FACCE-MACSUR

Yield Gaps of cereals across Europe

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WU-PPS, ZALF, IUNG, CEIGRAM, AU, SRI, UHMC, UHMI, INIAV, MU, ARVALIS, INRA, University of Agronomic Sciences and Veterinary Medicine of Bucharest, SLU, LUKE, TEAGASC, ADAS, SRUC, University of Leeds, VUPOP, Agricultural University – Plovdiv, University of Thessaly, Iowa State University, VITO, UNISS, Ages, Agroscope, Norwegian Institute for Bioeconomy Research, Norwegian university of life sciences, Wageningen Environmental Research.

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Instrument:	Joint Programming Initiative
Topic:	Agriculture, Food Security, and Climate Change
Project:	Modelling European Agriculture with Climate Change for Food Security (FACCE-MACSUR)
Start date of project:	1 June 2014
Duration:	36 months
Theme, Work Package:	CropM 6.3 / XC9.1
Deliverable reference num.:	C6.3/XC9.1-D1
Deliverable lead partner:	Wageningen University
Due date of deliverable:	April 2017
Submission date:	2017–06–09
Confidential till:	-

Revision	Changes	Date
1.0	First Release	2017-06-09

Abstract/Executive summary

The increasing global demand for food requires a sustainable intensification of crop production in low-yielding areas. Actions to improve crop production in these regions call for accurate spatially explicit identification of yield gaps, i.e. the difference between potential or water-limited yield and actual yield. The Global Yield Gap Atlas (GYGA) project proposes a consistent bottom-up approach to estimate yield gaps.

For each country, a climate zonation is overlaid with a crop area map. Within climate zones with important crop areas, weather stations are selected with at least 10 years of daily data. For each of the 3 dominant soil types within a 100 km zone around the weather stations, the potential and water-limited yields are simulated with the WOFOST crop model, using location-specific knowledge on crop systems. Data from variety trials or other experiments, approaching potential or water-limited yields, are used for validation and calibration of the model. Actual yields are taken from sub-national statistics. Yields and yield gaps are scaled up to climate zones and subsequently to countries.

The average national simulated wheat yields under rainfed conditions varied from around 5 to 6 t/ha/year in the Mediterranean to nearly 12 t/ha/year on the British Isles and in the Low Countries. The average actual wheat yield varied from around 2 to 3 t/ha/year in the Mediterranean and some countries in East Europe to nearly 9 t/ha/year on the British Isles and in the Low Countries. The average relative yield gaps varied from around 10% to 30% in many countries in Northwest Europe to around 50% to 70% in some countries in the Mediterranean and East Europe. The paper will elaborate on results per climate zone and soil type, and will also include barley and maize. Furthermore we will relate yield gaps to nitrogen use.

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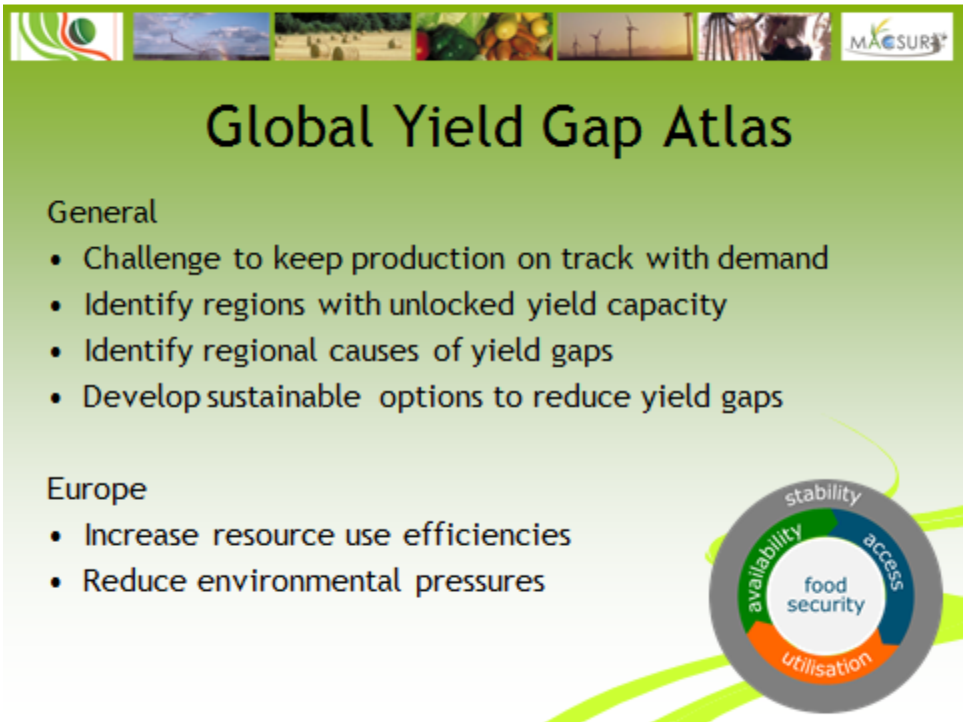
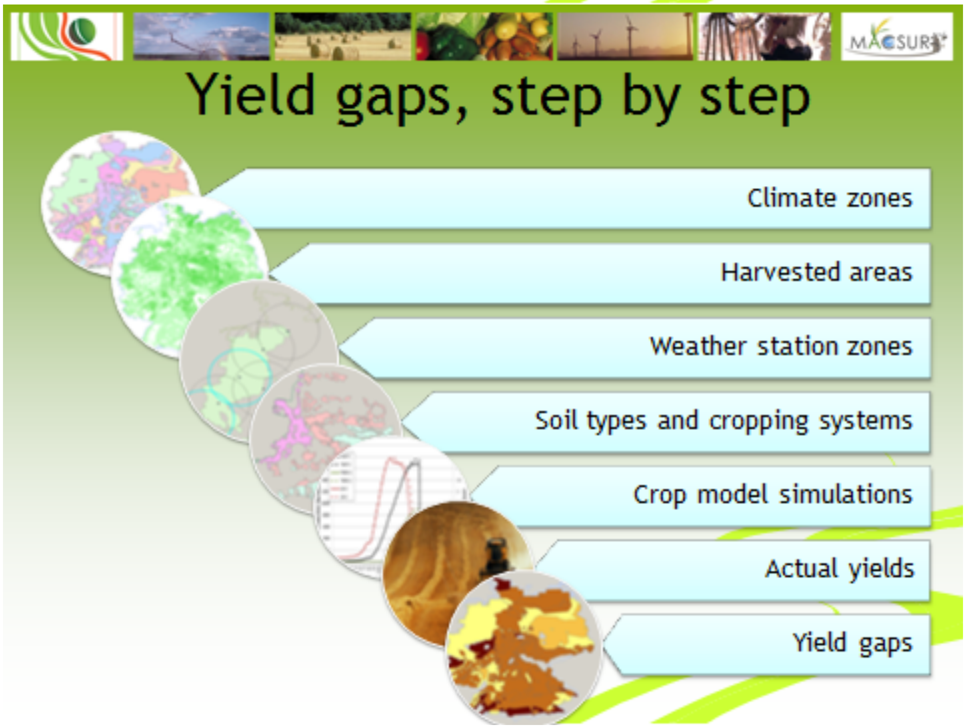
Introduction

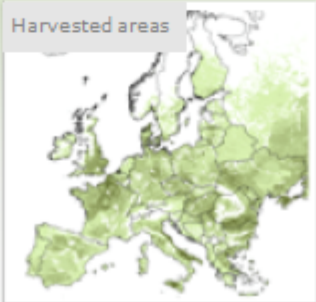


Methods


GYGA approach
• Bottom-up
– country-by-country approach
– using local data
– involving local scientists
• Standard protocols
– eg. Grassini et al., 2015 ; Van Bussel et al., 2015
• Transparency
– data available at www.yieldgap.org


Yield gaps, step by step
Climate zones
Harvested areas
Weather station zones
Soil types and cropping systems
Crop model simulations
Actual yields
Yield gaps

Selected climate zones for wheat



Country	All CZs (n)	Selected CZs (n)	Cover (%)
Netherlands	2	2	100
Switzerland	10	5	99
Denmark	3	2	99
Finland	6	3	99
Slovenia	7	5	99
Belgium	5	3	98
Hungary	8	6	98
Ireland	5	3	98
Sweden	11	5	98
United Kingdom	13	6	98
Bulgaria	23	5	97
Belarus	11	7	97
Estonia	4	2	97
Germany	16	9	97
Slovakia	14	9	96
France	26	10	95
Poland	17	9	95
Czech Republic	14	6	94
Austria	12	8	94
Lithuania	11	3	93
Luxemburg	4	1	89
Portugal	36	8	89
Norway	5	1	88
Romania	26	7	87
Ukraine	30	10	86
Latvia	7	2	85
Italy	33	9	84
Spain	48	13	82
Greece	37	8	73

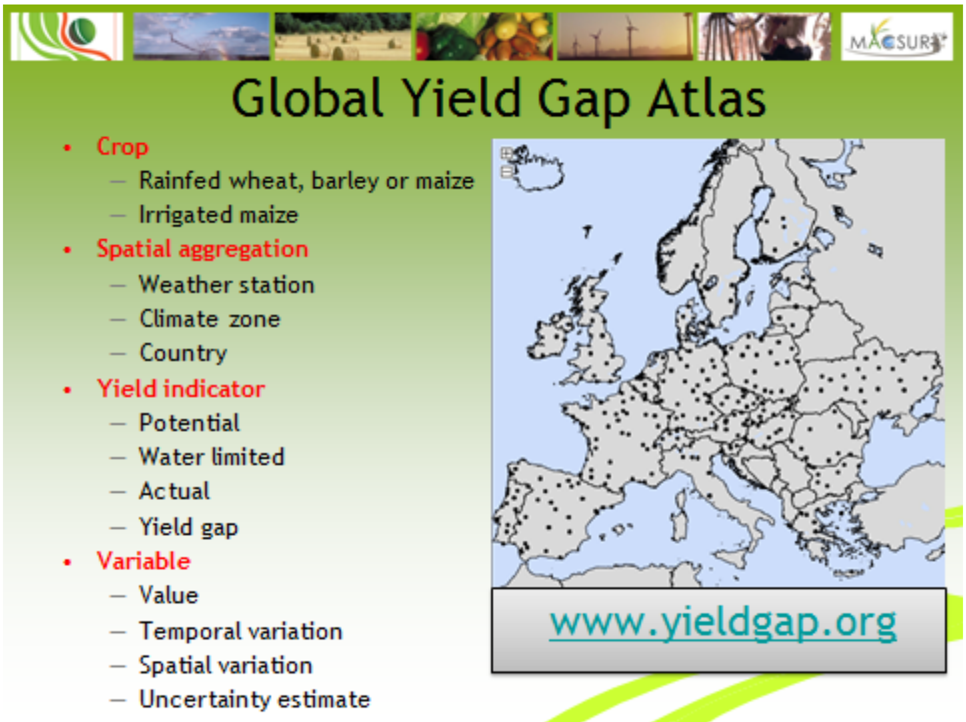
Crop model simulations

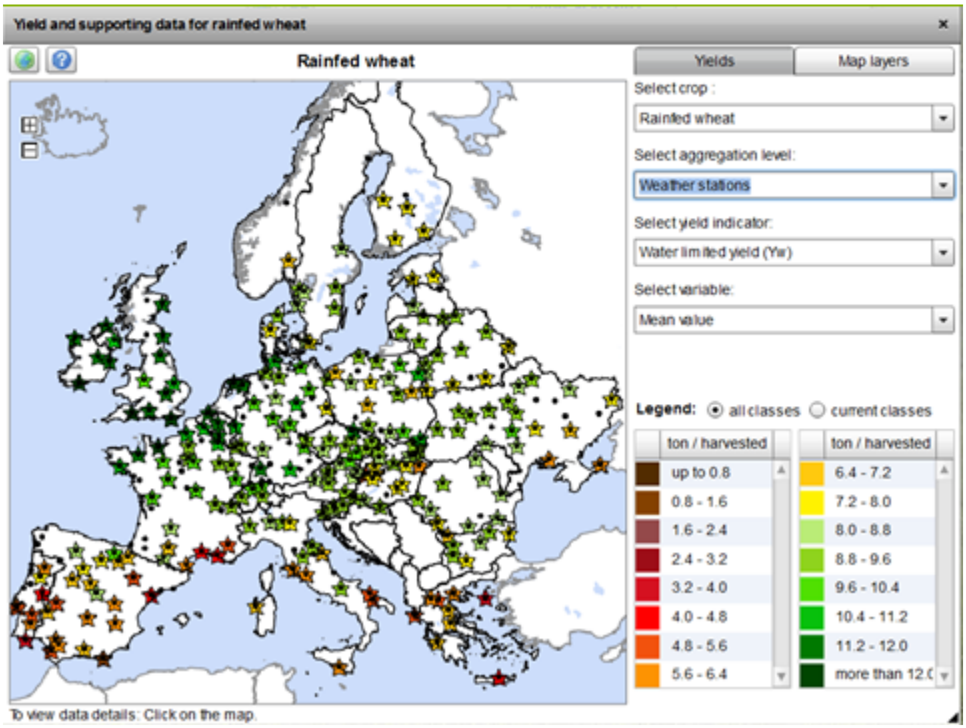
- WOFOST
- Potential yield (irrigated systems)
- Water-limited yield (rainfed systems)
- Simulation runs are combinations of
  - Weather station
  - Crop
  - Cropping system
  - Soil
  - Year

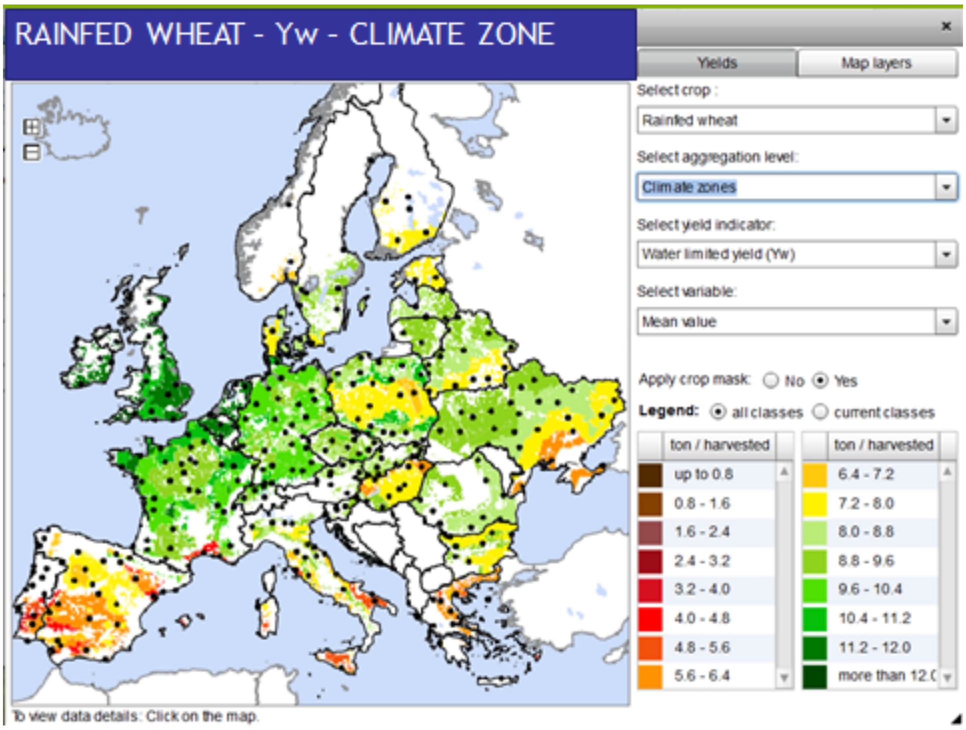
Calibration and validation

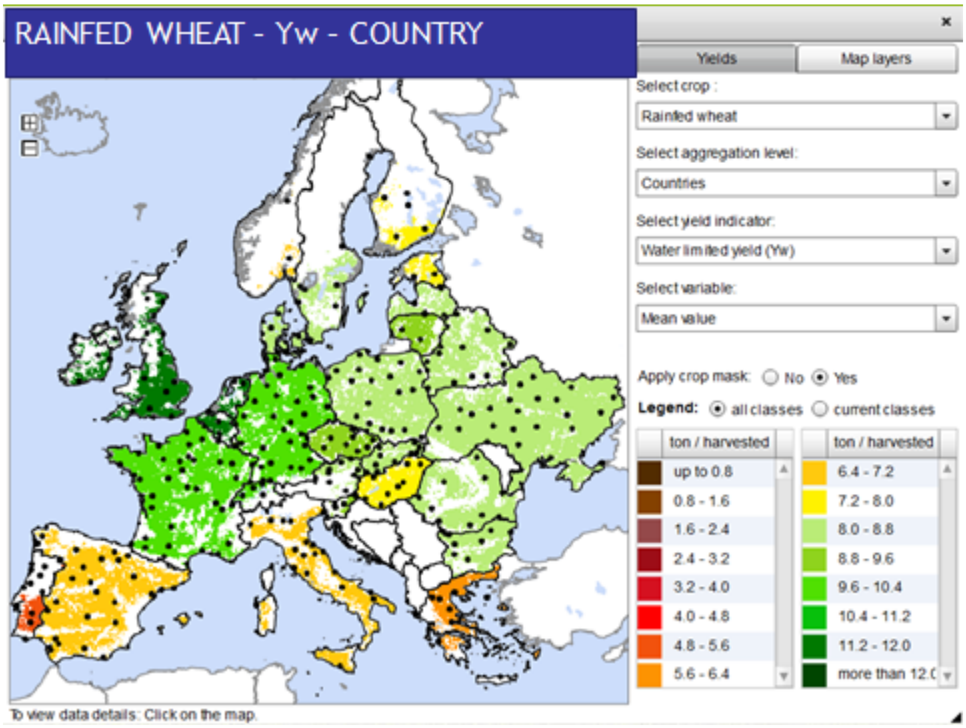
- Starting point
  - Default crop files based on Boons Prins et al., 1993 and Wolf et al. (2008)
- Calibration
  - Local crop calendars -> database (Country, CZ, Crop)
  - Check on plausibility of LAI_{max} and Harvest Index
- Validation
  - Grain yield of experiments
  - Country agronomists

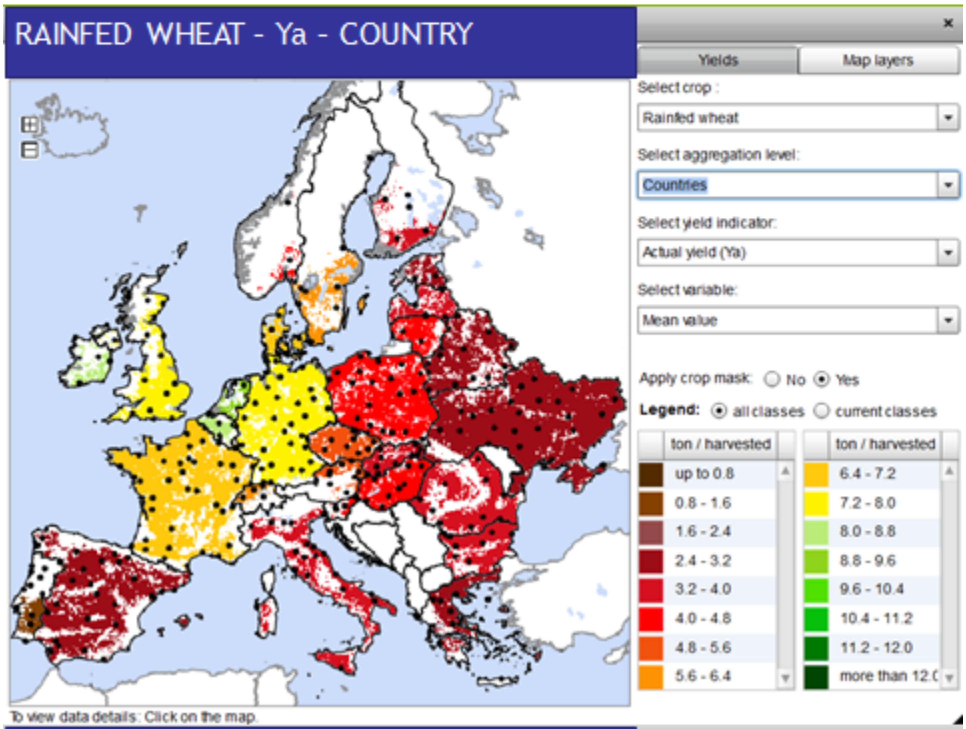
Results

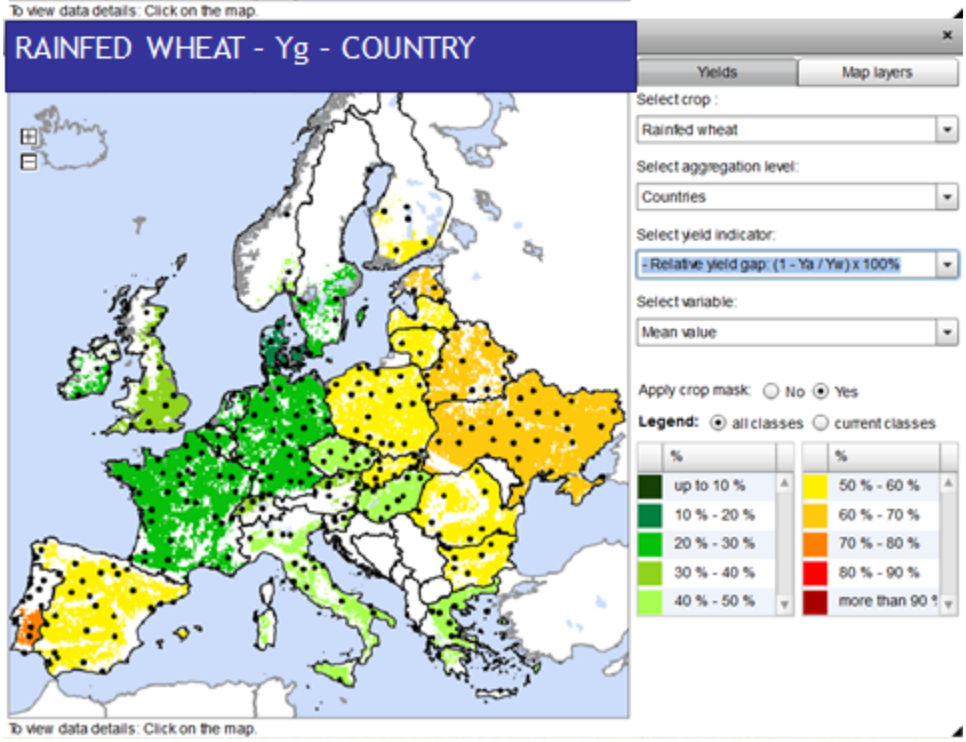

Global Yield Gap Atlas
Crop
Rainfed wheat, barley or maize
Irrigated maize
Spatial aggregation
Weather station
Climate zone
Country
Yield indicator
Potential
Water limited
Actual
Yield gap
Variable
Value
Temporal variation
Spatial variation
Uncertainty estimate
www.yieldgap.org


Yield and supporting data for rainfed wheat
Rainfed wheat
Yields
Map layers
Select crop :
Rainfed wheat
Select aggregation level:
Weather stations
Select yield indicator:
Water limited yield (Yw)
Select variable:
Mean value
Legend:
all classes
current classes
ton / harvested
up to 0.8
0.8 - 1.6
1.6 - 2.4
2.4 - 3.2
3.2 - 4.0
4.0 - 4.8
4.8 - 5.6
5.6 - 6.4
6.4 - 7.2
7.2 - 8.0
8.0 - 8.8
8.8 - 9.6
9.6 - 10.4
10.4 - 11.2
11.2 - 12.0
To view data details: Click on the map.


RAINFED WHEAT - Yw - CLIMATE ZONE
Yields
Map layers
Select crop :
Rainfed wheat
Select aggregation level:
Climate zones
Select yield indicator:
Water limited yield (Yw)
Select variable:
Mean value
Apply crop mask: No Yes
Legend: all classes current classes
ton / harvested
up to 0.8
0.8 - 1.6
1.6 - 2.4
2.4 - 3.2
3.2 - 4.0
4.0 - 4.8
4.8 - 5.6
5.6 - 6.4
ton / harvested
6.4 - 7.2
7.2 - 8.0
8.0 - 8.8
8.8 - 9.6
9.6 - 10.4
10.4 - 11.2
11.2 - 12.0
more than 12.0
To view data details: Click on the map.


RAINFED WHEAT - Yw - COUNTRY
Yields
Map layers
Select crop :
Rainfed wheat
Select aggregation level:
Countries
Select yield indicator:
Water limited yield (Yw)
Select variable:
Mean value
Apply crop mask: No Yes
Legend: all classes current classes
ton / harvested
up to 0.8
0.8 - 1.6
1.6 - 2.4
2.4 - 3.2
3.2 - 4.0
4.0 - 4.8
4.8 - 5.6
5.6 - 6.4
ton / harvested
6.4 - 7.2
7.2 - 8.0
8.0 - 8.8
8.8 - 9.6
9.6 - 10.4
10.4 - 11.2
11.2 - 12.0
more than 12.0
To view data details: Click on the map.


RAINFED WHEAT - Ya - COUNTRY
Yields
Map layers
Select crop :
Rainfed wheat
Select aggregation level:
Countries
Select yield indicator:
Actual yield (Ya)
Select variable:
Mean value
Apply crop mask: No Yes
Legend: all classes current classes
ton / harvested
up to 0.8
0.8 - 1.6
1.6 - 2.4
2.4 - 3.2
3.2 - 4.0
4.0 - 4.8
4.8 - 5.6
5.6 - 6.4
ton / harvested
6.4 - 7.2
7.2 - 8.0
8.0 - 8.8
8.8 - 9.6
9.6 - 10.4
10.4 - 11.2
11.2 - 12.0
more than 12.0
To view data details: Click on the map


RAINFED WHEAT - Yg - COUNTRY
Yields
Map layers
Select crop :
Rainfed wheat
Select aggregation level:
Countries
Select yield indicator:
- Relative yield gap: (1 - Ya / Yw) x 100%
Select variable:
Mean value
Apply crop mask: No Yes
Legend: all classes current classes
%
up to 10 %
10 % - 20 %
20 % - 30 %
30 % - 40 %
40 % - 50 %
%
50 % - 60 %
60 % - 70 %
70 % - 80 %
80 % - 90 %
more than 90 %
To view data details: Click on the map