WEB INTERFACE FOR SIMULATED DATA INTERPRETATION IN DSSAT

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Abstract. *With the growing demand for agricultural productsthere is search for technology to help increase yield, so that in the same area production the yield is higher than it was previously. With the simulation, you can get results related to time, planning, execution, money spent, among other things, with less effort, applied in several areas, such as in agronomy. The DSSAT - Decision Support System for Agrotechnology Transfer is a simulator, with various tools and spans various cultures. One of the difficulties in some computer simulations, is the level of knowledge needed to interpret the data obtained. Thus, the objective of this work is to build a web interface for viewing the results the simulations in DSSAT, to obtain the best man / computer integration. Thus presents a web interface for sending DSSAT output file, allowing view the yield data and facilitating decision making.*

Keywords: Computing, simulation, interface

1. INTRODUCTION

The increase in demand for food, combined with environmental problems and the globalization of markets has caused many agricultural production systems were modified. The new methodologies should assess the impact, stability and sustainability of production systems, and to facilitate the decision-making [1].

In developing these new methodologies interdisciplinarity is necessary, the integration of knowledge from different areas. In this scenario computing applied it is included in the agriculture development simulation models.

Through simulation it is possible to get prospects of results in a period of time less than would be required if the results were collected empirically. In addition, there are savings in time and monetary cost in comparison between simulated results and empirical results. It is possible to discard solutions that have a return below expectations before you even make expenses. However, should be considered the fact that a simulation, ignores some aspects and not is so complex as a field experiment. [2]

According Chwif and Medina [2], the model is an abstraction of reality, which seeks to represent the actual process in a simplified manner. Simulation models are implemented through the aid of a computer. Thus, as an analytical model can be represented by a set of equations, a simulation model can be represented by a programming language. To this end, instead of analytical models, the simulation models are run, instead of solved.

Among the simulation models of growth and development of plants, there is the Model DSSAT - Decision Support System for Agrotechnology Transfer [3,4]. The functionality of DSSAT combines data on soil, climate, crop management and experimental data. The crop simulation models can simulate the growth, development and yield as a function of soil dynamics, plant and atmosphere. The DSSAT supports more than 28 different cultures.

In handling DSSAT, the user interface is not user-friendly, since its operation requires a high level of knowledge of the input information and the interpretation of the data generated by the simulations, on which their outputs will be used to support the decision.

Thus has been more widely adopted, however, its use remains mostly in the realm of researchers and consultants with high levels of education and training. Some reasons for non-adoption or short-term use are high levels of expectations on the part of farmers, lack of user friendliness, the deterministic nature of outputs, and problems with up-scaling [5].

The DSSAT output files can be handled in different ways. In this context, this article aims to present a prototype web interface for viewing the results of simulations, providing a more friendly way to interpret the data for all types of users.

2. MATERIALS AND METHODS

Simulations were performed in DSSAT Version 4.5, with the standard experiment BRPI0202.MZX, getting as output file "OVERVIEW.OUT" (Figure 1), corresponding to a text file with the simulation results, such as name, techniques, productivity, among others.

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*SIMULATION OVERVIEW FILE

*DSSAT Cropping System Model Ver. 4.5.1.023 -Stub        JUN 18, 2015; 11:33:07

*RUN   1         : AG9010 - Rainfed          MZCER045 BRPI0202    1
 MODEL           : MZCER045 - Maize
 EXPERIMENT      : BRPI0202 MZ MAIZE IRRIGATED AND RAINFALL
 DATA PATH       : C:\DSSAT45\maize\
 TREATMENT  1    : AG9010 - Rainfed          MZCER045


 CROP            : Maize           CULTIVAR : AG9010           ECOTYPE :IB0001
 STARTING DATE   : MAR  1 2002
 PLANTING DATE   : MAR 13 2002        PLANTS/m2 :  5.0     ROW SPACING :  80.cm
 WEATHER         : BRPI   2002
 SOIL            : BRPI020001     TEXTURE : C     - TERRA ROXA (RAINFED)
 SOIL INITIAL C  : DEPTH:120cm EXTR. H2O:124.0mm  NO3: 48.4kg/ha  NH4:  5.0kg/ha
 WATER BALANCE   : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION      :        0 mm IN      0 APPLICATIONS
 NITROGEN BAL.   : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER    :       70 kg/ha IN      2 APPLICATIONS
 RESIDUE/MANURE  : INITIAL :  5100 kg/ha ;       0 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.  : DAYL=    0.00  SRAD=    0.00  TMAX=    0.00  TMIN=    0.00
                   RAIN=    0.00  CO2 =    0.00  DEW =    0.00  WIND=    0.00
 SIMULATION OPT  : WATER   :Y  NITROGEN:Y  N-FIX:N  PHOSPH :N  PESTS  :N
                   PHOTO   :C  ET      :R  INFIL:S  HYDROL :R  SOM    :G
                   CO2 372ppm  NSWIT   :1  EVAP :S  SOIL   :2
 MANAGEMENT OPT  : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:M
                   WEATHER :M  TILLAGE :Y
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Figura 1: DSSAT Output File

From the output file, an algorithm was developed in PHP to read this file, WEB interface called "DSSAT / webinterface" using Bootstrap [6], a front-end framework compatible with HTML5 and CSS3 that enables the creation of responsive layout, and generation of graphics data, used to Chart JavaScript library.

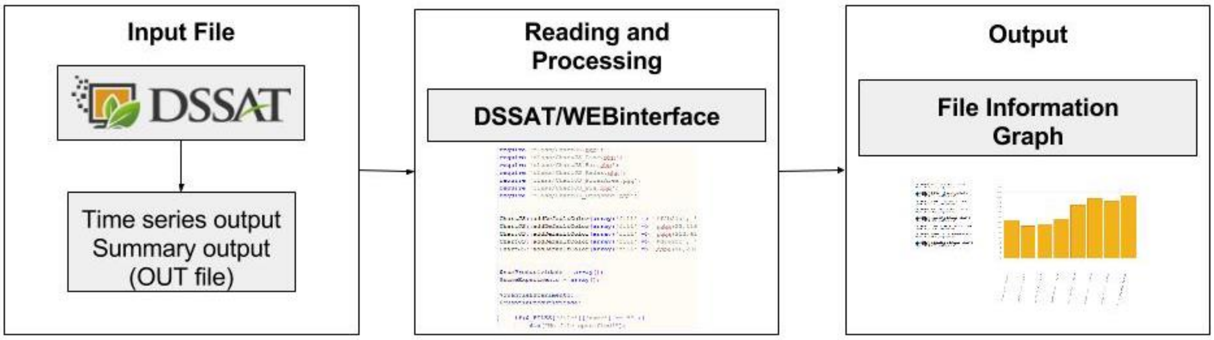

Figure 2: Process performed

In Figure 2 you can see the process performed, the input file will be "OUT file" obtained through DSSAT, then the user performs the upload of the file in the web interface, with the extension ".out" and then the algorithm runs, seeking the requested in this case generating as output a productivity chart with the information in the file.

3. RESULTS AND DISCUSSIONS

The output file DSSAT has a lot of information, making it difficult to interpret the results and decision making. In this prototype, productivity information were taken in different ways. In Figure 3, we can perceive the information taken from OVERVIEW.OUT input file.

TREATMENT 1 : AG9010 - Rainfed MZCER045
Maize YIELD : 3731 kg/ha [Dry weight]

TREATMENT 2 : DKB 333B - Rainfed MZCER045
Maize YIELD : 3144 kg/ha [Dry weight]

TREATMENT 3 : DAS CO32 - Rainfed MZCER045
Maize YIELD : 3384 kg/ha [Dry weight]

TREATMENT 4 : EXCELER - Rainfed MZCER045
Maize YIELD : 3891 kg/ha [Dry weight]

TREATMENT 5 : AG9010 - IRRIGATED MZCER045
Maize YIELD : 5226 kg/ha [Dry weight]

TREATMENT 6 : DKB 333B - IRRIGATED MZCER045
Maize YIELD : 5879 kg/ha [Dry weight]

TREATMENT 7 : DAS CO32 - IRRIGATED MZCER045
Maize YIELD : 5616 kg/ha [Dry weight]

TREATMENT 8 : EXCELER - IRRIGATED MZCER045
Maize YIELD : 6175 kg/ha [Dry weight]

Figure 3: File Info ".out"

Simulations were performed with eight different conditions (Treatment 1-8) by varying the type of management and type of maize seed. From the information obtained from the file in this case yield, they are on the screen, in an objective manner, through a graph (Figure 4), for a better view of productivity in the eight simulated situations.

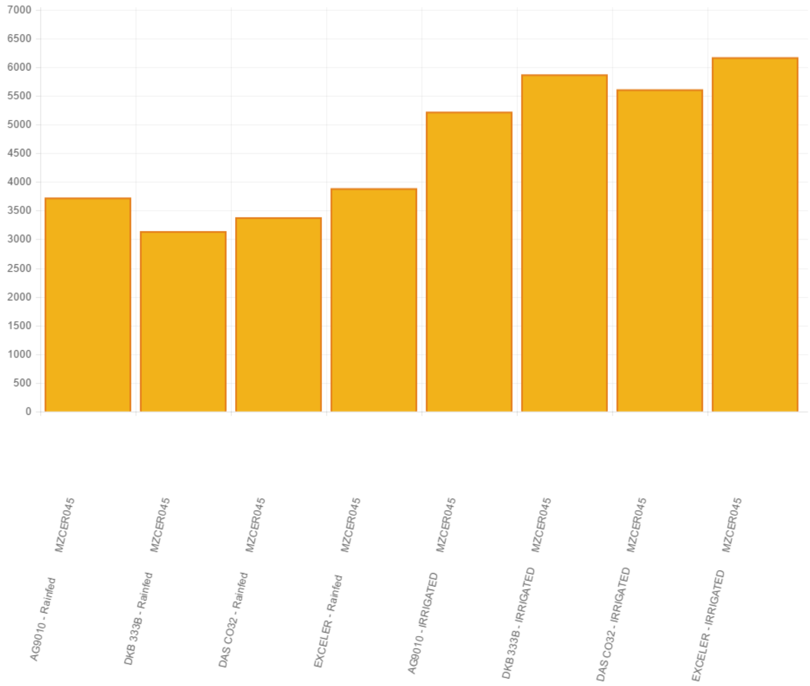

Figure 4: Yield Graph per hectare

On the y axis are shown productivity values, and the x axis 8 (eight) experiments conducted, making it possible to visually, identify which experience was obtained the highest productivity.

In Figure 5 you can see the full interface, which is divided into two sections, the upper part is located the form to upload the output file, at the bottom are shown of the results after the algorithm go through the file and generate the graphic.

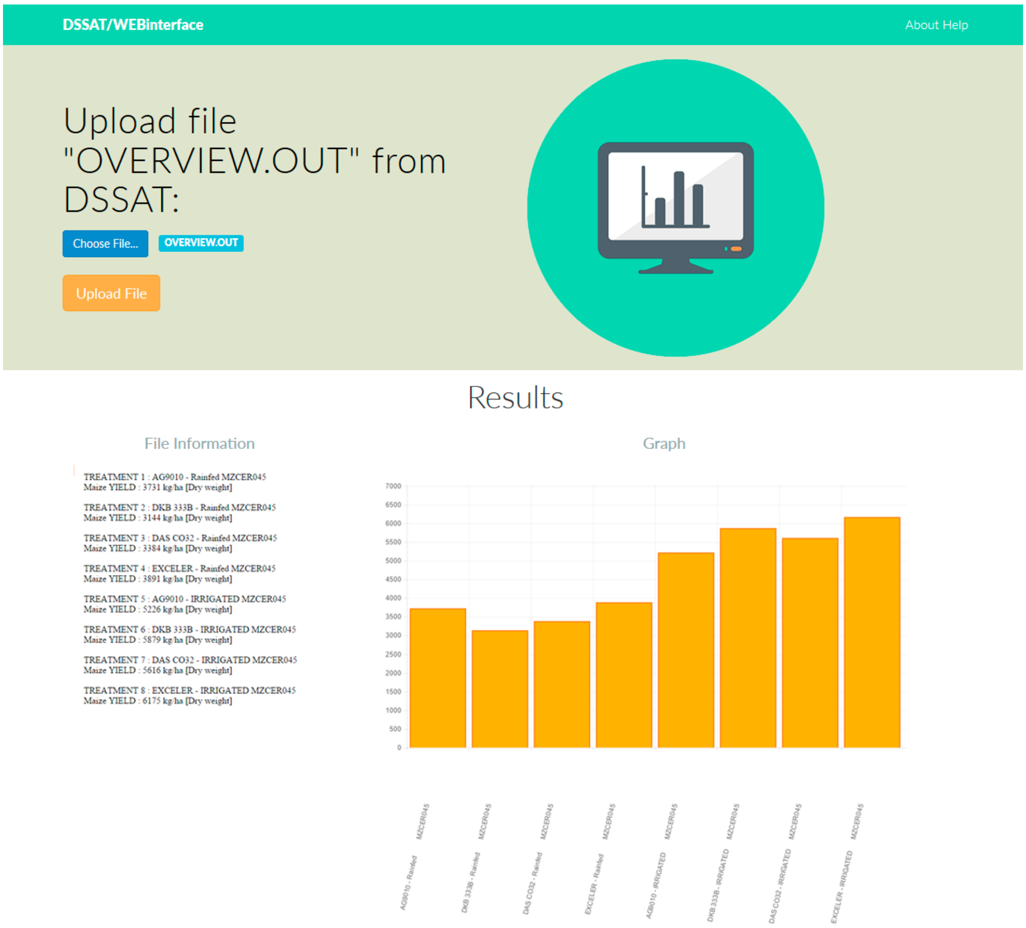

Figure 5: Interface with the results

4. Related Works

4.1 Yang and Huffman (2004, 2014)

In 2004 Yang and Huffman, created the EasyGrapher [7] that is a graphical display and statistical validation program designed for the decision support system for agro-technology transfer (DSSAT) suite of models.

EasyGrapher can expedite validation of DSSAT output, which normally requires considerable time and effort to export output data into external statistical packages. It allows users to create validation graphs, displaying simulated data against ground-truth data and calculate validation statistics such as root mean square error, mean error, forecasting efficiency and paired t-tests.

Already in 2014 Yang et al [8] also works with EasyGrapher (EG) with aim analyzing the outputs the DSSAT v4.xcrop models, and it also supports graphing Canadian Agricultural Nitrogen Budget (CANB) v3.0 model. EG allows users to manipulate hundreds of graphs within minutes and calculates evaluation statistics. The EG program has the potential to carry out graphic and statistical tasks for other models. Graphic and statistical evaluation examples were illustrated using field dataset collected from our experiments in Canada and China, as well as dataset resided in the DSSAT software.

Currently the EG is integrated with a suite of DSSAT tools, enabling the user, from the output files can display graphically simulated results, but this view is not always easy to access, forcing the user to be a specialist.

4.2 Teeravech et al (2013)

In 2013, Teeravech et al [9] presents a web-based crop simulation and prediction system called Tomorrow’s Rice based on DSSAT (version 4.0.2) model. Historical weather data are collected automatically in real-time from web services, which include the IRI/LDEO Climate Data Library for extracting daily precipitation and temperature from Global daily WMO weather station data and the NOAA NCDC GHCN, and the solar radiations from NASA Power database.

Users can evaluate rice yields given a planting date, crop and soil characteristics. The yield is presented as a box-plot distribution coming from 100 weather scenarios generated from statistics of past weather data, which can inform to optimization and risk management, e.g., choosing optimal sowing window in a growing season. This system is also able to estimate the long-term impact of climate change on rice yield by using a simple delta approach that integrated World Bank’s climate change data.

The Tomorrow's Rice user interface is extremely intuitive and easy to interpret, but it is usable only for rice cultivation yet, the next version of software with several improvements such as performance of the simulation, the weather data collection and simulation processes. We are trying to reduce the computation time by using a multi-threading technique. Moreover, the users will be able to control the other parameters such as irrigation, water management, fertilization and chemical applications.

4.3 Churi and Miozi (2013)

Also in 2013 Churi and Miozi [10], researched a decision support system for assisting strategic and tactical decision making of smallholder farmers to reduce climate risks and increase crop productivity of semi-arid areas. Specifically, the study assessed farm-level decisions used by the farmers for reducing climate risks; examined information communication and knowledge sharing strategies for enhancing decision making and designed a system for assisting the farmers in selecting appropriate options for improving crop productivity.

Development of DSS was governed by design science where prototyping approach was used to allow complete participation of end users. The proposed architecture allows difference agricultural actors participate in communicating agricultural information and sharing of knowledge with smallholder farmers.

The DSS was implemented and assessed by farmers as a useful tool for accessing information and advisories in agricultural systems. Two main components of DSS are the mobile phone communication manager and web-based communication manager. In this set up, different users that communicate can use different platform to share information. For example, when meteorological agent updates rainfall forecasts, farmers and extension workers get such information through mobile phone interface. Similarly, when farmers and other DSS users register themselves for the forecasts, then meteorological agent and agricultural actors would be able to see registered farmers through web interface.

More research is recommended to enable simple and affordable mobile phones be used by farmers to access wealth of agricultural knowledge and policies from research centers and government resources.

5. Conclusions and Future Works

From the product developed focused on the web, you get greater accessibility and commodity, a user can remotely access the application and use it without installing DSSAT Software on your computer, just having the simulated output files.

The information highlighted are sought in the file ".out". Thus, the work to locate them has become easier, since there is this pair (experiment name and Productivity) for each experiment performed. If they were executed, fifty experiments, we would have fifty pairs in a file with other information, may lead to confusion. With the solution presented, the user identifies the relevant information more easily. The graphic representation makes tangible the understanding of the results.

When we observe the related work, we identify a large area of research, since the use of agronomic simulation models is almost unique in research centers or to large farmers with skilled labor. With the development of this work, the goal proposed is achieved, by disseminating this knowledge through a simple data interpretation interface, assisting farmers in decision making.

It is worth mentioning, that the interface is designed for different screen sizes as it has responsive layout using HTML5 and Bootstrap Framework.

As future work, we suggest the parameterization of the output information of the simulated DSSAT file, allowing the user to select what to display in the web interface after sending the file as well as optimizing the use of mobile devices, as that depending on the amount of parameters, the visualization may become difficult.

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