Agro-met Expert System Using Climate Normal Phenology for Soya bean Crop in Regional Area

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Abstract: Weather is widely recognized as an important determinant of the level and variability of crop yield. For explaining this relationship between weather and crop yield it has been a common practice to use rainfall as a measure of weather condition, because rainfall is an essential component of the wider phenomenon of weather. However while considering the effect of weather on yield we must consider in addition to rainfall, the distribution of rainfall, maximum and minimum temperature, humidity, cloud cover, wind speed and such other things over different days of the season. During various stages of crop growth these weather variables are affects the crop. Thus weather needs to be recognized as a multidimensional phenomenon. In India farming sector is highly unorganized, and most of the systems followed are passed down through generations. Due to this many a times crop yield is much lower than expected due lack of knowledge or access to the knowledge. On top of it, recent climate changes are more vulnerable for the crop development. To overcome this we are building Agro met Expert System for the soya bean crop in Ahmednagar region of India, which contains standard weather predicted data from Indian Meteorological Department, Pune, Maharashtra, India and dynamic crop weather calendar as well as knowledge of agro-meteorology experts which will helps farmer for decision support through our system. Unfortunately we do not have enough experts and personals to reach out every farmer considering the vast expanse of the country. So that we are developing the Agro met expert system, Farmer will access the system using SMS (Smart Messaging System) on his/her mobile phone. In this paper, we use the decision tree algorithm for finding solution to the farmer's query about his crop. We are researching the inducement scheme for the farmer's and to explore the constitution with dynamically varying number of solutions to the farmer's query. The results are disposing by using the soya bean crop under the Climatic Normal phenology prediction model by classifying the large dataset repository amongst for soya bean has respectively diseases(70), pesticides(15) and fertilizer(16) and we have manage the risk by observing these dataset.

Keywords —***Agromet Expert System, Dynamic Crop weather Calendar, Decision Support, Phenology prediction model, Climatic Normal,Contigency Planning.***

I. INTRODUCTION

An expert system is a computer program that uses Artificial Intelligence (AI) technologies to simulate the judgment and behavior of human or an organization that has expert knowledge and experience in particular field. In Ahmednagar district soya bean crop is mostly taken by the farmer. Now a day, farmer uses a static crop growth calendar for the development of crop. This static calendar contains fixed information related to crop growth stages. But most of the time this static calendar not much useful due to the early/late rainfall. In our proposed system, we are creating dynamic crop growth calendar for soya bean crop, it will be automatically updated as per the rainfall predicted by IMD (India Meteorological Department), Maharashtra, India. This calendar will guide the farmer to get the optimal solution at any stage of the crop.

Our expert system includes the domain knowledge of soya bean crop, also their diseases, pesticides, fertilizer, irrigation and dynamic crop growth calendar. For Implementation of proposed system we used standard database of IMD (India Meteorological Department), Maharashtra, India and Mahatma Phule Rahuri Krishi Vidyapith, Ahmednagar.

IMD is an agency of ministry of Earth Science of Government of India .It does the task of weather prediction by daily, weekly, monthly and seasonally. IMD is responsible for forecasting naming and distribution of tropical cyclones. It obtains the meteorological observations and provides the current and forecasted information for operation of weather sensitive activities like agriculture irrigation, etc.

Mahatma Phule, Rahuri Krishi Vidyapeeth, Ahmednagar is the Agricultural University in Maharashtra. It gives services to farmers through education, research and extension education.

II. LITERATURE SURVEY

While doing literature survey, we found the existing systems which are listed below:

A. Decision tree based crowdsourcing approach:

In this approach, binary decision tree based crowdsourcing system for plant disease detection has been presented. By using binary decision tree reduces the average number of questions to be asked to accurately detect a disease from a large number of possible diseases. The proposed method exploits the power of crowdsourcing of farmers to increase the reliability of disease detection. According to authors best of knowledge, the approach of incorporating crowdsourcing based on binary decision tree for disease identification is their novel contribution in the agriculture field.

B. MODIS Automated mapping of soybean and corn using phenology:

The primary input data were the MODerate - resolution Imaging Spectrora diometer (MODIS) product MCD43A4, which offers nadir as well as bidirectional reflectance distribution function (BRDF) adjusted spectral reflectance. MCD43A4 uses daily Terra and Aqua satellite overpasses to compute the reflectance within each 16-day period by an algorithm based on the inversion of radiate transfer models.

III. DESIGN AND IMPLEMENTATION

We are developing the system which is beneficial for farmers for Ahmednagar region by improving their soya bean production and the flowchart of Dynamic Crop Weather Calendar is a shown in fig. (Dynamic Crop weather Calendar).

The dynamic calendar will be updated itself as per the rainfall (Early, Normal, Late) for Normal Rainfall static calendar is useful but dynamic calendar is useful for all onset of monsoon. Crop sowing is depend upon variety/duration (Short, Medium and Long), Phenology.

Phenology is a study of seasonal changes in the crops and animals from year to year. In this we have use the phenology prediction model for Extended Range /WRF forecast. Factors considered for phenology are climatic Normal (Progressive) (Early/Normal/Delayed),Probability of Extreme weather events, optimum weather conditions for higher fields .Due to climate variability changes are occurred in temperature, RF,MP for this we creates CSM/Statistical Models which will help to give the crop alert notification to farmer about weather changes and system will provides specific information.

Climate variability can be recovered by major pest, cross boundary pest and emerging pest. Using this concept of dynamic crop weather calendar we have reduce the risk for farmer's economical loss.

In our proposed system we have studied all types of diseases at each stage of the crop (i.e. soya bean) and providing suggestion to the farmer which is beneficial for production growth.

Dynamic crop weather calendar stages for the crop soya bean as depicted in Fig. (2).In our system we uses this stages and study all the phases of the crop, their diseases, pesticides, fertilizer in each phase.

We implemented our proposed system using Java as a front end language and MySQL as a back end language .In Java language Our proposed system covers all the parameters like creating Dynamic crop weather calendar, it will be very much beneficial for farmer during their crop yield to assist him.

We have used the Net beans IDE 8.0 as a platform for front end coding.

Development phase for the soya bean has stages as shown in Fig. (2). Soya bean is a Dicotyledonous plant that exhibit above the surface emergence. In germination stage the cotyledons are force through the soil to the surface.

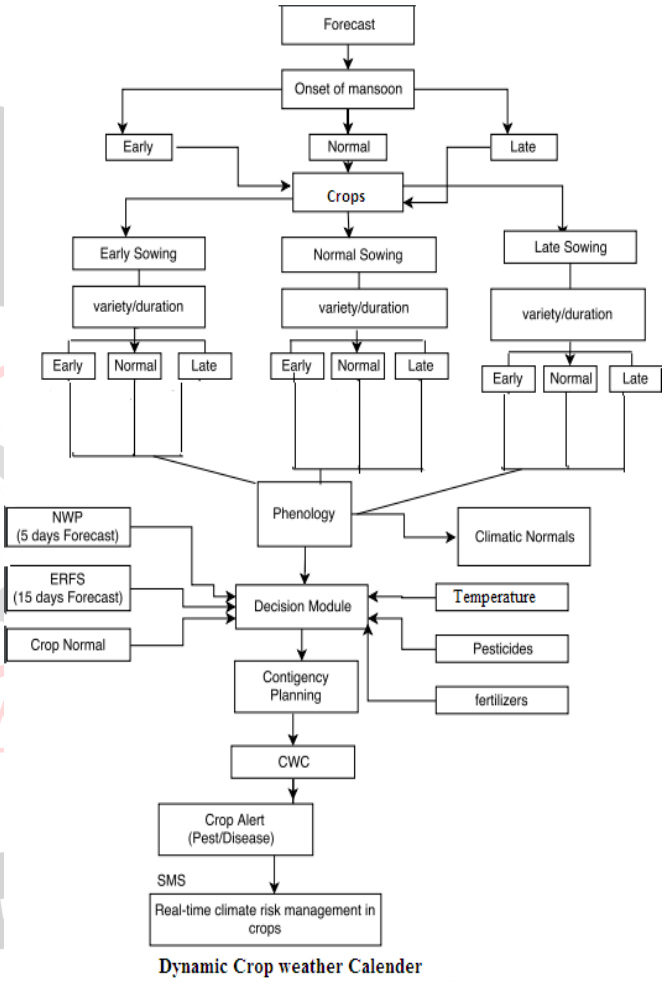

Fig. 1. Dynamic Crop Weather Calendar for real-time risk management in crops.

Development of the soya bean is divided into two different growth phases.

1) *Vegetative stage:* Emergence, Cotyledon, etc.

1) Reproductive stage: Beginning bloom, Full pod, Beginning seed, Full Seed, Full Maturity, etc.

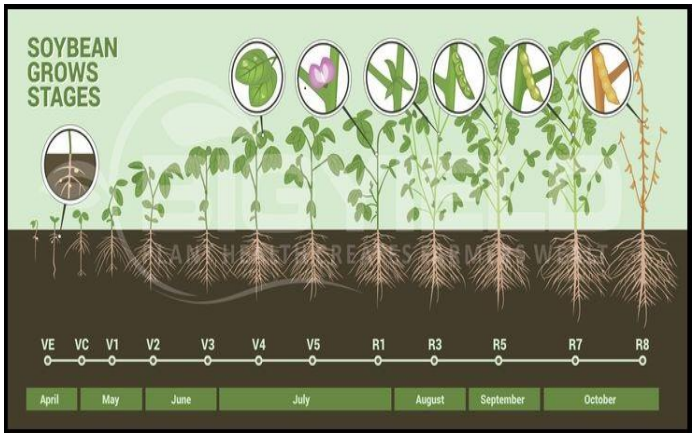

Fig. 2. Growth stages of soya bean crop

IV. SYSTEM ARCHITECTURE

System architecture of our proposed system is depicted in Fig (5).Here user is a farmer which gives the input through text by using mobile phone or web browser to the agro met expert system . Agro met Expert System receives the user request and it check with pool of question present in our database server (My SQL), if it present in it then find answers of the question in pool of answer which is also in database server and match it with database and gives the advice to the farmer by using the algorithm of Decision tree. Decision tree contain the classified crop diseases fertilizers and pesticides. Answer generation and decision engine consist of answers of farmers question based decision in response aggregation Give the advice to the farmer using Smart Messaging System. Java is use as an interface between user and the system for retrieving and storing data.

For this system also we have given the input Dynamic Crop Weather Calendar for managing the real-time risk in agriculture for farmers depicted in the Fig(1).We have create Dynamic Crop Weather Calendar for Soya bean crop is demonstrated in Fig. (3).Predicting phenological behavior in soya bean is difficult because of strong photoperiod and temperature effects of been developed, based upon field and controlled data (14, 15, 16). Soya bean growth and yield models depend upon good predictions of phenological events such as the beginning of flowering, early pod fill and maturity. Numerous models have been developed for this like climatic normal, probability of extreme weather events and optimum weather conditions for higher yield. Soya bean crop early sowing is done in July, normal (July-September) and late sowing done on month September. It uses the phenology model in that CSM/Statistical model gives the crop alert and pest/disease alert through the SMS (Smart Messaging System) to manage the real time climate risk in crop.

Pest and diseases information is also given due to the climate variability/change as per the farmer's query. Climate variability/change is happen due to the change in temperature (Temp), rainfall (RF) and management practices (MP).Major crops in soya bean crops are Aphid and Whiteflies. Cross boundary pest is utilize for the management of the soya bean pest.

In this paper, we have use the WRF (Weather Research and Forecasting) model is a next-generation mesoscale numerical weather prediction system designed not only for atmospheric research but also for operational forecasting applications. It has two features like dynamical cores and a data unification system, and a software architecture supporting parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of km.

A. Crop based binary decision tree:

A comprehensive dataset of detection of soya bean diseases [7] has been considered to demonstrate our results in terms of disease classification accuracy. For each disease there were several observations based on 35 nominalized attributes like severity, area damaged, leaf spots, etc. This dataset has been used to generate a decision tree using C4.5 algorithm [7] which uses the information gain criteria for selecting features depicted as different nodes in a decision tree. Fig (5) shows the system architecture of this.

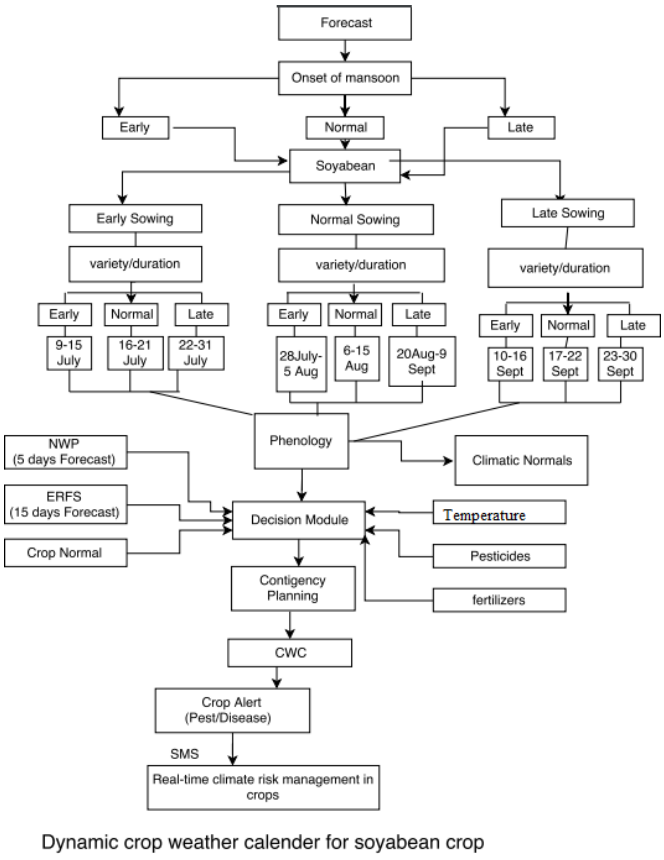

Fig. 3. Dynamic Crop Weather Calendar for real-time risk management for Soya bean crop.

B. Mobile crowdsourcing application for expert system: The questions to be asked by the farmers and answers are generated from the binary response decision tree.'N' farmers asked the questions to agromet expert system. We envision that a mobile phone based application can be preinstalled on farmer's mobile phone which can get triggered displaying a question Qi. A screen-shot of mobile phone crowdsourcing application displaying a particular question is shown in Fig(4). The questions can be asked in regional language to giving the responses to a large number of farmers. This questions observation of a farmer is considered by expert system and provide the binary response rN of the farmer FN.

Fig. 4. Screen shot of mobile crowd sourcing approach

B. Answer generation and decision engine:

A set of binary responses R ∈ {r1, r2, ⋯, rN} generated by expert system to the questions Qi asked by the set of N farmers F ∈ {F1, F2, ⋯, FN} are aggregated based on the majority rule to determine the final aggregated response Ri (refer Fig. 5). This response Ri to the question Qi helps to navigate in a decision tree to a next set of N farmers. This process continues in an iterative manner until a decision D about any disease, fertilizer and pesticides has been arrived.

As per considering the developed system we have system in place that is accessible from internet on mobile device or laptop with internet access. Database in our system is My SQL. The system is capable of answering queries and problems like crop diseases prevention, pest cure based on symptoms. We have added the provision for reporting diseases easily which are updated instantly in our database. System will provide the preventive measure to be taken to avoid adverse effect of would be weather based on next 5 days weather forecast and also give advice to farmer to overcome the damages of crop or input to crop due to the bad weather that took place during the past week and the advice will be in the form of irrigation, fertilizer/manure dose and pest control.

V. RESULT AND DISCUSSION

In this paper, we show the simulation results which were performed using SVM tool classifier. For simulation purpose, we use the soya bean large dataset repository. Soya bean diseases are characterized by 16 different dataset. Although, this dataset contains information about 70 diseases of soya bean crop, we considered only 20 diseases as the data for the remaining diseases was insufficient in terms of number of parameters and number of instance of the disease. By consulting all this parameter we make the agro met expert system with more accuracy than formal systems in that system 80% accuracy and in our system we will guarantee 89% accuracy, because we using standard database of (IMD)Indian Metrological Department for weather forecast data.

In this system we include more useful weather predictions data. Alerts and notifications related to weather are sent to the farmers so that they can take exact precautions before any damage is done by the weather anomaly.so this system best as compare to other previous systems which are developed for the agriculture system. We represent the accuracy graph by plotting the Performance Measure of our system with the previous existing system shown in Fig. (6).

TABLE I. PERFORMANCE MEASURE

Crop Type	Accuracy	
	2016	*2017*
Soyabean	88%	90%

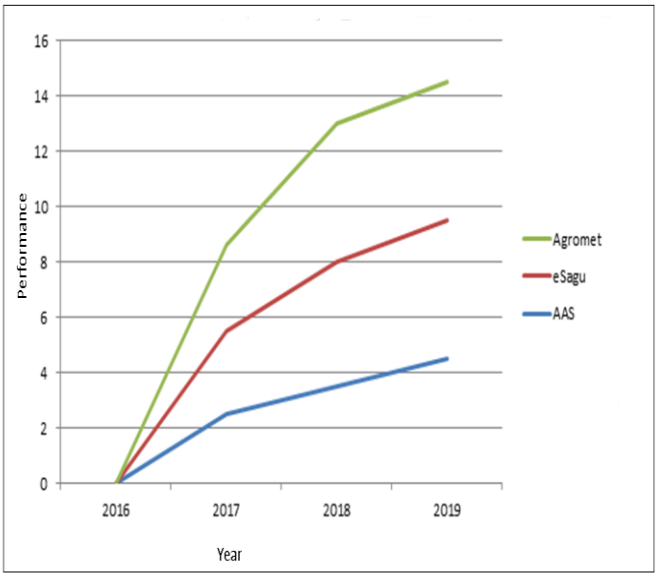

Fig. 5. Performance measure of Agro-met system with different system.

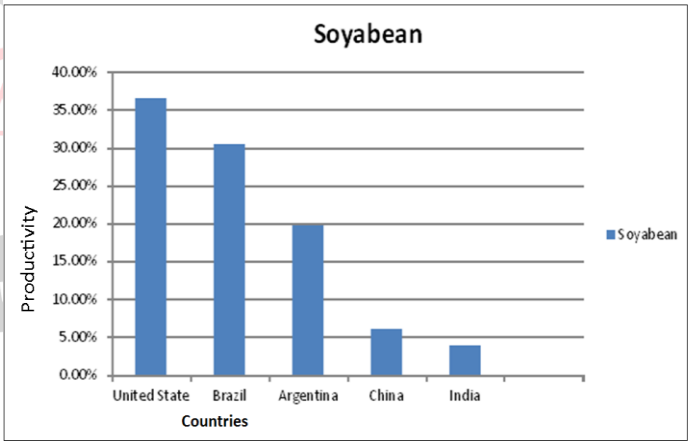

Fig. 6. India's production of soyabean crop as compare to other countries.

VI. CONCLUSION AND FUTURE SCOPE

In this paper, we have developed the expert system only for soya bean crop for Ahmednagar district only, it will helps /give advice to farmer regarding all kinds of diseases of soya bean crop, so that farmer can get the production as per his expectations. But in future it will be apply for all the type of crops .As our work region is only Ahmednagar district but in future work it will be covered the all area in country. Our system will focus on developing user friendly interface in regional language (Marathi).

In future, we aim to address the problem of more sophisticated data aggregation schemes applied on the questions obtained from the farmers. Furthermore, the future research will also include exploring the incentive scheme for the farmers and to explore the composition with dynamically varying number of solutions to the farmer's questions.

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REFERENCES

[1] S. Chaudhary, M. Bhise, A. Banerjee, A. Goyal and C. Moradiya, "Agro advisory system for cotton crop", 2015 7th International Conference on Communication Systems and Networks (COMSNETS), 2015.

[2] "India Meteorological Department", Imd.gov.in, 2017. [Online]. Available: http://www.imd.gov.in. [Accessed: 25- Oct- 2017]

[3] S. Islam, "ShellAg: Expert System Shell for Agricultural Crops", 2013 International Conference on Cloud & Ubiquitous Computing & Emerging Technologies, 2013.

[4] "Home | Department of Agriculture Cooperation & Farmers Welfare | Mo A&FW | GoI",Agricoop.nic.in, 2017. [Online]. Available: http://www.agricoop.nic.in. [Accessed: 05- Dec- 2017].

[5] 2017. [Online]. Available: http://www.maharain.com. [Accessed: 06- Dec- 2017].

[6] M. Aslam and A. Abdullah, "A Methodology and a Tool to Prepare Agro-Meteorological Maps as a Source of Big Data", 2015 IEEE International Conference on Multimedia Big Data, 2015.

[7] P. Singh, B. Jagyasi, N. Rai and S. Gharge, "Decision tree based mobile crowdsourcing for agriculture advisory system", 2014 Annual IEEE India Conference (INDICON), 2014.

[8] "nic.com", Nic.com, 2017. [Online]. Available: http://www.NIC.com. [Accessed: 20- Dec- 2017].

[9] 2017. [Online]. Available: http://www.imdagimet.gov.in. [Accessed: 20- Dec- 2017]..

[10] N. (NIC), ":: Department of Agriculture, Maharashtra State ::", Mahaagri.gov.in, 2017. [Online]. Available: http://www.mahaagri.gov.in. [Accessed: 04- Dec- 2017].

[11] B. Maurya, M. Beg and S. Mukherjee, "Expert system design and architecture for farming sector", 2013 IEEE CONFERENCE ON INFORMATION AND COMMUNICATION TECHNOLOGIES, 2013.

[12] "wotr.com - This website is for sale! - wotr Resources and Information.",Wotr.com, 2017. [Online]. Available: http://www.wotr.com. [Accessed: 06- Dec- 2017].

[13] V. Kumar, V. Dave, R. Nagrani, S. Chaudhary and M. Bhise, "Crop cultivation information system on mobile devices", 2013 IEEE Global Humanitarian Technology Conference: South Asia Satellite (GHTC-SAS), 2013.

[14] [online] Available at: http://[17] Hodges T. and French V. (1985) ,"Soyphen: Soybean growth stages modeled from temperature, day length and water availability. "Agron. J. 77, 500-505. [Accessed 25 Dec. 2017].

[15] [online] Available at: http://Jones P. G. and Laing D. R. (1978) ,"Simulation ofthe phenology of soybeans. "Agric. Systems 3,295-311.[Accessed 25 Dec. 2017].

[16] [online] Available at: http:// Mishoe J. W., Hesketh J. D., Boote K. J., Herzog D. C. and Tsai Y. (1980) ,"Phenology of soybean: Development Of a model. University of Florida, Gainesville. Unpublished Manuscript". [Accessed 25 Dec. 2017].

[17] [online] Available at: journal homepage: www.elsevier.com/ locate/ isprsjprs," Automated mapping of soybean and corn using phenology". [Accessed 21 Feb. 2018].

