WEATHER BASED DECISION SUPPORT THROUGH THE INTERNET FOR AGRONOMIC MANAGEMENT OF SUGARCANE

A SINGELS, AJ KENNEDY AND CN BEZUIDENHOUT

South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe 4300, South Africa

Introduction

Optimal management of natural and other resources is essential for successful sugarcane production in a globally competitive market. Sound management decision making requires timely, relevant and accurate information on the continually changing state of the sugarcane system as it is affected by environmental and management factors. Computer models, expert systems and databases (such as online weather data) are increasingly used to generate this information.

Adoption of existing decision support systems such as CANESIM (formerly called IRRICANE by Singels *et al.*, 1998) by farmers and extension officers has been slow. Potential users find the modelling and communications software complicated and difficult to use (T Culverwell and B Swart, Extension Department, Sasex, personal communication). Software developers also have difficulties in maintaining and supporting software installed on remote computers.

A possible solution to these problems is to capture and process data at a central site and provide access to decision support through the Internet (see e.g. Pan *et al.*, 1998). Reported here is the initial development of a system 1) to capture and process weather data from selected stations at a central computer, and 2) to provide access to these data and a crop model through the Internet, thereby facilitating interactive decision support for agronomic management of sugarcane. The use of this system is also demonstrated by applying it to estimate cane yields for selected scenarios.

Methods

Figure 1 shows the flow of data from automatic weather stations (AWS) to the SASEX computing centre for agronomic advice (CCAA), onto a Web server and then onto computers of Web users.

The different stages of data flow and data processing are now described.

Data capture and transfer from the AWS to CCAA

Hourly and daily values of radiation, wind speed, dry and wet bulb temperature and total rainfall are recorded on Campbell Scientific data loggers. Currently 10 AWS's are accessed (for a list see http:/www.sasa.org.za/sasex/irricane/tables/index.htm). Data are transferred either daily through Siemens cell phone modems directly onto a personal computer connected to the SASEX local area network (LAN), or monthly through serial link onto a laptop and then copied to the SASEX LAN. Intermittent disruptions of communication occurred early on in the project. These were due to weak signal amplitude, operator mistakes, cellular network errors, remote and local power interruptions and telephone cable theft. Most of these problems have subsequently been eliminated.

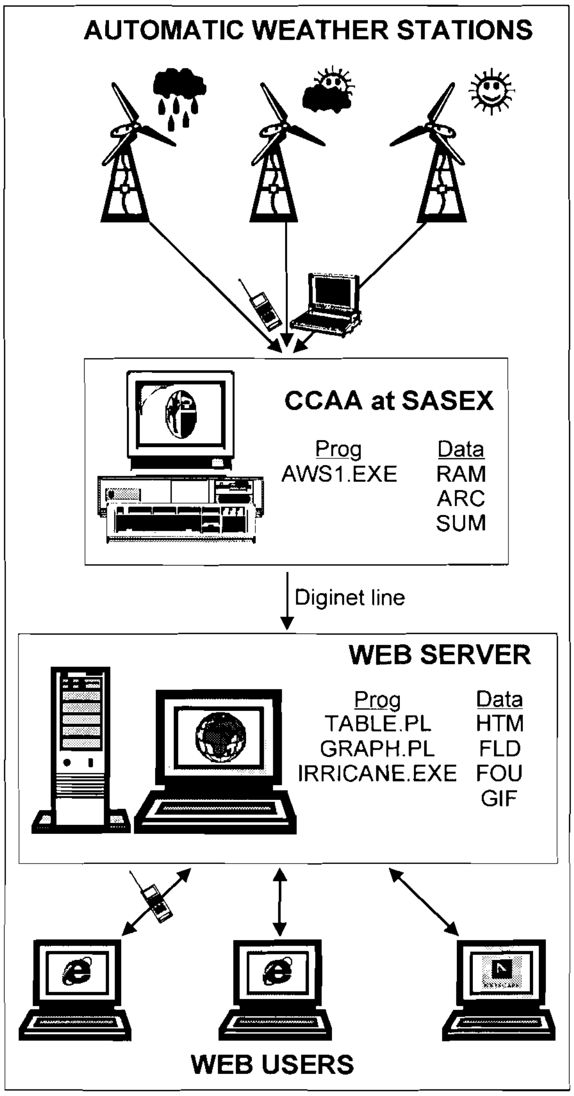


Figure 1. Data flow and processing.

Data processing at the CCAA

A Microsoft Quick Basic program named AWS1.EXE is executed automatically once a day to process downloaded data. Missing data from AWS data files are replaced with actual or long term mean daily data from specified substitute weather stations. The program calculates reference cane evaporation (Ecref) according to the method of McGlinchey *et al.* (1995) and daily potential stalk growth (Yref) according to the method of Thompson (1976). Four data files in ASCII format are produced:

- Processed weather data including Ecref since 1 Jan 1997 (*.RAM)
- Processed weather data for the last 14 days including Ecref and Yref (*.SUM)
- Weekly totals of rainfall and Ecref since 1 Jan 1997 (*.ARC)
- A report of processing problems and missing and corrupt data (*.FLT).

Data transfer from the CCAA to a Web server

Thirty data files (*.RAM, *.ARC and *.SUM of ten weather stations) are transferred using the File Transfer Protocol, from the CCAA to a Web server every day (90% success rate). The transfer is done automatically by a Microsoft Visual Basic program called BATCHER.EXE.

Data processing and flow on the Web

Two web pages have been coded by an Internet consultant (e-Pages) in HyperText Markup Language (HTML) generated with either Microsoft FrontPage version 3 (http://msdn.microsoft.com/frontpage) or Perl script (http://www.perl.com).

The first page (http://www.sasa.org.za/sasex/irricane/tables/index.htm) enables the user to view recent weather data of a selected station. Upon submission of the user's selection, a server based Perl script named TABLES.PL retrieves the relevant SUM and ARC files and generates the HTML code to display the information contained in these files on the user's computer.

The second page (http://www.sasa.org.za/sasex/irricane/index.htm) enables the user to generate a graph of cane yield over time of a specified scenario. The user has to:

- select a weather station from a list,
- specify the available water capacity (AWC) of the soil,
- specify the crop starting and ending dates, and
- specify whether it is a dryland or fully irrigated crop.

A Java (ttp://www.java.sun.com) applet embedded in the HTML code on the user's computer warns the user of irrational input or selections. Upon submission of the selection, a server based Perl script named GRAPH.PL creates a file (*.FLD) with the aforementioned user specific information as well as some additional inputs set at default values. These additional inputs were disabled to simplify the use of the page.

The name of the FLD file is submitted to the CANESIM model (file name: IRRICANE.EXE which outputs a file (*.FOU) containing daily records of all water balance components and stalk growth. The program is resident on the server in executable format (compiled in Quick Basic). The program was selected for this project because of its simplicity and low input requirements. Data from the FOU file are used as input by GRAPH.PL which then generates HTML code to display, on the user's computer, an image (GIF format) showing a graph of stalk mass versus days after emergence. Users can submit new specifications and the whole procedure is then repeated.

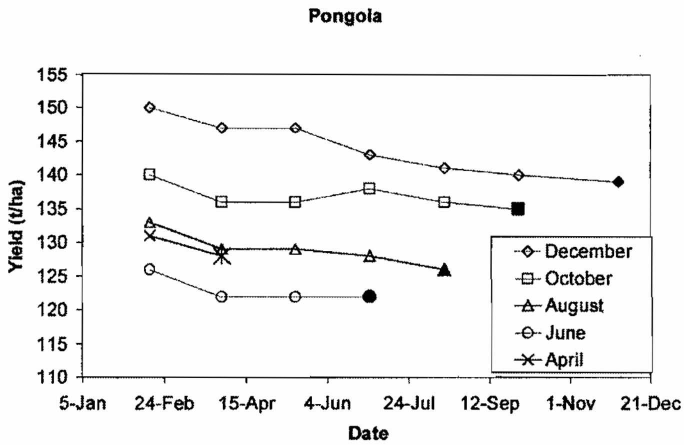
Application

The dynamic information available on these two pages can be useful to support agronomic management in different ways. Ecref data from the weather page can be imported or entered into simple spreadsheets to estimate recent water use by crops following the crop factor approach (Culverwell *et al.*, 1999). Climatically determined yield potential for given scenarios from the benchmarking page can also assist in identifying factors that cause actual yields to be less than potential yields, such as soil compaction, waterlogging, pests, weeds and nutrient deficiencies. Another potential use is in assisting yield estimation, an example of which is given below.

Yield estimates are calculated by running the CANESIM model with actual weather data from the starting date to the current date and completing the season with a given historical weather sequence to represent likely future weather. For this work we selected the weather of 1993 to complete the season with when the estimation date was before 31 May and weather of 1995 when the estimation date was after 31 May. This was done to emulate El Nino conditions for the first half of 1998 and La Nina conditions for the second half (Anon, 1998). As the season progressed the ratio of actual to forecast weather data used to calculate yield, increased. Figure 2 shows 1998 yield estimates and final calculated yield for five annual crops grown on soils with an available water capacity of 100 mm at Mt. Edgecombe (dryland) and Pongola (fully irrigated).

Pongola estimates decreased slightly as the season progressed because actual radiation was less than that of the selected future scenario. Late season crops had higher estimates than early season crops, which was also reflected in the final yields. Early estimates were remarkably close to final yields.

Mt. Edgecombe estimates for a given crop increased slightly over time because the actual crop water status was better than forecast. Estimates decreased sharply with harvest time because of poor water status towards the end of the season. Estimation accuracy could be evaluated by comparing estimates with the final yield calculated with actual weather data only. The difference between the mean estimate for the five crops and the mean final yield at Pongola varied from +5% at the first estimate to zero at the last estimate. For Mt. Edgecombe the corresponding figures are -16% and +2%.



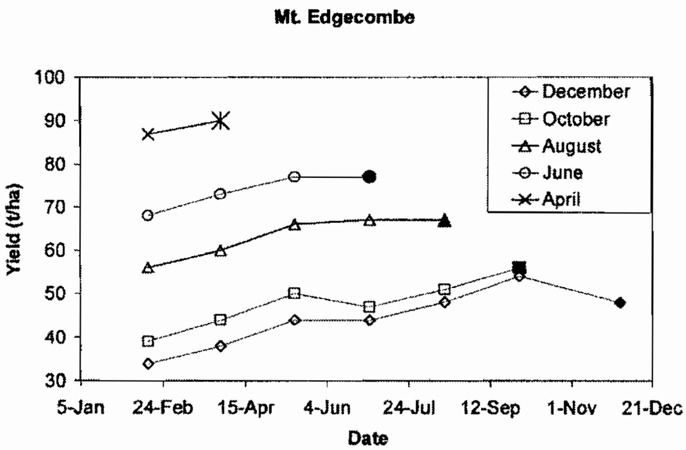


Figure 2. Yield at harvest estimated at different dates during 1998 based on actual and forecast weather data (symbols), and the final yield calculated from actual data only (last symbol in boldface) for five annual crops at Pongola (irrigated) and Mt. Edgecombe (dryland).

Conclusions

A system has been developed to capture and process automatically near real-time weather data and to provide Internet access to apply the CANESIM model interactively to these data. The system functions reasonably smoothly and can be used to assist in irrigation management, yield benchmarking and estimation. The system has not been operational long enough to assess the extent of the use and the impact it will have on agrotechnology transfer in the South African sugar industry. Extension officers, growers and millers will be involved with the further development of this facility.

Acknowledgements

The authors gratefully acknowledge owners of automatic weather stations who kindly allow SASEX access to their data, and SASEX extension staff for their valuable comments and ideas.

REFERENCES

Anon (1998). Seasonal outlook in Southern Africa. LOGIC, SA Weather Bureau.

Culverwell, TL, Proksch, L and Swart, C (1999). A practical irrigation scheduling method for sugarcane crops. *Proc S Afr Sug Technol Ass* 73 (this vol).

Pan, X, Hesketh, JD and Huck, MG (1998). An object-oriented and internet-based simulation model for plant growth. *Proc 7th Int Conf Computers in Agriculture* (Ed. FS Zazueta), ASAE, 345-351.

McGlinchey, MG, Inman-Bamber, NG, Culverwell, TL and Els, M (1995). An irrigation scheduling method based on a crop model and an automatic weather station. *Proc S Afr Sug Technol Ass* 69: 69-73.

Singels, A, Kennedy, AJ and Bezuidenhout, CN (1998). IRRICANE: a simple computerised irrigation scheduling method for sugarcane. *Proc S Afr Sug Technol Ass* 72: 117-122.

Thompson, GD (1976). Water use by sugarcane. *S Afr Sug J* 60: 593-600; 627-635.