Random Forest Classification Algorithm for Agricultural Data Analysis in Tirunelveli District

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Abstract: In India, 70% of people get their earnings through agriculture. It gives huge employment opportunities. Nowadays there are a lot of technology and software applications in agriculture to get faster information. But the lack of knowledge about software usage many formers still applying the traditional method. So that they are getting low productivity. Currently, organic and inorganic crops are important issues. It depends upon soil, fertility, seasons, water, weather and commodity prices etc. The formers to identify the deficiencies in the soil, PH value, Soil type, EC and soil texture to choose the correct crops to increase the production. In this paper soil fertility level is identified and crop selection by the use of a random forest classification algorithm in Tirunelveli district. The proposed method also used to identify the user location. Compared the existing feature selection methods, the proposed experimental results shows that the random forest classification algorithm for agricultural data analysis produce a high accuracy and less processing time.

Keywords: Agriculture, Attribute selection, filter method, soil fertility and random forest algorithm.

I. INTRODUCTION

Agriculture is the Indian Economy's most important sector. Indian agriculture accounts for 18% of India's gross domestic product (GDP) and provides a livelihood for 50% of India's population. India is the largest manufacturer of pulses, rice, wheat, spices, and spice products in the world. India has many business sectors to choose from dairy, meat, poultry, fishing, and food grains [1]. India has emerged as the world's second-largest producer of fruit and vegetables and remains one of the three main producers of numerous agricultural products such as paddy, rice, peas, groundnuts, rapeseed, natural products, fruits, sugar cane, coffee, jute, cotton, tobacco leaves, etc. On the other side, on the marketing front, Indian agribusiness is still facing problems such as low levels of cooperation and incorporation in the business sector, lack of accurate and useful necessary information to farmers on various agricultural issues [2].

India is an agriculture-based country, where over 50% of the people depending on agriculture. As per 2018, Agriculture employed 50% of the Indian work force with a contribution of 17-18% to the country's GDP. Agribusiness's dedication to India's national income is all the more relevant. Agriculture is the Indian economy's backbone [3]. Crop cultivation now is at a low level since many farmers are still following the traditional farming methods. So farmers, governments, agricultural scientists and researchers are exploring new methods for getting high yield from the farmland. Government of India is concentrating on the agriculture through several activities to increase crop productivity. Based on the Green revolution, new ideas can be introduced on specific crops. They depend on natural factors like water, soil, climate changes, etc. Crop production mainly depends on soil fertility. So, it is mandatory to identify micro nutrient content and to maximize the same to crops of high quality.

In India, deficiencies in the primary nutrients (Nitrogen, Phosphorous, and Potassium) are seen in the soil. So, it is mandatory to take necessary action for overcoming the deficiency by applying the correct quality of fertilizers for the crop. Soil health is a combination of physical, chemical and biological activities of soil [4]. The essential goal of any technology with respect to agriculture is to make improve crop production with many immediate and sustainable benefits.

Government of India has taken necessary steps to overcome this problem for ensuring good income to the farmers through the Information Communication Technology (ICT). Natural farming has gradually developed, encouraged by a variety of alerts but hampered by the counterculture label. Reporting the 1990s findings reveal presence of insect killers and chemical compounds in food for humans, mainly children (for instance, applied alar on apples). The rising demand for biologically formed food, it gives rise to stimulation of the development of natural farmhouse [5]. After the 2010 decade, the internet Archive is huge and growing every day. Now, most of the people are obtaining information from the internet, which is the most excellent stage to sell crops in the market and promote farming activities and for information to reaches farmers directly.

Farmers now use web pages and social media to acquire information regarding development techniques, agri-market information and share new intercropping ideas. Government of India hosts and maintains many agriculture information websites like iKisan.com [6].

With a rise in the Internet usage and increase in Smartphone access in rural areas, farmers have been able to make use of the Internet to obtain solution for problems in farming. Government along with various companies and NGOs has established mobile app applications for farmers that offer real-time information about weather, local markets, seeds, fertilizers among other things [7]. Farmers can also relate and get guidance from agriculture experts across the country via the apps. Government of India has introduced mobile phone applications to help the farmers in getting crop related information like insurance, and across the nation, current prices for agriculture products.

Agriculture plays a vital role in every nation's economy as it helps to feed a country's entire population. In this respect, it connects and communicates with all of that country's related industries. A country is generally regarded as a socially and politically stable nation if it has a rather strong agricultural base. The main source of work in most countries is an agricultural sector. Usually large farms need to hire additional hands for cultivation and take care of the related farm animals. Most of these large farms have nearby processing plants to finalize and develop their agricultural products [8].

Many new farms and businesses linked to farming make good use of modern equipment as well as science and technology concepts. Many farmers do not realize that soil testing has no relevant knowledge of their soil. Soil test reports enable farmers to make the choice of the right fertility and get knowledge of the use of fertilizer based on the soil requirement. Excessive distribution of fertilizers is sometime one of the major problems in agricultural domain [9]. This requires rectification through analysis of the soil fertility level. In addition, is important to define the time of distribution, type and quantity of fertilizers for healthy crop growth. Also farmers do not consider environmental factors in the choice of crops. This leads to poor harvest. These are the current issues of the agriculturists and farmers. In this regard, this study motivates the Virudhunagar District farmers via mobile app to assist and make the right decision to optimize the crop yield based on soil and water nutrient availability, analysis of crop prices, season basedinter cropping suggestions, ground water level availability, and also crop sowing recommendations based on environmental factors.

Data Mining relates to extracting information from large quantities of data. This techniques are applied on raw data and useful information extracted [10]. The knowledge or information are obtained might be used for some of the following implementations: Market research, Fraud prevention, Medicine, Educational Data Mining, Agriculture decision support system and Web Mining etc. Data defines raw data and information refers to meaningful information. A large amount of data, combined with the need for powerful data analysis methods, was characterized

as rich in data but poor in detail. Data on richest information repositories are available. Data mining has sophisticated algorithms to classify data. It is an analytical tool that helps uses in the analysis of information from a range of measurements or angles is identified, classified and reviewed [11]. These methods cannot find exact associations or predictions with massive amount of samples inside of the vast relational databases.

There are the following phases in the Knowledge discovery process:

1. Data Cleaning: Original data includes incomplete values, scattered data, insignificant data but unidentified information. The method of data cleaning is to eliminate missing values

2. Data Integration: In this stage, data are retrieved from multiple data sources and repositories are combined together with all sufficient data

3. Data Selection: In this step, relevant data are selected from various databases for processing.

The interesting hidden information is retrieved

4. Data Transformation: It is used for combining into forms and standardization using aggregation operations

5. Data Mining: It refers to extraction of the interesting information from the real data

6. Pattern Evaluation: It is used to identify accurate and interesting patterns of knowledge based on certain strategies.

7. Knowledge Presentation: Visualization and representation of information approaches are used in this process to show derived information

The following table 1 represent the comparison between the different decision support system.

It shows the comparison between different existing decision support system like CropSyst, SWASALT, e-Sagu, CROPWAT, CROPGRO Soybean Model, DSSAT – CERES (Wheat), mKRISHITM, DSSAT-CSM- CERES (Wheat) 4.0, IPM and CROPMAN models with its advantages and disadvantages. In his work, the proposed system is not only expecting the crop yield production value and the purposes behind its help, yet in addition the educators of specialists, including the recommendations to deliver more than crop yield prediction.

Table - 1 Comparison between the Different Decision Support Systems

S. No	DSS NAME	DESCRIPTION
1.	CropSyst	• Deep alluvial loamy sand typic Ustripsamment soils under hyper-thermic regime parameters are considered • Data set covered located in Ludhiana Punjab • Earlier the transplanting dates of crops were in May • Required frequent irrigation to meet crop requirements • Calibrated the model for shifting of transplanting dates of rice from May to June, which helped to increase the effective water utilization and in turn improved grain yield

2.	SWASALT	• Soil and irrigation data parameters have been considered • Haryana covered for data collection • Canal irrigation improved the percolation losses which resulted in water logging and soil salinization • Prevented Water logging and soil salinization, it helpful for utilization of water resources
3.	e-Sagu	• Climatic Data, Farm specific crop details parameters are considered • Data set collected in Tamilnadu district • There was a need to provide the farm specific pest management and other advice • Helped farmers for farm specific agro-expert decisions to the farmers to increase the crop yield
4.	CROPWAT	• Climatic and crop data parameters have been considered • Andhra Pradesh, Kashmir, West Bengal districts covered • Conventional irrigation scheduling was seen affecting the crop irrigation supplies and thus crop yield production • Helped estimation of the crop irrigation supplies to improve irrigation scheduling and in turn increase in crop yield
5.	CROPGRO Soybean Model	• Climatic Data parameters considered • Madhya Pradesh, Maharashtra, Rajasthan and Karnataka districts covered • Soybean grain yield was exaggerated by temporal variations of rainfall • Calibrated model facilitated enhancement of soybeanyield in water limiting environment based on climatic data
6.	DSSAT – CERES (Wheat)	• Climate, Water and Different Nitrogen Levels parameters considered • Data set collected in Semiarid and Sub Tropical region of Punjab • Crop productivity was affected due to increase in depth of quality ground water • Improved water productivity under dry land and limited water environments
7.	mKRISHITM	• Climatic Data, Farm specific crop details parameters are considered and data set collected in Maharashtra • There was a need to bridge the gap between farmers and agriculture expert for proper nutrient and pest management • Helped farmers for nutrient and pest management for Grape farms

8.	DSSAT-CSM-CERES (Wheat) 4.0	• Climatic Data parameters are considered • Data set collected in Ludhiana and Phillaur, Punjab • The model was evaluated for 13 datasets and assisted to increase crop yield, CWP, IWP
9.	IPM	• Climatic Data, Farm specific crop details parameters are considered and data set was collected in West Bengal • No support for effective Pest Management for crops. • Assisted farmers increase awareness about pest management
10.	CROPMAN	• Site Specific Climatic Data parameters considered and data set collected in Punjab • Crop productivity was exaggerated by incorrect transplanting dates which increased soil evapotranspiration and reduced water produced • Yield could be increased by shifting the transplanting from mid May to lower June onwards

ISSUES IDENTIFIED

The following issues were identified based on the decision support system.

- Supply and extension price of land
- Recent government regulations
- Global financial market stability, development and fluctuations
- The effect of global trade policies on food security and product supply and demand
- Bio fuels production and uses
- Irrigation
- Lack of mechanization
- Soil erosion
- Inadequate storage facilities
- Agricultural Marketing
- Inadequate transport facilities
- Scarcity of capital

II. RELATED WORKS

Decision Support Systems (DSS) are used for the generation of data for agriculture management systems viz., pest management, farm management and crop management systems [12]. The performance of these systems is low. Hence, the utilization of IoT based advanced techniques could improve the process of decisions of the farmer about crop fertilization. Many authors have done research using data mining techniques with small instances. The decision support system model, related to soil water balance, considers several factors that include soil type, weather, canal network, and crop type. Decision support systems are widely applied in various parts of India for different agricultural management activities. Furthermore, the issues are handover be the uncertainty related with expected instances. Which variations in non-living wealth are made place to place, and the contacts of these alterations are described using novel algorithms, crop productivity being one such activity which has provided considerably good results with the use of DSS [13][21].

The DSS named as "Crop Environment Resource Synthesis (CERES) -Wheat", is a component of DSSAT which was effectively applied for reproduction of the crop growth and progress of wheat under nitrogen levels, variable climatic condition, and water in semi-aridand subtropical regions of Punjab for five cropping seasons from 2000-2001 through 2004- 2005 [14][18].

The model outcome are accomplishes small pieces of yield and water efficiency exaggerated by the holding water capability of the soil. It was extended with Cropping System Model (CSM) named as "DSSAT- CSMCERES-Wheat 4.0". It was calibrated and validated on 13 different datasets of different farms of Ludhiana and Phillaur, Punjab collected between 2002-2006 to predict and increase crop yield and for irrigation scheduling. Advisory DSS performance plays a very significant role in Indian agriculture. e-Sagu, farm precise DSS residential through IIIT, Hyderabad, under the aegis of Media Lab Asia. It assists the progress in the farmhouse production distributing first-class farmhouse detailed agro-expert decisions in a sensible behavior of every farmhouse activities at the farmer's doorsteps. This recommendation was provided during at all periods of cultivation of crops at the beginning of the crop sowing stage giving up toharvesting stage, it decrease the price of crop growing along with boosting the farmhouse yield with the excellence of agricultural products [15][19].

"MKRISHITM" Decision Support System for suitable nutrient and pest management recommendation for grape farms throughout mobile phones. It was established by Tata Consultancy Services and set up in Borgaon village, Maharashtra. Integrated Pest Management is an essential factor in agriculture. For the environmental plant security of southern 24districts at West Bengal, an Integrated Pest Management (IPM) DSS named "Cell Phone" was created. The DSS helped for sustainable IPM by creating continuous awareness among farmers and in turn to get better crop productivity [16][20].

III. METHODOLOGY

Feature selection technique is also known as the preprocessing technique. Which is used to remove the unrelated and terminated elements the accuracy [17]. It is used to relate the data to the attributes and the classification algorithm. Feature selection method is essential one for the use of high dimensionality and the massive quantity of data to learn the task. Throughout the learning procedure the unrelated features are to converted overfit, computationally complex, become less comprehensible and decrease learning accuracy. Feature selection methods can be characterized into wrapper methods, Filter methods, and hybrid methods and embedded methods.

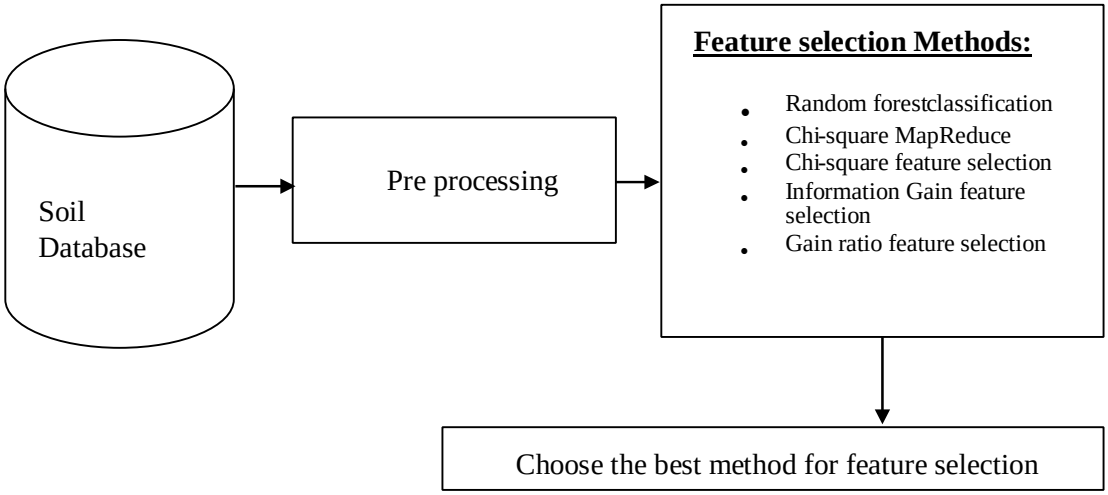


Figure 1. Workflow

The workflow of the proposed method is shown in Figure 1. It has the data preprocessing steps to remove the noisy values in the dataset and then select the relevant features for predict the soil fertility level by using attribute selection methods. In that, discover the finest attribute selection method compared with five feature selection methods.

3.1 Random Forest Algorithm-

Random forests algorithms are used for classification and regression. The random forest is an ensemble learning method, composed of multiple decision trees. By averaging out the impact of several decision trees, random forests tend to improve prediction. There are many different models available to make predictions on classification data. Logistic regression is one of the most common for binomial data. Other methodologies include support vector machines ("SVMs"), naive Bayes, and k-nearest neighbors. Random forests tend to shine in scenarios where a model has a large number of features that individually have weak predicative power but much stronger power collectively.

3.2 Soil data set attributes-

```
import soil as sd#

list for column headers names = ['Sample No', 'pH', 'EC', 'OC', 'N', 'P', 'K', 'S', 'Zn' , 'Fe' , 'Cu' , ' Mn' , 'Ca' , 'B' , '' Fertility Level']
```

Figure 2. List of soil data set attributes

Figure 2 represents the list of soil data set attributes like sample number, pH, EC, OC, N, P, K, S,Zn, Fe, Cu, Mn, Ca, B. These details will be stored in a soil database. Using above Python coding to list the above attributes and store it in a database.

```
# open file with sd.read_csv
df = sd.read_csv("https://soilhealth.dac.gov.in/NewHomePage/NutriPage ", names=names)
print(df.shape)# print head of print(df.head()) data set
```

Figure 3. Display the soil data set attributes in website

Figure 3 represents the soil database attributes which are available in a soil health website. Using above python coding to get separate attributes from that particular website.

Table - 2 Soil data set attributes

Attributes	Description
Sample No	Soil testing report identification number
pH	Soil pH value
EC	Electrical conductivity/mmhos/cm
OC	Organic Carbon/%
N	Nitrogen/ppm
P	Phosphorus/ppm
K	Potassium/ppm
S	Sulphur/ppm
Zn	Zinc/ppm
Fe	Iron/ppm
Cu	Copper/ppm
Mn	Manganese/ppm
Ca	Calcium/ppm
B	Boron/ppm
Fertility Level	soil: Very high, High, Medium, Low, Very Low

The above Table-2 represent the abbreviation of various soil data set attributes

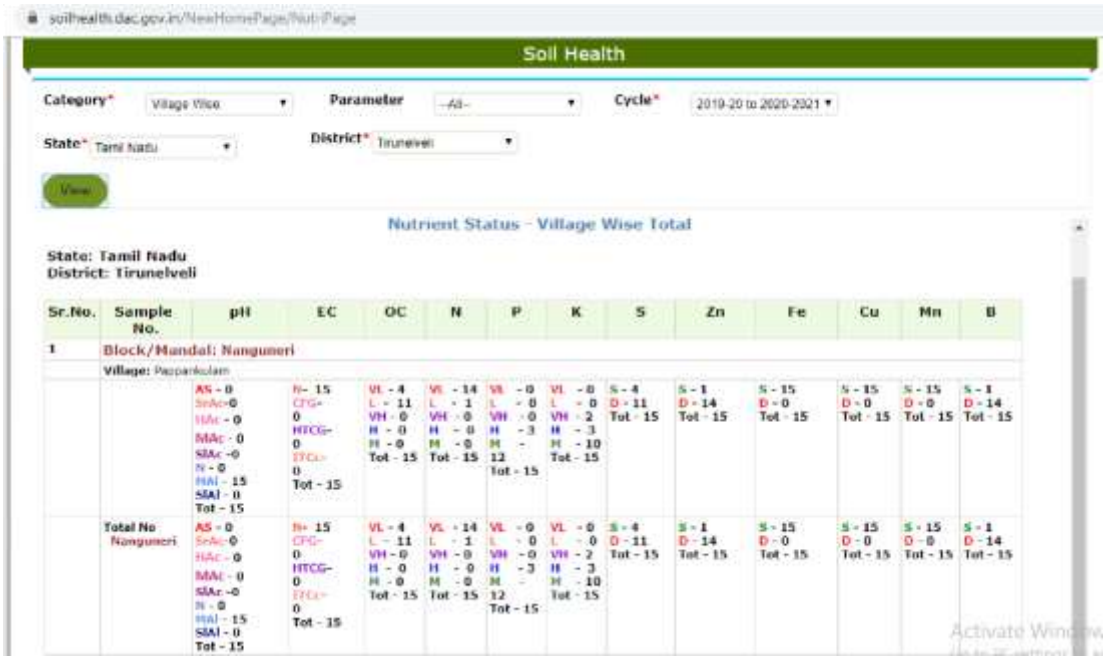


Figure 4. Sample soil nutrient status available in a website

Figure 4 represent a village wise sample soil nutrient status displayed in a website. Here we choose a Tirunelveli district and choose a Nanguneri block. It will display the soil details of the surrounding area of the block Nanguneri.

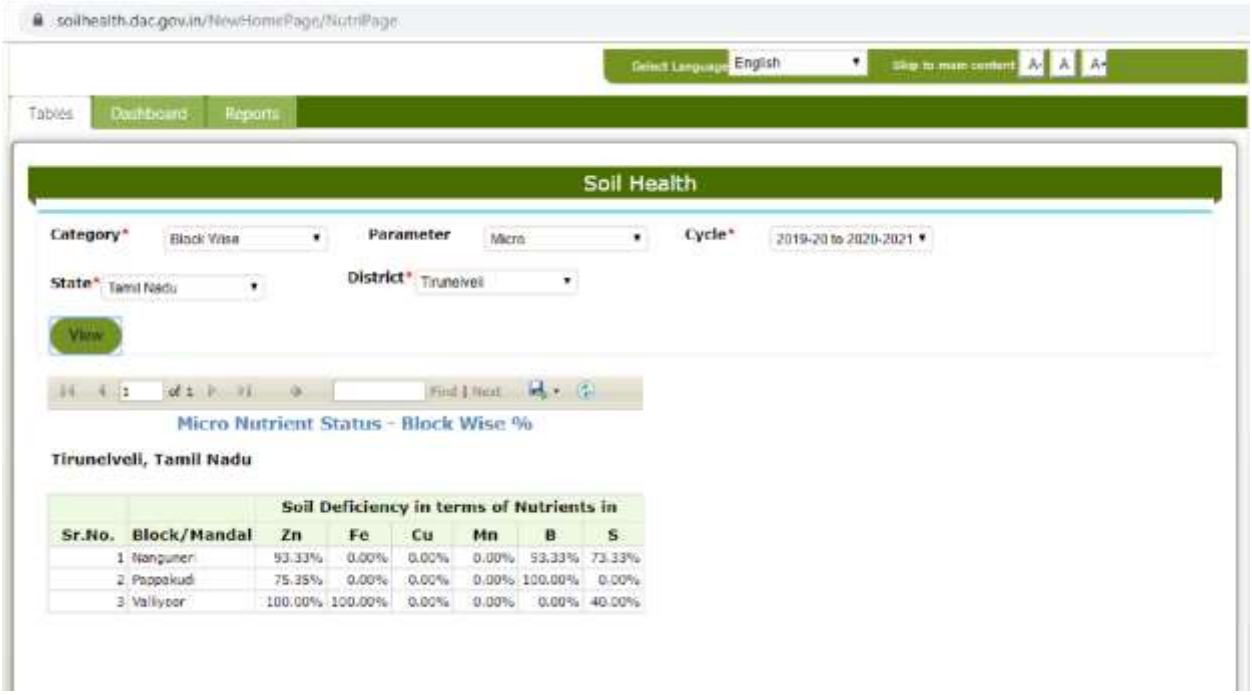


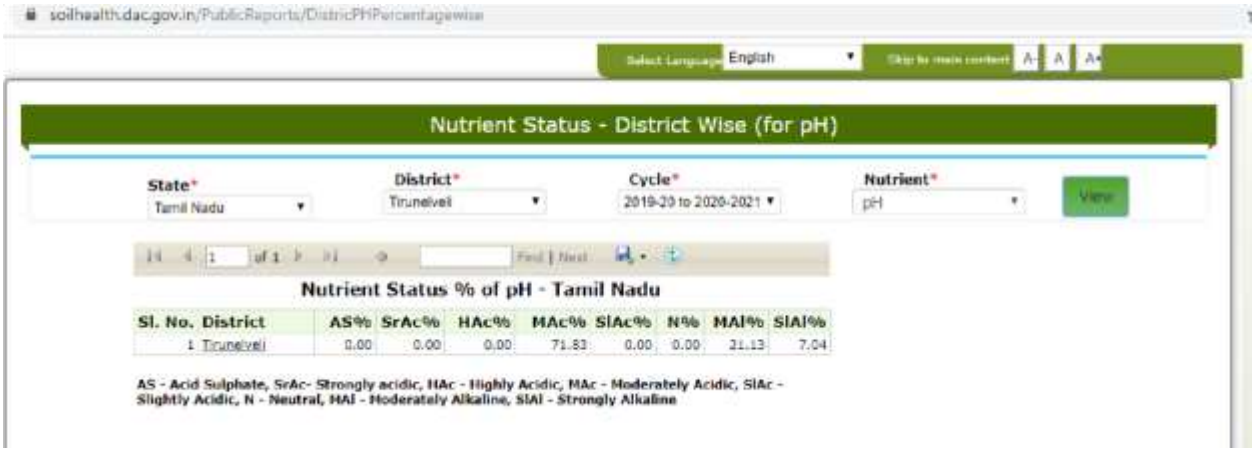
Figure 5. Display the block wise micro nutrient status

Figure 5 shows the micro nutrient status in block wise. Here the sample micro nutrient status will be displayed in a Nanguneri block.

Sr.No.	Block/Mandal	Zn	Fe	Cu	Mn	B	S
1	Alangulam	75.51%	8.65%	1.09%	2.10%	41.27%	16.02%
2	Ambasamudram	43.25%	0.40%	0.20%	0.40%	55.74%	1.06%
3	Cheranmahadevi	43.92%	16.54%	0.55%	2.91%	51.00%	5.34%
4	Kadaiyanallur	23.39%	6.80%	3.02%	0.27%	23.84%	7.98%
5	Kadayam	45.08%	6.04%	0.00%	1.15%	58.47%	20.58%
6	Kalakadu	55.20%	44.51%	6.48%	0.58%	40.39%	22.53%
7	Keelapavoor	46.59%	15.59%	1.77%	2.74%	48.02%	12.68%
8	Kuruvikulam	68.10%	28.98%	7.93%	5.13%	24.93%	1.45%
9	Manur	31.86%	0.03%	0.13%	0.98%	51.30%	6.99%
10	Melaneelithanallur	34.03%	6.11%	0.05%	2.47%	28.34%	5.65%
11	Nanguneri	14.78%	39.77%	0.48%	0.08%	58.79%	21.81%
12	Palayamkottai	55.40%	1.66%	0.03%	0.26%	62.15%	13.21%
13	Peppakudi	22.77%	0.00%	0.00%	0.00%	55.27%	6.23%
14	Radhapuram	56.33%	14.01%	5.52%	0.42%	55.13%	29.09%
15	Sankarankovil	30.55%	10.01%	0.21%	1.24%	28.26%	1.88%
16	Shencottah	30.14%	9.72%	0.21%	6.61%	44.50%	9.71%
17	Tenkasi	29.95%	21.18%	3.01%	0.28%	39.49%	8.10%
18	Valliyoor	52.40%	24.18%	2.58%	0.57%	24.95%	17.28%
19	Vasudevanallur	13.94%	7.80%	0.10%	0.94%	20.23%	6.55%

Figure 6. Display the micro parameter in Tirunelveli district.

Figure 6. Represents the various block wise soil data attributes in a Tirunelveli district.



Sl. No.	District	AS%	SrAc%	HAc%	MAc%	SlAc%	N%	MAl%	SlAl%
1	Tirunelveli	0.00	0.00	0.00	71.83	0.00	0.00	21.13	7.04

AS - Acid Sulphate, SrAc- Strongly acidic, HAc - Highly Acidic, MAc - Moderately Acidic, SlAc - Slightly Acidic, N - Neutral, MAl - Moderately Alkaline, SlAl - Strongly Alkaline

Figure 7. The district wise nutrient status

Figure 7 represents the Tirunelveli district nutrient status.

3.3 Creating a Random Forest Model

We are trying to predict whether a soil has low erosion. This coincides with the 'class' column, which will be our independent variable. We'll use all the other columns as features for our model. Here the python coding is used to test the soil in Tirunelveli district.

```
X = df.drop('class', axis=1)
y = df['class']
```

We'll use soil-test-split to split the data.

```
from sklearn.model_selection import soil_test_split

# implementing soil-test-split
X_soil, X_test, y_soil, y_test = soil_test_split(X, y,
test_size=0.33, random_state=66)
```

Now, we can create the random forest model.

```
from sklearn import model_selection

# random forest model creation rfc =
RandomForestClassifier()
rfc.fit(X_soil,y_soil)

# predictions
rfc_predict = rfc.predict(X_test)
```

3.4 Pseudocode for Random forest classification method:

Input: Pre- processed Data

Output: Relevant elements

Random Forest Classification:

Step 1: select the node elements in the data set

Step 2: calculate predictable frequency for each elements

Step 3: For each element in sequence, Calculate observed frequency

Step 4: sum the observed and predictable square values and divided by predictable frequency

Step 5: choose element with the maximum weight to be the subsequent node

Step 6: Takeaway the node element

Step 7: Repeat the above steps until all attributes have been used.

The above random forest classification methods are compared to find the best method for soil data. This method is used to improve the accuracy performance of the classification algorithm.

IV. Result and Discussion

R language is an open source software Package and it is mostly used to process the statistical data. It does not handle the large amount of data. So the Rhadoop, RmR, Rhdfs packages are used to integrate the R and Hadoop environment. It works with the terra bytes of data and easily handles the data. The proposed method code was written with the help of the Rhadoop packages. The main objective of proposed model is used to choose the important features for predict soil fertility level with high accuracy and less time. This work is compared with the other feature selection algorithm and the best one is taken into for random forest classification method.

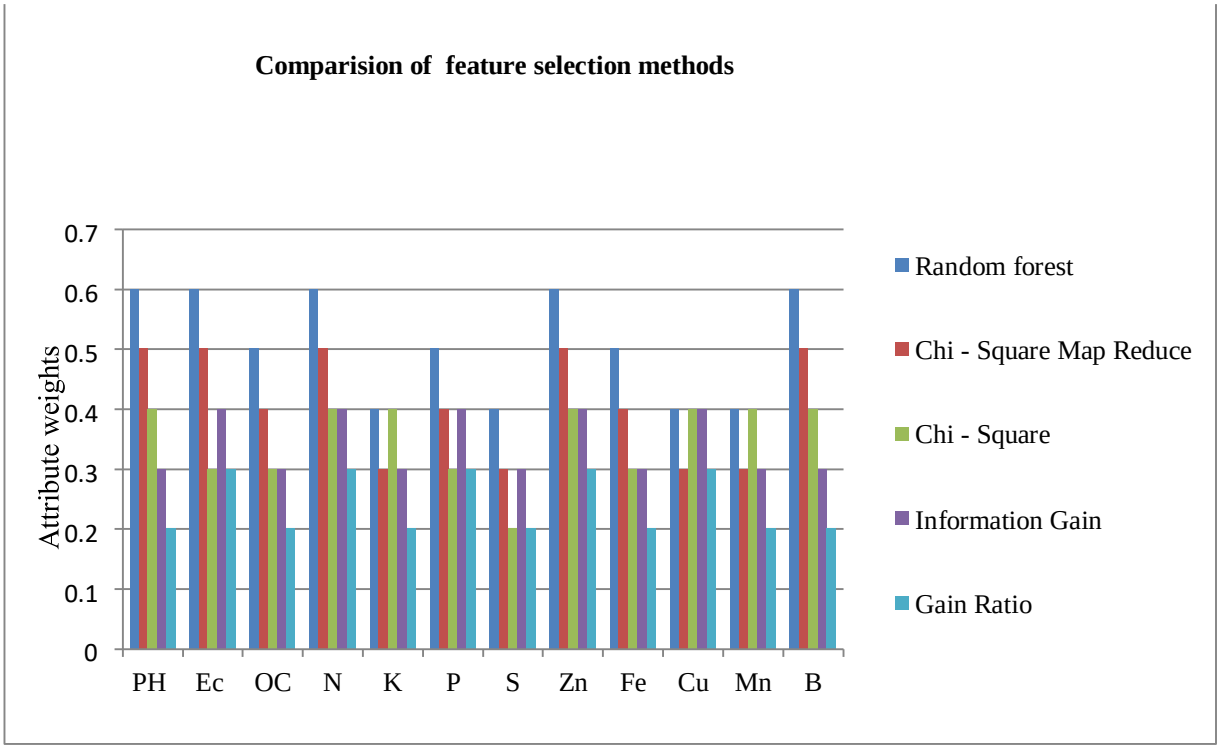


Figure 8. Comparison of feature selection methods

Figure 8. Shows the weights for the feature selection methods are compared. In that, Random forest classification method gives the relevant attributes compare with the chi- square map reduce, Information gain, chi-square and gain ratio features selection methods. The highest weight attributes are taken into the classification algorithms. The highest weight attributes are pH, K, N, Fe, S, B, and OC taken into the classification algorithms.

Table-3 Comparison results of feature selection methods

Feature Selection Methods	Accuracy (%)	Correctly Identified Features (%)	Incorrectly Identified Features (%)
Random forest classification	98	90	20
Chi-square Map Reduce	96	90	30
Chi-square feature selection	95	80	30
Information Gain feature selection	89	70	50
Gain ratio feature selection	91	80	40

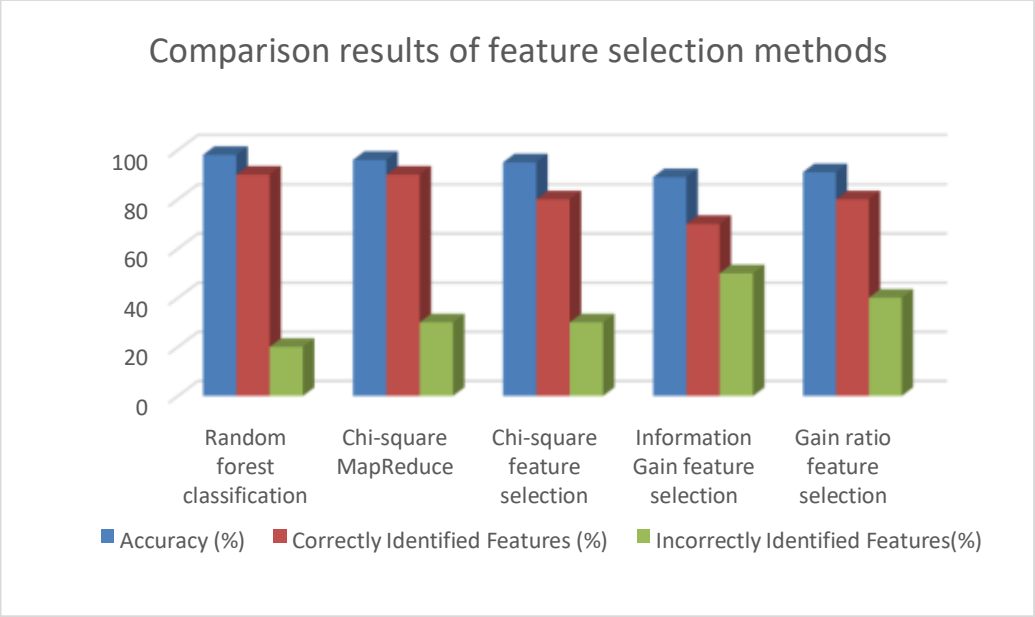


Figure 9. Comparison results of feature selection methods.

Figure 9 shows the comparison result of execution time, accuracy, and correctly identified features and incorrectly identified features of proposed approach with the existing feature selection methods. In that, Random forest classification method produces the relevant features from large data set to predict the soil fertility level.

V. CONCLUSION

Feature selection method can be widely used in many areas such as text mining, machine learning, statistics, web mining, image processing and micro array data analysis. Due to the availability of huge amount of data the feature selection has been a most important issue. To encounter the objective, a novel method has been proposed with the help of feature selection techniques to improve the performance like removing noisy data and accuracy of the data. The prosed work, using random forest classification method produced efficient results comparing with the other feature selection method. The experimental results shows that the random forest classification method gives 98% of high accuracy with the less time than the other feature selection methods. Here the attributes like pH, N, K, S, Fe, OC and B are taken in to additional classification algorithm. Thus the proposed method used to random forest classification algorithm for agricultural data analysis to produce a high accuracy and less processing time.

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