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Crop Monitoring in Europe – the MARS Crop Yield Forecasting System

Stefan Niemeyer

Monitoring Agricultural Resources Unit, Joint Research Centre

EXPO Milano, 09 October 2015

Overview

1. Why Crop Monitoring in Europe?
2. The MARS Approach
3. Products and outreach

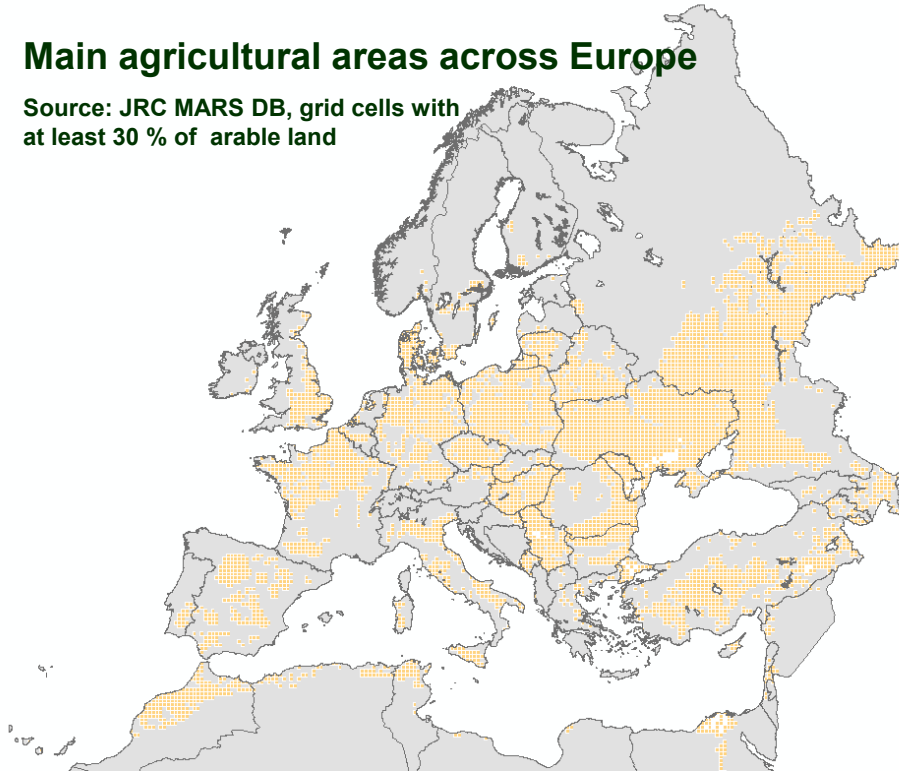


Key figures in EU Agriculture



Main agricultural areas across Europe

Source: JRC MARS DB, grid cells with at least 30 % of arable land



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Main agricultural areas across Europe

Source: JRC MARS DB, grid cells with at least 30 % of arable land

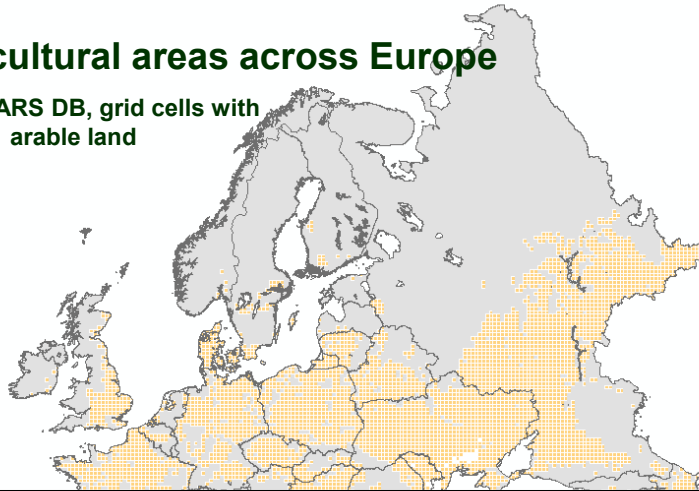
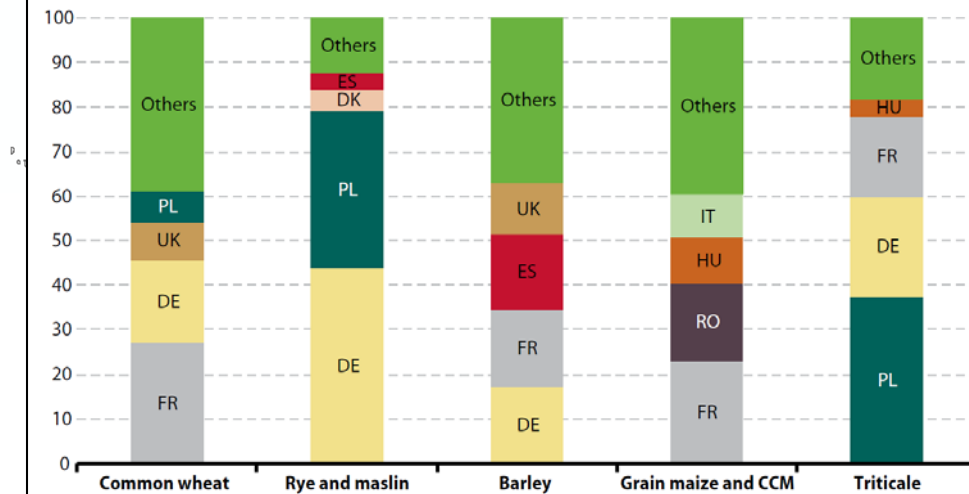
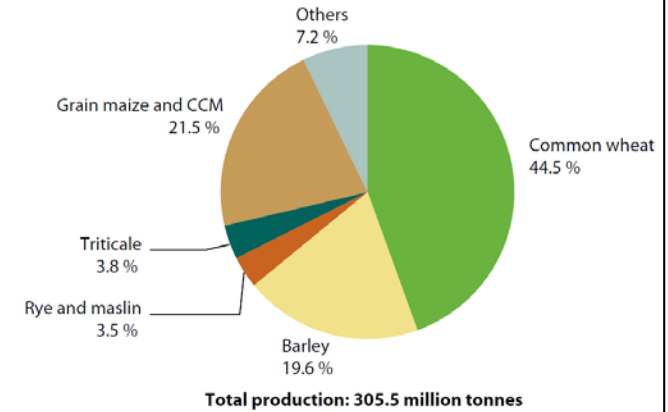


Figure 4.4: Production of cereals, 2013
(% of EU-28 total)



Source: Eurostat (online data code: [apro_cpp_crop](#))

Figure 4.2: Production of cereals in EU-28, 2013
(% of total production of cereals)



Source: Eurostat (online data code: [apro_cpp_crop](#))

Figure 4.1: Production of cereals, EU-28, 2007-13
(1 000 tonnes)

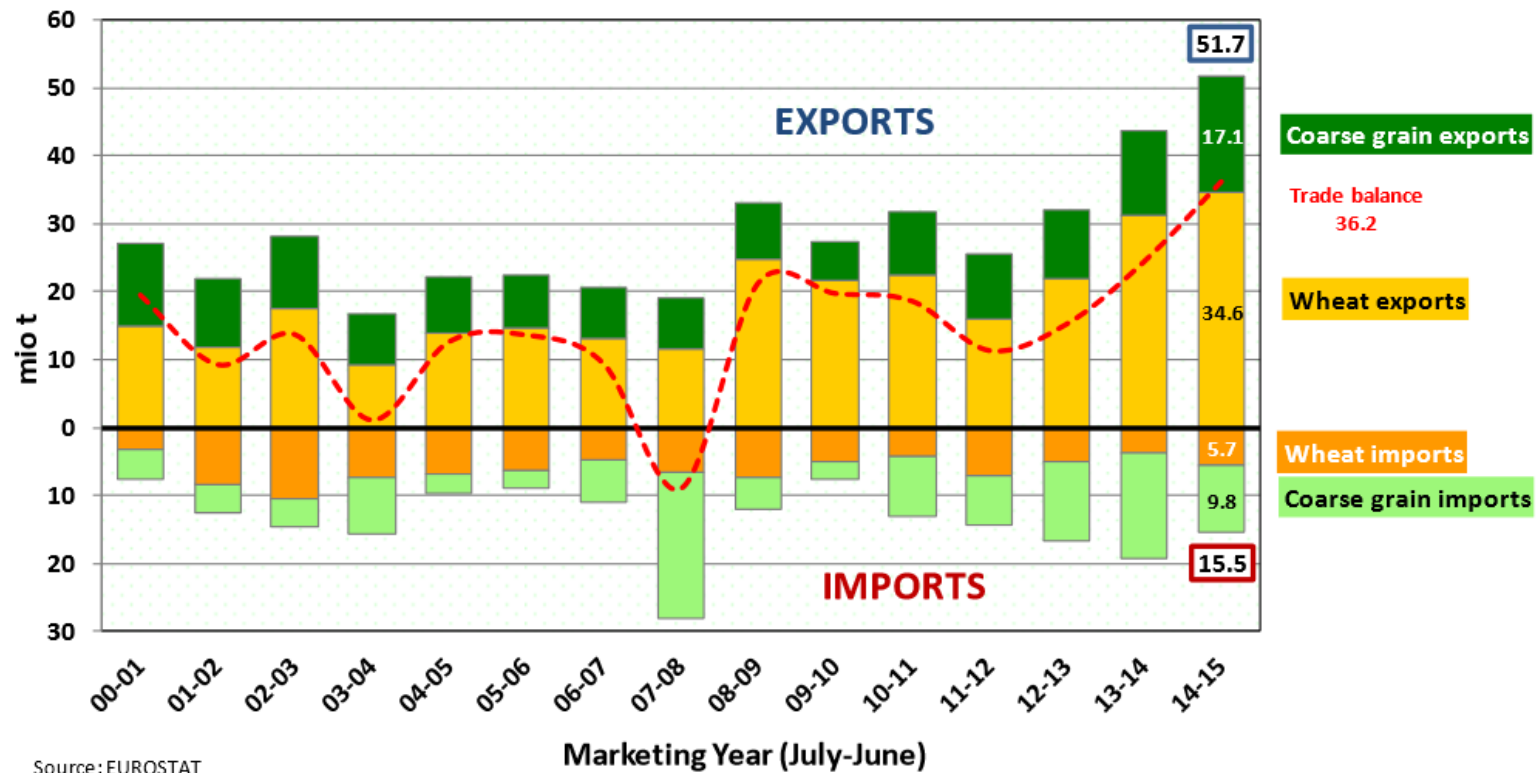


Source: Eurostat (online data code: [apro_cpp_crop](#))

Key figures in EU Agriculture



EU 28 - Cereals exports and imports from 2000/01 to 2014/15
including flour and other processed products in grain equivalent

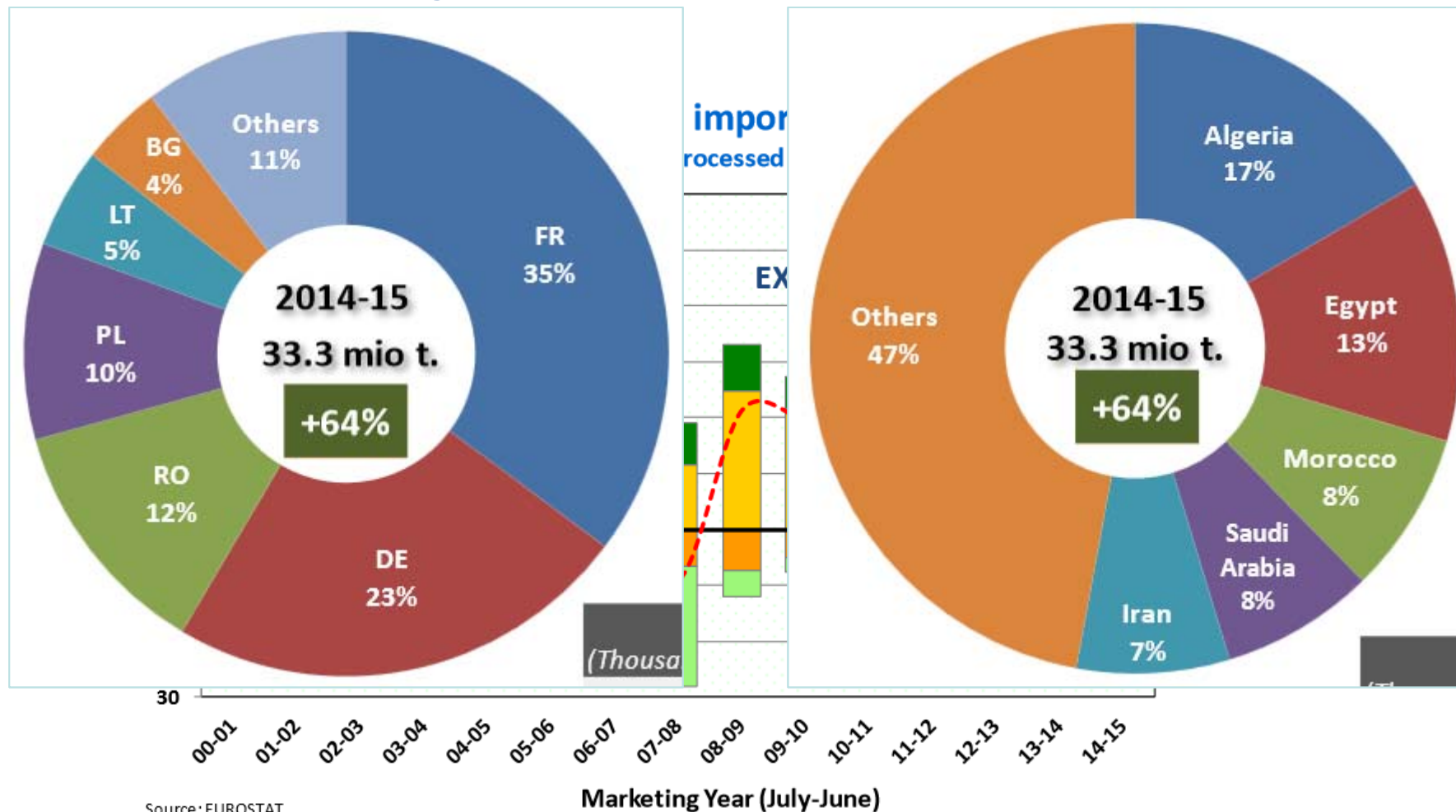


Source: EUROSTAT

Key figures in EU Agriculture



EU common wheat export (incl. flour and groats)

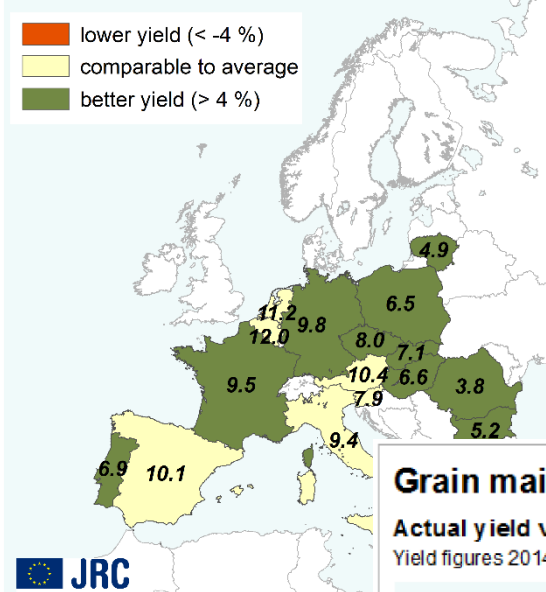


Grain maize - yield forecast 2011

Actual yield versus average yield 2006- 2010

Yield figures 2011 are expressed in t/ha and rounded to 100 kg

- lower yield (< -4 %)
- comparable to average
- better yield (> 4 %)

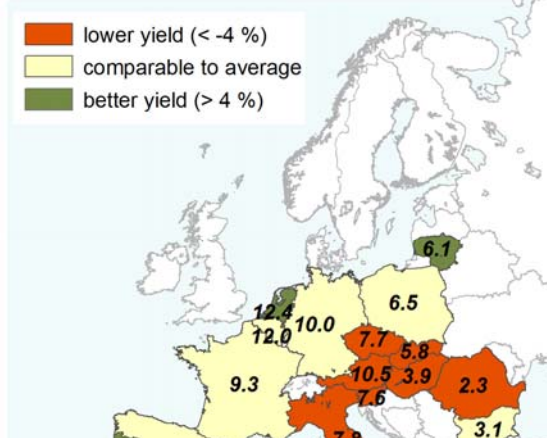


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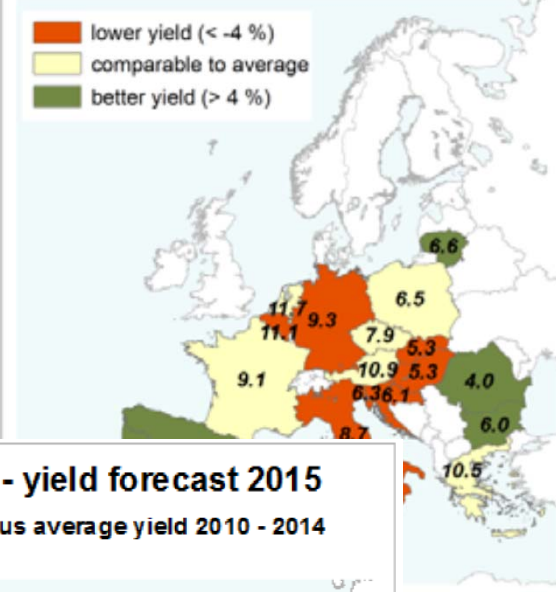


Grain maize - yield forecast 2013

Actual yield versus average yield 2008 - 2012

Yield figures 2013 are expressed in t/ha and rounded to 100 kg

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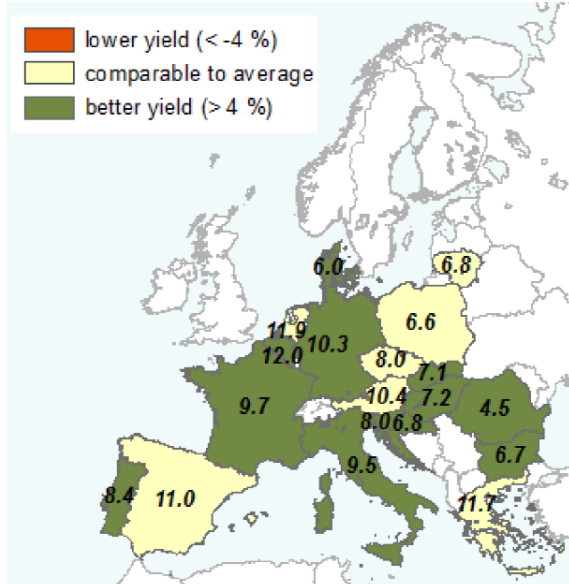


Grain maize - yield forecast 2014

Actual yield versus average yield 2009 - 2013

Yield figures 2014 are expressed in t/ha and rounded to 100 kg

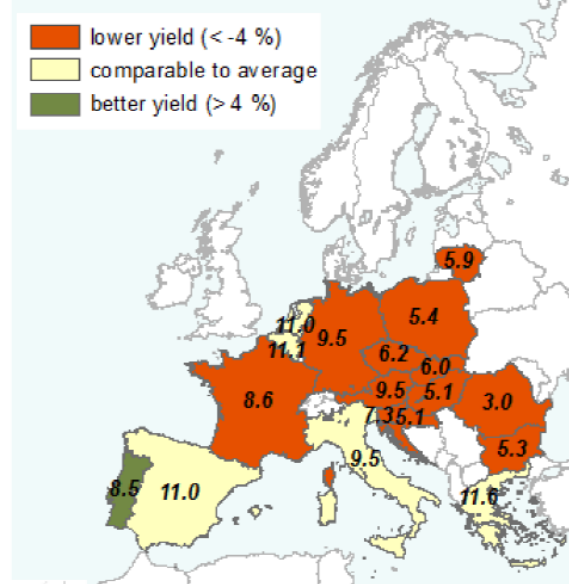
- lower yield (< -4 %)
- comparable to average
- better yield (> 4 %)



Grain maize - yield forecast 2015

Actual yield versus average yield 2010 - 2014

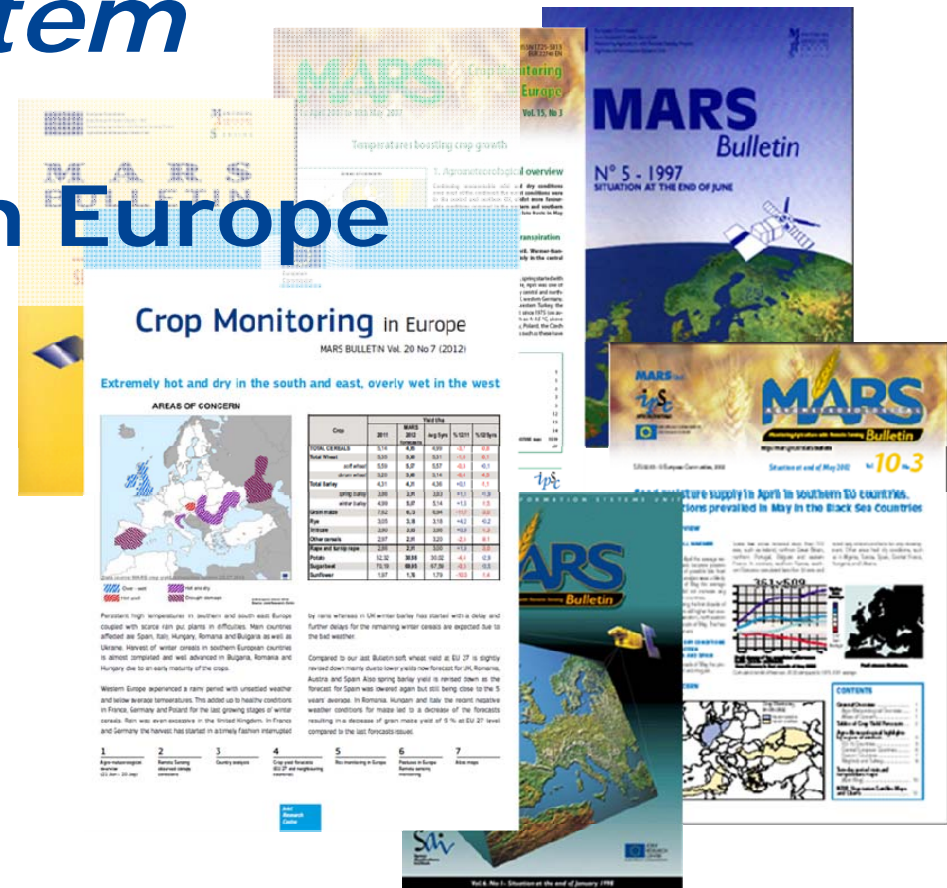
- lower yield (< -4 %)
- comparable to average
- better yield (> 4 %)



Yield variability

MCYFS - MARS Crop Yield Forecasting System

Crop monitoring in Europe





User requirements

- **independent, timely, scientific** and **traceable** crop yield forecasts
- for **all EU Member States** (EU28)
- and EU neighbouring countries
- for the **main arable crops** in Europe (currently 12 crops)

This information is utilised by the Commission services for the following main purposes:

- 1) Input for the **crop balance sheets**
- 2) Input for the **Early Estimate** System of Eurostat
- 3) Assessment of climatic conditions and potential impacts of **particular weather events** in Member States (e.g. droughts, heat waves)
- 4) Monitoring of crop conditions and forecasting in **third countries**

The activities are covered by the European Regulation 1306/2013 and financed by the EC.



.....translate into system requirements

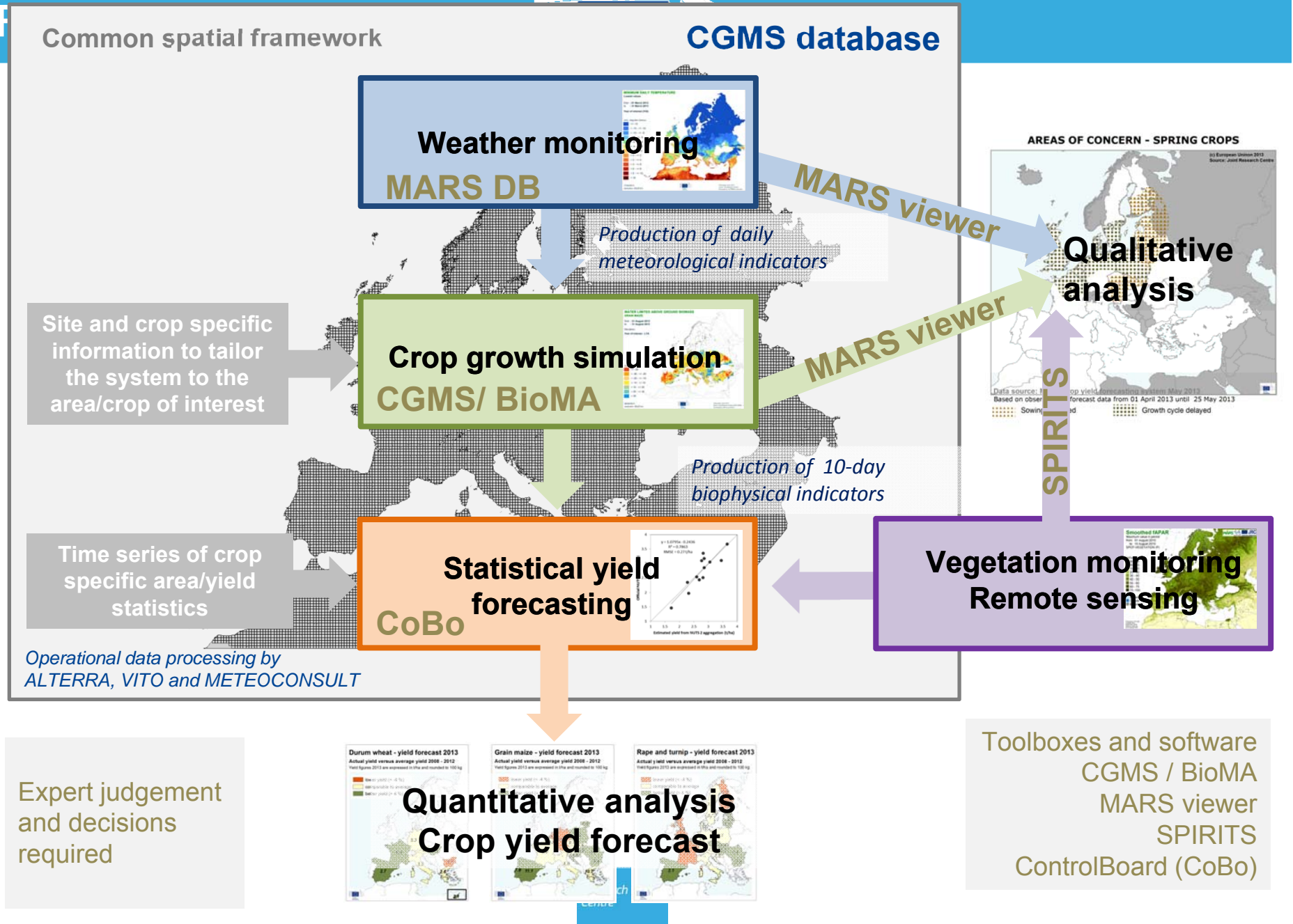
- 1) **Full** European coverage (and neighbouring countries) with **comparable** data and methods
- 2) Information availability in **near real time**
- 3) Comprehensive and common **spatial** framework
- 4) No single-source system that may miss key events, but use of **several sources** and methodologies in parallel
- 5) Redundancy and synergies between methodologies, **convergence of evidence**
- 6) **Traceability** and accepted procedures to allow for staff turn-over (ISO 9001 certification)

MARS Crop Yield Forecasting System



- **ICT-based**, sophisticated system tailored to support yield forecasting
- Based on four pillars: **agro-meteorology**, **crop growth modelling**, **remote sensing**, **agricultural statistics**
- **Near-real time** context: dataflow, data processing, analysis, bulletin production
- Constantly **innovation and refinement** ongoing to keep the system **updated** and at the **state-of-the-art**
- Current accuracy: < 5% overall yield estimates in EU
- Resources: **team of analysts** and project management at JRC, in-house **ICT support**, outsourced model infrastructure and technical routine work (**MARSOP** consortium)
- **Scientific networking** with universities, research institutions, national ministries, regional offices, etc. throughout Europe
- Key is the **analyst** and the **expert knowledge** available

MARS Crop Yield





Crop monitoring in Europe

MARS Bulletin Vol. 23 No. 9 (2015)

Little relief for summer crops

Yield forecasts for summer crops at the EU-28 level remain low and are comparable to last month's forecast. Slight upward revisions are due partly to improved weather conditions in western Europe, and partly to the expected diversion of the most affected grain maize crops to green maize.

In late August, large areas of central and eastern Europe experienced a heat wave and little or no significant rainfall. As most summer crops had already reached maturity in eastern Europe, this latest episode of dry and hot conditions did not have a relevant negative impact, and may even have been beneficial for ripening.

In central European regions, however, where summer crops were still in the grain-filling phase, crop conditions remain critical. The growth of non-irrigated crops in these regions was already stunted due to heat waves in July and early August. Southern Poland and southern Germany were particularly affected. All non-irrigated crops in these regions are in poor condition.

In France, rainfall in late August led to a significant improvement in the conditions of summer crops in western and southern regions, but conditions remain poor in eastern cropland areas.

Content:

1. Agro-meteorological overview
2. Observed canopy conditions by remote sensing
3. Country analysis
4. Crop yield forecasts
5. Pasture monitoring
6. Atlas

AREAS OF CONCERN - EXTREME WEATHER EVENTS



Based on observed data from 22 August 2015 until 18 September 2015

Blue hatched: Rain surplus; Red hatched: Hot and Dry

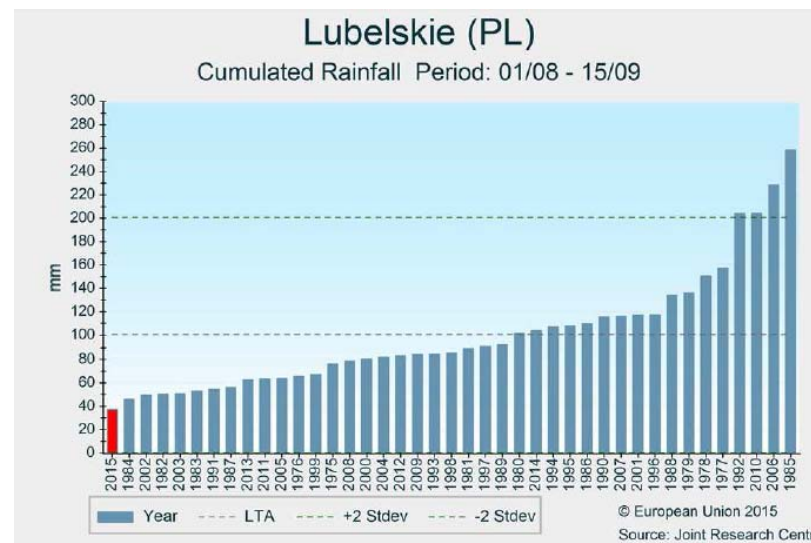
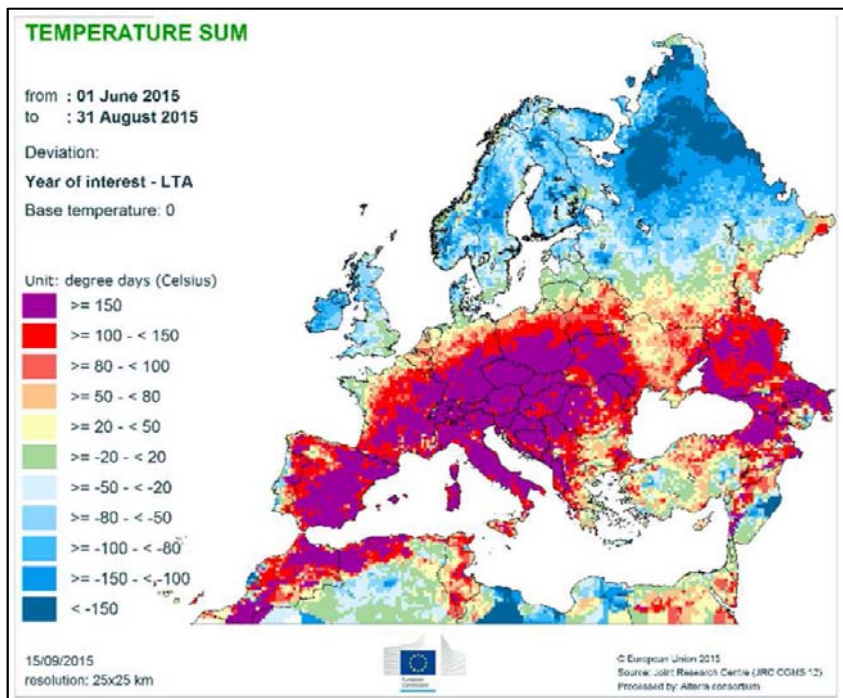
Crop	Yield t/ha				
	2014	MARS 2015 forecasts	Avg 5yrs	%15/14	%15/5yrs
TOTAL CEREALS	5.71	5.16	5.21	-9.6	-1.0
Total Wheat	5.90	5.57	5.44	-5.6	+2.5
soft wheat	6.14	5.81	5.67	-5.4	+2.5
durum wheat	3.35	3.20	3.26	-4.3	-1.7
Total Barley	4.90	4.63	4.49	-5.5	+3.1
spring barley	4.16	3.90	3.91	-6.2	+0.3
winter barley	5.92	5.60	5.36	-5.4	-4.5
Grain maize	8.07	6.43	7.02	-20.4	-8.5
Rye	4.23	3.72	3.58	-12.1	+3.9
Triticale	4.53	4.09	4.16	-9.7	-1.6
Other cereals	3.14	2.87	3.56	-8.6	-19.5
Rape and turnip rape	3.62	3.25	3.13	-10.2	+3.8
Potato	34.95	31.62	31.45	-9.5	+0.6
Sugar beet	77.08	70.54	70.46	-8.5	+0.1
Sunflower	2.15	1.87	1.91	-13.0	-2.0

Issued: 18 September 2015

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1.4 Weather forecast for the coming days (18 – 25 September)

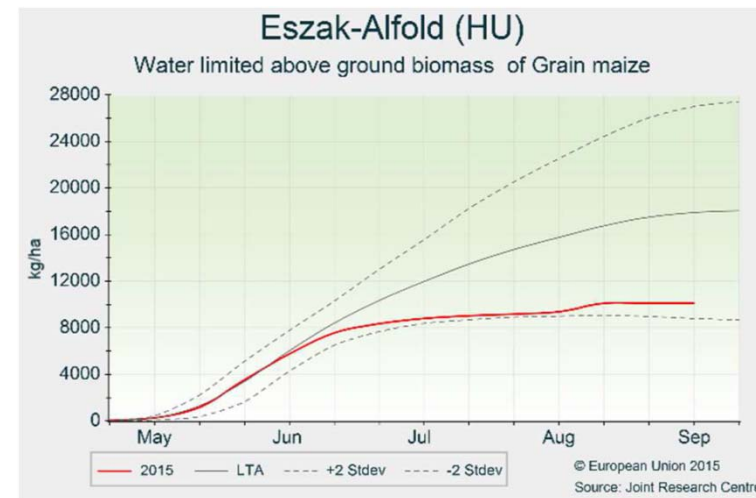
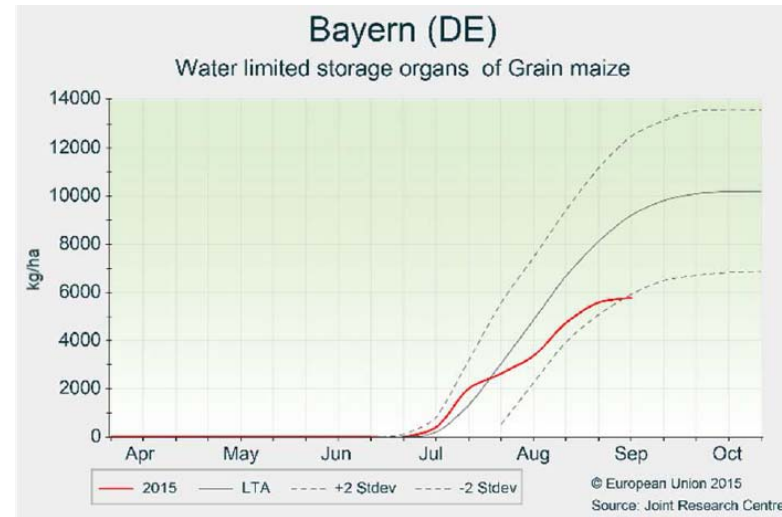
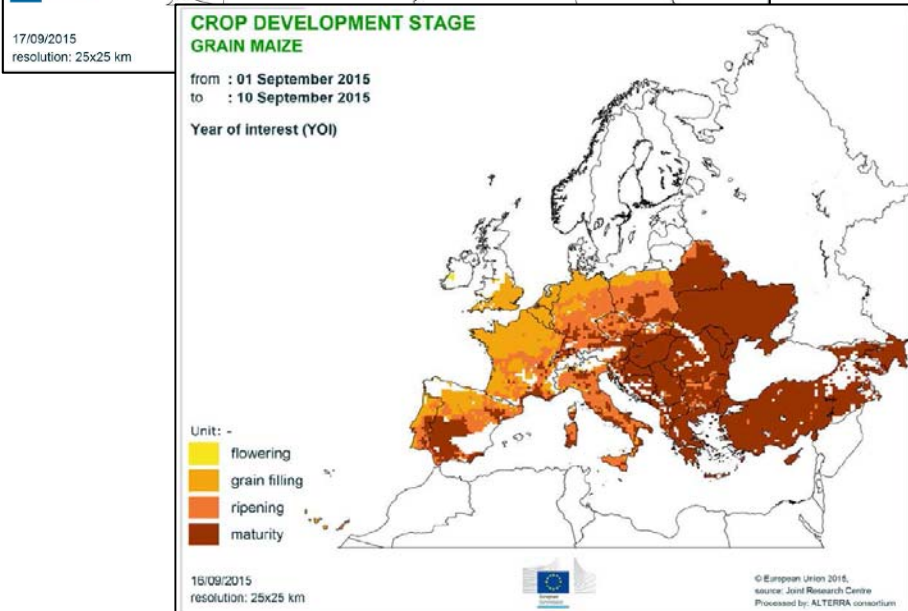
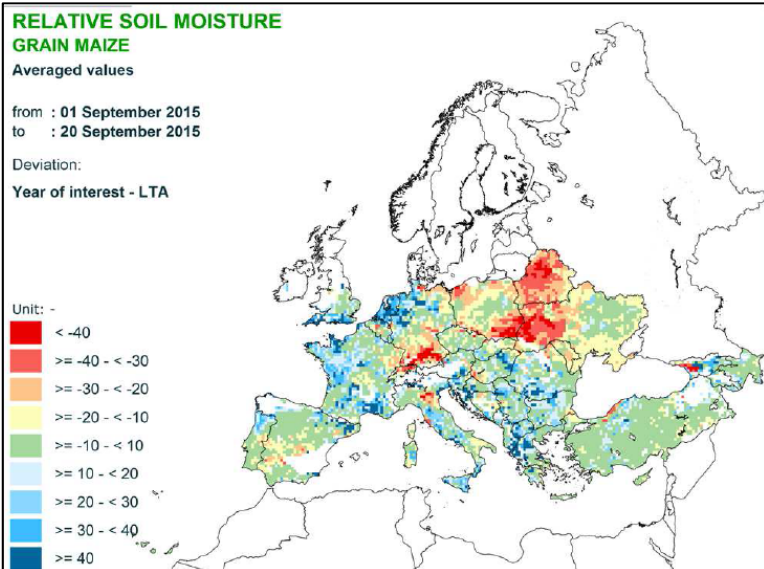
Warmer-than-usual weather is foreseen for the central and eastern Mediterranean region, eastern Europe and Turkey. Cooler-than-usual conditions will dominate in western Europe. Although some (mostly minor to moderate) rainfall episodes are expected in most of Europe, dry conditions will prevail over the Iberian Peninsula, the Mediterranean and eastern Europe.

The expected synoptic situation will divide Europe into Average daily temperature anomalies up to 8°C above the

Crop Monitoring in Europe



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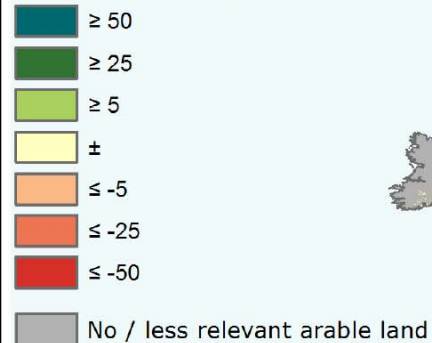
Crop Monitoring in Europe



Cumulated fAPAR comparison

Current year - Medium term average (MTA / 2007-2014)
 Considered period: 1 August 2015 - 10 September 2015

Relative differences (%) compared to MTA



Mask: Arable land mask based on GLC 2000
 Data source: MARS remote sensing database / METOP - AVHRR

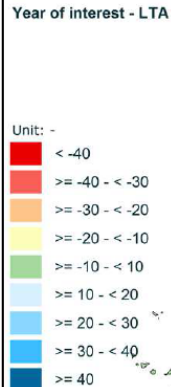
RELATIVE SOIL MOISTURE GRAIN MAIZE

Averaged values

Deviation: Year of interest - LTA

from : 01 September 2015
 to : 20 September 2015

Unit: -



17/09/2015
 resolution: 25x25 km

CROP DEVELOPMENT GRAIN MAIZE

from : 01 September
 to : 10 September

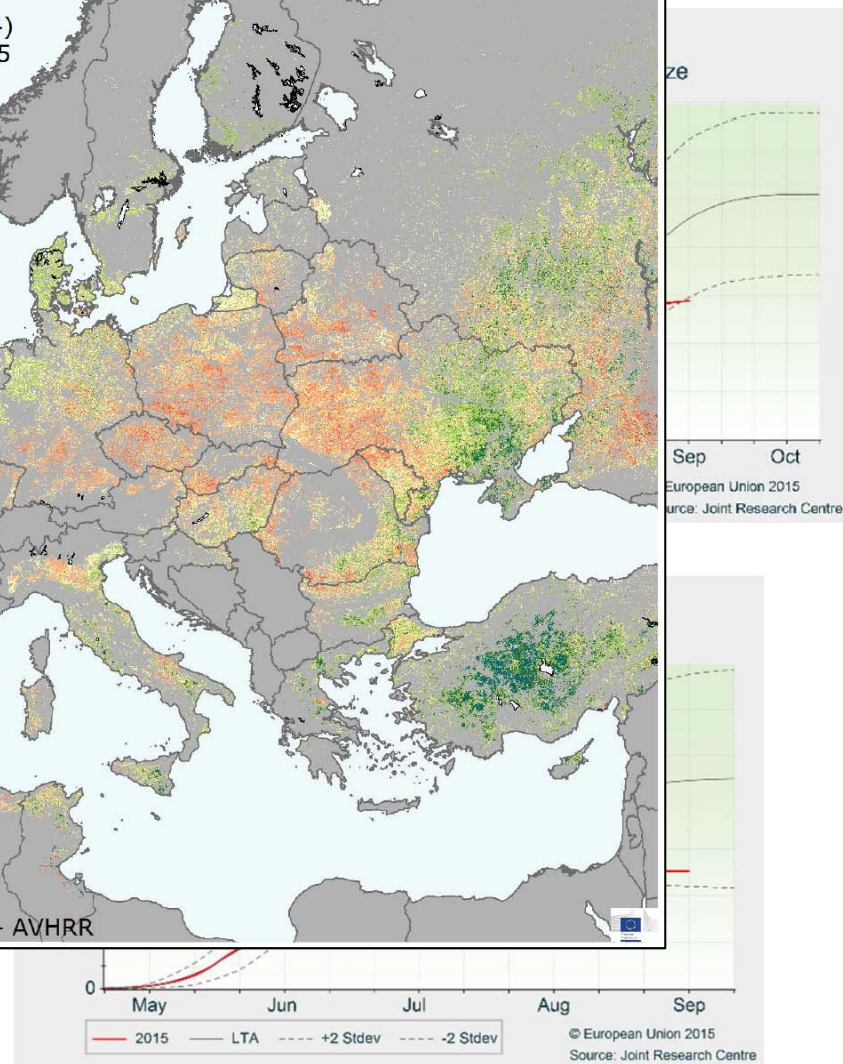
Year of interest (%)

Unit: -



18/09/2015
 resolution: 25x25 km

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 source: Joint Research Centre
 Processed by: ALTERRA consortium



Crop Monitoring in Europe



MARS Bulletin, Vol. 23, No. 9 (2015)

Italy

Recent rains only partially improved summer crop conditions

After the dry and warm conditions of the previous months, near- or above-average rainfall was registered from 1 August to 15 September across Italy. Although the beneficial rainfall partially limited the damage to summer crops, the yield forecast for maize remains far below last year's record level.

In Italy, weather conditions up to the first dekad of August were among the warmest experienced in many regions of the country, with temperatures about 3°C higher than seasonal values. Although temperatures returned to normal from the second dekad of August, the review period from 1 August to 15 September was warmer than usual by about 1°C. Cumulated rainfall across Italy was

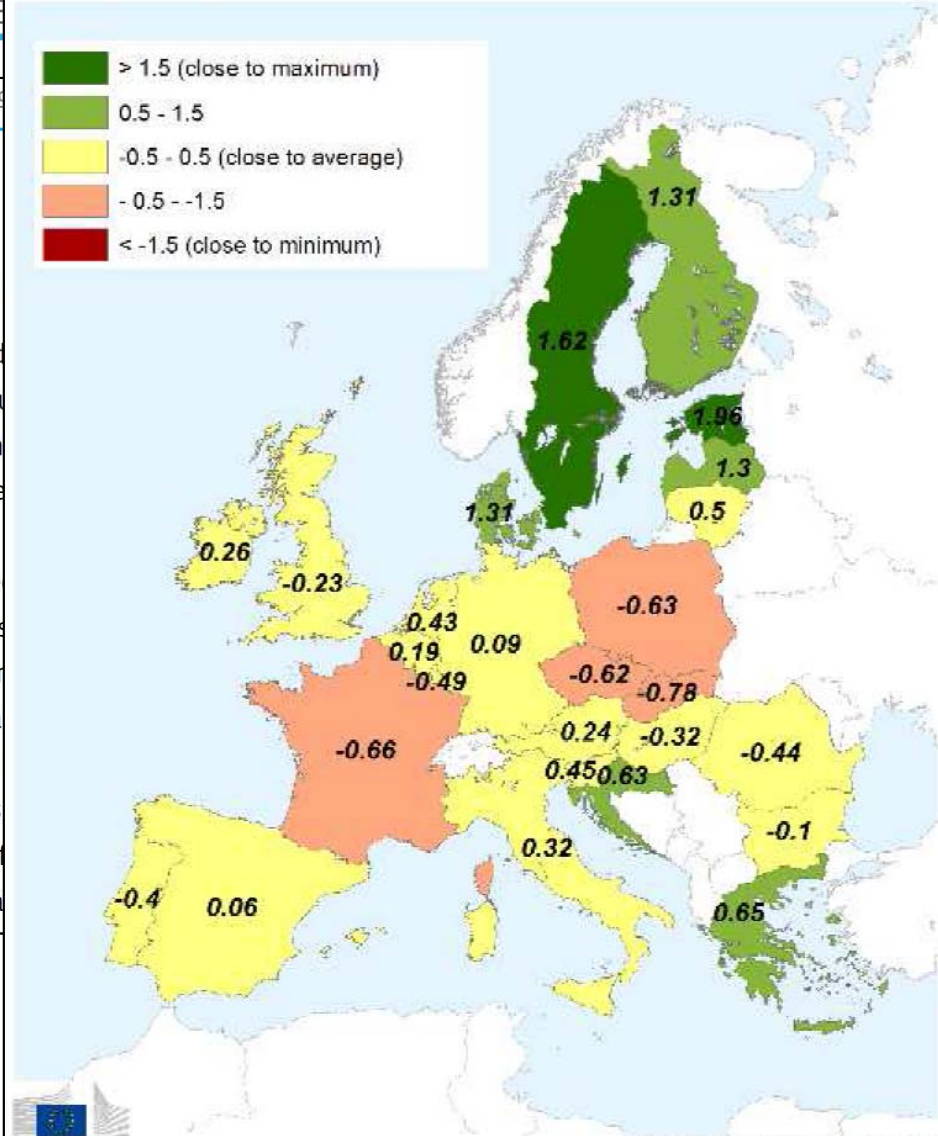
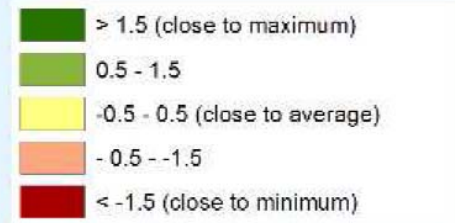
recorded in September causing local waterlogging, particularly in *Emilia Romagna*. Summer crops are in advanced development stages, but the prolonged high temperatures and dry conditions of the previous months have negatively affected crop growth, especially in rainfed areas. Maize is reaching the maturity stage thanks to the warm conditions, whereas the harvesting of winter cereals was completed in July. Irrigation and recent rainfall partially limited the damage to summer crops. While the yield forecast for maize remains well below last year's record level, it is close to the five-year average. The yield forecast for sunflowers is slightly below the five-year average due to the unfavourable weather conditions.

Crop Monitoring in Europe

Relative index of pasture productivity

Period of analysis: 1 April- 10 September 2015

Index based on METOP-AVHRR smoothed NDVI 10-day product.
Historical archive from 2007 to 2014



MARS Bulletin, Vol. 23, No. 9

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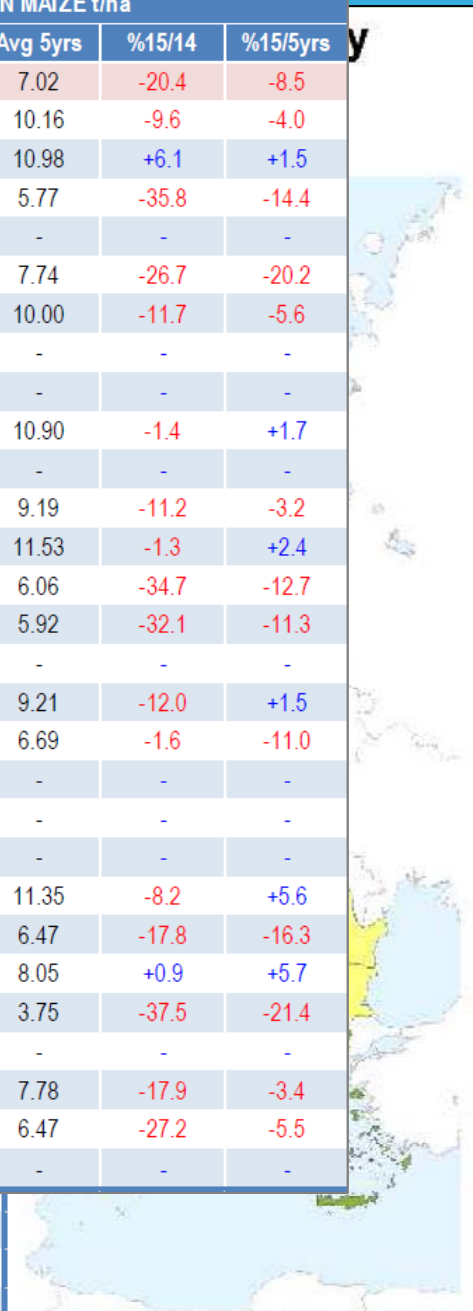
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Crop Monitoring in Europe

Re
Period
Index

Country	SOFT WHEAT t/ha					2014	2015
	2014	2015	Avg 5yrs	%15/14	%15/5yrs		
EU28	6.14	5.81	5.67	-5.4	+2.5	3.35	3.20
AT	5.98	5.55	5.30	-7.1	+4.8	4.78	4.48
BE	9.41	8.93	8.75	-5.2	+2.0	-	-
BG	4.22	4.30	3.94	+1.9	+9.0	-	-
CY	-	-	-	-	-	-	-
CZ	6.51	5.67	5.48	-12.9	+3.5	-	-
DE	8.64	7.67	7.64	-11.2	+0.3	-	-
DK	7.78	7.47	7.07	-4.1	+5.6	-	-
EE	3.99	3.76	3.37	-5.8	+11.7	-	-
ES	3.04	3.06	3.31	+0.4	-7.5	2.67	2.31
FI	4.06	3.60	3.70	-11.3	-2.6	-	-
FR	7.48	7.38	7.16	-1.4	+3.1	5.20	5.25
GR	3.31	2.91	3.04	-12.3	-4.3	2.96	2.70
HR	4.14	5.22	4.70	+26.2	+11.1	-	-
HU	4.71	4.48	4.21	-4.9	+6.3	4.55	4.32
IE	9.96	9.33	8.84	-6.3	+5.6	-	-
IT	5.29	5.48	5.38	+3.5	+1.8	3.13	2.98
LT	4.56	4.16	4.13	-8.8	+0.8	-	-
LU	6.13	6.00	5.98	-2.2	+0.4	-	-
LV	3.75	4.03	3.60	+7.5	+11.8	-	-
MT	-	-	-	-	-	-	-
NL	9.11	8.88	8.80	-2.6	+0.8	-	-
PL	4.97	4.27	4.32	-14.1	-1.2	-	-
PT	2.06	1.65	1.50	-19.9	+9.6	-	-
RO	3.65	3.46	3.23	-5.2	+7.1	-	-
SE	6.80	6.12	5.95	-10.1	+2.9	-	-
SI	5.23	4.96	5.02	-5.2	-1.1	-	-
SK	5.47	4.37	4.34	-20.1	+0.6	5.32	3.31
UK	8.58	8.09	7.63	-5.7	+6.0	-	-

Country	GRAIN MAIZE t/ha				
	2014	2015	Avg 5yrs	%15/14	%15/5yrs
EU28	8.07	6.43	7.02	-20.4	-8.5
AT	10.79	9.76	10.16	-9.6	-4.0
BE	10.50	11.15	10.98	+6.1	+1.5
BG	7.68	4.94	5.77	-35.8	-14.4
CY	-	-	-	-	-
CZ	8.43	6.18	7.74	-26.7	-20.2
DE	10.69	9.44	10.00	-11.7	-5.6
DK	-	-	-	-	-
EE	-	-	-	-	-
ES	11.24	11.08	10.90	-1.4	+1.7
FI	-	-	-	-	-
FR	10.02	8.90	9.19	-11.2	-3.2
GR	11.96	11.81	11.53	-1.3	+2.4
HR	8.11	5.29	6.06	-34.7	-12.7
HU	7.74	5.25	5.92	-32.1	-11.3
IE	-	-	-	-	-
IT	10.62	9.35	9.21	-12.0	+1.5
LT	6.05	5.95	6.69	-1.6	-11.0
LU	-	-	-	-	-
LV	-	-	-	-	-
MT	-	-	-	-	-
NL	13.06	11.98	11.35	-8.2	+5.6
PL	6.59	5.42	6.47	-17.8	-16.3
PT	8.44	8.51	8.05	+0.9	+5.7
RO	4.72	2.95	3.75	-37.5	-21.4
SE	-	-	-	-	-
SI	9.16	7.52	7.78	-17.9	-3.4
SK	8.39	6.11	6.47	-27.2	-5.5
UK	-	-	-	-	-



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2015

January	February	March	April	May	June	July	August	September	October	November	December	January 2016*
Thu 1 New Year's Day 1	Sun 1	Sun 1	Wed 1	Fri 1 Labour Day EXPO Milano 2015 opening	Mon 1	Wed 1	Sat 1	Tue 1	Thu 1	Sun 1 All Saints Day	Tue 1	Fri 1 New Year's Day
Fri 2 IDL, GEE, KRU, PTT, SEV	Mon 2	Mon 2	Thu 2 Maundy Thursday IDL, GEE, PTT, SEV	Sat 2	Tue 2 Anniversary of the Republic (IT) IPR	Thu 2	Sun 2	Wed 2	Fri 2	Mon 2 All Saints Day 45 IDL, IPR, GEE, PTT, SEV	Wed 2	Sat 2
Sat 3	Tue 3	Tue 3	Fri 3 Good Friday	Sun 3	Wed 3	Fri 3	Mon 3	Thu 3	Sat 3 Day of German Unity (DE)	Tue 3	Thu 3	Sun 3
Sun 4	Wed 4	Wed 4	Sat 4	Mon 4	Thu 4 Corpus Christi KRU, SEV	Sat 4	Tue 4	Fri 4	Sun 4	Wed 4	Fri 4	Mon 4
Mon 5	Thu 5	Thu 5	Sun 5 Easter	Tue 5	Fri 5	Sun 5	Wed 5	Sat 5	Mon 5	Thu 5	Sat 5	Tue 5
Tue 6 Epiphany IPR, KRU, PTT, SEV	Fri 6	Fri 6	Mon 6 Easter Monday IDL, IPR, GEE, KRU, PTT	Wed 6	Sat 6	Mon 6 PPT ³⁸	Thu 6	Sun 6	Tue 6	Fri 6	Sun 6 Cecilia's Day (IT) SEV	Wed 6 Epiphany
Wed 7	Sat 7	Sat 7	Tue 7	Thu 7	Sun 7	Tue 7	Fri 7	Mon 7 PPT ³⁷	Wed 7	Sat 7	Mon 7	Thu 7
Thu 8	Sun 8	Sun 8	Wed 8	Fri 8	Mon 8 PPT ³⁴	Wed 8	Sat 8	Tue 8	Thu 8	Sun 8	Tue 8 Immaculate Conception IPR	Fri 8
Fri 9	Mon 9 PPT ⁷	Mon 9 PPT ¹¹	Thu 9 PPT	Sat 9 Europe Day	Tue 9	Thu 9	Sun 9	Wed 9	Fri 9	Mon 9 PPT ⁴⁶	Wed 9	Sat 9
Sat 10	Tue 10	Tue 10	Fri 10	Sun 10	Wed 10	Fri 10	Mon 10	Thu 10	Sat 10	Tue 10	Thu 10	Sun 10
Sun 11	Wed 11	Wed 11	Sat 11	Mon 11 PPT ²⁰	Tue 11	Sat 11	Tue 11	Fri 11	Sun 11 National Day (ES) PPT ⁴²	Wed 11	Fri 11 BULL 12	Mon 11
Mon 12	Thu 12	Thu 12	Sun 12	Tue 12	Fri 12	Sun 12	Wed 12	Sat 12	Mon 12 National Day (ES) PPT ⁴²	Tue 12	Sat 12	Tue 12
Tue 13	Fri 13	Fri 13	Mon 13	Wed 13	Sat 13	Mon 13	Thu 13	Sun 13	Tue 13	Fri 13	Sun 13	Wed 13
Wed 14	Sat 14	Sat 14	Tue 14	Thu 14 Ascension Day IDL, IPR, GEE, KRU, PTT	Mon 14	Tue 14	Fri 14	Mon 14	Wed 14	Sat 14	Mon 14	Thu 14
Thu 15	Sun 15	Sun 15	Wed 15	Fri 15 IDL, IPR, GEE, KRU, PTT	Mon 15	Wed 15	Sat 15 Assumption Day	Tue 15	Thu 15	Sun 15	Tue 15	Fri 15
Fri 16	Mon 16	Mon 16	Thu 16	Sat 16	Tue 16	Thu 16	Sun 16	Wed 16	Fri 16	Mon 16	Wed 16	Sat 16
Sat 17	Tue 17	Tue 17	Fri 17	Sun 17	Wed 17	Fri 17	Mon 17	Thu 17	Sat 17	Tue 17	Thu 17	Sun 17
Sun 18	Wed 18	Wed 18	Sat 18	Mon 18	Thu 18	Sat 18	Tue 18	Fri 18 BULL 9	Mon 18	Wed 18	Fri 18	Mon 18
Mon 19	Thu 19	Thu 19	Sun 19	Tue 19	Fri 19 BULL 6	Sun 19	Wed 19	Sat 19	Mon 19	Thu 19	Sat 19	Tue 19
Tue 20	Fri 20 BULL 2	Mon 20 BULL 3	Wed 20	Fri 20	Sat 20	Mon 20	Tue 20	Thu 20	Fri 20	Sun 20	Wed 20	Mon 20
Wed 21	Sat 21	Sat 21	Tue 21	Thu 21	Sun 21	Tue 21 Independence Day (ME) IDL, GEE	Fri 21 BULL 8	Mon 21	Wed 21	Sat 21	Mon 21	Thu 21
Thu 22	Sun 22	Sun 22	Wed 22	Fri 22 BULL 5	Mon 22	Wed 22	Sat 22	Tue 22	Thu 22	Sun 22	Tue 22	Fri 22
Fri 23 BULL 1	Mon 23	Mon 23	Thu 23	Sat 23	Tue 23	Thu 23	Sun 23	Wed 23	Fri 23 BULL 10	Mon 23	Wed 23	Sat 23
Sat 24	Tue 24	Tue 24	Fri 24 BULL 4	Mon 24	Tue 24	Fri 24 BULL 7	Mon 24	Thu 24	Sat 24	Tue 24	Thu 24	Sun 24
Sun 25	Wed 25	Wed 25	Sat 25 Liberation Day (IT) IDL, IPR, GEE, KRU, PTT	Mon 25 White Monday IDL, IPR, GEE, KRU, PTT	Tue 25	Sat 25	Tue 25	Fri 25	Sun 25	Wed 25	Fri 25 Christmas Day	Mon 25
Mon 26	Thu 26	Thu 26	Sun 26	Tue 26	Fri 26	Sun 26	Wed 26	Sat 26	Mon 26	Thu 26	Sat 26	Tue 26
Tue 27	Fri 27	Fri 27	Mon 27 Queen's Day (NL) PTT	Wed 27	Sat 27	Mon 27	Thu 27	Sun 27	Tue 27	Fri 27	Sun 27	Wed 27
Wed 28	Sat 28 Day of Andalus (ES) BULL 12	Sat 28	Tue 28	Thu 28	Sun 28	Tue 28	Fri 28	Mon 28	Wed 28	Sat 28	Mon 28	Thu 28
Thu 29	Sun 29	Sun 29	Wed 29	Fri 29	Mon 29	Wed 29	Sat 29	Tue 29	Thu 29	Sun 29	Tue 29	Fri 29
Fri 30	Mon 30	Mon 30	Thu 30	Sat 30	Tue 30	Thu 30	Sun 30	Wed 30	Fri 30	Mon 30	Wed 30	Sat 30
Sat 31	Tue 31	Tue 31	Sun 31	Fri 31	Mon 31	Wed 31	Thu 31	Sat 31	Mon 31	Thu 31 EXPO Milano 2015 closing	Sun 31	Thu 31

Official JRC holidays (all sites) Site-specific holidays

JRC Science Hub: <https://ec.europa.eu/jrc>

*at the time of publication, 2016 official JRC holidays are not confirmed yet

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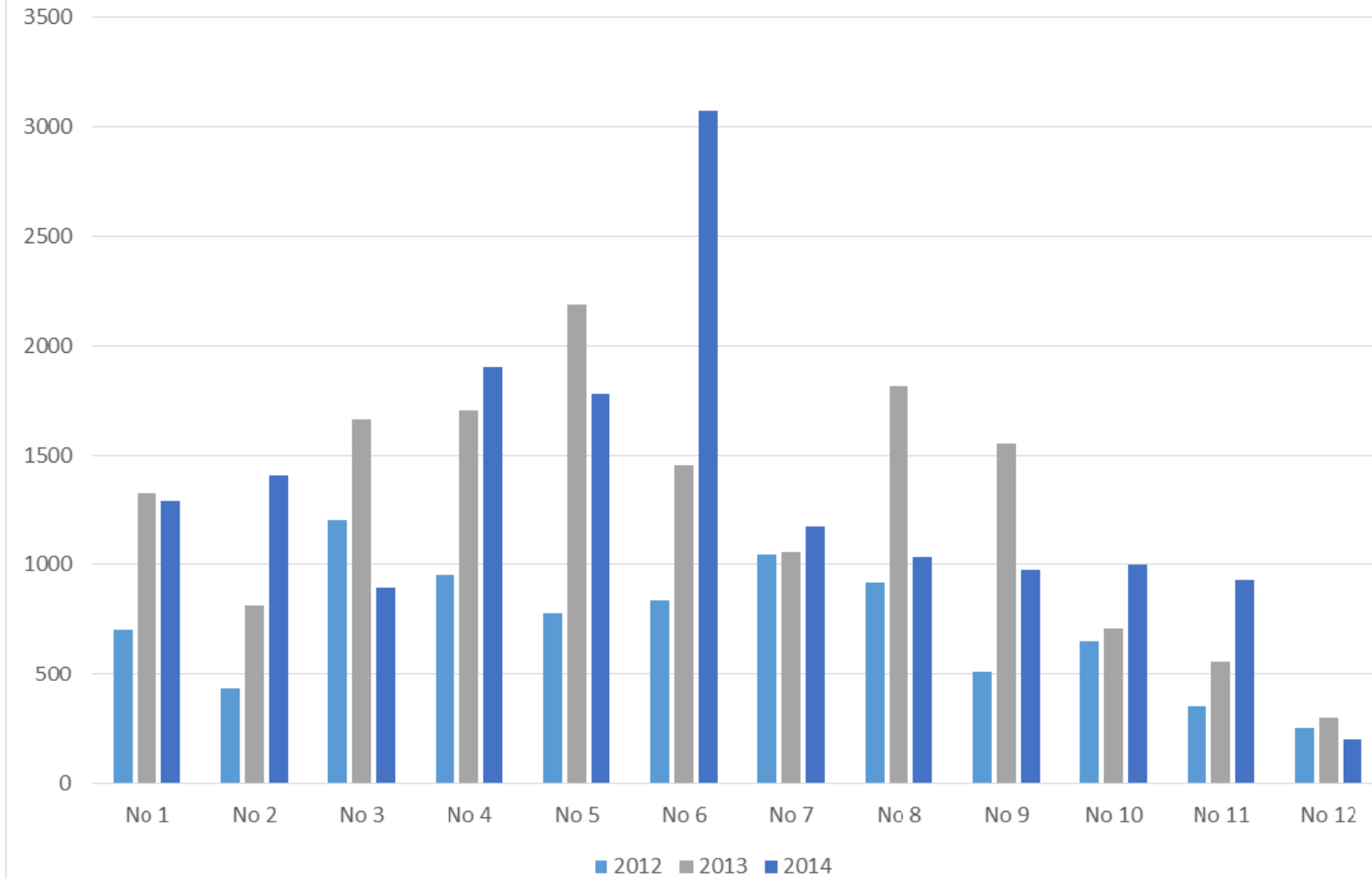
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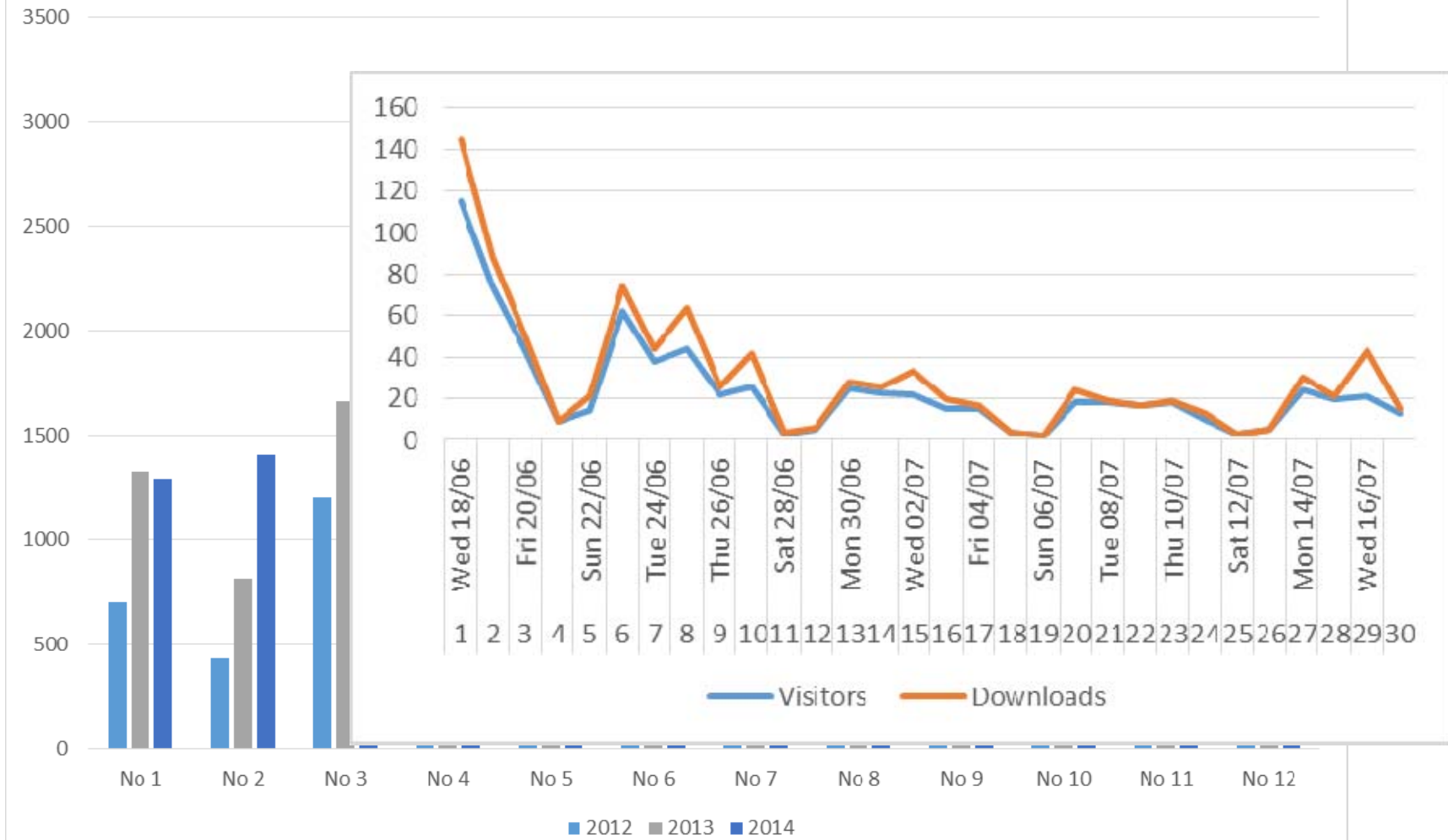


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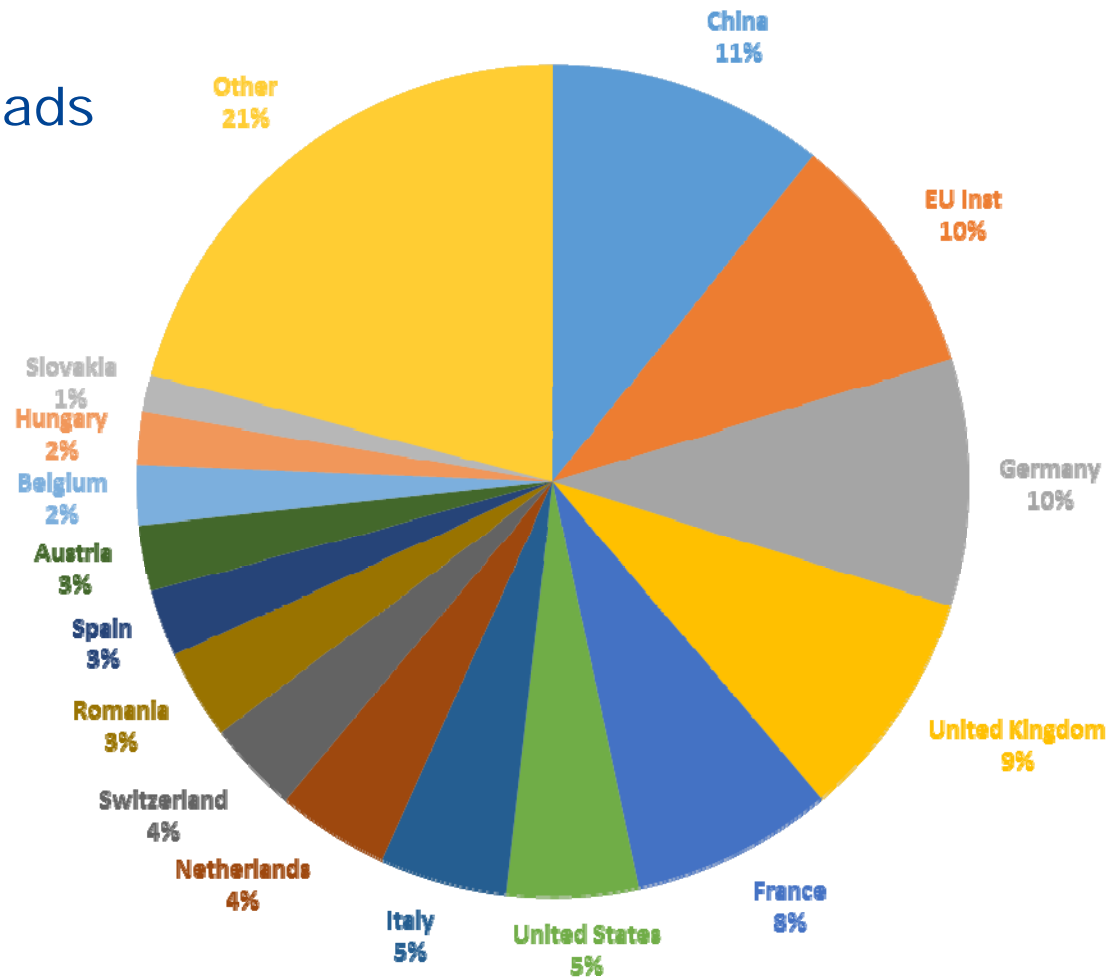
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- Serves as input to the European contribution to the **Agricultural Markets Information System** (AMIS) at FAO (G20 initiative)
- Part of the Group of Earth Observation Global Agricultural Monitoring activity (**GEOGLAM**) **Crop Monitor**
- In addition, **data dissemination** through the AGRI4CAST **resource portal** at: <http://agri4cast.jrc.ec.europa.eu> , incl.
 - Gridded meteorological data (“MARS database”)
 - Crop masks, crop calendars
 - Further resources incl. climate change simulations



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Thank you for your attention!