



Launch of an agro-meteorological bulletin and development of online products derived from dynamic climate models of grain growth for supporting agricultural policy makers.

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Project 20:

Development of agro-meteorological products for on-line diffusion.
Delegación Territorial en Castilla y León

Motivation

Castile and Leon has 9.422.200 ha, where more than half of the region's area (roughly 5.783.831 hectares) is arable land.

The land is generally dry, but fertile, thus predominating dryland farming.

Despite the declining of rural population, the agricultural production of the historically known as "the granary of Spain" still represents 15 percent of country's whole primary sector.

Wheat and **barley** are the most traditional crop. In addition, **sunflower** fields have spread in the southern plains.



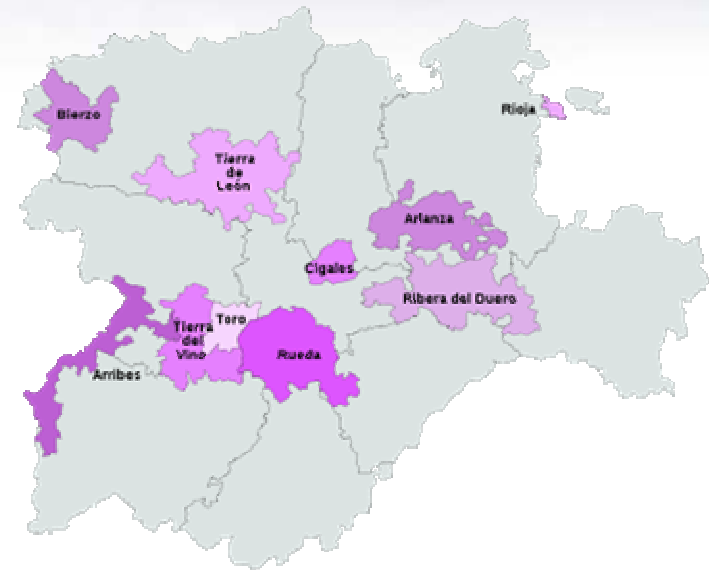
Motivation

The region is also at the forefront of quality **wines** production. In these areas there are more than 400 wineries, that allow the maintenance of the many rural towns population.

Obviously, all of these dryland farming have a strong dependency on meteorological factors.

Moreover, there are several irrigated zones where **maize**, **sugar-beets** and potatoes are grown. Meteorological information related to rain and moderate frosts could be critical to these irrigation cultivates.

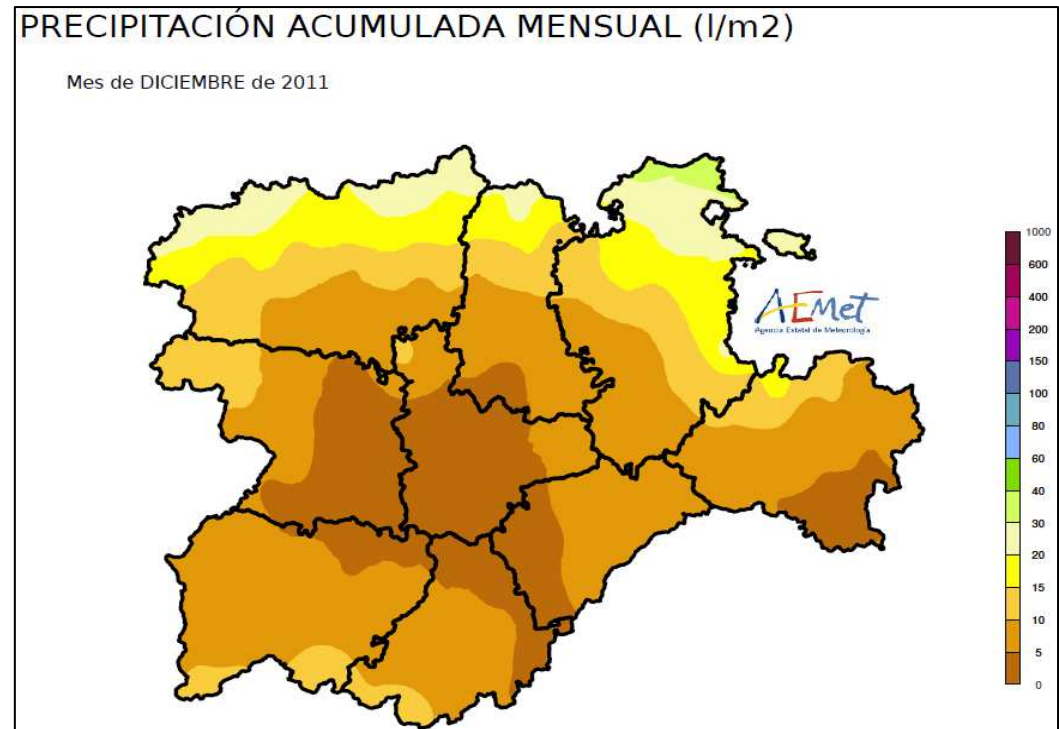
Therefore AMET, in collaboration with ITACyL, is raising and developing new supporting services for agriculture.



Summary of carried-out developments

1. -Agro-meteorological bulletin.

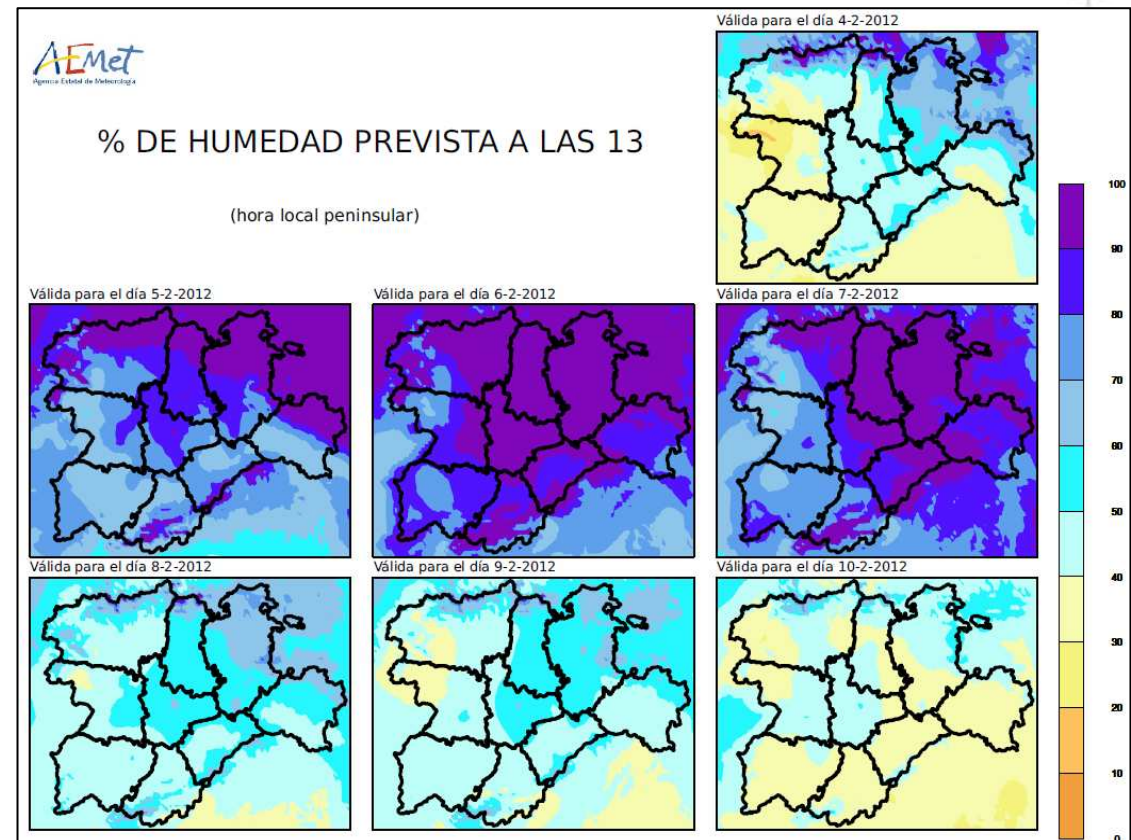
- Maximum daily precipitation
- Monthly accumulated rainfall
- Number of days with temperature below 0°C
- Number of days with temperature below -5°C
- Maximum wind



Summary of carried-out developments

2. –Seven-days prediction.

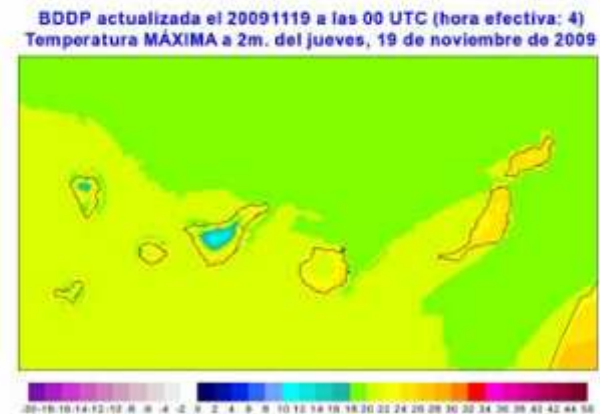
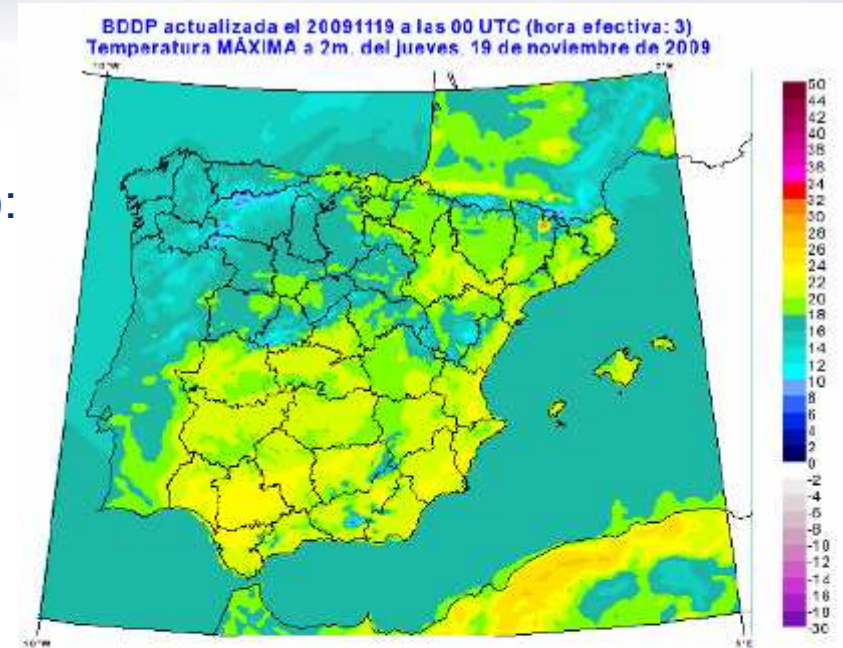
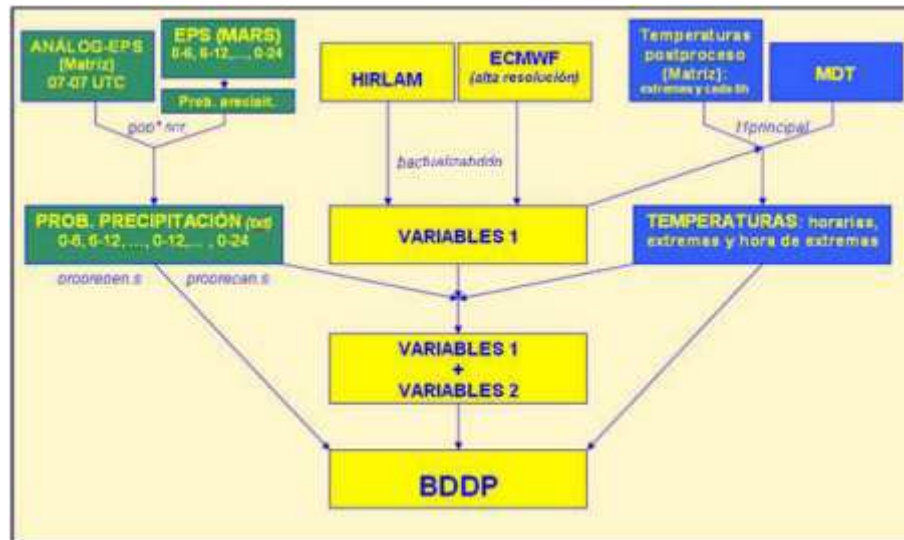
- Maximum daily precipitation
- Monthly accumulated rainfall
- Maximum wind.
- Minimum temperature
- Maximum temperature
- Moisture



Summary of carried-out developments

Use of BDDP (Numerical Weather Prediction):

- CEP
- HIRLAM



Summary of carried-out developments

Technologies.

Our software generates automatic bulletins in PDF format, that include visual maps derived from raster-TIFF images.

The development language depends on the needs of the project:

- Bash code using linux shell.
- ANSI C (Magic++, GribAPI, Gdal OGR, Geos, Proj, OCI - Oracle Call Interface)

```
#!/bin/bash

export PATH=/usr/local/bin:/usr/local/sbin:/usr/sbin:/usr/bin:/sbin:/bin
export ORACLE_HOME=/opt/oracle/instantclient
export HOME=/home/rosa

cd $HOME
cd BOLETIN_CLIMATOLOGICO

if [ ! -d pluvioTMP ];then
mkdir pluvioTMP
fi

if [ "$1" == "" ] ; then
echo " úsame: $0 dd/mm/yyyy"
exit
fi

fecha=$1
#fecha="01/01/2011"
llx="130000"
lly="4415000"
urx="655000"
ury="4825000"
#-7.3,40 +.3,-7.3,40.0,-1.7,43.5, 29.7,21);
#-spat xmin ymin xmax ymax

lILO=-7.20
lILA=39.90
urLO=-1.60
urLA=43.30
tamagnoy=$(echo "scale=3;a=${urLO} - ${lILO};a / 0.01" | bc)
tamagnox=$(echo "scale=3;a=${urLA} - ${lILA};a / 0.01" | bc)

lLOgr=$(echo "scale=3;${lILO} - 0.04" | bc)
lAgr=$(echo "scale=3;${lILA} - 0.04" | bc)
urLOgr=$(echo "scale=3;${urLO} + 0.04" | bc)
urLAgr=$(echo "scale=3;${urLA} + 0.08" | bc)
```

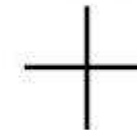
Current steps

The present project intends to generate products and services to control and improve agricultural production from agro-climatic models.

It is being developed in collaboration with ITACyL, supplementing us in those specific knowledge areas where they are experts.

The products will be broadcasted online, with our tools, designs and developments, and probably hosted in a ITACyL's server.

It will be needed to modelize at any time the state of the crop, depending on parameters such as soil type, kind of crop and, of course, weather data.

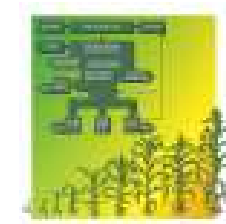


Dinamic Agro-climatic models

There are several agro-climatic models: APSIM, AquaCrop, CROPSYST, CROPWAT, DSSAT, STICS, SWAP, SWAT, WOFOST... each one with its pros and its cons.

For the purpose of this project, WOFOST model (Wageningen University, NL) is the one that seems to be the best option since:

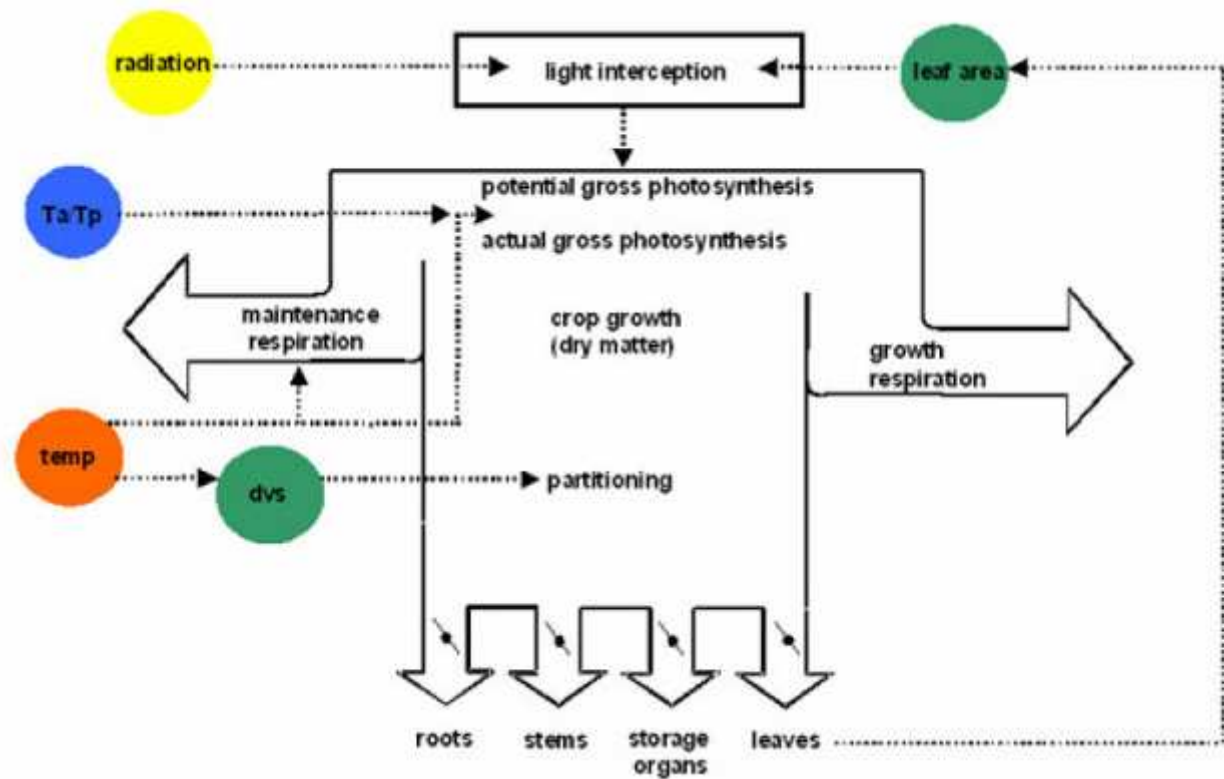
- It is satisfactory for both irrigated and dry farming.
- It allows to model and customize soil parameters.
- It is supported by the Joint Research Center.
- It is open source.
- It works properly under several O.S. (Windows, Linux..)
- It is free.



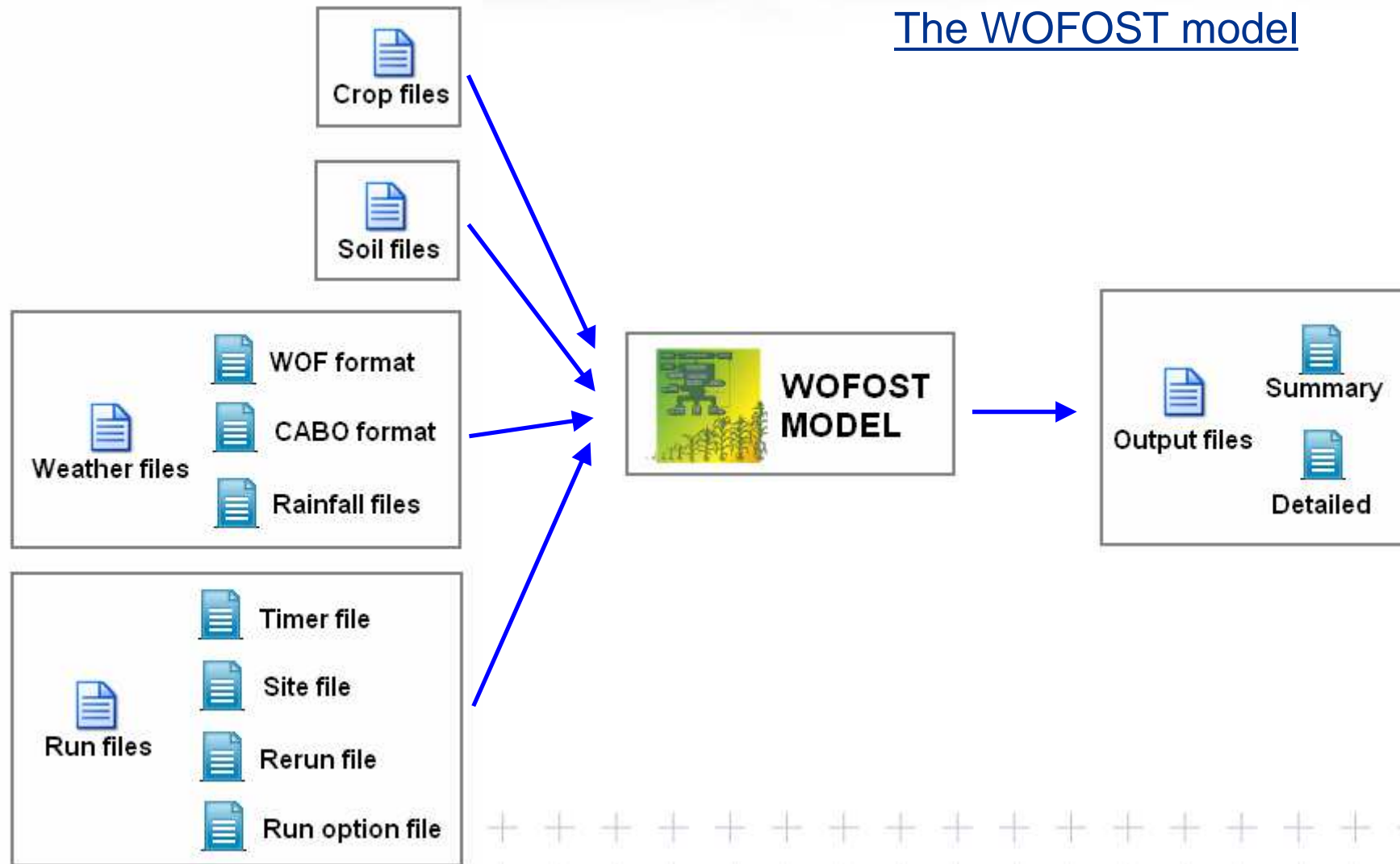
WOFOST

The WOFOST model

It simulates the crop growth and its production based on the incoming photo-synthetically active radiation absorbed by the crop canopy, its photo-synthetic leaf characteristics, and accounting for water and salt stress on the crop.



The WOFOST model



Meteorological Inputs

- Maximum temperature
- Minimum temperature
- Precipitation
- Number of days with precipitation
- Wind speed
- Early morning vapour pressure
- **Irradiation (key parameter)**

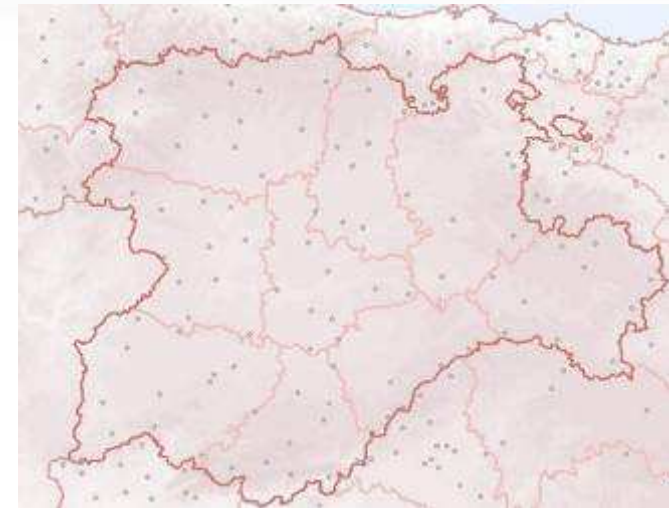
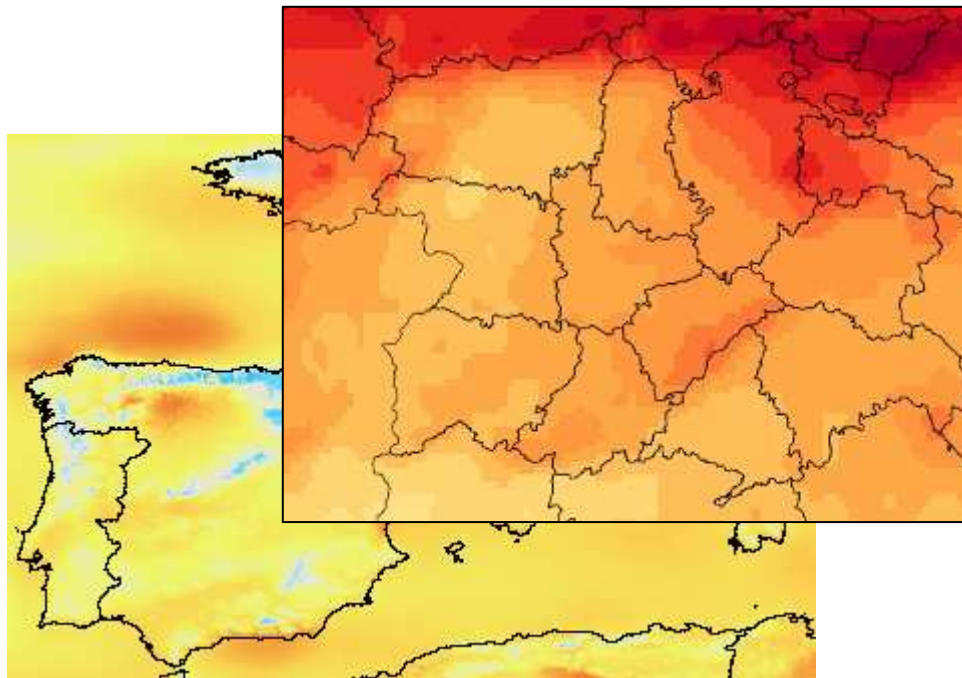


AEMET Weather Station Network

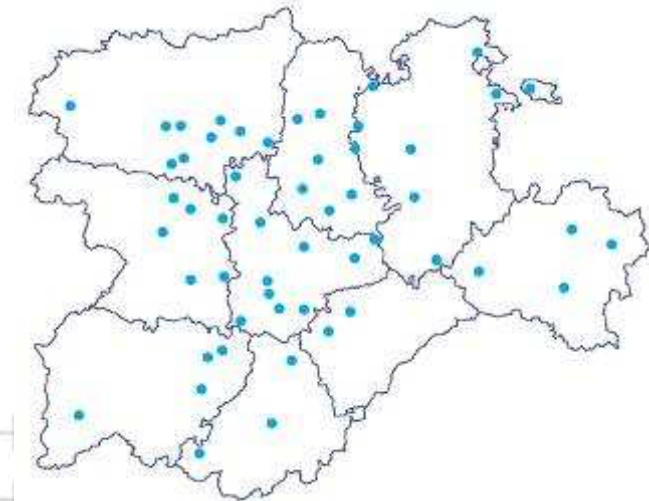
Source Inputs for Irradiation

Satellite information projects:

- CM-SAF (Climate Monitoring)
- H-SAF (Hydrology and water management)



ITACyL Weather Station Network



Meteorological Inputs

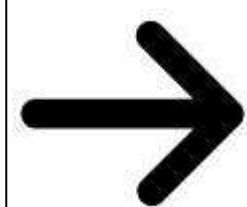
File Generator program

```
#include <stdio.h>
#include <stdlib.h>
#include "ociLib.h"
#include <proj_api.h>

void err_handler(OCI_Error *err)
{
    printf(
        "code : ORA-%05i\n"
        "msg : %s\n"
        "sql : %s\n",
        OCI_ErrorGetOCICode(err),
        OCI_ErrorGetString(err),
        OCI_GetSql(OCI_ErrorGetStatement(err))
    );
}

int generaArchivoWOF(OCI_Statement* st,int mode,char* n_estacion)
{
    //char cadena[80]; //80 son los caracteres máximos por líneas que lee el modelo WOFOST
    char consulta[800]; //
    char cadena[180]; //180, pues si los datos exceden da un error.
    char codigo[6]=" ";
    char nombre[30];
    char archivo[20];
    double latitud=0;
    double longitud=0;
    int altitud=0;
    double radiacion,viento;
    int e=0; //variable auxiliar
    int anno=1991;
    OCI_Resultset* rs;
    projPJ pj_merc, pj_latlong;

    //COMUN PARA TODOS LOS ARCHIVOS
    if (!(pj_merc = pj_init_plus("+proj=utm +zone=30 +ellps=WGS84 +datum=WGS84 +units=m +no_defs")) )
    {
        printf("error iniciando elipsoide!");
        exit(1);
    }
    if (!(pj_latlong = pj_init_plus("+proj=latlong +ellps=WGS84")) )
    {
        printf("error iniciando elipsoide!");
        exit(1);
    }
    sprintf(consulta,"SELECT SC.ESTACIONES.NOMBRE, SC.ESTACIONES.INDICATIVO FROM SC.ESTACIONES WHERE
OCI_ExecuteStmt(st, consulta);
rs = OCI_GetResultset(st);
OCI_FetchNext(rs);
```



Meteorological files

```
** WCCDESCRIPTION=Spain, LEON/VIRGEN DEL CAMINO
** WCCFORMAT=0
** WCCYEARS=1991-2011
2661 LEON/VIRGEN DEL CAMINO
1991 42.6 916. 0.18 0.55
11.8 -6.2 5.920 5.8 -999.0 54. 11.
15.6 -6.0 10.290 5.7 -999.0 31. 7.
18.0 -1.6 11.780 7.5 -999.0 108. 16.
21.2 -3.6 19.090 6.9 -999.0 18. 10.
27.6 -2.6 23.390 8.0 -999.0 22. 4.
31.6 2.0 25.790 10.5 -999.0 22. 4.
34.4 7.2 23.040 12.5 -999.0 5. 6.
34.8 6.2 23.230 13.2 -999.0 -0. 1.
31.6 5.0 16.900 13.2 -999.0 45. 11.
23.8 -3.4 11.450 8.9 -999.0 39. 13.
16.6 -5.6 7.730 7.6 -999.0 43. 15.
17.4 -2.4 5.180 6.3 -999.0 9. 5.
2661 LEON/VIRGEN DEL CAMINO
1992 42.6 916. 0.18 0.55
14.2 -7.6 6.840 5.1 -999.0 26. 2.
18.8 -6.0 10.450 5.3 -999.0 5. 1.
25.2 -3.6 15.220 6.2 -999.0 30. 1.
24.4 -1.8 21.420 7.4 -999.0 34. 5.
30.2 -0.4 21.440 9.2 -999.0 32. 11.
28.0 3.6 18.530 10.4 -999.0 67. 18.
34.4 8.0 24.700 13.2 -999.0 10. 6.
34.4 6.8 21.360 12.8 -999.0 61. 8.
29.0 4.0 17.500 11.0 -999.0 8. 5.
20.4 -2.0 9.790 8.9 -999.0 56. 11.
20.4 -0.8 7.130 9.2 -999.0 7. <null>.
13.0 -2.8 4.180 7.4 -999.0 68. 14.
2661 LEON/VIRGEN DEL CAMINO
1993 42.6 916. 0.18 0.55
11.6 -6.2 4.910 6.6 -999.0 0. 3.
16.2 -8.4 11.080 5.8 -999.0 12. 3.
19.2 -8.2 13.970 6.6 -999.0 18. 10.
22.2 -1.2 16.870 7.0 -999.0 37. 15.
22.2 1.2 17.240 9.3 -999.0 117. 19.
30.6 4.6 22.560 12.5 -999.0 56. 11.
34.0 4.4 24.740 12.3 -999.0 58. 3.
34.8 5.4 21.590 12.2 -999.0 45. 5.
28.6 0.4 13.500 10.7 -999.0 78. 16.
16.4 0.4 8.000 8.9 -999.0 94. 18.
16.2 -2.2 6.340 7.4 -999.0 34. 11.
13.0 -4.0 4.720 7.9 -999.0 9. 11.
2661 LEON/VIRGEN DEL CAMINO
1994 42.6 916. 0.18 0.55
```

Next steps:



Agricultural Scope Website

Monitoring Tools



Agricultural Recommendations



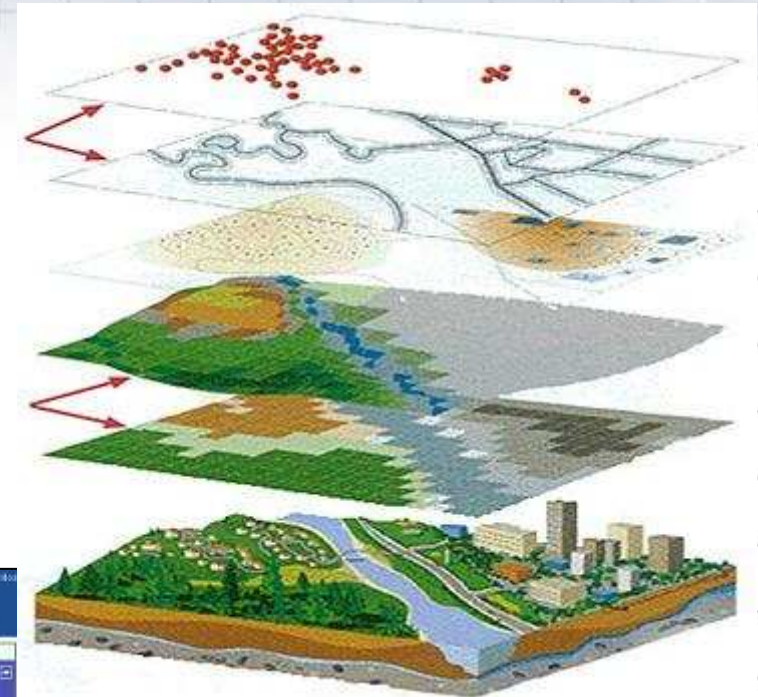
Commercial Utilities

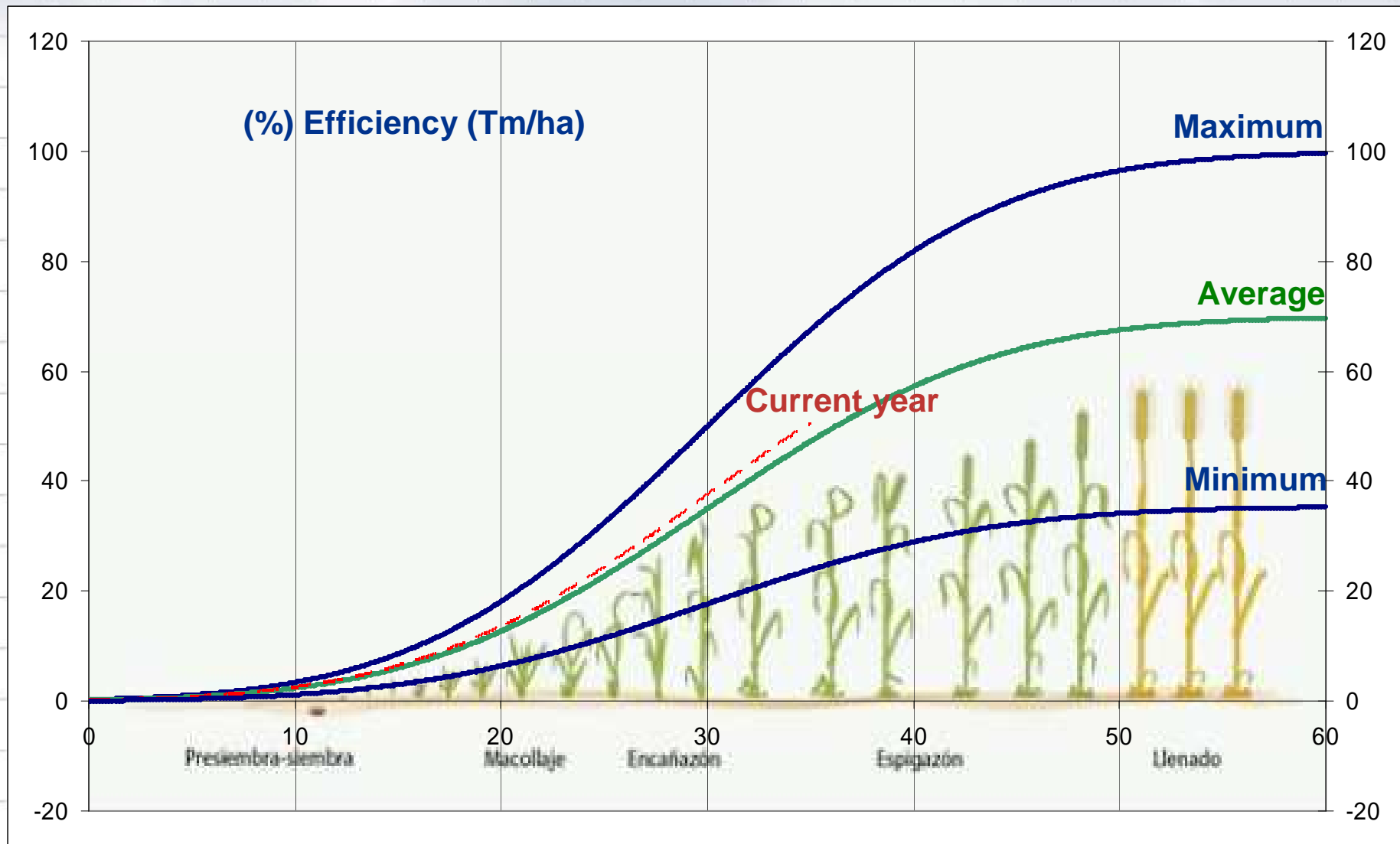


Monitoring Tools:

WebGIS:

- Weekly aerial images
- Information for each cultivated parcel
- Harvest predictions
- Meteorological monitoring bulletin
- Phytosanitary alerts





Agricultural Recommendations:

WebGIS:

- Fertilization advices
- Seeding recommendations
- Frosts map for degree days calculation (for crop choice, or growing cycles, by thermal integrals)
- Prediction bulletin (including InfoRiego tool)

Predicción de precipitación

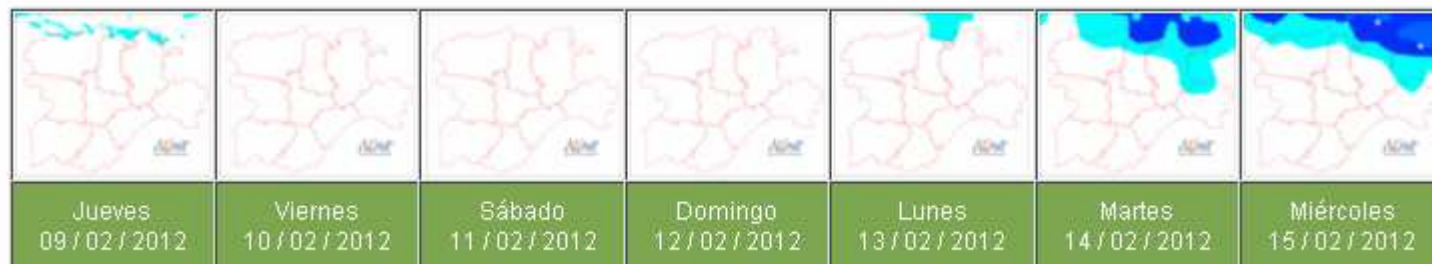
Burgos | Miranda de Ebro

Predicción de precipitación (l/m²) hecha el Jueves 09/02/2012:

Jueves 09/02/2012	Viernes 10/02/2012	Sábado 11/02/2012	Domingo 12/02/2012	Lunes 13/02/2012	Martes 14/02/2012	Miércoles 15/02/2012
0	0	0	0	1	4	2

Información suministrada por la Agencia Estatal de Meteorología

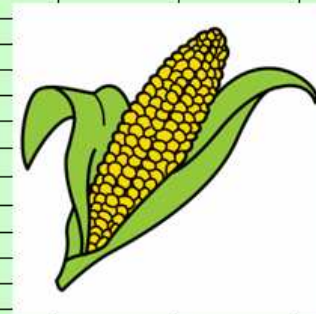
[Volver a pantalla inicial](#)



Agricultural Recommendations:

Choice crop by thermal integrals in order to FAO growing cycles

Fecha	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiembre	Octubre	Noviembre	Diciembre
1												
2												
3												
4												
5												
6												
7												
8												
9					Última helada							
10												
11												
12												
13												
14												
15												
16					Siembra							
17												

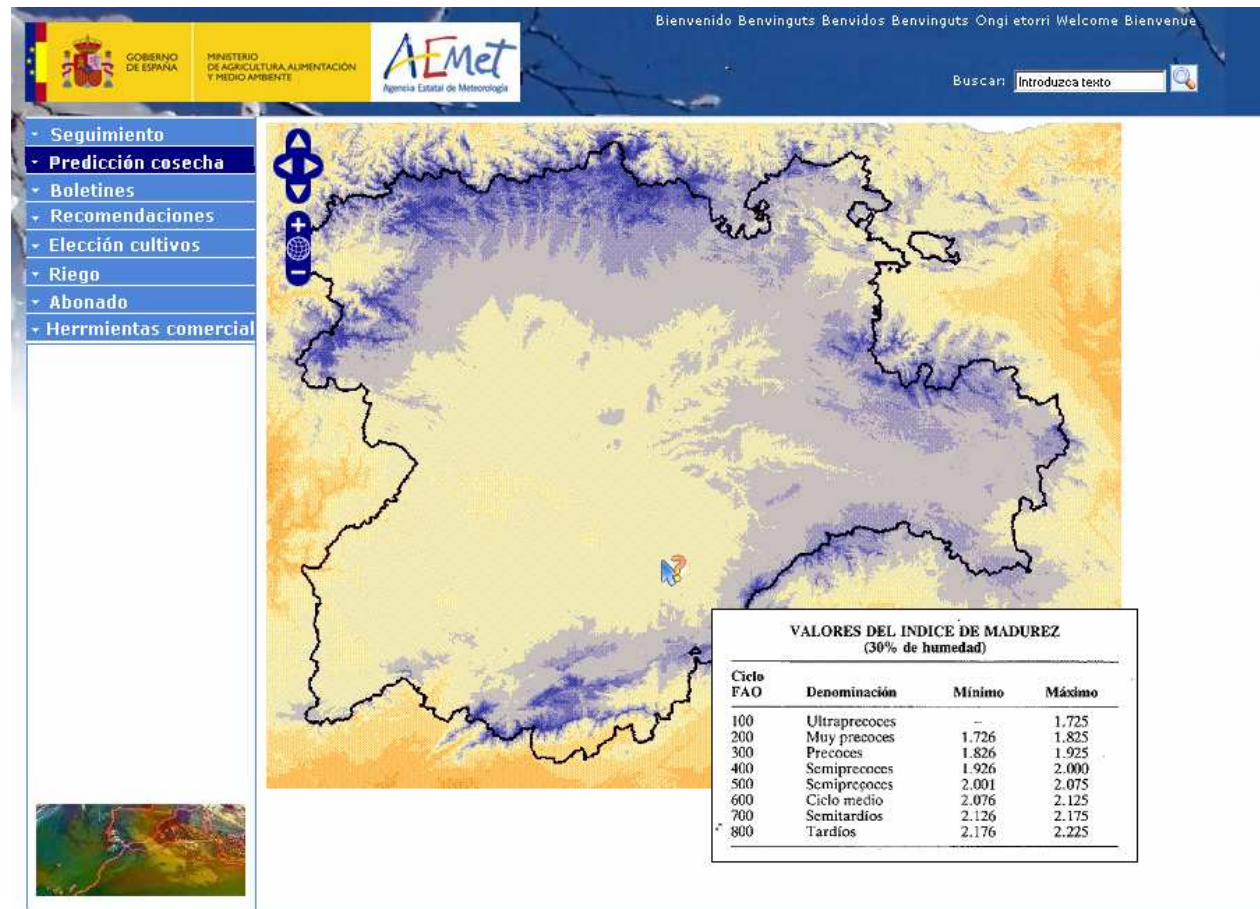


**VALORES DEL INDICE DE MADUREZ
(30% de humedad)**

Ciclo FAO	Denominación	Mínimo	Máximo
100	Ultraprecoces	–	1.725
200	Muy precoces	1.726	1.825
300	Precoces	1.826	1.925
400	Semiprecoces	1.926	2.000
500	Semiprecoces	2.001	2.075
600	Ciclo medio	2.076	2.125
700	Semitardíos	2.126	2.175
800	Tardíos	2.176	2.225

Agricultural Recommendations:

Example of frosts map to take decisions related to which kind of corn is recommended for each area.



Bienvenido Benvinguts Benvidos Benvinguts Ongi etorri Welcome Bienvenue

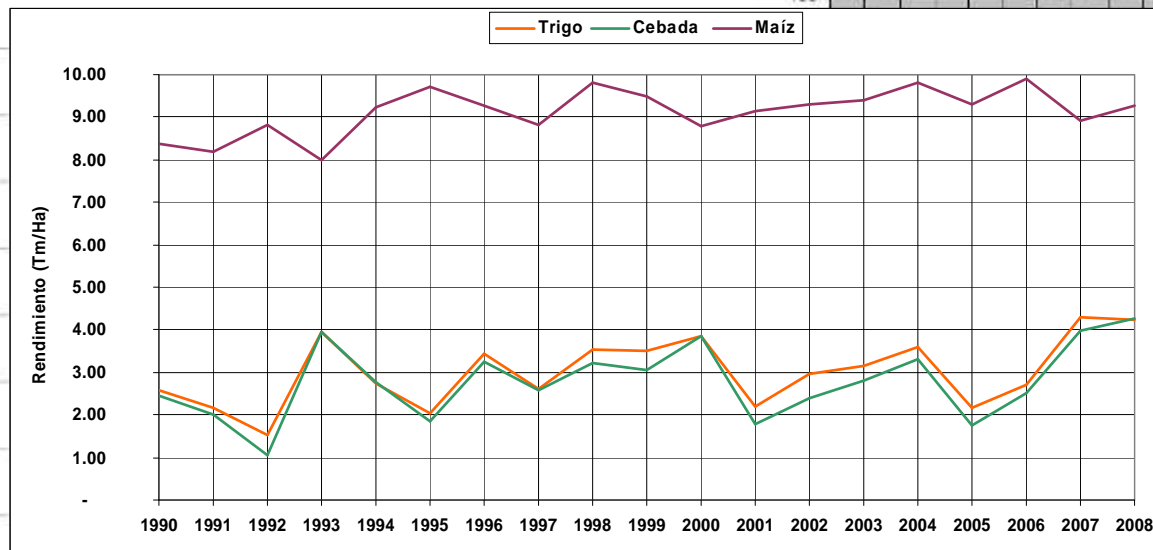
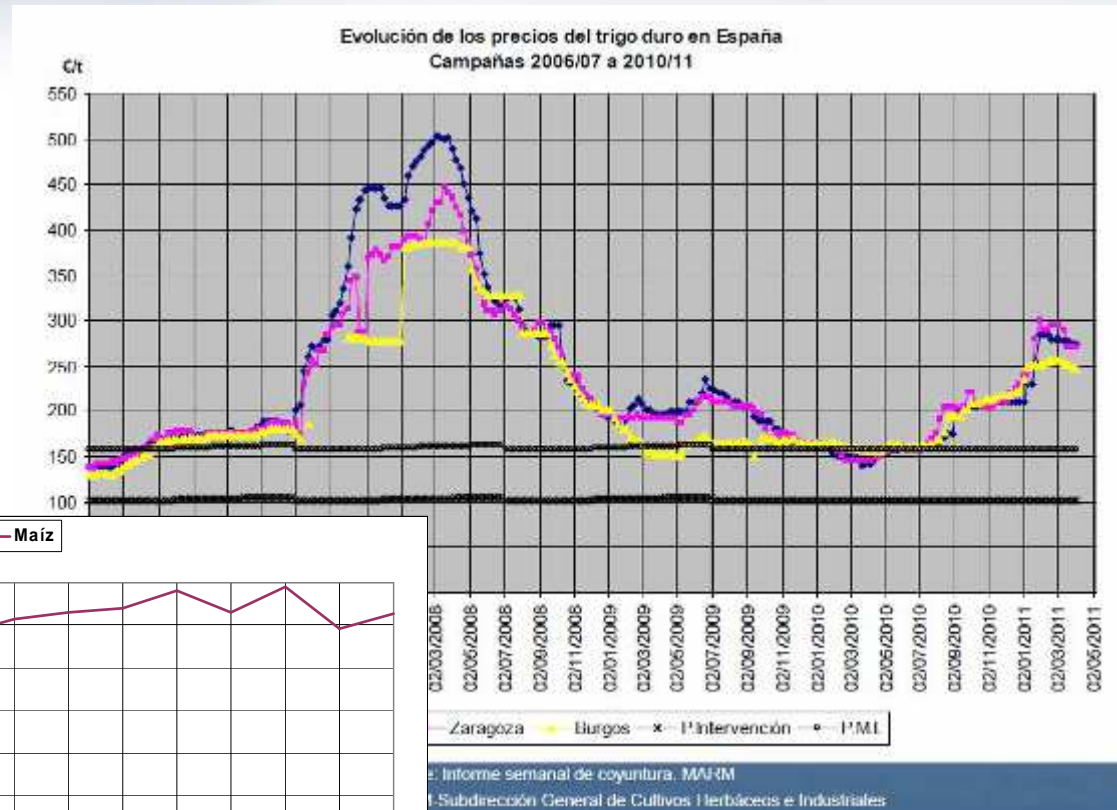
Buscar:

- Seguimiento
- Predicción cosecha**
- Boletines
- Recomendaciones
- Elección cultivos
- Riego
- Abonado
- Herramientas comercial

Ciclo FAO	Denominación	Mínimo	Máximo
100	Ultrapreococes	-	1.725
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800	Tardíos	2.176	2.225

Commercial Utilities

- Efficiency and productivity statistics.
- Historical and current tables of grain prices.



Future steps

- Include the possibility of ordering detailed studies upon request, downloadable in PDF / Excel, etc ...
- Make the tool extensible to the whole Spanish territory.
- Analyze and study more types of crops.
- Using agro-meteorological models more complex and complete.
- Collaborate with other governments / universities to study, not only agriculture but also forestry.





Thank you!

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