Data Mining Technology with Fuzzy Logic, Neural Networks and Machine Learning for Agriculture

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Abstract Farmers countenance failure as the crop cultivation decisions by farmers always depend on current market price as the production sustainability processes are not taken into consideration. So there should be some platform which guides the farmer for taking correct decision depending on their need, environment, and changing seasons. The system proposes Marathi calendar using nakshatras which guide farmer for crop cultivation decision. It aims to create methodologies to strengthen the farmers' economic conditions by providing informed decisions. The methodology used for the system specially uses data mining to generate expert decision along with the fuzzy logic, machine learning to give decisions appropriately to farmer for cultivation of expected crops.

1 Introduction

Agriculture theaters a vital role in India's financial system. Exploration in farming is intended for the sake of increased crop production at cheap expenditures and with amplified yield. Not only final product (crop produced) should be acceptable but also processes to develop that product should also be sustainable. Today's need is to train the farmer with sufficient as well as useful techniques necessary for farming. The farming usually depends on weather conditions and monsoon predictions. Each specific day in each and every season, according to farming practices has its own tasks to be worked out and if it is followed correctly it will consequence in increase yield of production.

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V. E. Balas et al. (eds.), *Data Management, Analytics and Innovation*, Advances in Intelligent Systems and Computing 839,
https://doi.org/10.1007/978-981-13-1274-8_6

The proposed work includes significant data from experienced farmers, the infallible and experienced procedure of farming, requirement of fertilizers, category of crops to be cultivated depending on farmers land condition, weather conditions, etc., to give suggestions to farmers for correct crop cultivation.

The proposed system analyzes methods such as fuzzy logic, neural networks to appropriately give decisions to farmer for cultivation of expected crops.

The system will provide the farmer with concrete model of farming which will be the perfect solution of sustainable agriculture.

2 Literature Survey: (See Acknowledgements)

From the table we can get to know that the production of crops is decreased tremendously over years. So the computer science and its algorithm can help the farmer to take informed decisions depending on different parameters such as climate, area, soil parameters, etc. Informed decision to farmers helps to take correct decisions to get increased yield for respective crop. Following are the authors who have studied on different aspects of the agriculture and provided some good solution (Table 1).

1. **Sawaitul et al.**, wrote about the effects of climatic conditions on agriculture. He has used prominent factors for weather prediction. He has checked the effect of variation of the different climatic parameters on the weather condition. The author has used algorithm such as back propagation and artificial neural networks [1].
2. **Somvanshi et al.**, did the analysis using Box Jenkins and ANN algorithm for rainfall prediction for agriculture purpose [2].
3. **Verheyen et al.**, discussed that different methodology of data mining are generally applied for calculation of farm land distinctiveness. The author has used *K*-Mean Algorithm for land classification by application of Global Positioning System Technology [3].

Table 1 % Growth rates in the Production of crop

Crops	1980–1990	1990–1996	1996–2005
Paddy	3.62	1.58	−0.07
Wheat	3.57	3.31	0.00
Jowar	0.27	−2.64	−4.09
Bajara	0.01	−1.51	1.68
Ragi	−0.10	0.19	−2.26
Pulses	1.49	−0.66	−0.83
Oil seeds	5.46	3.90	−0.88
Sugarcane	2.47	2.96	−1.95

Referred from Dr. Subhash Palekar's Book

4. **Jagielska et al**., illustrate solicitations to farming associated extents. They focused and discussed the parameter crop yield as very crucial factor for farmer. Earlier, the crop production prediction was calculated by the facts known to farmer as well as his experience on precise land, yield, and weather circumstance. They added discussion regarding statistics such as likelihood in concepts of probability, relationship rating with respect to fuzzy set concepts [4].
5. **Tellaeche et al**., identifying pest in accurate crop growing. Author has reviewed different software applications with respect to weeds revealing and finding accurate spray pattern for respective crop and related weed. They have proposed a system for giving decisions to farmers to identify the correct pattern. The algorithms used for the expert system are KNN, Fuzzy logic techniques [5].
6. **Veenadhari** The author has taken into consideration the Bhopal district of Madhya Pradesh for the study. They analyzed effect of climatic conditions with respect to rabi as well as kharif crop yield. The technique used is decision tree analysis. The study is undertaken for soyabean and wheat crop. The effects of rain, temperature, humidity, etc., are studied. So the study shows that paddy crops are mostly affected by rainfall and wheat crop is having dependency shown for temperature parameter mostly [6].
7. **Shalvi and De Claris** In this paper the author stated that Bayesian network is a popular application frequently used for agriculture databases. The system designed for farming purpose uses most popular methodology of Bayesian network. Finally they concluded that Bayesian Networks are realistic and proficient [7].
8. **Chinchulunn et al**., The paper categorize the data mining algorithms KNN rules into two classes, i.e., (1) Coaching (2) Testing. They proposed that fewer points need to be considered in first class [8].
9. **Rajagopalan and Lal** The comparative analyses of data mining technologies and their applications are considered for agricultural databases. For example they took KNN for application on daily precipitations simulation, etc. [9].
10. **Veenadhari et al**., The author has discussed SVM methodology for categorization of data into two classes [10].
11. **Tripathi et al**., They have shown the application of Support Vector Machine based algorithms on future weather prediction. They verify the results for weather alteration on precipitation over India [11].

As nearly all the ES (expert system) concentrates on exacting features of yield similar to insect, weeds, compost, etc. So all the expert systems and technology available for farmers are giving solutions to problems but they are scattered among different applications. So farmers are not getting ONE STOP solution. Similarly the expert systems are designed are either for particular area or for according to some climatic parameters. So farmer needs expert system which may possibly answer nearly all the questions and suggests the better solution for their existing situation.

Also none of the system helps the new grower about the knowledge of farming concept

(1) What to grow when?
(2) What types of land required for which crops?
(3) Which type of fertilizers is required for specific crop?
(4) What can be taken as mixed crop? etc.

The literature survey provides that no recent work endow the farmer with the appropriate decision of crop cultivation throughout the life cycle of crop. Every expert system designed until is addressing only one problem as a system. So the proposed system will provide farmer with solutions to almost every problem to take informed decisions regarding crop cultivation, type of crop pattern, when to cultivate what, when to do spraying for crops and requirement of resources and remedies for the types of diseases.

The proposed expert system is using Google map GPS for getting the land area of farmer and depending on the attributes of land and other parameters outputs will be given to the farmer. The proposed system uses Fuzzy logic adaptive techniques such as adaptive neuro-fuzzy inference systems (ANFIS) and fuzzy subtractive clustering. The feed forward back propagation artificial neural network, this methodology has been used in our proposed system for modeling and forecasting of various crop yield, type of crop cultivation, etc., on the basis of various predictor variables, i.e., input by farmer, viz. type of soil, season, nakshtra, insecticide, fertilizer, rainfall.ANN with zero, one, and two hidden layers have been considered (Fig. 1).

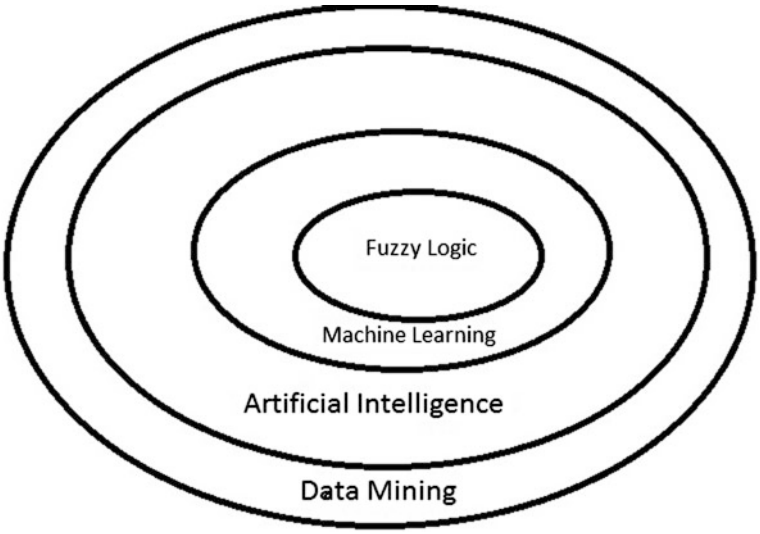

Fig. 1 Relationship between data mining algorithms

3 Proposed Work

In any sector management is important aspect. Agriculture field is also management related field. In agriculture Informed decisions are taken by the farmers based on the knowledge experience he had. Nowadays due to complex, complicated, computational world, it is required to adapt exact activity or agriculture process for cultivation of crop. Also it is required to make sure that no farmer survives on one crop pattern. So we suggest that farmer should use multiple crop patterns as per season in all types of monsoon regions of India reason for cultivation and profit. So we used data mining along with Artificial intelligence, Machine learning and fuzzy logic for well-being of crop and overall agriculture sustainability.

The three terms we used are as follows and can be described as Fig. 1

(I) Artificial Intelligence

In this we proposed all farming activities are designated in such pattern so that it is automation of crop pattern. For the given selected crop AI will take inputs such as

- Climate needed for that crop, according to climate—Atmospheric temperature, humidity, sunlight, etc. These are the direct inputs taken from the local weather forecasting department of India
- Soil required for that crop (TYPES OF SOIL)
- Plowing date required for that crop in various range
- Harvesting date required for that crop in various range
- Insecticides bites for that crop
- Fungicide bites for that crop
- Fertilizers for that crop
- Water requirement for that crop.

All the inputs are considered by AI for any type of crop. The simple algorithm of AI can take this information as input for producing proper crop decision. The inputs are also taken by machine learning algorithm at highest level by using ANN.AI uses more static programming instruction (Fig. 2).

(II) Machine Learning application in agriculture [12]

Full exploitation of data mining technology can be done by machine learning. Machine learning actually processes the data for example study of pattern recognition in agriculture field for particular crop or suitable cropping pattern. It also makes comparisons to give most suitable crop pattern that can be produced. Machine learning uses dynamic program instruction as well as static programming instructions too. Machine learning takes changing inputs such as change in temperature value which in turn makes changes into

- Harvesting time
- Spraying patterns of Insecticide and Pesticide

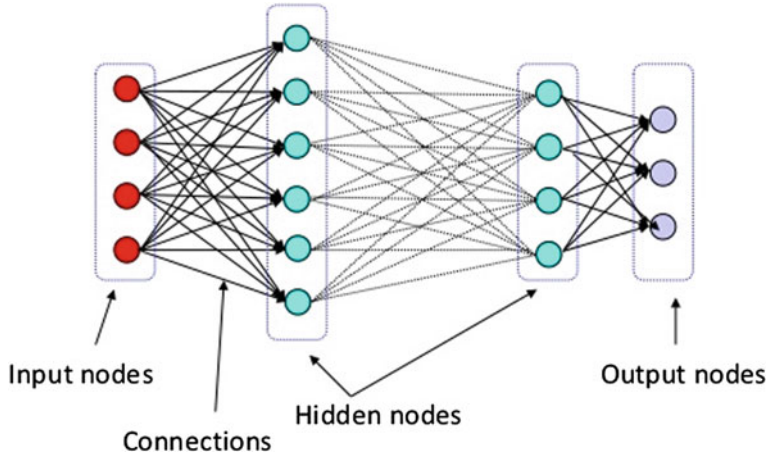

Fig. 2 Application of ANN, AI and machine learning and fuzzy in agriculture

- Water Requirement
- Fertilizer Usage-If temp is high farmer should not increase fertilizer usage for that period.

While using machine learning level in farming we can use more ANN to increase relationship between interconnected group nodes. So that back propagation can be applied more rigorously and by adjusting the network to reflect the exact decision. ANN is really helpful for making pesticide and fungicide spraying decision. We can also make use of Image processing and other tools which are not the subject of this paper.

(III) Fuzzy application in farming [12]

The fuzzy logic technique can be applied for agriculture to check feasibility of activity. We can also use fuzzy for evaluation of agriculture activity based on economic viability of the cropping pattern. In machine learning it may happen that depending on the data and activity input it will produce a single restricted output solution. It will not provide flexibility of solutions to be applied but fuzzy along with data can give us more than one solution flexibility in following aspects

- Inter cropping decision (Provide Options-refer Fig. 3)
- Insecticide and Fungicide determination decision(Less Expensive and Exact)
- Type of water input process determination
- Soil preparation decision
- Handling Control and decision making complex models.

Fig. 3 Mix cropping pattern

4 Result

There is no secret to success. It is the result of perfection, hard work, learning from failure, loyalty, and persistence. Productivity is never an accident. So for better crop yield and correct informed decision by farmer can be done using Machine learning algorithm. The following table shows the varying parameters input to agriculture and different algorithms we have used with the probable result (Fig. 4).

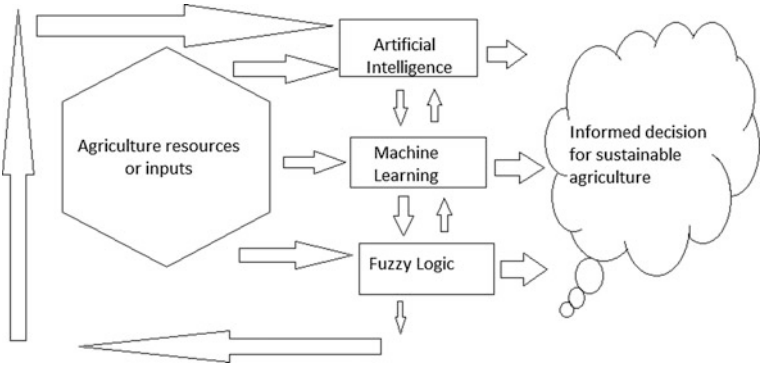

Fig. 4 Data flow of data mining for sustainable agriculture

Table 2 Result in different phases of data mining depending of inputs given

Farming input parameters	AI	Machine learning	Fuzzy	Result	Example
Temperature	Climate region	Suitable crop	Feasibility and economic viability	– Tropical crops – Hill Crops – Input usage	Coconut to Apple
Soil	Type of soil	Suitable crop	Feasibility and economic viability	Mix cropping pattern	Black cotton soil, Laterite. Sugarcane and cotton
Humidity	Type of climate region	Suitable crop	Feasibility and economic viability	– Crop Protection spray – Mix crop pattern	Kharip or rubby
Sunlight	Hot/cold region	Suitable crop	Feasibility and economic viability	– Amount of photosynthesis evaluation – Productivity	Increases 2.5 gm^2 foot food production
Above table inputs with machine learning in data mining technology gives following informed decision					
Fertilizer	Cropping pattern depending on temperature	Age of the crop and exact selection of fertilizer	Availability of water and climatic condition	– Guidance for fertilizer selection	NPK, micronutrients
Pesticide	Temperature, humidity and product stage	Organic composition mixture suggestion	Feasibility check	Increased productivity and crop protection	Insecticide and fungicide
Water requirement	Water resource as input	Per liter requirement	Type of irrigation	Irrigation system recognition	Drip, Sprinklers, Flood water
Human hours	Permanent and temperature combination	Temporary labor time schedule	Type of skilled and unskilled labor feasibility	Skilled and unskilled Human resource requirement	Human resources Per hour basis

The diagram given shows that the inputs from agriculture such as type soil, water, fertilizer, etc., are given to AI, Machine learning and Fuzzy logic. They will also get processed and exchanged amongst them for getting informed decision (Table 2).

5 Conclusion

Data mining is more about "farming" than it is about hunting. It is about cultivation decision making with the help of related output nodes. The real meaning of data mining is learning from the past, live in the present, and believe in the future. It is hard to prepare this type of model because interdisciplinary knowledge of Agriculture and climatology, geology, fluid engineering, agronomy and data mining

is required for that but it can be handled all type of data by systematic approach of programmer or researcher.

So the paper has focused the possible inputs, outputs and usage of different algorithms to give correct decision to farmers for increased crop yield.

Now a day agriculture activity or decisions are very complex and not proper foundation for that by using data mining we can do that properly.

Acknowledgements Survey on Data Mining Techniques in Agriculture M. C. S. Geetha Assistant Professor, Dept. of Computer Applications, Kumaraguru College of Technology, Coimbatore, India. International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 2, February 2015

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