RESEARCH INVENTY: International Journal of Engineering and Science
ISSN: 2278-4721, Vol. 1, Issue 6 (October 2012), PP 50-55
www.researchinventy.com

A Theoretical Framework for Development of Decision Support System for Agriculture

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Abstract: Agriculture is very complicated system interconnected with wide range of factor that are affecting in the development of right kind of decision. Major premise of making right decisions is the ability to accurately assess crop growth and food supply, and an scientific decision- making process to provide appropriate strategies based on fact. The social-economical factor of problem is also a very vital role playing factor in the decision maker. The shift towards participatory research and development approaches recognizes the benefits of fostering collaborative and mutually beneficial relationships between scientists and stakeholder. It helps in developing decision support system to make agriculture science more accessible for farmers and extension officers. This can be accomplished partly by using the decision support system (DSS) that provide accurate and detailed information about agriculture. In this paper, decision support system for agriculture frame was studied and developed to meet the increasing demands. This paper focused on the factor that involves in designing the decision support system for agriculture.

Index Terms—Agriculture, ICT, Database, GIS, DSS for agriculture.

1. Introduction

EVER since they were created in the 70s, Decision Support Systems (DSS) have been a great source of help with different management problems such as the optimization of travel times in airlines or train companies, medical diagnosis, business management, natural resource management, agriculture and forestry. The application of DSSs to farm management involves a range of opportunities and challenges. The latest years has seen mankind confronted with the problem of food security worldwide. Issues such as declining profitability of agriculture, climate variability and increasing concerns over the environmental impacts of farming pose complex challenges for farm management. DSS is based on the search for technology that can make agricultural systems science more accessible and useful for guiding management of production [i.e. farming] systems [1]. Agriculture farmers and scientist faces a great challenge in effectively manage information in order to improve the economic and operational efficiency of operations, reduce environmental impact and comply with various documentation requirements. Interactive computer pro- grams that utilize analytic methods for developing models to help decision makers formulate alternatives, analyze their impacts, and interpret and select appropriate options for implementation[2]. Participatory DSS development involves local actors and researchers cooperating as active co-experimenters engaged in joint learning [3]. Participatory DSS development integrates researchers, developers and users perspectives to clarify objectives and foster co-learning [4]. In order to meet this challenge, the flow of information between decision processes must be analyzed and modeled as a output and outcome.

2. Application of ICT In Agriculture

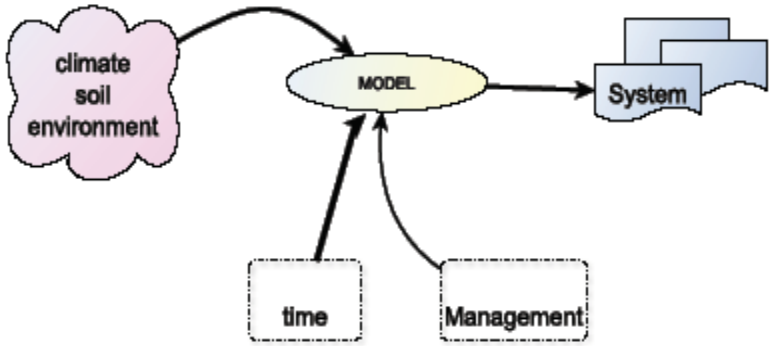
In the 60s and 70s we had a focus on the role of the mass media. Television was thought to play a decisive role in bringing about social change in rural and remote areas. In India, the Satellite Instructional Television Experiment (SITE) project, which started in 1975, aimed to reach 2,400 villages in 20 districts with satellite television broadcasts [5]. Indian agriculture is faced with multiple challenges. It has to ensure sustained food security to ever growing population at one hand and also to enable our farmers and the agro industries to become strong enough for facing the global competition. The technological gaps between research and Farmers are very wide. Woman, the half of agricultural work force is still unawares of the technological skills. The barriers of customs, veil, religion and social bondages could be overcome by educating them through TV, cassettes, e-mails or other modern communication appliances. The international computer networking and communication systems alone could help in decision making for appropriate and economic viable agricultural

productive[6]. Information and Communication Technology (ICT) is also playing a role in production planning, delivery scheduling, quality control, packaging, ranking, climatic data awareness, marketing and labour needs and costs, all need information accurate information and data analysis for decision making [7]. Using information and communication networking systems, South African made its fresh fruit export more competitively [8].

3. Overview of DSS

A. Meaning and Concept of DSS

Decision Support System (DSS) is an interactive, flexible, and adaptable computer based information system that utilizes decision rules, models, and model base coupled with a comprehensive database and the decision makers own insights, leading to specific, implementable decisions in solving problems that would not be amenable to management science models. Thus, a DSS supports complex decision making and increases its effectiveness [9].



-The Skeleton of Information System Building

An interactive computer programs that utilize analytical methods, such as decision analysis, optimization algorithms, program scheduling routines, and so on, for developing models to help decision makers formulate alternatives, analyze their impacts, and interpret and select appropriate options for implementation[2].

B. Approach to development of DSS

There is no universally accepted taxonomy of DSS either. Different authors propose different classifications. Using the relationship with the user as the criterion, Haettenschwiler [10]. differentiates passive, active, and cooperative DSS.

- **A passive DSS:-**
  A passive DSS is a system that aids the process of decision making, but that cannot bring out explicit decision suggestions or solutions.
- **A active DSS:-**
  An active DSS can bring out such decision suggestions or solutions.
- **A cooperative DSS:-**
  A cooperative DSS allows the decision maker (or its advisor) to modify, complete, or refine the decision suggestions provided by the system, before sending them back to the system for validation.The system again improves, completes, and refines the suggestions of the decision maker and sends them back to her for validation. The whole process then starts again, until a consolidated solution is generated.

C. Type of DSS

The important types of decision support systems are listed as follows

- **A model-driven DSS:**

A model-driven DSS emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data intensive. Dicodess is an example of an open source model-driven DSS generator [12]

- **A communication-driven DSS:**

A communication-driven DSS supports more than one person working on a shared task; examples include integrated tools like Microsoft's NetMeeting or Groove [13].

- **A data-driven DSS:**

A data-driven DSS or data-oriented DSS empha- sizes access to and manipulation of a time series of internal company data and, sometimes, external data.

- **A document-driven DSS:**

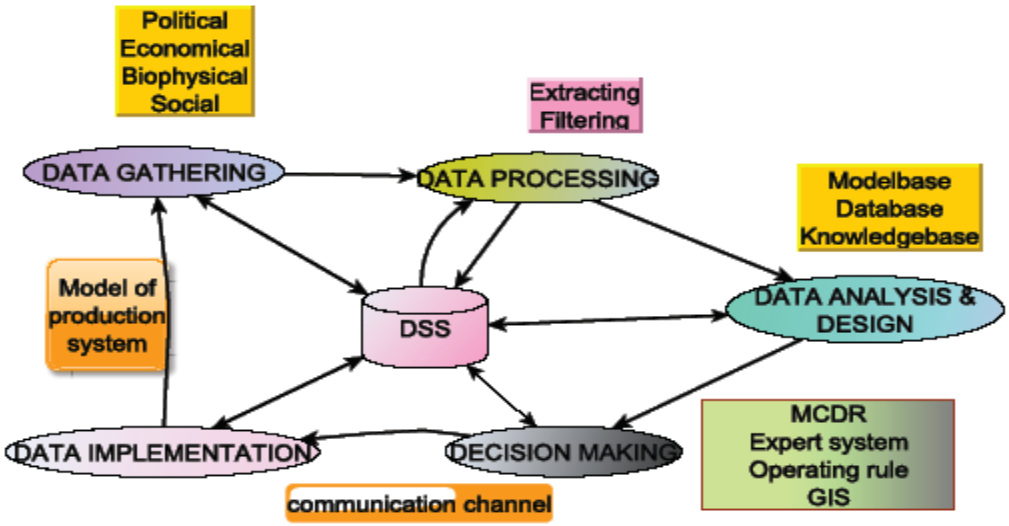
A document-driven DSS manages, retrieves and manipulates unstructured information in a variety of electronic formats.

- **A knowledge-driven DSS:**

A knowledge-driven DSS provides specialized problem solving expertise stored as facts, rules, procedures, or in similar structures. [11]. Our aim is to develop a data-driven DSS for agriculture. In this paper we studies the factor that are taking a part to develop the DSS.

4. FRAMEWORK OF DSS

It has been suggested that one of the main contributions to the poor uptake of previous agricultural DSS has been the failure of many developers to pay attention to users, their needs and requirements, and to the environment in which they operate [14].The proposed framework divided into five main subsection. These sub-systems are in cycle form. The system can be more improved in the process of decision making if the system is validated by requirement analysis and specification .if it is not then it should be reconstructed until the appropriate model is generated.



-The Proposed Framework Of DSS Building

A. Data Gathering

Many of Agriculture DSS failed due unproven and unstructured knowledge and information about the agriculture. It has been found that one of the main contributions to the poor uptake of previous agricultural DSS has been the failure of many developers to pay attention to users, their needs and requirements, and to the environment in which they operate [14].Many system development methods use the notion of task to describe the users interaction with the system. Tasks and their components are identified as part of the requirements analysis process and the system's ability to support the users tasks, physical or mental are a measure of a systems success. This environment is characterized by low and variable funding, poor communication between end user and developer, and variable levels of product development skill [14].Many researcher found different kind of tools to find out the concerning information gathering. Mainly three types of tools were found as it described below.

1) Participatory Action Research:

PAR involves: forms of inquiry where researchers and the researched population form collaborative relations in order to identify and address mutually conceived issues or problems through cycles of action and research[15].PAR can be de- fine by collaborative or collegiate relationships between researchers and stakeholders[16].FARMSCAPE project, which used PAR to investigate whether farmers could value simulation as a decision support tool for managing their farming system[17].

2) Question oriented Approach: The models these systems contained were capable of producing information that the user required but the way the system had been designed prevented the user from accessing that information. Its suitability for use in the agricultural context was further demonstrated when the method was applied to the user requirements for the DESSAC project [18].

3) Workshop: Norton and Mumford describe work- shops for idea generation a useful way of tapping the imagination and intuition of crop protection specialists when trying to come up with new options for pest management. They also suggest that their system and decision analysis techniques are best employed in the context of interdisciplinary workshops [19].

B. Data Processing

The agriculture have been surround by many factor which involves technical(GIS, communication, computer) and non-technical fact(climate, soil, weather). The agricultural knowledge base in particular is growing rapidly, as science improves its understanding of biological and chemical processes, and the quantity of data can be overwhelming. Filtering and assimilating this mass of information is a formidable task particularly given the limitations of human processing. Unlike a computer, we cannot manipulate many things in our heads at one time and we are known to make errors in logical thinking[1]. To store the data related to the processes of interest in the agriculture Decision support system, both spatial and feature related as well as time series data. This section of proposed model involves the registration of measurement into database and their sub-sequent processing, retrieval and storage. The economical, biophysical (soil, water, forecasting) are kept in the form of information and this information will keep in the form of database after filtering. The information must be according to the boundary of problem and information gathering.

C. Analysis and Design

In the analysis process each function should be analyzed separately. There are certain analytical items related relative model will be designed for each analytical item. The design of the model is the key of the whole system.For decision support, relative professional knowledge will also be attached with the models. The models used to infer the state of the system so that reasonable decision alternatives can be formulated. Analysis models and tools should be designed to predict response and provide forecasts. Using data from the Data Collection System, and historical and GIS data needed to calibrate GIS models for the better response of result.The input to this stage is a set of sub-tasks, ranked questions and information sources. The task now is to translate these into a system specification. A system specification is defined as a document that clarifies a clients requirements in an unambiguous form by re-specifying the requirements and distinguishing between system functions and the constraints the system developer has to work under [20].

D. Decision Making Process

Making the decision could be defined as integration of result produced at stages of process with computer, human logic and integration of previous developed model. ” Gathered and merges the conclusions from knowledge-based and numerical techniques and the interaction of users with the computer system through an interactive and graphical user interface”. An expert system is defined as a computer program designed to model the problem solving ability of a human expert [21]. Now a day many researcher shift their intention to develop the expert system based ADSS. It is also defined as a system that uses human knowledge captured in a computer to solve problems that ordinarily require human expertise. Consisting of a set of rules and user-supplied data which interact through an inference engine, an expert or knowledge-based system is able to derive or deduce new facts or data from existing facts and conditions. Expert-system shells and programming languages have become widely available allowing users to define databases and rule sets. Prasad et al. formulated an expert system in Indian fruit culture and described development of a rule-based expert system, using expert system Shell for Text Animation (ESTA), for the diagnosis of the most common diseases and insects occurring in Indian mango [22].Most of the agricultural data have geographic attributes, GIS is an important tool for agricultural analysis. It is very important to include GIS into the DSS for regional agricultural management; however, it does not mean that the system should be developed on professional GIS, Multi-objective modeling methods have been used for several decades to determine the trade- offs between various objectives in these problems. Due to the conceptual difficulties involved in using multi objective models (i.e., selecting criteria, specifying satisfying values, and evaluating trade-offs), several researchers have developed multi objective decision support tools which meet two of the three requirements of a DSS. The methods differ in the type of information they request, the methodology used, the sensitivity tools they offer, and the mathematical properties they verify. Indeed, practical applications of the multi criteria approach are hindered by the ambiguity of choosing one particular method among all those available. Each method may potentially lead to different rankings, and the choice of a methodology is subjective and dependent on the decision makers pre-disposition [23]. The operating rule can be defined as outline and rule of DSS in which the system will have to operate.

The communication channel is defined as the medium of massage and technology passing between the scientist and stakeholder (former) to educate them about the system operation and operating rules. ICT, e-mail, mobile device, EDI and many other medium can be used to massage passing. Training of Stakeholder mainly end user could lead to better performance of DSS System.

E. Decision Implementation

Decision implementation System have made for disseminating decisions regarding agriculture under normal conditions, and flood warnings, weather forecasts, and disaster response in affected and specified areas. This block represents the actual decision made by the decision maker (single or group) based on the results of the multi criteria analysis, Expert system and GIS. Some basic data as field location, field soil type or some constant data can directly retrieved from the system database while others that are more transient such as soil, water content, biophysical content have to be input by user. The system then will use those data, supported by analysis models and domain knowledge, to give an understandable decision result. In simple words, it can be defined as formulation of actions to be implemented in solving a specific problem".

The above development begins with the collection and processing of data, followed by analysis of various agriculture problem domains and then analysis with Expert and interpretation along with decision maker. The outcome model of decision maker will lead to formulation of plan. In practice, the above stated system development process is not in the step-by-step process but in cyclical process which involve all the sub-part of system. All the sub-part process i.e., entering data in process (information gathering), analysis being performed, and decision being taken in almost in the continuous fashion.

5. Conclusion

With the increasing of population throughout the world the need for increased the agriculture production, there is a definite need for improvement of management of world agriculture resource. This could be solved by more and more application of ICT and their involvement in every stage of production from soil identification to till production. In present scenario, every part of the world is conducting the survey to gather empirical information on crop, livestock and other agriculture resource. Good decision making is always a critical. Good planning always lead to good decision making. Planning and development process of agriculture DSS constitute a multi-complex problem which is very difficult to be solved, if it is not faced thoroughly. The interdependence between various activities on one hand and other hand service are making the planning very difficult. The decision making processes demand from producer (information)/ decision maker a qualitative evaluation and other problem that they are facing. Our proposed model involves social-economical, GIS, MCDR, Expert system help to decision maker to develop. Our process model could lead to make agriculture DSS more appropriate and lead to expected agriculture solution model.

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