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ResearchArticle

Impact of Weather and Climate Change in the Area of Cultivation and Cropping Pattern in Villupuram – A Micro Analysis in Machine learning

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Abstract

Climate change and agricultural production are also interrelated. So in the article, we will look at the Villupuram district's studies in agrarian production-related to climate change. Agriculture is considering to be the lifeblood of Tamil Nadu. The majority of the people in Villupuram are engaged in agriculture. Villupuram district is one of the agriculture districts in which 75% of the population is involved in agriculture. There are 5.68 farm families from Lakh in the Vilupuram District. Seventy-five percent are marginal farmers, 16 percent are small farmers, and 9 percent are large farmers. Big farmers account for 42 percent, 34 percent higher than the state average. The district of Vilupuram shares a unique position in developing state food grains. The section of Vilupuram ranked first in food grain production from 2013-14 to 2017-18. Villupuram accounts for more than 10 percent of the state's food production per year. In this article, I have taken two Machine learning algorithms. Taking ten years of data, I can predict that the current rainfall will be 70% and the temperature will be 20%, and in the future, the precipitation will decrease by 30%, and the temperature will increase by 60%. I want to point out that the amount of agricultural production related to weather is presently 30% and that the show may decrease by 10 to 20%. I will explain with Random Forest and Logistic Regression that Random Forest works very well and gives good results.

Keywords: Climate Change, Cropping, Cultivation, Machine learning

1. Introduction

The agricultural economy of Tamil Nadu depends primarily on the Southwest Monsoon (June to September) and the Northeast Monsoon (October to December). The rainwater from these two seasons is collected and used in dams and canals for agricultural and drinking water purposes. Further, in the state's agrarian economy, the powerful Tamil Nadu states (Cauvery, Tamiraparani, and Pennaiaaru rivers play a vital role). Similarly, large lakes such as Chembatambakkam, Poondiand Puzhal assist in meeting the drinking water requirements of the Chennai Metropolitan Area. Every year, Tamil Nadu gets an average rainfall of 958mm; of this, 31% of the rain is from the monsoon in the southwest, and 50 percent is from the monsoon in the northeast. Again, 75 percent of the rain falls in Tamil Nadu's coastal areas, and the rest falls in the interior. Farmers have been badly hit by climate change. Monsoon winds bring rain to Tamil Nadu agricultural economy of Tamil Nadu is critical to this factor. Reductions or increases in the number of actual Precipitations received are responsible for changes in the monsoon wind's character. For example, he refers to the observation that there will be a 9 percent shortfall in the rain during 2010-40 and a 14 percent shortfall during 2040-2070 years Studies have shown that the coastal regions receive more and the interior areas less rain from the most significant amount of rain that Tamil Nadu received from the northeast monsoon. It means that the inner regions of Tamil Nadu receive 25 percent of the shower. Likewise, the northern region generally receives more precipitation than the southern parts of Tamil Nadu. States that there was an average temperature increase of 0.8 ° for 1951 and 2008.

Climate change is the cause of the crisis in agricultural production. Agriculture is the first to be affected. Climate change is having a significant effect on agriculture is supported by the observations made by the citizens of Villupuram District. In 1993 Villupuram District was carved out of the former South Arcot District. The district of Cuddalore in the east and south, Salem and Dharmapuri in the west, and Tiruvannamalai and Kancheepuram district in the north border the

district. Manimutharu, Kedilum, Komuki, Sankarapani, Senchi, and Pennai are the major rivers that pass through this district. Paddy, groundnut, and sugar cane are among the major crops grown. During the southwest and northeast monsoons, the Villupuram district receives widespread rain, an average of 1119mm annually. The prevailing temperature here ranges from 21°C to 40°C between March and May. Red gravel soil is the soil in this district. Agriculture can be seen to be affected due to temperature fluctuations. The residents of this district have been forcing to adjust to the failed monsoons and drought-like conditions. Farmers earn very little income.

1.1 Cyclic Agriculture production diagram

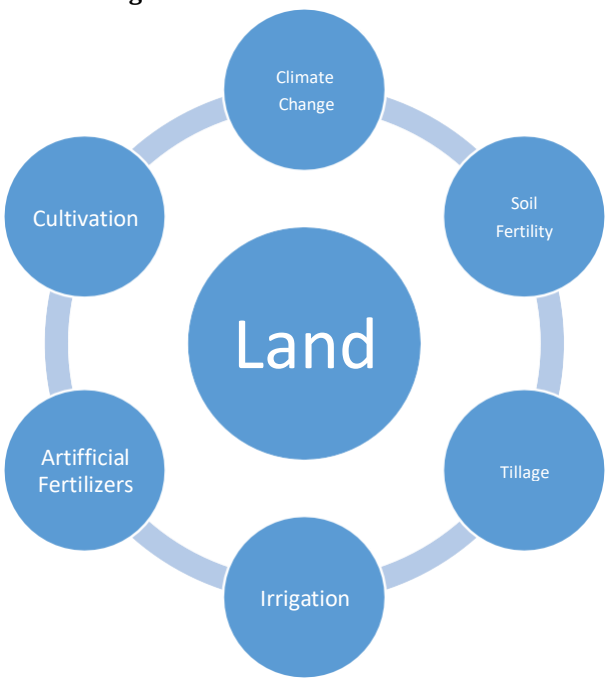
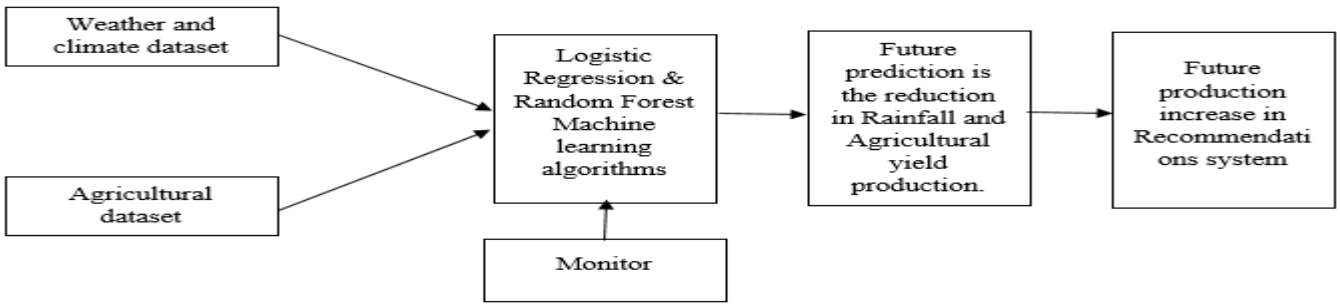


Diagram-1 Cyclic Agriculture production diagram

A study report entitled 'Crop Insurance to Fit Climates and Respond to Climate Change' explores the effect of climate change on agricultural economics across Tamil Nadu in a detailed manner. Based on the total irrigated land, the amount of yield, and the changes in the amount of rain during the southwest and northeast monsoons, I undertook this report. The study states that 81 percent of farmers are experiencing terrible consequences due to monsoon failure. The study points out that the northeast Villupuram district is more affected than the delta zone. The research also focuses on how farmers in this district are badly affected by crop damage and water supplies. We can see summers rise above-average temperatures when analyzing the data from 1994 to 2011. During the 1994-95 to 2009-10 seasons, the rain during the northeast monsoons was uneven. Since 2003-04, the amount of rain during the southwestern monsoon has decreased. Similarly, summers can also note that the amount of rains received during the northeast monsoons is declining from 2005 to 2006.

1.2 Overview of my work

Diagram-2 Overview of Architecture Diagram



I have taken the data for ten years of weather and climate data in this article from 2010 to 2020. Data was collecting from the Indian meteorological department in Chennai Online data set in Villupuram District and Agricultural production dataset in Tamil Nadu Agricultural University dataset. I have two machine learning algorithms used in this work (Random forest and Logistic regression). I am telling you what the temperature and rainfall are like now and how they will be in the future, and how much of the agricultural production associated with it will be present and the end.

Random forest algorithm used to do usual pre-process method and feature extraction in weather and climate important point of rainfall and temperature data will be feature selected method in using the 80% of train set of data and 20 percentage test set data, and the same processing method used in agriculture production implementation work method in random forest algorithm using the classification result. Overall the temperature of 2.C has risen over the last ten years (2010-2011 to 2019-2020). The average improvement in the amount of rainfall in the previous ten years was 276mm. Over the past ten years about crop cultivation, 18482 hectares of crop cultivation area have been decreased. The annual rainfall for the district of Villupuram will reduce by 4.0 percent by the end of the century.

2. Literature Review

To estimate the crop yield of major cereal crops in Bangladesh's central district. This paper focuses on using data mining techniques to extract information from agricultural data. After obtaining all the result tables and maps, we have written software that considers the tables of our findings to post-process the data and offer the best three crops to choose from in order of preference across all the importance of agricultural districts for agriculture. The software generates 'Zero' if there are no workable alternatives. I base these recommendations on combining the district's annual per hectare area yield and the crop species' net worth. There are five environmental variables in various sections, three biotic variables and crops. To improve accuracy and improve geographical data transparency, our data processing model will be used for geospatial analysis1.

Yields from crops are critically weather-based—increasing empirical literature models this relationship to forecast climate change's impact on the sector. We describe a yield modeling strategy that uses a semi-parametric version of a deep neural network that can simultaneously account for complex nonlinear relationships and known parametric structure in high-dimensional datasets. Using data on maize yield from the United States Midwest, we show that this approach outperforms the same traditional statistical methods and entirely non-parametric neural networks in predicting outcomes during model training over a year. The effects of climate change on maize yields are significantly adverse but less severe than those expected using classical statistical techniques, using scenarios from a series of climate simulations. Our method is less disruptive, particularly in the warmest regions and the most critical plans. We start by comparing the different approaches' accuracy when forecasting yields in years that have not been using to train the model. Bagging substantially improved the parametric model's precision and the SNN, but the bagged SNN performed better2.

The management of crops in a specific agricultural area depends on that region's environment, as climate can significantly affect crop productivity. Weather data in real-time will help achieve effective management of crops. This thesis surveys the effect of climate disasters on agriculture, the sensitivity of agriculture to climate changes. It has also found how data mining helps to interpret and forecast the useful pattern of enormous and dynamically altered climate data. This study provides farmers with good decision-making support for planting the crop and alerts farmers to disaster security. Various clustering algorithms, such as Multidimensional Analysis, Statistical Analysis, Mining Association Law, Novel Clustering, Multi Fractal Detrended Cross-Correlation Analysis, K-Mean Clustering, and Non-linear Least Square Regression, have been developed. Climate parameters such as average solar radiation, average minimum temperature, average maximum temperature, water deficit, and process duration have been established in this survey3.

This paper has three datasets, such as the soil dataset, the rainfall dataset, and the yield dataset. In this article, I use K-Nearest Neighbour, Support Vector Machine, and Least Squared Support Vector Machine. A comparative analysis shows the suggested training model's accuracy and error rate. With a minimum error rate, the training model's accuracy should be higher. The research paper offers information on how they could apply data analytics to sugarcane crop datasets. Three datasets are called Soil dataset, Rainfall dataset, Yield dataset. These datasets contain several parameters that help

understand crops' status and classify the data into different groups by conducting supervised data set training obtained from agriculture. We used three major supervised learning algorithms to train and create a model, such as KNN, SVM, and LS-SVM. The sample data's cross-validation process indicates each algorithm's precision to prepare the datasets and implies squared error. This role is independent of the domain. We can also introduce data-independent systems in the future. It means whatever information format, our approach should operate with the same efficiency4.

The effect of the seasonal forecast on society, industry, agriculture, and almost all aspects of human life forces scientists to give the topic proper attention. As the primary factor, weather forecasts are published based on synoptic assessments a day in advance, among other seasonal climate attributes. Statistical and mathematical models are then using for further climatic projections. The proposed method provides reliable results for months in progress within a reasonable period. The need to produce such prediction tools has been identifying by officials from the Sri Lankan Department of Meteorology. More K-Nearest Neighbor (KNN)-based smart weather forecasts have been developing recently. Data mining methods have a degree of trust in the expected solutions in terms of prediction accuracy and the frequency of accurate predictions. Data analytics could tailor more advanced approaches to the study that algorithms based on K-Nearest Neighbor (KNN) can provide better performance than other techniques in comparison. Also, to improve the presentation of the K-Nearest Neighbor (KNN) algorithms, it is possible to incorporate other statistical feature selection techniques to achieve better predictability. More advanced approaches can tailor more advanced methods to resolve complex climate prediction problems and have better results5.

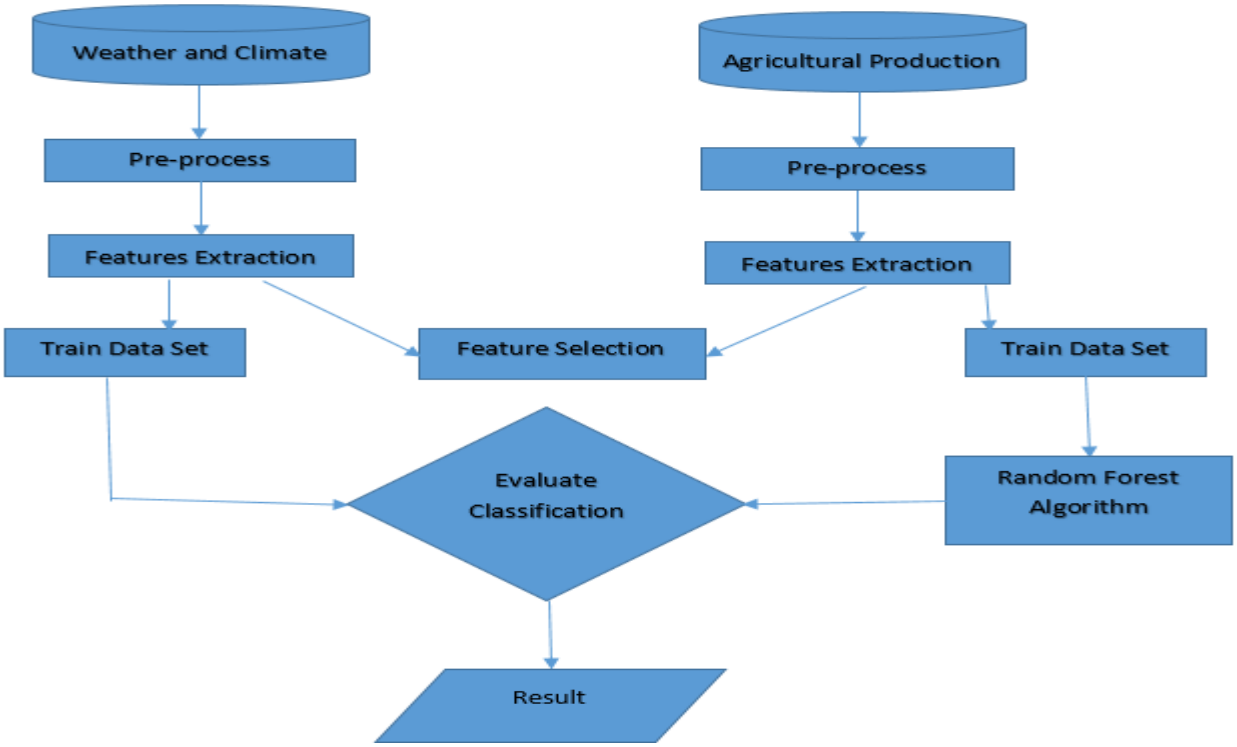
3. Problem Identification

- The research analyses climate change and global warming problems in the study.
- Rain and crops system analysis in the Villupuram District
- We will also look at the amount of heat and rain in the future and the associated agricultural production.

4. Proposed work

Random forest algorithm used to do standard pre-process method and feature extraction in weather and climate important point of rainfall and temperature data will be a feature-selected method using the 80% of train set of data and 20 percentage test set data. Furthermore, the same processing method used in agriculture production implementation work method in random forest algorithm using the classification result.

4.1. Proposed workflow diagram -3



4.2. Proposed Algorithm

Steps for implementation are given below:

- The phase of Data Pre-processing
- Fitting the algorithm of Random Forest to the training set
- Predicting the outcome of the test
- Check the precision of the outcome (Creation of Confusion matrix)
- I was visualizing the outcome of the test collection.

4.3. Random Forest Pre-process

- The pre-processor label encoder algorithm was used to normalize the data.
- This approach is straightforward, and it involves converting each value in a column to a number.
- So it removed the encode target labels with a value between 0 and 1
- (span divided into max-min)
- Label encoder can be used to normalize labels

4.4. Random Forest Features

- All of the random forest specials features are listed k, and selecting the desired application is referred to as n.
- It is calculated by focusing the d point from the aspect of k.
- The edges are broken using the daughter to divide them into several parts.
- It can be used in 3 modes from each node until it reaches its target.
- Four methods can be used repeatedly to create trees named n and create forests to achieve their goal.

4.5. Working of Random Forest Algorithm

- Samples are A started respectively from the selected database.
- This result will make a difference. Any decision will get a pre-announced account result. It will be using to cast the highest number of votes in the next phase.
- Finally, the prediction with the highest number of votes is declared or selected as the best result.

4.6. Random Forest implementation work diagram

- Training begins with the number of k starting points in the data collection. Selected data Creates subgroups associated with.
- Select number n Creates desired result trees and repeats until the result is reaching Allocate.
- Votes determine selected data points, Excessive ballots, and the final result.

This diagram illustrates that random resources work in two modes, first setting the point n and creating future predictions with the first method's products in the second method.

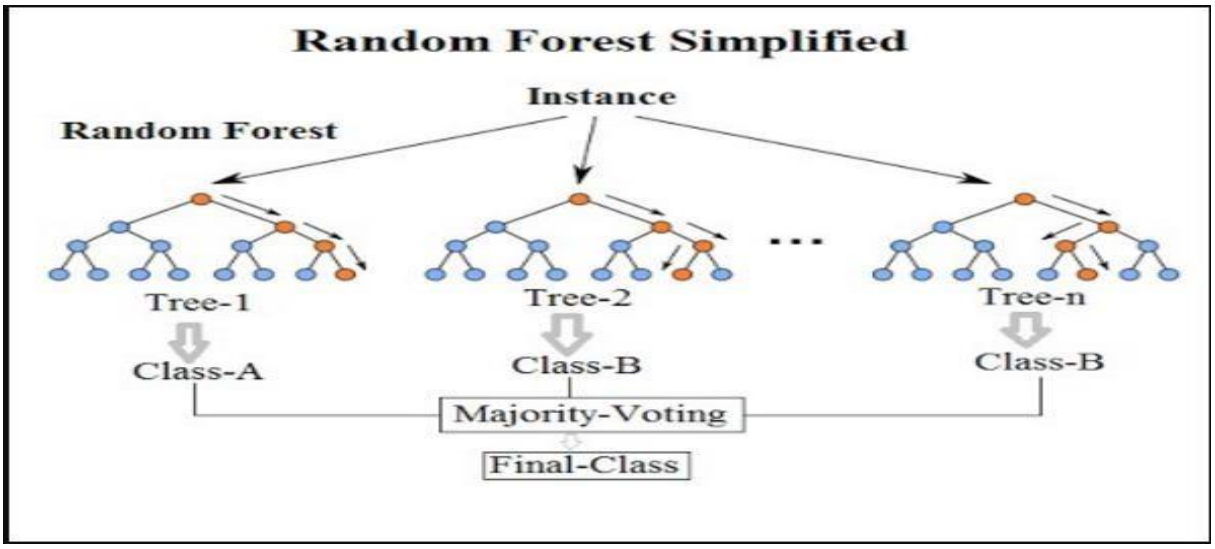


Diagram-4 Random forest simplified

Elementary and total features of the random forest system are k. Selecting the best and most desirable quality from it starts as m. We can see through this picture that we take approximate features and observations, and next, we use the element of k to handle the best approach to find the way the daughter is not determining in the same way. There are three stages to my dream has its goal, and we are using four methods step by step to create my trees. There is how a random forest is making. Assume that there is a dataset containing several images of fruit. So, to the random forest classifier, this dataset is given. The dataset is broken down into subsets and supplied to each decision tree. Each decision tree generates a prediction result during the training process, and when a new data point occurs, then the Random Forest classifier predicts the final decision based on the majority of outcomes.

4.7. Evaluating a Classification method:

Log Loss or Cross-Entropy Loss:

Table-1 Cross-Entropy Loss

Cross-Entropy	**Positive Value**	**Negative Value**
Predicted Positive	True Positive Rate	False Positive Rate
Predicted Negative	False Negative Rate	True Negative Rate

- It is characterizing by a value of zero and operates at regular intervals.
- The rating between the binary types is thus determined.
- 0 Indicates the B binary classification of the nearest focal point.
- If the expected value decreases from the actual value, the record loss will increase.
- Low-value reduction indicates high accuracy.
- y = True Positive, p = Predictive positive.

Confusion Matrix:

- The confusion matrix gives a table of the results of the model.
- There is mainly a table of errors.
- A confusing table is when the correct prediction of the total number and the false forecast is clearing.
- The matrix looks like the table below:

$$\text{Accuracy} = \frac{\text{TP+TN}}{\text{Total Population}}$$

AUC-ROC curve:

- ROC stands for a curve of features. AUC stands for the areas below the curve.
- This classification is used with ROC and AUC to describe its function.
- ROC Y stands for a cure as TPR and X stands for FPR.
- TPR =True Positive Rate, FPR =False Positive Rate.

4.8. Random forest algorithm to perform predictions.

- Each end uses the tree's rule to take the necessary features in the data tests and save the expected result.
- Voting is determining by random forest, with the goal being predicting.
- Each expected result has objectives, and they are used to measure votes.

Take, for example, 100 random end trees from a random forest. It is calculating by taking it into the test process one by one. Each destination consists of three parts. The X, Y, Z. The random result is based on the number of X, Y, Z trees in the forest. If 60 of these votes are for X, they will determine what the node should look like. The tree's leafy branch works with formulas to distinguish between these and is characterizing by a random wild result. Thus, an unexpected product is categorized to determine the forest's best outcome and precisely the work.

4.9. Advantages of Random Forest

- Random Forest does two things: the categorization and the other is regression.
- It is capable of handling massive, high-dimensional datasets.
- It increases the model's accuracy and avoids the problem of overfitting.

5. Weather and climate-based agricultural production proposed work.

Agricultural production takes place in a recycled manner. They keep climate change and sow crops. Agricultural production also takes place on a seasonal basis. They are monsoon crop production season, winter crop production system, and summer crop production system. In this way, agricultural production is recycling according to the weather. Significant changes in agricultural output will see due to climate change. They depend on the monsoon for agriculture. Climate change may reduce the amount of soil produced by agriculture. For example, rising temperatures during the summer can lead to famine and flooding during the rainy season.

Table-2 Temperature and Rainfall

Years	Temperature (+increase,-Decrease) in ºC	Rainfall (+increase,-Decrease)
2010-2011	+ 0.7 ºC	-120
2011-2012	+ 0.7 ºC	-80
2012-2013	+ 0.6 ºC	-150
2013-2014	+ 0.6 ºC	-180
2014-2015	+ 0.6 ºC	-230
2015-2016	+ 0.5 ºC	-60
2016-2017	+ 0.7 ºC	-200
2017-2018	+ 0.8 ºC	-140
2018-2019	+ 0.5 ºC	-180
2019-2020	+ 0.3 ºC	+50

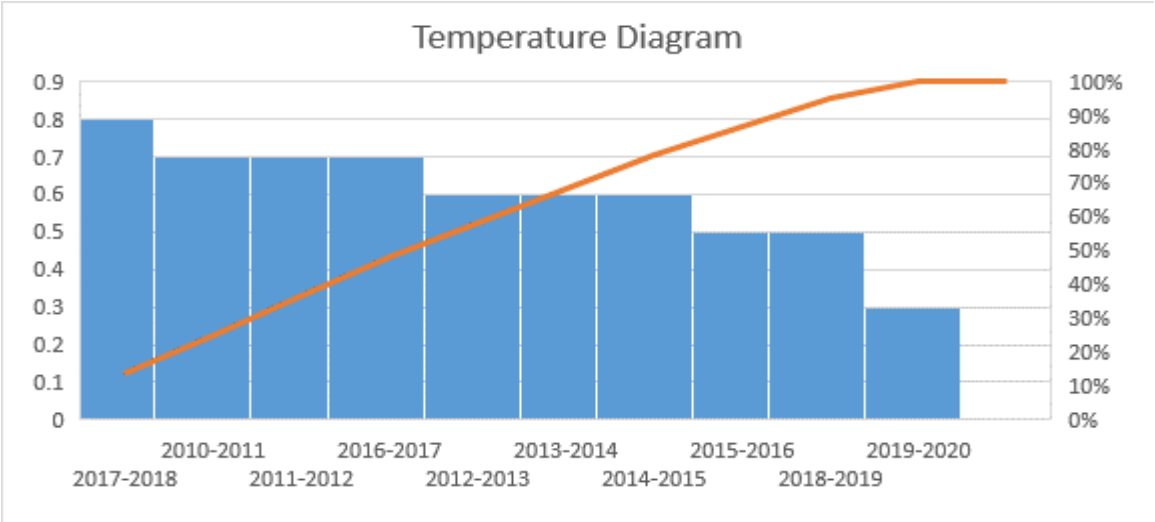


Diagram-5 Temperature Diagram

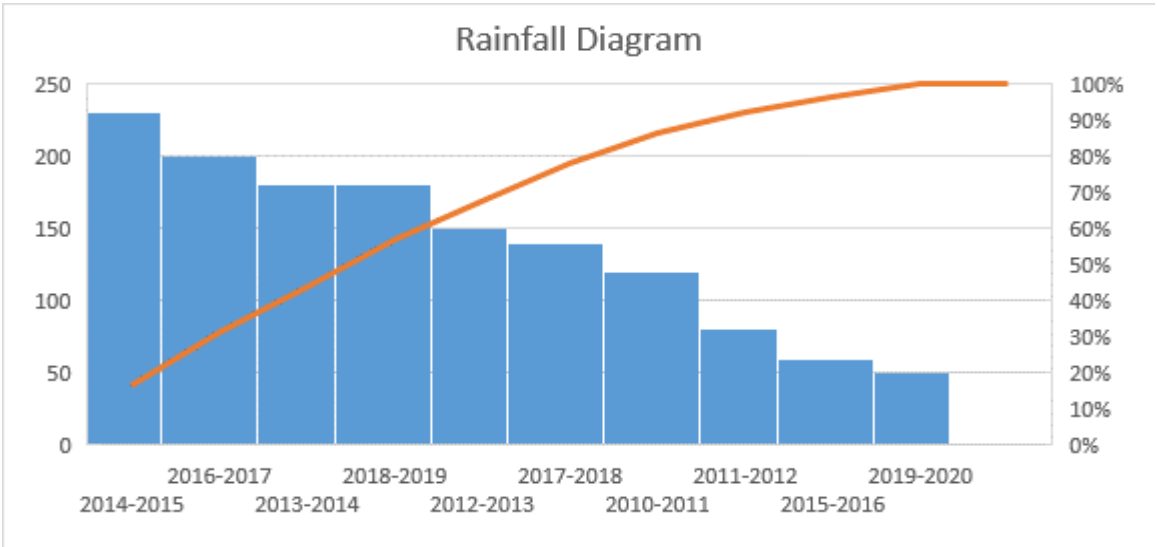


Diagram-6 Rainfall Diagram

The temperature diagram shows which years the temperature is higher than which year in 10 years and lower. The maximum amount of temperature increase between 2010 and 2020 was 0.7^0C. The destruction of arable lands and

forests are the most crucial reason for the temperature rise, and thus the amount of temperature is increasing. There is also the reason for the declining rainfall. The rainfall diagram-4 illustrates which years have seen the lowest rain in the last tenyears. The maximum rainfall in 2014-2015 was 800 mm above average rainfall.

Humans are increasingly destroying natural resources and failing to reach the maximum rainfall level. Also, only 3% and 4% of the natural rainfall is due to declining forests. Temperatures are higher than ever, with annual rainfall less than 2%. The most important reason for this is The destruction of forests by humans. The increase in temperature depletes our able lands and forests and houses and factories, causing a decrease in rainfall. The water absorbed in the factories is thus finishing the groundwater level. The average annual rainfall, which expects to be large, is due to low pressure. Current rainfall is declining. In the future, the temperature will rise, and the precipitation will decrease. The groundwater level is also dropping so will the rain in Villupuram in the future.

The district's monthly rainfall is 1060.3 mm. In the coastal zone, the rain is heavier compared to the inland regions. During the Northeast and South-west monsoon seasons, about 93.82 percent of the average rainfall is receiving. Except for the Marakkanam and Vanur blocks, the district usually does not get heavy rain. The rain is moderate in the Kandamangalam and Kolianur blocks; in the Kallakurichi and Sankarapuram Blocks, it is scarce. The Villupuram district's annual rainfall normal (1970-2000) is 1029 mm.5 For the periods. Currently, the Villupuram district's rainfall is 30 % less than the average rainfall. I researched this with a machine learning algorithm and found 70% rainfall. I would also say that there will be 95% rainfall with a Random forest algorithm and logistic regression algorithm in the future. I would say that the Random forest algorithm gives a much better result than the logistic regression algorithm.

6. Changes in the cropping pattern of the Villupuram district

The soil's cropping pattern can depend on the local conditions of the environment and rainfall—the table on the changes in cropping patterns in the Villupuram District. Four main groups have been dividing into crop production Paddy, pulses, oilseeds, and commercial crops. Cereals include paddy, Cholam, Cumbu, ragi, Varagu, maize. The pulse crops are Redgram, Bengal gram, Greengram, and Blackgram. Groundnut and gingelly are the oilseed components, and cotton remains; the commercial crops of the district of Villupuram are sugar cane and banana. The grouping of crops is base on the study area's main cropping pattern and data availability. The data set for the field of cultivation of crops used for the years 2010-2011 and 2019-2020 is available on the Chennai Department of Economics and Statistics' official website. In the field of cultivation in the study area, there is a downward trend during the study period. According to the above figures, 722203 hectares of cultivated land have been used for other agricultural purposes and left unused due to the absence of irrigation facilities in the cultivation field. The Villupuram district's temperature has gradually increased in recent years, rainfall is also declining, and the locality's climate condition has severely affected the cropping pattern and cultivation area.

Table-3 Changes in Cropping Pattern of the Villupuram District

S.No	Crops	2010-2011	2019-2020	Changes
1	Paddy	21.50	41.00	20.50
2	Cotton	1.50	3.50	2.00
3	Sugarcane	3.50	12.50	9.00
4	Cereals	12.00	23.00	11.00
5	Pulses	12.00	21.00	9.00
6	Oil Seeds	10.00	15.00	5.00
	Total	**60.50**	**113.00**	**53**

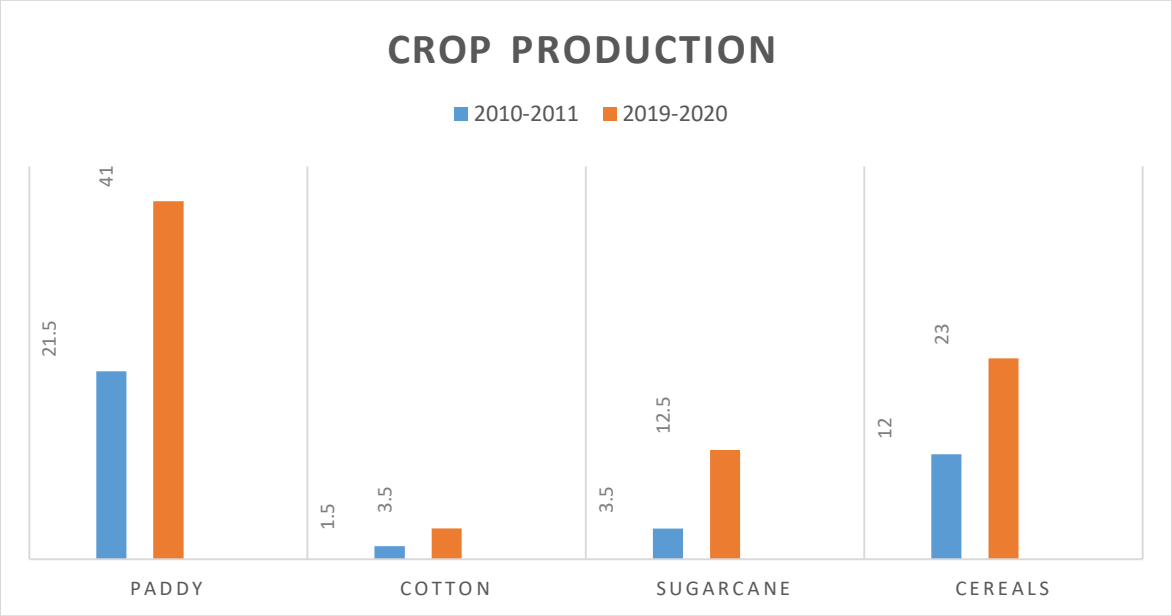


Diagram-7 Agricultural Crop Production

I have taken for study only the significant crops in Villupuram (Paddy, cotton. Sugarcane, and Cereals). Agricultural production has more than doubled in 2019-2020 compared to 2010-2011. There have been significant improvements in agricultural production in the intervening eight years. Agricultural production is increasing or decreasing due to climate change. Figure-5 illustrates that taking two years of the farm output has increased output by 50% in Villupuram district. Modernized agricultural industry production and can only increase agricultural output by 10% and 20% in the future over current production levels. Climate change and population growth are the most critical factors contributing to the decline of agricultural production in the future.

Agriculture is affected by climate change in many ways, some of which are as follows:

- Water use will depend on the size and quality of the crops grown on the farmland, but production will be significantly affected if the number of water increases or decreases due to climate change.
- Agricultural inputs Pesticides, herbicides, and fertilizers can cause significant agricultural production changes.
- Agricultural production is affected by changes in the environment, reducing soil erosion and crop diversification.
- Intermittent cropping of the cultivated land and cultivating the climate may reduce production and input quality.
- Soil erosion is more or less adapted to climatic conditions if the ascent adaptation is high or low, and soil erosion is more likely to be caused by flooding. These are the effects of climate change.

7. Conclusion

Overall, the temperature of 2.5.C has risen over the last ten years (2010-2011 to 2019-2020). The average improvement in the amount of rainfall in the previous ten years was 276 mm. Over the past ten years about crop cultivation, 18482 hectares of crop cultivation area have decreased. The annual rainfall for the district of Villupuram will reduce by 4.0 percent by the end of the century. In my article, I will report that the temperature will increase in the future, and rainfall will decrease. I have also the government has announced. Random forest better than the logistic regression is the best result in future prediction rainfall 99%, and same machine learning method in Agricultural production is likely to be between 60% to 70% in the future. I will recommend agriculture researchers and describe and implement this in the future.

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