DECISION SUPPORT SYSTEM FOR PRECISION AGRICULTURE

B.Venkatalakshmi[1], P.Devi[2]

[1]Professor, TIFAC-CORE in Pervasive Computing Technologies, Velammal Engineering College, Tamil Nadu, India
[2]PG Student, TIFAC-CORE in Pervasive Computing Technologies, Velammal Engineering College, Tamil Nadu, India

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. The main aim of the work is to develop a system that can provide information about the expected yield in each season with better accuracy. The decisions available to them currently are only a shallow guide for farmers due to them being unaware of various methodologies. Inefficiency in a farmers' decision results in the low productive rate of paddy than the expected rate. The growth of seasonal crops is decided basically by two factors, namely the soil type and the season. Also based on the crop type the farmer must adoptively use the insecticides and fertilizers. Thus the parameters to be considered are identified and the simulation is tested using a tool called "Netica". Based on the performance the DSS guides the farmers to improve the crop growth. The simulated results can be extended for real time usage in mobile application.

Keywords: Decision Support System, Netica, Precision Agriculture.

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1. 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 [1]. In consequence of India's success in the spheres of globalization and economic reforms the agricultural sector seeks attention and meticulous planning to enjoy its benefits of increased productivity growth in the agricultural sector [2]. Training the farmers, educating them appropriately and reorienting them to take up new activities through adaptation of new technologies are of utmost importance. Precision agriculture is mainly aided by Information Technology (IT), which enables the maker to collect information and data for better decision making and better output. The concept of precision agriculture offers the promise of increasing productivity while decreasing production cost and minimizing environmental impacts. Precision farming technology includes the components like Remote Sensing (RS), Geographical Information System (GIS), Global Positioning System (GPS), Soil Testing, Yield Monitors and Variable Rate Technology. Decision support systems [2] [3] [4] are an interactive, computer-based systems which help users in making decisions. Besides the provision of storing and retrieval of data, these decision support systems enhance information access and retrieval functions also. There has been a great source of help offered by the DSS for different fields like management problems, medical diagnosis, and natural resource management. Appropriate use of decision-making tools increases productivity, efficiency, effectiveness allowing the users to make optimal choices for technological problems and their parameters, for planning and processing. The application of

DSS to agriculture involves a range of opportunities and challenges. Agriculture farmers and scientist faces a great challenge in effectively managing the information in order to improve the economic and the crop productivity rate. Major idea of making right decisions is the ability to accurately assess crop growth, and a scientific decision- making process to provide appropriate strategies based on fact. In order to meet this challenge, the flow of data between decision processes and the input from the user must be analyzed and modeled for an efficient output and outcome. Interactive computer programs help decision makers formulate alternatives, analyze their impacts, infer and select appropriate options for implementation. This helps in developing decision support system to make agriculture science more accessible for farmers and scientists. This can be achieved partly by using the decision support system (DSS) that provide accurate and detailed information about agriculture for the decision of crop.

2. RELATED WORK

A Decision support system is designed for optimizing the water consumption in orchards by employing precision agriculture through information and communication technology [6]. Remote sensing, Information Technology and geospatial methods are used to quantify the spatial variability in agricultural fields. This is used for developing the zones that will optimize the inputs such as irrigation, fertilization, improving the quantity and quality of the yields. Spatial analysis is used for analyzing the data in its spatial context. An autonomous platform is employed for obtaining the plant data from the vision systems and laser scanners. These are used for the purpose for predicting the yield and the leaf prediction area. The data obtained through this method is combined with the abiotic data regarding the soil and climatic conditions. The GIS framework provides the statistical

analysis method, the link to the geo-database which contains the data sources such as tables, maps, remote sensed data, and a link to the information of the decision makers. Recognizing the variables that are important for defining the quality and quantity of the yield is complex due to the high spatial and temporal variability in agricultural fields. The proposed GIS methodology includes a web based GIS interface to be developed and used as a decision making tool. This will help farmers to support efficient and sustainable management of orchards.

The spatial decision support system uses the multi-criteria that is intended for the regional planning and also promotes the idea for group decision making [7]. The paper introduces a framework that integrates the environmental and economic criteria together and then builds the hierarchy for the wind farm using the Weighted Linear Combination (WLC) algorithm along with the Geographic Information Technology (GIS). WLC assigns values to each factor and with the assigned values it then combines it with the map layers to produce the individual stability maps. Then these assigned factor weights by the individual participants uses the BORDA method for ranking and for generating group weights which were used for consequent WLC aggregation and generation for wind farm site selection. The BORDA method is used to determine the collective rank and relative importance for each decision factors with the weights assigned by the participants.

A decision support system is developed which produces more accurate information about the expected harvest in each season. The farmers were not able to sell their harvest at a reasonable price [8]. The system estimates the expected harvest by analyzing the past data using the regression analysis technique. The system promises in reducing the price fluctuations henceforth safeguarding the customer and farmers making use of the information provided by the decision support system. As a result of which the farmers are protected from unexpected decrease in the price of paddy by providing information on the expected price of paddy under prevailing situations. If the performance is below the expected level, the system will predict some possible situations which enable to overcome the difficulty and special attention to support the farmers. The architecture consists of a database, which contains data on agriculture. Linear regression model is used to forecast the expected price using historical data on the price and quantity. The system estimates the slope of the linear regression line and then using that value, intercept has been calculated. Using this result in the database system, we can calculate the quantity of harvest and the expected price. Hence central issue of price fluctuations in paddy cultivation can be minimized using this system by protecting farmer and consumer. The software has been basically developed for paddy cultivation and addresses the issues regarding the paddy cultivation.

The paper "A Decision Support System for Rice Cultivation on Acid Sulfate Soils in Malaysia" [9] mainly focuses on developing a decision support system for cultivation of rice in acid sulfate soils. Generally acid sulfate soils are unfit for

the crop production. Hence to put acid sulfate soils into productive use, several steps have been followed. These procedures are integrated to decision support systems. In order to get maximal profit, micro economic analysis on the production function is carried out. The production function is a mathematical relationship describing the way in which the quantity of a particular product depends on the quantity of the inputs used. From this production function the amount of revenue can be calculated.

The rice is grown on the acid sulfate soils under various steps. The test was conducted as field trial and pot experiment. Data from both the experiments were analyzed to produce the yield. The pot experiment refers to the potential yield and the field experiment refers to the actual yield. From this the field yield percentage can be calculated. To validate the production function, the other treatments of lime and the fertilizer application were carried out. Simple micro economic analysis was done as an approach of decision model. Hence this decision model would then try to find optimal solution for obtaining the maximal revenue.

Simulation is done in several models. The first model determines the yield using production function. The output of this produced the output on application of lime and fertilizer and the predicted yield. The output of this stage is used as an input for the next stage. The final process in this is the calculation the marginal profit. Total revenue can be calculated from the predicted yield and rice price. This model was able to predict the maximal profit for rice cultivation on acid sulfate soils.

3. PROPOSED SYSTEM

To keep up with rising populations, global food production must increase by 70 percent in order to be able to feed the world. By collecting real-time data on weather, soil and air quality, crop maturity and even equipment and labor costs and availability, predictive analytics can be used to make smarter decisions. This may be achieved by integrating various technology solutions. The farmer's decisions range from choice of the crop, irrigation methods, and type of pesticides, time of fertilizing and strategies of trading and marketing methodologies. The objective of our work is to develop a precision agriculture, in cultivating suitable seasonal crop and cultivating the crop as per the health status of the soil.

3.1 System Architecture

Seasonal crops are those that are grown after the harvest of the regular crop. These methods are practices in order not to leave the field fallow. There are set of seasonal crops that can be grown after the harvest of the domestic plant. This seasonal crop cultivation varies from state to state. And the harvest periods for these crops are less when compared with the regular crop. The sample architecture of the seasonal crop Decision Support System has been shown in Figure 1.
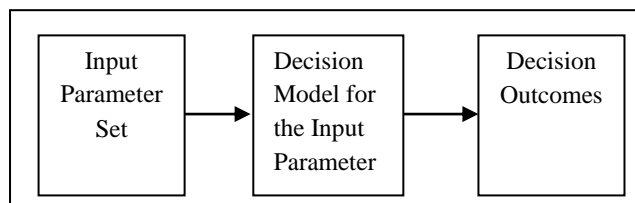
Fig 1 Architecture for Seasonal Crop Decision System

The input parameter set includes factors like season that is the month suitable for cultivation, the type of the soil. Based on the type of soil and the season selected the decision support system will decide the crop to be cultivated for the fore coming days. According to the inputs given the decision will arrive at the type of crop to be chosen. The output for the set of input parameters is obtained after the design analysis decision model of multiple input factors. The outcome for the seasonal crop decision model is the type of crop. Based on the type of crop the factors like the fertilizers to be added for the preparation of the field, the methodologies used for irrigation and intervals for the irrigation, the fertilizers to be added after sowing the seeds, the weed control mechanisms and the intervals of spraying them, insecticides, the harvest period and the yield that can be obtained from the input. A mobile application will be developed to help farmers decide about the seasonal crop to be cultivated and the fertilizers to be added for preparing the field for the cultivation of the regular crop. And the application also gives the report about the maximum yield and revenue to the farmers based on the cost of inputs involved.

4. RESULTS AND DISCUSSION

The proposed architecture in section III has been implemented using Decision Support software called Netica. This software has an intuitive and smooth user interface. This tool makes use of Bayes networks for the development of any complex decision support systems.
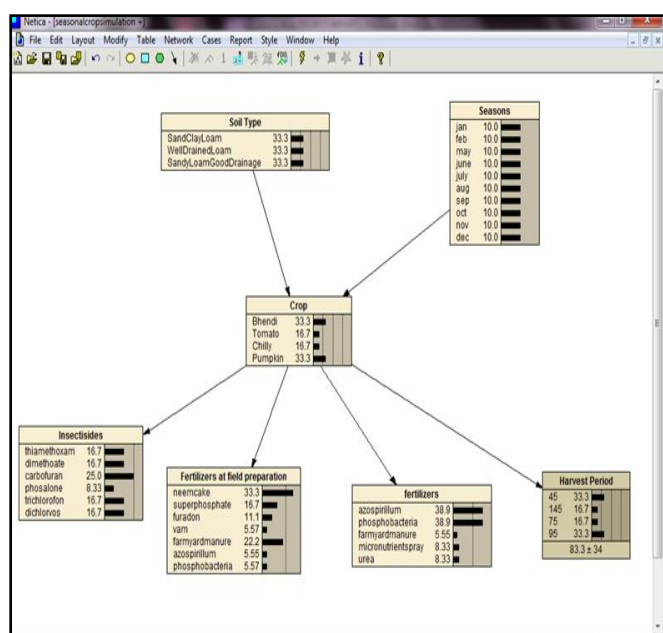

Fig 2 Decision Nodes before Simulation

Initially the decision nodes look like in Figure 2. The soil type and the seasons acts as the parent node for the child node Crop. Based on the type of the soil and season the crop will be decided and the other parameters like fertilizers to be used at the time of field preparation and also during the cultivation, insecticides the harvest period for that particular crop will be displayed.
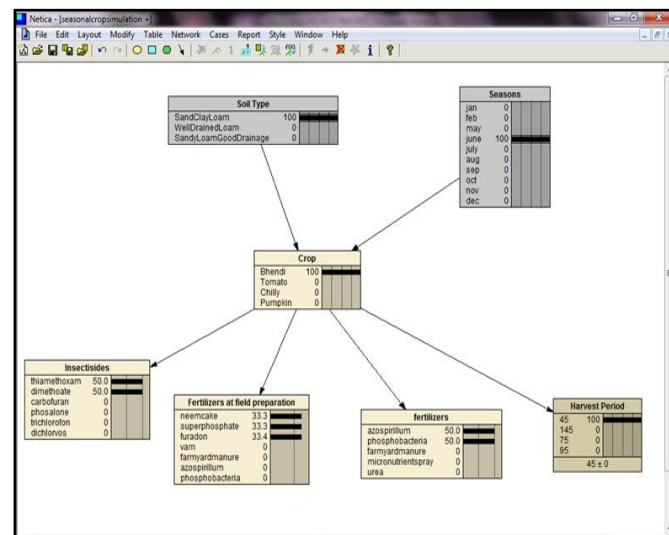

Fig 3 Decision Obtained for the Crop Bhendi

In Figure 3, the output obtained here based on the soil type and the seasons. Bhendi can be grown in sandy/ loamy soils and in the month of June, August and February.

5. CONCLUSIONS AND FUTURE WORK

The real time data is obtained and studied in detail. The results obtained through simulated DSS confirms the reliability of identification of suitable crops to be cultivated. The future work includes developing a mobile application to help the farmers in improving their yield. This application decides about the type of crop to be cultivated based on multiple factors as inputs. The simulations are further displayed to the farmer in his mobile, and the crop management techniques will also be analyzed and decision will be provided about the applications of fertilizers in correct proportions, the pests and the weed control mechanisms.

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BIOGRAPHIES

Dr.B.Venkatalakshmi, has received her Bachelor of Engineering from Madurai Kamaraj University, Madurai in 1992. She received her Master of Engineering from Anna University, Chennai in 2004. She received her Doctorate in Multisource Network coding for MANETS from Anna University. Her research interests includes Pervasive Computing, Network Coding, Digital Signal Processing, RFID, Mobile AdHoc Networks.

Devi.P was born in Chennai, Tamil Nadu (TN), India, in 1991. She received her Bachelor in Computer Science and Engineering (B.E. C.S.E) from St.Peters University, Chennai, TN, India, in 2012 and pursuing Master of Engineering in Mobile And Pervasive Computing (M.E. M.P.C) from Velammal Engineering College, Chennai, TN, India, in2014. Her research interests includes Pervasive Computing, Mobile Computing.