SUGARCANE GROWTH IN INDIA: PROBLEMS AND PROSPECTS

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ABSTRACT

Sugarcane is one of the most important cash crops in India. India being a major consumer of sugar occupies the second place in sugarcane production, next to Brazil. In recent times, sugarcane has become a preferred crop for renewable and eco-friendly energy production. Excepted rise in demand for energy has improved the scope of sugarcane production. In this backdrop, the study focuses on the trend and growth of production area, production and productivity of sugarcane crop in India for the period 2001-02 to 2017-18. The relationship between harvested area and production is tested with the help of a regression model. Apart from that, the study analyzes the state wise growth rate of sugarcane sector. The study is based on secondary data collected from various government reports and publications. The result highlights that all the three variables under consideration witness positive growth rate. About 65% of the production comes from two states, Uttar Pradesh and Maharashtra. Comparatively states falling under tropical region have higher yield per hectare than states of sub-tropical region. Finally, to an extent, this paper suggests ways to improve sugarcane productivity.

Keywords: Growth, Production, Region, Sugarcane, Yield.

INTRODUCTION

Sugarcane (*Saccharum officinarum*) belongs to the genus *Saccharum,* and family *Poaceae.* It is believed to have originated in New Guinea and then cultivated throughout the tropical and subtropical regions of the world (Daniels and Roach, 1987). Sugarcane cultivated in India belongs to two main groups: (a) *S. barberi* and *S. Sinense* and (b) *S. officinarum*. Sugarcane typically contains 63-73% water, 11-16% fiber, 12-16% soluble sugars, and 2-3% non-sugar carbohydrates. Temperature ranging from

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$19\text{-}21^0\text{C}$ to $27\text{-}38^0\text{C}$ is best suited for sugarcane cultivation. Its byproduct includes ethanol, bagasse, molasses, crude wax etc. Being a water-intensive crop, sugarcane accounts for about 86% of the sugar crops and it is mostly cultivated for its sucrose content. Of late, sugarcane has been recognized as an important energy source in terms of bio-ethanol production (IISR, 2015). Brazil alone accounts for 37% of the world's total sugar cane cropped area (26 million hectares) and other top 5 countries are India, Thailand, China, and Pakistan (FAO, 2018). India accounts for about 25% of the global sugar production and around 7.5% of India's rural population has engaged in sugarcane farming (Solomon, 2016). About 51% of the India's sugarcane production is produced from the tropical regions (Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh) and the remaining i.e., 49% is from the sub-tropical regions (Uttar Pradesh, Bihar, Uttarakhand, Punjab and Haryana), despite the latter having 55% of the total area under sugarcane (GOI, 2016).

Sugarcane crop and its products contribute about 1.1% to India's GDP. The contribution of sugarcane to the agricultural GDP has increased steadily in the last two decades. Also, Sugarcane and sugar industries act as a major source of employment and livelihood in India. More than 50 million farmers are engaged in sugarcane cultivation and processing industries. Obtaining a maximum yield from the sugarcane crops improves those farmers economic condition (Powar et al., 2020). Sugarcane production in India has increased significantly over the time and its average annual production is 355 million tons. But the major impediment is its productivity which has remained stagnant. It is known that productivity is governed by the combination of climate, technology, genetic resources, farm management practices, states pricing policies and decisions. However, Indian farmers have been largely using traditional methods which mainly results in low productivity. Under such contradictory situation, state intervention is inevitable. There is no doubt that, the government has intervened in number of forms such as Essential Commodity Act (1955), Sugar Control Order (1966), Sugarcane Development Fund (1982), Delicensing Sugar Sector (1998), Fair and Remunerative Price (2009-10), Ethanol Blending Programme (2012), Scheme for Extending Financial Assistance to Sugar Undertaking (2014) etc. Despite many efforts by both the Central and State Governments, India's sugarcane sector is grappled with lot of issues by varying degree and nature. Moreover, state-wise variations exist in production area, production, and yield of sugarcane. Therefore, considering the importance and need, the present study has been undertaken to analyze the trends and growth performance of sugarcane crops in major sugar producing states and India as a whole.

MATERIALS AND METHODS

The secondary data for the period 2000-01 to 2017-18 have been collected and analyzed to draw meaningful interpretations and to assess the situation of sugarcane cultivation in India. In order to analyze the growth rate, the time-series data of the area, production, and yield of sugarcane were collected from various publications, and

official records such as Ministry of Agriculture and Farmers Welfare, Ministry of Commerce and Industry and Agricultural Statistics at a glance. For data analysis, STATA software was used. Compound Growth rate method has been used to calculate the growth rate whereas Double log Linear Analysis method is employed to study the non-linear relationship between area and production (Pramod et al., 2022; Shukla et al., 2022).

Compound Growth Rate Analysis

In this study, an exponential function was used to estimate the compound growth rate by marking time as the independent variable and production area, production, and yield as dependent variables. This exponential trend equation gives a constant rate of increase or decrease per unit of time and they are termed as Compound Growth Rate. Compound growth rate was estimated by fitting the exponential trend of the following type;

$$Y = ab^t \dots\dots\dots\dots\dots (1)$$

Where,

Y = the area/production/yield

t = time variable in years

a = constant

$b = (1 + r)$

and r = Compound Growth Rate

The equation (1) takes the linear form by taking logarithms of both sides of the equation,

$$\text{Log } y = \log a + \log b$$

Compound Growth Rate (CGR) = Antilog (log b-1) * 100

Double log Linear Analysis

Log-linear analysis is a widely used method for the analysis of multivariate data. Logarithmically transforming variables makes the relationship non-linear, while still preserving the linear model. With the help of regression model, relationship between production and area under sugarcane has been studied. Also, Durbin Watson Test is conducted to measure the autocorrelation. The following functional form of Double-log has been employed;

$$\ln Y_i = \beta_0 + \beta_1 \ln X_i + \varepsilon_i$$

If X (area) increases by 1%, Y (production) will change by β_1%. In that case, β_1 is the elasticity of production with respect to area under sugarcane.

RESULTS AND DISCUSSION

The results of growth estimation of total area, production and yield of sugarcane crop in India during 2000-01 to 2017-18 and state wise growth rate for those three variables for the period 2007-08 to 2017-18 is discussed here. In addition, export and import growth rate of sugar has been analyzed. Outcome of Double log Linear Analysis between production and area under sugarcane has been deliberated at the end.

India ranks second after Brazil in terms of area and production of sugarcane among world nations. However, in terms of productivity, India ranks way below at tenth place (Mall et al., 2016) and the probable reason for the low yields could be exhaustion of soils. The area, production, and productivity of sugarcane in India (during 2000-01 to 2017-18) are presented in Table 1. The area under sugarcane in India had increased from 4315.5 thousand hectares in 2000-01 to 4737 thousand hectares in 2017-18. Assured demand by the government for sugarcane products relative to other crops encourage farmers to go for sugarcane area expansion. However, sugar cane should be encouraged in areas which have ample water supplies for sustainable development (GOI, 2013). There were ups and downs in area under sugarcane in the reference period. These fluctuations were mainly due to drought and fluctuating sugarcane prices (Sundara, 2011). At the same time, sugarcane production had increased from 295955.3 thousand tons in 2000-01 to 379905 thousand tons in 2017-18. It may be noted that there were about 28% increase in production during the period of study. The increased production has to be achieved from the existing sugarcane area through improved productivity but it was not as desired. The productivity was maximum (80198 kg ha^{-1}) in the year 2017-18 and it was minimum in the year 2008-09 with 64553 kg ha^{-1}. The estimated Compound Growth Rate for the reference period was 0.52, 1.40 and 0.87% per annum for the area, production and productivity respectively.

Sugarcane and sugar beets are the two main plant sources from which sugar is produced. Nearly 80% of global sugar production is derived from sugarcane and the remainder comes from sugar beets. In India, sugar is processed mostly from sugarcane and sugar beets have not made major inroads in sugar production. Next to cotton, sugar is the second largest agro-based industry in the country. Between 2000-01 and 2017-18, Brazil is the largest producer of sugar followed by India (3 crore tons) however India is the largest consumer of sugar in the world (2.6 crore tons). A rising trend in individual household consumption of sugar could be attributed to rapid urbanization and subsequent change in their food habit. Brazil, as the largest exporting country in the world accounts for about 45% of global exports. India is one of the top five exporters in the world dominating world sugar trade but its export share was marginal due to larger domestic demands. India's export as well as import of sugar has increased significantly during the years 2000-01 to 2016-17 (Table 2). The exports have increased from Rs. 430.98 Crores in 2000-01 to Rs. 8639.83 in 2016-17. The imports also revealed the similar trend which is largely due to government policies like zero import duty, 2009. As far as sugar is concerned, India is a net exporting country with

exports more than the imports resulting in positive Balance of Trade. But the gap has narrowed down in 2016-17 when compared with the previous year due to inconsistent export subsidies (WTO, 2021). Further, the estimated compound growth rate of imports (37.34%) during the reference period is higher than the exports (19.29%) which warrant incentives for export promotion.

Table 1. Area, production and productivity of sugarcane in India

S. No	Year	Area (in '000 Hectare)	Production (in '000 tons)	Yield (kg/Hectare)
1	2000-01	4315.5	295955.3	68580
2	2001-02	4411.5	297205.4	67371
3	2002-03	4519.8	287369.4	63580
4	2003-04	3938.1	233858.9	59384
5	2004-05	3661.3	237082.7	64754
6	2005-06	4201.4	281165.9	66922
7	2006-07	5151	355520	69022
8	2007-08	5055	348188	68879
9	2008-09	4415	285029	64553
10	2009-10	4175	292302	70020
11	2010-11	4884.8	342381.6	70091
12	2011-12	5037.7	361036.5	71668
13	2012-13	4999	341200	68254
14	2013-14	4993	352142	70522
15	2014-15	5067	362333	71511
16	2015-16	4927	348448	70720
17	2016-17	4436	306069	69001
18	2017-18	4737	379905	80198
	CGR	0.52	1.40	0.87

Source: Ministry of Agriculture and Farmers Welfare, Govt of India

Table 2. Export and import of sugar in India

(Values in Rs. Crores)

S. No	Year	Export	Import
1	2000-01	430.98	31.11
2	2001-02	1728.29	32.60
3	2002-03	1769.49	32.83
4	2003-04	1216.59	62.70
5	2004-05	149.52	976.17
6	2005-06	557.09	651.80
7	2006-07	3127.47	3.49
8	2007-08	5412.16	2.24
9	2008-09	4448.74	583.11
10	2009-10	110.23	5961.24
11	2010-11	10352.27	2723.21
12	2011-12	12973.73	374.67
13	2012-13	8576.83	3094.38
14	2013-14	7152.17	2279.21
15	2014-15	5296.53	3645.15
16	2015-16	9787.95	4011.03
17	2016-17	8639.83	6849.63
	CGR	**19.29**	**37.34**

Source: Ministry of Commerce and Industry, Govt of India

In India, sugarcane faces tough competition for land from a number of other cash crops such as cotton, tobacco, groundnut etc. Sugarcane occupies only 3% of India's gross cropped area but accounted for about 6% of the total value of agricultural output (Price policy for Sugarcane, 2013). Selected state wise area under sugarcane during the period between 2007-08 and 2017-18 is presented in Fig. 1. Uttar Pradesh alone accounts for 47% of total sugarcane area in India and the largest concentration is in the upper Ganga-Yamuna Doab, Rohilkhand and trans-Saryu areas of the state. The data shows that area under sugarcane is highest at about 2179 thousand hectares in Uttar Pradesh during 2007-08. In 2012-13, there was increase in cultivation area (2212 thousand hectares), then slowly to 2228 thousand hectares in 2013-14 and 2234 thousand hectares in 2017-18. Sugarcane area expansion was aided by institutional factors including State's support prices and subsidies on fertilizers (Vikas and Babu, 2017).

However, the estimated compound growth rate is only about 0.23% per annum for the state. High sugarcane arrears in Uttar Pradesh have potentially hampered the cane growth rate of the state. Maharashtra stands second position in cultivation area under sugarcane, which shows the highest at 1093 thousand hectares in 2007-08 and its trend has declined to 902 thousand hectares in 2017-18; moreover, the growth rate of Maharashtra is negative 1.73% in the reference period. In all possibility, lopsided pricing policy of sugarcane in Maharashtra affected the cane growth pattern. Karnataka occupies the third place in area under sugarcane crop with over 7% of the total area, it shows that the area under cultivation has increased from 306 thousand hectares in 2007-08 to 370.3 thousand hectares in 2017-18, thus its growth rate is about 1.75% per annum. Revenue sharing formula of the state government has led to the expansion of sugarcane in Karnataka despite being a water stressed region. Bihar followed by Tamil Nadu has a predominant position in the area under sugarcane crop. Chhattisgarh shows the highest growth rate in the area under sugarcane cultivation during the reference period, with the compound growth rate of 7.30%. This is mainly due to the state governments' obligation to distribute sugar to the needy through public distribution system. Followed by Bihar, Jharkhand, Madhya Pradesh, Karnataka and West Bengal has a positive growth rate in the reference period. Overall, the sugarcane cultivation area in India is showing a declining trend during the reference period.

India accounts to about 18% of the world's sugarcane production. India's average annual production of sugarcane is 35.5 crore tons and it is produced in tropical and sub-tropical regions. The production of the sugarcane crop is sensitive to fluctuations in climatic conditions. Sugarcane production is a major source of employment and plays a vital role in the economy of the state. In India, about 5 lakh skilled and unskilled workers are engaged in cultivation of sugarcane and its allied industries (Krishnakant et al., 2015). Fig. 1 shows selected state wise trend and growth of sugarcane production. About 47% of the production comes from Uttar Pradesh which is located in the sub-tropical region. Socio-economic condition of the farmers in western Uttar Pradesh is largely depending upon sugarcane production. Production trend of Uttar Pradesh increased from 124665.3 thousand tons in 2007-08 to 177033.33 thousand tons in 2017-18.
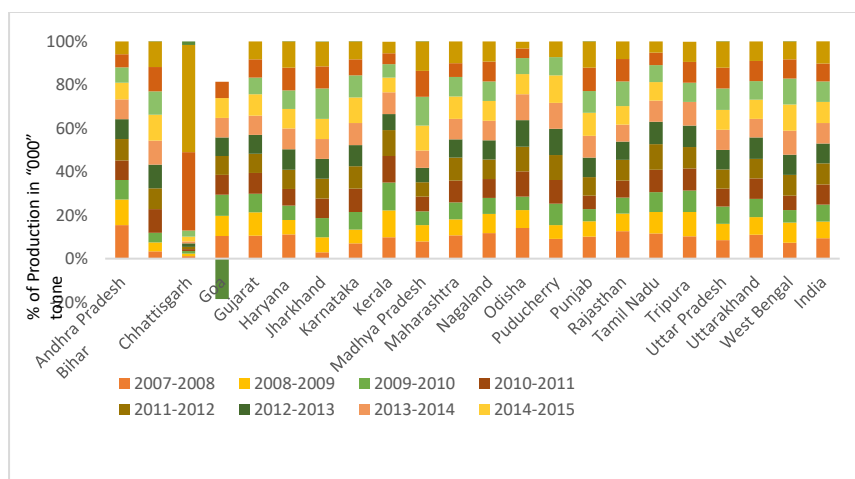
Figure 1. Selected State Wise Sugarcane Production in India (2007-08 to 2017-18)

The compound growth rate (CGR) of Uttar Pradesh is 3.24% which is higher than the national average (0.80%) in the reference period. It may be attributed to state advisory price (SAP) launched by the state government, which boosted the sugarcane cultivation. From the study it is found that there are fluctuations in the production of sugarcane in Maharashtra, and no uniform pattern of growth was observed. This uneven trend is associated with the uncertain monsoon and instability in the area under production of cane in the state. Even though, Maharashtra is the second (21.8%) top producer in India, its growth rate during the study period was negative 0.58%. Karnataka stands third in sugarcane production during 2007-08 to 2017-18, and it accounts to the growth of 1.57% per annum. Trends of production has increased from 26240 thousand tons in 2007-08 to 31135.19 thousand tons in 2017-18 and the reason behind it is better technical efficiency of sugarcane farmers of the state (Ahmad and Abdulla, 2016). Tamil Nadu occupied the fourth position in production of sugarcane against fifth position in area under sugarcane during the reference period. Bihar and Gujarat are the other major sugarcane producers in India. Overall growth of sugarcane production is accounted highest for Chhattisgarh (40.50%), followed by Jharkhand (12.99%), Bihar (12.31%) and Madhya Pradesh (4.98%) in the reference period. The result shows, twelve states accounted for negative growth with decreased output over the time.

The productivity of land depends on the optimum allocation of resources, which would have an impact on the cost and revenue composition of the produce. India has the second largest area under sugarcane cultivation but the yield per hectare is extremely low when compared with other major sugarcane producing nations. In fact, over the years productivity has remained stagnant (Uperti and Singh, 2017). In 2017-18, India's average yield of sugarcane was 47.74 t ha^{-1} which is much lesser than the market leader, Brazil (72.62 t ha^{-1}). It offered incentives for the production of ethanol from sugarcane,

which helped Brazil to consolidate its position in the world market (Matos et al. 2020) Fig. 2 demonstrates the state wise trend of sugarcane yield for the period 2007-08 to 2017-18.
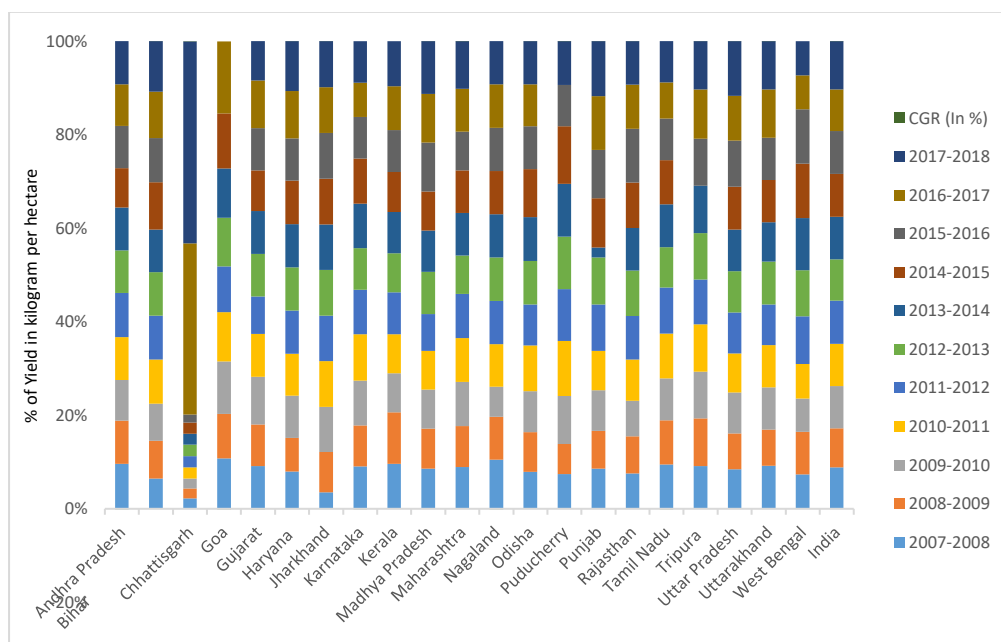

Figure 2. Selected State Wise Yield of Sugarcane Crop in India (2007-08 to 2017-18)

The CGR of sugarcane yield for national level is just 1.39% and the data also reveals unstable productivity for the country as whole. Kerala is the leading state, with 109840 kg ha^{-1}, as far as average yield of sugarcane is concerned which is followed by Tamil Nadu and Maharashtra with 99814 and 92000 kg ha^{-1} respectively. Among the UTs, Puducherry has the highest yield i.e., 125000 kg ha^{-1} in 2017-18 which is higher than all other states of India. The highest yield of the crop was recorded in 2014-15 i.e., 165089 kg ha^{-1}, contrary to it; the lowest (85421 kg ha^{-1}) was registered in 2008-09. Uttar Pradesh was observed with 3.01% of growth rate in the reference period. There is no doubt that the average yield of the state has gone up from 57212 kg ha^{-1} (2007-08) to 79245 kg ha^{-1} (2017-18), however it is lower than the all-India average (80198 kg ha^{-1}). Adoption of improved sugarcane varieties might increase the states productivity both in terms of yield as well as sugar contents. The estimated result indicates the productivity growth rate is highest for Chhattisgarh at 30.94%. Its productivity trend shows that it has increased from 2477 kg ha^{-1} in 2007-08 to 48070 kg ha^{-1} in 2017-18. Followed by Jharkhand, Bihar, Uttar Pradesh, and Punjab have registered highest positive growth rates in the reference period. From the study it is found that the sugarcane yield in Nagaland is very low (43510 kg ha^{-1}) as compared to other states, with compound growth rate of negative 1.16% per annum. It is evident

that there is an urgent need to improve productivity since it is a prerequisite for the holistic development of a region (Yasmeen et al., 2018).

Regression analysis is used to analyze the relationship between variables area under cultivation and sugarcane production are presented in Table 3. The usage of logarithmic values favours in reduction of size of the larger values. Hence, log has been used in both sides of the model. Production mainly depends on the level of area devoted for the production purpose over a period. Thus, production is kept as the response variable and area in hectares as the outcome variable.

Table 3. Double log-linear regression function

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.611701	1.088492	2.399376	0.0299
LNA	1.184626	0.130493	9.078109	0.0000
T	0.006148	0.002408	2.553369	0.0221
R-squared	0.911752	Mean dependent var		12.65750
Adjusted R-squared	0.899986	S.D. dependent var		0.143131
S.E. of regression	0.045265	Akaike info criterion		-3.201549
Sum squared resid	0.030734	Schwarz criterion		-3.053154
Log likelihood	31.81394	Hannan-Quinn criter.		-3.181087
F-statistic	77.48789	Durbin-Watson stat		1.590739
Prob(F-statistic)	0.000000			
Dependent Variable: LNP				
Method: Least Square				
Sample: 2001-2018				
Obserations: 18				

Source: Computed Data

$$\text{Model: (log Production)} \quad \hat{Y}_t = \hat{\beta}_0 + \hat{\beta}_1 X_t \text{ (log Area)}$$

The AIC and SIC criterion is used to identify the best fit and simplicity of the model and results in a best fit (AIC = -3.20 and SIC = -3.05). The overall specification of the model is statistically significant at one percent level ($F_{(18,1)}$ = 77.5). 89% of variation in the model has been explained (Adj. R = 0.89). The model elucidates that, if there is 1% increase in the cultivation area then there will be an increase of 1.18 level of production in the study region. The cane productivity in the country demands

improvement, which is much below than the major sugar-producing countries. Climatological factors like maximum and minimum temperature, rainfall and precipitation on sugarcane yield was varied across the states of India. Therefore, it can be considered to have a state specific climate policy to mitigate the negative implication of climate change in cane farming (Jyoti and Singh, 2020).

CONCLUSION

This study has measured the growth rate and changes in time trends of harvested area, production, and yield of sugarcane crop in India. Sugarcane growth in production, area under cultivation and yield has been positive with about 1.40%, 0.52% and 0.87% respectively. However, the growth rate is least for cropping area under sugarcane which does not augurs well for the sector. Most of the selected states have nominally increased their yield rate but again India's productivity level is comparatively lesser than world nations which ought to be improved upon. Besides, India has to chalk out long term strategy to increase their productivity to meet the expected increase in global demand. For improved cane productivity, sustainable agro-techniques, climate resilient varieties, bio-intensive module and need based machinery and equipment has to be developed. Reducing the cost of production, improving sugar content in cane, ensuring better prices for the produce and close coordination of sugar mills with farmers will also ensure desired growth in productivity.

REFERENCES

Ahmad, M.A. (2016). Determinants of efficiency in sugarcane production in India: a study of major sugarcane producing states. *The Indian Economic Journal*, p. 349-359.

Daniels, J. and Roach, B.T. (1987). Evolution and Taxonomy. In: DJ Heinz (ed). Sugarcane improvement through breeding (1st edition). Elsevier.

FAO. (2018). FAOSTAT. Food and Agriculture Organization of the United Nations, Rome, Italy. http://www.fao.org/faostat/en/#home

Govt. of India. (2013). Price policy for sugarcane. Commission for agricultural cost and prices. Ministry of Agriculture, New Delhi. Pp. 85.
https://cacp.dacnet.nic.in/ViewReports.aspx?Input=2&PageId=41&KeyId=536

Govt. of India. (2016). Price Policy for Sugarcane. Commission for Agricultural Cost and Prices. Ministry of Agriculture, New Delhi.

IISR. (2015). Vision 2050. Indian Institute of Sugarcane Research. *Indian Council of Agricultural Research*, Uttar Pradesh, India.

Jyoti, B. and Singh, A.K. (2020). Projected sugarcane yield in different climate change scenarios in Indian states: A state-wise panel data exploration. *International Journal of Food and Agricultural Economics*, 8(4): 343-365.

Kant, K., Tripathi, S.P. and Meena, M. (2015). Cost of cultivation of sugarcane crop in Meerut district of Uttar Pradesh. *International Journal of Forestry and Crop Improvement*, 6(1): 41-48.

Mall, R.K., Sonkar, G., Bhatt, D., Sharma, N.K. and Singh, K.K. (2016). Managing impact of extreme weather events in sugarcane in different agro-climatic zones of Uttar Pradesh. *Mausam*, 67(1): 233-250.

Matos, M., Santos, F. and Eichler, P. (2020). Sugarcane world scenario. In: Fernando Santos, Sarita Rabelo, Mario De Matos, Paulo Eichler (Editors). Sugarcane biorefinery, technology and perspectives (1st edition). *Elsevier*. Pp. 289.

Powar, R.V., Mehetre, S.A., Patil, P.R., Patil, R.V., Wagavekar, V.A., Turkewadkar, S.G. and Patil, S.B. (2020). Study on energy use efficiency for sugarcane crop production using the data envelopment analysis (DEA) technique. *Journal of Biosystems Engineering*, *45*(4): 291-309.

Pramod, G.U., Mishra, R.R. and Ahmad, N. (2022). Growth & Instability of International Trade of Sugar in India. *Economic Affairs*, *67*(1s): 113-118.

Price Policy for Sugarcane. (2013). The 2014-15 Sugar Season. Commission for Agricultural Costs and Prices. *Department of Agriculture and Cooperation, Ministry of Agriculture*, Government of India, New Delhi.

Upreti, P. and Singh, A. (2017). An Economic analysis of sugarcane cultivation and its productivity in major sugar producing states of Uttar Pradesh and Maharashtra. *Economic Affairs*, 62(4): 711-718.

Shukla, S.K., Jaiswal, V.P., Sharma, L., Gaur, A., Tiwari, R. and Srivastava, A. (2022). Growth analysis in sugarcane ratoon crop as influenced by potassium nutrition in subtropical India. *Communications in Soil Science and Plant Analysis*, 1-13.

Solomon, S. (2016). Sugarcane production and development of sugar industry in India. *Sugar Tech,* 18(6): 588-602.

Sundara, B. (2011). Agrotechnologies to enhance sugarcane productivity in India. *Sugar Tech*, 13(4): 281-298.

Vikas, A. and Babu, M.D. (2017). State intervention: a gift or threat to India's sugarcane sector? *Working Paper 385*. Institute for Social and Economic Change, Bangalore, India.

WTO. (2021). India- Measures concerning Sugar and Sugarcane- Reports of the Panel. Geneva, Switzerland.

Yasmeen, Patil, S.S., Hiremath, G.M. and Ananda, N. (2018). Economics of sugar production of cooperative sugar factories in North Eastern Karnataka. *Economic Affairs*, 63(1): 159-164.