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2009 MOROCCO JOINT CROP BULLETIN

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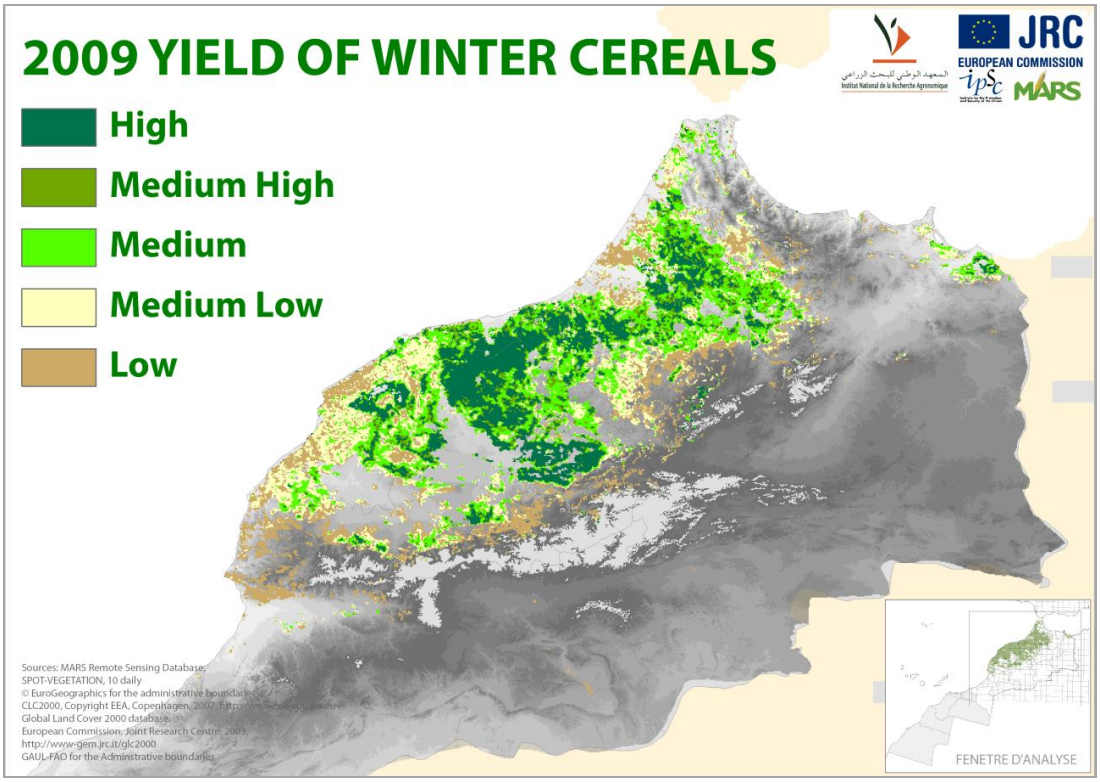
September 2008 - May 2009

ABOVE NORMAL AND PROTRACTED PRECIPITATION FAVOURED AN EXCEPTIONAL FINAL CEREAL YIELD

The 2008-2009 agricultural season was characterized by abundant and well distributed precipitation. This is expected to be the best season for winter cereals in the last 20 years, both in terms of yield and production.



The map corresponds to the grouping into 5 classes of the average dekadal NDVI (See METHODOLOGICAL NOTE) from February untill March 2009 and these classes correspond to five probability levels of yield for cereal. Non agricultural lands have been masked using the "Global Land Cover 2000 for Africa" (GLC2000 version 5.0, Mayaux et al., 2004).

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2009 Winter Cereal National Yield Forecast

CROPS	YIELD FORECAST (tons/ha)				
	2009	2008	Avg 5 yrs	% 09/08	% 09/Avg
Soft Wheat	2.13	1.46	1.24	+56.3%	+68.3%
Durum Wheat	2.03	1.28	1.30	+58.8%	+55.9%
Winter Barley	1.41	1.13	1.08	+25.4%	+31.3%

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HIGHLIGHTS

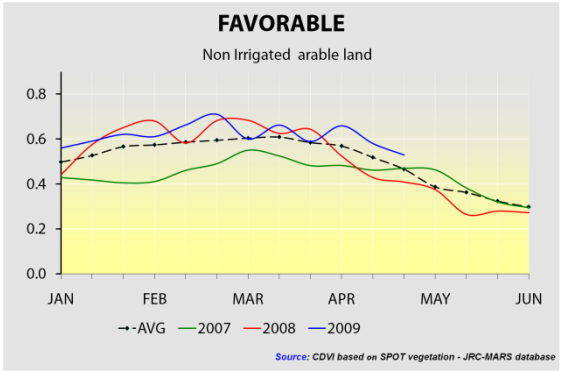
In Morocco winter cereals (soft wheat, durum wheat and barley) are produced all over the country, occupying nearly two thirds of agricultural lands with limited variations from year to year. Cereal production in the 2008-2009 agricultural season was characterized by abundant and well distributed precipitation and since rainfall is by far the most important factor affecting cereal production in the Moroccan agricultural environment, the combination of events was such to make this the best season in the last 20 years. The outcome could have been even better if the weeds had been more properly controlled, nitrogen optimally applied and if sowing had taken place earlier in all parts of the country. Humid conditions were also the cause of the insurgence of Yellow Rust in northern areas of Morocco.

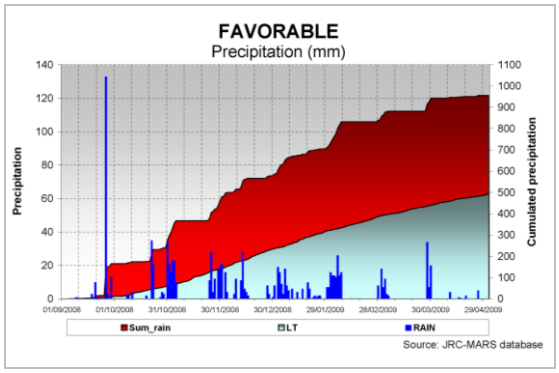
AGROMETEOROLOGICAL ANALYSIS

There was abundant precipitation especially in the eastern, northern, central and west-central parts of the country. Rainfall from September to November 2008 was high enough to permit early sowing; however, significant areas were flooded during January, especially in the Gharb province limiting access to the fields. The values of the NDVI show an increase at national level from November 2008 to March 2009, with values exceeding those of both the 5 years average and of the previous season. The NDVI was less significant in the Northern part of the country due to excess of water on the surface. There was a high variability of conditions among the country agro-ecological zones (**Favorable, Intermédiaire, Défavorable Sud, Défavorable Orientale, Saharienne)** with a clear gradient of moisture from North to South and from West to East.

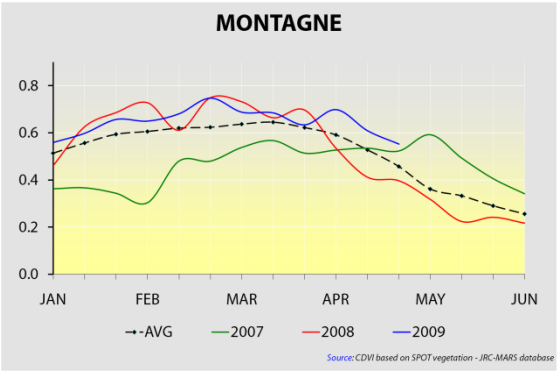
ANALYSIS IN THE SINGLE AGRO-ECOLOGICAL ZONES

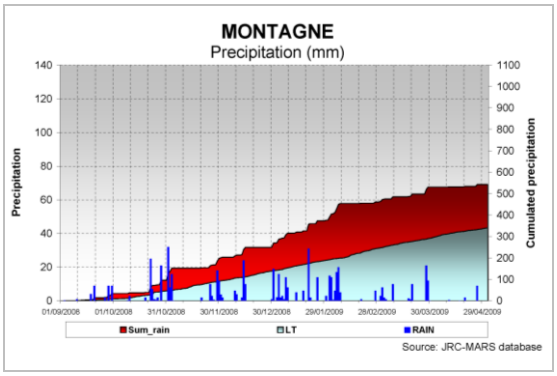
The **Favorable** agro-ecological zone contributes in average to 42% (1979–2008 data) of the national winter cereal production. This zone is usually the rainiest of Morocco and the cumulated rainfall from September 2008 to end of May 2009 exceeded by about 90% the long term average. Average dekadal NDVI value from February to April 2009 exceeded the values of the two last seasons as well as that of the long term average (1999 to 2008). A significant part of this zone was flooded during January.



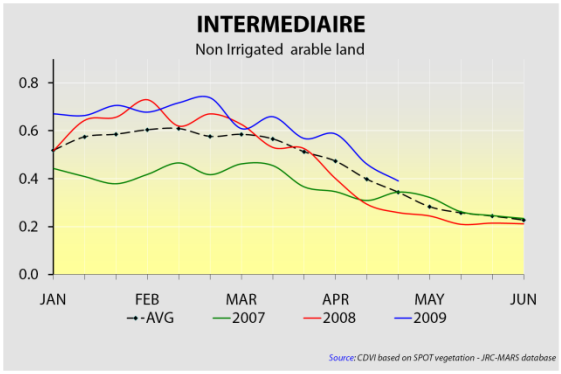


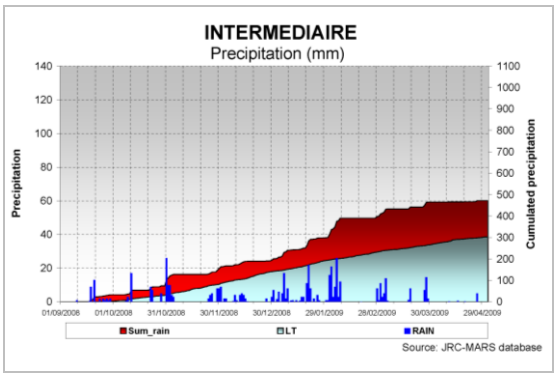
The **Montagne** agro-ecological zone contributes in average to 12% of national winter cereal production and due to the elevation it is characterized by low temperatures. Cumulated rainfall from September 2008 to the end of May 2009 exceeded by about 57% the long term average. Average dekadal NDVI from February till April 2009 was more than 20% above the values of the two last seasons and 44% above the long term average (1999 to 2008). This value is however also affected by the extensive forests and rangeland cover.



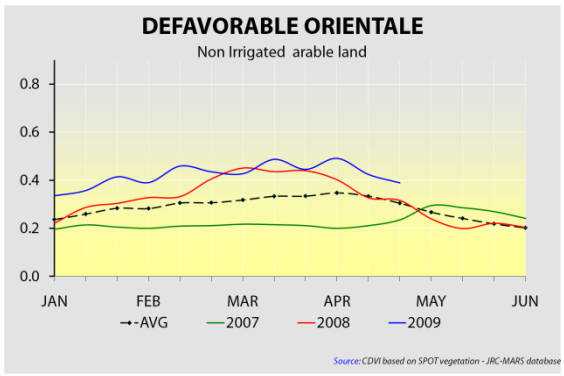


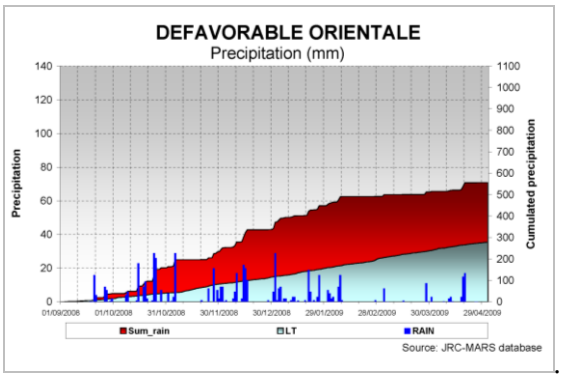
The **Intermédiaire** agro-ecological zone contributes in average to 17% of national winter cereal production This zone received less rains than the Favorable zone. Cumulated rainfall from September 2008 to the end of May 2009 exceeded by about 65% the long term average and the average dekadal of NDVI from February till April 2009 was more than 60% above the values of the two last seasons and 75% above the long term average (1999 to 2008). Crop production levels were also affected mainly by late sowing, yellow rust and weeds which affected the zone.



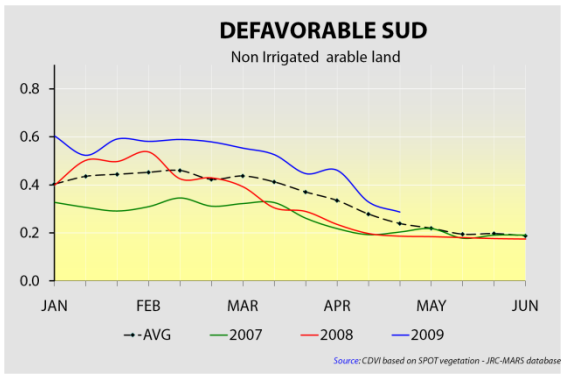


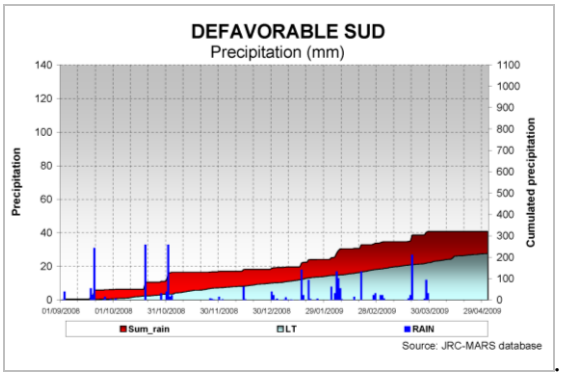
The **Défavorable Orientale** agro-ecological zone contributes in average to 7.5% of national winter cereal production. This zone is arid and receives generally very few rains. However this season the cumulated rainfall from September 2008 to end of May 2009 exceeded by about 83% the long term average. The average dekadal NDVI value from February till April 2009 was more than 13% above that of the two last seasons and 43% above the long term average. However this zone is characterized by wide arid rangelands and has relatively very few agricultural areas.





The **Défavorable Sud** agro-ecological zone contributes in average to 17% of national winter cereal production. This zone is arid to semi-arid and receives generally few rains. This year it received relatively less rains than other areas of Morocco still the cumulated rainfall from September 2008 to the end of May 2009 exceeded about 50% the long term average. On the opposite, average dekadal NDVI values from February to April 2009 was more than 48% above the values of the two last seasons and 69% above the long term average (1999 to 2008) due to higher temperatures. This is a barley growing area and accounts for 28% of national production.





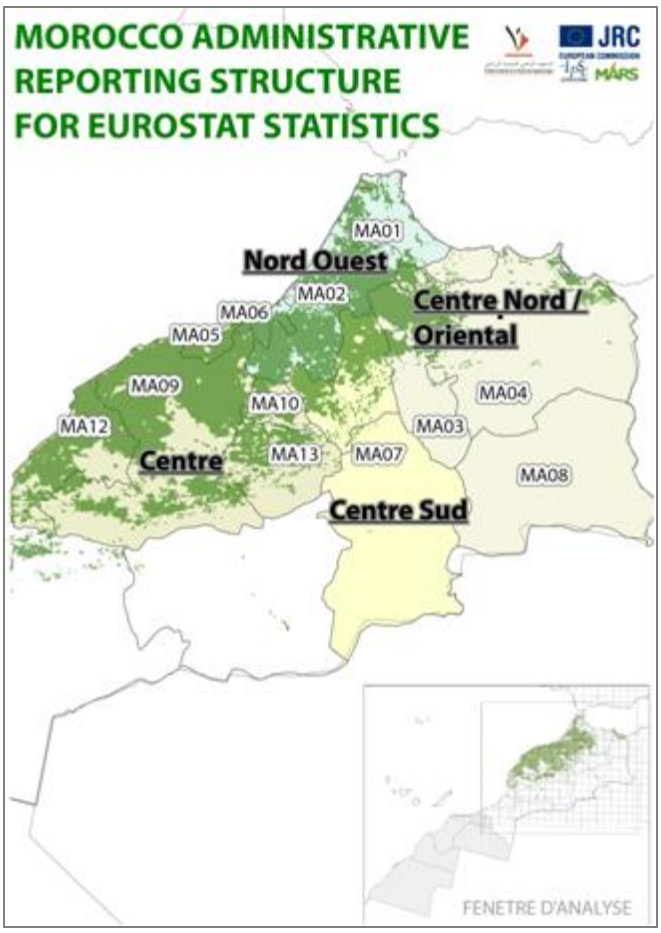
The **Saharienne** agro-ecological zone contributes in average to very little (4%) of national winter cereal This zone is arid to desert and generally receives very few rains. Cumulated rainfall from September 2008 to end of May 2009 did not exceed the long term average.

YIELD FORECAST

The yield forecasts for winter cereal in the **2008-2009** agricultural seasons are significantly higher than those of the of the **long term average (1979-2008)** and also of those of the **previous season (2007-2008)**. The yields at national level, estimated using the CGMS (see METHODOLOGICAL NOTE) are **2.1 t/ha for soft wheat, 2.0 t/ha for durum wheat and 1.4 t/ha for winter barley**.

In the 2008-2009 growing season, **5.1 million hectares of winter cereals** were sown in Morocco **(2.0, 0.9 and 2.2 million respectively for soft wheat, durum wheat and barley)** with no particular difference from the previous seasons. According to these values **the overall production is estimated at 10.6 million tons**.

The CGMS was adapted to the specific Moroccan data sources (statistical records from "Direction de la Programmation et des Affaires Economiques" of the Ministry of Agriculture), integrating the established MARS Bulletin procedures with Moroccan expertise. The estimates are referred to the Eurostat NUTS (Nomenclature des Unités Territoriales Statistiques / Nomenclature of Territorial Statistical Units) which are institutional reference administrative units. The **NUTS0** corresponds to the national level; **NUTS1** are intermediate sub-national units derived from the aggregation of Regional Units. **NUTS2** are generally Regional Units while **NUTS3** are sub-regional and correspond to those units commonly referred to as Provinces. This administrative aggregation hierarchy may at times not correspond to nationally recognized units. This is the case of Morocco



YIELD ESTIMATES AT NUTS 2, NUTS1 AND NUTS0 LEVEL

Soft Wheat yield forecasts (tons/ha)

Administrative level		2009	2008*	Average 5 years	% variation 09/08	% variation 09/Avg
NUTS2	MA01	1.58	1.76	1.47	-10.2%	7.5%
	MA02	2.98	1.60	1.70	86.8%	75.0%
	MA03	2.45	1.97	1.63	24.3%	50.2%
	MA04	1.47	1.32	1.03	11.0%	42.2%
	MA05	2.45	1.31	1.60	87.0%	52.4%
	MA06	2.04	1.11	1.03	84.3%	98.2%
	MA07	2.41	1.74	1.59	38.2%	51.5%
	MA08	1.19	1.07	0.86	11.3%	38.8%
	MA09	1.70	0.79	1.12	116.2%	51.5%
	MA10	1.89	0.15	0.58	1134.2%	226.6%
	MA12	1.28	0.41	0.78	211.2%	65.2%
	MA13	2.46	1.46	1.24	68.8%	98.7%
NUTS1	Nord Ouest	2.20	1.49	1.40	47.9%	57.1%
	Centre Nord/Oriental	1.70	1.46	1.17	17.1%	45.1%
	Centre	1.96	1.15	1.18	70.7%	65.1%
	Centre Sud	2.41	1.74	1.59	38.2%	51.5%
NUTS0	**MOROCCO**	**2.13**	**1.36**	**1.27**	**56.3%**	**68.3%**

* Source of the data: "Direction de la Programmation et des Affaires Economiques (Ministry of Agriculture)"

Durum Wheat yield forecasts (tons/ha)

Administrative level		2009	2008*	Average 5 years	% variation 09/08	% variation 09/Avg
NUTS2	MA01	1.64	1.80	1.71	-9.2%	-4.5%
	MA02	2.68	1.63	1.90	64.7%	41.4%
	MA03	2.39	1.71	1.63	40.1%	46.8%
	MA04	1.43	1.17	1.05	21.8%	35.7%
	MA05	2.32	1.55	1.70	49.8%	36.4%
	MA06	1.44	1.11	1.31	29.9%	9.3%
	MA07	2.13	1.84	1.62	15.9%	31.3%
	MA08	1.28	1.08	0.94	19.0%	35.6%
	MA09	2.01	0.63	0.97	219.5%	107.5%
	MA10	1.40	0.27	0.54	410.9%	160.8%
	MA12	1.46	0.24	0.59	510.8%	147.2%
	MA13	2.14	2.09	1.50	2.7%	42.4%
NUTS1	Nord Ouest	1.92	1.51	1.64	26.9%	16.8%
	Centre Nord/Oriental	1.70	1.32	1.21	28.9%	40.6%
	Centre	1.87	1.17	1.17	60.2%	60.0%
	Centre Sud	2.13	1.84	1.62	15.9%	31.3%
NUTS0	**MOROCCO**	**2.03**	**1.28**	**1.3**	**58.8%**	**55.9%**

* Source of the data: "Direction de la Programmation et des Affaires Economiques (Ministry of Agriculture)"

Winter Barley Forecasts (tons/ha)

Administrative level		2009	2008*	Average 5 years	% variation 09/08	% variation 09/Avg
NUTS2	MA01	1.47	1.74	1.41	-15.8%	4.2%
	MA02	2.08	1.22	1.36	70.4%	53.0%
	MA03	1.56	1.59	1.32	-2.5%	17.6%
	MA04	1.44	1.32	1.12	9.0%	29.2%
	MA05	1.99	0.74	1.28	170.1%	55.4%
	MA06	1.41	0.74	0.93	90.0%	52.5%
	MA07	2.11	1.60	1.40	31.9%	51.2%
	MA08	1.21	1.02	0.90	18.1%	34.3%
	MA09	1.38	0.40	0.75	248.6%	85.1%
	MA10	1.50	0.26	0.63	489.4%	138.7%
	MA12	1.12	0.15	0.58	641.7%	92.8%
	MA13	1.16	1.74	0.86	3.6%	35.8%
NUTS1	Nord Ouest	1.65	1.24	1.23	33.8%	34.3%
	Centre Nord/Oriental	1.40	1.31	1.11	6.7%	26.0%
	Centre	1.43	0.80	0.92	78.8%	55.4%
	Centre Sud	2.11	1.60	1.40	31.9%	51.2%
NUTS0	**MOROCCO**	**1.41**	**1.13**	**1.08**	**25.4%**	**31.3%**

* Source of the data: "Direction de la Programmation et des Affaires Economiques (Ministry of Agriculture)"

METHODOLOGICAL NOTE

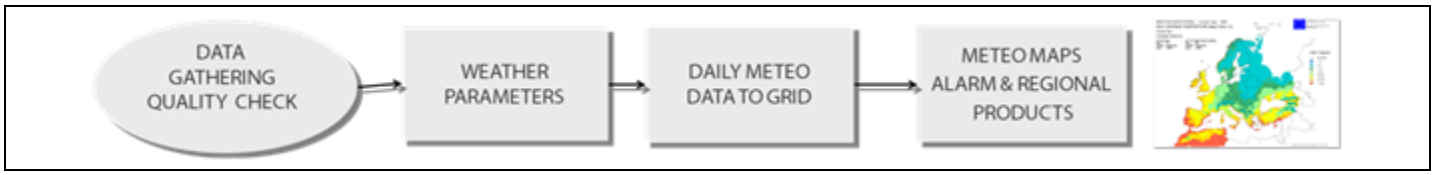
Crop Growth Monitoring System (CGMS)

The Crop Growth Monitoring System (CGMS) developed by the MARS Project provides the European Commission (DG Agriculture) with objective, timely and quantitative yield forecasts at regional and national scale. CGMS monitors crops development within the EU27 countries and also beyond European boundaries (Turkey, Ukraine, Morocco, Algeria and Tunisia) specific bulletins are produced also for Pastures and Grassland within the EU27 and for Rice in China and India.

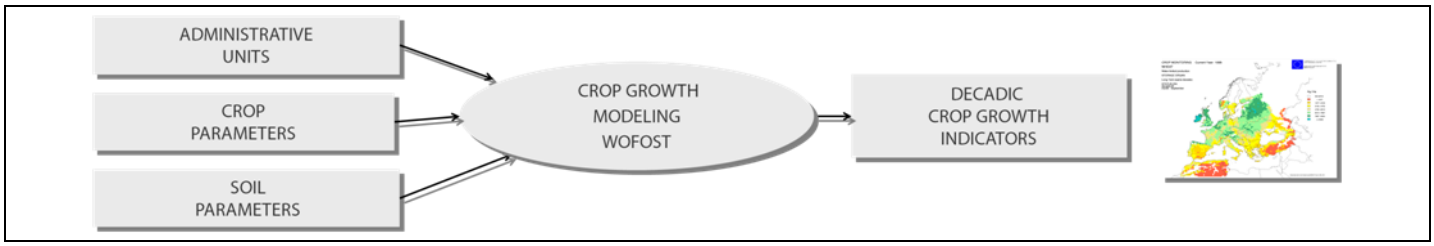
The system is driven by meteorological data modified by soil characteristics and crop parameters. This mechanistic approach describes the crop development in terms of biomass, storage organs etc. along the combination with the phenological development, from sowing to maturity, on a daily time scale.

The main characteristic of CGMS lies in its spatial structure which integrates interpolated meteorological data with soil features and crops parameters, through elementary mapping units for the simulation in the crop model. The core of the system is based on 2 deterministic crop models, WOFOST and LINGRA. GIS tools are used to prepare data and to produce results maps. Input and output are stored in a data base. Statistical procedures are used to forecast quantitative crops yield. In summary, CGMS consists of three main parts:

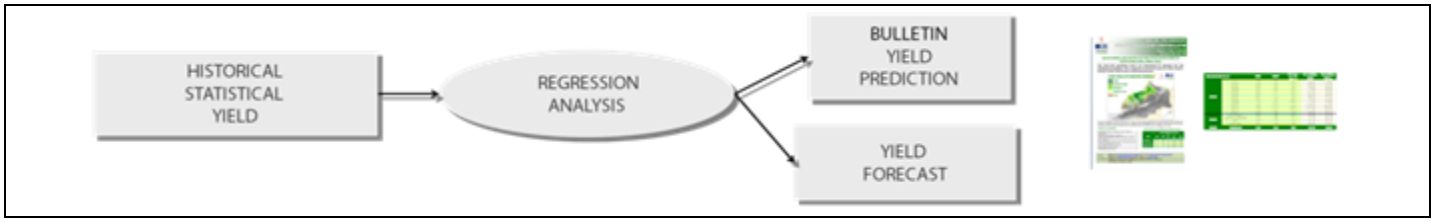
Level1: Weather Monitoring



Level2: Simulation of the crop growth



Level3: Statistical evaluation of the results and crops yield forecasts



NDVI

NDVI of croplands is a strong indicator of cereal yields at national as well as at agro-ecological zone levels (Balaghi *et al*., 2008). The MARS-STAT provides extracts of the Moroccan window for all dekadal images of NDVI from 1998 until 2009. By superimposing the NUTS boundaries over the 1 km-resolution NDVI-rosters, average and national NDVI-values were computed for each dekad. In this computation, only the pixels covered by cropland were accounted for. The differentiation with the non-agricultural land use was based on the map "Global Land Cover 2000 for Africa" (GLC2000 version 5.0, Mayaux *et al*., 2004), which also has a 1 km resolution. In the GLC2000, the agricultural parts are defined as areas with over 50% cultures and/or pastures.

EMPIRICAL YIELD FORECASTING

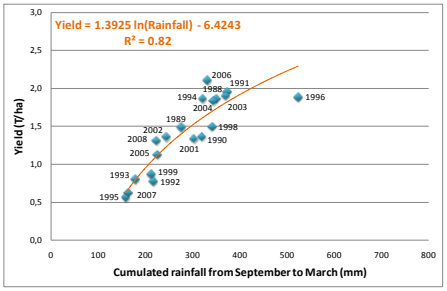
Beside crop yield estimates using CGMS system, winter cereal production was also early predicted for 2008-2009 cropping season, at national level in Morocco, based on an empirical approach. Following the rule developed by Gommes *et al.* (2007), three different methodologies have been used to forecast the production for each of the three major crops (soft wheat, durum wheat and barley): (1) historical analysis, (2) linear regression analysis between rainfall[1] and yields, and (3) linear regression analysis between NDVI[2] and yields[3]. These methodologies to estimate crop production in Morocco were developed by Riad BALAGHI and Mohammed JLIBENE (INRA, Morocco). These methodologies were partly

[1] *Rainfall time series were acquired from the Ministry of Agriculture (MAPM, Rabat).*
[2] *NDVI time series were obtained from the SPOT-VEGETATION website (http://free.vgt.vito.be) and 2008-2009 dekadal NDVI were obtained from JRC.*
[3] *Cereal statistics were acquired from Direction de la Programmation et des Affaires Economiques, in Rabat.*

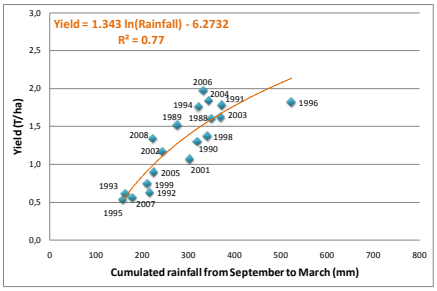
developed with the significant contribution of Bernard TYCHON (ULg, Belgium) and Herman EERENS (VITO, Belgium). The authors thank the following people who contributed to these estimates: Mohamed BADRAOUI, Rachid DAHAN and Hassan BENAOUDA (INRA, Morocco), Hamid FELLOUN and Fatiha SELOUANI (Ministry of Agriculture, Morocco), Bettina BARUTH and Giovanni NARCISO (JRC, Italy).

Historical Yield Analysis: Historical analysis is based on the search of similar cropping seasons from a rainfall point of view in the available time series (from 1988 to 2008), as rainfall is by far the main factor that drives crop production in Morocco. During 2008-2009 cropping season, cumulated rainfall from September 2008 till March 2009 (484mm) is at the same level as for 1995-1996 cropping season (524mm). In 1996 cereal yields were 1.89 tons/ha for soft wheat, 1.82 tons/ha for durum wheat and 1.57 tons/ha for barley at national level. Then, during the current season yields are expected to be at least at the same level as for 1995-1966. However, technological trend should be added to 1995-1996 yield levels. The resulting yield estimates based on historical analysis are 2.5, 2.3 and 1.6 tons/ha for soft wheat, durum wheat and barley, respectively.

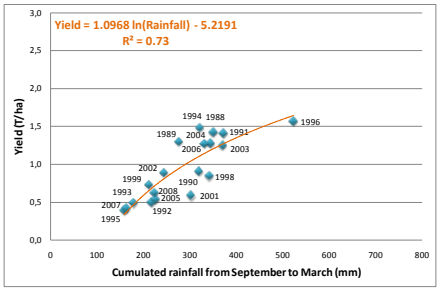
Rainfall Yield Estimates: The shape of the relationship between cumulated rainfall from September to March is lognormal for the soft wheat, durum wheat and barley. The three lognormal models have highly significant R^2-values ranging from 0.82 for soft wheat to 0.77 and 0.73 for durum wheat and barley. According to these lognormal relationships and taking into account the current cumulated rainfall from September to March (483mm) at national level, the expected national yields for the three main cereals are 2.2, 2.0 and 1.6 tons/ha for soft wheat, durum wheat and barley, respectively.



1a



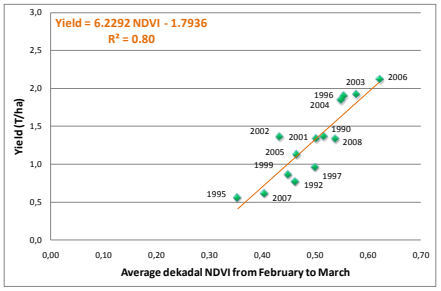
1b



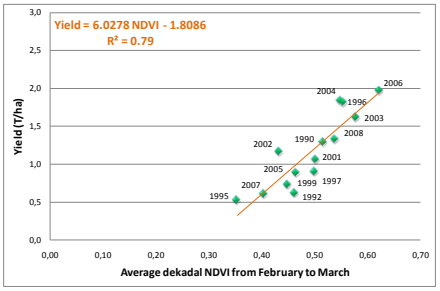
1c

Relationship between soft wheat (1a), durum wheat (1b), barley (1c) and cumulated rainfall (from September to March) at national level in Morocco, data from 1988 to 2008.

NDVI Yield Estimates: The relationship between average dekadal NDVI from February to March is linear for soft wheat, durum and barley (Balaghi *et al.* 2008). The three linear models have highly significant R^2-values ranging from 0.80 for soft wheat to 0.79 and 0.60 for durum wheat and barley. During 2008-2009 cropping season average dekadal NDVI value from February to March was equal to 0.61 at national level. According to these linear relationships and taking into account the current national NDVI value, the expected national yields for the three cereals are 2.0, 1.9 and 1.3 tons/ha for soft wheat, durum wheat and barley, respectively.



2a



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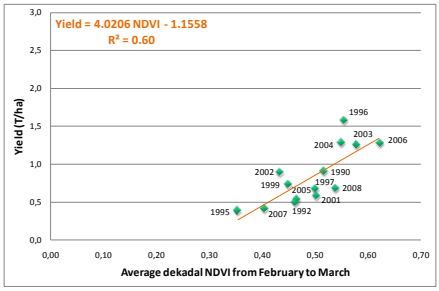

2c

Relationship between soft wheat (2a), durum wheat (2b), barley (2c) and average dekadal NDVI (from February to March) of croplands at national level in Morocco, data from 1990 to 2008.

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