ALERT SYSTEMS IN DECISION SUPPORT SISTEMS FOR SUGAR BEET AND POTATO CROP PEST MANAGEMENT

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Abstract: The Alert System for Decision Support Systems is based on the need of farmers to be informed and warned using a simple e-mail, in automate manner and real time, about the plant protection problems that appears on agriculture lands and solutions to solve them. These recommendations are triggered by the alerts that can be launched based on two types of rules: rules created using only meteorological data and rules defined by data mining technologies and based on a complex of various data. In this paper we show how to define and use the simplest type of alerts - meteorological alert. In order to make the best recommendations as information or warnings, we used previous developed diseases infection models and to get a real observations about meteorological data we used an innovative automate mechanism to collect values measured by the portable meteorological station directly on the farmer crops.

Key words: Alert systems, Decision Support Systems, Pest management

INTRODUCTION

Sugar beet and potato crops are constantly threatened by pests and diseases but, depending on weather conditions, the severity of attack is very variable from year to year and often control strategies are applied without considering this variability. Following the global climate change predictions, meteorological conditions are leading to increase the disease and pest pressure.

There is a great need for effective forecast model and warning systems for pests and diseases in order to minimise the use of chemicals in agriculture. For example, in potato crops there are two approaches available for the forecasting of potato late blight in order to reduce fungicides use compared to routine spraying: (i) Simple meteorological rules related to the life cycle of *Phytophthora infestans* that use rainfall, temperature and humidity over a given periods to predict spore production and subsequent periods when risk of infection is greatest (ii) Decision support systems (DSS), usually utilizing the simple rules that rely on data from in-field automatic weather stations or available as digital files from Internet/official sources (Savescu & Rafaila, 1978; Bouma & Hansen, 1999; Hansen, 1999).

Farmers need information about the risk of attack by different pests and diseases long before spraying. The latest mode of information technology is the Internet and mobile phone (Murthy, 2009).

The objective of this study was to develop a first proposal for an Alert System as a part of a Decision Support System for precision agriculture management of sugar beet and potato pests and diseases. The recommendation, in the form of SMS or e-mail message directed to the farmers, are based on previous experience and data achieved in various research projects and literature about pest risk occurrence, diseases infection models or forecasting models. The evaluation of this system will occur in the near future.

MATERIAL AND METHOD

In order to get meteorological data, a portable Metrilog station was installed on each of the three area of study (Bucharest, Brasov and Paulesti). Its sensors measured values for following parameters: AirPressure, Conductivity, LeafWetness, Precipitation, Relative Humidity, Soil Moisture,

Soil Temperature, Solar Radiation, Temperature, Wind Direction, Wind Speed, Wind Speed (gust). Using a GSM/GPRS service, the data values measured from 15 in 15 minutes were sent on a Metrilog Internet server (Fig. 1). From this place we get this data to our servers in a same periodicity with a delay between 30 and 45 minutes.

We send Metrilogs's data by SQL Server Integration Services software packages in a meteorological database administrated by SQL Server Database Engine.

The Data Warehouse was created using SQL Server Analysis Services. Reports from Precision Agriculture Data Warehouse (PADW) were created with SQL Server Reporting Services and data mining analysis using Microsoft SQL Server Data Mining Tool. The edition and version for SQL Server is Enterprise and 2005.

The alerts were built using Transact-SQL and MDX languages, administrated by SQL Server Database Engine as jobs and e-mails were sent with SQL Server Database Mail. Data in PADW were summarized on hours, days, decades of month, months, trimesters, semesters, years, stations. The measures used are minimum, average and maximum of Metrilog's parameters values.

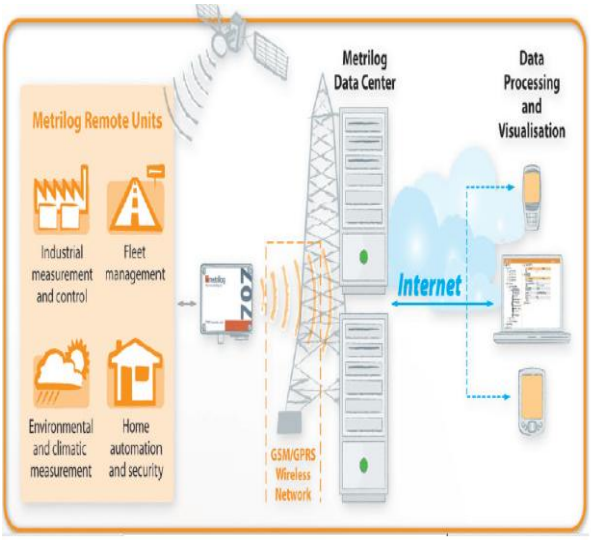


Fig.1 Metrilog flow of data (source: http://www.metrilog.at/ **)**

RESULTS AND DISCUSSIONS

The 12 reports with data from PADW were developed and are accessible over the internet (Fig. 2). As example-"Metrics on month decades for a machine" presents data about all decades of months for 2009 year for Brasov station and all parameters (Fig. 3). The reports are parametrized, so the report parameters as metrics (sensor parameters), station, year or moths can be choosed dynamically. The PADW data can be showed in a chart; figure 4 show the average month values for 3 stations in 2009.

A rule for Alert System for Precision Agriculture (ASPA) can be defined in following way: "IF ASPA_rule_is_true THEN E-mail_to_Farmer ("You have to follow the recommendations")".

The ASPA rule defined on data mining technologies are complex and combine meteorological data with result of previous plant protection project research. An example of this ASPA data mining rule can be :

- "IF Temperature is between 10 and 23^0 C and then10 hours or more of temperatures greater than 10^0C AND
- Relative Humidity is greater than 90% AND
- leaf wetness greater than 90% AND
- Month is June AND Plants is Potato AND …
- THEN Appear "Late blight infection probability it is very high".

At a certain period, the Alert System verify the rule and send an e-mail to the farmers if it is true.

The farmer recommendations are defined corresponding to this rule or more exactly corresponding to its level of probability to be true. If the level of probability is medium, the recommendation is: ”urgently check the potato crop, starting with late blight sensible varieties”, if the level of probability is high: ”fungicide application against Late Blight are needed”.

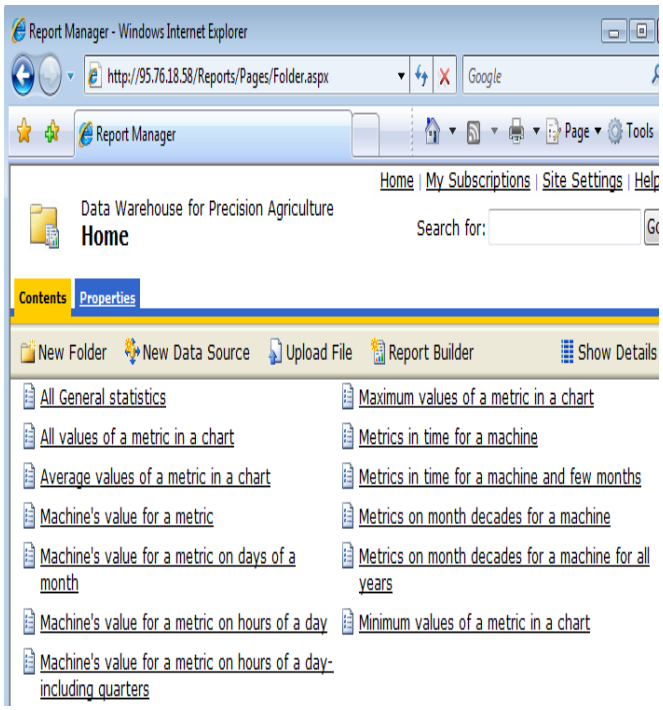
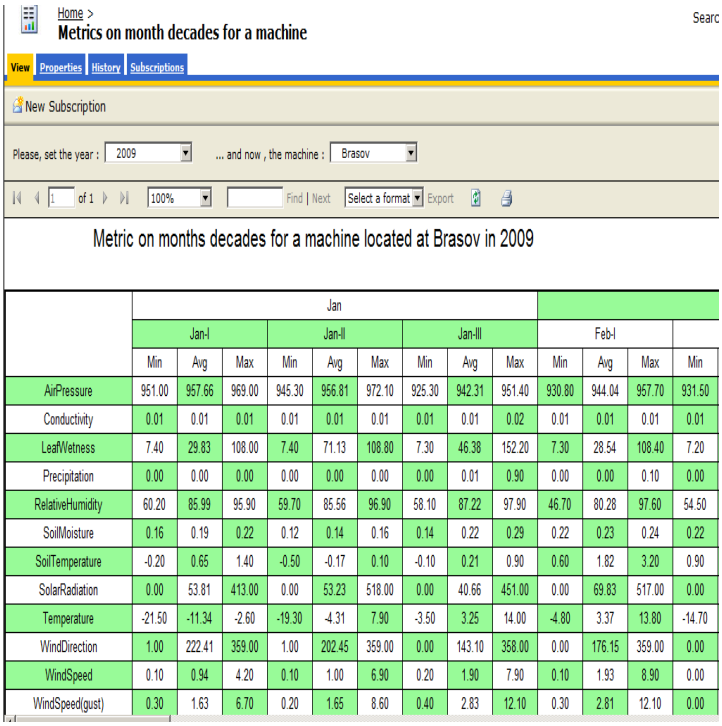


Fig.2 Reports from DWPA



	Jan									Feb-I			
	Jan-I			Jan-II			Jan-III						
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
AirPressure	951.00	957.66	969.00	945.30	956.81	972.10	925.30	942.31	951.40	930.80	944.04	957.70	931.50
Conductivity	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
LeafWetness	7.40	29.83	108.00	7.40	71.13	108.80	7.30	46.38	152.20	7.30	28.54	108.40	7.20
Precipitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.90	0.00	0.00	0.10	0.00
RelativeHumidity	60.20	85.99	95.90	59.70	85.56	96.90	58.10	87.22	97.90	46.70	80.28	97.60	54.50
SoilMoisture	0.16	0.19	0.22	0.12	0.14	0.16	0.14	0.22	0.29	0.22	0.23	0.24	0.22
SoilTemperature	-0.20	0.65	1.40	-0.50	-0.17	0.10	-0.10	0.21	0.90	0.60	1.82	3.20	0.90
SolarRadiation	0.00	53.81	413.00	0.00	53.23	518.00	0.00	40.66	451.00	0.00	69.83	517.00	0.00
Temperature	-21.50	-11.34	-2.60	-19.30	-4.31	7.90	-3.50	3.25	14.00	-4.80	3.37	13.80	-14.70
WindDirection	1.00	222.41	359.00	1.00	202.45	359.00	0.00	143.10	358.00	0.00	176.15	359.00	0.00
WindSpeed	0.10	0.94	4.20	0.10	1.00	6.90	0.20	1.90	7.90	0.10	1.93	8.90	0.00
WindSpeed(gust)	0.30	1.63	6.70	0.20	1.65	8.60	0.40	2.83	12.10	0.30	2.81	12.10	0.00

Fig. 3 “Metrics on month decades for a machine ” report from DWPA

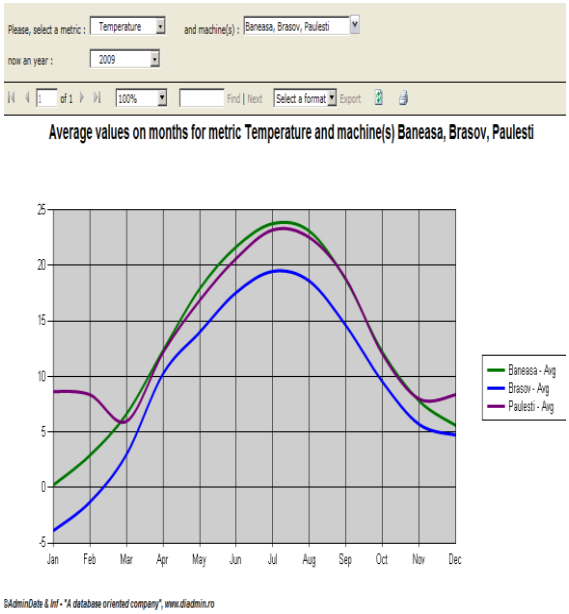


Fig. 4 Chart report from PADW

CONCLUSIONS

- These software systems are a good opportunity for protection plant research project results to be known more rapidly by farmers as information or warning alerts.
- The e-mail was built to be read by different mobile devices or printed and distributed to the farmers.
- There are 700 stations installed in Romania; the systems can be used in other area were Metrilog stations function, that can be very useful in developing more and more research studies. Improvements of forecasting systems for pests and diseases on field crops rely on close collaboration between researchers and farmers especially needed for validation and implementation of the new models.
- The next step in our researches will be to develop the more complex Alarm Systems for Decision Support System, connecting meteorological data type with data achieved by Unmanned Aerial Vehicle.

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