Climate-Crop Interaction Modelling

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Abstract: **India's economy mainly depends on agriculture. Agriculture is a business which has to face many risks. Climate, political, biological, geographical and economic factors are those on which the Crop Productivity mainly depends. In recent years it has been recognized that there exists an interaction between climate and the crop. The interaction of the crop-climate may change the impact of the climate change on the crop. A Climate-Crop interaction model, in which the growth of the crop model is coupled with a climate model, is one of the tool to access the interaction of the climate-crop. In this paper, a new methodology for the extraction of crop yield response to the climate factors and change from the long-term observations is described. As there exists a vast data to adapt practically, it is necessary to adapt methods for using the higher processing power like High Performance Computing(HPC) technology.**

Key words:- New methodology, Crop model, Crop productivity, Climate model, HPC.

I. INTRODUCTION:

The response of crop yield to the climate change have been received a major attention about three decades. The importance of understanding the response of the crop yield to the climate change have triggered the development of the number of crop models which varies from statistical to the complex process in the crop growth and development. There are many studies available for the climate-crop interaction. The climate-crop interaction can affects the variation in the crop productivity.

Our research explores many features of agriculture and then takes a look at how the geographical-information science can improve the formers using High Performance Computing(HPC) which uses the Supercomputers and many computer clusters in order to solve the computation problems as agricultural activity monitoring. Agriculture is providing the means of the livelihood for more than half of the India's population. India had ranked second in worldwide in the farm output. In these days, it is necessary of growing need for the power of HPC. The field of agriculture has a lot of scope to improve the use of HPC. Its solutions help to focus on the internal resources, and the time on research that helps to reach goal. Agriculture is a field which is closely related with the data analysis.

II. HIGH PERFORMANCE COMPUTING (HPC) AND AGRICULTURE:

Due to the rapid growth in the HPC it has become a key for technology which is now driving future research and the development activities. Agriculture has a lot of scope for improving and use HPC. It helps to divide the problem into number of small fragments and after to those different processors will help to find the solution of the different parts using the algorithms such as parallel processing algorithm and many required softwares. So the problem with the huge computation which takes the small amount of time can be done at early using the HPC. Supercomputing facility allows the globally convex, estimation of the large, and the flexible agricultural production system. In agriculture the climatic changes and the nature of the soil plays an important role. By using HPC we can analyze many minute details of the soil and the climate, which in turn increases the crop yield exponentially.

HPC will make possible the microscopic analysis of soil and the climate. This plays a major role in increasing of the crop yield exponentially. When an agricultural research involves a vast land area, the satellite imagery is necessary. The use of the satellite imagery in the agricultural research has its own limitations. It can't capture the minute details which are related with the soil and the crop where the simulation models can help which calculates a large amount of data to present the final output. This calculation requires a fast processing speed and database to store the huge amount of output formed where in HPC works.

III. FEATURES OF INDIAN AGRICULTURE:

Indian agriculture has some main features which are given below,

i. **Subsistence Agriculture:** Many parts of India have this subsistence agriculture. Most of the farmers owns a small piece of land, grows the crop

with the help of his family and then consumes almost the entire farm produce. These kinds of agriculture have been practiced in India for several years.

ii. **Pressure of population on agriculture:** Indian population is increasing at a rapid speed and puts heavy pressure on the agriculture. Agriculture have to provide employment to large section of work has to feed the millions. When we have a look into the present need of food grains, its necessary for an additional 12-15 million hectares of the land.

iii. **Dependent upon monsoon:** The agriculture of India is mainly depending on monsoon which is irregular, unreliable, and uncertain. Instead of the large scale expansion of the irrigation facilities, only one-fourth of the cropped area is provided by the perennial irrigation and remaining of the cropped area has to face brunt of vagaries of monsoons.

iv. **Variety of the crops:** India is a country with various types of climate, relief and soil conditions. Hence, there is large variety of crops in India. Both of the temperate and tropical crops are grown in India. Only few countries in world have variety of the crops comparable to the crops produced in India.

v. **Predominance of the food crops:** As Indian agriculture needs to feed a large population, the production of the food crops is first priority of farmers everywhere in the country. Nearly two-third of total cropped area is given to cultivation of the food crops. With change in the cropping patterns, the share of the food crops have come down from 76.8 per cent in 1950-1951 to 54.8 per cent in 2012-13.

IV. WEATHER APPLICATIONS IN AGRICULTURE:

Temperature, solar radiation and precipitation are main drivers of the crop growth. The role of the climate as determinant of the agriculture has been recognized. Climate change is a greatest limitation which is making farming more difficult. The problems that farmers facing relates to the intra-seasonal factors of rainfall, unseasonal rains and extreme events. These problems cause heavy loss to crops in every year.

There exist some weather related applications which may be used to predict climatic change in advance. This helps the farmer to take the necessary action. By using the HPC automatic adjustments of the daily watering to the crops according to weather conditions were controlled which will help to avoid the wastage of water.

Weather Research and Forecasting (WRF) is one of the parallel open source application which may be used and implemented. Weather predicting application is the compute intensive application. There are several significance of the weather forecast in the agricultural field,

i. The weather forecast events help for the suitable planning of the farm.
ii. It helps into withheld or undertake sowing operation.
iii. It helps in the farming operations like, to irrigate crop or not, whether to start the complete harvesting or withhold it, and when to apply fertilizer or not
iv. It helps into take measures to fight the frost.
v. It helps in the measures to protect the live stock.
vi. It also helps in the management of the cultural operations like hoeing, plugging, harrowing, etc
vii. It helps in the transportation and the storage of the food grains.

4.1 Challenges Confronting Indian Agriculture:

Though the above mentioned features stand as a pillar to the country's agriculture; still the crop production faces few issues. Climate change is the greatest limitation making farming more difficult. Climate change has the potential to negatively impact agriculture due to drastic changes in temperature, rainfall, CO2, solar radiation and the interaction of these elements. The world's agricultural systems rely substantially on increasing use of fertilizers. But now, the world's farmers are witnessing signs of a declining response curve, where the use of additional fertilizer yields little additional food product.

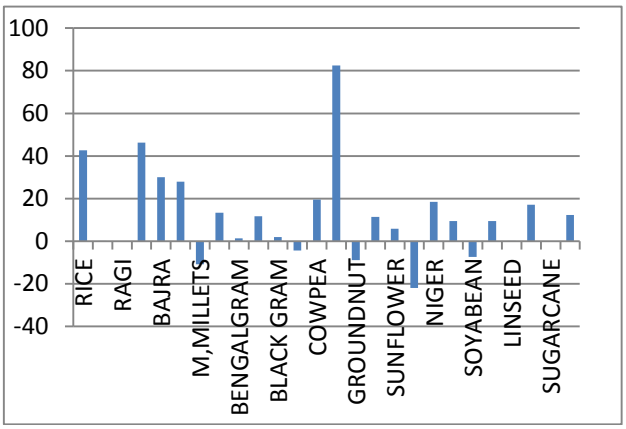

Figure 1: Trend analysis of different crops over Karnataka for the period 2001 – 2012

In the above shown graph (Figure 1) it is shown that the trend analysis of different crops over Karnataka region for the period of 2001-2012. In the X axis we have taken the data of different crops which are grown in Karnataka and in the Y axis we have taken the data of rainfall over the Karnataka region.

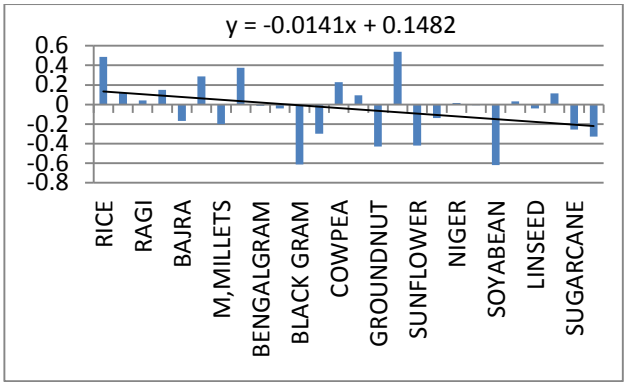

Figure 2: Correlation analysis of different crops over Karnataka with annual rainfall.

In figure 2, it is shown that the correlation analysis of different crops over Karnataka region with the annual rainfall for the period of 2001-2012. In the X axis we have taken the data of different crops grown in Karnataka region and in the Y axis we have taken the data of rainfall over the Karnataka region. For this a trend analysis is done which gives the trend value as $y = -0.014x + 0.148$.

Fig. 3 shows the architecture of crop prediction which includes an input module which is responsible for taking input from farmer. In that the farmer has to provide area of land, region, economic status and city. The farmer is also responsible for interacting with predicted results. After selecting the city parameter based on altitude, longitude and latitude automatic climatic data will be reflected from crop knowledge base. The feature selection module is responsible for subset selection of attribute from crop knowledge base for robust learning. The crop knowledge base is consist of farm knowledge such as region-id, region-name, soil-type, water ph, rainfall, humidity, sunlight, land information, environmental parameter, city, pesticides information, crop knowledge such crop type, seed type. The knowledge-base also includes the samples of crop with corresponding farm knowledge, environmental parameter, and pesticides information. After subset selection of attribute, the data goes to classification and association rule for grouping similar contents. Then prediction rules will be applied to output of clustering to get results in terms of crop, pesticide and cost.

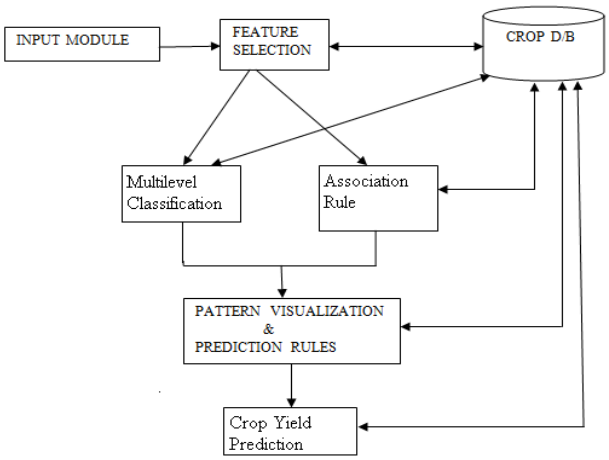

Figure 3: Architecture of crop yield prediction.

V. CONCLUSION:

Agricultural production is very much dependent upon environmental variables and is also an important agent of environmental change. This Paper considered the subject of sustainability of Agriculture, which is an inherently 'fuzzy' problem with innumerable grey areas due to the arbitrary and intangible nature of the term ‘sustainable’. It involves complex issues such as timeframes, differing scales in space and levels of permanence. HPC provides an integrated, flexible, scalable and easy-to-use problem solving environment for Agriculture. Improved irrigation techniques provided by HPC have the potential to increase crop production. HPC also helps in Improved farming techniques in areas that rely on rainfall also could improve yield. Improving the use of fertilizer, especially on rain fed land, also would help production. Climate change will affect agriculture in different regions of the India in different proportions.

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