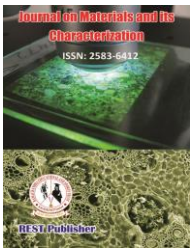
Journal on Materials and its Characterization
Vol: 3(1), March 2024
REST Publisher; ISSN: 2583-6412
Website: http://restpublisher.com/journals/jmc/
DOI: https://doi.org/10.46632/jmc/3/1/2



Analysis of Sugar Production Based on Productivity and Recovery Rate

[*] Tejaswi Satyajit Kurane
Rajarshi Chhatrapati Shahu College, Kolhapur, Maharashtra, India.
Corresponding Author Email: tejustat@gmail.com

Abstract: *The present investigation emphasizes growth and instability of sugarcane in Maharashtra. Sugarcane is the important cash crop of the Maharashtra. An effort has been made in this study to examine the trends in area, production, productivity of sugarcane and to determine the factors which are contributing toward productivity of sugarcane in major sugar producing states of Uttar Pradesh and Maharashtra. It has been observed that area expansion has significantly contributed towards increased production of sugarcane but productivity has remained stagnant. it was found to be higher for Maharashtra than Uttar Pradesh. The data obtained from secondary sources were analysed to examine the factors which effect on the sugarcane acreage in Maharashtra state and Uttar Pradesh for analyse by using linear multiple regression based on Neronian Partial Adjustment Model. The present project attempts to study the trend and growth rates of Sugarcane production Maharashtra. The time series data on area, production and productivity of Sugarcane pertaining to the period 1950-51 to2022-23 were used for the study. useful information for further planning and corrective measures for future development of Maharashtra State. The area, production and productivity of sugarcane crop have been estimated in Maharashtra district.*
In this study we fit the linear regression model on the data and find the coefficient of model and fit the predictive model. Also, we check the multicollinearity in the data by VIF and find the ridge regression for the given data.
Keywords:*Productivity, Sugar Recovery, Ridge Regression, Multicollinearity.*

1. INTRODUCTION

In India, sugarcane is the most important commercial crop which is grown over 2.57% of its gross cropped area. Globally India is the second largest producer of sugarcane after Brazil and accounts for about 25% of the world's production. It has engaged around 7.5% of the country's rural population in sugarcane farming and contributed to 10% of the agricultural GDP in 2010-11 (Solomon, 2016). The sugar industry of India is the second largest agro-based industry after textiles and it has successfully contributed towards providing employment and economic development of country (Ahmed and Rahman, 2014). The sugar industry has supported 6 million farmers and their families. Maharashtra is the second largest sugarcane growing state in India. Sugarcane is most important crop in Maharashtra. It has an important position in agricultural economy of Maharashtra well as in India. Sugarcane belongs to bamboo family of a plant and it has indigenous to India. is a steady growth in area and production of sugarcane over the years. However, the decline in its productivity in recent decades is of great concern. In India Uttar Pradesh stands first both in area and production of sugarcane while Tamil Nadu ranks first in productivity of sugarcane. Maharashtra and Karnataka stood second and third ranks in area and production respectively. Punjab ranks third in sugarcane productivity (India agristat.com). The present study aims at examining the growth in area, production, and productivity of sugarcane in Maharashtra. Climate plays an important role in all the phases of the sugarcane plant. Since, the plant stands in the field for 12-24 months, hence, goes through all possible limits of weather parameters i.e. rainfall, temperature, sunshine, humidity etc. All these parameters have a role in plant growth, sugar yield, quality and content of juice etc. For good growth of plant and high production, specific weather conditions with suitable parameter are required. It is generally observed that, among all sectors agricultural sectors or agriculture production activities are most sensitive and vulnerable to climate change (T Deressa, R Hassan, D Poonyth, and Dec 2005). Climate change is a direct input to the agricultural production process, so the agricultural sector has been a natural focus for research. Sugarcane is the main resource of raw material not only for sugar manufacturing but also other allied industries. Sugarcane is the backbone of farming community and providing employment opportunities to large number of people (Rahman and Bee, 2019). The Indian sugar industry uses sugarcane in the production of sugar and hence maximum number of the companies. Sugar recovery is the most vital economic indicator of any sugar factory. It indicates the sugar production from per metric ton of sugarcane.

OBJECTIVES:

- To fit the prediction model
- To study the effect of different factors on the production of sugar
- To check correlation between production, productivity, sugar crushed, sugar recovery
- To compare sugar production in Uttar Pradesh and Maharashtra
- To examine the regression model for production, productivity, sugar crushed, sugar recovery in presence of multicollinearity.

DATA SOURCES AND DESCRIPTION:

Here, we take the data of production of sugar in sugar cane industry. In that we consider the factor production of sugar cane, Area under sugar cane cultivation, productivity, cane crushed, sugar recovery, sugar, number of factories. As Uttar Pradesh having first highest area and Maharashtra state having second highest area of sugarcane production in India. So,for study purpose we take all India, Uttar Pradesh and Maharashtra state.

DataSource:
https://www.researchgate.net/publication/323263544_An_Economic_Analysis_of_Sugarcane_Cultivation_and_its_Productivity_in_Major_Sugar_Producing_States_of_Uttar_Pradesh_and_Maharashtra

STATISTICAL TOOLS:

1. **Regression: OLS and Ridge estimator**
2. **Correlation**
3. **Test of Normality**
4. **Time series**

STATISTICAL SOFTWARE:

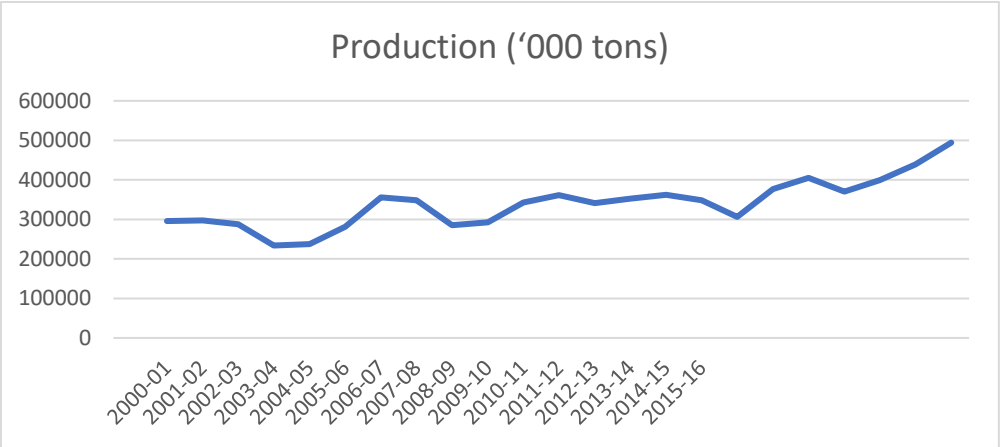
1. **SPSS**
2. **R-SOFTWARE**

MICROSOFT TOOLS:

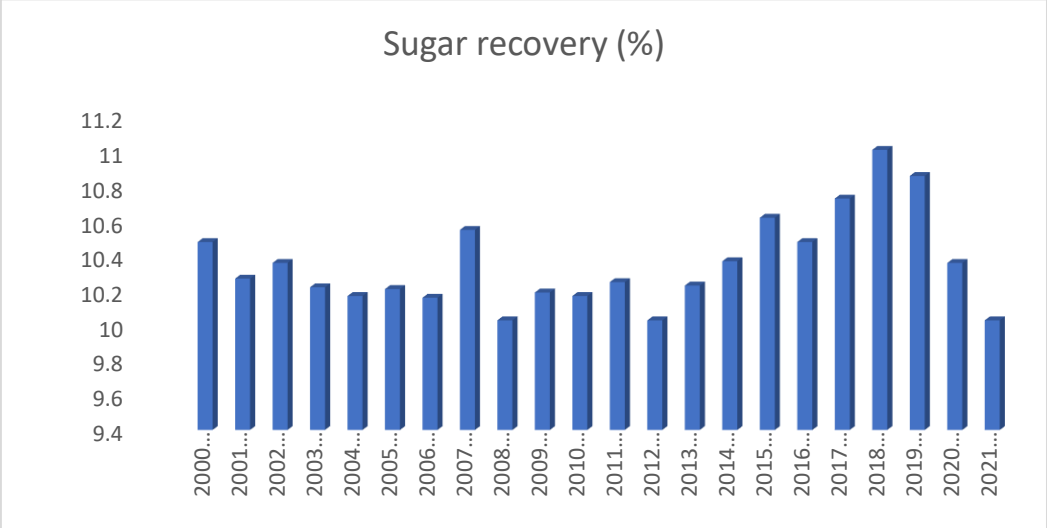
1. **MS-EXCEL**
2. **MS-WORD**

ANALYSIS:

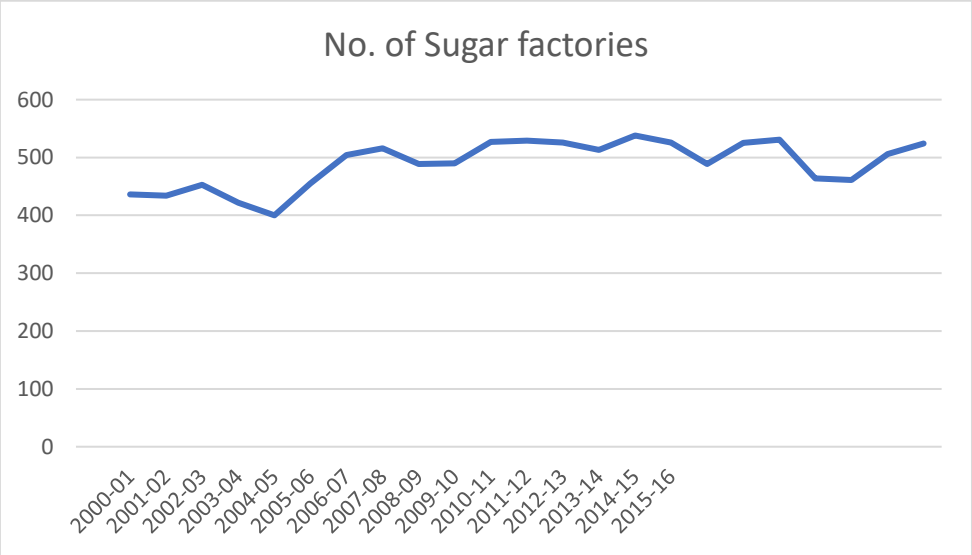
1. **Graphical Representation:**



The production of sugar cane increases from 2018 onwards



The sugar recovery rate changes at alternative years. The highest sugar recovery rate in 2018-19



The number of sugar factories reduces suddenly in 2004-05

2. REGRESSION ANALYSIS: FOR ALL INDIA

Regression Model

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

$Y = \text{Sugar}$

$X_1 = \text{Production}$

$X_2 = \text{Productivity}$

$X_3 = \text{Cane Crushed}$

$X_4 = \text{Sugar recovery}$

Regression Statistics	
Multiple R	0.999535514
R Square	0.999071244
Adjusted R Square	0.998852713
Standard Error	217.9816504
Observations	22

ANOVA TABLE

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	868927363.9	217231841	4571.76196	1.6015E-25
Residual	17	807771.9988	47515.99993		
Total	21	869735135.9			

To test:

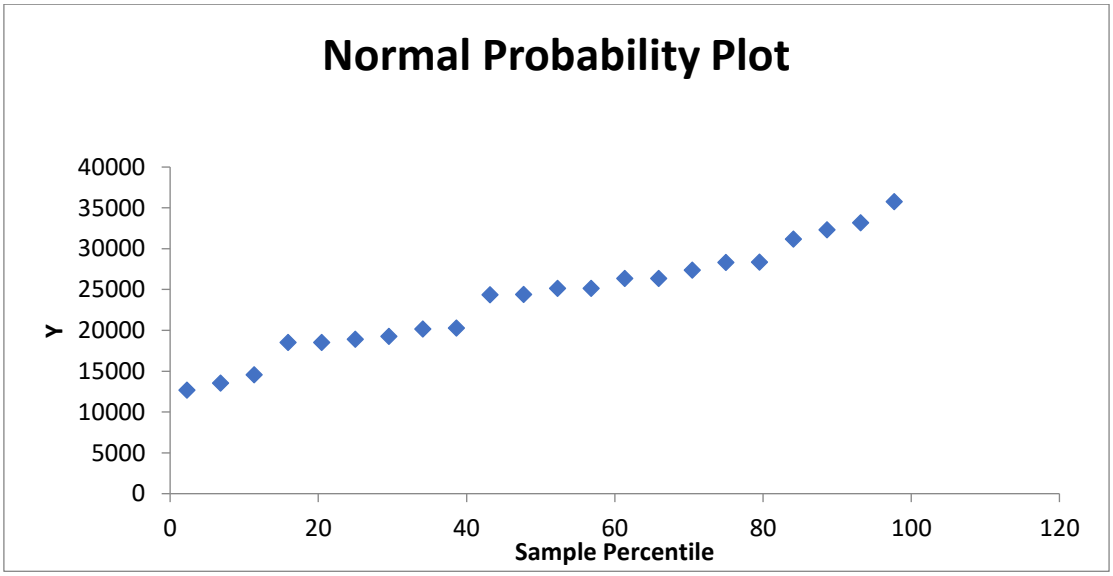
H0: The regression coefficient is not significant

H1: The regression coefficient is significant

	Coefficients	Standard Error	t Stat	P-value
Intercept	-25019.017	1892.45197	-13.22042376	2.25572E-10
Production	0.000295153	0.004587955	0.064332118	0.949456207
Productivity	-16.8384375	16.69187179	-1.008780665	0.327223518
Cane crushed	0.103494299	0.003544931	29.1950096	5.75219E-16
Sugar recovery	2524.468128	197.8360107	12.76040757	3.90901E-10

So, the variables Cane crushed and sugar recovery are significant

$$Sugar = -25019.02 + 0.0003 * (Production) - 16.83(Productivity) + 0.10(cane\ crushed) + 2524.46(sugar\ recovery)$$



2. REGRESSION ANALYSIS: FOR MAHARASHTRA

Regression Statistics	
Multiple R	0.996965
R Square	0.993939
Adjusted R Square	0.993333
Standard Error	9.049565
Observations	45

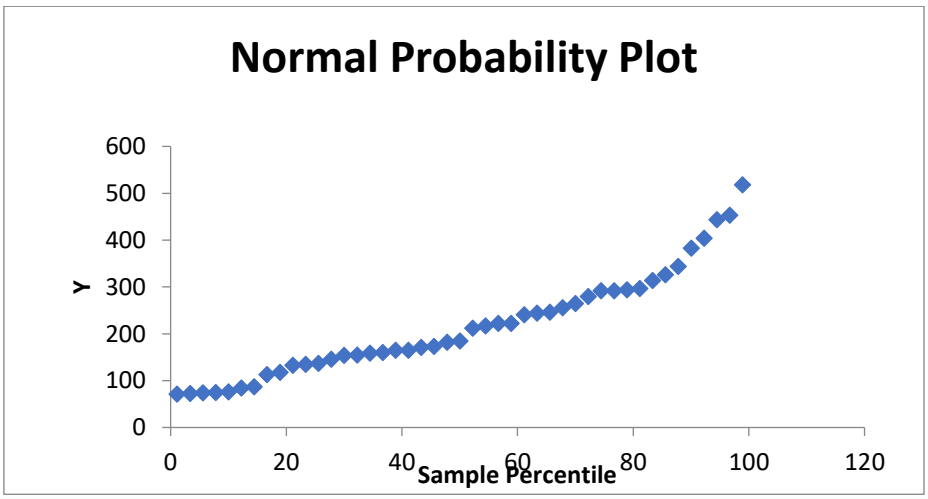
ANOVA TABLE

	df	SS	MS	F	Significance F
Regression	4	537194.8	134298.7	1639.896	9.34E-44
Residual	40	3275.785	81.89462		
Total	44	540470.6			

	Coefficients	Standard Error	t Stat	P-value
Intercept	215.8013	46.3717	4.65373	3.54E-05
Production	0.014048	0.000893	15.73835	9.81E-19
Productivity	-2.54314	0.191259	-13.2968	2.88E-16
Cane crushed	-0.00141	0.00073	-1.93252	0.060398
Sugar recovery	-2.51446	3.859521	-0.6515	0.518452

So, the variables production and productivity are significant

$$Sugar = 215.80 + 0.014(Production) - 2.5431(Productivity) - 0.0014(cane\ crushed) - 2.5145(sugar\ recovery)$$



3. REGRESSION ANALYSIS: FOR UTTARPRADESH

Regression Statistics	
Multiple R	0.998981
R Square	0.997963
Adjusted R Square	0.997764
Standard Error	42.04679
Observations	46

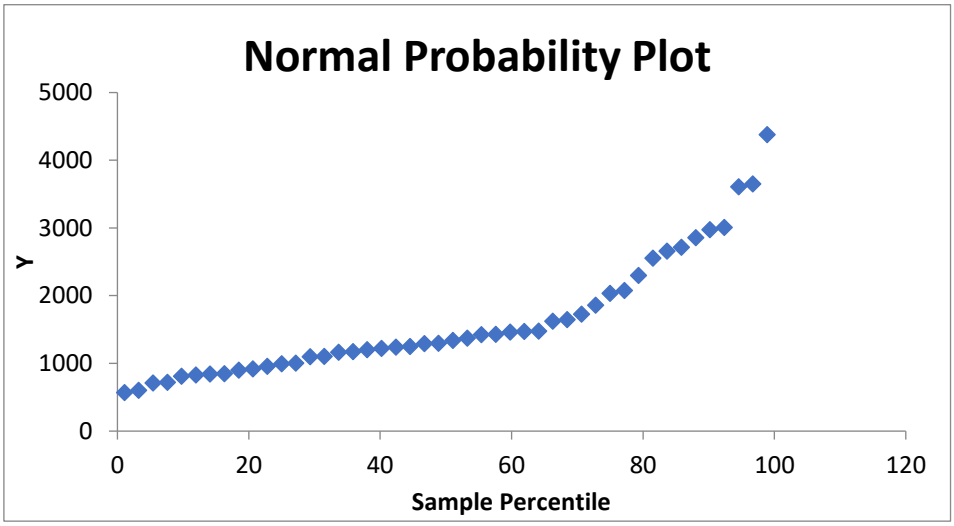
ANOVA TABLE

	df	SS	MS	F	Significance F
Regression	4	35505397	8876349	5020.751	1.47E-54
Residual	41	72485.24	1767.933		
Total	45	35577883			

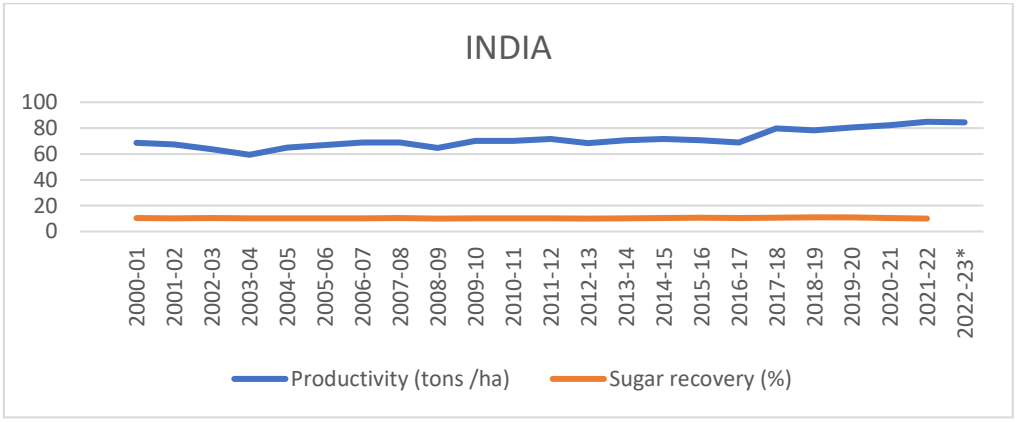
	Coefficients	Standard Error	t Stat	P-value
Intercept	-1261.62	244.6139	-5.1576	6.75E-06
X Variable 1	0.003387	0.001253	2.702865	0.009957
X Variable 2	1.583314	2.972093	0.532727	0.597098
X Variable 3	0.08292	0.002352	35.25897	2.72E-32
X Variable 4	121.93	24.93245	4.890415	1.59E-05

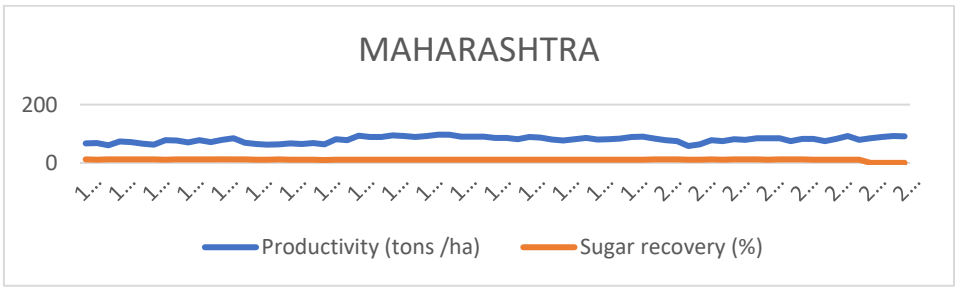
So, the variables Cane crushed and sugar recovery are significant

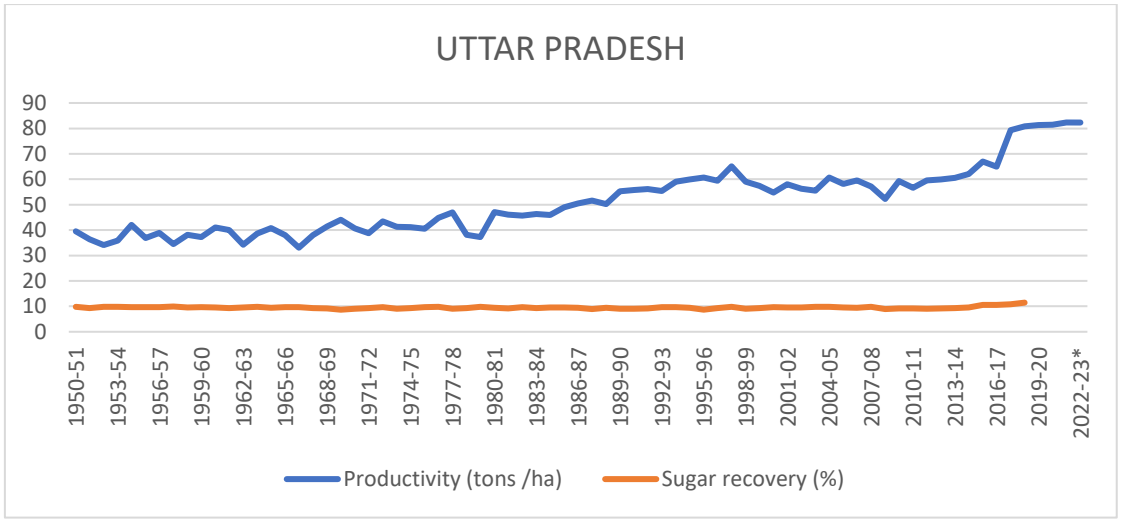
$$Sugar = -1261.62 + 0.004 * (Production) + 1.58 * (Productivity) + 0.083 * (cane\ crushed) + 121.93 * (sugar\ recovery)$$



LINE CHART: for productivity and sugar recovery rate







The Productivity of Uttar Pradesh changes drastically as compare to all India and Maharashtra

CORRELATION MATRIX: For India

	Production	Productivity	Cane crushed	Sugar recovery	Sugar
Production	1				
Productivity	0.887328448	1			
Cane crushed	0.974479966	0.853174505	1		
Sugar recovery	0.330948993	0.405621702	0.288487662	1	
Sugar	0.973754491	0.860923783	0.994754239	0.380150951	1

CORRELATION MATRIX: For Maharashtra

	Production	Productivity	Cane crushed	Sugar recovery	Sugar
Production	1				
Productivity	0.69464833	1			
Cane crushed	0.984066015	0.631500571	1		
Sugar recovery	-0.498126142	-0.350402702	-0.522676258	1	
Sugar	0.982207933	0.560563102	0.975148257	-0.490424062	1

CORRELATION MATRIX: For Uttar Pradesh

	Production	Productivity	Cane crushed	Sugar recovery	Sugar
Production	1				
Productivity	0.958458223	1			
Cane crushed	0.957976032	0.924709934	1		
Sugar recovery	-0.48041371	-0.445029888	-0.543027219	1	
Sugar	0.965786619	0.933416394	0.997757341	-0.50802542	1

MULTICOLLINEARITY

VIF: INDIA

	R-square	VIF
Production	0.961459362	25.94663862
Productivity	0.802494497	5.063150054
Cane crushed	0.951173998	20.48089065
Sugar recovery	0.184179881	1.225760406

Ridged Estimator for India:-

Intercept	-2.773854e+04
Production	7.586664e+01
Productivity	5.707508e-02
Cane crushed	1.927160e+03
Sugar recovery	3.939932e-02

PREDICTIVE MODEL:

$$Sugar = -2.773854e + 04 + 7.586664e + 01(productivity) + 5.707508e - 02(cane\ crushed) + 1.927160e + 03(sugar\ recovery) + 3.939932e - 02(production)$$

VIF: MAHARASHTRA

	R-square	VIF
Production	0.977782315	45.00918947
Productivity	0.572994293	2.341889077
Cane crushed	0.975069501	40.11151181
Sugar recovery	0.289279737	1.407023342

Ridged estimator for Maharashtra :-

Intercept	-1.295270e+04
X variable 1	-5.990231e+01
X variable 2	6.032032e-02
X variable 3	1.436372e+03
X variable 4	5.843363e-02

PREDICTIVE MODEL:

$$Sugar = -1.295270e+04 - 5.990231e+01(productivity) + 6.032032e-02(cane\ crushed) + 1.436372e+03(sugar\ recovery) + 5.843363e-02(production)$$

VIF: UTTAR PRADESH

	R-square	VIF
Production	0.954281629	21.87304538
Productivity	0.919865909	12.47908331
Cane crushed	0.927459229	13.78535113
Sugar recovery	0.320109477	1.470825031

Ridged estimator for Uttar Pradesh (Model) :-

Intercept	3.160961e+03
x variable 1	1.160121e-02
X variable 2	5.049926e-04
X variable 3	1.567323e-03
X variable 4	1.323471e-04

PREDICTIVE MODEL:

$$Sugar = 3.160961e+03 + 1.160121e-02(productivity) + 5.049926e-04(cane\ crushed) + 1.567323e-03(sugar\ recovery) + 1.323471e-04(production)$$

3. CONCLUSION

Linear regression model is good fit for the given data. Also, we predict the production of sugar with various value of productivity, sugar recovery rate, cane crushed quantity. Also there exist the correlation between all these regressor variables in Maharashtra and Uttar Pradesh. Here, exists the multicollinearity in variables so find the ridge estimator for the given model and fit the final Linear regression model.

REFERENCES

[1]. Ahmed, M. and Rahman, F. 2014. Changing Paradigms in Regulating and
[2]. Deregulating the Sugar Pricing Mechanism in India. Saaransh. RKG Journal of Management, 5(2): 77-86.
[3]. Rahman, F. and Bee, N. 2019. Trends and Pattern of Sugarcane Production in Shahjahanpur District, Uttar Pradesh: A Geographical Analysis. Economic Affairs, 64(3): 537-545. DOI: 10.30954/0424- 2513.3.2019.9
[4]. Sen, P.K. 1968. Estimates of the regression coefficient based on Kendall's tau. J.Amer. Statist. Assoc., 63 : 1379-1389.
[5]. Li, S. and Lund, R.B. 2012.Multiple change point detection via genetic algorithms.J.Clim., 25 : 674–686.