Yield gap analysis of cereals in Europe

Supported by local knowledge

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Yield gap analysis of cereals in Europe

- Background
- Methods
- Example for winter wheat
Background of yield gap analysis

- Challenge to keep production on track with demand
- Identify regions with unlocked yield capacity
- Identify regional causes of yield gaps
- Develop options to close yield gaps
Production ecological principles

Yield gap

Potential

Water limited

Water and nutrient limited

Actual

Defining factors
- Radiation
- Carbon dioxide
- Temperature
- Crop features

Limiting factors
- Water
- Nutrients

Reducing factors
- Weeds
- Pests and diseases
- Pollutants

Crop Yield

eg. Van Ittersum & Rabbinge, 1997
Yield gap analysis of cereals in Europe

- **Background**

- **Methods**
  - Global versus local studies
  - Approach in Global Yield Gap Atlas

- **Example for winter wheat**
Global and continental yield gap studies

- Consistent
- Generic crop growth models
- Coarse, lacking local detail and hence less agronomic relevance

Mueller et al., 2012
Licker et al., 2010
Global studies: a comparison at local level

Data from Stehfest et al. (2007), Deryng et al. (2011) & Müller et al. (2012)

After Van Ittersum et al., 2013
Regional and local yield gap studies

- Inconsistent concepts and methods
- models, experiments, best management practices
- local relevance, but difficult to compare

Fermont et al., 2009

Hochman et al., 2012
Global Yield Gap Atlas (GYGA) approach

- **Bottom-up**
  - local data for weather, cropping systems and soils
  - involving local scientists
  - upscaling to national, continental and global levels

- **Standard protocols**, available at [www.yieldgap.org](http://www.yieldgap.org)

- **Transparency**
  - data available at [www.yieldgap.org](http://www.yieldgap.org)
Country agronomist

- To improve quality and local relevance
- Data collection
- Co-running locally calibrated models
- Assessing the outcome
Spatial framework and upscaling

After Ewert et al., 2011

Stratification Climate Zones

Identification of sampling points Weather Station Buffer Zones

Aggregation to Climate Zones

Aggregation to countries

Crop yield simulation in buffer zones

Combinations of
- Dominant soil types
- Dominant cropping systems

After Ewert et al., 2011
Derived versus actual weather

Van Wart et al., 2013
Yield gap analysis of cereals in Europe

- Background

- Methods

- Example for winter wheat
  - Germany
  - Poland
  - The Netherlands
GYGA standard protocol, step by step

Climate zones

Crop-specific harvested areas

Weather station buffer zones

Soil types and cropping systems

Crop model simulations

Actual yields

Yield gaps
Climate zones – GYGA extrapolation domain

Three factors
- Growing degree days (10)
- Aridity (10)
- Temperature seasonality (3)

Van Wart et al., 2013
Selected climate zones for wheat

Selected zones: 
>5% of national harvested area

Climate zones
Harvested areas
(SPAM)
Weather stations > 15 years daily data
Weather station buffer zones – 100 km
Selected weather station buffer zones

> 50% cover of harvested area
European Soil Database

- Available Water Capacity
- Maximum rooting depth
- Ground water classification

Panagos et al., 2012
Select dominant soil map units

Soil map units

3 dominant soil map units

Harvested areas
Crop model simulations

- Potential and water-limited yield

- Runs per country
  - 3 to 4 crops
  - 3 to 15 weather buffer zones per crop
  - 3 soil map units x 5 soil type units
  - 15 to 20 years

- Calibrated crop models
  - WOFOST for all countries
  - Local model (optional)
Observed yields in variety trials

- **Variety trials**
  - ~ 700 recent crop-year-location combinations
  - Selected best variety

- **Potential yield**
  - Ample nutrients and crop protection
  - No water stress

- **Water-limited yield**
  - Ample nutrients and crop protection
  - Rainfed
Crop model simulations – potential yield
Actual yields (Ya) from regional statistics

- Recent five years
- NUTS-2 or NUTS-3 level
- Converted to DM yield
Yield gap: \((Y_w - Y_a)\), relative to \(Y_w\)
Comparison CGMS – GYGA: Potential yield

Boogaard et al., 2013

Crop Growth Monitoring System
- 25 x 25 km grid
- Interpolated weather per grid cell
- Model inputs per grid cell

Global Yield Gap Atlas
- Selected zones
- Actual weather per station zone
- Model inputs per zone
Comparison CGMS – GYGA: Potential yield

<table>
<thead>
<tr>
<th>Station</th>
<th>CGMS (t DM/ha)</th>
<th>GYGA (t DM/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schleswig</td>
<td>9.0</td>
<td>9.9</td>
</tr>
<tr>
<td>Neuruppin</td>
<td>8.5</td>
<td>8.0</td>
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<tr>
<td>Dresden</td>
<td>9.0</td>
<td>7.8</td>
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<tr>
<td>Mannheim</td>
<td>8.8</td>
<td>7.8</td>
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</table>
Yield gap analysis of cereals in Europe

- Global Yield Gap Atlas (GYGA) uses a consistent global approach with local relevance

- Interested to join?