Original Article

Analysis of Sugarcane Production in India using Mathematical Model

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Abstract - Agriculture plays a vital role in the Indian economy. Over seventy percent of the rural households depend on agriculture. Agriculture is an important sector of Indian economy as it contributes about 17% to the total GDP and provides employment to over two third of the population. Agriculture derives its importance from the fact that it has vital supply and demand links with the manufacturing sector and is a source of employment generation for the rural population in India. Sugar industry is the second largest agro-based industry in the country. Uttar Pradesh is the largest State of India and is pre-dominant in agricultural crops and has faster endowment in sugarcane crop. Sugar industry in India has been focal point for socio-economic development in rural areas by mobilizing rural resources, generating employment and higher income etc. In the present paper, an attempt has been made to study the production trend and growth rate for Sugarcane by using three years moving average for area sown, productivity and production. It is observed that area sown has constantly increased from 2.05 M hectare in 1958-59 to 4.79 M hectare during 2018-19. The production has also increased from 74.11 M tones in 1958-59 to 380.34 in 2018-19. The growth rate has been highest at the level of 5.98 % per annum during 1958-59 to 1968-69 and lowest i.e. 0.67% during 1998-99 to 2008-09. The productivity level has been 36132.33 kg/ha during 1958-59 which has gone up to 79398.67 kg/ha during 2018-19. The productivity level has shown positive growth rates per annum during all the periods except 1998-99 to 2008-09. State-wise analysis has also been carried out for Sugarcane producing States and it is concluded that government may take appropriate measures to provide necessary infra-structure and technology, as these states have suitable Agro-climate condition for sugarcane.

Keywords - Area Sown, Growth Rate, Productivity, Production, Sugarcane.

I. INTRODUCTION

Agriculture in India is one of the most prominent sectors to its economy and about 70% of the population depends on Agriculture. The sugarcane and potato are the main cash crops and providing huge employment opportunities in rural and urban areas. India has emerged as the largest sugar producing country in the world with a 18.7% share of the world's sugarcane production. India is the second-largest producer of sugarcane in the world. India is known as the homeland of Sugar. Brazil is the largest sugarcane producing country in the world followed by India, China and Thailand. Sugar industry is the second largest agro-based industry in the country. Sugar industry in India has been focal point for socio-economic development in rural areas by mobilizing rural resources, generating employment and higher income etc. Uttar Pradesh is the largest State of India and is pre-dominant in agricultural crops and has faster endowment in sugarcane crop. While agriculture in India has achieved grain self-sufficiency but the production is, resource intensive, cereal centric and regionally biased. India also needs to improve its management of agricultural practices on multiple fronts. The total food grain production is estimated to be 305 million tones during 2020-21 and the production of sugarcane has been 356 millions tones in the same year.

II. REVIEW OF WORK DONE

A lot of work has been attempted for enhancing the productivity, quality and generation of employment in sugarcane crop. Some of the findings are: Yadav (2008) has studied the mechanization of sugarcane in India and found the positive impact of technology and mechanization in India. Singhals (2008) have suggested implementation of computer based decision support system for sugarcane producers in order to get higher return. Hirudayanathan and Krishanan Murthi (2007) have studied sugarcane crops in small farms in Southern India and suggested strategy to earn high return to sugarcane grower in small farms. Thorbum, Webster, et al (2007) have studied the sugarcane production in Australia and found balanced production and environmental goals of nitrogen and fertilizers. H.Swain and R.R. Bhakur (2006)- have studied the trends and variability of commercial crops in Rajasthan and found the bumper rise in the production of potato crops and obtained growth rate @ 2.95% per annum and sugar production declined @ 1.15% per annum. M.S. Swaminathan (2006) – highlighted four pillars for agricultural development mainly productivity, quality, profitability and sustainability. Kumar Kishore and Agrawal P.C. (2004) have studied the impact of water resource management on production. They have developed a linear model and found that one percent increase in irrigated area, the production increase @ 52.5 kg per hectare.

III. METHODOLOGY

Secondary data has been used from the published reports and datasets.

The following formulae were used:

A. Three Year Moving Average

$$Y_{t+1} = \frac{Y_t + Y_{t+1} + Y_{t+2}}{3}$$

Where Y_t is variable (area sown, production or productivity)

And t is period, say, t = 0,1,2…..

B. Growth Rate

The moving averages have been used to estimate growth rates.

$$R_t = \frac{Y_1 - Y_0}{Y_0} * 100$$

Where R_t is the simple growth rate during two periods

Y_t -> Value of the variable of the time t.

IV. RESULTS AND DISCUSSIONS

The sugarcane crop generates highest employment of rural population for the various activities such as ploughing, preparation of land, irrigation, sowing the crop, application of fertilizers & pesticides, supervision, getting sugarcane after removing top of sugarcane, carrying sugarcane to the factory etc. Table -1 presents the major sugarcane producing countries in the world. It is seen from this table, that Brazil is the highest producing country and has 37% share. India is the second highest country with 18.7% share. Thus Brazil and India together produce more than 55% sugarcane in the world.

Table 1. Major sugarcane producing countries in the world

Country	Production M Tones	%age Share of the country	Area M Hect	%age Share of the country
Brazil	747	37.0	10.0	36.3
India	377	18.7	4.7	17.1
China	217	10.8	2.8	10.2
Thailand	104	5.2	1.4	5.0
Pakistan	67	3.3	1.1	4.0
Maxico	57	2.8	0.8	2.8
Colombia	36	1.8	0.4	1.5
Guatemala	36	1.8	0.3	1.1
Australia	34	1.7	0.4	1.6
USA	31	1.6	0.3	1.3
Rest of the World	310	15.4	5.3	19.2
Total	2016	100	27.5	100

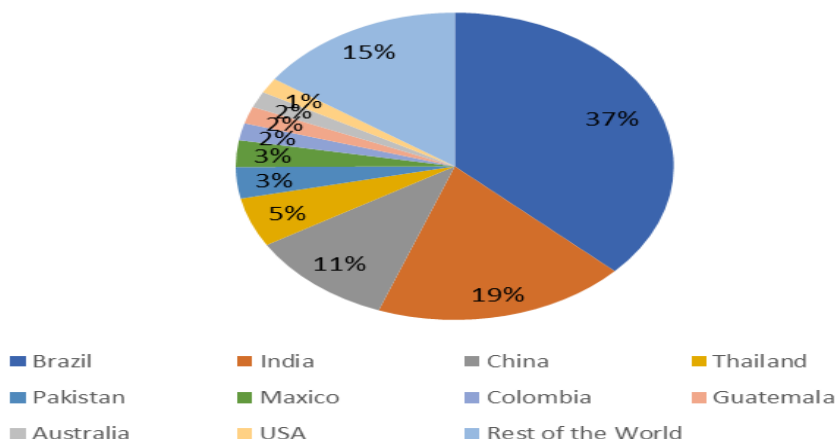*Source: Food and Agriculture Organization – 2019*

Table 2. Three year s moving average of area, production and yield of the Sugarcane

Year.	Area sown M Hect	Growth rate per annum	Production M Tones	Growth rate per annum	Yield Kg/Hect	Growth rate per annum	Irrigated area %age
1958-59	2.05		74.11		36132.33		66.82
1968-69	2.44	1.90	118.40	5.98	46340.67	2.83	75.50
1978-79	2.95	2.09	152.49	2.88	51544.00	1.12	77.70
1988-89	3.35	1.36	208.45	3.67	62203.33	2.07	86.24
1998-99	4.07	2.15	289.19	3.87	71090.00	1.43	91.99
2008-09	4.55	1.18	308.51	0.67	67816.67	-0.46	93.72
2018-19	4.79	0.53	380.34	2.33	79398.67	1.71	95.45

Table-2 presents the three yearly moving averages of area sown and production for Sugarcane. Yield rates have been estimated using three year moving averages of area sown and production. It is observed that area sown has constantly increased from 2.05 M hectare in 1958-59 to 4.79 M hectare during 2018-19. This table also shows annual growth rates during different periods. During 1988-89 to 1989-99 the highest growth rate in area sown i.e. 2.15% was observed which was declining constantly up-to 2018-2019. The production has also increased from 74.11 M tones in 1958-59 to 380.34 in 2018-19. The growth rate has been highest at the level of 5.98 % per annum during 1958-59 to 1968-69 and lowest i.e. 0.67% during 1998-99 to 2008-09. The productivity level has been 36132.33 kg/ha during 1958-59 which has gone up to 79398.67 kg/ha during 2018-19. The productivity level has shown positive growth rates per annum during all the periods except 1998-99 to 2008-09. The highest growth rate was observed during 1958-59 to 1968-69 (i.e. 2.83%) and lowest during 1998-99 to 2008-09.

Table 3. Area, Production and Yield of Sugarcane (2018 – 2019)

	Area M Hect	%age of Total Area	Production M Tones	%age of Total Production	Yield Kg/ ha.	%age Area Irrigation 2016-17
Uttar Pradesh	2.22	43.94	179.71	44.33	80807	95.8
Maharashtra	1.16	22.98	89.77	22.14	77200	100
Karnataka	0.47	9.31	42.41	10.46	90000	99.8
Bihar	0.23	4.46	20.12	4.96	89181	80.9
Tamil Nadu	0.17	3.29	17.14	4.23	103000	100
Gujarat	0.15	3.06	11.33	2.79	73182	94.5
Haryana	0.11	2.15	8.51	2.10	78243	100
Punjab	0.10	1.88	7.77	1.92	81828	97.1
Madhya Pradesh	0.11	2.13	5.28	1.30	48905	99.9
Uttarakhand	0.09	1.80	6.33	1.56	69553	99.2
Andhra Pradesh	0.10	2.02	8.09	2.00	79359	92.6
Others	0.15	3.00	8.96	2.21	59074	-
All India	5.06	100	405.42	100	80105	95.5

The state-wise analysis for Sugarcane is presented in Table-3. It is seen that the major states producing about 90% of the total sugarcane are Uttar Pradesh (43.94%), Maharashtra (22.98), Karnataka (9.31%), Bihar(4.46%) , Tamil Nadu (3.29%), Gujarat (3.06%) and Haryana (2.15%). The highest productivity has been observed of the order of 103000 kg per ha in Tamil Nadu followed by Karnataka (90000 kg per ha, Bihar (89181 Kg per ha), Punjab (81828 kg per ha) and Uttar Pradesh (80807 kg per ha).

V. CONCLUSION

To enhance the production of the sugarcane to achieve the projected targets, the following strategies are suggested:

- Farmer's participation
- Reasonable Minimum Support Price of Sugarcane
- Continuous monitoring of area, inputs, production and its productivity
- Timely payment to the farmers by the sugar factories
- Dissemination and application of Technology and Research
- Crop Insurance
- Need for development of HYV suitable for Rainfed area
- Adoption of latest technology and practices for production, processing and marketing of sugarcane crop and its byproducts
- Promotion of cold storages, which will help in generating employment through marketing of sugarcane juice
- Development of processes and processing machinery for diversified products from sugarcane

REFERENCES

[1] Agricultural Statistics At A Glance., Ministry of Agriculture &Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare , Directorate of Economics & Statistics, Govt. of India, (2020).

[2] Annual Report., Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Govt of India, (2020-2021).

[3] Annual Report, Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Govt of India, (2020-2021).

[4] Department of Agriculture, Cooperation & Farmers Welfare Website. Https://Agricoop.Nic.In

[5] Ministry of Jal Shakti Website Https://Jalshakti-Dowr.Gov.In

[6] Niti Aayog Website Https:// Https://Www.Niti.Gov.In

[7] S C Gupta, Fundamentals of Statistics, Himalaya Publishing House, (2018).

[8] S C Gupta, VK Kapoor, Fundamentals of Mathematical Statistics, Seventh Revised Edition, Sultan Chand & Sons, (1980).

[9] C. H. Hanumantha Rao., Agricultural Growth, Rural Poverty and Environmental Degradation In India – Oxford University Press, New Delhi, (1994).

[10] Kishore Kumar & P C Agrawal., Water Resource Management for Sustainable Agricultural Production – National Conference on Environment and Challenges In Central Himalaya, Srinagar (Garhwal), (2004).

[11] P C Agrawal & Kishore Kumar., Technology & Environment Impact on Agricultural Production- International Conference on Environment and Development – Challenges & Opportunities. Delhi University, Delhi (2005).

[12] Kishore Kumar & P. C. Agrawal., ICT for Agricultural Development, Proceeding of International Conference on Challenges In Networking & Future of E-Commerce CNFE-05, April, 9-10, 2005 Organized By APIIT SD India, Panipat, Haryana, (2005) 335-341.

[13] Agricultural Situation In India., Directorate of Economics And Statistics, Ministry of Agriculture, Government of India, (2006).

[14] Iqbal Badar Alam., Agro Industries: Key To Economic Progress – Published In Kurukshetra, 54(4) (2006).

[15] H. Swain & R.R. Bhakur., Trends And Variability of Some Cereals, Pulses And Commercial Crops In Rajasthan, (2006).

[16] Hirudayanathan & Krishna Murthi – India Sugarcane Trash Collection In Small Farms In Southern India – Published In Sugarcane International Journal of Cane Agriculture In November / December, (2007).

[17] Ramesh Chand & S.S. Raju., Risk In Indian Agriculture - A Case Study of Six Major Crops, (2007).

[18] Thorbum, Webster, Biggs, Park Biggs., Australia., System To Balanced Production And Environment Goals of Nitrogen Fertilizer Management – Published In Sugarcane International Journal of Cane Agriculture In November, (2006).

[19] Yadav – India., Mechanization of Sugarcane In India. Published In Sugar Cane International – A Journal of Cane Agriculture, (2008).

[20] Singhals – South Africa., A New Approach Towards Implementing Computer Based Decision Support for Sugarcane Farmers and Extension Staff – A Mechanization Case Study. Published In Sugarcane International Journal – A Journal of Cane Agriculture, (2008).

[21] P C Agrawal & Kishore Kumar., Application of ICT In Managing Agricultural Productivity And Food Security In India, Journal of IPEM, 3(1)(2009) 28-31.

[22] Prabha Rani, PC Agrawal & Kishore Kumar., Strategic role of Information Technology for Rural Prosperity in India, Journal of IPEM, 54(1) (2010) 1-6.

[23] Kishore Kumar, DC Agrawal & P C Agrawal., Management of Agri-business and Technology for Employment Generation in Sugarcane Crop, Journal of Institute of Professional Excellence & Management), 4(1) (2010) 32-37.