IMPLEMENTATION OF DECISION SUPPORT SYSTEMS FOR CROP PLANNING TO ENHANCE FARMER'S INCOME AN IMPERATIVE

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Abstract

The central government of India is striving hard to double the income of farmers by the year 2022. Number initiatives have been taken by government to enhance income by providing financial assistance through "Kisan Sanman Nidhi", implementing Agricultural Laws for MSP and APMC and Providing IT solutions to enhance yield. But still they are not successful in achieving goal of doubling the income of farmers. Among the various obstacles one of the most influencing factors in doubling the farmer income is the uncertain price of the produced crop. The implementation of law of MSP Guaranty is looks impractical as government can't purchase the whole agriculture produce of all the farmers. As the price of agriculture product is depend on demand and supply. The better solution is to choose the crop which has very less coverage in current season. This information may be provided from the agriculture department through DSS for crop selection and planning based on the current coverage of each crop. This paper discusses the various systems available for assisting farmers. Opinions of farmers on need of the decision support for crop selection and planning. Finally introduce conceptual model for implementing the decision support system.

Index Terms: Crop Coverage, Crop Planning, Crop Selection, Decision, Support

1) INTRODUCTION

India is a farmers land. Since ancient time farmers are practicing subsistence agriculture. In this method of farming peasant grow only those crops which are required to survive their families. Here the farmers aim was growing enough food to feed themselves and their whole family. Consequently result of this type of farming was limited local requirements with less or no surplus trade [1]. Later barter system became practiced where the agriculture products were exchanged other products with neighbours, relatives and villagers. In this system demand was very less or no surplus trade. After the era globalisation the market of agricultural products was spread not only at country level but at global level as well. Indian farmers started to export and their products to other countries. [3]

Unlike western countries government of India does not put any kind restriction on cultivation area of each crop. In western countries this kind of restriction imposed on farmers in order avoid surplus production or scarcity of particular agriculture product and maintain balance between requirement and production of agriculture products. On the contrary Indian farmers are free to select any crop which is economically and socially feasible. Consequently as a result there is always imbalance between demand and supply of agriculture products. [3]

It is quite difficult to think development of our farmers without improvement in practices of agricultural. Huge amount of data is available with respect to agricultural development. Ample of research has been taken in the agricultural field. The data can be made available in systematic

way in order to support farmers to take proper decisions of related to farming. Number of information systems, expert systems and Decision support system has been developed to address certain problem faced by farmers. [4]

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 [2]. ES is a computer based expert system that help decision maker to solve the problem interactively [3].

An Expert System is a clever computer program which designed to imitate the behaviour of human being during problem solving [5]

Farmers has to take decision at different stage of farming like decisions to be prior to plantation or sowing the crop, decision during the cultivation till harvesting and decisions post harvesting.[1]

2) REVIEW OF LITERATURE

Prior to design and implement the DSS from crop planning researcher has conducted a thorough study of literature available. To assist the farmer's different expert systems, information systems and decision support systems have been design, developed and implemented. Let's have glance on them following section brief the name, purpose of the agricultural systems. **[30]**

Amnon Nevo, Ilan Amir (1991), in order to determine the crops suitability for the given plots developed an expert system CROPLOT based on rules. **[5]**

R. M. Caldwell (2003) at outset paper briefs the definition of decision and there steps of decision process. The authors have explored the evolution of decision support system since last two decades. [**6**]

J.W. Jones and others (2003) The DSSAT (Decision Support System for Agro Technology Transfer) is being used across the world since 15 years by the researchers. This application incorporated 16 modules. This application covers different crop with the use of tools containg evaluation and application for different purposes. [**7**]

B. Manos and others (2004) this paper performed an analysis of the applications and their contribution of DSS in the field of agriculture and other sectors with respect to f in agriculture and other fields especially for the management and planning. **[8]**

The author **R.M. Sodtke (2005)** with an illustration of a multi-objective DSS used for supporting the management and selection of crops. It provides disciplined approach and gives results with respect to, acquisition of knowledge, design, and representation of knowledge and evaluation of DSS. **[9]**

K.B. Matthews, M.G. Hutchins (2006) a multi-perspective thought has been proposed in this paper. An approach for connecting the design-use gap with the researchers who are acting as

facilitators and the computer tools and their outputs performing as boundary objects by which problems may be discovered.[10]

Ganesan V. (2007 This application helps the farmers of kerala for taking the decision with respect to leading crops such as rice, coconut, banana, pepper, cashew, brinjal, lady figure and cucurbits. The system named as 'CROP-9-DSS' is acting as an ES to scientists, agriculture officers who's are rendering their services in agriculture field and ectension activities. It provides suitable recommendations to them. [11]

Prof. Mrs. J.R.Prasad and other (2008) with an intension to provide a DSS which is easy to interact with user friendly interface, authors proposed a system that assists farmers with respect to rain fall, soil structure. The farmers are supposed to provide the current sown or plantation status of each crop based on which they can find the most appropriate crop with better returns on the selected crop. [12]

Matthews K.B., G. Schwarz, K. Buchan and M. Rivington (2008 The paper evaluate authors current and past efforts in promoting the use of model based simulation farm-scale case-studies as a foundation for decision support in the situation of the DSS development literature..[13]

K.R.Thorp (2008), the author has put an attempt to design and develop a simple DSS named "Apollo" that assist the farmers and research scholars. An application of DSSAT crop growth models in for the farming datasets of analysis. [14]

YANG Yushu and other (2009) A support system has been developed by the authors which recommends the use fertilization as per to the samples of different soil and their nutrient content in the soil. The system enhances the yield of the crop. Ultimately it improved the quality decision level of intelligence in the agricultural management. [15]

G. A. Peterson, D. G. Westfall & N. C. Hansen (2009) Proper soil and crop management applications are imperative for the sustainable production of crops especially in semi-arid atmosphere, It assits farmers in the area of enhance soil organic matter, reduction of soil erosion, improve in soil structure and rate of infiltration. [16]

Emmanouil, Stiakakis, Sifaleras, & Angelo (2010) the primarily focuses of the authors of this research paper on industry of food production. The model has been designed the uses number of variables as inputs and gives outputs, such , the number of employees, capital expenditure, net sales, investment on R&D, and net profit. Further, key policies and factors are identifying in this research, this plays an important role in the food producer achievement. [17]

Caroline Parker & Murray Sinclair (2010) A DSS are useful mechanism in transferring the best practices and scientific knowledge to the farmers. This paper proves with evidence that systems which were failed were not user centred. The study taken in to consideration various DSS proposed for use in crop production enterprise in the UK. [18]

Wang Zhi-Qiang and other (2010) The DSS has been aimed to suggest a most efficient strategies for solving the problems in crop cultivation. An agricultural spatial DSS called ADSS was studied and eventually developed to addresss the increasing demands. Monitoring

the growth of crops providing accurate and timely information potential production of the each crop. [19]

S. J. Yelapure, Dr. R. V. Kulkarni, (2012) in this paper authors reviewed 10 different ES and DSS. At the outset need of expert system in agriculture is explained. Further review of different expert systems in agriculture sector has been briefed. in the final conclusion of paper author emphasises on the s need of development of an expert system for soybean crop in order to guide to farmers to take feasible decision into various aspects of management of crop like preparation of soil, management of fertilizers, selection of seed, management of irrigation, pest management, control of weed and nutrition deficiency management etc.[20]

Mo Lia, Ping Guoa,b,*, Xiao Liua, Guanhua Huanga, Zailin Huoa(2013) in this article express that traditionally farmers are using excessive water and fertilisers to gain higher yield. The system render graphical user interface and the results are provided to help farmers to take sound decisions**. [21]

Vidya Kumbhar, T.P.Singh (2013) the authors reviewed more than 25 ES and decision support system and   their application. The practices of different DSS across the country are addressed in this paper. This paper provides comprehensive picture of present state of art of various DSS. [22]

Ayubu J. Churi and others (2013) this study aimed at farmers to reduce risks of climate fluctuation and increase crop yield especially semi-arid areas are addressed through. Comprehensive investigative of decision support systems that assisting the smallholder farmers. The researcher enables simple application and affordable mobile phones used by farmers to access agricultural knowledge wealth and various policies recommended by the research centres and government organization. [23]

R G Joshi,Parag Bhalchandra,Dr H S Fadewar and Dr S D Khamitkar (2014) in this paper address the question, what will be the best standard software development life cycle(SDLC) for development of decision support system that are specially used in agricultural domain. These DSS play significant role in taking decisions regarding selection of plant. [24]

Waghmode M. L, Dr. P.P. Jamsandekar (2014) applications of DSS in different sector is addressed in this paper. DSS are used in many fields like medicine, agriculture, education; business, railway etc are summarized [25]

Petr hanzilik,Frantisek,Josef Pavlicek(2015) A client server based architecture for development of DSS application has been presented. The server encapsulates solution with respect to knowledge model, knowledge engine construction and integration. A detail case study on "plant leaf recognition agent" is demonstrated this article is divided in five sections. [26]

Sahu, B.S. Dhekale , P. Mishra , Chellai Fatih (August 2020) The major aim of this article is to offer decision support with respect to recommending the water, weed, pest and management of diseases, nutrient deficiency management based on the value of soil test. Assistance is provided to the farmer, students, research workers, agriculture workers, extension

workers and others in spite of expert's absence. Indeed dedicated effort has been made to design and implement DSS with existing data in order to bridge the gap between the farmers the expert's and. [27]

V.D. Tarpara, M.G. Dhandhalya, Haresh Chavda, V.L. Purohit (2020) return on investment on the ground nut crop is calculated and analysed in this paper. Productivity during the years 1990 to 2012 in the Gujarat state are considered for analysis [28]

Susilawati C.L (2012), proposed model comprise an infrastructure consists of series of check dam constructed by computerized simulation. A DSS model known RMA-DSS (Rainwater Management for Agriculture Decision Support System) for the semi-arid village Daieko region with poor rainfalls situated on the Savu Islan. [41]

R.L.McCown and others (1996), an initiative was commenced in 2007 to support the development and use of APSIM the science modules and infrastructure software that simulates agricultural production. The design, development and maintenance is monitored by standards of rigorous science and software engineering. [45]

CropMan (2021) is a Busines-to-Business (B2B) platform provided for farmers to sale their produced agri products through online (https://www.cropman.in/). Customer can also buy agri related products from original producer. Thousands of individuals are trusted and happy farmers; crop man. In is single stop solution for selling and buying of Agri products. [48]

CROPWAT (2021) is tool developed by the Land and Water Development Division of US to support water scheduling decision CROPWAT is Windows base application program for the calculation water requirements and irrigation requirements of crop based on climate, soil, and crop data. CROPWAT 8.0 can also be used to estimate crop performance under both rain fed and irrigated conditions and evaluate farmers' irrigation practices. [51]

Rait Mitra (2021), is the web portal developed by Department of Agriculture. It has been launched especially to provide Extension services of agricultural department to farmers. Further transfer the knowledge of latest technology the farmer's community, high yielding varieties, imparting training, demonstrations to farmers to enhance knowledge and skills in order to increase the production of agricultural products and its productivity. Technical information like fertilizers, seed, soil testing are provided. There is lot of scope for proving present state of crop in order to select the crop this portal provides. [29]

Farmers (2021), information and services to farmers are made available through this web portal. It supplements the existing channels of delivery by employing the information and communication technologies provided for by the central agriculture department. Farmers' Portal is one spot to meet all informational needs of Agriculture. It also covers Fisheries and Animal Husbandry sectors sale/storage, production. [30]

Soil Health Card Portal (2021) is an application being used for the registering of soil samples collected at farm fields and entry of test results. This sample information is then sent to the National Soil Health Card Portal (http://soilhealth.doe.gov.in). Sample registration requires

entry of details an out farmer, his land holding, crop for which recommendations are sought and fertilizers available to improve the health of the soil.

Once net connection is established there after the collection of sample and the entered data is pushed on the server. [31]

Crop Darshak Aap (2021) is a web based application available in the form of mobile app and web portal. The Government wants clear picture of the crops being planted or sown and the kind of irrigation being adopted for the selected crop throughout all the farm lands in the state. Similarly, farmers can file their complaints directly through Crop Survey Software www.cropsurvey.karnataka.gov.in. [32]

Bhoomi Project (2021) this portal is the project of management and on-line delivery of land records in Karnataka. [2]

This reviewed literature has been used and regard as guiding material for conducting present study designing, developing and implementing solution as Decision Support System.

3) OPINIONS OF FARMERS ON NEEDS OF INFORMATION FOR CROP PLANNING

The opinions of 400 farmers from all the Hobli/Taluks of Belgaum district have been collected through schedule for the study. Gathered facts and strategies are considered as basic building blocks of the implementing of DSS for select and planning the appropriate crop. Following tables summarise the problems faced by farmers with respect to crop selection and the information needs at three stage of Crop Planning decision making. Initially information required prior to Sowing or plantation, later scheduling the farming activities and finally after harvesting of the crop.

a. Problems Faced By Farmers

Table 1: Incur loss on crop

Sr. No	Criteria	Farmers	Percentage
1	Yes	211	52.75
2	No	26	6.5
3	Some times	163	40.75
Total		**400**	**100**

Source: Survey Data

Facts in the Table 1 show overall more than 90% farmers are incurring losses. Nearly 53% farmers expressing that they have incurred loss on their agricultural products. More than 40% cultivators express that they get some times incur losses. Only 6.5% of farmers accepts that the earn profit from agriculture.

Table 2: Frequency of Loss

Sr. No	Criteria	Farmers	Percentage
1	Never	25	6.25
2	Once In Five Crops	29	7.25
3	Once In Four Crops	35	8.75
4	Once In Three Crops	105	26.25
5	Once In Two Crops	134	33.5
6	Always	72	18
	Total	**400**	**100**

Source: Survey Data

Table 2 show the frequency of loss here we can observe that 18 percent of farmers committed that they always incur losses. More than 33.5% farmers agree half of the times they experienced loss. More than 26% express they incur loss once in 3 crops. Overall 8.75% farmers have experience loss in every 4th crop. More than 7% people find a loss on every fifth crop. Very less farmers that is 6.25% practicing profitable farming.

b. Information Needs Prior To Sowing or Plantation of Crop

The following table depicts the summery of information need prior to plantation or sowing the crop to assist farmers in taking strategic decisions on selecting the appropriate crop.

Table 3: Information needs prior to sowing

Sr. No.	Kind information	Farmers	%
1	Past Years Production and Average Rate	327	81.75
3	Present Coverage of each crop	333	83.25

Source: Survey Data

Table 3 shows more than 81% farmers want to facts related to production and rate of each crop in past year. Similarly more than 83% farmers need information of present crop coverage.

c. Information Needs Scheduling The Farming Activities

The following table depicts the summery of information need to assist the farmer in taking tactic and operational decisions. This information would help in scheduling cultivation activities for better yield of the selected crop.

Table 4: Information needs after selection of crop

Sr. No.	Kind information	Farmers	%
1	Water Management	236	59
2	Weed Management	141	35.25
3	Pest Management	196	49
4	Fertilizers Management	232	58

Source: Survey Data

Table 4 show nearly 60% farmers want to facts related to management of water and fertilizers. Nearly 50% farmers need data related to past management. Overall 35% farmers need information of weed control.

d. Information Needs Post Harvesting of the Crop

The following table depicts the summery of information need to assist the farmer in taking strategic, tactic and operational decisions after harvesting the crop.

Table 5: Information needs after harvesting

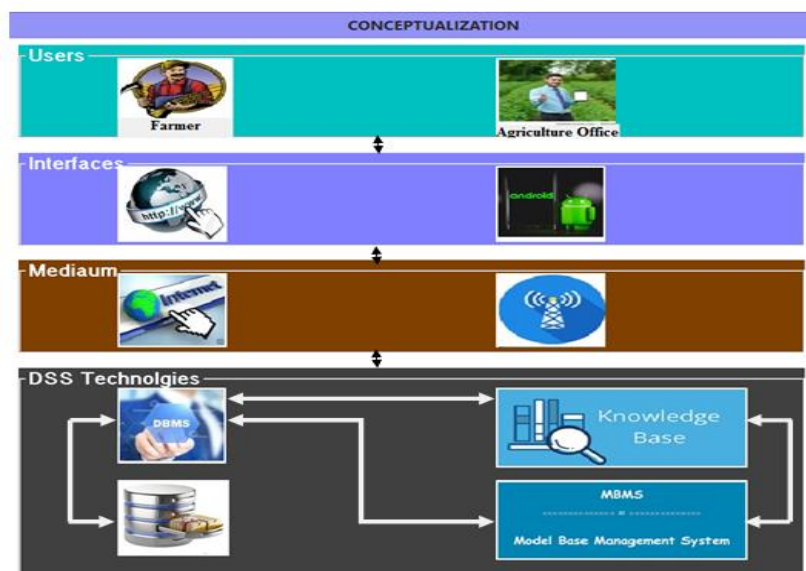| Sr. No.	Information Needs	Farmers	Percentage
1	Facility of mortgage loan on crop to withheld sale crop at low price	177	44.25
2	where you get higher rate for the crop	225	56.25
3	buyer to purchase crop at field	146	36.5
4	MSP procurement of your crop	89	22.25

Source: Survey Data

Table 5 shows more than 56% farmers want to know the places where they get better price for their crop. Nearly 45% farmers' need data related to facility of mortgage loan on crop to withheld sale crop at low price. Overall 35% farmers need information of weed control. More than one third farmers expect information buyer for the crop at field and nearly one forth farmers want know MSP procurement of the.

4) CONCEPTUAL MODEL OF DSS

The figure 1 shows conceptual model of the proposed system designed to assist the farmers during the different phases of farming. The information is provided through Decision Support System incorporating web based and android based assistance. This information is accessible on phone and computers on interfaces like apps or web portals on browsers. These gazettes may be connected through terrestrial connection or through radio network. The DSS technologies consist of database management system, knowledge base system and model management system.

Figure 1: Architecture of CroPlan DSS

a. Components of DSS

1. Users

i. Farmers: Although there are many types of stake holders of the system the focus of developing the system of enhancing the income of the farmers.

ii. Agriculture Officers: An Agriculture Officer at each hobli centre collect information from village accountant and gives it to Assistant Director (AD). An Assistant Director at each Taluk provides current status of crop cultivation information every week to joint director. In the agricultural department at district level there is a Joint Director (JD).

2. User Interfaces

The system should provide two types viz:

i. Web Portal: farmers and agriculture officers connected through internet and computer literate can use this interface to access the information and enter the crop cultivation Information

ii. Android Application: To access the information and enter the crop cultivation information Farmers and agriculture officers who are connected through internet and using smart phones can use this interface

3. Database Management System

The system need to maintain the records of the farmer's details, land details, crop details, and cultivation of crops, yield and Database management system manages the data required for DSS e.g. Price of agriculture products, harvesting etc.

4. Knowledgebase Management System

This module accepts the user input parameters and search the information from database and model management system required for the selection of crop. This module is heart of the DSS which actually deduce the information from the database and the model management system.
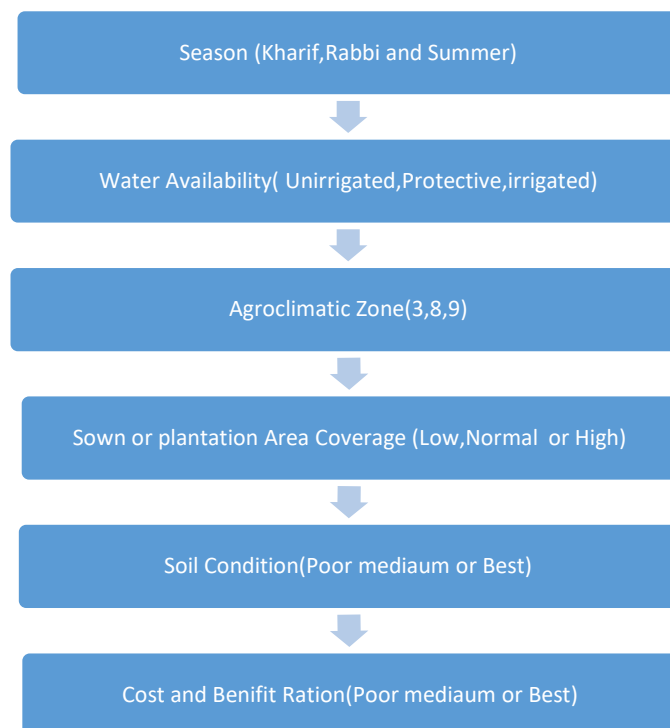
5. Model Management System

This system maintains the standard requirements of each crop based on expert recommendations each crop has certain requirements like type of soil, fertilizers requirement, water schedule, pesticide schedule, weed management, season, etc.

b. Crop selection Process

The figure 2. Shows the phase followed inference engine to suggest the crop to be grown. In each phase the one parameter is considered and filter of crops takes place which would be input for the next phase. In the first phase the present season is consider and according crops are shortlisted for the next phase consideration. In the next phase availability of water is considered, in the third phase agro-climatic zone is assessed to choose crops suitable for the zone of the farmers field. The present crop coverage is considered in order to shortlist the crops with less percentage of coverage than normal or targeted area. In the fifth phase the availability of soil nutrients are considered and based on the PH, EC and OC level crops are shortlisted. Finally the cost and benefit ratio is considered, this ratio is calculated as income per day.

Figure 2: Crop Selection Phases

Season (Kharif,Rabbi and Summer)

Water Availability(Unirrigated,Protective,irrigated)

Agroclimatic Zone(3,8,9)

Sown or plantation Area Coverage (Low,Normal or High)

Soil Condition(Poor mediaum or Best)

Cost and Benifit Ration(Poor mediaum or Best)

c. Planning of Crop Schedule

Once the farmers choose the crop to be grown the system suggest the schedules of farming activities. These schedule activities are the best practices of the farmers in the north Karnataka and recommendations of University of Agriculture Sciences, Dharwad. This schedule consists of chronological activities related to major agricultural functions shown in the figure 3
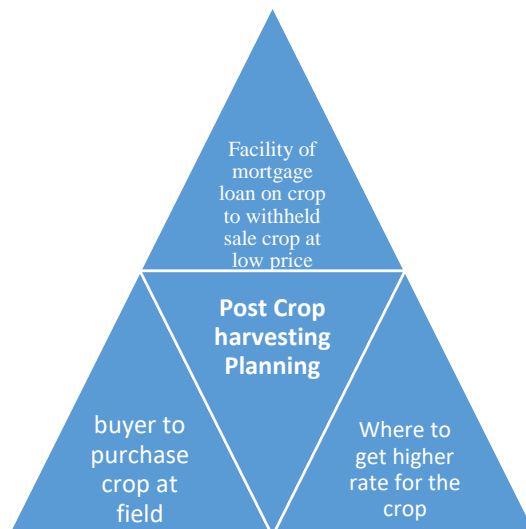
Figure 3: Scheduled Farming Functions

d. Post Crop harvesting Planning

Once the farmers harvest his crop the system provides the post harvesting aids as shown in the figure 4. Firstly information related mortgage loan is provided to withhold the sale of crop at low rate. Secondly find the market which offer higher rate for the grown crop finally MSP procurement and buyer who purchase the crop at filed itself.

Figure 4; Post Harvesting Information Aids

5) CONCLUSION

Plenty decision support systems have been developed for the farmers for fertiliser, management, pesticide management water management, weed management, and climate information. These systems have been focused on the enhancing the yield of the crop. But no system has been developed so far to address the problem of ensuring reasonable price for his crop. This paper has provided with information needs of farmers collected through sample survey. A conceptual framework of DSS that helps the farmer to select the crop based on the information of demand and potential supply of crop has been proposed. Further system suggests the schedules of farming activities. Once the farmers harvest his crop the system aids in post harvesting functions.

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