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Analysis on Present Mathematical Model for Predicting the Crop Production

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Abstract*: India is a worldwide agriculture business powerhouse. Future of agriculture-based products depends on the crop production. A mathematical model might be characterized as a lot of equations that speak to the conduct of a framework. By using mathematical model in agriculture field, we can predict the production of crop in particular area. There are various factors affecting crops such as Rainfall, GHG Emissions, Temperature, Urbanization, climate, humidity etc. A mathematical model is a simplified representation of a real-world system. It forms the system using mathematical principles in the form of a condition or a set of conditions. Suppose we need to increase the crop production, at that time the mathematical model plays a major role and our work can be easier, more significant by using the mathematical model. Through the mathematical model we predict the crop production in upcoming years. .AI, ML, IOT play a major role to predict the future of agriculture, but without mathematical models it is not possible to predict crop production accurately. To solve the real-world agriculture problem, mathematical models play a major role for accurate results. Correlation Analysis, Multiple Regression analysis and fuzzy logic simulation standards have been utilized for building a grain production benefit depending model from crop production. Prediction of crop is beneficiary to the farmer to analyze the crop management. By using the present agriculture data set which is available on the government website, we can build a mathematical model.

Keywords: Crop Production Prediction, Mathematical Model, Regression Analysis, Fuzzy Logic Model

I. INTRODUCTION

This paper consists of an analysis on present mathematical models for predicting crop production. Rural Communities face various challenges related to crop production. India, being an agro-based economy, relies intensely on the increases it brings about from its rural masses. Its need is to provide the guidance to rural area farmers for good production of crops. An Algorithm for performing determination and assessing the rural yield for an assortment of Rabi and Kharif crops has been created. A model for determining harvest yield dependent on recorded information and appropriate outer climatic data was created. The strategy included advancement of reasonable climate lists which were utilized as regressors [8] in the model, deciding their appropriate loads for the genuine assurance and limiting the error term. All around coordinated and exact prediction of crop and production can be very useful in strategy making for capacity, distribution, evaluating, marketing, import-trade and so on. We can avoid the unnecessary loss by predicting the future and suitable conditions for crops. Weather is the most crucial factor affecting the crop production. By using previous year's data, we can analyze the crop production of future. Seasonable and accurate forecasts of crop production can be quite helpful in policy making for storage, distribution, pricing, marketing, import-export etc. We can predict the crop season wise as we consider the season Rabi, Kharif, summer, winter, autumn, whole year.

Following steps, we will consider for predicting the data and to develop the mathematical model.

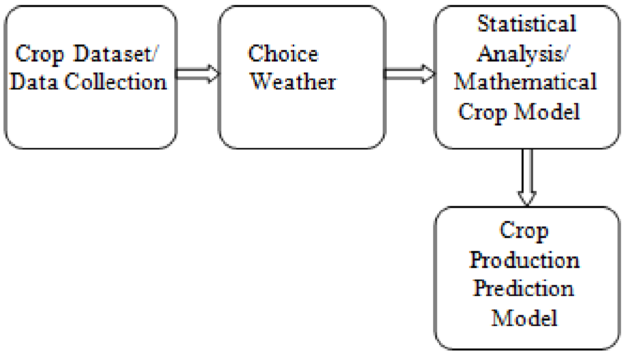

Fig 1. Crop Prediction Model

By using a regression model and a fuzzy logic model we can predict the production of crops like wheat, rice, cotton, maize, tea depending on weather, soil, and various crop parameters. It gives a more accurate prediction by using a fuzzy logic technique. This model is the best achievable crop prediction depending on environmental conditions. As per past previous year production data available, the prediction of crop will be more perfect. Thus, this model will suggest suitable and profitable crops system model to the farmer

II. LITERATURE REVIEW

Foreseeing the possible impacts of atmosphere changes on crops prompts the utilization of factual models to calculate how the crop reacts to atmosphere factors. The factual model was prepared on recorded harvest yields, and how they identified with past information on greatest temperature, least temperature and precipitation. A multiple linear model was created to foresee crop yield utilizing climatic factors. Fuzzy Logic is helpful for crop prediction.

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Fuzzy Logic Framework is one of the most renowned uses of the Fuzzy Logic and Fuzzy Logic set hypothesis. The quality depends on their two-overlap identity.

On the one hand, they can deal with phonetic ideas. On the other hand, they are the all-inclusive approximates ready to perform non-straight mappings among data sources and yields.

Fuzzy Logic [1] based frameworks utilize semantic factors to reason utilizing an arrangement of logical decisions that contain IF-THEN guidelines, which associate antecedent(s) and con-sequent(s), separately. A predecessor is a fluffy provision with a certain degree of membership (somewhere in the range of 0 and 1). Fuzzy Logic principles can have numerous precursors connected with AND/OR administrators, where all parts are determined simultaneously and settled into a solitary number. Consequents can likewise be included multiple parts, which are then amassed into a solitary yield of a fluffy set. The Mamdani inference technique was utilized. In light of the Mamdani inference technique for the arrangement of rules, the collected yield is given by,

$$\mu(B)=max(min\{\mu(A)input(i), \mu(A)input(j)\}); \text{ range between 1 to N} \quad (1)$$

III. METHODOLOGY

The examination endeavored to utilize a regression model to predict the yield of harvest dependent on changes in maximum temperature, least temperature and precipitation over the zone of study. Single mass curve procedure was utilized to decide the nature of atmosphere information. The exploration statistically characterized the factors under scrutiny included mean and skewness. Connection examination was done to decide the factual connection between the factors under scrutiny. Regression was done by utilizing statistical programming. Information produced as yield in this relapse was used in model check and investigation. Endeavors were made to think of a various direct regression equation that best speaks to the connection between the factors. The model was checked utilizing a contingency table and determined. For this analysis, a dataset is extracted from connect https://data.gov.in. In this Government site datasets are shared containing information of recent years. This dataset contains different segments in Microsoft Excel like creation territory, crop, crop year and seasons. This CSV record has the hundred records of eight districts of Maharashtra territory of India. In addition, this record contains information utilized for twenty different harvests.

Steps to follow-

1. Choose Particular crop
2. Choose the Particular Location
3. Consider the factor affecting on particular crop
4. Consider the Temperature, Humidity, Rainfall these different parameter
5. Apply Fuzzy set function
6. Calculate the Relationship between Crop Yield and Variations in Climatic Elements
7. Apply Regression Analysis
8. Finally verify the model of crop prediction.

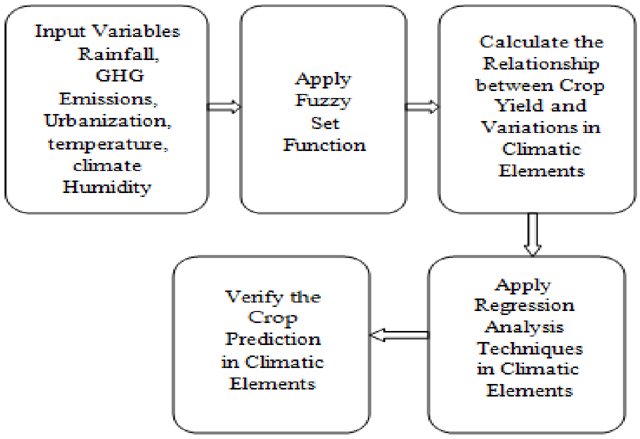

Fig 2. Methodology

IV. MATHEMATICAL MODEL

Correlation Analysis-

Correlation analysis means Relationship is useful to research the reliance between at least two factors. There are various strategies to perform correlation analysis: Kendall Pearson, Spearman relationship tests. By using Pearson test, we have to calculate the relationship between the crop yield and climate condition.

$$r=\sum(x-m_x)(y-m_y)/ sqrt[\sum(x-m_x) 2\sum(y-m_y)2] \quad (2)$$

Where,

r means Pearson correlation to measure linear relationship between the two variables,

m_x and m_y are the means of the two variables,

x and y are the values of the two variables

degrees of freedom: df = n−2

Calculate the t value. We can plot the linear regression curve,

$$t=\frac{r\sqrt{n-2}}{\sqrt{1-r2}} \quad (3)$$

Multiple Regression analysis-

Multiple Regression Analysis refers to a lot of strategies for contemplating the straight-line connections among at least two factors. In this method, we calculate the β's in the condition:

$$Y= \beta_0+\beta_1 x_{1j}+\beta_2 x_{2j}\ldots\ldots+\beta_p x_{pj}+\varepsilon_j \quad (4)$$

Fuzzy Logic

$$\mu(B)=max(min\{\mu(A)input(i), \mu(A)input(j)\}); \text{ range between 1 to N}$$

V. EXPECTED RESULT

Calculate Regression Factor and t-test through dataset available on government website

State	District	Year	Crop	Season	Area
Maharash	NASHIK	1998	Jowar	Kharif	600
Maharash	NASHIK	1998	Jowar	Rabi	5600
Maharash	NASHIK	1999	Jowar	Kharif	700
Maharash	NASHIK	1999	Jowar	Rabi	5900
Maharash	NASHIK	2000	Jowar	Kharif	1000
Maharash	NASHIK	2000	Jowar	Rabi	6900
Maharash	NASHIK	2001	Jowar	Kharif	1100
Maharash	NASHIK	2001	Jowar	Rabi	3900
Maharash	NASHIK	2002	Jowar	Kharif	1100
Maharash	NASHIK	2002	Jowar	Rabi	3400

Fig 3. Dataset of Jawar Crop in Nashik

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Above figure mention the Nashik, Maharashtra state Jowar crop production area per year.

Calculate the regression factor

SUMMARY OUTPUT								
Regression Statistics								
Multiple F	0.011795							
R Square	0.000139							
Adjusted I	-0.01319							
Standard I	1.228577							
Observati	77							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regressio	1	0.015753	0.015753	0.010436	0.918903			
Residual	75	113.205	1.5094					
Total	76	113.2208						
	Coefficient	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	1999.654	0.161966	12346.13	2.6E-238	1999.331	1999.977	1999.331	1999.977
X Variable	6.94E-07	6.79E-06	0.102159	0.918903	-1.3E-05	1.42E-05	-1.3E-05	1.42E-05

Fig 4. Regression Factor

Evaluate the regression factor of above data

t-Test: Paired Two Sample for Means		
	Variable 1	*Variable 2*
Mean	1999.662	11984.41558
Variance	1.489747	430214753.9
Observati	77	77
Pearson C	0.011795	
Hypothesi	0	
df	76	
t Stat	-4.22416	
P(T<=t) or	3.3E-05	
t Critical o	1.665151	
P(T<=t) tw	6.59E-05	
t Critical t	1.991673	

Fig 5.t-test

Calculate the result of above data using t-test

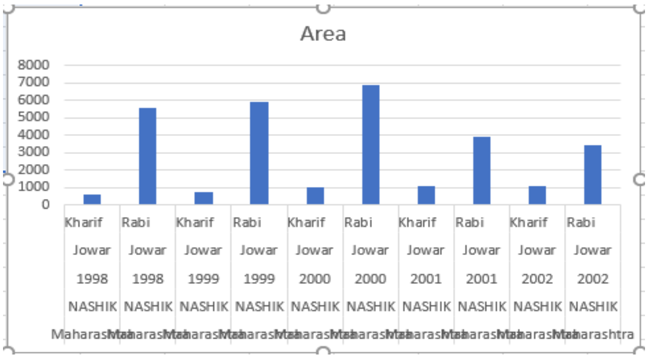

Fig 6.Graph of Jawar Crop in nashik

Fig 6 indicates the graph of jawar crop production per year by using regression analysis.

VI. CONCLUSION

We conclude that to solve the real-world agriculture problem by mathematical models plays a major role for accurate results. Multiple Regression analysis and fuzzy logic simulation standards have been utilized for building a grain production benefit depending model from crop production. Prediction of crop is beneficiary to the farmer to analyze the crop management. By using the present agriculture data set which is available on the government website, we studied a mathematical model to predict the crop production.

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