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DECISION SUPPORT SYSTEMS IN AGRICULTURE

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ABSTRACT

India is an agricultural Country and 56.6% of its population depends on agriculture. Designing a Decision Support System (DSS) for crop cultivation enables the farmers to make effective decision for higher yield. The parameters that are considered for the enhancement of a seasonal crop growth are type of soil and season, Insects-Pests management, irrigation methodologies. DSS is interactive computer-based system that help decision makers solve unstructured problems under complex and uncertain conditions by providing access to data through procedures and analytical reasoning. These systems have been designed to address complex tasks involving multiple disciplines of agriculture, enabling us to mimic the necessary requirements of crop with respect to the land characteristics so that the optimum objectives specified by the user is obtained. Geographical Information System (GIS) and Remote Sensing (RS); DSS are being extensively used world-wide using state of art technologies, integrating multiple models for sustainable agriculture development from farm to fork, despite "Problem of Implementation". Once the barrier is crossed, it will give a leading role to DSS in global sustainable agriculture.

Keywords: Decision Support System, Agriculture, decision making and ICTs

INTRODUCTION

Agriculture is the backbone of Indian Economy. By agricultural development through productivity growth rural income can be raised and rural poverty is alleviated. The concept of productivity growth gained importance for sustaining the output growth over the long run as input growth is insufficient to generate output growth because of diminishing returns to input use (Tyagi, Vandana, 2012). Agriculture is considered as a complex process of air, water, weather, soil, plant, animal, micro-organism, which are again unreliable and uneven in distribution, covering many disciplines and interacting at various scales (Bennet & Bennet, 2008 and Shim, Warkentin, Courtney, Power, Sharda & Carlsson, 2002) . In order to manage different crops one has to generate alternatives to make choice, supported by estimation, evaluation and/or comparison. There is a substantial amount of empirical evidence that human initiative judgment and decision making can be far from optimal and it deteriorates further with add-ed complexity and stress (Adams, Cook & Corner, 2000) . Also decisions made by the farm man-agers are irreversible and have far-reaching consequences for the crop being managed (Moore & Chang, 1980). Therefore, aiding the deficiencies of human judgement and quality decision making has been a major focus of research to develop less intensive and integrated farming systems with lower inputs of fertilizers and pesticides and with re-stricted use of the natural resources (water, soil, energy, etc.) with the broader objective to maintain crop production in both quantitative and qualitative terms, maintain or preferably improve farm income, and at the same time reduce negative environmental impacts as much as possible.

For making rational decisions, disciplines such as statistics, economics and operational research have developed various methods, which have recently been enhanced by various techniques originat-ing from Information Science, Cognitive Science, Artificial Intelligence and Pattern recognition. These methods have been implemented in the form of computer programs either as stand-alone system or complex computing environments for complex decision making using common name of decision support systems (DSSs). Regarded as response to complexity, Decision Support System (DSS) is an interactive computer-based system or subsystem in-tended to help decision makers to use information and communication technologies, data, knowledge and/or models to facilitate formal and informal communication, mining knowledge, and building knowledge repositories (Courtney, 2001). DSS improves personal efficiency; speed up the process of decision making; increases organizational setup and control; encourages exploration and discovery of unknown data; speeds up problem solving capabilities; facilitates interpersonal communication; promotes learning and training abilities, provides new evidences in support of a decision and reveals new approaches to think about the problem more specifically through automation of managerial process.

WHAT ARE DECISION SUPPORT SYSTEMS?

It as "useful and inclusive term for many types of information systems that support decision making". According to Finlay P.N. (1994), it is "a computer-based system that aids the decision making process". Turban E. (1995) has defined it specifically as "an interactive, flexible, and adaptable computer based information system, especially developed for sup-porting the solution of a non-structured management problem for improved decision making". In order to avoid exclusion of any of the existing types of DSSs, we define them roughly as inter-active computer based systems that aid in making a quality decision.

CHARACTERISTICS AND CAPABILITIES

Decision Support System comprises of vast set of character-istics and capabilities of DSS. The key characteristics and capabilities of DSS as follows:

- Ability to support in semi-structured and unstructured problems, including human judgment and computerized information.
- Ability to support managers at all levels.
- Ability to support individuals and groups.
- Ability to present knowledge on ad hoc basic in customized way.
- Ability to select any desired subset of stored knowledge for presentation or derivation during problem solving.
- Ability to support for interdependent or sequential decisions.
- Ability to support intelligence, design, choice and implementation. viii. Ability to support variety of decision processes and styles.
- Ability to support modelling and analysis.
- Ability to support data access.
- Benefits must exceed cost.

- Allow modification to suit needs of user & changing environment.
- Support quick decision-making using standalone, integration or web-based fashion DSSs having maximum number of these key characteristics and capabilities can be more useful and adoptable.

MAJOR FIELDS OF DSS

Personal Decision Support Systems (PDSS): Usually small-scale systems that are developed for specified managers.

Group Support Systems (GSS): they use combination of DSS technologies to facilitate the effective decision process.

Negotiation Support Systems (NSS): Here primary focus remains on negotiation between opposite perceptions.

Intelligent Decision Support Systems (IDSS): It uses artifi-cial intelligence techniques to facilitate decision.

Knowledge Management-Based DSS (KMDSS): They pro-vide knowledge storage, retrieval, transfer using organi-zational memory and inter-group knowledge access.

Data Warehousing (DW): systems that provides the large-scale data infrastructure in multiple formats for decision support.

Enterprise Reporting and Analysis Systems: enterprise focused DSS including executive information systems (EIS), business intelligence (BI), and corporate performance manage-ment systems (CPM). BI tools access and analyze data ware-house information using business intelligence software, query and analysis tools (Nelson R.R., Todd P.A. & Wixom B.H. 2005).

CLASSIFICATION OF DECISION SUPPORT SYSTEMS

There is no niversally accepted taxonomy of DSSs, as difer-ent authors propose different classifications. However, important types of Decision Support Systems are:

A Model-driven DSS: Model-driven DSS provides access to and manipulation of various underlying models by using data and parameters provided by users to assist decision making process. Gachet A. (2004) is an example of an open source model-driven DSS generator.

A Communication-driven DSS allows more than one per-son to work on a one task. Microsoft's NetMeeting or Groove is an example of communication driven DSS.

A Data-driven DSS or data-oriented DSS emphasizes access to and manipulation of internal or external data. Example of such DSS is OLAP.

A Document-driven DSS utilizes unstructured information in a variety of electronic formats for manipulation, retrieval and man-agement ; example includes Google Search Engine.

A Knowledge-driven DSS stores facts, rules, procedures and structures for expertise problem solving purposes. Mycin is an example of knowledge driven DSS.
Area Specific DSS

NUTRIENT MANAGEMENT

Fertilizers and lime are increasingly expensive but are commonly needed to grow high-yielding and good-quality crops. However, unnecessary use is wasteful, reduces farm profits and increases the risk of diffuse nutrient pollution. To maximize profits and avoid waste, farmers need to plan their use of nutrients for each field crop in each year. Organic manures (farmyard manure, sewage sludge, slurries, etc.) contain large quantities of nutrients which can often mean that large reductions are possible in the need for inorganic fertilizers. Nutrient management can play an important role in many of the regulatory and non-regulatory duties of farm-related management, and can protect, restore and enhance the status and diversity of all surface water ecosystems and ensure the progressive reduction of groundwater pollution.

INSECT AND PEST MANAGEMENT

Plant protection is definable as the reasoned application of differ-ent methods, products as well as chemicals to allow optimal pro-ductive factors, with the objective to satisfy farm worker, consumer and safeguard environment. The concept of computerized DSSs for pest management is not new. DSS models have been developed for diseases that could expand very rapidly or those that should be controlled regularly. Development of weather-related DSS dur-ing 1990s resulted in a lower risk of crop damage by diseases and pests and minimal use of other input dosage.

AGRICULTURAL LAND USE AND PLANNING

With the rise in human population and their aspirations, land becomes an increasingly scarce resource – a scenario calling for land use plan-ning. Land use planning is defined as a systematic assessment of land and water potential, alternative land use choices for better eco-nomic and social conditions. It has become essential to mitigate the negative effects of land use and to enhance the efficient use of resource with minimal impact on future generations. Land use plan-ning is becoming complex and multidisciplinary as planners face multiple problems that need to be addressed within a single planning framework. These includes non-point-source deforesta-tion, urbanization, pollution, ecosystem deterioration, water alloca-tion, global warming, poverty and employment, deterioration of farm-land and low economic growth.

GLOBAL ENVIRONMENT CHANGE AND FORECASTING

Now-a-days global environment change is happening. Human activ-ities related to the production, supply and consumption of food are responsible for changing global climate and giving rise to other globally and locally environment changes (GECAFS, 2005).

WATER AND DROUGHT MANAGEMENT

Nearly one billion people worldwide are malnourished. The majori-ty of these people live in developing countries, where increasing water scarcity complicates efforts towards food self-sufficiency. Huge amounts of water are needed to produce more food and eradicate hunger among increasing populations.

FUTURE TRENDS

Researchers are optimistic about the future of DSS. This optimism continues to produce products and contributions to literature. A host of new tools and technologies are adding new capabilities to DSS. They include hardware and mathematical software development, artificial intelligence techniques, data warehousing and mining, OLAP enterprise resource planning, ERP, intelligent agents and World Wide Web (WWW). Separated from operational data-bases and optimized for decision support, data warehousing is an integrated, time-variant and non-volatile collection of a relational or multidimensional database (MDDB). It organizes data as an n-dimensional cube so that users deal with multidimensional data views such as crop, region, yield and area, with speedy query response time. Also known as knowledge Data Discovery, Da-ta Mining refers to discovering hidden pattern from data, not known before. It attempts automatic extraction of knowledge from the large databases like data warehouse, spreadsheets, weather observatories, text documents etc. DSS as a solution to optimize irrigation and better water management.

Facing obstacles such as limitation on volumes of water withdrawal or volatile agricultural prices, farmers must adapt by changing their practices. Thanks to more accurate irrigation technologies it is possible to reduce water use in agriculture, improve productivity, and ultimately produce as much or even more with less water.

FUTURE OF DSS

Being a key part of sustainable agriculture, DSS will become more and more robust. The increased connectivity of technologies and the multiplication of smart devices on the field stimulates the accumulation and storage of data. By integrating and analysing the captured data, DSS are meant to become more accurate as well as reliable. Last but not least, actors from the sector have the ambition to make DSS more ergonomic and user-friendly. Companies already offer mobile interfaces on smartphones and tablets, that are easy to handle and can be used in real time, directly on the field. Such developments allow more farmers to use DSS, since, at the end of the day, they are the final recipients and users of new technologies which will revolutionize agriculture.

CONCLUSION

DSS practice, research and technology continues to evolve though its history covers only a relatively brief span of years. There is no general account of classification and architecture of DSS. But it is possible to reconstruct the history from retrospective accounts considering published and unpublished material and redefine classifi-cation and architecture of DSS through in-depth research and literature contribution. Agriculture is in the midst of powerful changes influenced by industrialization and modernization, farm consolidations, environmental limitations, land use conflicts and overall in-creased risk; the availability, accessibility and application of contemporary expert agricultural information in the form of portable DSS is of high priority for farmers, technicians and researchers. With these changes and demands, different useful, scientifically valid and user-specific models have been implemented successfully. Many scientific and academic institutions have turned to computerized DSSs as a means of packaging biological and technical information to make the information more easily accessible and useful for various intending users in a short span of time.

In the last one decade researchers have reviewed the use of computer models in land use planning, forecasting, agronomical practices, water resources and emphasized the need for DSSs to make these models more useful. Incorporation of simulation and optimization models with interactive graphical capabilities is encouraging the acceptance of techniques related to literature de-velopment in practice.

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