

## **ET 1.2 - Expert Team on Crops : Agromet Services and Products**

This report is a contribution within the framework of the expertise launched by the WMO-CAGM, developed by the team of experts charged by the subject Agromet Services and Products.

On this occasion, i would like to thank all the members of the team, particularly Mr Federico Spanna and Mr Vernon Carr for their important contributions. I also thank Dr Nabsanu N. Chattopphday for her a valuable advice. All my considerations are addressed to Dr Robert Stefanski for his managerial qualities, which have been a great source of motivation.

### **Terms of Reference**

- (a) Review existing operational agricultural meteorological services for the crops sector;
- (b) Review existing operational agricultural meteorological service for early warning systems for crop management (e.g. water supply) and pests/diseases for crops(ALL);
- (c) Based on this reviews in (a) and (b), develop a list of requirements for operational agricultural meteorological services for the crops sector and for early warning systems for pests/diseases;
- (d) Make recommendations based on (a), (b), and (c) and prepare a report for CAGM;
- (e) Review the procedures for development and delivery of quality (validated, verified, and reliable) agricultural meteorological products for crops through collaboration and coordination with other WMO Programmes and international and regional organizations;
- (e) Prepare a draft handbook of recommended procedures for development and delivery of quality (validated, verified, and reliable) agricultural meteorological products for crops;

## **Membership for the Expert Team**

<b>Hatem Baccour</b>	<b>RA I</b>	<b>Tunisia</b>
<b>Nzue Kouakou Augustinra</b>	<b>RA I</b>	<b>Côte d'Ivoire</b>
<b>Mao Liuxi</b>	<b>RA II</b>	<b>China</b>
<b>Gilma Carvajal</b>	<b>RA III</b>	<b>Ecuador</b>
<b>Adrian Trotman</b>	<b>RA IV</b>	<b>British Caribbean Territories (BCT)</b>
<b>Vernon Carr</b>	<b>RA V</b>	<b>Australia</b>
<b>Federico Spanna</b>	<b>RA VI</b>	<b>Italy</b>

## **Review existing operational agricultural meteorological services for the crops sector**

Weather forecasts are provided by meteorological services to farmers in the form of a bulletin in most of the time. These forecasts relate to meteorological parameters that have a great impact on agricultural production for quantity and quality, in irrigation management or in the work organization. For this purpose, these parameters include rain, temperature and wind. Although the quality of the short and medium-term forecasts of 24 to 72 hours has improved significantly, the way in which they communicate to farmers is a real challenge for this information to be interpreted by the farmer and especially his reaction or rather his confidence. In relation to this 'uncertain' information, whatever the level of performance and the tools implemented by the weather services to continuously improve the quality of these forecasts, such as large computers, numerical weather models and meteorological observation systems.

Monthly and seasonal forecasts are also provided to farmers by several meteorological centers. These forecasts are usually presented in tabular form, particularly in the case of African countries or in maps form. The big challenge is understanding the meaning of this information and how to take advantage of it. The reliability of these forecasts as well as the farmer's confidence in this type of forecasting remains a challenge to be reached.

In the majority of agrometeorological bulletins we find tables of climatic data representing the recent past (5 to 10 days).

Each information relating to a climatological parameter thus provided is of great help for the decision-making of the farmer. Indeed, climatic data are used to estimate the agricultural potential of a given region (pedoclimatic zoning). This information can also contribute to the introduction of new crops and farming

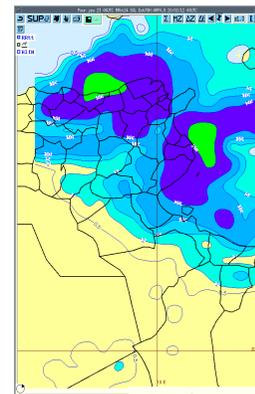
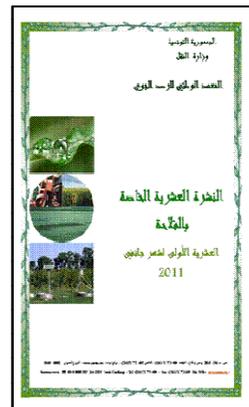
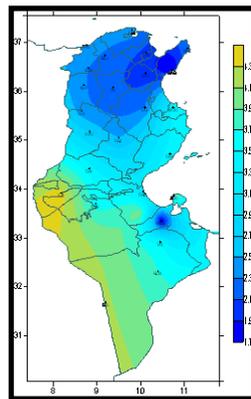
methods. The short and medium-term weather forecast makes it possible to organize work in the fields, to program the spreading of the phytosanitary treatments or to adapt the irrigation doses.

## Case study

### In Africa

#### 1° Tunisia

In the case of Tunisia, the INM ([www.meteo.tn](http://www.meteo.tn)) publishes periodically every 10 days a bulletin containing climatic tables of the recent past, maps and weather forecasts for all country regions. These bulletins are sent to different structures of the Ministry of Agriculture and not directly to farmers.



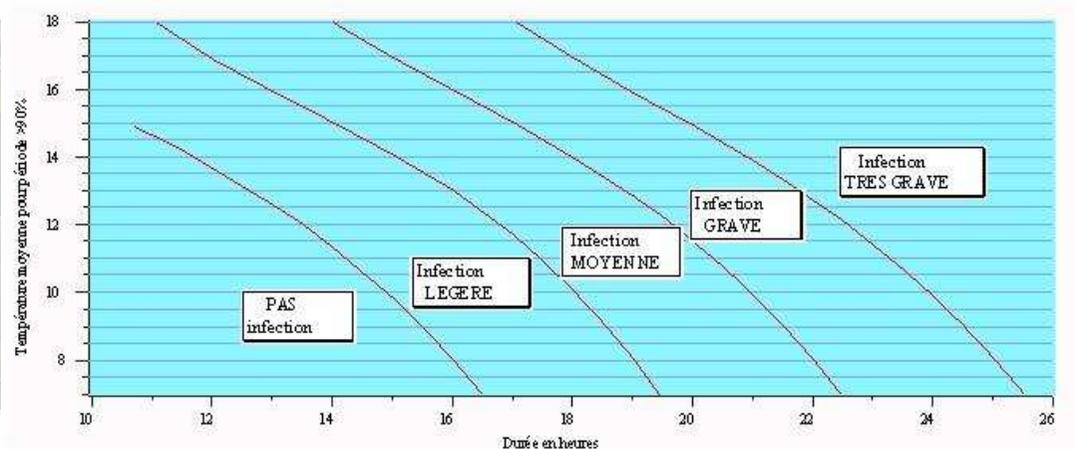
More detailed reports are also produced monthly with maps and statistics on the distribution of rainfall throughout the country. The SPI is also developed by meteorological observation station. This report is sent to the agricultural authorities.

The INM has also developed a pilot experiment in 'Cap Bon', a region in the north-east of the country where water demand by different economic actors such as tourism, agriculture, households and agriculture is highly important. The products provided as part of this experience in the form of newsletters were instead sent directly to farmers.

The objectives of the experiment were mainly :

- Encouraging farmers to use meteorological information in the programming of their work, in particular the management of irrigation and phytosanitary treatments,
- Establishing links between INM departments and farmers,
- The economic evaluation of meteorological information in the management of the farm, particularly in the irrigation water economy and the rationalization of the use of plant protection products.

This experiment has shown with the help of farmers in the region, how we can optimize the use of water, for irrigation and reason the use of phytosanitary treatments and this through agrometeorological information



## 2° Algeria

The Algerian Ministry of Agriculture, Rural Development and Fisheries periodically publishes an agrometeorological bulletin containing climate tables and weather forecasts by major regions as well as the impact of the climatic conditions of the period (here it is the decade) on vegetation and the spread of insects.

The bulletins also include agricultural technical recommendations such as the treatment of diseases, need for irrigation, maintenance of the drainage network installations ... etc. [http://www.minagri.dz/bulletin%20AgroMeteo/2017%202018/BAGM\\_N06\\_du\\_23\\_au\\_28\\_10\\_2017.pdf](http://www.minagri.dz/bulletin%20AgroMeteo/2017%202018/BAGM_N06_du_23_au_28_10_2017.pdf).

### **3° Senegal**

The National Agency of Civil Aviation and Meteorology in Senegal, under the program AGRHYMET an agrometeorological bulletin is provided every decade describing meteorological situations with forecasts, hydrological, agricultural, phytosanitary, pastoral, the state of the vegetation growth based on NDVI index on maps. In this bulletin we also find the situation of the agricultural market including information on supply and prices.

[http://www.anacim.sn/document/gtp\\_2017/bulletin%20i%20C3%A8re%20d%20C3%A9cade\\_juin\\_2017.pdf](http://www.anacim.sn/document/gtp_2017/bulletin%20i%20C3%A8re%20d%20C3%A9cade_juin_2017.pdf)

### **4° Morocco**

In Morocco the Department of National Meteorology offers its customers in the agricultural fields adapted products in the form of weather and climate bulletin with a frequency of ten days and monthly. These bulletins contain observed data and weather forecasts.

[http://www.marocmeteo.ma/q=fr/produits\\_services/agriculture](http://www.marocmeteo.ma/q=fr/produits_services/agriculture)

### **5° Rwanda**

Rwanda Meteorology Agency provides for the crop sector essentially weather forecast short, medium, seasonal and inter-annual ranges respectively.

<http://www.meteorwanda.gov.rw>

### **6° Specialized centers**

In Africa, specialized centers such as the AGRHYMET publish special bulletins on agro-hydro seasonal forecasts as part of the fight against drought in the Sahel region of Africa. Climatic conditions as well as the durations of the dry sequences. <http://www.agrhymet.ne/bulletin.html>

ACMAD offers climatological and meteorological products. For example precipitation forecasts, storms development and flood risk. Although these products are of a regional and strategic nature generally intended for policy makers and governments, they could provide valuable support for the agricultural production sector as well as for farmers. <http://www.acmad.net/new>

## **In North America**

### **1° Canada**

In Canada, there are several government, professional and civil society centers and organizations, such as the Agricultural Pest Prediction Information Center, the Quebec Center for Research and Development, the Atlantic Weather Agency and the Ministry of the Environment and Climate Change. This Ministry provide bulletins and decision support tools for farmers, particularly on computer platforms. These bulletins are complete and well developed. These bulletins are also rich in meteorological information such as short and medium-term forecasts, agroclimatic data such precipitation totals, climatic summaries or cumulative degree-days by type of crop. <http://www.agrometeo.org>.

Farmers can find essential information to assess the best time to intervene to protect their crops through a large number of bioclimatic models. With these models, for example, it is possible to determine more precisely which is the most effective time to apply a pesticide and thus reduce input costs.

### **2° USA**

In the United States, several institutions and organizations provide different services such as bulletins, monitoring and alerts. Such U S Department of Commerce – NOAA and US Department of Agriculture - NASS. In these bulletins we find information concerning different meteorological parameters such as rain, temperature and humidity. These bulletins also provide a map of the US to represent the distribution of drought's impact and intensity as well as its (likely) prediction. Agricultural production data are also presented. Regional rainfall map for the world are also provided in these periodic weekly bulletins.

<https://www.usda.gov/oce/weather/pubs/Weekly/Wwcb/wwcb.pdf>

## **In South America**

### **1° Brazil**

The National Institute of Brazilian Meteorology provided through its website [www.inmet.gov.br](http://www.inmet.gov.br), very useful information for agriculture. Short and medium term forecasts as well as seasonal climate forecasts and climate monitoring indices such as SPI are available on this site. bulletin and maps for different agroclimatic parameters such as ETP, ETR, rain, temperature, air humidity ... etc, are also presented in this site as a decision aid for the agricultural sector.

## **In Asia**

### **1° India**

A very wide range of information and agrometeorological services is provided by different departments in India. For example the Indian Meteorological department offers in its website a lot of valuable information useful for agricultural community. <http://www.imdagrimet.gov.in>.

The National Agromet Advisory Bulletin is produced weekly with data on key climatic parameters for agricultural production, SPI, soil moisture, NDVI and soil moisture predictions as part of the framework monitoring the risk of drought. All this information is presented in map form all over India. Regional weather forecasts are also provided in this bulletin, providing a very useful dashboard for farmers.

### **2° Korea**

Several agrometeorological products are provided by different institutions. Digital climate map (DCM), plant disease and insect prognosis services and real time agrometeorological weather observation data, are provided by National Center for Agrometeorology. <http://www.ncam.kr/>

Korea Meteorological Association provides drought information and agrometeorological information, which contains different meteorological parameter. <http://www.weather.go.kr/weather/>. The Rural Development Administration provides observation data, analysis of agrometeorology for station or period and sequential information of agrometeorology.

## **In Europe**

Some years ago Zoltán Dunkel of the Hungarian Meteorological Service published the study “Improving grometeorological Bulletins Perspectives from RA VI (Europe)” This study summarized the results of a questionnaire sent to the States of RA VI in order to collect information’s about the agro-meteorological bulletins and their main contents. He wrote:

“As a conclusion we can summarise that the ‘Agrometeorological Bulletin’ should consist of two parts. The first part could be a diagnosis, the second part a forecast. Both parts could contain beside the meteorological data, phenological information and yield parameters. The diagnosis could be short or detailed, regarding the impact of the meteorological factors in the last period (day, week, moth or season) upon the evolution of the growth status of the main crops,

estimation of agrometeorological conditions for the growth, development and yield formation of the crops, the sequence of the phenological phases, available soil moisture and soil water deficit at various depths, the advance or delay of the vegetation development and indication of favourable weather conditions for each crop. Beside the meteorological data, the bulletin should deal with the soil moisture as well. The forecasting part could contain information on the perspectives of the meteorological conditions for the next period, day and week. Among the possible meteorological information we have to mention the minimum and maximum expected temperature and rainfall probability, prediction of phenological stage, rate of growth and development of crops and their expected yields and dates of harvesting, expected available water content, as well as certain necessary recommendations for the farmers for the use of different technologies in accordance with the new conditions. Various annexes on daily values of mean, minimum, maximum and normal temperature (as graphics) and distribution of precipitation, available soil moisture and water deficit over the examined region are also included in the bulletin. In both parts, various types of maps are always a core part of the bulletin”

In the following years, the situation has not changed so much, but it is made greater use of decision support systems, especially for pest management and water management. There is also an improvement of services and a progressive downscaling to regional scales rather than national.

It is believed that this could be the main development in the coming years to meet the requirement of the European regulations

On this basis a new search has been made based on the resources available on the web related to some countries of RA VI.

### **1° Italy**

At national scale there is a meteorological service but there are few agrometeorological products. There is only a phenological newsletter with spatial information and a newsletter with climatological maps of thermopluviometric variables (All.2)

In Italy many regional services have been developed. In Italy there are 21 Regions and each one of them has developed its own agro-meteorological and plant pathology services that provide agro-meteorological data and disseminate informations.

The phytopathological and entomological models used are defined in the following tables.

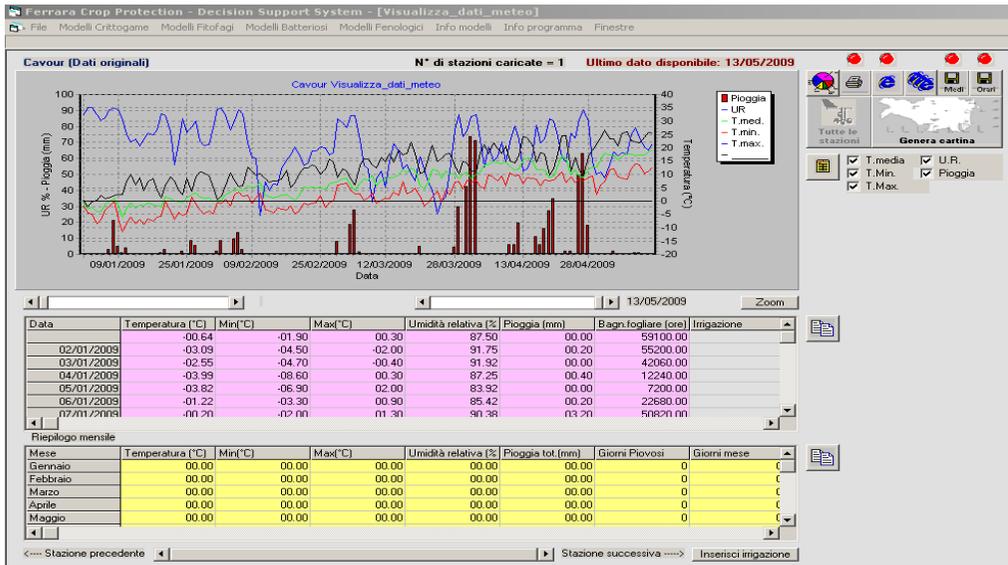




**Ex. The scheme of phytopathological model for Plasmopara viticola**

Italian regional services are also developing Decision support systems based on interactive platforms. These systems are going to be applied both for the pest and disease control both for choosing the best agronomic practices like the use of water through the water balance formulation. Several regions have already applied these systems by offering services that run locally or on web-based platforms

Some examples of regional web-sites (Tuscany, Sicily, Puglia, Piedmont regions)



## 2° Russia

At the national scale the main governmental body in charge of weather forecasting and climatology is Russian Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET) The web site is <http://www.meteorf.ru>

Regarding the phytosanitary services, the body with functions of control and supervision is the Federal Service for veterinary and phytosanitary surveillance [http://www.fsvps.ru/fsvps/main.html? language=en](http://www.fsvps.ru/fsvps/main.html?language=en)

It works under the control of the Ministry of Agriculture of the Russian Federation and carries out its functions directly through regional organizations cooperating with other federal executive authorities, local self-government institutions, public associations and other organizations.

There is also a private company, the CROP MONITORING AND AGRONOMIC SERVICE, that offers services for monitoring crops and agronomic services to identify production problems and optimize crop yields.

<http://www.sgs.ru/en/Agriculture-Food/Seed-and-Crop/Crop-Monitoring-and-Agronomic-Services.aspx>

## 3° Romania

The web-site of the national meteorological and climatological forecasts

[http://www.meteoromania.ro/anm/?lang=ro\\_ro](http://www.meteoromania.ro/anm/?lang=ro_ro) where the following services can be found:

- agrometeorological bulletin with 7 days forecasts
- soil moisture – daily service
- temperature and precipitation maps 3 months
- regional temperature and precipitation maps 14 days

The web-site of the national Agricultural Ministry :

<http://www.madr.ro/protectia-plantelor-si-carantina-fitosanitara.html>

On this site guidelines for monitoring of different adversities can be found

The web-site of Agricultural Department publishes the phytosanitary bulletins

<http://www.dabn.ro/index.php/avertizare-boli-daunatori/1079-buletin-de-avertizare-nr-38-42-din-16-august-2016>

On the following web-sites, agronomic bulletins can be downloaded

<https://www.gazetadeagricultura.info/plante.html>

<http://agroromania.manager.ro/articole/agrometeo/buletin-agrometeorologic-pentru-perioada-12-18-octombrie-22019.html>

#### **4° Germany**

At the national scale general informations about the national phytosanitary situation can be found on the web-site of Ministry of Agriculture:

[https://www.bmel.de/EN/Homepage/homepage\\_node.html](https://www.bmel.de/EN/Homepage/homepage_node.html)

The Regional Plant protection Services produce and publish phytopathological bulletins

This is an example of monthly bulletin published by the Regional Freiburg Plant protection Service

[http://www.fr.ch/iag/files/pdf85/bulletin\\_phyto\\_05\\_2016\\_1\\_flash.pdf](http://www.fr.ch/iag/files/pdf85/bulletin_phyto_05_2016_1_flash.pdf)

For some diseases the phytopathological models are used (ex. PHYTOPRE for Potato blight *Phytophthora infestans*) (<http://www.phytopre.ch/>).

#### **5° Switzerland**

The web-site of the Federal Plant protection Service is :

<https://www.blw.admin.ch/blw/it/home/nachhaltige-produktion/pflanzenschutz/pflanzengesundheit-eidg-pflanzenschutzdienst.html>

Meteo and phytosanitary bulletins are produced and published using **AGROMETEO** <http://www.agrometeo.ch/> a national platform which brings together the tools and information to support decision-making for better management of plant-health control in agriculture. It relies on a network of over 150 stations that provide weather data used by different risk prediction models. Agrometeo also contains information on diseases and pests, phenology, maturation of the grapes, plant protection products and their dosage depending on the leaf surface, as well as a model for irrigation in fruit. All this information are made available to producers

## **Pest and Disease Models**

Currently available models for downy mildew and powdery mildew of the vine, the moths *Lobesia botrana* and *Eupoecilia ambiguella*, apple scab and fire blight. Since 2009, the weather forecast of the next 5 days has been integrated in the models mildew, powdery mildew and *Lobesia*. This allows real risk forecasts.

On the following website there is an article regarding VitiMeteo-Plasmopara

[http://www.agrometeo.ch/sites/default/files/documents/12\\_vm-plasmopara\\_rsvah443192.pdf](http://www.agrometeo.ch/sites/default/files/documents/12_vm-plasmopara_rsvah443192.pdf)

Any Canton has his own Plant protection Service. The example of Canton of Liebegg is <http://www.liebegg.ch/> and the bulletins are produced at Cantonal scale.

An example of bulletin produced by the Canton of Neuchatel: <http://www.ne.ch/autorites/DDTE/SAGR/production-vegetale/Pages/L'arboriculture.aspx>

## **6° France**

At national level the weather forecast services are supplied by :

**MeteoFrance** <http://www.meteofrance.com/accueil>

The weather prediction models developed by Météo-France are:

AROMA: Western European detailed simulations with a resolution of 1 km

ARPEGE: simulations worldwide

At the national level there are forecasts to 7 days with daily bulletins

There are also bulletins with monthly forecasts created with models that are designed to determine the average weather conditions in the next three months on a large scale such as Western Europe. Contrary to daily forecasts, the informations are neither detailed nor quantified, but they provide a qualitative forecast with information on the key trends

Phytopathological and agronomical bulletins

At the national level the phytopathological bulletins are available on the website of the Ministry of Agriculture: <http://agriculture.gouv.fr/bulletins-de-sante-du-vegetal>

These bulletins are available for all users on the websites of regional agriculture and DRAAF Rooms (Direction Régionale de l'Alimentation, de l'Agriculture et de la Forêt Grand Est)

Here is an example of a weekly bulletin in the Department of Normandie [http://draaf.normandie.agriculture.gouv.fr/IMG/pdf/BSV\\_Colza\\_no25-12oct\\_cle0763ef.pdf](http://draaf.normandie.agriculture.gouv.fr/IMG/pdf/BSV_Colza_no25-12oct_cle0763ef.pdf)

The website <https://vespa.cortext.net/> provides a platform dedicated to the development of the adversity that gives information at the national level to model and predict the attacks on crops, and to reduce the use of pesticides. It has a database of plant health bulletins from the 60s onwards

With reference to the use of water resources there is a public information service provided by **EAUFRANCE** <http://www.eaufrance.fr/docs/bsh/2016/09/>

The national bulletin on the hydrological situation consists of a set of maps and related observations showing the monthly development of water resources. It describes the quantitative status of aquatic environments (useful rain, river flows, the groundwater level), with suggestions to limit the uses of water during the shortage period.

At regional level, there are different centers that deal with the production and spreading of agricultural meteorology bulletins.

For example, for the region Côte d'Azur and Provence the **CIRAME Centre d'Information Régional Agrométéorologique** <http://www.agrometeo.fr/> offers the following products:

Meteorological data

Climatic and agroclimatic reports

phytopathological reports every two weeks

Monthly bulletins on the hydrological ground conditions

Agrometeo weekly bulletins - in collaboration with the Chamber of Commerce,

An example of phytopathological bulletin :

[http://www.agrometeo.fr/bsv/BSV\\_PACA\\_Arbo\\_23\\_28\\_septembre\\_2016.pdf](http://www.agrometeo.fr/bsv/BSV_PACA_Arbo_23_28_septembre_2016.pdf)

The Regional Agriculture Chambers have the task to create and disseminate bulletins

For example for the Department Tarn-et-Garonne <http://www.agri82.fr/bulletins-vegetaux>

for the Department Midi-Pyrénées <http://www.mp.chambagri.fr/-Bulletin-Sante-du-vegetal-.html>

## **In Australia**

The information provided is largely focused on that currently provided by the Bureau of Meteorology (BoM) for the agricultural sector. In some instances products and services may have an overlap or linkage with other sectors in the community. In the Australian farming sector the top five elements used in decision making from user surveys 2009-2011 inclusive were Rainfall, Thunderstorms, Wind speed, Wind Direction and Fire Danger. This provides a guide to the most important weather and climate information required by the farmer in day to day decision making.

In Table 1 below describes the attributes of various products and services and were included according to the following general principles:

- Producer on a routine basis
- based on sound scientific and meteorological information
- operationally supported and sustainable in the long term
- able to show evidence of a demonstrated benefit to agriculture

and having at least one or more of the following attributes:

- supported by a validation or verification process
- subject to ongoing review and improvement
- easily accessible
- easy access to help or training guides for the product or service
- provide a return on investment to the grower
- affordable

Each product describes its target group according to the three main practices in the region, Horticulture, Broadacre cropping and Livestock. Many individual farmers or cooperatives undertake mixed farming in order to reduce their overall risk to exceptional weather and climate conditions especially when significant global phenomena such as the El Nino or La Nina are present or forecast.

**Table 1 - Review of operational agrometeorological products and services**

Source Provider/Service name B= BoM C= CSIRO O=other	Target group H=Horticulture B=Broadacre L=Livestock	Support	Frequency A=automatic M=Manual Update frequency	Output channel W=Web based M= Mobile/app V=Video E= Email F=FTP O=Other	Meteorological variables used	Lead time	Algorithm source	Spatial data / highest resolution	Verified/ method	Comments
B, Forecast Rainfall	H,B,L	Yes	A, Twice a day	W,M,F	24 hour rainfall, 1-4 day rainfall, 5-8 day rainfall totals	8 days	Consensus- Multi model Weighted ensemble mean rainfall	Yes 0.5 degree grid	Yes Brier Skill Score	
B, Rainfall ranges	H,B,L	Yes	A, Monthly	W,M,V	Rainfall	Up to 18 months	Statistical / actual records. Compares 90 <sup>th</sup> / 10 <sup>th</sup> percentiles and normal rainfall	Point based	No	
B, Climate outlooks	H,B,L	Yes	A, monthly worded outlook manual	W,M,V,E	Rainfall, Max / Min Temperature	Up to 8 months	Dynamical model (POAMA)	Yes 250km	No	Video produced each month
B, Radar	H,B,L	Yes	A, 6 minute	W,M	Rainfall intensity, cumulative totals	None	Radar reflectivity	Yes, 500m	No	
B, Rainfall and River Conditions	H,B,L	Yes	A, hourly	W	Recent rainfall Flood conditions	None	Observed	No, point based	Limited QC on data	
B, Recent rainfall	H,B,L	Yes	A, daily	W	Maps of recent rainfall totals	None	Observed	Yes, 5km	QC applied to data	
B, Frost potential	H,B	Yes	A, daily	W	Maps/tables of forecast temperatures in bins hours below +4,+1, -2, -5 deg C	Up to 48 hours	Consensus	No, point based	Yes, consensus model verified using Brier Skill Score	
B, Recent evapotranspiration	H	Yes	A, daily	W	Maps, tables of recent ETo based on observations	None	Observed, derived using FAO56	No, point based	Yes, study done and peer reviewed	
B, Forecast wind speed and direction	H,B	Yes	A, twice daily	W	ACCESS R and ECMWF model predictions	Up to 7 days	NWP	Yes, 12.5km	Yes, NWP verification statistics. Bias, RMSE RMS error	
B, Sheep graziers	L	Yes	M, when	W,E,F	Temperature,	24 hours	Nixon Smith	Y, weather	Some	

warning			warning thresholds exceeded		Rainfall, wind speed		(1972)	district based only	validation of Nixon Smith completed	
B, Brown Rot Advice	H	Yes	M, when warning thresholds exceeded	W,E,F	Relative humidity, temperature, leaf wetness	24 hours	Threshold based on Mills period Product of Temp and leaf wetness	Y, weather district based only		
B, Downy Mildew Advice	H	Yes	M, when warning thresholds exceeded	W,E,F	Temperature, rainfall, ground and leaf wetness	24 hours	Primary infection 10:10:24 rule	Y, weather district based only		Difficult to validate. Need manual inspection of crops.
B, Animal Health Emergency (airborne virus)	L	Yes	M, triggered on request from emergency services	E	Wind speed and direction	24 hours	HYSPLIT model, ACCESS Global model	Y, kmz format		Limited to emergency service distribution
O, Department of Agriculture Western Australia, Wheat yield constraint calculator	B	Yes	M	O, software	Statistical	Season				
O, Queensland department of Agriculture and Fisheries, CropARM	B	Yes	M	O, software	Statistical	Season	APSIM based			
O, Meat and Livestock Australia, Rainfall to Pasture Growth	L	Limited online support	M	O, software	Statistical	Up to 3 months				
C, O APSIM initiative UQ, DAF QLD	B,	Yes	M	O, software	Statistical, requires SILO data	Season				Designed for agribusiness consultants
O, Internet based Agricultural Warnings, DELWP VIC	L	Yes	A,	W	Based on BoM gridded forecasts	7 days	Nixon Smith (1972)	N, Point based		
O, Katestone	L	Yes	A	W, E	NWP & observed conditions	7 days	Thom(1958) Whittler (1993) Armstrong(1994) THI based			
O, Birchip Cropping Group, Yield Prophet.	B	Yes	M	W,M,E	APSIM based Crop yield scenarios	Season	APSIM based	N, point based		

## **Some existing operational agricultural meteorological service for early warning systems for crop management and pests / diseases for crops**

In some African countries several early warning systems are used.

The agroclimatic methods : there are those based on precipitation data estimated by the NOAA satellite. A precipitation index is thus calculated to qualitatively reflect the impact of climate on crops and pastures.

Based on a water balance index (FAO) : this is the difference between the rainfall received by the crop and the water lost by the crop and the soil, taking into account the water retained by the soil. The mapping of this index makes it possible to detect areas facing agroclimatic constraints requiring solutions.

Remote Sensing Method : the Normalized Vegetation Index (NVI) profile gives a good indication of crop yields.

Satellite precipitation estimation and AVHRR imagery can be used to detect water conditions and potential stress levels spatially on maps, thus providing a tool for early warning

The SPI index is also developed by meteorological observation station. This report is instead sent to the agricultural authorities.

The monitoring of the weather conditions and monitoring device of the appearance of the symptoms makes it possible to make a prediction of risk of infection and emergence of the diseases. Tracking recent past time and time forecasting allows the development of disease warnings and intervention decision.

This method was used in Tunisia as part of a pilot project between the INM and farmers, and showed that it is possible to better optimize the number of treatment with phytosanitary products to reduce on average 2 treatments on the entire agricultural season without affecting the usual yields.

## **Some requirements for operational agricultural meteorological services for the crops sector and for early warning systems**

- Adapted services to the specific needs of each country according to the constraints and especially climatic factors which are determining for its agriculture,
- Accuracy services offered especially for weather and climate forecasts,
- Easy to receive services depending on the means of communication available at the farmer's,

- Easy services to interpret by farmer,
- The offered services must have a direct and concrete economic impact for the farmer,
- Optimization of the use of phytosanitary products which are very expensive and harmful for the health and the environment,
- Early warning systems must take into account and integrate the socio-economic aspect and resources of each country.

## **Recommendations**

Taking into account the requirement of the agricultural sector and based on the experience of some countries and results of certain pilot projects, it's recommend :

Concerning the services to be offered to the agricultural sector the focus should be on :

- Short and medium –range weather forecasts and seasonal forecasts of high quality and geographically more precise,
- Access to nearby real time observations
- The detection of drought,
- Crop forecasting,
- Clear statement with advice or instructions for reactions and treatment if necessary regarding the risk of disease occurrence and spread of insects,
- train farmers on the meaning and use of weather products for agriculture
- The means of communication offered depends in country resources: radio, TV, telephone and internet.
- Focus on sending mobile services (since its strong evolution and democratization)
- Have the reflex to always ask for a feedback from the farmer for the validation and continuous improvement of the services provided.

As an early warning system :

Develop **warning maps** for each country for special conditions that are favorable to the appearance of diseases and spread of insects (similar to the hazard warning cards due to

dangerous weather conditions). On that point the zoning to be adopted is the agricultural region or locality.

This application (warning maps) may be produced in coordination with other WMO programs and international or regional organizations.

*Elaborate by **Hatem Baccour***

: