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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Profitability and Yield Prediction on Agricultural Crops of India

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DOI: https://doi.org/10.55248/gengpi.234.4.38180

ABSTRACT:

Across the world India is the second largest having a population of more than 1.3 billion people. Many people are dependent on agriculture but the sector lacks efficiency and technology especially in our country. By bridging the gap between traditional agriculture and data science and machine learning, effective crop cultivation can be achieved. In developing countries, farming is considered as the major source of revenue of many people. In modern years, agricultural growth is engaged by several innovations, environments, techniques and civilizations. In addition, the utilization of information technology may change the condition of the decision making and thus farmers may yield the best way. People in various countries especially the ones that are in developing phase have been practicing agriculture for years but the results have never been satisfying due to various factors. These factors affect the crop yield. To fulfill the needs of around 1.3 billion people of our country, it is very important to have a good yield of crops. Due to factors like soil type, precipitation, seed quality, lack of technical facilities etc. the crop yield is directly influenced. Thus, the focus is on implementing crop yield prediction systems by using the Machine Learning techniques by doing analysis on agricultural datasets. The advancement in the field of Machine Learning and Data Science has helped in the growth of the improving gains in agriculture. Machine learning is one of the technologies that is benefitting the farmers to minimize the losses in the farming by providing rich and helpful recommendations and insights about the crops. Application of machine learning in the field of agriculture allows more efficient and precise farming with less manpower with very high-quality production.

Key words: CSV Dataset, Machine learning and Crop profitability prediction

I. INTRODUCTION

Across the globe India is the second largest country having a population of more than 1.3 Billion. Many people are dependent on agriculture but the sector lacks efficiency and technology especially in our country. By bridging the gap between traditional agriculture and data science, effective crop cultivation can be achieved.In developing countries, farming is considered as the major source of revenue for many people. In modern years, agricultural growth is engaged by several innovations, environments, techniques and civilizations. In addition, the utilization of information technology may change the condition of decision making and thus farmers may yield the best way. For the decision making process, data mining techniques related to agriculture are used. Data Mining is the process of analyzing, extracting and predicting the meaningful information from huge data to extract some pattern. This process is used by companies to turn the raw data of their customer to useful information. The process of Data Mining includes first selection of data followed by pre- processing of data and then transforming the data to get patterns which can then be used to predict useful insights. Preprocessing includes finding outliers and detecting missing values whereas transformation finds the correlation between objects. Applying the data mining techniques on historical climate and crop production data several predictions can be made on the basis of knowledge gathered which in turn can help in increasing crop productivity

II. MOTIVATION

Agriculture is the most important sector that influences the economy of India. It contributes to 18% of India‘s Gross Domestic Product (GDP) and gives employment to 50% of the population of India. People of India have been practicing Agriculture for years but the results are never satisfying due

to various factors that affect the crop yield [3]. To fulfill the needs of around1.2 billion people, it is very important to have a good yield of crops. Due to factors like soil type, precipitation, seed quality, lack of technical facilities etc. the crop yield is directly influenced. We focus on implementing crop yield prediction systems by using Machine learning techniques by doing analysis on agriculture dataset. For evaluating

performance Accuracy is used as one of the factors. The classifiers are further compared with the values of Precision, Recall and F1 Score. Lesser the value of error, more accurate the algorithm will work. The result is based on comparison among the classifiers.

II .1) SCOPE

The scope of this project is to investigate a dataset of crop records for the agricultural sector using machine learning techniques. Identifying crop predictions by farmers is more difficult. We try to reduce this risk factor behind selection of the crop.

II .2) OBJECTIVES

1) Data Preprocessing

2) Data Visualization

3) Using various algorithms and comparing the accuracy

III. RELATED WORK

In agriculture, Machine Learning is considered as a novel field, as a variety of work has been done with the help of machine learning in the field of agriculture. There are different philosophies made and evaluated by the researchers all through the world in the field of agriculture and related sciences

[1] Author name:

Thomas van Klompenburga ,AyalewKassahuna ,CagatayCatalb, □

Description:

In this,the author proposed the system using deep learning for predicting the crop yield profit by various algorithms likeDeep neutral networks(DNN),Convolutional Neural Networks (CNN) and Long-Short Term Memory (LSTM).

[2] Author name:

Anakha Venugopal, Aparna S, Jinsu Mani, Rima Mathew, Prof. Vinu Williams

Description:

This crop production with the aid of machine learning techniques. The technique which results in high accuracy predicted the right crop with its yield. The machine learning algorithms are implemented on Python 3.8.5(Jupyter Notebook) having input libraries such as ScikitLearn, Numpy, Keras, Pandas. Developed Android application queried the results of machine learning analysis. Flutter based Android app portrayed crop name and its corresponding yield.

[3]Author name:

CH. Vishnu Vardhan Chowdary, Dr.K.Venkataramana [5]

Description:

They developed id3 algorithm for getting improved and great quality of crop yield of Tomato and is executed in Php platform and datasets are used as csv. Temperature, area, humidity and the production of tomato crop are the different parameters used in this study.

[4] Author name:

R. Sujatha and P. Isakki [6]

Description:

They utilizes data mining techniques for prediction.

This model worked on different parameters such as crop name, land area, soil type, pH value, seed type, water and also foreseen the boom and diseases of plants and in this way empowered to choose the descent crop dependent on climatic data and required parameters.

[5] Author name:

N. Gandhi, L. J. Armstrong, O. Petkar and A. K. Tripathy

Description:

They proposed the SVM for crop yield prediction of rice. In this method, the dataset used consists of different parameters such as place, temperature, precipitation and manufacturing. On this dataset, the implemented classifier is sequential minimal optimization.

IV. DATASETS

We have considered 2 datasets. One finds out the profit and classifies it if there is profit or loss. The second dataset predicts the production.

DATASET 1;

We combined data from different sources. The data contain column:

i)Crops

ii)State

iii)Cost of Cultivation (`/Hectare) A2+F

iv)Cost of Cultivation (`/Hectare) C2

v)Cost of Production (`/Quintal) C2,

vi)yield produced and

vii) support price.

The profit for each row was calculated using the formula;

C1 -> Cost of cultivation(`/Hectare) A2+FL

C2 -> Cost of Cultivation (`/Hectare) C2

Cp -> Cost of Production (`/Quintal)

Profit = (Yield *Support Price) - (C1 + C2 + (Yield*Cp)).

datainput - DataFrame

Index	Crop	State	ltivation (`/Hecta	Cultivation (`/Hec	Production (`/Qui	d (Quintal/ Hecta	Support price
0	ARHAR	Uttar Pradesh	9794.05	23076.7	1941.55	9.83	6000
1	ARHAR	Karnataka	10593.1	16528.7	2172.46	7.47	6000
2	ARHAR	Gujarat	13468.8	19551.9	1898.3	9.59	6000
3	ARHAR	Andhra Pradesh	17051.7	24171.7	3670.54	6.42	6000
4	ARHAR	Maharashtra	17130.5	25270.3	2775.8	8.72	6000
5	COTTON	Maharashtra	23711.4	33116.8	2539.47	12.69	5515
6	COTTON	Punjab	29047.1	50828.8	2003.76	24.39	5515
7	COTTON	Andhra Pradesh	29140.8	44756.7	2509.99	17.83	5515
8	COTTON	Gujarat	29616.1	42070.4	2179.26	19.05	5515
9	COTTON	Haryana	29919	44018.2	2127.35	19.9	5515

DATASET 2;

datainput - DataFrame

Index	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
0	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Arecanut	1254	2000
1	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Other Kharif pulses	2	1
2	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Rice	102	321
3	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Banana	176	641
4	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Cashewnut	720	165
5	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Coconut	18168	6.51e+07
6	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Dry ginger	36	100
7	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Sugarcane	1	2
8	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Sweet potato	5	15
9	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Tapioca	40	169
10	Andaman and Nicobar Islands	NICOBARS	2001	Kharif	Arecanut	1254	2061
11	Andaman and Nicobar Islands	NICOBARS	2001	Kharif	Other Kharif pulses	2	1
12	Andaman and Nicobar Islands	NICOBARS	2001	Kharif	Rice	83	300
13	Andaman and Nicobar Islands	NICOBARS	2001	Whole Year	Cashewnut	719	192

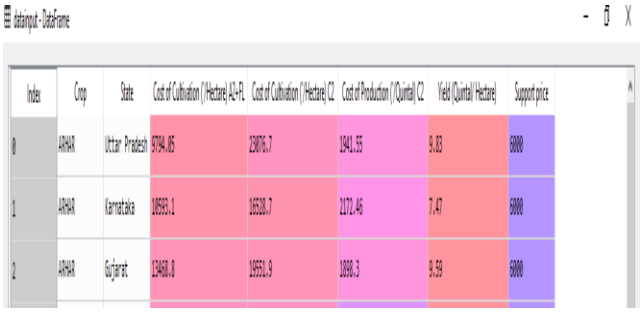
In the Second dataset we have State_Name, District_Name,

Crop_ Year, Season, Crop, Area and Production.

We will be predicting the production of the crops using regressors.

V. DATA PREPROCESSING

After adding the support price column and profit in our dataset and labelling them as 0 and 1, preprocessing techniques were applied such as missing values. The crops and state columns were encoded using labels and the one hot encoder was applied so as to avoid ranking



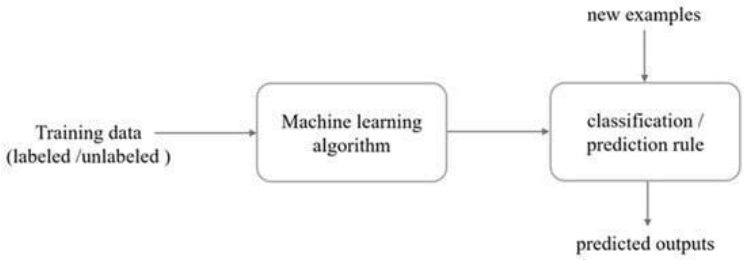
Index	Crop	State	Cost of Cultivation (`/Hectare) A2+FL	Cost of Cultivation (`/Hectare) C2	Cost of Production (`/Quintal) C2	Yield (Quintal/ Hectare)	Support price
0	ARHAR	Uttar Pradesh	9794.85	23076.7	1541.55	6.83	6000
1	ARHAR	Karnataka	10593.1	16538.7	2172.46	7.47	6000
2	ARHAR	Gujarat	13468.8	19551.9	1868.3	9.59	6000

Dataset 2 contains many missing values. During the preprocessing step these rows are dropped since the number of instances is very large.

VI. PROPOSED SOLUTION

In the system, we propose tests of many algorithms and by studying the classification report we compare the algorithms and choose the best one. It has to find accuracy of the training dataset, accuracy of the testing dataset, specification, False Positive rate, precision and recall by comparing algorithms using python code.

Flow diagram ;



The following Involvement steps are :

1.Define a problem

2.Preparing data

3.Evaluating algorithms

4.Improving results

5.Predicting results

We will be applying classification algorithms on dataset 1 and regression for prediction of Production on dataset 2.

Algorithms applied:

1)Classification:

a)Decision Tree

b)Logistic Regression

c)K nearest neighbour

d)Random forest Classifier

2)Clustering

3)Regression:

a)Decision Tree

b)Random forest

VII. PERFORMANCE EVALUATION

Let us first briefly understand some of the performance evaluation metrics:

1)General Definitions

1.True Positive (TP) depicts the number of instances where the system detects for a condition when it is really present.

2.True Negative (TN) depicts the number of instances where the system does not detect a condition when it is absent.

Observations to the total predicted positive observations. Low false positive rate means high precision. In this research the precision 0.788 is obtained which is pretty good.

2)RECALL

Positive observed values proportion is correctly predicted. (Actual defaulter‘s model will correctly predict the proportion)

Recall = TP / (TP + FN)

Recall (Sensitivity) - Recall is the ratio of correctly predicted positive observations to the all observations in actual class -yes.

3)F1 SCORE:

F1 score is the process of finding the calculated weighted average of Precision and Recall. The score is considered for both false positives and false negatives. Intuitively it is not easy to understand accuracy, but F1 is usually more useful than accuracy, especially if uneven class distribution is considered. Accuracy is the best way, if false positives and false negatives have similar cost. To better look at the precision and recall, the cost of false positives and false negatives should be very different.

General Formula:

F- Measure = 2TP / (2TP + FP + FN)

F1-Score Formula:

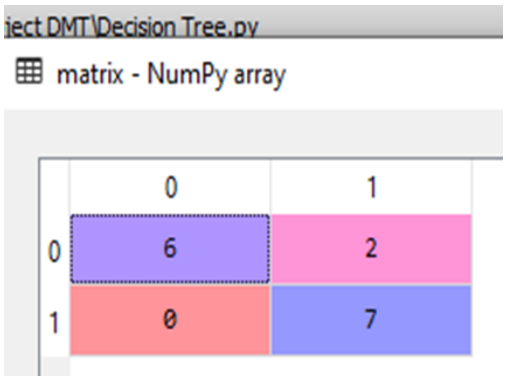
F1 Score = 2*(Recall * Precision) / (Recall + Precision)

4)PRECISION:

Precision = TP/TP+FP

Precision helps when the costs of false positives are high.So let’s assume the problem involves the detection of skin cancer. If we have a model that has very low precision, then many patients will be told that they have melanoma, and that will include some misdiagnoses. Lots of extra tests and stress are at stake. When false positives are too high, those who monitor the results will learn to ignore them after being bombarded with false alarms.

Decision Tree;



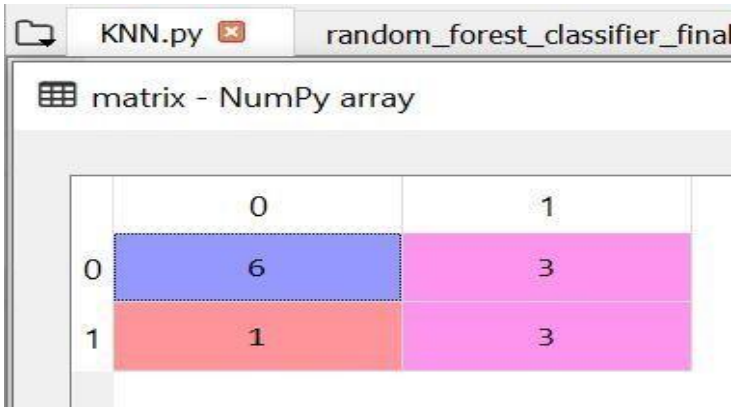
Confusion matrix:

Classification report:

Class	Precision	Recall	F1 Score	Support (num of examples)
0	1.00	0.86	0.92	7
1	0.89	1.00	0.94	8
Accuracy	0.93			15

K nearest neighbor classifier;

Confusion Matrix :



Classification report :

Class	Precision	Recall	F1 Score	Support (num ofexamples)
0	0.50	0.75	0.60	4
1	0.86	0.67	0.75	9
Accuracy	0.69			13

Random Forest Classifier;

Confusion Matrix :

Classification report :

Random forest regressor on dataset 2:

The mean absolute error comes out to be 155503.99436675265 The R2 score is 0.91

Class	Precision	Recall	F1 Score	Support (num ofexamples)
0	0.57	1.00	0.73	4
1	1.00	0.67	0.80	9
Accuracy	0.77			13

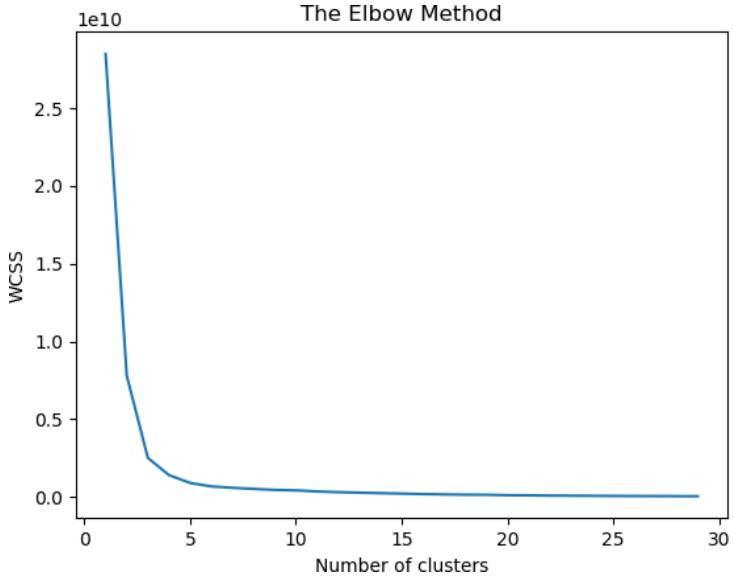
VIII.CLUSTERING

After applying clustering we plotted the elbow graph to check how many clusters gave optimal results.

An ideal way to figure out the right number of clusters would be to calculate the Within-Cluster-Sum-of-Squares (**WCSS**).

WCSS is the sum of squares of the distances of each data point in all clusters to their respective centroids.

The idea is to minimise the sum.



This graph shows that 3 clusters are best suited for the dataset.

IX.RESULTS AND DISC

Algorithm	R2 score	Mean absolute error
Decision Tree	0.84	167163.3086041714
Random Forest	0.91	155503.99436675265

USSION

For classification algorithms, Logistic regression performed the best for predicting the profit on a given crop, state, costs of cultivation (C1,C2), cost of production (Cp), and support prices provided by the government for the year 2020-21As we saw the second dataset did not perform so well. Additional columns like rainfall and temperature need to be added to improve the accuracy of the models.

Algorithm	Precision		Recall		F1 Score		Accuracy
	Class 0	Class 1	Class 0	Class 1	Class 0	Class 1	
Logistic Regression	1.0	0.89	0.86	1.0	0.92	0.94	0.93
DecisionTree	0.78	1.0	1.0	0.75	0.88	0.86	0.87
Randomforest	0.86	0.75	0.75	0.86	0.80	0.80	0.80
K nearest	0.50	0.86	0.75	0.67	0.60	0.75	0.69

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