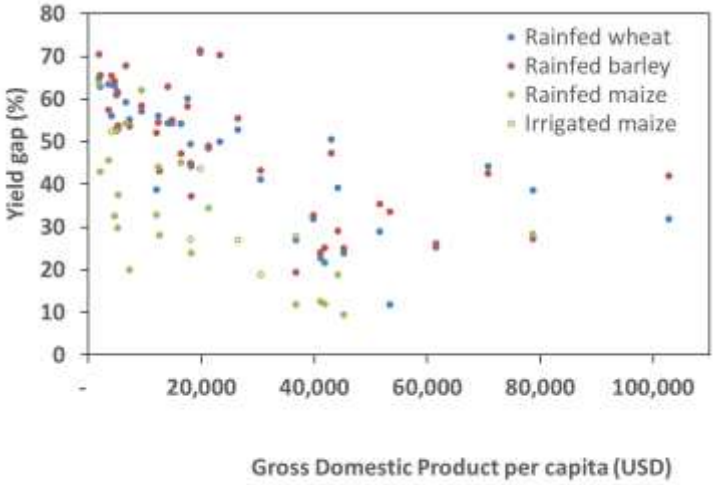


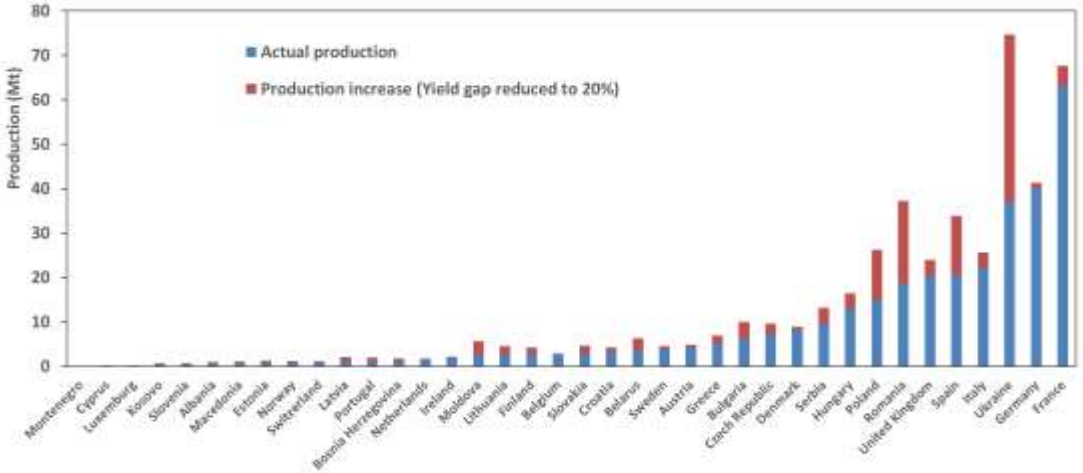
Modified from: van Ittersum and Rabbinge, *Field Crops Research* (1997)

M: Relative yield gap closure – scope for management





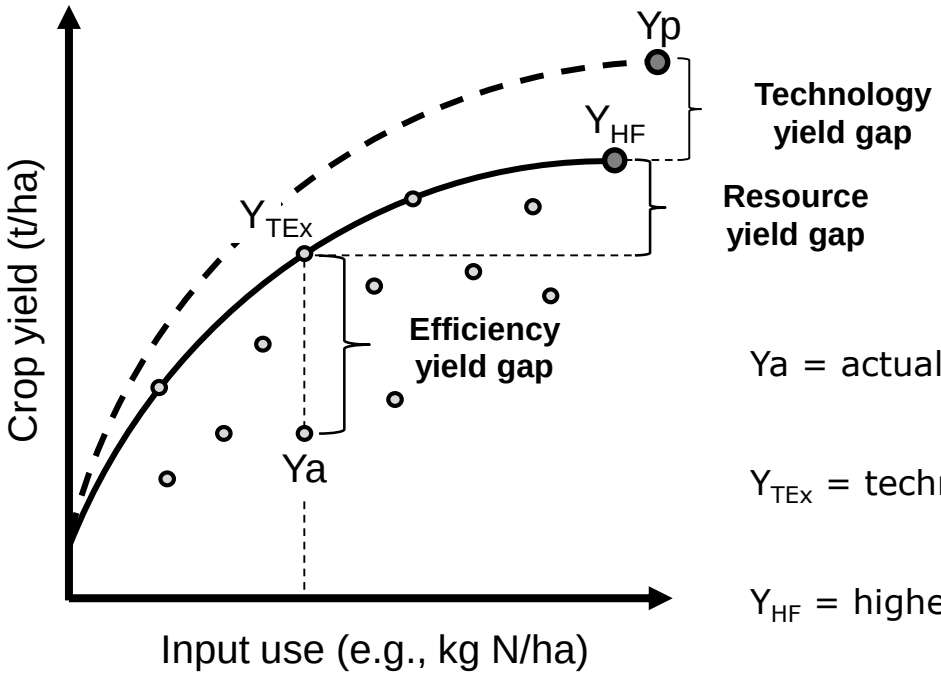




Yield gaps closed to 80% of Yw: + 128 Mt or 39% of wheat!

Schils et al. (2018) Eur. J. Agronomy

Yield gap decomposition



Ya = actual farmers' yields
- farm surveys: field / crop level

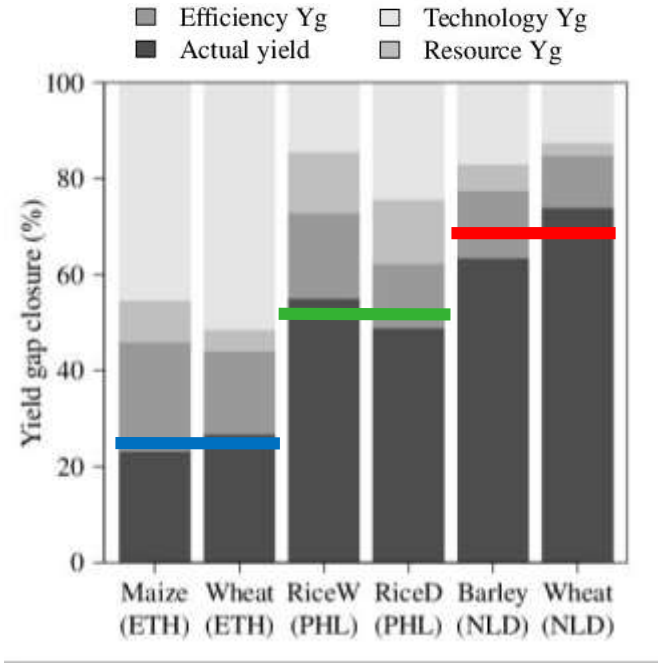
Y_{TEx} = technical efficient yields
- stochastic frontier analysis

Y_{HF} = highest farmers' yields
- average Ya > 90th percentile

Yp = climatic potential yield
- own simulations / GYGA

Schils et al. (2018) Eur. J. Agronomy

Yield gaps and their causes



Southern Ethiopia

Large yield gap attributed to technology yield gaps.

Silva et al. (AgSys, under review)

Central Luzon, Philippines

Medium yield gap due to efficiency, resource and technology yield gaps.

Silva et al. (2017a, EJA)

The Netherlands

Small yield gap attributed to efficiency yield gaps.

Silva et al. (2017b, AgSys)

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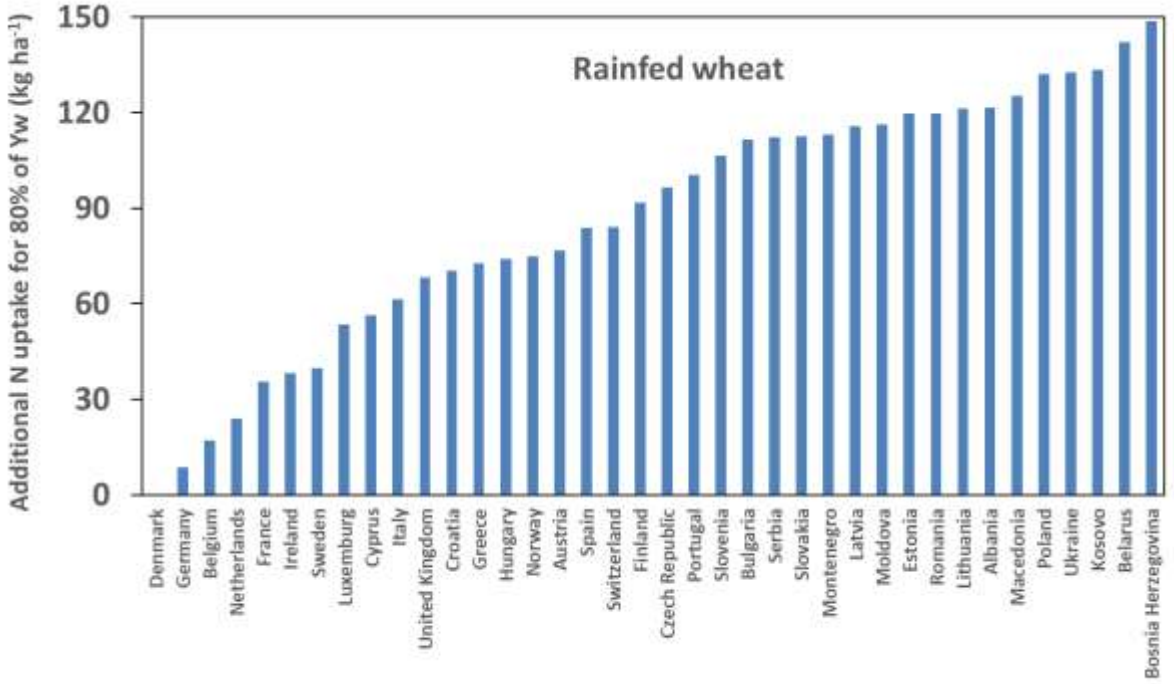
Silva et al. (2021) Global Food Security

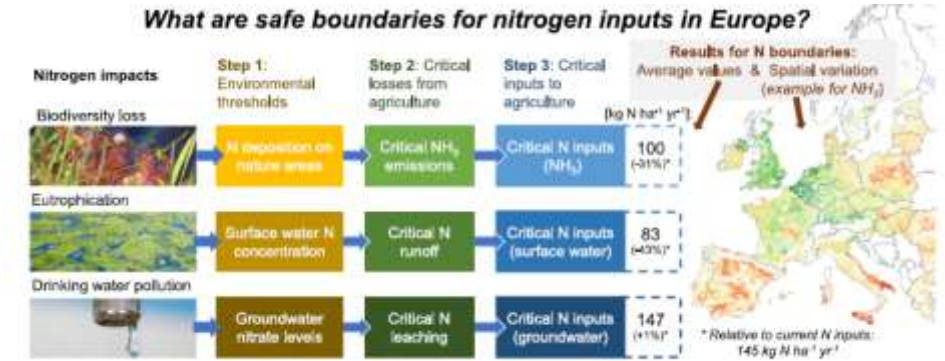
Additional N uptake when yields increase to 80% Yw



Schils et al. (2018) Eur. J. Agronomy

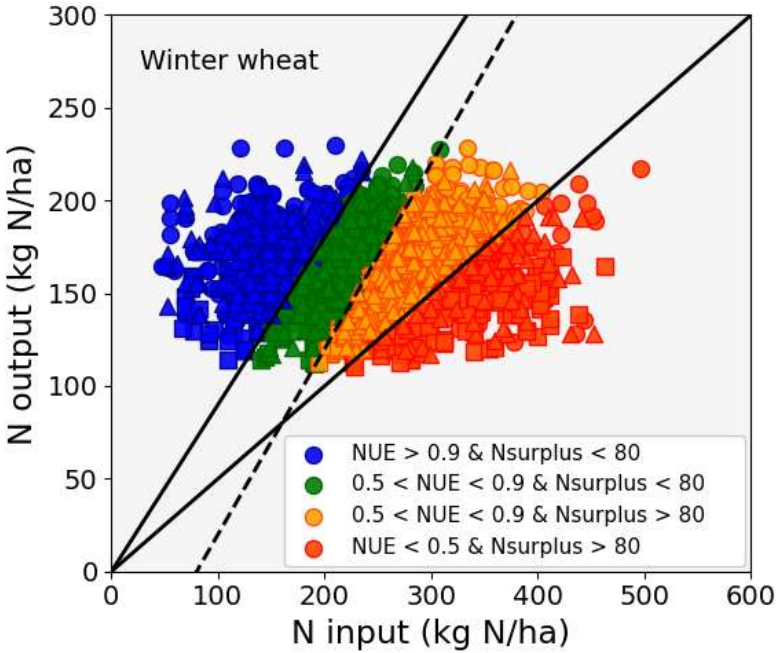
But...environmental limits

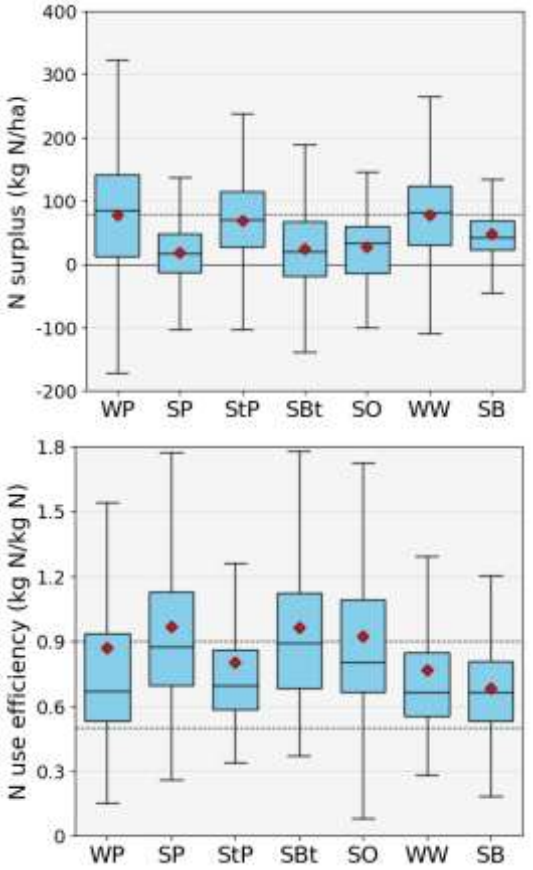
- To respect thresholds in EU N inputs must decrease:
  - 31% for N deposition
  - 43% for N concentration in runoff to surface water
  - 1% for nitrate concentration in leachate to groundwater



De Vries et al. (2021) Science of the Total Environment

Example for the Netherlands





Silva et al. (2021) Field Crops Research

To conclude

- Crop yields are a function of G x E x M
- There are substantial opportunities to increase production through better management (M)
- This will require more, and in particular better timing and placement of inputs
- While environmental limits must be respected
- Moreover, circularity requires increased use of organic inputs: good for system level performance, but challenging for crop management

Future harvest

Thank you for your attention!

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