A Data Mining Approach for the Estimation of Climate Change on the Jowar Crop Yield in India

Ananthoju Vijay Kumar, T. V. Rajini Kanth

Abstract--The Intergovernmental Panel for Climate Change (IPCC) projections on temperature predicts an increase of 1.8 to 4.0°C, by the end of this century. There is a likelihood of a considerable impact on agricultural land-use due to snow melt, availability of irrigation, frequency and intensity of inter and intra seasonal droughts and floods, soil organic transformation matters, soil erosion and availability of energy as a result of global warming, impacting agricultural production. Global warming due to greenhouse effect is expected to impact hydrological cycle viz. precipitation, evapo-transpiration, soil moisture etc., which would create new challenges for agriculture. In the present paper an attempt is made to predict the impact of temperature variance on the Jowar crop production. To know the impact of temperature on the Jowar crop yield in India, an experiment is conducted on the Jowar yield and temperature of India from the period 1950-2011. In the experiment it is proved that Jowar yields are very fewer dependent on the temperature. In the end it is know that there may be other factors impacting the yield at a high level because Jowar crop yields were increased even when the temperature is decreased.

Keywords -Yield Estimation, Data- mining, Correlation, Correlation Analysis, Regression and Regression Analysis.

I. INTRODUCTION

The atmosphere surrounding the earth is made up of nitrogen (78%), oxygen (21%) and the remaining 1%, is made up carbon dioxide, methane and nitrous oxide. These gases also called greenhouse gases act as a blanket and trap heat radiating from the earth and make the atmosphere warm. Due to the industrial revolution global atmospheric concentrations of these greenhouse gases have increased noticeably as a result of human activities. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture. As a result we are witnessing global warming. The increasing green-house gases (GHG) resulted in global warming by 0.74°C over past 100 years. This became the motivation for doing the experiment to know the impact of temperature on the Jowar crop production in India. To estimate the temperature's influence on the Jowar crop's yield in India an experiment is conducted on the dataset of Jowar crop's yield and temperature. For the experiment Jowar yield and temperature (including maximum and minimum) are collected from the sources like Department of Agriculture and Statistics.

India and the Department of Agriculture and Cooperation, India. The dataset of Jowar crop's yield and temperature during 1950-2011 is as shown in the below table.

Agriculture crops yield and Temperature dataset

Year	Min-temp	Max-temp	Jowar-yield
1950	14.82	29.83	353
1951	14.73	30.40	381
1952	15.21	30.57	420
1953	15.43	30.71	455
1954	15.18	30.19	527
1955	14.97	29.91	387
1956	14.91	29.71	451
1957	14.80	29.98	499
1958	15.47	30.63	503
1959	15.12	30.17	484
1960	14.95	30.56	533
1961	14.97	29.76	440
1962	14.78	30.05	529
1963	14.63	30.23	501
1964	14.74	30.43	536
1965	14.70	30.52	429
1966	14.97	30.95	511
1967	14.58	30.38	545
1968	14.54	30.26	523
1969	14.93	30.90	522
1970	14.71	30.29	466
1971	14.23	29.72	460
1972	14.68	30.63	449
1973	15.07	30.52	544
1974	14.58	30.54	643
1975	14.57	30.03	591
1976	14.54	30.37	667
1977	14.68	30.33	739
1978	14.67	30.03	708
1979	14.83	30.62	699
1980	15.03	30.62	660
1981	14.86	30.22	727
1982	14.73	30.19	657
1983	14.59	30.08	725
1984	14.83	30.24	715
1985	14.83	30.59	633
1986	14.83	30.34	576
1987	14.88	30.76	762
1988	15.03	30.53	697
1989	14.56	30.33	869
1990	14.83	30.04	814
1991	14.93	30.46	655
1992	14.61	30.52	982
1993	14.73	30.72	895
1994	15.01	30.49	779
1995	14.98	30.53	823

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1996	15.06	30.63	957
1997	14.58	29.98	697
1998	15.23	30.76	859
1999	15.00	30.92	847
2000	14.82	30.71	764
2001	14.89	30.82	771
2002	15.37	31.09	754
2003	15.16	30.58	716
2004	15.03	30.73	797
2005	15.16	30.63	880
2006	15.25	31.03	844
2007	15.33	30.79	1021
2008	15.3	30.9	962
2009	16	31.3	860
2010	15.9	30.7	949
2011	16.2	31.8	954

Table: M1

A chart view of the temperature and agriculture crops yield

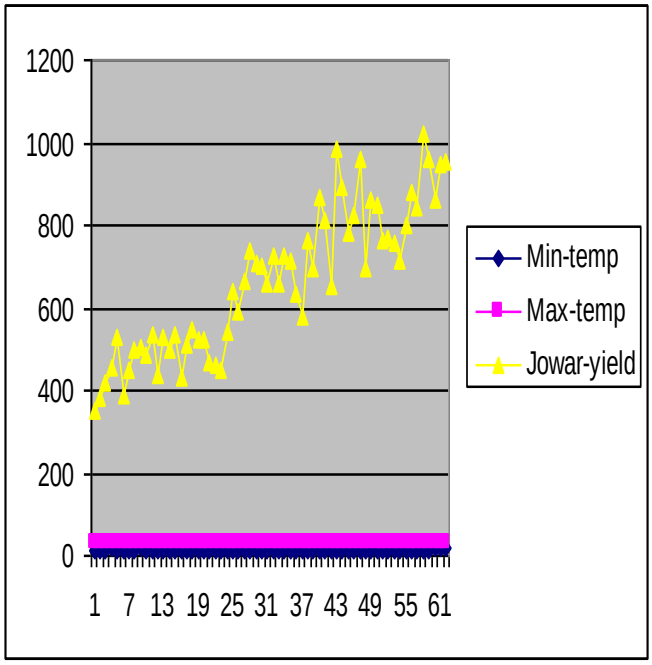


Chart: M1

Growth rates of yield of Jowar crop in India during 1950-2011

The Jowar yield during the studied period in India is clearly increased from the year 1950 to 2011. The results of the research revealed the truth that the Jowar yield was increased every year expect the years 1965-66, 1985-86 and 2000-01. During the years 1955-56, 1960-61, 1965-66, 1970-71, 1975-76, 1980-81, 1985-86, 1990-91, 1995-96, 2000-01,2005-06 and 2010-11 the growth rates are 9.63, 37.73, -19.1, 8.62, 26.82, 18.27, -9.44, 28.59, 1.11, -7.17, 15.18 and 7.84. The growth rates are increased during the years 1960-61, 1990-91, 1975-76 and decreased badly during the years 1965-66, 1985-86 and 2000-01.The growth rates of the Jowar crops yield during the period 1950-2011 are represented in the table form and chart form.

Growth rates of Jowar crop yield in India

Year	Jowar growth rates
1950-51	0
1955-56	9.63
1960-61	37.73
1965-66	-19.51
1970-71	8.62
1975-76	26.82
1980-81	18.27
1985-86	-9.44
1990-91	28.59
1995-96	1.11
2000-01	-7.17
2005-06	15.18
2010-11	7.84

Table: M2

A Chart view of the growth rates of Jowar crop's yield in India

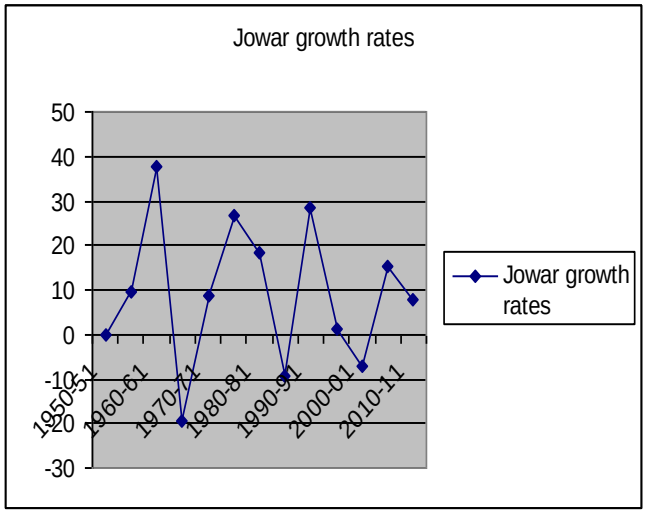


Chart: m2

II. IMPACT OF TEMPERATURE ON THE JOWAR CROP YIELD IN INDIA

To estimate the influence of the temperature on the Jowar crop's yield in India, an experiment is conducted on the data set of Jowar yield and minimum temperature and maximum temperature. The present data set is constructed on the basis of data collected from the Department of Agriculture and Statistics, India and Department of Agriculture and Cooperation, India, for the period of 62 years, i.e., from 1950-2011. To know the actual relationship between the temperature and Jowar crop yield in Inida statistical analysis is performed on the dataset using a statistical analysis tool, SPSS (Statistical Package For Social Science). The tool spss is found very useful for this kind of research and helped a lot for conducting this experiment. The results of the statistical analysis proved that there is a low-medium positive influence on the Jowar crop yield in India.

The results of the correlation between the temperature and yield of Jowar crop's yield

There is low positive (0.353) and moderate correlation (0.525) found between minimum temperature, maximum temperature and Jowar yield. The correlation coefficients are pearson correlation coefficients, the test of significance is 2-tailed and the results are significant at 0.01 level of significance.

Correlations

		JOWARYEI	MINTEMP	MAXTEMP
Pearson Correlation	JOWARYEI	1.000	.353**	.525**
	MINTEMP	.353**	1.000	.658**
	MAXTEMP	.525**	.658**	1.000
Sig. (2-tailed)	JOWARYEI	.	.005	.000
	MINTEMP	.005	.	.000
	MAXTEMP	.000	.000	.
N	JOWARYEI	62	62	62
	MINTEMP	62	62	62
	MAXTEMP	62	62	62

**. Correlation is significant at the 0.01 level (2-tailed).

Regression analysis between crops yield and temperature

The regression analysis is performed on dataset of Jowar yield, minimum temperature and maximum temperature to know how the yield is dependent on the temperature. The results of the experiment revealed that the Jowar yield is slightly dependent upon the maximum temperature and minimum temperature.

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	MAXTEMP, MINTEMP[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: JOWARYEI

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.525[a]	.276	.251	153.4511

a. Predictors: (Constant), MAXTEMP, MINTEMP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	529228.6	2	264614.3	11.238	.000[a]
	Residual	1389288	59	23547.251		
	Total	1918516	61			

a. Predictors: (Constant), MAXTEMP, MINTEMP

b. Dependent Variable: JOWARYEI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-6625.888	1561.635		-4.243	.000
	MINTEMP	7.163	73.941	.014	.097	.923
	MAXTEMP	235.683	67.201	.516	3.507	.001

a. Dependent Variable: JOWARYEI

The Linear regression results between minimum temperature and Jowar yield are as follows.

Independent variable	Min - temp
Dependent variable	Jowar - Yield
Method	Linear regression
R*R	0.13
d.f	60
sigf	0.005
b0	-1992
b1	177.7
Standard Error	0

Table: m3

For the linear regression between the minimum temperature and Jowar yield a linear regression equation is derived as follows.

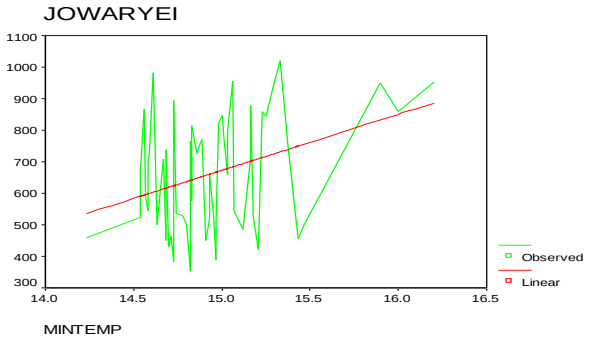
Y=-1992.6+177.7X

Where

X: minimum temperature

Y: Jowar yield

A Chart view of the linear regression between the Jowar yield and minimum temperature.



The Linear regression results between maximum temperature and Jowar yield are as follows

Independent variable	Min - temp
Dependent variable	Jowar - Yield
Method	Linear reg
R*R	0.28
d.f	60
sigf	0.005
b0	-6649.3
b1	239.96
Standard Error	0

Table: m4

For the linear regression between the maximum temperature and Jowar yield a linear regression equation is derived as follows.

Y= -6649.3+239.9X

Where

X: maximum temperature

Y: Jowar yield

A Chart view of the Linear regression between the Jowar yield and maximum temperature.

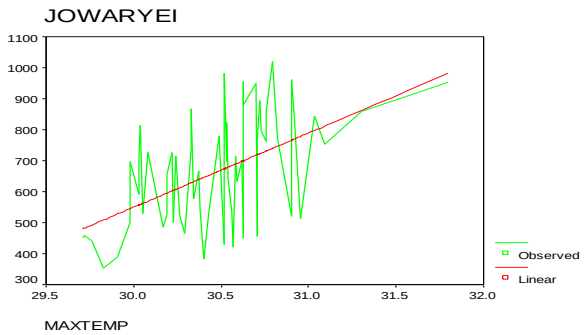


Chart: m5

III.CLUSTERING WITH K-MEANS

To classify the yield of Jowar data into groups, K-means quick clustering technique is used. The quick clustering with iterations has divided the yield data into two clusters, initially, with cluster center points, 353 and 1021. Finally, the cluster center points are moved to 516.56 and 818.87 with a change of 163.563 and 202.133 in the first and second clusters. The clustering technique grouped the yield data as follows, the first cluster has 32 cases and the second cluster has 30 cases. The total valid cases are 62 and missed cases are null.

Initial Cluster Centers

	Cluster	
	1	2
JOWARYEI	353.00	1021.00

Iteration History[a]

	Change in Cluster Centers	
Iteration	1	2
1	163.563	202.133
2	.000	.000

a. Convergence achieved due to no or small distance change. The maximum distance by which any center has changed is .000. The current iteration is 2. The minimum distance between initial centers is 668.000.

Final Cluster Centers

	Cluster	
	1	2
JOWARYEI	516.56	818.87

Number of Cases in each Cluster

Cluster	1	32.000
	2	30.000
Valid		62.000
Missing		.000

A pie chart view of the Jowar yield Clusters

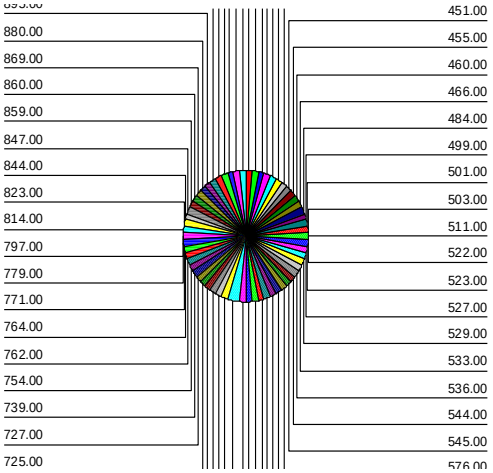


Chart: m6

IV.CONCLUSTION

During the years 1955-56, 1960-61, 1965-66, 1970-71, 1975-76, 1980-81, 1985-86, 1990-91, 1995-96, 2000-01,2005-06 and 2010-11 the growth rates were 9.63, 37.73, -19.1, 8.62, 26.82, 18.27, -9.44, 28.59, 1.11, -7.17, 15.18 and 7.84. The growth rate were very high during the years 1960-61, 1990-91, 1975-76 and decreased badly during the years 1965-66, 1985-86 and 2000-01. Similarly, the minimum temperature and maximum temperatures are varied in between 14.23 to 16.2 and 29.72 – 31.8. The results of the correlation and regression analysis of Jowar crop yield and temperature proved as there is a low positive relationship between them.

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Mr.Ananthoju Vijay Kumar perusing Ph.D from Acharya Nagarjuna University, Guntur, Andhra Pradesh since 2008 to till date. He has obtained his Master of Computer Application degree from Osmania University, in June 2006 and Bachelor of Computer Application from Kakatiya University, in May 2003. His specialization area in research is Data mining in Agriculture. He is presently working as a Contract Lecturer in the Department of Computer Science, University College of Sciences, Satavahana Univeristy, Karimangar, Andhra Pradesh, India from August 2007 to till date. Prior to that he worked as a Assistant Professor, in the department of Computer Applications, SRM PG college, Karimnagar, Andhra Pradesh, India, from June, 2006 to August 2007. His total teaching experience is 8 years. He had attended several national and International seminars and conferences for paper presentation. He also published several articles in the various journals.

Dr. T. V. Rajini Kanth has obtained his Ph.D. degree in C.S.E. branch from Osmania university, Hyderabad in July, 2008 and M. Tech. (C.S.E.) degree from Osmania University, Hyderabad in January, 2001. His specialization area in research is “Spatial Data mining”. He obtained his PGDCS degree from HCU, Hyderabad in 1996. He received his M. Sc. (Applied mathematics) degree in the year 1989 from S.V. University, Tirupati as University Ranker. He is working as a Professor and Head, Department of IT, GRIET, Hyderabad since 2008 June. His writings have appeared in numerous Professional conferences and Journals (International journals-21, national level-4,). He was an author for few books i.e Artificial Intelligence etc. He has conducted two International conferences namely ICACT-08, and ICACM-11 at GRIET, Hyderabad and also acted as session chair for many conferences. He was convener for Pragnya-08, a national level technical fest at GRIET. Apart from that many National level ROBO workshops were conducted namely RoboTrix, eTrix, iTrix, LogiTrix, VisionTrix and Haptic Robotic arm in association with IIT Bombay and Technophilia etc.. Apart from these presently guiding around 22 Ph.D. scholars at various universities namely, JNTUH, JNTUK, JNTUA and NU. He is currently editor for two journals. He was called for about 50 AICTE sponsored workshops as resource person.