PROJECT SYBIL PRESENTATION
"SYBIL DSS" - Agricultural Risk Assessment Models for Grapes

Presented at the VACRO Day Workshop (under VALUE) in Palermo, Italy on Oct. 21, 1994
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1 - TITLE OF THE PROJECT

SYBIL, European Previsional Model Based Decision Support Systems
Using Agro-Meteorological Data (P.M.D.A)
or
SYBIL: Integration of Agro-Meteorological Previsional Models in
Computerized Decision Support Systems (DSSes)

2 - PARTNERS

Project Coordinator:

BALIS = Bayerischen Staatsministerium für Ernährung, Landwirtschaft und Forsten [Dr. Johann Bergermeier] (G) - *role in the project* = management, model information distribution, model implementation, DSS delivery.

Partners:

UST = Laboratorio di Ingegneria Informatica; Dipartimento di Informatica e Studi Aziendali; Università delgi Studi di Trento (I) - *role in the project* = adapt models for wine, apple, and fertilization, model implementation, meteo data management, expert system component implementation, DSS delivery.

DIPSS/RCF = Danish Institute of Plant and Soil Science; Research Centere Foulum; Dept. of Agrometeorology (DK) - *role in the project* = model adaptation for humid conditions, DSS delivery.

TUM = Technische Universitaet Muenchen-Weihenstephan (Technical University of Munich); Institut und Bayerische Landesanstalt fuer Landtechnik (Institute of Agricultural Engineering) (D) - *role in the project* = define and develop SQL database for meteo data with a standardized format, generalized meteo data library implementation.

ACTA = Association De Coordination Technique Agricole (F) - *role in the project* = define and develop SQL database for meteo data with a standardized format, model adaptation for wine, apple, wheat, and irrigation, model implementation, DSS delivery.

3 - DURATION

Start: July 1, 1992
Duration: 3 years
Finish: June 30, 1995

4 - OBJECTIVES

(1) To **integrate** well tested agro-meteorological previsional (i.e., predictive; e.g., risk assessment) models into an interactive computerized decision support system (DSS) with connections into regional agro-meteorological data networks to provide individual farms with crop management advice;

(2) To **establish** a methodology for ensuring modularity, portability, and extensibility between regions by introducing uniform software engineering, including uniform choices for data structures, computer platform, and user interface;

(3) To **disseminate** validated agro-meteorological previsional models within a decision support system (DSS) to address pest control, fertilization and irrigation, and making this system (which includes regional model adaptation functionality) available for field testing and use by technicians in any EU region;

In particular, the SYBIL DSS described here should help grape agriculturalist intelligently manage vineyards such that environmental impact is reduced and economic returns are increased. The grapes models in the DSS are designed to evaluate the risk of the grape vines to pest and fungus damage. By evaluating this risk, a grower has the option to apply pesticides and fungicides only when needed and avoid using these, often environmentally damaging, chemicals blindly on a regular basis or when the risk of pest and fungus damage is small. This evaluation has the potential to save both time and money because expensive chemicals will not be applied when they do not benefit the grape vines.

5 - CONCLUSION OF THE PROJECT

This is a list of results at this point in the project. Note that although the project will not be complete for 8 more months, all aspects relevant to grape production have essentially already been completed at this point in time.

(1) A **methodology for ensuring transportability** of models/DSSes has been created and followed.

(2) A **common DSS platform** has been built using the "transportability methodology" so that the models and the DSS are modular, extendable, and can be run on 4 different computer platforms all with the same "look-and-feel" graphical user interface (GUI). Additionally, the DSS can be coded in 5 different speaking languages, and the user can interactively select which language is desired.

(3) A **meteorological data library** that manages meteorological data (a component we call the Meteo C Library) has been implemented and coupled into the DSS. It allows the seamless access of meteorological data, whether stored in ASCII files, or in SQL databases. It has the capability to handle many different types of meteorological data (in different formats), but allows the models to access all types of meteorological data in the same way so that models do not have to be re-written to handle different types of data. One example is if a model requires hourly data, and the meteo data to be used is minutely, the meteorological data library can provide hourly values from this minutely data.

(4) An implementation of the **P.R.O. model** from Germany has been integrated into the DSS. This P.R.O.-SYBIL model addresses peronospora on grapes and predicts when infection of peronospora has occurred. This information allows the grape agriculturalist to apply the first fungicide spraying only when needed and helps this user avoid using these dangerous, expensive chemicals before it is necessary. The use of this model in the region where it was developed (around Rheinhessen, Germany) has allowed grape agriculturalist to save between one and four spraying applications per year, with an average saving of two sprayings.

(5) An implementation of the **E.P.I. model** from France has been included into the DSS. This E.P.I.-SYBIL model also addresses peronospora on grapes and assists a grape agriculturalist in determining when infection of peronospora has occurred. The information given in the E.P.I. model is more general than the P.R.O. model, but with interpretation and/or localization (see expert system component below), it can assist this user in determining when it is necessary to spray against peronospora.

(Note: We think it is particularly interesting to run both the P.R.O. Model and the E.P.I. Model during a season, comparing and contrasting the information from these models for the final determination of when a grape agriculturalist should spray against peronospora.)

(6) An **expert system component** (utilizing an artificially intelligent (AI) search technique called a genetic algorithm(GA)) for localizing/regionalizing/adapting models to the region in which they need to be used has been created, implemented, and connected with the DSS. This component makes the included models more robust and transportable because the expert system component can locate a good set of reasonable internal parameters which will work well for the area in consideration.

(7) Two different **economic models for the application of fertilizer** have been merged into the DSS. These models help the agriculturalist decide how much fertilizer to apply to crops. The first model considers historical weather and crop performance data, costs, and profits, and uses a simple extrapolation technique to give advice. On the other hand, the second model, also considers all these issues, but additionally, this model can take into account environmental costs, and utilizes a linear programming technique to give advice.

(8) A **DSS manual** giving a detailed description of every aspect of the DSS has been produced.

6 - APPLICATIONS

(1) Put the currently developed DSS into use by growers (or institutions which directly support growers). This would utilized the grape models which are currently included in the DSS (i.e., the P.R.O. model and the E.P.I. model). The DSS could be installed at a particular site (or a group of sites) where one or more growers could access the system to gain advice and predictions about the status of particular pests and fungus which attach grape vines.

(2) Use the common DSS platform (i.e., the general, portable, extendable, modular platform which was developed in this project) to expand the current DSS to include other models or to build a new DSS. The expansion of the DSS could be done to include more functionality, such as:
- new models
- new meteorological data management components (for example, to handle data obtained via telemetric techniques so that decision support could be provided to remote areas)
- etc.

7 - REQUIRED ACTIONS IN THE FRAME OF EXPLOITATION

The general actions to put the currently developed SYBIL DSS described here into use are:

(1) **Installation** - install the DSS at the site(s);

(2) **Translation** - include any additional desired speaking language(s) (i.e., the entire DSS includes English, but only approximately 10-20% of the messages also include an Italian translation, so more translation may need to be done);

(3) **Data Format Registration** - register the necessary meteorological data format(s) (i.e., register the data format(s) that are used by the agriculturalist(s)) within the meteorological data library inside of the DSS so that the local meteorological data can be read and used by the DSS;

(4) **Modification** - if the meteorological data does not match the model requirements, consider making small modifications to the models (they are modular and extendable so this is not a major effort);

(5) **Data Gathering** - gather historical meteorological and epidemiological data for the region in which the models are to be used so that model localization/adaptation can be carried out;

(6) **Run Localization/Adaptation Component** - use the gathered historical data to run the localization/adaptation component to adapt the models to the area in which they are to be used;

(7) **Ensure Availability of Temporal Meteorological Data** - models require certain meteorological data values (such as, humidity) with a certain frequency (such as, hourly), so a way of getting the necessary data must be found;

(8) **Local Personnel Training** - users should be briefly trained in the use and maintenance of the DSS;

(9) **React to Feedback** - examine the accuracy of the models in the region(s) used and the feedback from agriculturalists who are using the DSS, and consider additional small changes to the DSS and models so that the user are content with the performance.

8 - PARTNER(S) INVOLVED

The University of Trento (UST) would be involved in this exploitation action since they have been the main implementers of the portable/modular/extendable DSS which includes grape models. The University has the expertise and capability to handle all aspects of this type of exploitation, except for the expert evaluation of the output of the DSS during one season. Perhaps additional partners could be involved in some of the tasks based on their modeling expertise.

9 - COMPARISON WITH STATE-OF-THE-ART

These are some general comments on how the SYBIL DSS discussed here compares with the state-of-the-art in the area of agro-meteo (agricultural-meteorological) DSSes.

(1) Presently farmers in Italy (and Southern Europe) in general tend not to use DSS computer tools even though a number of quality institutions are in place that could support them in the localization and use of such tools. Therefore, utilizing a vineyard component of the SYBIL DSS in Sicily would be a step forward in the transfer and utilization of new technology.

(2) At this time, no general strategies, guidelines or methodologies apart from ad hoc ones exist for adapting or transferring agricultural models developed in one European region to another European region. SYBIL is the only such European project that we have found which addresses this issue.

(3) Most models currently in use tend to be bound to one set of meteorological data which is collected locally and stored in a particular format. This tends to make the model overly specific and inflexible, so that it is not easily put into use elsewhere.

(4) Many existing models are overly fitted or "tuned" to the microclimate, soils, epidemiological factors, or other conditions of the local agricultural environment of the region in which they were originally developed. SYBIL overcomes this problem by using the expert system component (with a genetic algorithm within it) as a systematic and automated way to adapt model parameters to perform well in a new region.

(5) The implementation of most models is overly bound to a particular hardware and software platform (e.g., Unix or MacIntosh). SYBIL recognizes that the end user may have a computer different from that used in the original implementation of the models, so it has strived to use a strategy that simultaneously supports implementation under PC (DOS or MS-Windows), MacIntosh, or Unix platforms without any changes.

(6) Using FREE public domain tools (e.g., linear programming module or graphical user interface (GUI)) was part of the strategy to permit a maximal immediate distribution of the product at the end of the project. On the other hand, some of the flashy advanced widget options included in commercial GUIs are not present in SYBIL, but the user interface is nonetheless a sufficient GUI - being graphically oriented, menu driven, appealing and user-friendly.

10 - ADVANTAGES

This SYBIL DSS has the possibility to provide these general advantages:

(1) **reduce the time spent** each season applying chemicals (fungicides and pesticides) to vineyards;

(2) **reduce the amount of money spent** on chemicals;

(3) **reduce the impact on the environment** through the reduced use of chemicals.

Additionally, the following are some of the more specific advantages.

(4) The DSS provides an **up-to-date assessment** which can be can used by the agriculturalist to make intelligent decisions with respect to crop management.

(5) The information provided is for **supporting decisions**; therefore, the agriculturalist may deviate from any advice given, and can consider how any advice given fits into his overall management scheme and how it compares to his management experience. Specifically, the DSS does not just give one particular piece of advice, but it will also offer alternatives. For example, the DSS can detect when a particular model is approaching the moment when it would suggest spraying, so it will inform the grower, and the grower can decide if he would be more comfortable going ahead and spraying now.

(6) **No specialized equipment** is required, that is, the DSS runs on low-cost, standard-configuration computers.

(7) The **DSS is robust** enough to adapt to the region in which it is being used, and it is **portable**, therefore, the effort and cost to obtain computerized decision support is minimized for all future exploitation activities.

(8) A **reduction in the cost to obtain expert advice** can be realized because the DSS can provide certain types of information which sometimes is only available from experts.

(9) Overall, the **DSS is cost effective**, that is, it has the potential to "pay for itself" in a short amount of time.

In general, the way people operate should change for the better. In traditional cases where growers do not have an understanding of the deep mechanisms of pest infestation (and/or do not have availability to up-to-date information), they apply an amount of pesticide/fungicide which is preventative against the worst scenario observed across many years just to be absolutely safe. The SYBIL approach attempts to greatly reduce the amount of pesticide/fungicide applied in a typical year by making a better assessment of a crop's risk to pest damage in the current year's circumstances.

11 - TECHNICAL RISK INVOLVED

The one risk seems to be if the DSS is used, and the DSS does not recommend that the agriculturalist spray the grapes vines in time, and then the crop may become damaged by the pest/fungus before interventions can be applied, and the harvest could be reduced.

12 - PERSPECTIVE OF EXPLOITATION

The University of Trento imagines "marketing the DSS" by sending out brochures to potentially interested agricultural support institutions in Italy. The University of Trento may accept one-on-one contracts to (a) provide the services necessary to install and adapt the DSS in a local environment, (b) provide training to local personnel, (c) issue periodic bulletins and updates to the software package and (d) expand the DSS to include new desired functionalities.

The University of Trento also intended to apply for VALUE funding since no real resources exist for following through on the above plan. A more secure means of ensuring the success of the exploitation effort would be to identify specific institutions interested in being recipients of a SYBIL DSS, and using VALUE funds to demonstrate the feasibility of installing DSSes at these sites.

13 - COST OF EXPLOITATION AND TIME REQUIRED

The costs of exploitation (and the time required) are as follows:

(1) **computer cost** for one of the following computers if one is not currently available: an IBM PC computer with MS-Windows 3.1 or a Macintosh computer;

(2) **labor cost** for: set up and installation; any translation that may be necessary; DSS modification to register the type of meteorological data that will be used; making small modifications to the DSS so that it functions smoothly in the new environment; gathering the necessary historical data; and running the adaptation component (time required = **3 to 6 months**);

(3) **labor cost** for training local personnel to use the DSS (time required = **1 week**);

(4) **labor cost** for monitoring the use of the DSS and having an expert agriculturalist examine the output of the DSS (time required = **1 season of part-time work**);

(5) **labor cost** for gathering feedback from user(s) and making any suggested or necessary modifications to the DSS; (time required = **3 months**).