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# The Impact of Data Analytics in Crop Management based on Weather Conditions

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**Abstract**

*Agriculture is the most significant application area particularly in the developing countries like India. Data mining plays a crucial role for decision making on several issues related to agriculture field. The goal of the data mining process is to extract knowledge from an existing data set and transform it into a unique human understandable format for some advance use. Crop management of certain agriculture region is depends on the climatic conditions of that region because climate can make huge impact on crop productivity. Real time weather data can helps to attain the good crop management. Utilization of information and communications technology enables automation of extracting significant data in an effort to obtain knowledge and trends, which enables the elimination of manual tasks and easier data extraction directly from electronic sources, transfer to secure electronic system of documentation which will enable production cost reduction, higher yield and higher market price. Also identified that how the data mining helps to analyze and predict the useful pattern from huge and dynamically changed climatic data. In agricultural and biological engineering, researchers and engineers have developed methods of fuzzy logic, artificial neural networks, genetic algorithms, decision trees, and support vector machines to study soil, climate conditions and water regimes related to crop growth and pest management in agriculture. In this paper summarizes the application of data mining techniques, Neural Networks, Support Vector Machine, Big Data analysis and soft computing in the agriculture field base on weather conditions.*

***Key Words: Agriculture, Efficient crop management, Weather data, Climate change, Data mining, Soft Computing, NeuralNetworks, Fuzzy Logic, Big data and Support Vector Machine***

## 1. Introduction

Farming is the backbone of all monetary movement. Horticulture as a business is interesting yield generation is subject to numerous climatic, geological, natural political and monetary variables that are for the most part autonomous of each other. The development of human progress over the ages was for the most part affected by the headway in agribusiness segment. Independence in horticultural creation gives a country the pride of having the capacity to sustain its populace all alone. Tragically, it is influenced unexpected components like overwhelming precipitation, absence of rain, bug assaults, and intrinsic characteristics of the dirt and approaches of the Government. Henceforth, expectation of horticultural generation on a yearly premise is intense employment, however deserving of the exertion since it will give the agriculturists a premonition of what they could expect in the following year. Late advances are presently a day's ready to give a considerable measure of data on horticultural related exercises, which can then be broke down with a specific end goal to discover imperative data and to gather pertinent data. The monetary commitment of horticulture to India's GDP is relentlessly declining with the nation's expansive based financial development. Arrangements followed in the nation and nature of innovation that got to be distinctly accessible after some time has strengthened a portion of the varieties coming about because of normal variables. The Agricultural yield is principally relies on upon climate conditions, maladies and bugs, arranging of reap operation. Successful administration of these components is important to assess the likelihood of such negative circumstance and to minimize the outcomes. Precise and dependable data about chronicled trim yield is along these lines essential for choices identifying with rural product administration. Information mining procedures go for finding those examples or data in the information that are both important and intriguing to the rancher. Before, this yield forecast has really depended on agriculturist's long–term encounter for particular yield, crops and climatic

conditions. The rural yield is essentially relies on upon climate conditions. Understanding the relative Importance of these Climate elements to product yield variety could give significant data about harvest planting and administration under environmental change condition for ranchers. Development in information estimate requires computerized strategy to concentrate vital information. By applying information mining procedure it is conceivable to remove helpful learning and patterns. Learning picked up in this way, might be connected to build work proficiency and enhance basic leadership quality. Data innovation has turned into a necessary piece of our every day life. Procedures for overseeing information have turned out to be essential and regular in industry and administrations. This is particularly valid for agribusiness, keeping in mind the end goal to modernize and better apply GPS innovation. Investigation is required for finding the future climatic states of specific locale where the information mining assumes an imperative part to analyze chronicled climate information and locate the required arrangement. The information can be broke down in a social database, an information stockroom, a web server log or a straightforward content record. The aim of this paper is to give insights about various information mining strategies of farming area so analysts can get insights about proper information mining systems in setting of harvest administration in light of climate conditions.The paper is organized as follows section 1 discusses the introduction and literature survey section 2 discusses the methods of climate system. Section 3 discusses thedata mining and applications of data mining techniques used in agriculture domain based on weather conditions. Section 4 discusses the conclusion.

### 1.1 Literature Survey

Beside the research work on agriculture, several websites by both central and state governments are in service. These websites are providing information on different phases of agriculture in their own way. A top down strategy is mainly used for flow of information. Data on seeds, pesticides, machinery and fertilizers are made available and is not properly utilized by the end users such as agricultural officers and farmers. Most of the websites are merely provides the static data and lack in the dynamic interface among stakeholders. The authors specify how various factors that directly and indirectly affect the farming can be studied and analysed in precision farming. The authors have coined various applications of soft computing techniques in soil, water and weather context, also its future in precision farming is discussed. For examining the null hypothesis and its importance in crop insurance, an extensive literature survey was conducted. Research papers in journals like American Journal of Agricultural Economics, Canadian Journal of Agricultural Economics, Agribusiness, and North Central Journal of Agricultural Economics were reviewed to analyze the findings of various researchers working in the general area of frequency distributions for historical crop yields. In addition to the literature survey, a quantitative analysis of actual yields is considered necessary to test the null hypothesis. [5] Dorfan (1991) Argues that a large amount of agricultural economic data is inconsistent with the assumption of normality of Crop yield distribution. [6] The importance of skew ness in crop yield forecasting is specified by Gallagher by Suggesting that ignoring skewed distribution will lead to underestimation of most likely yields.[7] Just and Weinenger (1991) have studied country level data and based on their experiment the disagreed with crop yield distributions are non normal argued that the evidence available to date is not enough to disapprove normality of crop yields. [9] Norwood B. Roborts, Lusk (2004) – By their studies it was observe that the semi parametric model ranked highest for forecasting purposes.[8] Ramirez, Misra & Field (2003) – Studied yield distribution of these crops and conclude that they are non normal and left skewed. [10] From the research article “Data mining of agricultural yield Data: A comparison of regression models” George RuB express that large amount of data which is collected and stored for analysis. Making appropriate use of these data often leads to considerable gains in efficiency and therefore economic advantage. This paper deals with appropriate regression techniques on selected agriculture data.[11] “Classification of agricultural land soils: A data mining approach” In this research paper V. Ramesh and K. Ram explains comparison of different classifiers and the outcome of this research could improve the management and systems of soil uses throughout a large fields that include agriculture, horticulture, environmental and land use management. From “Generalized software tools for crop area estimation and yield forecast” Roberto Benedetti and others describes the procedure that leads to the estimates of the variables of interest, such as land use and crop yield and other sampling standard deviation, is rather tedious and complex, till to make necessary for statistian to have a stable and generalized computational system available.

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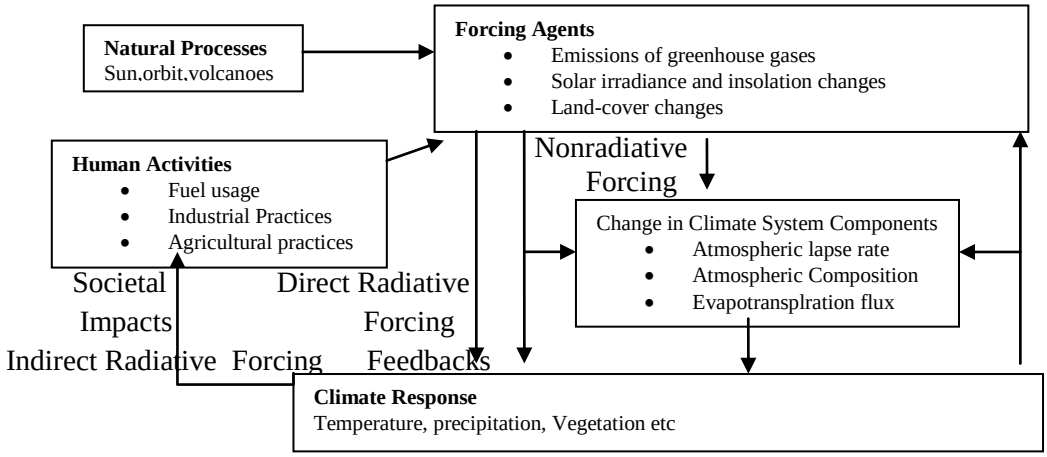
## 2. Climate System

The climate system is highly complex. Under the influence of the sun's radiation, it determines the earth's climate (WMO, 1992) and consists of:

- the atmosphere: gaseous matter above the earth's surface;
- the hydrosphere: liquid water on or below the earth's surface;
- the cryosphere: snow and ice on or below the earth's surface;
- the lithosphere: earth's land surface (e.g., rock, soil and sediment);
- the biosphere: earth's plants and animal life, including humans.

Although climate relates only to the varying states of the earth's atmosphere, the other parts of the climate system also have significant roles in forming climate, through their interactions with the atmosphere. The Global Climate Observing System (GCOS) has developed a list of variables essential for monitoring changes in the climate system.




## 3. Data Mining

Data mining is a procedure of extricating/comparing the important information from the substantial database by utilizing diverse apparatuses and strategies. Information mining programming is one of various demonstrative devices for breaking down information. Mechanized imminent investigation, coming about because of information mining, goes past occasion examination by utilizing review apparatuses, trademark for choice emotionally supportive networks. Framework investigation is the reason for anticipating key parameters in characterizing arranging components and their measurement. It permits clients to examine information from a wide range of measurements or edges, classify it, and compress the connections recognized. Information mining methods utilized as a part of horticulture for expectation of issue, infection location, and atmosphere conditions, improving the pesticide etc. Information mining assignments can be separated into distinct and prescient. While enlightening assignments intend to discover human translated examples and relationship, in the wake of considering information and in addition the whole model development, anticipating undertakings mean to foresee some reaction of intrigue. Despite the fact that the objectives of depiction and forecast may cover, the principle distinction is that prescient errands require an uncommon variable of reaction. Reaction might be all out or numerical, which additionally groups information mining as characterization and relapse. Information mining or information revelation in databases (KDD) is an interdisciplinary field where we coordinate strategies from various fields including information base frameworks, measurements, science, superior processing, counterfeit consciousness, neural systems and machine learning.

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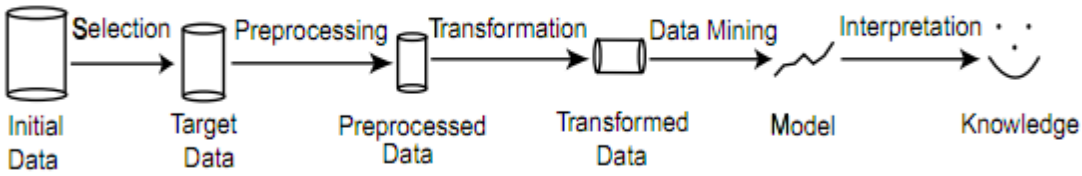


**Fig.1 : Data mining KDD Process**

### 3.1 Data Mining in Agriculture

Modern age has brought significant changes and information technologies in different areas of human activities have found wide application thus also in agriculture. Development and introduction of new information technologies which enable global networking, give agriculture the labelof 'IT agriculture'. Information technologies increasingly provide assistance in systematic approach to solving agricultural problems. Access to the right information enables preparation of accurate reports, for example about using protective equipment, number of work hours of the machine on a specific crop, or a number of hired season work force. At the same time it is easier to keep track of work and verify exchange of information. Agribusiness is plenteous with assorted data which conditions the need to utilize information mining. Through information mining horticultural associations are equipped for delivering spellbinding and prescient data as support to basic leadership. All rural ventures require proficient investigation of their farming information, undertaking which is long haul and exceptionally costly. Farming endeavors are exceptionally situated on utilizing data about market of agrarian items. Capacity to utilize information in databases to extricate helpful data for top notch farming is a key to achievement of rural ventures. Agrarian data frameworks contain monstrous measures of data including data about yields, clients, showcase… With the utilization of information mining strategies, helpful examples of data can be found in this data, which will be utilized for further research and report assessment. Important question is the means by which to group extensive measure of information. Programmed arrangement is done on the premise of likenesses present in the information. This kind of characterization is just helpful if the conclusion gained is adequate for the agronomist or the end client. Issue of anticipating generation yield can be illuminated with information mining methods. It ought to be viewed as that the sensor information are accessible for some previous tense, in which suitable generation yield was recorded. This data makes an arrangement of information which can be utilized for learning methods for characterizing future creation yields, on the grounds that new sensor information are accessible. yield expectation was directed in view of rancher's understanding of certain farming societies climate conditions and products. At the point when information mining apparatuses are characterized on elite parallel frameworks, they can be broke down with huge databases in minutes. Speedier preparing is required in such framework to get the compelling outcomes from complex frameworks. Fast preparing and exact result from the framework makes it workable for clients to dissect huge arrangement of data. Bigger databases, thusly, gives more enhanced expectations.

- Agricultural organizations store huge amounts of data in the form of crop databases. Trends in these databases can be identified using data mining practices, which sort and model the data in order to arrive at a conclusion. The data mining applications present the data in the form of data marts.
- In the agricultural industry, however, the lack of standard vocabulary has hindered the process of data mining to a certain extent. This could lead to unnecessary problems, during the process of data mining. The increase in the use of standardized terms will reduce the percentage of errors in the data mining process.

These data analysis help us to provide a better understanding of large data these two forms are as follows:

- **Classification:** In Classification prophesies unconditional and calculation models predicts continuous valued functions.
- **Prediction:** In prediction which is used to predict the data according to the given data.

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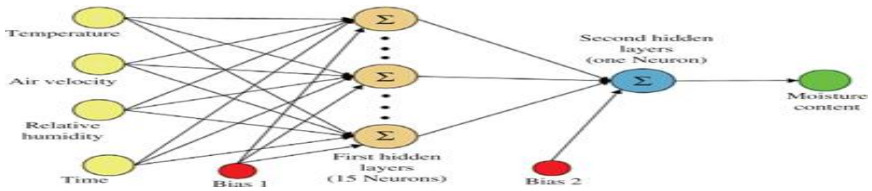
Information and communication technologies (ICTs) play an important role in agriculture scenario to increase the production, efficiency. Agricultural engineering is the one engineering discipline that deals with using various engineering techniques in a cost effective way to increase the productivity with minimum impact on the environment. The one thing that is yet to be exploited in Indian agricultural scenario is the use of computing and engineering techniques to solve the problems faced by farmers in the real time scenario. The problems faced by farmers are complex as well as the resources required for the solution is pretty huge. Even if a near optimal solution is obtained, it will have a very large impact. This can be very much achieved by the use of technology and other soft computing techniques.

### 3.4 Soft Computing

Mechanical developments in delicate processing strategies have conveyed computerization capacities to new levels of utilizations. Delicate figuring procedures can be generally utilized as a part of examining the previous conditions to foresee a future situation that incorporates post-gather, preparation, climate conditions, cost of vegetables, plans, soil richness. Prepare control is an imperative use of any industry for controlling the mind boggling framework parameters, which can enormously profit by such headways. Routine control hypothesis depends on scientific models that depict the dynamic conduct of process control frameworks. Because of need in intelligibility, traditional controllers are frequently sub-par compared to the astute controllers. Delicate figuring systems give a capacity to settle on choices and gaining from the solid information or master understands. In addition, delicate figuring procedures can adapt up to an assortment of ecological and strength related instabilities.

#### 3.4.1 Artificial Neural Network (ANN)

ANN is a versatile modeling system which permits the accomplishment many complicated tasks with ease. ANN is the result of extensive research carried out in the field of Artificial Intelligence (AI) and machine learning problems around the world. The tool easily adopts itself to the prediction of mathematical relations, recognition of particular patterns, error correction and noise removal in signals. Hence, the application of ANN for predicting agricultural production might enable estimation of the yield levels of crops as a function the annual rainfall levels and climate changes in the previous years. Thereby more and more land for agriculture is taken out use to serve other purposes every year. Thus, there is a significant degradation of land due to erosion and conversion. Pollution in water sources is another threat for agriculture. Other available resources are also affected badly, due to which agriculture sector is badly affected. Various factors, if summarized include the drastic increase in population all over the globe, the change in climatic conditions of agricultural land, the scarcity in water resources, monoculture in farming, etc.




#### 3.4.2 Neural networks

Neural networks are one main soft computing technique that can be used in agriculture systems. Data related to various factors related to agriculture is collected and is feed to neural network. Based on the training data feed, the required information is tapped. It includes the prediction of climatic conditions, availability of rain fall; since rain fall is one important factor in which whole of Indian agriculture depends on probability of occurrence of adverse climatic conditions, drought, soil fertility, occurrence of diseases as well as weed problems. The recent advancement in technology enables one to predict the diseases that a crop can have from just analysing a leaf. That is the extent to which technology has grown. But the services are not directly available to the farmers. Existence of middleman is the one main problem. If adverse climatic conditions can bepredicted and known to the governing authorities, the measures to overcome it can be taken care, and

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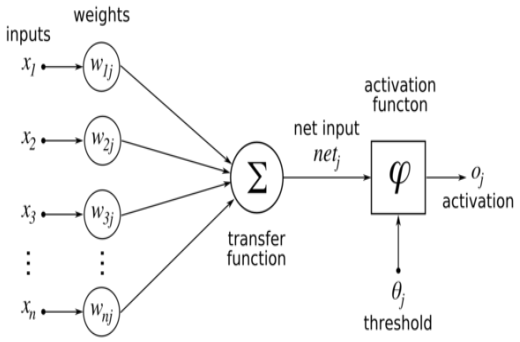
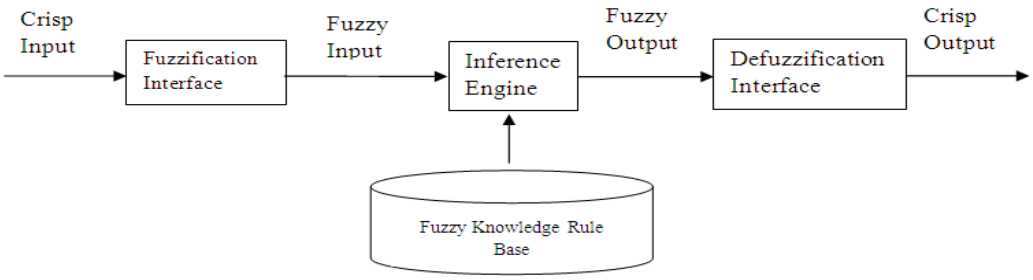
various schemes for it can be designed and implemented. Climate change stresses agriculture via rising temperatures and changing precipitation patterns, as well as increased soil vulnerability, climate variability, pests and crop disease, and increased atmospheric carbon dioxide. Affordable greenhouse solutions work

on a small, sustainable scale to mitigate some of the effects of climate change and provide strategies for smallholder farmers to adapt to the changing environment. Thus schemes like that can be designed and provided to the farmers if required. Effective watering can be made possible in drought affected areas by implementing moisture sensitive sensors and making the farmers aware of the optimum water required for each crop, which can again achieved by using fuzzy logic systems. The whole system proposed will be a cyclic interrelated system with components that can be designed from the data obtained from artificial neural network and fuzzy logic system. The transportation of the produce from production site to the seller and consumer was one concerning factor. It can again be solved by pre arranging the agricultural vehicles based on the outcome prediction of each crop. Farmers if educated well on the recent technologies and if given with anytime anywhere mobile devices will benefit a lot from the technology and thereby the productivity as well as profitability of the hard work can be improved to a larger extend. Thus, from the case study and application of technology for the issues raised by the farmers, it is evident that there is wide scope of research to be carried out in order to enhance lifestyle of farmers, their productivity growth and hence economy of Indian agricultural scenarios.




### 3.4.3 Fuzzy Expert System

Fuzzy logic is one of the methods of Soft Computing. Soft Computing is a computational method that is tolerant to sub-optimality, impreciseness, vagueness and thus giving quick, simple and sufficient good solutions (Chen and Chen, 1994)[1]. Lotfi A. Zadeh, a professor at University of California at Berkeley was the first to propose a theory of fuzzy sets and an associated logic, namely fuzzy logic (Zadeh, 1965)[11]. Essentially, a fuzzy set is a set whose members may have degrees of membership between 0 and 1, as opposed to classical sets where each element must have either 0 or 1 as the membership degree—if 0, the element is completely outside the set; if 1, the element is completely in the set. Fuzzy expert systems use fuzzy logic instead of classical Boolean logic and collection of membership functions and rules that are used for reasoning about data. They are oriented towards numerical processing and handles uncertain or imprecise information. A fuzzy expert system is an expert system, a Basic Components of a Fuzzy Expert System shown below



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The algorithm for performing the fuzzy logic genetic algorithm regression based on weather parameter can be summarized as follows:

Step I Mapping solution space into farm, that is, binary strings. Construct fuzzy fitness function using an objective function.

Step II Create initial weather conditions, that is, an agriculture of fuzzy regression coefficient which is randomly specified.

Step III Evaluate each pest based on weather conditions in the agriculture in terms of its pest management.

Step IV If termination conditions exist, go to step VIII.

Step V Finding new pest using selection methods, which randomly selects the current field.

Step VI Create new pesticide by mating randomly selected pests based on climate change. The resulting offspring replaces the original pest in the agriculture.

Step VII Mutate some randomly selected pest with their specified possibility.

Step VIII Stop, return the best pest estimation and management it into fuzzy coefficient.

**3.4.4 Genetic algorithm**

Genetic algorithmis a method of optimization and research technique which uses techniques based on evolution, specifically inheritance, mutation and selection.Genetic algorithm is similar to the natural evolution process where a population of a specific species adapts to the natural environment under consideration, a population of designs is created and then allowed to evolve in order to adapt to the design environment under consideration for solving optimization problems Genetic algorithm at the same time processes a set (climate changes) of potential solutions (individual) for a given problem. Algorithm begins with a set of solutions called sub-population; more specifically it creates a certain number of random solutions. All those solutions don't need to be good, a set of solutions may be completely omitted, or the solutions may even overlap. Suitability of those solutions based on criteria of performance is evaluated and used to select solutions making a new, better subset of potential solutions (Huang et al., 2010). Bad solutions are disregarded, and good ones kept. Good solutions are then hybridized and the whole process is repeated. In the end, similar to the process of natural selection, only the best solutions remain. So, from the set of potential solutions to the problem competing with one another, the best solutions are chosen and combined with each other with the purpose of getting one universal solution from the set of solutions which will get better and better, similar to the process of organism population evolution. Genetic algorithms are used in data mining to formulate hypotheses about variable dependencies, in the shape of association rules or some other internal formalism. Careful selection of structure and parameters of the genetic algorithm can secure a significant chance to come up with globally optimal solution after an acceptable number of iterations. Genetic algorithms can be used for the process of decision making with the purpose of finding appropriate crops to grow which are profitable.

**3.5 Machine Learning**

There are four main approaches to machine learning of structural desc1iptions. In *similarity based learning,* the space of concept descriptions is delineated in advance and searched for concepts which best characterize the structural similarities and/or difference between known examples. There is a fundamental distinction between exact approaches, which guarantee to produce just that set of concepts which are consistent with the examples, and heuristic methods, which come up with a "good" concept but not necessarily the best one. In *explanation-based learning,* p1ior knowledge in the form of a "domain theory" is used to guide the interpretation of new examples. What is learned is not so much new knowledge,

for the domain theory already contains a complete and consistent prescription for interpreting all the examples that will be encountered, but rather new and more efficient ways of employing that theory to interpret examples. Clearly the assumption of a folly comprehensive domain theory is unrealistic in virtually all practical applications of machine learning, and *combined explanation- and similarity-based learning* is an attempt to weaken it by assuming an incomplete domain theory and augmenting it by processing new examples and incorporating them into the theory, either to correct erroneous parts or to add new rules to the theory. Finally, in *case-based learning,* example cases are stored and indexed in ways that highlight

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similarities and differences between them, and retrieved to aid in the interpretation of new, unseen, cases. Machine learning is a young field of research, and the methods that are best understood are also tend to be ones that suffer from serious drawbacks. Either they are computationally infeasible in all but very simple situations (such as exact similarity-based learning), they are not too far removed from conventional statistical methods (such as approximate similarity based learning), or they make assumptions so rigorous as to be untenable in practical situations (such as explanation-based learning). Nevertheless, the last two or three years have seen a substantial increase in our understanding of the application of ultimately more

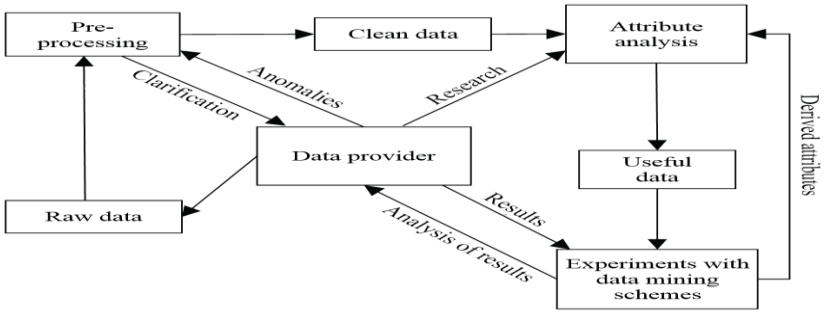


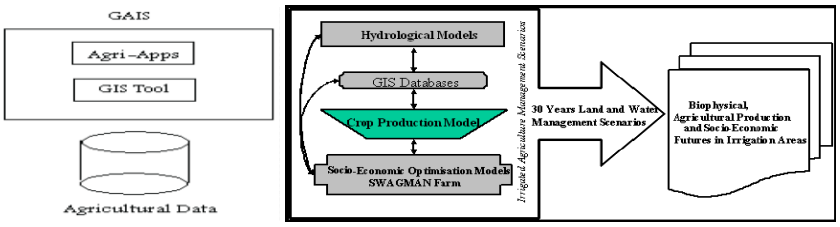

**Fig. 2. Process model for a machine learning (data flow diagram)**

**Software and Techniques used for constructing visual data mining framework as follows**

| Software and Techniques used | Purpose |
|---|---|
| ArcGis, Quantum GIS and Microsoft access database | For data preprocessing |
| GRASS software package | For generating the map |
| Viasual data mining | For predicting the pattern of agricultural land soil type |
| WEKA of Microsoft Excel | For used to analyze the data. |

### 3.3 Geographic Information System (GIS)

Geographic information systems (GIS) provide valuable tools in monitoring, predicting, managing and fighting the spread of pests and diseases. The tools offer opportunities for cost-effective and efficient targeting of control interventions. In monitoring, GIS can be used to determine the spatial extent of a disease, to identify spatial patterns of the disease and to link the disease to auxiliary spatial data. GIS can also be used to predict the projected spread of diseases, to provide input for risk assessment models in pest control and in quantifying changing thresholds of pests and diseases due to climate change. In order to use GIS techniques at a larger scale, a protocol for data collection and management is essential. While natural inputs in farming cannot be controlled, they can be better understood and managed with GIS applications such as crop yield estimates, soil amendment analysis, and erosion identification and remediation. Enhancing a GIS with land-cover data layers has proved helpful to crop growers' associations, crop insurance companies, seed and fertilizer companies, farm chemical companies, libraries, universities, federal and state governments, and value-added remote-sensing/GIS companies.




### 4. Conclusion

Agriculture is the most vital field which demandscomplete attention. Indian agricultural scenario is yet toundergo transformations in the modes of agriculturalproductivity. This paper therefore aims to provide aninsight to improve productivity and add value to thefarmer's effort by applying technology in them. The work limits to presenting the applicabilityof the above said technology to improve Indianagricultural conditions. However, further research isopened up to come out with predictive model usingagricultural empirical data and formulate all possiblerisk management strategies for the same.Agricultural organizations and their management tryevery day to find information (knowledge) in large databasesfor business decision making. Often the case is thatthe solution for their problems was within their reach andthe competition has already used this information. Datamining, through better management and data analysis, canassist agricultural organizations to achieve greater profit.Therefore it is crucial that managers of agricultural organizationsget to learn about the idea and techniques ofDM, because the amount of available information is sure togrow in the future, and it will not become clearer and easierto understand and make decisions. Understanding of the processes whichare carried out and decisions being made in agricultural organizationsis enabled through data mining. By the use ofdata mining technique acquired knowledge can be used tomake successful decisions which will advance the successof the agricultural organization on the market. Data miningrequires a certain technology and analytic techniques,as well as the systems for reporting and monitoring whichcan measure results. These patternscan be used for diagnosing crop condition, prognosingmarket development, monitoring customer solvency. However,available raw agricultural data are widely distributed,by nature different, and extensive. Agricultural institutions use datamining technique and applications for different areas, forinstance agronomists use patterns measuring growth indicatorsof plants, crop quality indicators, success of takenagrotechnical measures and managers of agriculturalogranizations pay attention on user satisfaction and economically optimal decisions. In the future, more indicators, such as soil parameters and management practices, will be needed to investigate the variability in crop yields at regional or national scales .Thisinvolves building up suitable forecast model(s) which hascertain merits over the traditional forecasting method.Two main factors such as climate change and the yield change were identified by using CSIRO and MIROC model.This analysis provides the good decision support to the farmers for planting the crop and also helps to alerts the farmers for protecting their field from disaster. The various clustering algorithms such as Multidimensional analysis, Statistical analysis, Association rule mining, Novel Clustering, Multi Fractal Detrended Cross Correlation Analysis (MF-DXA), K-Mean clustering and Non-linear Least Square Regression were identified. Climatic parameters such as Average solar radiation, Average minimum temperature, Average maximum temperature, Water deficit and Phase length were encountered in this survey.

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