

Literature Review on Decision Support Systems in Agriculture

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Abstract— India is land of farmers. Agriculture is primary sector of Indian economy. Farmers need latest knowledge to take strategic, tactic and operational decisions. Traditionally decisions of Indian farmers are based on their own experience and expert judgment. Few advanced farmers approaches agriculture scientists and experts in order to get latest information of fertiliser management, pesticide, soil preparation, seed selection and weed management. Most of the farmers are isolated with this expert's and scientist's knowledge due to lack their easy availability. Android app, web and SMS based DSS will make easy availability of agricultural knowledge. After considering success of DSS in various sectors numerous DSS were developed in agriculture. Agricultural DSS are helps farmers to take right decision at right time to get high yield and economically reasonable price to their crop. This paper present need and reviews of various DSS in agriculture. Finally paper concluded with a necessity of a DSS to provide up-to-date information of present demand and potential supply of agricultural products in order to choose the appropriate crop to be grown and its planning.

Keywords— DSS, Agriculture, Demand, Supply

INTRODUCTION

Decision Support System is computerized system, which includes models and databases used in decision making. They are tools that help everyone who makes decision and choosing the best alternative solution that is economic, social or environmental point of view [1].

Economically reasonable price for the crop and higher crop yield is the aim of farmers. To achieve this aim, up-to-date information of present demand and potential supply of agricultural products is essential. Based on present state of agricultural products demand and supply information farmers can choose the appropriate crop to be grown. This leads to better price for their crop. Similarly farming based on expert's knowledge and latest research leads to higher drop yield.

Every year different government departments are assigned the work to monitor dynamic agricultural situations in all around the country. This leads, thousands of digital and non digital data files are generated. These records include hundreds of pest-scouting, yield surveys, and other such activities. The data collected, is not organized, it is difficult to integrate and does not provide a complete picture. Thus the lack of data integration and organization leads to an under-utilization of precious and expensive historical data, and inevitably results in a limited ability to provide decision support.

I. NEED OF DECISION SUPPORT SYSTEM IN AGRICULTURE:

A. NEED OF INFORMATION SUPPORT:

In spite of huge collection of information it is of useless until it reaches to its stakeholders. We can see that every year farmers are committing to suicide due to non repayment of loan. As per farmers report 2014 every year 10000 to 18000 farmers committed to suicide. There are number of reasons for the suicide but the major reason is due to getting substantially unfair price to their agriculture products. Agriculture product rates are purely depending on the demand and supply. There is imbalance of total requirement of products and its availability (demand and supply). It happens because the farmers are not getting the up-to-date information while selecting the crop such as:

1. Total requirement of the particular agricultural product
2. Total land required to fulfill the requirement,
3. Previous stock is available,
4. Total land already planted/sown for the respective crop,
5. Available scope for the particular crop.

If the selection of crop by the farmers is based on above information then probability of getting appropriate price for their crop will be high.

There are many parameters for the better yield of particular agricultural product, such as type of land, use of fertilizers', way of farming, rain fall, and whether condition etc. These parameters are uncontrollable. But decision of which crop can be grown is purely in the hands of farmer. This decision can be taken correctly if up-to-date information is available.

B. DSS FOR DECISION MAKING:

Traditionally, agriculture decision making in India is not data driven, but usually based on expert judgment. The data under consideration, such as production of each crop, requirement of particular crop in the market, price, and present stock recordings contains huge analytical potential in two major respects. Firstly, short term decision making and day to day tactical handling of issues related to pest management and secondly, long-term decision making, strategic planning like selecting the crop and policy making where one needs to observe the complete history of events, and related facts such present demand and potential supply of agricultural crop.

II. REVIEW OF DIFFERENT DECISION SUPPORT SYSTEMS IN AGRICULTURE SECTOR:

A Decision Support System can be build to provide up-to-date information through various electronic means such as websites, Android Apps, SMS etc.

B.Manos and others, (2004) [1]. Basic concepts, characteristics, structure of DSS, web based decision, process of decision making in agriculture sector, roll payed by DSS in decision making in agriculture has been described in the outset

of this paper. This paper analyse the contribution and application of DSS in agriculture and other fields, mainly in the field of Planning and management of farms. Authors have made a taxonomy survey based on the analysis of all the published applications during 1987 to 2001. The relevant classification of DSS, the types of DSS, operation model of research applied in DSS, category of decisions in the field, and year of their applications. In the conclusion of this survey authors decisions in agriculture are not based stable, simple and well-defined rules but on knowledge, information, experiences and skills of the producers. DSS have wide application in decision making concerning problems of the agricultural sector with not well structure and complexity.

Vidya Kumbhar, T.P.Singh (2013) [2]. At the outset paper cited the status of Indian agriculture with reference to area, production, irrigation has been projected. A justification is also given regarding how naturally Indian land is better compared the peer countries in the world. Authors of this paper highlighted the huge amounts of data of agriculture research and advancements in different areas have made available. The biggest challenge to extract knowledge from data it needs methods and techniques such as decision support system to bridge the knowledge gap. This paper reviews and summarizes the application decision support system, advisory decision support system in different agriculture practices in Indian context. The decision making can be made effective in agriculture domain by advanced information technology techniques and integrating information. Paper has given a conclusion that, in India, simulation based techniques are widely applied in different areas like increase crop water requirements, farm irrigation scheduling, crop yield, and to study the impact of climatic parameters. Advisory systems are also playing an important role in Indian scenario based on Information Communication Technology. In India majority of the rural population lives in rain-fed regions, therefore challenge before Indian agriculture is to transform rain-fed farming into more sustainable and productive systems to better support the population dependent on it. The soil nutrient parameters such as Nitrogen (N), Phosphorous(P) and Potassium (K), the other parameters such as soil water content, evaporation, soil water restoration index and soil minerals play important role in crop productivity. There is a need to develop a DSS for effective management and utilization of soil nutrients. The literature also shows that there is a need to develop a GIS based decision support systems in India. The expert systems based on spatial database on agriculture will improve the performance on agriculture management which in turn will be helpful for sustainable agriculture management in India.

Ganesan V. (2007) [3]. This paper focus on development of Expert System in the area of agriculture for Integrated Crop Management decision aids, encompass water management, fertilizer management, crop protection systems and identification of implements. In order to remain competitive, the modern farmer often relies on agricultural specialists and advisors to provide information for decision-making. An expert system normally composed of a knowledge base (information, heuristics, etc.), inference engine (analyzes knowledge base), and end user interface (accepting inputs, generating outputs). Software named 'CROP-9-DSS' incorporating all modern features like, graphics, photos, video

clippings etc. has been developed. This package will aid as a decision support system for identification of pest and diseases with control measures, fertilizer recommendation system, water management system and identification of farm implements for leading crops of Kerala (India) namely Coconut, Rice, Cashew, Pepper, Banana, four vegetables like Amaranthus, Bhindi, Brinjal and Cucurbits. 'CROP-9-DSS' will act as an expert system to agricultural officers, scientists in the field of agriculture and extension workers for decision-making and help them in suggesting suitable recommendations.

R.M. Sodtke [4], The author presents theory, methods and results of a knowledge-based decision support system for the agricultural practice and extension services. By the example of a multi-objective DSS supporting the selection and management of cover crop stands the methodical approach and results regarding DSS design, knowledge acquisition, knowledge representation, and DSS evaluation is presented. Thus, the paper especially focuses on the integration of expert knowledge and modeling uncertainties by fuzzy inference technologies. Discussing the validity and limits of the DSS as well as options for DSS application or integration into other models will round off the presentation.

The DSS supports selecting appropriate cropping strategies (decision variables like cover crop, cropping method, sowing date, etc.) which depend on multiple cropping objectives (e.g.: nitrogen conservation, soil protection against erosion) and non-(directly)-controllable state measures in the decision space (e.g.: cropping situation, site characteristics). This paper consider technical aspects, but current requirement of the crop and sowing data is not considered in the decision making.

Prof. Mrs. J.R.Prasad and other (2008) [5], This paper suggests development of a decision support system for agriculture based on the natural language processing. The agricultural sector which is core part of the Indian economy, represents 35% of The impact of climate change on agriculture is expected to impact on agricultural productivity and shifting crop patterns. The analytical data about the rainfall pattern, soil structure of the area will be maintained at back end, the system will retrieve the information based on the interaction with the user, which will be a farmer in this case. The authors aim to provide a user friendly decision support system. In addition to rain fall, soil structure farmers should be provide the current status of each crop sown so that they can find the appropriate crop that will give better returns

Wang Zhi-Qiang and other (2010) [6], in this paper, an agricultural spatial DSS (ADSS) frame was studied and developed to meet the increasing demands. A major premise of making right decisions is the ability to accurately assess crop growth and food supply, and a scientific decision-making process to provide appropriate strategies or countermeasures based on them. This can be accomplished partly by using the decision support system (DSS) that provide accurate and detailed information about crop growth and food supply. The system, based on the spatial information technologies and crop growth simulation methods, contains three parts: (1) a spatial agricultural resources data warehouse has been constructed; (2) a crops monitoring and simulation package was studied and developed; (3) a spatial decision support package for food-

supply security developed. The ADSS has been applied to the Northeast China and been proven to be a successful tool for crop growth monitoring and food security strategies. The ADSS was aimed at suggesting efficient strategies for problems in crop growth and food safety as well as providing timely and accurate information about crop growth and food supply.

Waghmode M. L, Dr. P.P. Jamsandekar (2014) [7], This paper explores applications of DSS in different sectors and its use. DSS are used in many fields like agriculture, medicine, business, education, railway etc. Following four DSS in field of agriculture has been reviewed

- A. DSS system named ADSS Agricultural Decision support system was designed to predict crop prediction, opportunity to forward plan in response to climate forecasts to influence productivity at field & regional scales.
- B. DSSAT4 package, developed that allow rapid assessment of several agricultural production systems around the world to facilitate decision-making at the farm and policy levels
- C. Nature Serve Vista is a powerful, flexible, and free decision-support system that helps farmers to integrate conservation with land use and resource planning of all types
- D. ProDEX is a software tool used in environmental protection, air and soil pollution control & has been developed by University of Ljubljana, Slovenia.

Ayubu J. Churi and others (2013) [8], This study aimed at investigative decision support systems for assisting smallholder farmers to reduce climate risks and increase crop productivity of semi-arid areas. Further, 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 designed using prototyping approach by allowing complete participation of end users. The DSS was implemented and assessed by farmers as a useful tool for accessing information and advisories in agricultural systems. The research is recommended to enable simple and affordable mobile phones be used by farmers to access wealth of agricultural knowledge and policies from research centres and government resources.

K.B. Matthews, M.G. Hutchins and G. Hill [9], this paper argues that while in the main DSS tools have failed to live up to expectations it may be that the expectations were unrealistic. The design-use gap of DSS for environmental management is partially the inevitable cycle of expectations experienced by any innovation. A number of techno-centric silver bullets to the design-use gap have been identified including GIS integration and the perennial user friendliness and transparency. More recently frameworks, standards and reusable components have been proposed. A growing body of evidence exists, however, that indicates the usefulness of tools depends much less on their technological or indeed scientific sophistication but on having a clear understanding of their role and how the researcher will interact with the stakeholders.

The paper proposes multi-perspective deliberation as an approach to bridging the design-use gap with the researchers acting as facilitators and the tools or their outputs acting as boundary objects through which issues can be explored.

S. J. Yelapure, Dr. R. V. Kulkarni, (2012) [10], this paper explains need of expert system in agriculture and review of various expert systems in agriculture. Author reviewed 10 various DSS and Expert systems viz. CALEX is user friendly computer program that simulates human problem solving behaviour, Malformation disease of Mango i.e. ESMMDM, proposed expert system FuzzyXPest, related to Rice crop, the development of an expert system for Oil-Palm disease control diagnosis(PEKA-SEWIT), POMEE is an expert system for apple orchid management, UNU-AES is an expert system in agri forestry management, CITEX an expert system is developed for Orange production, NAPER-WHEAT is another expert system developed for irrigated Wheat management, TOMATEX is a expert system developed for Tomato with two subsystem, MANAGE is expert system developed to diagnose pest and disease for rice crop. Paper concluded with a need to develop a system for soybean crop to guide to Growers to take decision into different aspects of crop management like soil preparation, seed selection, pest management, fertilizer management, weed control, irrigation management, nutrition management etc.

Rait Mitra Portal (2017) [11], The Department of Agriculture has been created mainly to provide Agricultural Extension services to farmers and to transfer the latest technical knowledge to the farming community, introduction of high yielding varieties, laying demonstrations, imparting training to farmers to improve skills & knowledge to boost up the agricultural Production and productivity.

The Department of Agriculture established “Raitha Samparka Kendras” at hobli(tahasil) level with the objective of providing updated crop production related knowhow, arrangement of critical agricultural inputs, primary soil and seed testing facilities and arranging interface with public and private sector technologies.

These Kendras are established with the objectives:

- To provide technical information on crop selection, crop production related know-how, market information etc., to farmers.

- To provide primary seed and soil testing facilities locally.

- To facilitate on site provision of critical inputs like seeds, bio-fertilizers and plant protection chemicals.

This portal provides technical information like seed, soil and fertilizers, there is scope for proving present state of crop in order to select the crop.

Farmers Web Portal (2017) [12], This web portal to make available relevant information and services to the farming community and private sector through the use of information and communication technologies, to supplement the existing delivery channels provided for by the department. Farmers’ Portal is an Endeavour in this direction to create one stop shop for meeting all informational needs relating to Agriculture, Animal Husbandry and Fisheries sectors production, sale/storage of an Indian farmer. Once in the Farmers’ Portal, a farmer will be able to get all relevant information on specific subjects around his village/block /district or state. This information will be delivered in the form of text, SMS, email

and audio/video in the language he or she understands. These levels can be easily reached through the Map of India placed on the Home page. Farmers will also be able to ask specific queries as well as give valuable feedback through the Feedback module specially developed for the purpose.

IV. CONCLUSIONS

India is traditionally land of farmers. As per census of 2011 nearly half of our population (47%) is depending on agriculture as per world bank report of 2015 the total arable land of India is 60%. This is substantially higher index compared to its peer countries. As per as irrigated land is concerned 36% of land is irrigated. This is the second highest percentage in the world. Based on these facts we can infer the farmers of this 36% land can independently select their crop without relying fully on rain fall.

As result of review of various DSS above it found that they support decision of different aspects of crop management like soil preparation, seed selection, pest management, fertilizer management, weed control, irrigation management, nutrition management etc. None of the DSS has addressed the problem of getting appropriate price for the crop of farmers. Agriculture product rates are purely depending on the demand and supply. we experience there is always in demand and supply of agriculture products. This results in shortage of some agricultural products and huge surplus of of other agricultural products. Due to this shortage consumer suffer the problem of unaffordable prices of the products. On the contrary due to surplus of production of certain crop farmers face intolerable losses. The government also suffer problem of improper planning of import and export policies of such products. Agriculture extensive services such as fertilizer manufacturers, pesticide and herbicide manufacturers also face problem of planning their strategies of production of their products. The researchers have to try to give best solution for the all above problems by developing the DSS for crop selection and planning, which provide the up-to-date data of present demand and potential supply of each crop. Farmers will be able to select best crop based on the up-to-date data of present demand and potential supply of each crop.

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