The Global Yield Gap Atlas: current and future applications

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and many, many collaborators

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UNIVERSITY & RESEARCH

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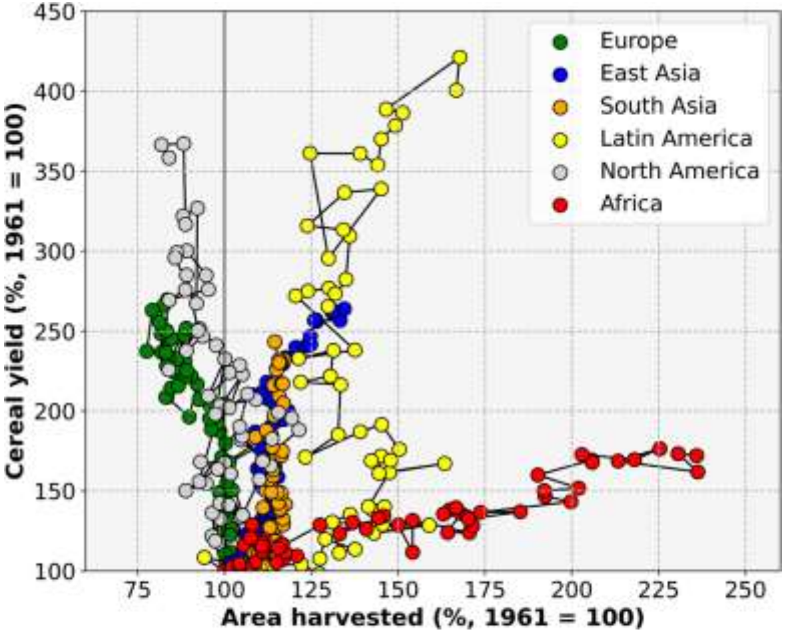
University of Nebraska Lincoln

Global Yield Gap Atlas

Future food production needs and possibilities

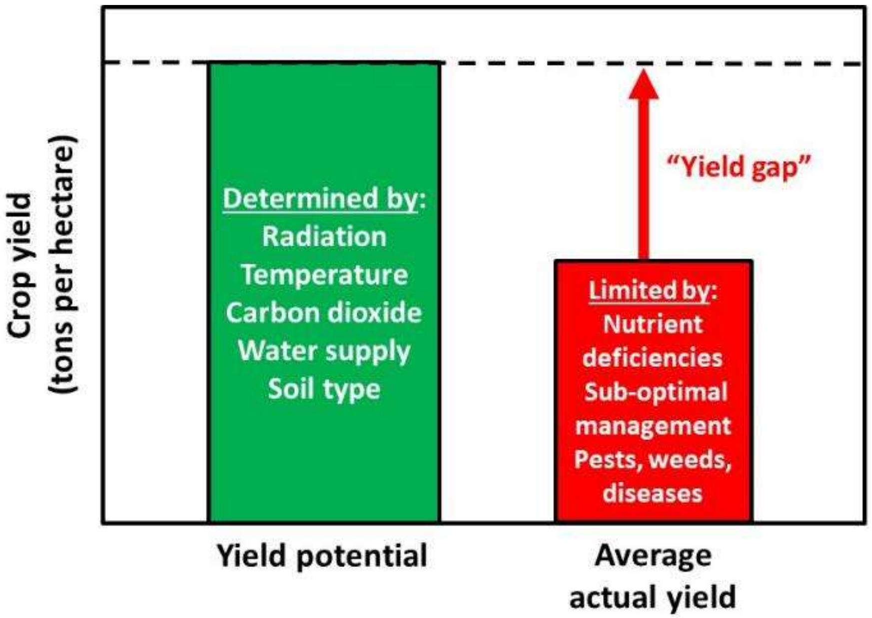
The need and possibilities for extra food is very region-specific

So, it is crucial to know where production can be increased and how



Giller, ... Van Ittersum (2021). Food Security

What is the Global Yield Gap Atlas (GYGA)?



The world's leading database platform on **high-quality agronomic data** with **local to global relevance** of the following data:

1. Actual and potential yield and yield gap
2. Actual and potential water productivity
3. Actual and potential nutrient requirements
4. Underlying data on weather, soil and cropping systems
5. Climate zones and Technology Extrapolation Domains (TEDs)

Van Ittersum et al. (2013) Field Crops Research

Coverage of GYGA

Figure 1 (above): Countries involved in GYGA

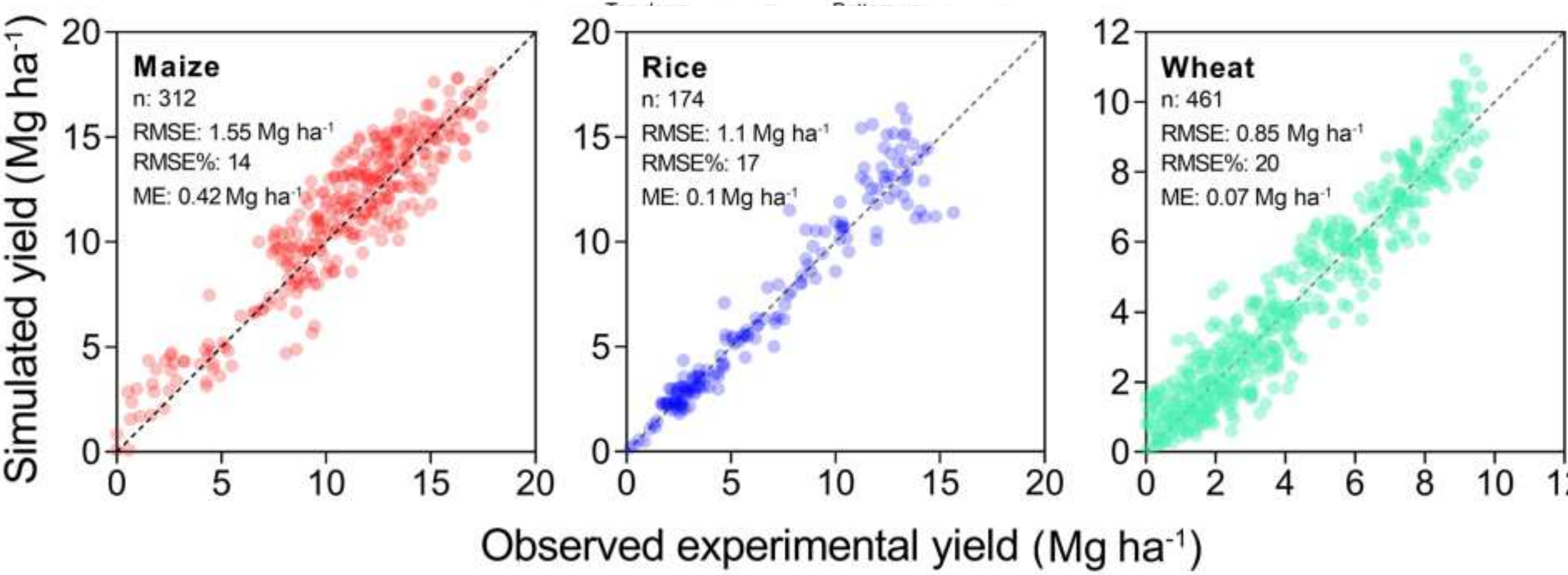
Crop	% Global area	% Global production
Rice	88%	91%
Maize	76%	86%
Wheat	60%	65%
Soybean	71%	82%

- **Established in 2011**
- **70+ countries** across **six continents** and **13 major food crops**
- Serves strategic decision making and research **by public, private and non-profit sectors** for yield optimisation and resource use efficiency

www.yieldgap.org
Broad usage up to 2022:
50,000 website visits per year, 30,000 data downloads

Global Yield Gap Atlas

What makes GYGA's bottom -up approach unique?



Rattalino Edreira, Andrade, Cassman, Van Ittersum, Van Loon and Grassini (2021) Nature Food

GYGA team and our international network

(Not a complete overview)

Global Yield Gap Atlas

Yield gaps for rainfed maize

(red and green indicate cases with largest and smallest gaps, respectively)

Since 2019: Yield Gap Closure indicator for the assessment of SDG2 by the United Nations Sustainable Development Solutions Network (UN-SDSN)

gap.org

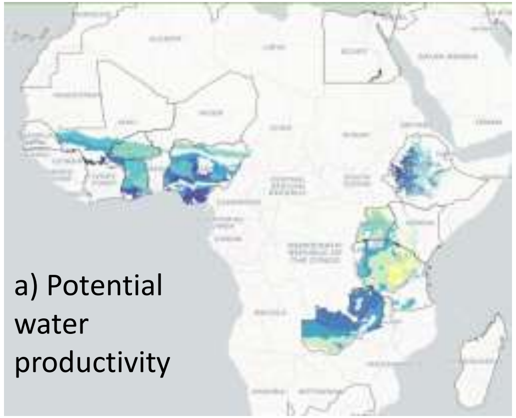
Global Yield Gap Atlas

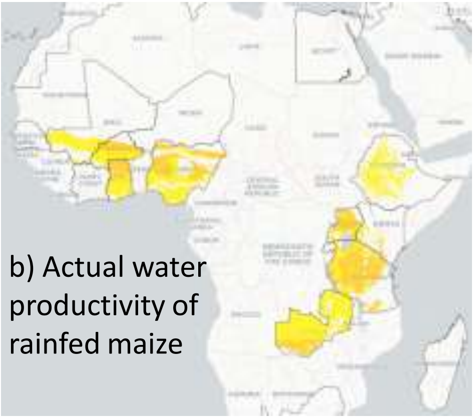
Resource use efficiency

Rainfed maize

Legend:

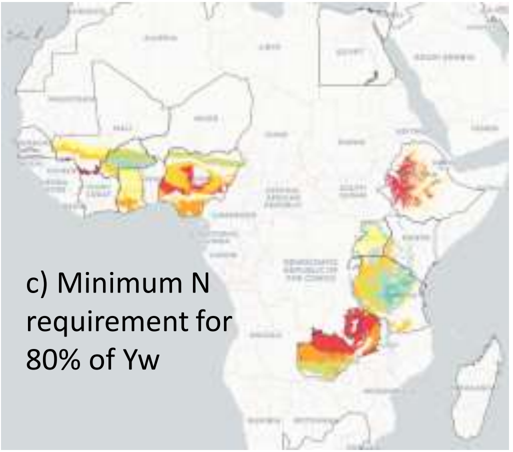
kg / mm water ha	kg / mm water ha
up to 3	15 - 18
3 - 6	18 - 21
6 - 9	21 - 24
9 - 12	24 - 27
12 - 15	more than 27

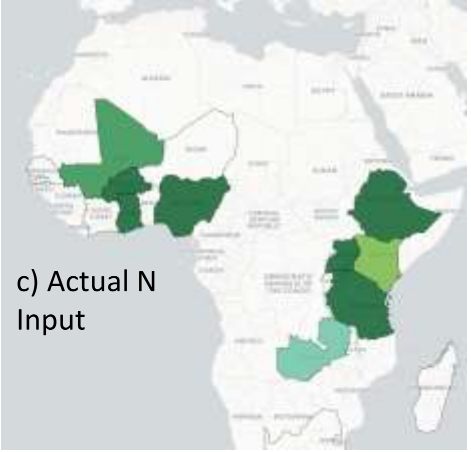

a) Potential water productivity


b) Actual water productivity of rainfed maize

Legend:

kg N/harvested ha	kg N/harvested ha
up to 10	110 - 145
10 - 20	145 - 185
20 - 35	185 - 230
35 - 55	230 - 280
55 - 80	280 - 335
80 - 110	more than 335


c) Minimum N requirement for 80% of Yw


c) Actual N Input

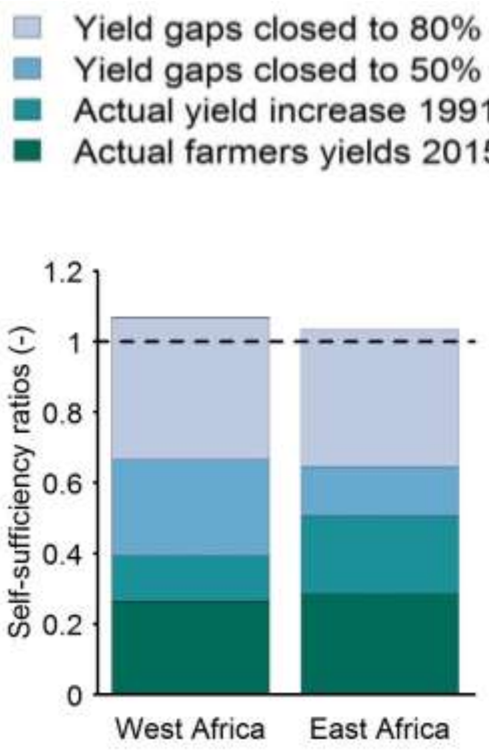
GYGA updates

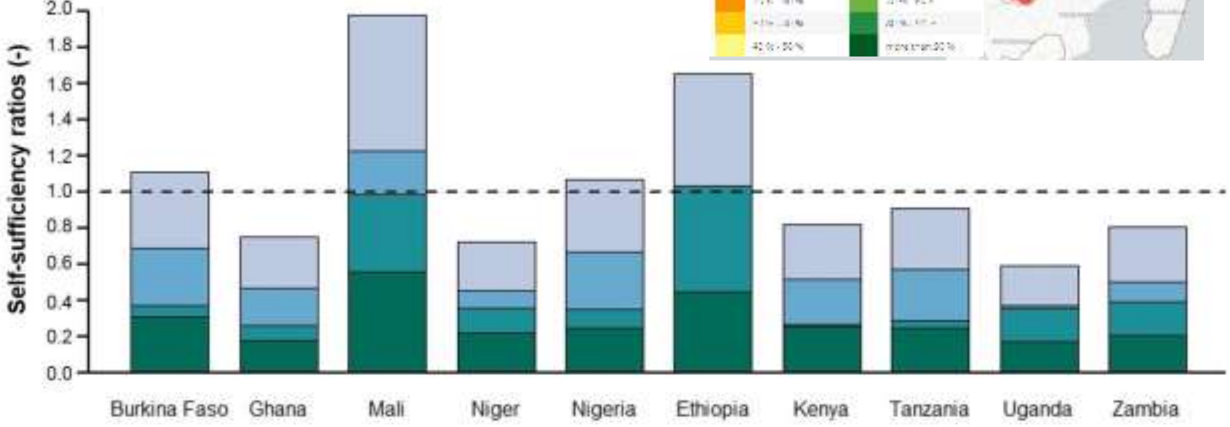
- **What has been updated/added in 2022?**
  - Establishment of API access (available for Gold and Platinum sponsors)
  - Addition of cotton in China; wheat in China and Canada; rice in Argentina; soybean in Europe; rice in South East Asia; faba bean and peas in Europe
  - Updated data cereals of 10 countries in Sub-Saharan Africa
- **What is in the pipeline for 2023?**
  - Updated data for maize, wheat, and soybean in Argentina
  - Update of wheat in Australia
  - Addition of sunflower in Argentina; soybean in China; soybean, wheat, maize in Paraguay; wheat in Georgia; potato in Europe
  - Effects of climate change scenarios on yield gaps for cereals in SSA

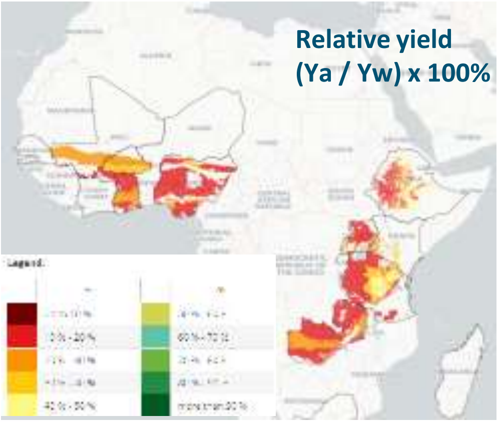
Global Yield Gap Atlas

Current and future applications

Can sub-Saharan Africa feed itself? 10 countries - 2050



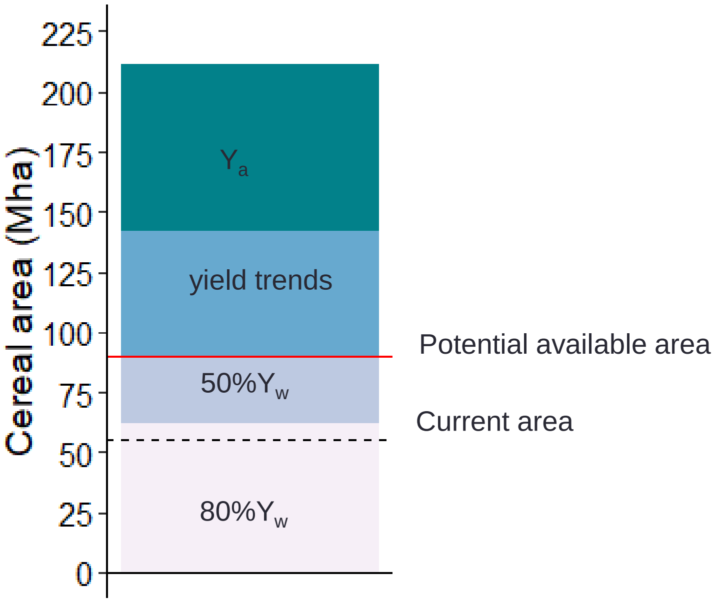




Update of: Van Ittersum et al., 2016 (PNAS)

Self-sufficiency through area expansion?

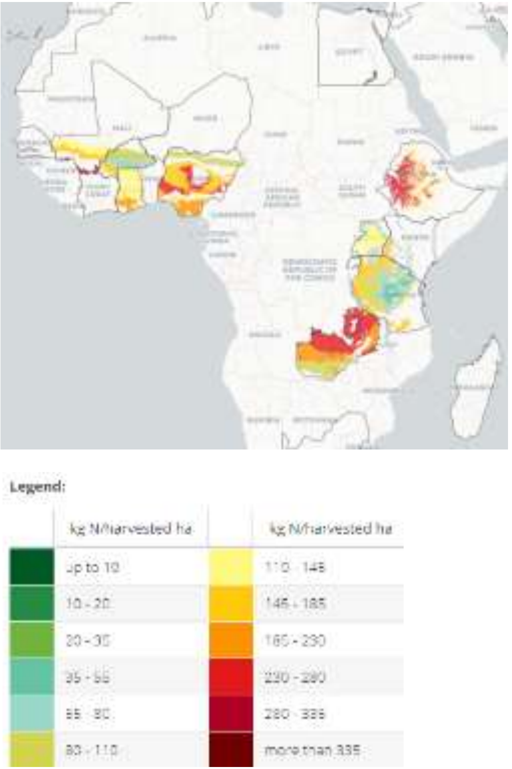
- Current area is just enough with 80% Yw for ten SSA countries
- Potentially available area is just sufficient with 50%Yw
- Lower yields require land that is not there!



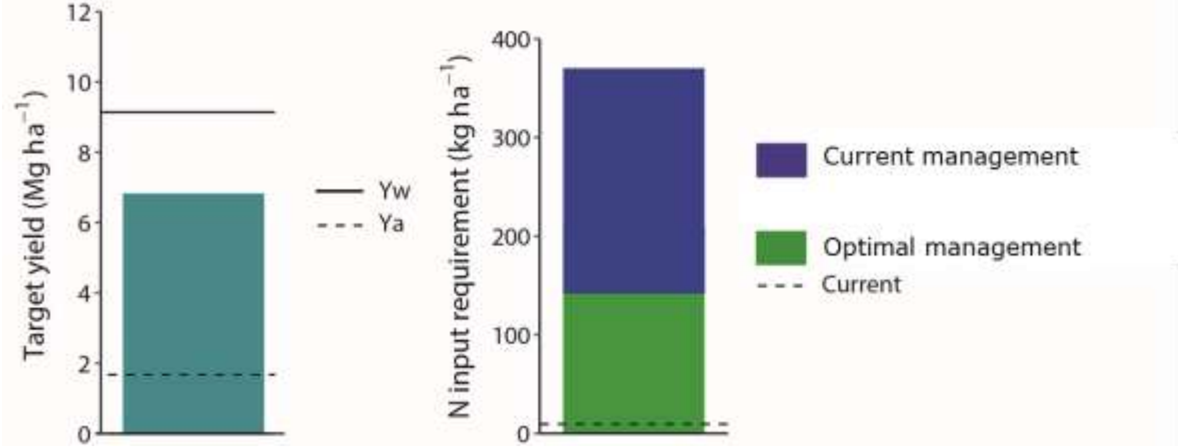
Update of: Van Ittersum et al., 2016 (PNAS)
Chamberlin et al., 2014 (Food Policy)

Nitrogen input requirements

- Crop nutrient requirements will have to increase, current yields are achieved at the expense of soil nutrient mining

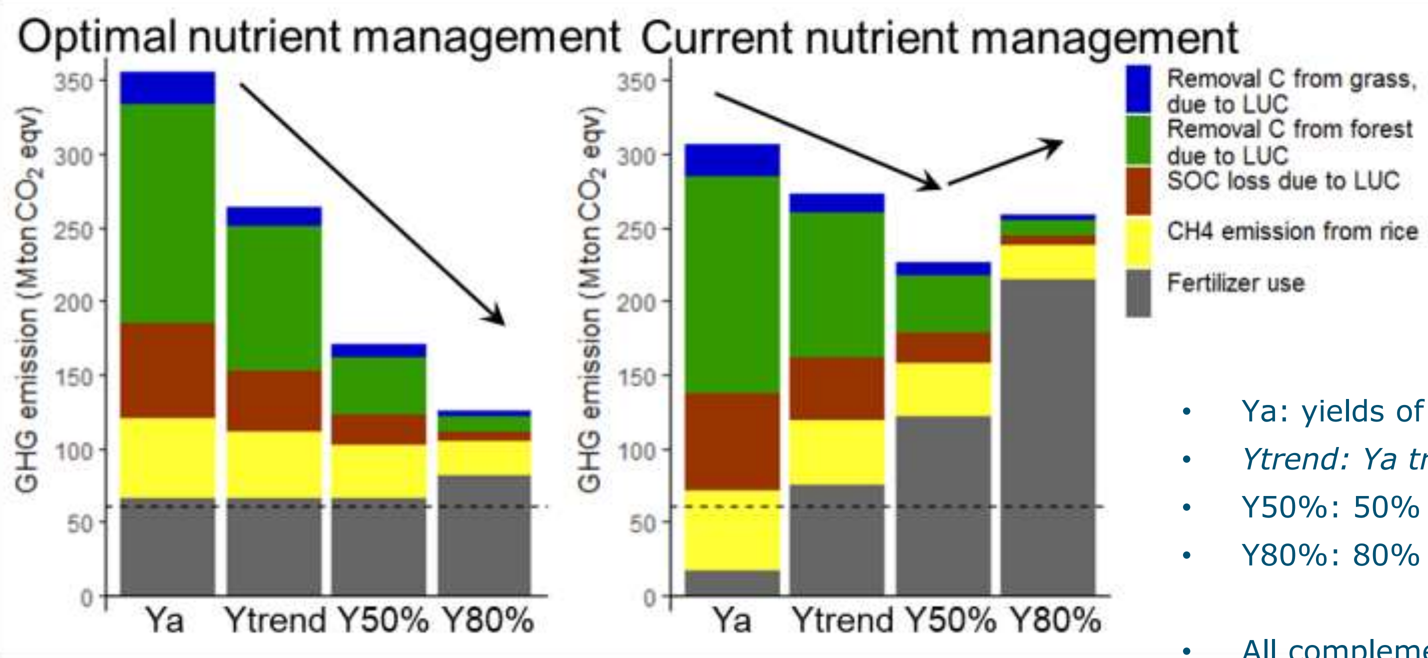


Example for maize: minimum N requirement for 80% of Yw



Source: Ten Berge et al. (2019) Global Food Security

GHG emissions cereal self-sufficiency 2050



- Ya: yields of 2015
- *Ytrend: Ya trend extrapolated to 2050*
- Y50%: 50% Yw
- Y80%: 80% Yw

- All complemented with area expansion to achieve SS=1

Global Yield Gap Atlas

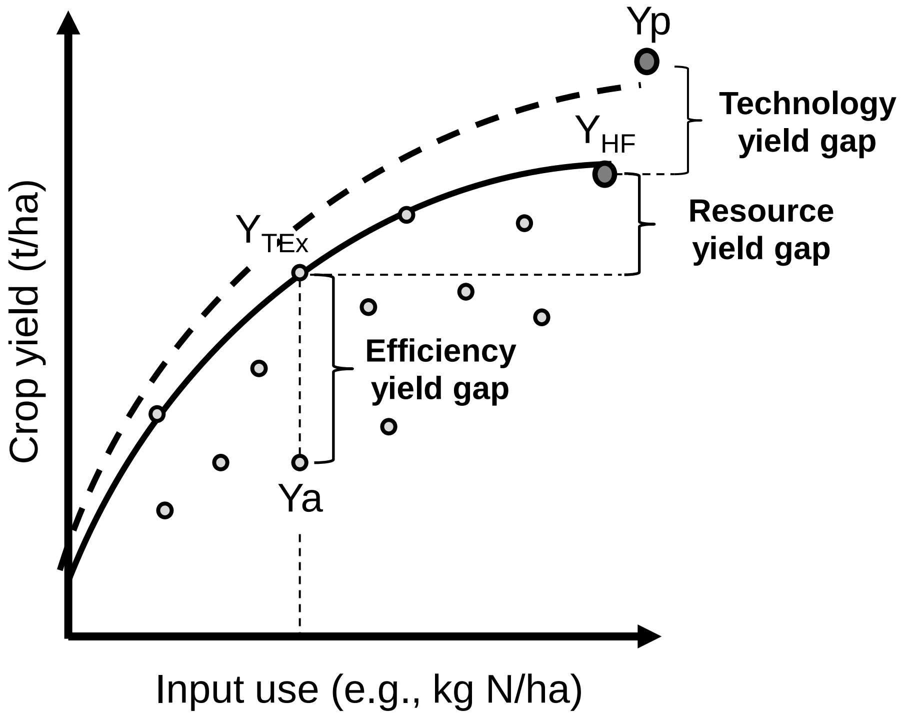
Source: Van Loon et al. (2019) Global Change Biology & Van Dam (2020) MSc thesis

Other food availability studies

- China – rice (Yuan et al., 2021)
- SE Asia – rice (Deng et al., 2019)
- Iran – all crops (Soltani et al., 2020)
- Indonesia – Oilpalm (Monzon et al., 2021)
- Europe (Schils et al., 2018)
- Crisis in Ukraine (De Sourza Noia Junior et al., 2022)
- Grain legume production in Europe and substitution of animal-based proteins (Van Loon et al., in prep)

Extending yield gap work

- Understanding yield gaps: yield gap decomposition
- Towards agronomic and policy interventions
- Genetic yield gaps
- Extending yield gap notion to intercrops, perennials, crop-livestock
- Climate change impact and adaptation



Silva et al. (2017) Eur. J. Agron.

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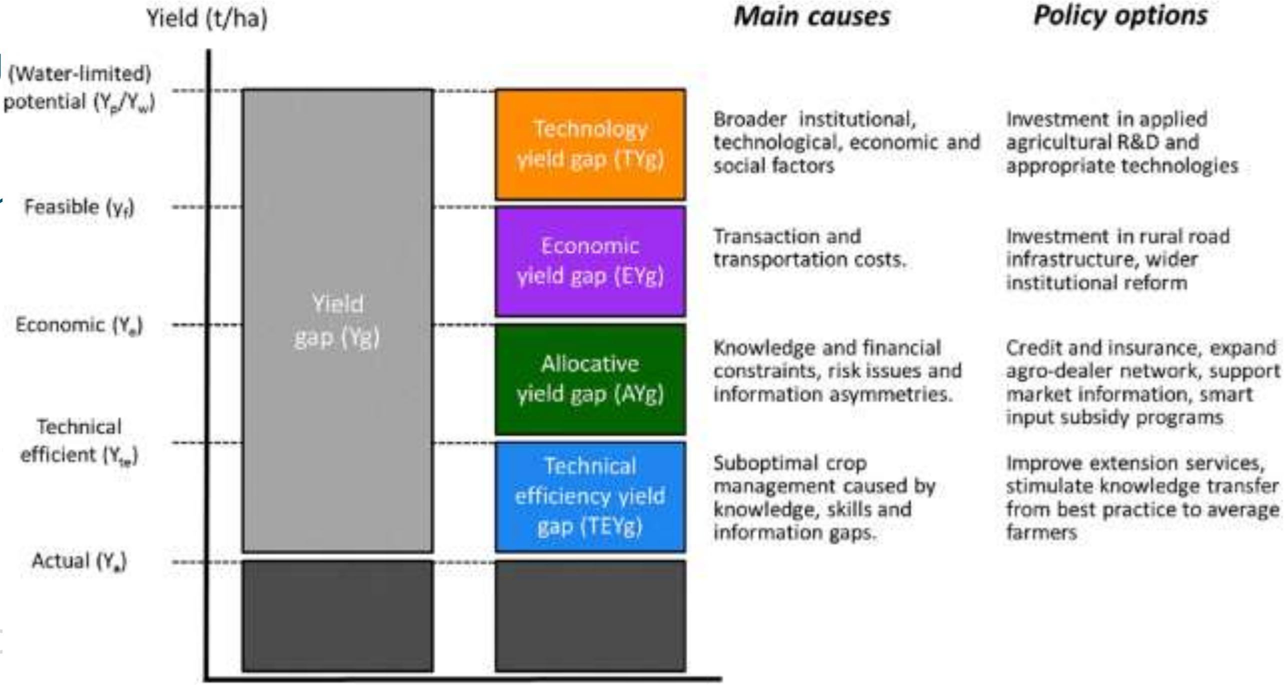

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Van Dijk et al. (2020) Agricultural Systems

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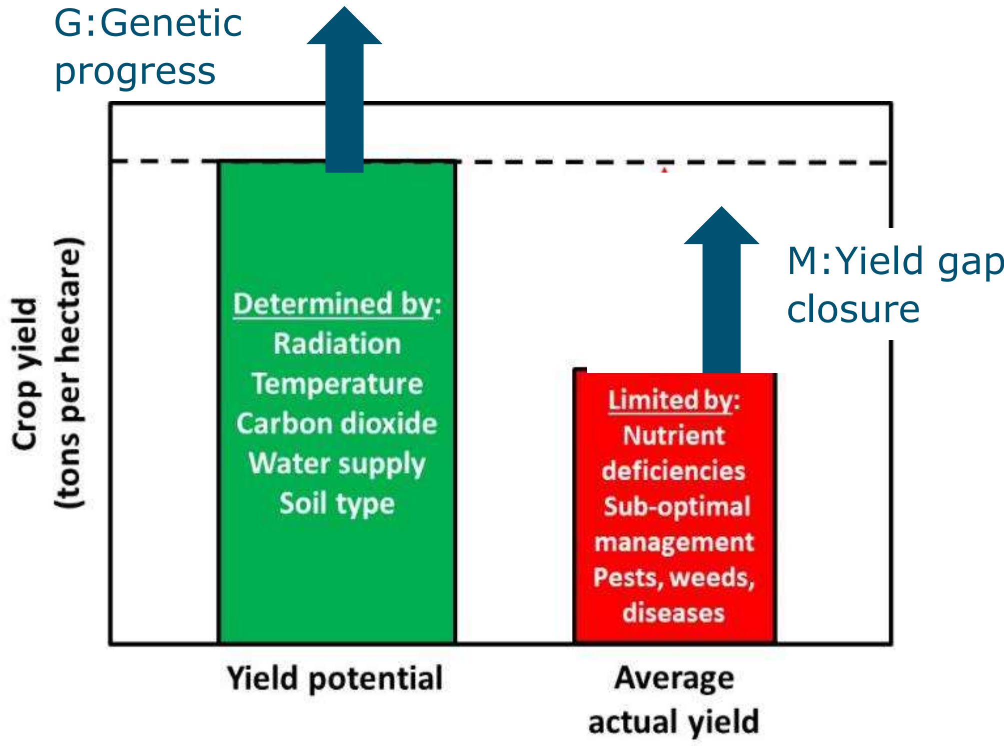

Senapati et al. (2022) Nature Food

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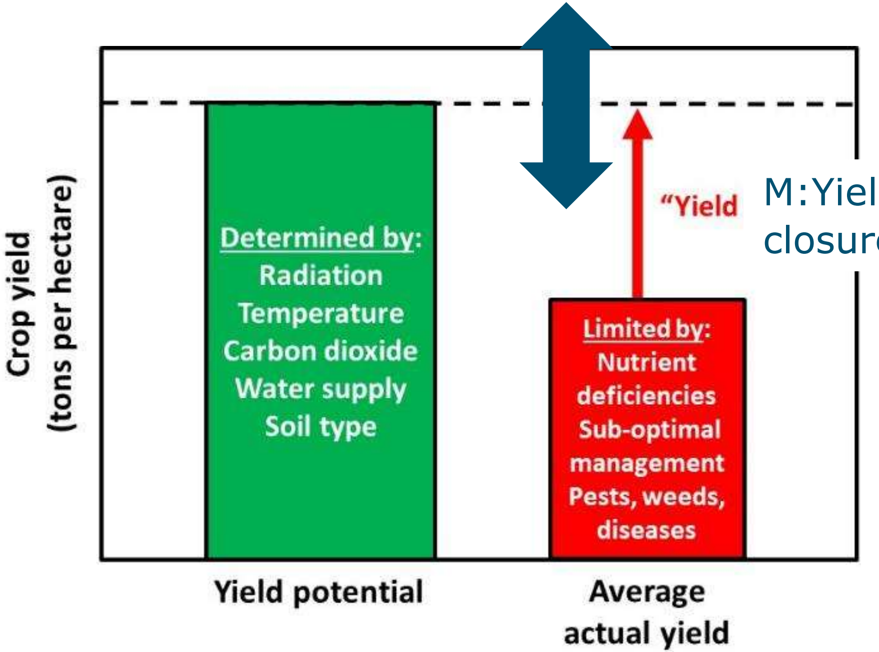
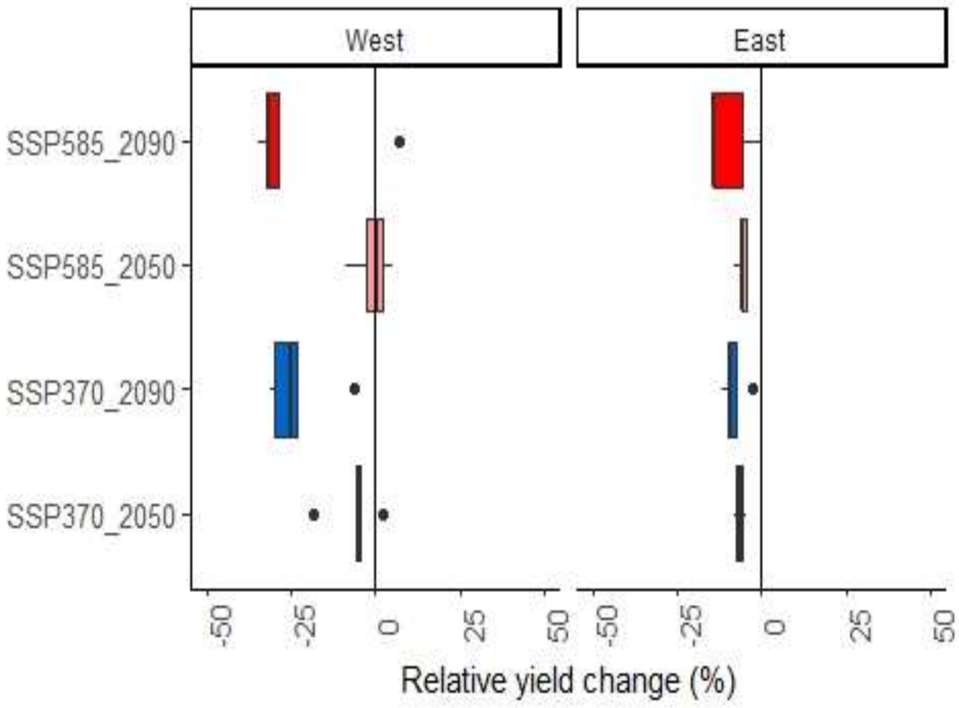
E:Climate (change)



M:Yield gap closure

Climate change impact on rainfed potential yield of four cereals in SSA



Aggregated effect on four cereals: maize, millet, sorghum and wheat in 10 countries:

- West SSA
  - 2050: not significantly affected
  - 2090: minus -25%
- East SSA
  - 2050: minus 6%
  - 2090: minus 9%

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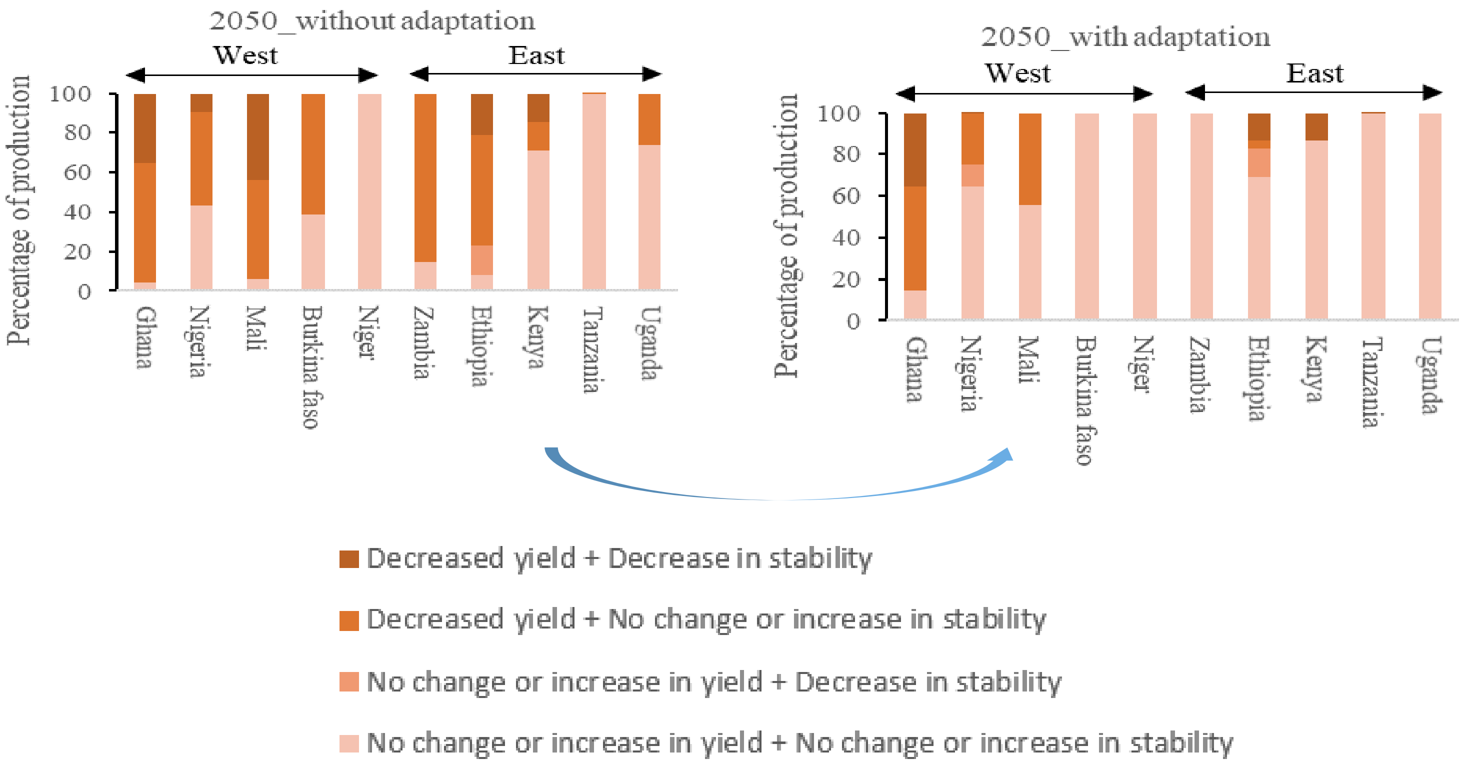
Alimagham et al., in review

Adaptation using existing cultivars of four cereals



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Future harvest

Thank you for your attention

- Explore www.yieldgap.org
- Reach out to us at gyga.support@wur.nl
- Or martin.vanittersum@wur.nl