Online Data Management System for On-farm Trials

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The online data management system for on-farm trials (WebFarm) is a prototype software to customize recording of on-farm trials under the Indian Agricultural Statistics Research Institute, New Delhi. The prototype WebFarm is a three-layered design. Client Side is the Interface Layer, implemented in HTML and JavaScript. Server Side is the Application Layer connecting the client side layer and the database and is implemented in Java Server Pages. Database layer is implemented using Microsoft Access 2000. The developed WebFarm can be implemented as a network-based system with a server, so that information is available online. WebFarm runs on any node of the Internet through a browser. Security features are provided in such a way that only the administrator can access the database. It has facilities for browsing and searching the information and online help for smooth navigation. There is a provision for interacting with the System Administrator through e-mail. This will reduce the delay in receiving the data. Further, IASRI can distribute the work, like—checking of schedules, coding of data and converting data to electronic form to various centers conducting on-farm trials. As a result, they can be directly used for statistical analysis.

1. Introduction

Computers have been used in agriculture and allied fields for over 30 years. Areas of usage have advanced from computing, to the existing multitude of uses in Agricultural Research, Decision Support System, Monitoring, Evaluation and Control, Information Management and Dissemination, Teaching and Training etc. The use of computers created awareness on the potentialities of Computer and Information Technology in agriculture. Thus, an Information System can be evolved virtually for any field where information is to be handled and one such field is Agriculture.

Over the few decades, the country has made impressive progress in agriculture which still remains the most vital sector in the Indian economy, contributing about 22% to the national income and about 80% of the rural population earns its living from agriculture and agro-based industries. Agriculture requires a fairly large database, be it for implementation and monitoring of research programs, lab-to-land programs, development plans and programs etc. The development of databases and the information systems related to these require input from various sources, their processing and dissemination for planners, policy makers, development programs, research, administration and

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other coordinating agencies. Computers with their capacity to store large amount of information, ability to retrieve required information and its processing and dissemination of information on computer networks have opened up vast potentialities for agricultural development.

The present era has seen an exponential increase in the growth and diversification of all forms of information, which is sometimes called as information explosion. This was possible due to the impact of computer technology in the modern society. One of the major benefits of this revolution has been the evolution of Computer-based Information Systems (CIS). Information systems are assuming an ever increasing importance in agricultural development and computer-based information systems/databases and computer communication networks are today and in foreseeable future, a prerequisite for taking a coherent and balanced decision.

The production of food grains is increasing year by year. This has been possible through the endless hard work of agricultural scientists, be it in the field of varietal development or crop development or improving better agricultural packages and practices or through extension services. Even this record production can be improved if right information about agricultural practices is made available to the farmers at the appropriate time. This has been achieved through the untiring efforts of Agricultural Scientists associated with National Agricultural Research System (NARS). For increasing the productivity, the newer technologies in agriculture are being developed at research stations by conducting agricultural experiments over time and space, before these are recommended to farmers for adoption. The developed technologies are tested on farmers' field through on-farm trials. The field of concern in this dissertation is the data management of on-farm trials conducted under All India Coordinated Research Project (AICRP) on Cropping System Research (CSR). At present on-farm trials are being conducted at 32 NARP-Zones/Districts of the country under AICRP on CSR. Around 3000 trials are conducted every year at various centers. IASRI is associated with Planning, Designing and Statistical analysis of these trials. At present three types of trials are being planned for various centers.

a. Response of nutrients (N, P, K) on farmer's fields.

b. Agronomic management practices for sustainable production.

c. Intensification and diversification of the existing cropping systems.

2. Need for Online Data Management System

The above stated trials are conducted on various cropping system and the data generated from these trials are filled manually and submitted to the IASRI and PDCSR (Project Director for Cropping Systems Research) for further analysis. Separate data schedules for each type of trials have been developed by the IASRI and these are filled in at research stations after completion of trials. The data from various centers is received by post and lot of effort is made in scrutinizing, coding and validation of data. This validated data is then converted to electronic form for statistical analysis. During scrutiny many trials are rejected because of some discrepancies. The most common discrepancies observed are—inconsistent

choice of fields for trials in different seasons and inappropriate choice of varieties for the trials in NARP zones, etc.

With the advancement of computer technology and availability of ARIS network at various Agricultural Universities/ICAR Institutes, it is advantageous to use the computer technology in the data management of large number of on-farm trials conducted across the country. This necessitates the development of a web-based data management system for on-farm trials so that the data generated at different centers is available to IASRI and PDCSR in the electronic form. This will avoid delay in receiving the data and its subsequent transfer to electronic form. Further, this will enable different centers to enter the data at their stations before transferring it to IASRI. This will reduce the time in the processing of data for statistical analysis

3. ITC's e-Choupal Model: The Gateway to Disseminate Information

The WebFarm will be based on almost the same concept as ITC's e-Choupal. e-Choupal provides the information related to weather, best agricultural practices, marketing information, crop related information, government plans, news and e-mail facilities. As it is clear from the Figure 1, not everybody can access all this information. To access the information, there must be a user name and password. Each registered *sanchalaks* (coordinator) get a user name and password. The *sanchalaks* are the interface between the computer and the farmers. These *sanchalaks* are trained by the ITC. The interface is essential as most of the farmers are either illiterate or not computer savvy. This model is really useful for poor farmers who want to get timely information. With the same concept, WebFarm promises to provide the same kind of interface which will be the Research and Development Wing of the IASRI

Figure 1: e-Choupal's Online Information Disseminating Model

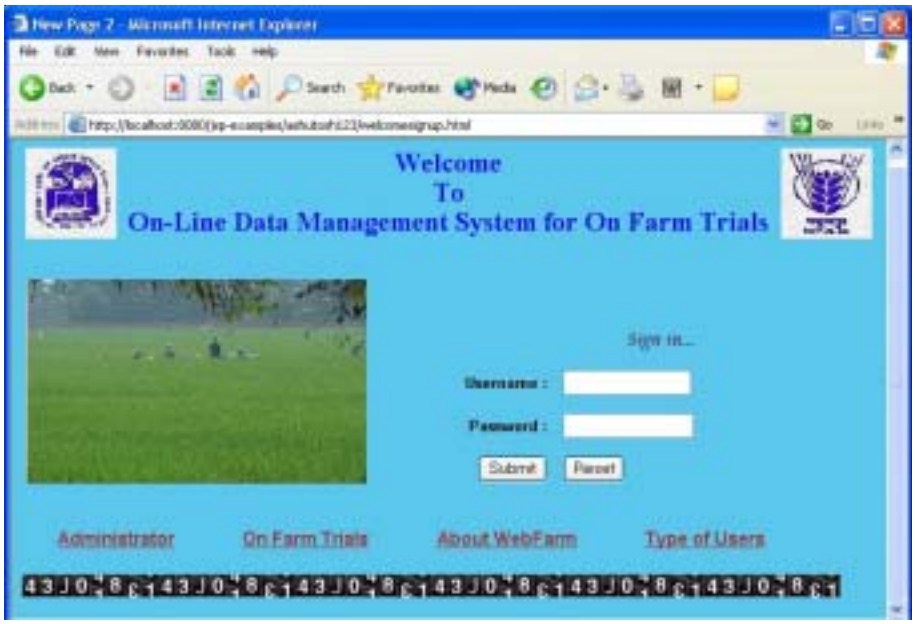
Source: http://www.echoupal.com/main.asp

as it means to get the inputs from the farmers. WebFarm thus also aims to create the database which will be helpful in solving the farmers' problems while ITC's e-choupal provides the information regarding the technological network with government agencies, suppliers, consultants etc.

4. WebFarm Model and Methods

The WebFarm (Figure 2) is developed as a web-based application, using Java technology. Therefore, it is an independent platform and can be accessed from any computer connected to the Internet. The user only has to confirm that the computer has a web browser. The most commonly used web browsers are Internet explorer 5.0 or above from Microsoft Corporation and Netscape communicator from Netscape Communications. WebFarm successfully runs on both the browsers. Any client on the network with above-mentioned browsers can have access to use this software.

Figure 2: Online Data Management Systems for On-farm Trials



Source: IASRI

5. Types of Users

There are three types of user in this system:

- End Users Administrator,
- End User, and
- Special user

5.1 End Users Administrator

The Administrator is in charge of the WebFarm and possesses all rights needed for WebFarm administration. He can insert information about a new cultivator, add

new users, delete any existing information and exercise full rights to search and update any existing information. To log on WebFarm as administrator one must type in correct administrator username, authenticated password after having selected the option A*dministrator*. When the administrator successfully logs on to WebFarm, the *toggle* frame of the home page contains additional links through which he can perform various administrative tasks.

5.2 End User

End users are the NARP zone research workers. They have the authority to insert and navigate information regarding NARP zones. These users have no access to the user information. These users are the actual workers who will enter the information. If an end user wants to modify the information in the database then he can do that. To log on WebFarm as an end user one must type correct end username and authenticated password.

5.3 Special User

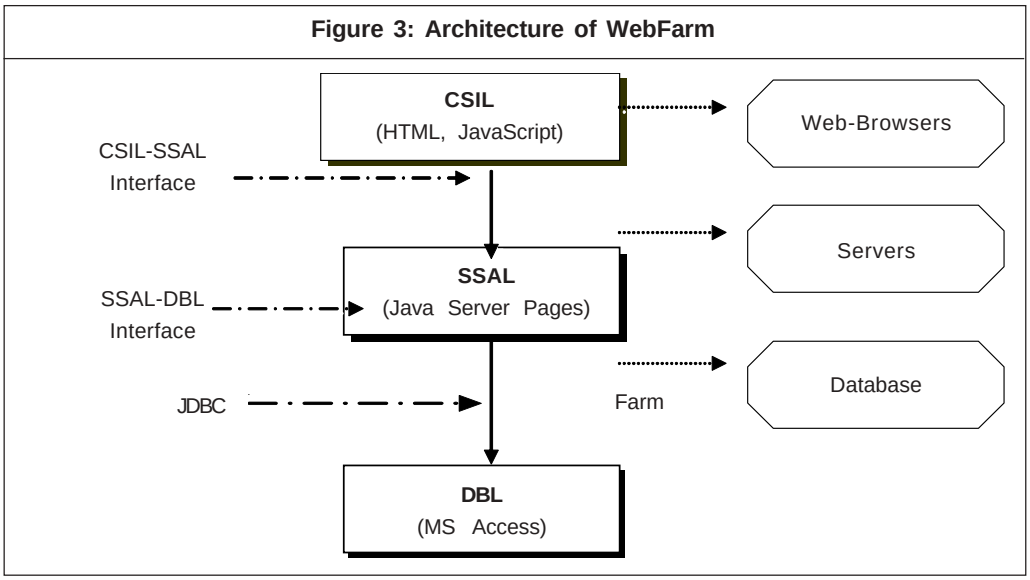
These users can navigate the WebFarm by entering correct username and password assigned to them by the administrator. If the special user is having problem in navigating or installing the software or working with the software, he can view the help page and get the information by clicking on the relevant links. If the end user wants more information regarding the software he can do so by sending an e-mail to contact people i.e., he should click Contact Us option.

6. Architecture of WebFarm

WebFarm is composed of the following three layers (Figure 3):

- Client Side Interface Layer (CSIL)
- Server Side Application Layer (SSAL)
- Database Layer (DBL)

Figure 3: Architecture of WebFarm



6.1 Client Side Interface Layer (CSIL)

The Client Side Interface Layer is developed using HTML on JavaScript and contain reports and forms required for presenting the data to the user and accepting information and other required functionality. WebFarm runs at any node of the network through the browser. To run the WebFarm with full functionality, one must have Internet Explorer 5.0 or Netscape Navigator pre-installed.

JavaScript

JavaScript is an easy-to-use object scripting language designed for creating live online applications that link together objects and resources on both clients and servers [Shiran *et al.,* (1998)]. While Java is used by programmers to create new objects and applets, JavaScript is designed for use by HTML page authors and enterprise application developers to dynamically script the behavior of objects running on either the client or the server. JavaScript's design and concepts represent the next generation of software for the Internet and is designed for creating network-centric applications having open- and cross-platform which is complementary to and integrated with Java and HTML.

6.2 Server Side Application Layer (SSAL)

Server Side Application Layer is implemented using Java Server Pages. These Java Server Pages generate HTML pages according to the user's action and requests.

Java Server Pages (JSP)

The Java Server Pages 1.1 specification provides web developers with a framework to create dynamic content on the server using HTML templates, and Java code, which is secure, fast and independent of server platform. [Avedal *et al.,* (2000)].

Java Server Pages (JSPs) are, on the whole, text files that combine standard HTML and new scripting tags. JSPs look like HTML, but they get compiled into Java servlets, the first time when they are invoked. The resulting servlet is the combination of the HTML from the JSP file and embedded dynamic content specified by the new tags.

Everything in a JSP page can be categorized firstly as Elements that are processed on the server and secondly, Template data, i.e., data other than elements.

A JSP page is executed by a JSP engine or container, which is installed on a web server, or on an application server. When the client asks for the JSP resource the engine wraps up that request and delivers it to the JSP along with a response object. The JSP processes the request and modifies the response object to incorporate the communication with the client. The container then wraps up the responses from the JSP page and delivers it to the client.

SSAL-DBL Interface

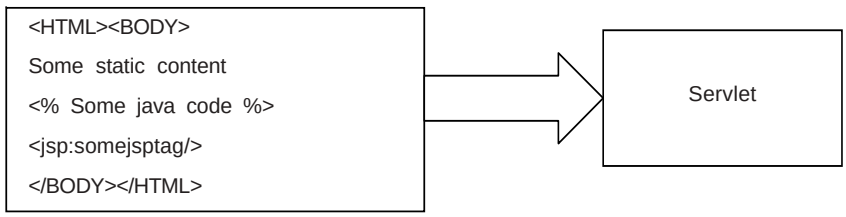
The SSAL-DBL interface (Figure 4) is implemented using the JDBC API (Java Database Connectivity). As its name implies, the JDBC API is a set of specifications that defines how a program written in Java can communicate and interact with a database. It defines how the communication is to be carried out and how the application and database interact with each other. More specifically, the JDBC API

defines how an application opens a connection, communicates with a database, executes SQL statements, and retrieves query results [Siple (1998), White *et al.,* (2000)]. JDBC provides a vehicle for the exchange of SQL between Java application and databases. Basic JDBC interaction, in its simplest form, can be broken down into following four steps (Figure 4):

1. Open a connection to the database.
2. Execute a SQL statement.
3. Process the results and
4. Close the connection to the database.

The first time the engine intercepts a request for a JSP, it compiles this translation unit (the JSP page and other dependent files) into a class file that implements the servlet protocol. If the dependent files are other JSPs they are compiled into their own classes.

Figure 4: SSAL-DBL Interface



Tomcat-5.0

The Tomcat-5.0 is the reference implementation for JSP. The Tomcat contains a simple JSP engine for developing and testing Java Server Pages. The Tomcat-5.0 also contains a simple HTTP web server and a JSP-enabled engine [http://java.sun.com].

The Tomcat-5.0 can be implemented on Windows NT 4.0 Service Pack 4, Windows 98 and Windows XP platforms with the pre-requirement of JDK version 1.2 and later.

6.3 Database Layer (DBL)

Database Layer is implemented using Microsoft Access 2000 (Jet 3.5 engine). It is used for designing tables, relationships, referential Integrity Rules, and Queries. The relational approach is used to design the database. The fundamentals of Normalization Theory are used to normalize the different tables of the database [Date (1975), Desai (1999)]. All tables have proper interaction among themselves via primary key—foreign key relationship wherever needed.

7. Limitations of WebFarm

Every system has its own limitation and WebFarm is not an exception, especially in Indian scenario where most of the farmers are illiterate and not computer savvy.

Thus, feeding the reliable online data will be questionable as data can be manipulated even at the preliminary stage. Hence adaptability of WebFarm technology is necessary for the farmers. Even the cost factor in accessing the computer is questionable. It also depends on IASRI on how efficiently it manages all these online data to provide timely and needful information. Therefore, IASRI has to be geared up for the same.

8. Conclusion

It is difficult to make an instant solution for every situation otherwise every commercial software package would not have various successive improved versions after the first release. At present we see the following enhancement in the WebFarm.

- WebFarm has been developed for 'On-farm Trials' experiments. The present database has been implemented using MS Access. Better support at the back end in terms of security, concurrent usage etc., can be provided if database is supported on MS SQL server, Oracle etc. There might be a day when WebFarm will be enriched with all sorts of information regarding on-farm experiments.
- Development of module for statistical analysis of data stored by this software.
- Automatic delivery of the report of statistical analysis to the NARP Zone Researchers.
- More and more expert groups from different fields can be brought for common discussion.

Glossary

- WebFarm — On-Line data management system for on-farm trials.
- IASRI — Indian Agricultural Statistics Research Institute.
- HTML — Hyper Text Mark-up Language.
- CIS — Computer-Based Information Systems.
- NARS — National Agricultural Research System.
- AICRP — All India Coordinated Research Project.
- PDCSR — Project Director for Cropping Systems Research.
- CSIL — Client Side Interface Layer.
- SSAL — Server Side Application Layer.
- JSPs — Java Server Pages.
- JDBC — Java Database Connectivity. ✠

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