The AGROSYS Relational Database: An Information System for Agricultural Decision Support Systems

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ABSTRACT

The Agronomic System Database (AGROSYS) is a structured information system which gives to the user access to data and information on many different agro-biological issues (Caldeira and Pinto, 1997). This information has been collected from literature reviews, field experimentation, and the contributions of experts in many different areas. The development of a relational database makes the data set of the system explicit and normalized, i.e., the information does not have any redundancy or ambiguity, and is easily updated. As an application example we have designed a system coupled with a GUI interface, between a set of crop simulation models included in a commercial decision support system (DSSAT) and the AGROSYS database. The AGROSYS prototype runs on Microsoft Windows 95 with Access version 7.0 or later.

1. INTRODUCTION

Technological advances in agricultural decision support systems, namely in crop simulation models, provide new opportunities for the characterization of crop production. Field application of decision support systems has shown that they rely on large amounts of data and information. Therefore the effective use of these tools require their integration with structured information systems. Relational database management systems (RDBMS) are good and tested examples of well structured information systems.

As an application example this paper presents an interface between the AGROSYS prototype and DSSAT[1] (Tsuji et al., 1994) "XCREATE.EXE" application user interface and provide to DSSAT crop models a source of information with support on a relational database. It runs on Windows 95 environment using Microsoft Access version 7 relational database management system (RDBMS). All the programming was done with Microsoft's Visual Basic version 4. For accomplish this task we will provide some concepts about crop models and information systems, followed by the definition of a Entity-Relationship model and diagram, and by a brief presentation of the prototype interface for managing experiments and writing FileX files in substitution of DSSAT application "XCREATE.EXE".

Since the pioneer works of Loomis and Williams (1963), Wit (1965), Ducan et al. (1967) and Stapleton (1970), crop models have evolved from primitive tools to more complex applications. Unfortunately, crop models data structures do not always follow such progressive levels of sophistication. The large majority of crop models still works with classic ASCII file systems.

Agricultural crop production systems are complex, requiring integration of biological information, business management decisions, and social issues (Willett and Andrews, 1996). Because of that diversity modern agricultural decision support systems require considerable amounts of data from different sources (Sharifi and Keulen, 1994). Ritchie (1991) argued that the success in simulation is dependent on the availability of the appropriate information.

As Stonier (1991) pointed out "the most important input into modern productive systems is no longer land, labour or capital - it is information. When you know enough, you can greatly reduce the requirements for any of these". Monteith (1996) claims that "crop models cannot be built without invoking a set of hypotheses and the set cannot be rigorously tested without measurements that describe the performance of the crop over a wide range of environments. Such information is rarely available." Crop model performance depends on the availability and quality of the data needed to run the simulations. The level of complexity that a crop model can

[1] Decision Support System for Agrotechnology Transfer (DSSAT) version 3 is a decision support system composed by data files and crop models developed by the International Benchmark Sites Network for Agrotechnology Transfer, Hawaii, USA.

address depends on the objectives of the model and on the amount of data available for model building and testing (Boote et al., 1996). Simulation models have a great thirst for data, i.e., they need the sources of information to be readily available (Jones, 1993).

Such an important issue cannot continue to lay down on file processing. A number of characteristics distinguish the database approach from the classical file processing systems (Martin, 1977). A fundamental property of databases is that they do not contain only information itself but also data description (Elmasri and Navathe, 1989). This definition is stored in the data dictionary. It is the data dictionary that makes program/data independence possible. That is, it makes possible to determine the structure and content of the database by examining the stored information. It is not necessary to maintain external documentation of file format as is done in file systems (Kroenke, 1995), where data definition is typically part of the program itself. Hence, these kind of programs are constrained to work with only one specific file whose structure is declared in program headings (Benyon, 1997), demanding reprogramming and recompilation wherever data structure changes.

2. AGROSYS DATA MODEL

AGROSYS data model was constructed from data specifications provided by a preliminary data analysis with entity-relationship model (E-R model). The foundations of E-R model can be found in Chen (1976). E-R model provide a language for expressing the users' data model, or the structure of data and data relationships in the users' work environment.

E-R models are composed by entities and relationships. An entity is something important to the users of the system that is to be built. Examples of entities are "X weather station", "Y N fertilizer", or "wind velocity at a given moment". Entities have attributes which describe the entity characteristics. Examples of attributes are "wind direction", "maximum daily temperature". Entities can be associated with one another in relationships.

The scheme in Figure 1 is called entity-relationship diagram (E-R diagram). Such diagrams are standardized (Chen, 1976; Kroenke, 1995). According to those conventions, entities are shown as rectangles and relationships as diamonds. Entities and relationships names are inside the shapes.

The data analysis contains the following great groups of information:

- weather
- soils
- crops
- management inputs
- field-measured crop information
- DSSAT FileX experiment file and simulation controls.After the design of a relational data model based on Agrosis E-R diagram the prototype was constructed in Microsoft Access version 7. Figure 2 show the interface screen between DSSAT FileX and the AGROSYS relational database.

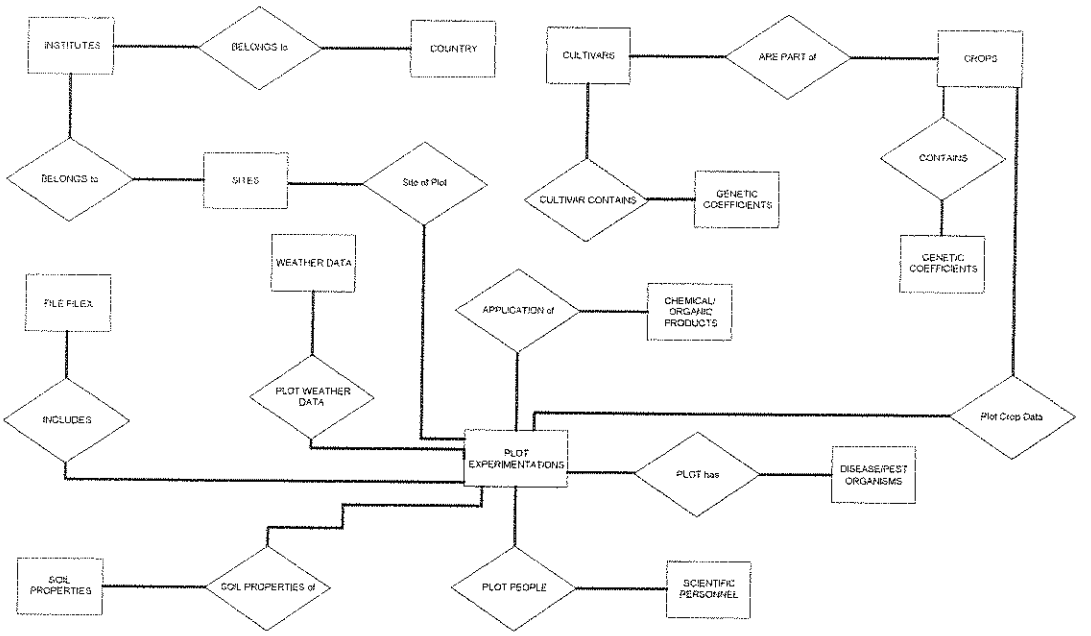

Figure 1: Agrosys E-R diagram.

3. DISCUSSION AND CONCLUSIONS

Agricultural decision support systems are information-rich and require regular updating, for example as new cultivars or weather records are released. The ability to make changes and extend the data and information of such systems is essential, and may be the difference between their success or their failure (Farrell et al., 1992).

To be successful, technology transfer tools must be easy to use. A consistent user interface with intuitive functionality that conforms to other familiar standards (like Microsoft Windows) is much more likely to be adopted than one that requires the user to remember codes and many special functions (Kollasch and Twery, 1995).

A relational database management system was developed for use in an IBM-compatible microcomputer with Microsoft Windows environment and using Microsoft Access version 7 or later. This database, called AGROSYS, intends to act as a proposal to replace the old fashioned file system types, still in use on the majority of agricultural decision support systems, by structured information systems. This paper also presents an interface between the AGROSYS relational database and the DSSAT suite. This prototype provides a better source of input data then DSSAT's native ASCII file system because it is structured on a relational database and the user doesn't have to remember codes and special functions. Its GUI interface has greatly improved the accessibility and usability of all kind of data.

Relational databases are powerful information systems that simplify the design and implementation of agricultural decision support system. Integration of agro-technology transfer systems - like DSSAT - with relational databases will be crucial in the future for their acceptance. Another important issue of the AGROSYS prototype should be the identification of future research paths in the area of technology transfer. AGROSYS utilization will point out which components are the weakest.

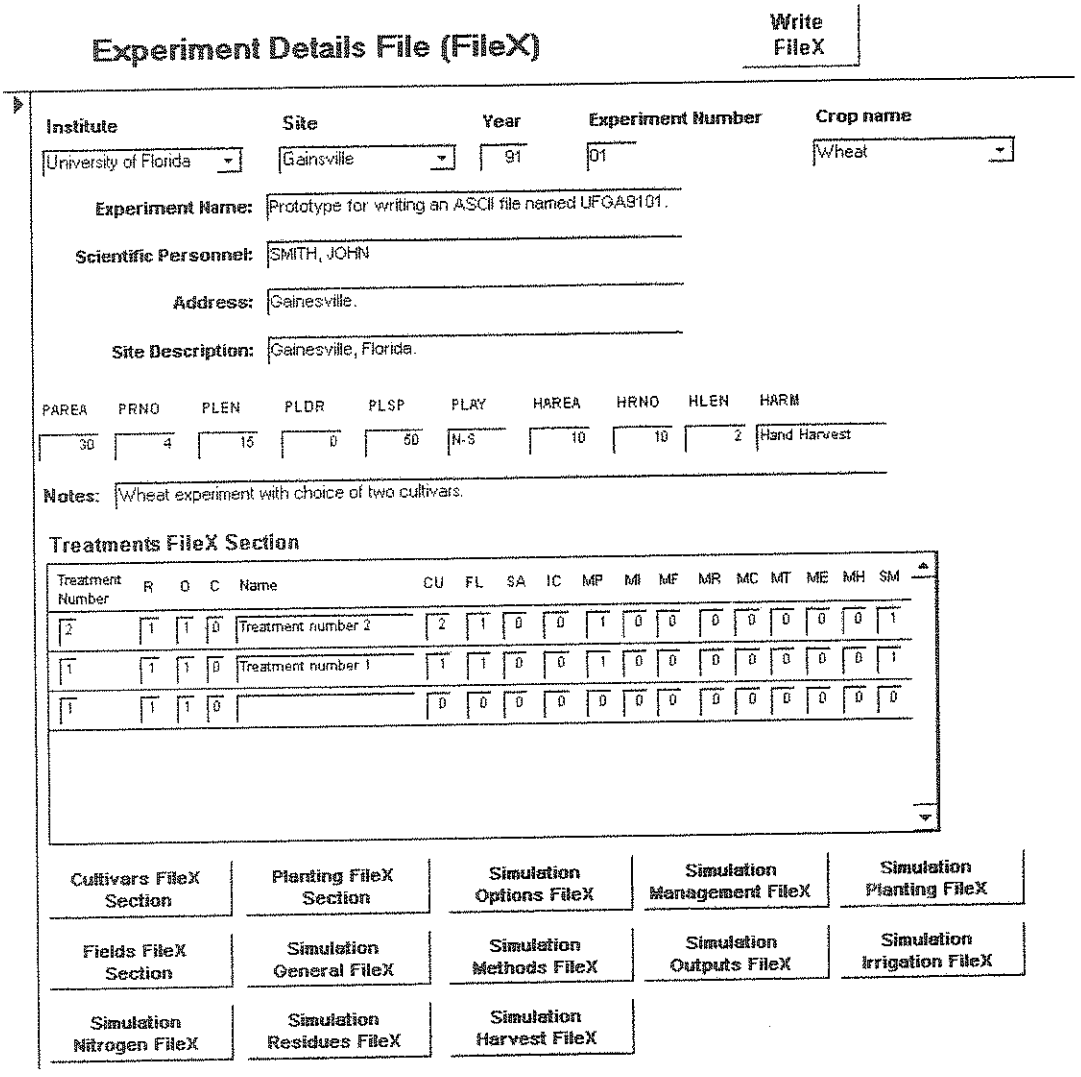

Figure 2: Screen interface between AGROSYS database and DSSAT FileX.

4. SOFTWARE

The software described in this paper (AGROSYS database and further documentation) is available from the authors.

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