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Fitting a Linear regression Line and prediction of rice production in India by multiple regression model

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Abstract: As India is a land of cultivation and rice is a major food for most of the Indians, Indian authorities is trying heart and soul to increase the rice cultivation by improving the irrigation system, giving minimum support price to farmers every year. We have a general notion that production of rice mainly depends on Rainfall, rice cultivation land, Minimum support price set by the government every year. Hence after critical analysis using multiple regression model and using SPSS Software version 20 of IBM interesting result has come out. It has been found that rainfall has very less impact on the production of rice in India, whereas minimum support Price has high impact on production of rice along with Rice Agricultural land available. Hence a regression line has been fit using minimum support Price and available Agricultural land in India. Interestingly the regression line has fit to ninety nine percentage accuracy level with a standard error of the estimate as 2.92790.The model has been verified by predicting the rice production, once the minimum support Price set for a given year by the government and available rice cultivation land for the year is given. Here the rainfall as a factor was found to have a lesser impact on the production of rice which signifies that there is other alternative source available for irrigation, other than depending on rainfall, using which farmers are able to irrigate their agricultural land on time.

Keywords: Minimum support price, Multiple regression model, Agricultural land.

1. INTRODUCTION

Rice is a monocot which is normally grown as an annual plant. Its biological name is Oryza sativa. It is one of the world's largest consumed food which is most popular in the region of Asia and Africa. Here in this research we have considered secondary Data for 13 years , then identify the factor which influence the production of rice in India and fit a regression line based on the selected factors which has a influence on rice production and finally can predict the production of rice . The method used for the analysis is Multiple regression Analysis, also SPSS version 20 is used to analyse the data and finally interpretation is done on the outputs

2. LITERATURE REVIEW

In [1] this paper, it is studied and examined that if there exists any factors which can be utilized to predict the future production of rice with the help of previous available data. The main factors (or data) that were taken into consideration for the production prediction in this paper are, the total land used for rice cultivation, irrigation, and historical production data. To effectively determine the rice production, the authors have taken data from 1950 to 2012 for each of the factors. The objective of this paper is to show how the mathematical tools like Multivariate Correlation Analysis and Time Series Analysis, and their proper utilization can be used to give an idea about the future production of rice in terms of quantity.

In [2] this paper, the authors have tried to determine various factors on which the production of rice mainly depends, and then they have use the factors in their analysis to find a way to predict the possible rice production in any future year. The different factors which the authors have considered important are precipitation, temperature, yield of rice in previous years, availability of area for cultivation, and evapotranspiration. The data-set used for analysis in this paper is specifically taken from the 27 districts of Maharashtra for the years 1998-2002 to find the experimental results with the help of WEKA tool after applying SMO classifier. The main objective of this paper is to show the importance of

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machine learning techniques for the prediction of crop yield under different climatic situation. The technique and algorithm like Support Vector Machine, which is a supervised machine learning algorithm, is used during the analysis in order to determine the future rice production. The SVM can be used for both, classification and as well as regression.

In [3] this paper, the authors have tried to examine the effect of climatic change on the production of rice. Climatic factors like increase in the level of CO_2 or increase in the temperature is studied extensively in this paper. And after analysis they have estimated that the yield in crop is found to have increased after an increase in the level of the CO_2, but when there is an increase in the value of temperature, it is found that the yield of rice decreases. For the purpose of prediction and analysis, the authors have used crop simulation models like, ORYZA1 and SIMRIW. The main aim of this paper is to find common factors that influence the production of rice in different countries of Asia, and to provide the way that can help in the production of rice even more like, modification in the date of sowing, and selection for varieties with a higher tolerance of spikelet fertility to temperature.

In [4] this paper, the authors have discussed about different environmental factors that can influence the yield of crop, and they have also tried to find if these factors are related with each other or not. The different factors that are taken into consideration are, Area under Cultivation, Annual Rainfall, and Food Price Index. This paper describes about the Regression Analysis Model which can be used to predict the yield of crop after including all the three factors that are discussed above. The primary objective of this is paper is to highlight the factors that are considered as main affecting criteria, and to find the relation among these factors, and also to estimate that up to what extent these factors are responsible for the prediction of crop. And finally using Regression Analysis Model, the authors have tried to give an experimental relation among these factors so as to predict the yield of crop.

3. METHODOLOGY USED

The secondary data collection method was used here for the research. Thirteen years Annual Monthly Rainfall data (in mm) is collected from the Indian Metrological Department(IMD), Production of Rice in India(in Million Tons) is collected from (farmer.gov.in) .Minimum support Price data(in Rupees) is collected from Reserve Bank of India(RBI).The data related to Agricultural Land for Rice production(in Million Hectares) is collected from(farmer.gov.in).

The established relationship and the study of the impact of production of rice in India is assumed to be influenced by the factors MSP , rice agricultural Land ,rainfall which are independent variable here.

The following regression model is assumed here

$Y=A+BX_1+CX_2+DX_3$

Where

Y=production of Rice

X_1=Minimum Support Price

X_2=Rainfall

X_3=Rice agricultural land

A=constant

B,C,D=are the relationship co-efficient between dependent and independent variables.

Finally using SPSS Software version 20 of IBM the Multiple Regression analysis was conducted.

Studying the impact of the factors Minimum Support Price, Rainfall, Rice agricultural land on production of Rice the final regression line is fitted.

4. RESULTS AND DISCUSSION

Taking the independent variables as Minimum Support Price, Rainfall and Rice Agricultural Land the regression line $Y=A+BX_1+CX_2+DX_3$ has been fitted.

Using the software SPSS , it is found from table 4 that the p value for the factor rainfall is 0.974 which is greater than 0.05,hence it is found to have less impact in the regression line. Whereas for the factor Minimum Support Price ,the p value in the table 4 is found to be 0.000 which is less than 0.01and as such it is found to have high impact in the regression line .Also for the factor Agricultural land for rice the p-value in table 4 is found to be 0.043 which is less than 0.05 and as such this factor is found to have high impact in the regression line.

Thus the factors MSP, Agricultural land for rice are taken into consideration for the regression model excluding the factor Rainfall.

Therefore the fitted regression line is

$Y=A+BX_1+DX_3$

Hence,

Production of Rice=A+B (Minimum Support Price)+D(Agricultural Land for rice)

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Here the independent variables are Minimum Support Price, Agricultural Land for rice and dependent variable is Production of Rice.

Serial Numbers	Year	Rainfall (mm)	Rice production (Million tons)	MSP (Rs)	Agricultural Land (Million Hectares)
1	1994.00	1295.30	81.81	340.00	42.81
2	1995.00	1242.40	76.95	360.00	42.84
3	1996.00	1182.90	80.74	380.00	43.43
4	1997	1183.10	82.55	415.00	43.45
5	1998	1208.80	86.03	440.00	44.80
6	1999	1116.60	89.48	490.00	44.97
7	2003	1187.30	88.52	550.00	42.59
8	2004	1106.50	83.13	560.00	41.90
9	2005	1208.30	91.79	570.00	43.65
10	2006	1161.60	93.35	580.00	43.81
11	2007	1179.30	96.68	745.00	43.91
12	2008	1118.00	99.17	900.00	45.54
13	2010	1215.50	95.97	1000.00	42.86

The p value in table 6 for ANOVA for the fitted regression line has come to be 0.000 which is less than 0.01, which indicates that the regression relationship was highly significant in predicting the production of rice in India. Also in table 5 the R square value is 0.852 which is much higher which again confirms that the fit is good. From table 7 the B values found are MSP=0.027 and Agricultural land for rice=2.151, constant=-20.836, therefore the fitted line is

$Y= -20.836+0.027X_1+2.151X_3$

Production of Rice= -20.836+0.027(Minimum Support Price)+2.151(Agricultural land for rice)

The p value in table 7 for the factor (Minimum Support Price)is 0.000 less than 0.01 and the factor (Agricultural land for rice) is 0.027 which is less than 0.05.Both the factor has shown a high impact in the fitted regression line .Also the Beta for the factor Minimum Support Price(MSP) is 0.801which is much greater and Rice agricultural Land the Beta value is 0.323 which is greater, Hence we can say that the impact of MSP and Agricultural Land for rice shows very high impact in the fitted regression Line.

Table.1. Data of 13 years

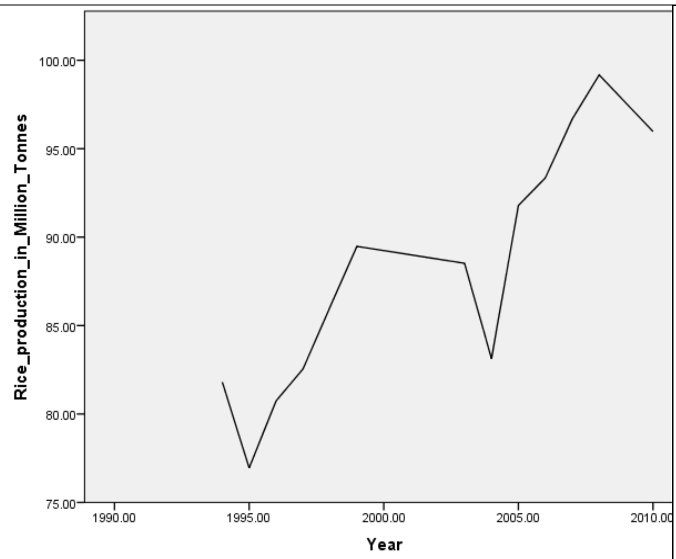

Fig.1.Year versus Rice Production

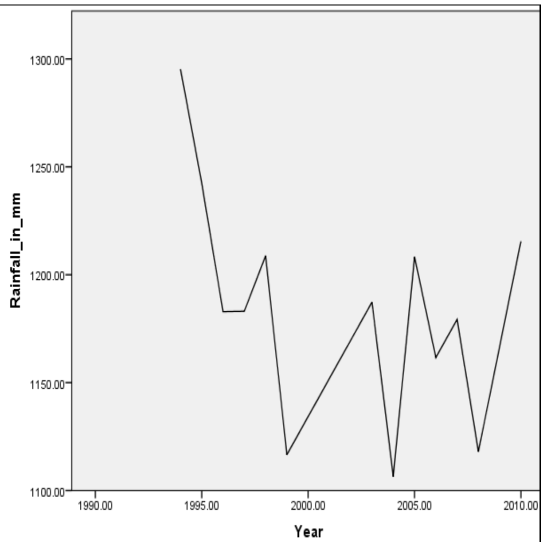

Fig.2.Year verses Rainfall

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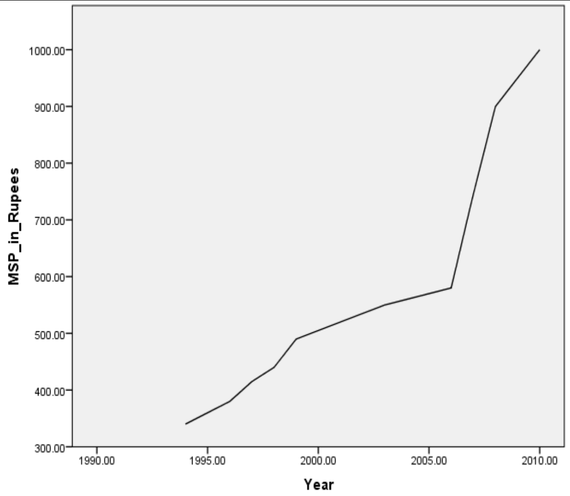

Fig.3.Year versus MSP

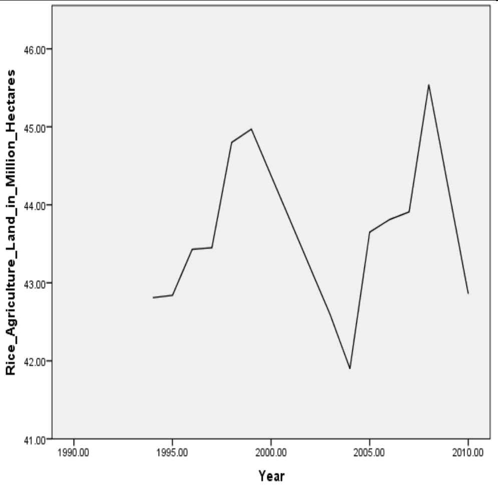

Fig.4.Year versus Rice Agricultural Land

Table.2. Regression Model Summary including Rainfall

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.923a	.852	.803	3.08609

a. Predictors:(Constant),rice Agriculture Land ,MSP, Rainfall

Table.3. ANOVA table including Rainfall

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	493.428	3	164.476	17.270	.000b
Residual	85.716	9	9.524		
Total	579.144	12			

a. Dependent Variable: Rice production
b. Predictors: (Constant), Rice Agriculture Land, MSP, Rainfall

Table.4. Coefficients table including Rainfall

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-21.979	51.222		-.429	.678
Rainfall_	.001	.019	.005	.033	.974
MSP_	.027	.005	.801	5.841	.000
Rice Agriculture Land_	2.160	.918	.323	2.353	.043

a. Dependent Variable: Rice production

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Table.5.Regression Model Summary excluding Rainfall

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.923a	.852	.822	2.92790

a. Predictors: (Constant), Rice Agriculture Land, MSP

Table.6. ANOVA table excluding Rainfall

ANOVAa

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	493.418	2	246.709	28.779	.000b
Residual	85.726	10	8.573		
Total	579.144	12			

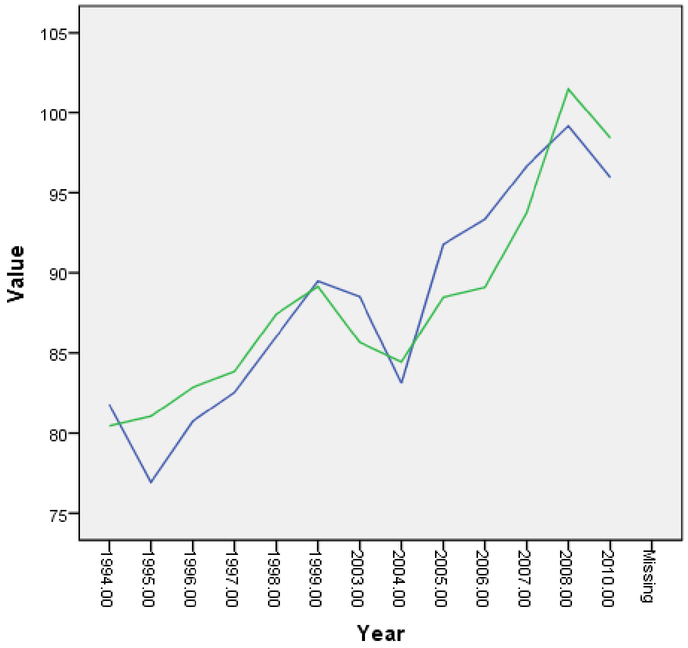
a. Dependent Variable: Rice production

b. Predictors: (Constant), Rice Agriculture Land, MSP

Table.7.Coefficients table excluding Rainfall

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-20.836	35.901		-.580	.575
1	MSP_	.027	.004	.799	6.419	.000
	Rice Agriculture Land_	2.151	.833	.321	2.581	.027

a. Dependent Variable: Rice production



Actual Rice production (Blue line)

Prediction of Rice Production (Green Line)

Fig.5. Comparison of Actual Rice production with the predicted Rice Production(in million tons)

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CONCLUSION

The fitted multiple regression line is Production of Rice= -20.836+0.027(Minimum Support Price)+2.151(Agricultural land for rice) and with ninety nine percentage confidence level.

The regression equation above has established that taking two factors of MSP and Agricultural Land for rice production at Zero, the Rice production in India will be decrease by 20.836 Million tons. The finding presented also shows that taking Agricultural Land for rice production at Zero, Rupees One increase in the Minimum Support Price would lead to a 0.027 Million Tons increase

in the Rice Production in India, while increase of 1 Million Hectare of Land would lead to 2.151 Million tons increase in Rice production in India.

Here the rainfall as a factor was found to have a lesser impact on the production of rice which signifies that there is other alternative source available for irrigation, other than depending on rainfall, using which farmers are able to irrigate their agricultural land on time.

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