# **Internet Applications For Agrometeorological Products**

# - Experiences From Europe \*\*

Giampiero Maracchi<sup>1</sup>, Anna Dalla Marta<sup>2</sup>, Andrea Triossi<sup>2</sup>, Simone Orlandini<sup>2</sup>

<sup>1</sup> Institute of Biometeorology - National Research Council. Piazzale delle Cascine 18, 50144 Firenze, Italy. E-mail maracchi@iata.fi.cnr.it.

<sup>2</sup> Department of Agronomy and Land Management – University of Florence. Piazzale delle Cascine 18, 50144 Firenze, Italy.

#### Abstract

Internet represents the suitable tool to disseminate information among a wide range of users in real time. In the last few years a large number of agrometeorological products were available on the web, elaborating information concerning the condition of many processes of agricultural system. Data, models, warnings, advises can be provided to the users, in order to support their decision making and so reducing the quantity of high cost and pollutant chemical and energetic inputs. The present situation in Europe has been analysed and the results are summarised in this paper. The considered processes, the required input data and models, the needed interaction with the users, the main outputs and the final users are considered and discussed.

#### Introduction

Usually farmers have to make decisions in condition of risks or uncertainties due to the high level of complexity of the agricultural systems. Many production factors are not defined and they are outside of the farmer control. In the last few years the changing in the international markets and the technological innovation have modify the agricultural production, increasing the complexity of decision making. A higher number of topics have to be considered to elaborate the best decisions: biology, agronomy, marketing, legislation, etc. (Orlandini and Cappugi, 2002).

Accordingly, the lack of precise information increases the level of uncertainty in farm management. To overcome these problems, farmers have increased the level of energetic and chemical inputs above the real system requirements with the aim of decreasing the variability of quality and quantity of final yield. Unfortunately, the real consequence of this strategy has been the reduction of potential farmer income and the increasing of environmental impact (Travis et al., 1992).

A solution to interrupt this negative trend is to substitute expensive and pollutant chemical and energetic inputs with elaborated information of high quality. In this way it is possible to decrease the risk of the uncertainties of farmer decision making and thus to minimise the excess of input application, as well as to increase the potential income for farmers activity (Maracchi, 2001).

In such a perspective, agrometeorologically based decision support system can provide a wide range of suitable information for the farmers (Silver, 1991). Many processes of agricultural system can be analysed according to the relationships with weather variables: crop growth and development, quality and quantity of yield, crop protection, water requirements, etc. Thus their dynamics can be described allowing to simulate and forecast the main elements, with a real benefit for

<sup>\*\*</sup> This paper will be published in the forthcoming Proceedings of the Expert Group Meeting on Internet Applications for Agrometeorological Products held 6-9 May 2002 in Washington, D.C. USA.

the decision making and farm management, both for tactical and strategic purposes (Seeley, 1994).

# **Internet** applications

The agrometeorologically based decision support system should satisfy the following criteria (Zadoks and Rabbinge, 1989):

- Simplicity
- Time efficiency
- Reliability
- Solidity
- Updating facility
- Upgrading facility

To satisfy these criteria, agrometeorological information should be elaborated at regional level and then disseminated to the users in good time. Among the advanced technologies available in the world today, INTERNET represents the suitable tool to reach these goals. Many are the advantages of using Internet to elaborate and disseminate information in the field of agrometeorology products:

- Fast utilisation of information
- Interaction and feedback with the users
- Immediate display of the information
- Facilitate understanding of advises and warnings
- Increasing of computer use by the farmers
- Reduction of information production costs
- Fast upgrading and updating
- Continuous check of system performances
- Application of multimedia tools (text, graphic, map, figure, audio, video, etc.)

In the last few years an increasingly interest on this subject has been observed and a big number or Internet applications for agrometeorological purposes has been realised. Among the countries, but also within the same country, different applications have been realised, characterised by a different structure and organisation. To describe the present situation the main experiences in Europe have been analysed and the results are discussed in this paper.

# Agrometeorological Products – Experiences From Europe

The following points characterise the structure and the organisation of the applications available in Europe:

- Private or public organisation
- Type of information (weather forecast, irrigation, crop protection, phenology, soil ploughing, haymaking, etc.)
- Additional information (job opportunities, lows, research programs, etc.)
- Availability of agrometeorological data (numerical or graphical display or possibility to download them)
- Simulation and forecast models (application or possibility to download them)

- Type of access (free, registration, password)
- Access free of charge or by payment
- Timestep of updating of information and data
- Temporal resolution (hourly, daily, weekly, etc.)
- Spatial resolution (micro, meso or macroscale) and use of interpolation methods to prepare thematic maps
- Feedback and interaction with the users
- Type of users (farmers, technicians, public administrator, etc.)
- Language (only national language or also International ones)
- Use of remote sensing
- Use of weather numerical models

## Agrometeorological data

A large number of applications can support agricultural activity by providing weather data. Data can be displayed in numerical and graphical format (free of charge) and in some cases data can be also downloaded in ASCII or EXCEL files (usually in this case by payment). Hourly values and daily (weekly or monthly) mean, maximum and minimum values are generally presented (Fig. 1). Other elaborations can also be provided (generally on demand), such as degree day accumulation, etc., for specific aims. In few cases data can be generated by using numerical weather models, so allowing the creation of territorial maps (Fig. 2). In some cases remote sensing techniques (radar or satellite) can be applied to create maps of precipitation, temperature, etc.

## Information for crop protection

In many cases agrometeorological data, crop monitoring and simulation models are the bases for the elaboration of information concerning the development of pathogens or insects. User feedback is generally required to input field data and to choose the input data file, so improving simulation models performance. Numerical or graphical outputs can be provided (Fig. 3), with special warnings when the risk level is above the pesticide application threshold. Strategies for pesticide application can be proposed, according to traditional, integrated or biological crop protection methods (Orlandini, 1998). In some cases models can be downloaded to run the simulation using the farm personal computer. When input data are created by using interpolation methods (also by applying numerical weather model or remote sensing), risk maps can be produced for the whole analysed region (Fig. 4).

## Information for crop irrigation

After crop protection, the management of crop watering represents a very frequently provided product. Also in this case, agrometeorological data, crop monitoring, user feedback and simulation models are the bases for the elaboration of information concerning water balance and so crop water requirements (Fig. 5). The consideration previously proposed for crop protection can be considered also in this case, as concerning the characteristics of the outputs and the possibility of displaying critical period for crop water availability. The possibility of downloading the models is available as well (Fig. 6). When input data are created by numerical weather models or remote sensing, risk maps can be produced.

## Information for crop development and growth

Available in a lower number of Internet applications is the information concerning the crop growth and development. By using models, field monitoring and weather data, a wide range of processes are considered, such as phenology of crop, harvest management, quality and quantity of yield. Crop maps can be used to show the regional dynamics of crop growth and development (Fig. 7). In many cases, output crop data can be used as input of crop protection and irrigation agrometeorological products.

## Weather forecast and additional information

Frequently weather forecast represents the only information provided by the agrometeorological Internet applications. Weather forecast may be available at local level, but it is also presented for the whole country or for the entire world (Fig. 8). Weather forecasts are generally provided for a period ranged from one to three days in a detailed format. One week is the limit for presenting weather conditions trend. Numerical weather forecast model can be used to create territorial maps of agrometeorological variables, used as input of simulation models.

In few cases agrometeorological variables are used to give information on soil ploughing, haymaking, use of fertilisation. Additional information can be also concerned with job opportunities, special lows, newsletter, technical news, etc., also depending on the degree of feedback or interaction with the users. Links with other agrometeorological WEB sites can be provided.

## Conclusions

The results of this study emphasised the wide range of agrometeorological products based on Internet available in Europe. They are proposed to support the activity of different categories of end users. Agrometeorological technical information, advises and warning are elaborated for farmers, technicians of extension services and public administrators. Weather data interest a wider target, including sport, tourism, traffic, transport. University sites are specially prepared for researchers and students.

A particular attention should be addressed to the characteristics of the output and the possibility of using multimedia tools to give a complete picture of agricultural system conditions. To involve the final users in the elaboration of agrometeorological products, all the tools to increase the interaction and the feedback should be applied.

## References

Maracchi, G., 2001. Meteorologia e climatologia applicate. Istituto Geografico Militare, Firenze, Italia (in press).

Orlandini, S., 1998. Agrometeorological models for crop protection. Pages 213-222 *in* Proceedings of International Symposium in Applied Agrometeorology and Agroclimatology, 24-26 April 1996, Volos, Greece.

Orlandini, S. and Cappugi, A., 2001. Sistemi di supporto alle decisioni e servizi agrometeorologici. Pages 279-295 *in* Meteorologia e climatologia applicate. Istituto Geografico Militare, Firenze, Italia (in press). Seeley, M.W., 1994. The future of serving agriculture with weather/climate information and forecasting: some indication and observations. Agricultural and Forest Meteorology 69: 47-59.

Silver, M.S., 1991. Systems that support decision makers: description and analysis. Chichester, Wiley, pp.254.

Travis, J.W., Rajotte, E., Bankert, R., Hickey, K.D., Hull, L.A., Eby, V., Heinemann, P.H., Crassweller, R., McClure, J., Bowser, T. and Laughland, D., 1992. A working description of the Penn State apple orchard consultant, an expert system. Plant disease, 76: 545-554.

Zadoks, J. C. and Rabbinge, R., 1989. Prospect for simulation and computerised decision making. Pages 301-308 *in* Simulation and system management in crop protection (Eds.

Rabbinge, R., Ward, S.A. and van Laar, H.H.). Pudoc Wageningen, the Netherlands.



Figure 1 – Graphics of agrometeorological data (www.ivia.es/estacion).



Figure 2 – Creation of weather variable map starting from local measurements, by using a cluster of Artificial Neural Networks (www.pstabruzzo.it/arssa/neuromap1.html).



Figure 3 – Bulletin for Sclerotinia crop protection management (www.agriknoledge.co.uk).



Figure 4 – Maps of light leaf spot forecast (www3.res.bbsrc.ac.uk/leafspot).

File Multima Vosolia	e frefait) Brunerit 7		(Bia)
-takto	1 1 1 Conce Laboration (	Armotope - Dr - D - D	
indiana 🕢 fatta elferren di	ince of articlel at all (weight) of this		* (Pha Cologenatio
lati finci Linceristi Nina, Genera Recisariata Hone In Mit Shere	DALLYET is a simply address of the same of	Crarify and Control Crarify Cr	
	The program nine under Winds order receiter: ETic is related Perman Montain Perman Montain Perman Montain Perman Montain Perman Receited	ner sel can accept data in different acros, e g, nel 8, dry b ind unong cau of itrae mathana,	dit bereperatures in places of relation humority, surveives duration in place of

Figure 5 – Estimation of Potential Evapotranspiration (www.silsoe.cranfield.ac.uk/iwe/dailyet.htm).

food Part	Alter-Harseeff Internet England		2003			
Phydrica .	Valokies Profesti Drusenti 1					
interva -	- OIA Cons Inden Straden					
em 🕲 teta ginne nie unidana da fonderaat ganada kala 📃 🖉 👘						
rimen	t of Rural Engineering and Natural Resource Protection		1			
RIS	SOFT					
vnloa	ad Facilities					
Main	Index }					
Ugnus h orde to make aras To dow o I Tou ma	ity of Harred. There will be direct lake to have whether your program to a r to build up DREFOFT we would like to know whether your program to a ext available to the public hypothing it on as the vertee. If you don't have and valued colliveare you may obcore the corresponding halo from the Software Log into the IRRESOFT the server ( <i>fincher and Jamed Software</i> ) or also use the to log rate the <i>IRRESOFT flap</i> server You may also use the to log to be <i>IRRESOFT flap</i> server	erver from for Software Desception Pages valable as public domain, shareware or commercial software and whether p-nic where you may permanently store your files, this could be done at the <i>IR</i> Description Page or you may density log into the flip server to the <i>IRRISOPT flip server</i>	rou would like RISOFT fay			
			-1			
	Information	Action to be taken	1			
	Information Ftp Surver :	Action to be taken ftp.hrz.uni-knesel.de	1			
	Information Ftp Surver : Login name :	Action to be taken ftp.hrz.uni-knowel.de anstyrotor				
	Information Fip Surver : Login name : Password :	Action to be taken Fip.hirx.uni-kunnel.do sintegrasco your@email.uddress				
ftp	Information Fip Surver : Login name : Password : Directory :	Action to be taken Fip.hrz.uzi-knorel.do anorymoto your@enail.address /pub/icristdy				
ftp	Information Fip Surver : Login name : Password : Directory : For Downloading :	Action to be taken Fip.hrz.usi-knowel.do antoymou your@enail.nfdress /gob/irriwfd Ge to the corresponding directory				

Figure 6 – Download of IRRISOFT program for irrigation management in Germany (www.wiz.uni-kassel.de/kww/irrisoft/download.html).



Figure 7 – Map of ripening period based on thermal pattern (www.pstabruzzo.it/arssa/vendemmia2.html).

Remark and Deve	Asyment - Microsoft Tritornet Explore	"				aldi X
THE MUNICIPAL Vie	olice Preferit Drumenti 7	12	W. Street			
+ (satro + =	Cons Indee	Crimologia -	学生の・	1		
Bedeste (Chitty (Yes)	w.thii digangit+ yindez.htali					2 Prive Cologananti **
Hone	Farent and Probably			startine .		
1	The DMI Wea	ther For	ecasting	g System	<u>111</u>	
Herearch and Development Weiterstein Weiterstein Herearcheat Einen An genete Development Herearcheat Herearcheat Philosophian Philosophian Philosophian Philosophian	The person DN weather forecasting system is larged on HRLAV2.5. The transmit methods and part model Currently, the optime to Eulerian dynamics and the cloud-conservation ocheres 40.0000 MII without social blocks in intermittent and is based on optimum interpolation. The operational system currentlest affort neutral model stated DNH-BRLAVG_DNN+BRLAVA(D0H-BRLAV- cod DNH-BRLAVG_DNN+BRLAVA(D0H-BRLAV- tent) and DNH-BRLAVG_DNN+BRLAVA(D0H-BRLAV- tent) and DNH-BRLAVG_DNN+BRLAVA(D0H-BRLAV- tent) and DNH-BRLAVG_DNN+BRLAVA(D0H-BRLAV- tent) and the provide interpret of contrasts information for each model about which are thereast interclave acceleration of the applied time state, again and the interpret consultate into the interclave acceleration of the applied time state, again and the interclave interpret and the interclave acceleration of the applied time state, again and the interclave interclave and the interclave acceleration of the applied time state, again and the interclave interclave acceleration and the interclave acceleration of the applied time state, again and the interclave interclave acceleration acceleration acceleration in the interclave acceleration acceleration acceleration in the interclave interclave acceleration interpret interclave acceleration acceleration in the interview interclave acceleration in the interview interpret interclave acceleration in the interview interview acceleration in the interview interview acceleration in the interview interview acceleration interview inte					
	1	-				
	Constant Autor					
	in authorities (used)	402	69	800 - L	-62°	
	754 dpoints (miat)	110	210	202	170	
	Phandor of vertical levels	31	91	31	31	
	Horisantal resolution	0,45*	0,15*	0,15*	0,05*	
	Tievestep	340)	903	90 e	306	
	Boundary; age	12.b	01	0.h	0 h	
	Boundary hequincy	1/(5-1)	1/11 10	143.41	1/(1.1)	
	The forecasting system is run	en a NBC - ED4	supersompute	r with connection the Karan Entern	s to other DMI Dis observations	-
e)	the second s					🙂 ävtenet
(Rut 0 010	1 . Anibal Jaeler	Euromettai	Marceoff	Tesearch and D	evelop	10.49

Figure 8 – Weather forecast page in Denmark (www.dmi.dk/eng/f+u/index.html).