Working Paper 441

Sustainability Concerns on Sugarcane Production in Maharashtra, India: A Decomposition and Instability Analysis

Abnave Vikas B

ISBN 978-81-7791-297-5

Institute for Social and Economic Change (ISEC) is engaged in interdisciplinary research in analytical and applied areas of the social sciences, encompassing diverse aspects of development. ISEC works with central, state and local governments as well as international agencies by undertaking systematic studies of resource potential, identifying factors influencing growth and examining measures for reducing poverty. The thrust areas of research include state and local economic policies, issues relating to sociological and demographic transition, environmental issues and fiscal, administrative and political decentralization and governance. It pursues fruitful contacts with other institutions and scholars devoted to social science research through collaborative research programmes, seminars, etc.

The Working Paper Series provides an opportunity for ISEC faculty, visiting fellows and PhD scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.

Working Paper Series Editor: **Marchang Reimeingam**

SUSTAINABILITY CONCERNS ON SUGARCANE PRODUCTION IN MAHARASHTRA, INDIA: A DECOMPOSITION AND INSTABILITY ANALYSIS

Abnave Vikas B*

Abstract

This paper measures the instability levels in the area, production and productivity of sugarcane in Maharashtra in particular and India as a whole, using the available secondary data from 1966-67 to 2012-13. The analysis periods have been classified into five sub-periods and the growth trend, decomposition analysis and the Cuddy Dell Instability Index have been used for the analysis. The trend of sugarcane productivity in India as a whole is found better than in Maharashtra state in particular. The decomposition analysis result reveals that the contribution of area expansion is relatively more important as compared to productivity expansion to increase sugarcane production. Instability analysis indicates that the level of instability in the area, production and productivity of sugarcane is almost stagnant in India as a whole, whereas the level of instability in the area, production and productivity of sugarcane has been drastically increased in Maharashtra. There is no association found between low growth rate and high instability and vice versa. Therefore, this paper suggests that the sugarcane yield needs to be improved through the use of high yielding varieties of sugarcane, improved cultivation practices and better water and soil management to make it profitable and sustainable.

Keywords: Growth and Decomposition Analysis, Instability, Sugarcane Sustainability, Maharashtra.

Introduction and Motivation

The sugarcane crop plays a key role in the process of development as it generates income and employment. It is also noteworthy for being labour intensive, needing rapid investment, and giving high returns as compared to other crops, and its significant contribution to the country's as well as the states' economies. Maharashtra is one of the leading states in terms of sugarcane production. The establishment of the sugar industry has been rapid in Maharashtra, with a high growth in area and production of sugarcane over the years. Though the sugar industry takes second place to textiles in Maharashtra, no other agro-based industry can compete with it due to the large impact it has on the sugarcane growers and their livelihood. However, the fluctuation in area and production and continuous decline in the yield of sugarcane are the main causes of concern in Maharashtra's sugarcane sector. Despite innovations and adoption of technology and irrigation, especially in Maharashtra, the sugarcane area, production and yield are subject to large fluctuations adversely affecting the sugarcane growers' decisions to invest in sugarcane cultivation and their livelihood. Instability in sugarcane production is not only harmful to agricultural development but also affects the economic condition of a country like India, where the largest share of the labour population depends on agriculture.

Due to the increasing number of sugar factories and distillery plants, there is a great demand for sugarcane with high yield. Therefore, sugarcane production has been increased over the years in

* PhD Research Scholar at CDD, Institute for Social and Economic Change, Bengaluru, India. Emails: vikasba@isec.ac.in; vksabnave@gmail.com.

The present paper is a part of Abnave Vikas B's ongoing PhD thesis at ISEC. The author extends his gratitude to the Prof. M. Devendara Babu (supervisor), Prof. R. S. Deshpande, Doctoral Committee members, panel experts and the anonymous referees for their useful comments. However, the usual disclaimers apply.

India, particularly in Maharashtra. Apart from increasing production, stability over the years is also equally important. From the sustainability point of view, the rate of increase in area, production and yield of sugarcane should be steady or stable. But in reality, there are lots of fluctuations/instability in the area, production and productivity of sugarcane that need to be studied along with factors responsible for them. The declining trend in productivity may affect the future competitiveness of sugarcane growers, and therefore it needs to be investigated.

Instability in sugarcane production is causing a serious shock to farm income and the supply of sugarcane to the sugar mills. It increases the risk involved in sugarcane production and affects the price stability (Chand and Raju, 2008) and it increases thevulnerability of sugarcane growers. It means variability in sugarcane production that influences the prices of sugarcane and it automatically affects the profit level of sugarcane crop and the rate of labour absorption. The sugarcane production system would become even more unsustainable when the risk involved and instability are higher. These are the growing concerns about the increased variability in sugarcane production, productivity, and farm income faced by the sugarcane growers and sugar mills. As a result of rapid investment, some changes have taken place in the sugarcane sector in the country as a whole and Maharashtra in particular, and these changes need to be taken into consideration from the sustainability point of view.

Brief Review of Literature and Research Gaps

The potential that exists for sugarcane production in Maharashtra has been shown by the steady growth in its cultivation area and production due to extensive assistance from the government to the sugarcane growers in the form of financial assistance, training programmes, extension services, etc. Despite these efforts by the government, there has been a continuous decline in productivity in recent decades, which is a cause of concern. The Directorate of Economics and Statistics (DES) data reveals that the productivity of sugarcane in Maharashtra was 91.2 tonnes per hectare in TE 1980-81; it declined to 84.8 tonnes per hectare in TE 2011-12. Land degradation is a major reason for low sugarcane yield in Maharashtra due to the excess use of water and higher dosage of fertilisers (Samui et al, 2005). The instability in sugarcane production has increased significantly and area instability for sugarcane increased much more as compared to the yield instability. Apart from these, the growing of sugarcane has been found unsustainable with its yields getting adversely affected due to over-exploitation of irrigation (Mehta, 2013). Chand et al (2011), however, found a declining trend in instability in area and production over a period of time due to unequal irrigation coverage.

Sugarcane and sugar production is characterised by fluctuating trends in India. According to the Agricultural Outlook and Situation Analysis Report 2014, the existing sugar cycle[i] is more responsible for this problem in India's sugarcane sector. This problem leads to the gradual discontinuing of sugarcane cultivation and also directly influences the economic viability of sugarcane cultivation. A study by Parmar (2012) analysed the factors responsible for determining the area and production of commercial crops. The low level of profitability and instability in sugarcane yield are the main responsible factors. The positive impact of Green Revolution and new economic reforms created channels among the various crops (Sihmar, 2014). Tripathi and Prasad (2009) noted that the post-

reform period helped to reduce the yield and production instability for the sugarcane crop. However, it also indicated that instability in the area under sugarcane increased.

Sugarcane productivity is a function of a number of factors, both physical and non-physical. Rainfall influences the yield of sugarcane indirectly. Due to extremely high and low temperatures, sugarcane yield was low in Uttar Pradesh compared to Maharashtra, while higher rainfall adversely affected sugarcane growth and yield in Maharashtra (Samui, et al, 2014). Nanware and Gund (2013) found a high positive correlation between the percentage of drip irrigation and per hectare yield of sugarcane (an increase of one percentage of the drip irrigated area causes an increase of 0.705 tons per hectare yield of sugarcane). Trash blanketing management can help to improve sugarcane productivity in the medium term or long term. Moreover, the elimination of trash burning practices in sugarcane cultivation led to a more sustainable production system (Digonzelli et al, 2011).

The economic factors affecting the productivity of small sugarcane farmers and low productivity were largely issues like failure to plough out old cane, low price, limited training, limited access to cheap credit, high transport cost, and scarcity of inputs (Chidoko and Chimwai, 2011). The family size, adequacy of irrigation and availability of labour had anon-significant relationship with productivity, while availability of credit, farm mechanisation, and availability of inputs were highly significant for sugarcane productivity (Lalitha, 2001). Rangaswami (1978) has covered the issues of price and non-price factors of supply. The study's main concern is an analysis of the factors which affect the supplies of sugarcane and processed products. Non-price factors like yield, relative profitability and rainfall were observed to influence the supply to a greater or lesser extent.

These existing studies on sugarcane sustainability are inadequate on several counts. First of all, the assessment of sugarcane instability has been examined only in a limited way – in terms of instability in sugarcane production at the aggregate level and most of the studies have restricted themselves only to the national level. Secondly, though very few studies were conducted in the past related to the sugarcane instability, there is a paucity of literature on the sources of change in sugarcane production. Moreover, despite Maharashtra having a dominant share in sugarcane production, many studies on the instability of sugarcane cultivation have not looked at Maharashtra's sugarcane scenario and factors responsible for instability in the area, production and productivity. None of the studies have been extended to analyse theassociation between growth rate and instability. Keeping this in view, there is a need to know the growth trends and instability in sugarcane production in India as a whole and in Maharashtra in particular because the instability measure captures the uncertainty faced by sugarcane growers and mills due to unpredictable fluctuations in sugarcane production.

Objective

To examine the growth trend and instability in the area, production and productivity of sugarcane in the light of uncertain cultivation in India as a whole and Maharashtra in particular.

Data and Methods

The present analysis is based on secondary data which was collected from the Directorate of Economics and Statistics (DES), Government of India website for 47years from 1966-67 to 2012-13. The analysis periods have been classified into five sub-periods to determine the trends, growth pattern and instability level of sugarcane production including:

Period I (1966-67 to 1979-80): Spread of Sugarcane Factories, Introduction of Sugarcane Price Policies (SAP).

Period II (1980-81 to 1990-91): Technology Dissemination, Prominent Role of the State, Sugarcane Development Plan (1982).

Period III (1991-92 to 2000-01): Early Economic Reform/ Delicensing and Decontrol of Sugar Sector (1998).

Period IV (2001-02 to 2012-13): Mature Economic Reform/ Sustainable Development Based Cropping System (SUBACS) (2000).

Period V (1966-67 to 2012-13): Overall Period.

(a) Growth Rate Analysis

In order to examine the trends in the area, production and yield of sugarcane, the growth rate was estimated by using the following semi-log form of equation (1).

$$\log Y_t = a + bt \qquad \text{---------- (1)}$$

Where, Y_t defines the time series data of the area, production and yield of sugarcane crop, 't' is the trend period (i year), 'a' is the constant coefficient and, 'b' is the slope coefficient.

(b) Decomposition Analysis and Instability Index

To measure the relative percentage contribution of area and yield towards the total sugarcane output change, decomposition analysis[ii] was used. The change in sugarcane production during any time period was decomposed into different components in the following manner which was used by Allauddin and Tisdell (1986) and Devraj (2006):

Production = Area*Yield

$Po = A_o*Y_o$; $P_n = A_n*Y_n$

$Pn = (A_o+\Delta A)*(Y_o+\Delta Y)$

$Pn = (A_o*Y_o)+(A_o*\Delta Y)+(\Delta A*Y_o)+(\Delta A*\Delta Y)$

For the calculation of change in Production, P_n Subtracting by P_o,

$Pn-Po = (A_o*Y_o)+(A_o*\Delta Y)+(\Delta A*Y_o)+(\Delta A*\Delta Y) -(A_o*Y_o)$

$\Delta P = [A_o*\Delta Y] + [Y_o*\Delta A] + [\Delta A*\Delta Y]$ ---------- (2)

Change in production = Yield effect +Area effect + Interaction effect

$P_{o,}$ A_o and, Y_o are area, production and yield in the base year and $P_{n,}$ $A_{n,}$ and Y_n are area, production and yield in a current year.

An index of instability was computed for examining the nature and degree of instability in area, production and yield of sugarcane at India and Maharashtra levels. A linear trend y = a+bt +e was fitted to the indices of area, production and productivity and trend co-efficient b' was tested. For a better measure of variability, the instability index was adopted which was developed by Cuddy and Dell (1978)[iii] as follows:

$$II = CV * \sqrt{1 - \bar{R}^2} \quad \text{---------- (3)}$$

Where, II – Instability Index, CV – Coefficient of variation, $\bar{R}^2$– coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

For this analysis, the Instability Index values (in per cent) were divided into three groups, which indicate the different ranges of instability. The ranges of instability are as follows: (a) Low degree of instability = between 0 to 10; (b) Moderate degree of instability = between 10 to 20; (c) High degree of instability = greater than 20.

Results and Discussions

Growth Trendanalysis

The growth in the area, production and productivity of sugarcane is examined to know the pattern of changes taking place in the sugarcane crop in India and Maharashtra state. The period-wise annual compound growth rates in the area, production and productivity of sugarcane in India and Maharashtra state have been presented in Table 1. Looking at the growth trends in area, production and yield of sugarcane in India and Maharashtra state, the Compound Growth Rate (CGR)reveals that the growth trends have been significant in all the decades, except the period 2001-02 to 2012-13 of the area under sugarcane in India. The production of sugarcane has been found significant and also the growth rates of yield. The area under sugarcane was increased during all five periods with the growth rate of 2.14 per cent, 1.76 per cent, and 1.90 per cent, 1.63 per cent and 0.08 per cent respectively. The production of sugarcane also significantly increased during all the five periods with growth rate of 3.41 per cent, 3.25 per cent, 2.73 per cent, 2.58 per cent, 0.12 per cent, respectively. While the growth of productivity was significantly positive, it was found to show a declining trend in India. In the case of the total overall period sugarcane, the area, production and productivity were found positive and showed significant growth. It is clear that the growth rate of area and production of sugarcane in India increased over periods of time.

Table 1: Growth Rate of Area, Production and Yield of Sugarcane during 1966-67 to 2012-13

(in per cent)

Period	India			Maharashtra		
	Area	Production	Yield	Area	Production	Yield
1966-67 to 1979-80	2.14 (3.95)***	3.41 (4.48) ***	1.24 (3.31)***	2.72 (2.90) **	6.56 (6.99) ***	3.73 (7.76) ***
1980-81 to 1990-91	1.76 (2.71)**	3.25 (4.35) ***	1.36 (4.87) ***	3.33 (2.74) **	0.79 (0.67)	-5.20 (-4.78) ***
1991-92 to 2000-01	1.90 (3.34) **	2.73 (4.31) ***	0.81 (2.35) **	4.20 (2.77) **	6.51 (4.26) ***	4.04 (6.23) ***
2001-02 to 2012-13	1.63 (1.98)	2.58 (2.47) *	0.93 (2.62) **	7.80 (3.01) **	9.69 (3.00) **	1.75 (1.99)
1966-67 to 2012-13	0.08 (19.93) ***	0.12 (21.28) ***	0.07 (13.60) ***	3.91 (18.56) ***	3.96 (14.64) ***	0.03 (0.18)

Note: Figures in parenthesis shows 't' values. *** .001 level, * *.01 level.

Source: Author's Estimation (based on Directorate of Economics and Statistics (DES) data, MoA, GoI).

The growth rate of Maharashtra's sugarcane shows that the area under sugarcane increased significantly during all five periods with a growth rate of 2.72 per cent, 3.23 per cent, 4.20 per cent, 7.80 per cent and 3.91 per cent respectively. The growth rate of sugarcane production in Maharashtra increased significantly for all periods, except that the technology dissemination period was found positive, but insignificant, while the growth rate of productivity was noticed to be negative and significant. During1991-92 to 2000-01, the Agriculture Development Department was started by the co-operative sugar factories and through this department, sugarcane cultivation was promoted among farmers. And the growth rate of sugarcane factories increased from 10 per cent in 1970 to 42 per cent during 1991-2007 (Kumbhar, 2009). This may have contributed to increasing the total area and production in Maharashtra. The growth rate of productivity for the overall period (1966-67 to 2012-13) has been recorded to be less and insignificant. It is clear that the area expansion under sugarcane crop is relatively higher in India and Maharashtra.

Decomposition Analysis

Sources of Change in Sugarcane Production

The growth analysis of the area, production and yield of sugarcane crop revealed the general pattern of growth and direction of changes. But this analysis doesn't evaluate the exact contribution of area and yield towards the sugarcane production growth. It is a necessity to identify sources for change in sugarcane production for understanding which factor is relatively lagging behind and to identify the reasons or constraints for that. It will also help us to understand the drivers for the enhancement of sugarcane production. So, it is required to examine the sources of sugarcane output. To examine the sources of output for sugarcane, the total change in production is divided into three effects, i.e., area effect, yield effect and interaction effect. The relative contribution of the area, yield and their interaction to change in sugarcane production in India, and Maharashtra is presented in Table2.

Table 2: Decomposition of Change in Production of Sugarcane in India and Maharashtra (in per cent)

Period	India			Maharashtra		
	Area Effect	Yield Effect	Interaction effect	Area Effect	Yield Effect	Interaction effect
1966-67 to 1979-80	34.60	57.66	7.74	38.84	44.21	16.94
1980-81 to 1990-91	67.94	23.20	8.87	319.66	-126.40	-93.26
1991-92 to 2000-01	74.20	22.98	2.82	47.66	39.88	12.47
2001-02 to 2012-13	89.95	8.87	1.18	113.12	-8.13	-4.99
1966-67 to 2012-13	43.81	25.87	30.32	80.48	3.36	16.16

Note: Sum of all three effects =100

Source: Author's Estimation (based on Directorate of Economics and Statistics (DES) data, MoA, GoI)

During the period 1966-67 to 1979-80, an increase in output of sugarcane was mainly due to increase in yield with the contribution towards productivity for this crop of around 58 per cent in India. But after the period 1966-67 to 1979-80, the area effect was the major driving force for sugarcane output growth in India and in Maharashtra state. For the overall period (1966-67 to 2012-13), area effect contributed more in sugarcane production, followed by interaction effect and yield effect. The decomposition analysis result reveals the same for Maharashtra state like for India that yield effect (44 per cent) was the most responsible for sugarcane output growth followed by area effect (39 per cent) and interaction effect (17 per cent) during the period 1966-67 to 1979-80. It is found that major output expansion of sugarcane was influenced by the expansion of area under sugarcane rather the expansion of yield in India and Maharashtra. However, the yield of sugarcane has not witnessed a significant expansion in India and Maharashtra. The major reasons for this stagnant productivity of sugarcane are- varietal weakening, decline in land productivity, over-exploitation of irrigation, low technology adoption, etc. The low and fluctuating productivity of sugarcane over the years is a major challenge for the sugar sector in Maharashtra.

Relationship of Sugarcane Production to Area and Yield

A common method for measuring the changing attitude of area and production and yield and production of sugarcane crop is the value of correlation which is shown in Table 3. The values of correlation coefficient (r) of area and production of sugarcane are in the range of (0.931 to 0.987) for all five periods, which is highly significant at 1 per cent significance level in India. Whereas, the values of correlation coefficient (r) of yield and production are in the range of (0.720 to 0.932) for all five periods which is significant, but less than the values of association between area- production. It implies that the increment in the area is strongly affecting the production of sugarcane to increase in India.

Table 3: **Relationship between Area and Production and Yield and Production of Sugarcane**

Period	Value of Correlation (r)			
	India		Maharashtra	
	Area - Production	Yield - Production	Area - Production	Yield – Production
1966-67 to 1979-80	0.954***	0.876***	0.882***	0.862***
1980-81 to 1990-91	0.938***	0.840***	0.699**	0.026
1991-92 to 2000-01	0.931***	0.720**	0.943***	0.730**
2001-02 to 2012-13	0.967***	0.819***	0.986***	0.768***
1966-67 to 2012-13	0.987***	0.932***	0.985***	0.192

Note: *** .001 level, **.01 level

Source: Author's Estimation (based on Directorate of Economics and Statistics (DES) data, MoA, GoI).

In the case of Maharashtra state, the relationship between area and production of sugarcane in all the periods are very strong (range in between 0.699 – 0.985) and 1 per cent significant level, except the period of 1980-81 to 1990-91.During the periods 1980-81 to 1990-91 and overall period 1966-67 to 1979-80, the relationship between yield and sugarcane production was not shown to be significant as the values of 'r' are 0.026 and 0.192 in Maharashtra. It implies that the production of sugarcane has increased due to increase in its area in Maharashtra state.

Instability Measurement

Instability in Area, Production and Yield of Sugarcane

An important form of risk faced by sugarcane growers and sugar mills in India and Maharashtra is instability in sugarcane area, production and productivity. The result of this risk is volatility in price (price risk). Due to the price risk and instability in the area, production and productivity are associated either with uncontrolled factors (droughts, climate conditions) or with cultivation strategy (over-exploitation of land). The fluctuations in the area, production and productivity of sugarcane in India and Maharashtra state are interrelated. But the variation in yield may be due to technological changes, weather /climatic conditions like drought, high temperature – rainfall, etc. The instability indices for sugarcane area, production and yield are shown in Table 4whichis measures the level of risk involved in sugarcane production in India and Maharashtra.

Instability analysis clearly indicates a wide range of instability over the periods. India shows a low degree of instability in area during periods I, period II, period III, period IV and, period V with 7.87 per cent (at 1 per cent significance), 7.02 per cent (at 5 per cent significance), 4.89 per cent (at 1 per cent significance), 9.53 per cent (at 10 per cent significance) and 7.85 per cent (at 1 per cent significance) respectively, while the degree of instability in the production also low during period II and period III with 7.93 (at 1 per cent significance), 5.22 per cent (at 1 per cent significance) respectively. The moderate degree of production instability recorded during the period I, period IV, and period V with 11.17 per cent (at 1 per cent significance), 11.85 (at 5 per cent significance) and 10.72 (at 1 per cent significant) per cent respectively. Instability in sugarcane yield in India found very low during all periods with 5.24 per cent (at 1 per cent significance), 2.98 (at 1 per cent significance) and 3.13 (at 5 per cent significance), 4.11 (at 5 per cent significance) and 6.19 (at 1 per cent significance) per cent

respectively. It is clear that the overall instability in the production of sugarcane is higher than the instability in area and productivity of sugarcane in India and the degrees of instability in area, production and yield have declined during the technology dissemination and early reform periods in India.

Table 4: Instability in Area, Production and Yield of Sugarcane in India and Maharashtra

Field of Measurement	Measurement Statistics	Period I	Period II	Period III	Period IV	Period V
India						
Area	CV	11.51	9.05	7.28	10.78	23.44
	t value	3.98***	2.76**	3.46***	2.02*	19.12***
	$\bar{R}^2$	0.53	0.40	0.55	0.22	0.89
	Instability Index (%)	**7.87**	**7.02**	**4.89**	**9.53**	**7.85**
Production	CV	17.21	13.26	9.39	14.46	35.08
	t value	4.34***	4.35***	4.6***	2.53**	21.16***
	$\bar{R}^2$	0.58	0.64	0.69	0.33	0.91
	Instability Index (%)	**11.17**	**7.93**	**5.22**	**11.85**	**10.72**
Yield	CV	7.26	5.37	3.83	5.14	14.15
	t value	3.33***	4.85***	2.34**	2.68**	13.98***
	$\bar{R}^2$	0.48	0.69	0.33	0.36	0.81
	Instability Index (%)	**5.24**	**2.98**	**3.13**	**4.11**	**6.19**
Maharashtra						
Area	CV	17.23	17.61	16.68	35.02	59.83
	t value	3.02**	2.75**	2.94**	3.10**	12.02***
	$\bar{R}^2$	0.38	0.40	0.46	0.44	0.76
	Instability Index (%)	**13.52**	**13.69**	**12.26**	**26.21**	**29.47**
Production	CV	29.74	12.42	21.65	40.35	60.29
	t value	6.74***	0.69	4.39***	3.30***	10.98***
	$\bar{R}^2$	0.77	-0.05	0.67	0.47	0.72
	Instability Index (%)	**14.15**	**--**	**12.44**	**29.28**	**31.79**
Yield	CV	16.51	20.28	13.19	10.97	15.31
	t value	7.75***	-5.06***	6.09***	2.07*	0.03
	$\bar{R}^2$	0.82	0.71	0.80	0.23	-0.02
	Instability Index (%)	**7.01**	**10.90**	**5.89**	**9.63**	**-**

Note: CV - Coefficient of Variation, *** .001 level, ** .01 level and, * .05 level.

Source: Estimation based on Directorate of Economics and Statistics data

Instability indices for Maharashtra state clearly show that Maharashtra has a higher degree of overall instability as compared to India in area, production and yield. In Maharashtra, the mature economic reform period and an overall period show high instability in area of sugarcane with 26.21 (at 5 per cent significance) and 29.47 per cent (at 1 per cent significance) respectively, while the moderate degree of instability in area of sugarcane is found during the period I, period II and period III with 13.52 per cent, 13.69 per cent and 12.26 per cent which is significance at 5 per cent compared to other

periods. For the same periods (mature economic reform period and overall period), the degree of instability in production is found high in Maharashtra with 29.28 per cent and 31.79 per cent at 1 per cent significance levels respectively, and during the period I, period II, and period III recorded moderate degree of instability in sugarcane production. In the case of instability in yield of sugarcane in Maharashtra, it shows a high degree of instability during the overall period (15.48 per cent) followed by period II (10.90 per cent), period IV (9.63 per cent), period I (7.01 per cent), and period III (5.89 per cent). The comparison of t-value for India and Maharashtra shows that the instability in area, production and yield of sugarcane in India is more significant than Maharashtra during 1966-67 to 2012-13. It is pointed out that the overall instability in the production of sugarcane is higher compared to the area and productivity. Instability in the production of sugarcane is caused by instability in area and yield. It is found that the instability in area, yield and production has declined. The main cause of increased instability in yield of sugarcane was the several droughts during period III (1991-91 to 2000-01) and period IV (2001-02 to 2012-13). Due to the scarcity of water, the decline in irrigated area also contributed to the increase in yield instability.

It is noticed that the level of instability in area, production and productivity of sugarcane is almost stagnant in India, whereas the level of instability in area, production and productivity of sugarcane has drastically increased in Maharashtra. A result of instability in sugarcane area, production and productivity is directly on the livelihoods and the welfare of the sugarcane growers. It is clear that the risk involved in Maharashtra's sugarcane crop cultivation is higher and it shows an increasing trend over the periods. Due to increasing risk and declining yield of sugarcane crop, Maharashtra's sugarcane cultivation is moving towards unsustainability.

Factors Causing Instability

There is no doubt that the area and production of sugarcane has increased (area effect), but the productivity (yield effect) has not increased significantly, especially in Maharashtra. The state's support prices, subsidies on fertilisers, electricity and assured demand are encouraging sugarcane production relative to other crops. Therefore, the growers are going for sugarcane area expansion. There are some major reasons for the expansion of sugarcane in Maharashtra. The state's licensing policy is in favour of establishing new sugar mills or expanding the existing capacity of mills. Apart from licensing favour, the co-operative sugar mills are getting large support from the state governments as compared to the private mills. These state policies have led to a rapid expansion of sugar mills and encouraged sugarcane production in Maharashtra along with water exploitation in the state (World Bank and GOI, 1998).There are institutional factors, including subsidy, which drive the area expansion of a particular crop, and farmers read the market signal as well as incentives to shift. A lot of sugarcane cultivation is made possible due to a better support price and other support mechanism for the sugarcane growers where the soil and climatic conditions do not support a sugarcane crop. For example, out of the total sugar mills in Maharashtra state, 40 per cent mills are in drought-prone districts that are more suited to growing oilseeds and pulses. The main reason for the increase in the instability of sugarcane area and production during the period 2001-02 to 2012-13 seems to be the extreme water shortage due to high instability in rainfall (around 8 per cent in India and 18 per cent in Maharashtra) and the sugarcane crop

was also affected by whitefly disease. Moreover, instability has increased due to sugarcane pricing uncertainty in major sugar growing states in India (MoA, 2014).During the period 2004-05 to 2011-12, the fluctuation in prices of sugarcane paid by sugar mills to Maharashtra's sugarcane growers was high. The price paid by sugar mills to growers was Rs.135 per quintal in 2004-05, which declined to Rs 93 per quintal during 2006-08 and again increased to Rs 235 per quintal in 2011-12. Whereas the highest sugarcane producing state, Uttar Pradesh, has less fluctuation and shown an increasing trend (increased from Rs.104 to Rs 240 per quintal) (CACP Report, 2013-14 Sugar Season). However, the Statutory Minimum Price (SMP) / Fair and Remunerative Price (FRP) suddenly increased from Rs. 81.18 per quintal to Rs. 129.84 per quintal after 2008-09, it reached Rs. 210 per quintal in 2012-13. The gap between the total price payable and total price paid by the sugar mills to the sugarcane growers has been increasing over the years. It is not a healthy progress from the point of view of sugar mills as well as growers. The increasing amount of unpaid sugarcane arrears is not a one day or one year phenomenon. This problem started especially after the central government replaced the Statutory Minimum Price (SMP) with the Fair and Remunerative Prices (FRP) for sugarcane in 2009-10. The percentage of arrears on the price payable to the sugarcane growers was around 3 per cent in 2008-09, which has gone up to around 50 per cent in 2014-15 and around 30 per cent in 2017-18.These changes in price have suddenly caused the instability of sugarcane. Instability in sugarcane production is not only due to irrigation shortage and price fluctuations but also due to the lower rate of productivity during the period 2001-02 to 2012-13 in India and Maharashtra. The main cause of low instability during the period 1991-92 to 2000-01is found to be the low rainfall instability and low growth rate in India.

Association between Growth Rate and Instability

Table 5 provides the grouping of different periods by combining different types of association of growth rates and instability index in sugarcane production in India and Maharashtra. In the case of area, all periods were falling under the low growth rate and low instability category in India. In terms of production, the association between growth rate and instability of sugarcane production in India, period III recorded low growth rate and low instability, whereas period IV and period V recorded in low growth rate and moderate instability and period I came under the medium growth rate and moderate instability category. All five periods fell under low growth rate and low instability category in terms of yield in India. From this we conclude that when it came to association between growth rate and instability, there was low growth rate and low instability in India.

Table 5: Association between Growth Rate and Instability of Sugarcane Production in India and Maharashtra State

Types of Association	India			Maharashtra		
	Area	Production	Yield	Area	Production	Yield
High Growth Rate and High Instability	-	-	-	IV	IV	-
Medium Growth Rate and High Instability	-	-	-	V	V	-
Low Growth Rate and High Instability	-	-	-	-	-	-
High Growth Rate and Moderate Instability	-	-	-	-	I,III	-
Medium Growth Rate and Moderate Instability	-	I	-	II,III	-	-
Low Growth Rate and Moderate Instability	-	IV, V	-	I	II	II,V
High Growth Rate and Low Instability	-	-	-	-	-	-
Medium Growth Rate and Low Instability	-	II	-	-	-	I,III
Low Growth Rate and Low Instability	I, II, III, IV, V	III	I, II, III, IV, V	-	-	IV

Note: Period I - 1966-67 to 1979-80; Period II -1980-81 to 1990-91; Period III- 1991-92 to 2000-01; Period IV- 2001-02 to 2012-13; Period V - 1966-67 to 2012-13.

High Instability (greater than 20 per cent), Moderate Instability (10-20 per cent), Low Instability (less than 10 per cent), Low growth rate (less than 3 per cent), Medium growth rate (3-6 per cent) and, High growth rate (6 per cent and above).

Source: Estimation based on Directorate of Economics and Statistics (DES) data, MoA, GoI.

In the case of Maharashtra, the association between growth rate and instability of sugarcane is found mixed. Period II and period III fell under the medium growth rate and moderate instability category, while period I recorded medium growth rate and low instability and period IV came under the high growth rate and high instability category of association in terms of area in Maharashtra. As for the association between growth rate and instability with regard to production, period IV recorded high growth rate and high instability, while period I and period III recorded high growth rate and moderate instability, and period II recorded low growth rate and moderate instability. As for the association between growth rate and instability with regard to yield, period II and period V were found to show low growth rate and moderate instability, while period IV was found to show low growth rate and low instability and period I and III came under the medium growth and low instability category in Maharashtra.

It is found that the instability was low when the growth rate was also low and instability was high when growth rate was also high. There is no association found between low growth rate and high instability and vice versa. It is the inter linkages between growth rate and instability. Both are moving in the same direction, and the instability will be high when growth rate is also high. Therefore, out of five periods, not even a single period was well placed with low risk and high growth in India and Maharashtra state.

Summary and Policy Implications

The above discussion highlighted the fact that the area and production of sugarcane have increased over the years. The fluctuations in sugarcane production in India are basically influenced by the coverage of the area rather than productivity levels. The growth rate of area and production of sugarcane in India increased over periods of time while the growth of productivity was significant, but showed a declining trend in India. The contribution of area expansion was relatively more important in increasing sugarcane production as compared to productivity improvement in India and Maharashtra. Instability analysis indicates that the degree of instability in area, production and yield was shown to be less during the early reform periods due to the low instability in rainfall and low growth rate in India. Instability indices for Maharashtra state clearly showed that Maharashtra has a higher degree of overall instability than the all-India level in terms of area, production and yield. It means more risk and variability are involved in Maharashtra's sugarcane cultivation. It is also found that the instability in sugarcane production has declined when the instability in area, yield and rainfall have declined. Moreover, the relationship between growth rate and instability in sugarcane cultivation was found to be positive.

To reduce the risk involved in sugarcane cultivation, the area under sugarcane is increasing day by day but its yield is almost stagnant. So, there is a need to make efforts for enhancement of productivity. Therefore, this paper suggests that the sugarcane yield needs to be improved through the use of high-yielding varieties of sugarcane, improved cultivation practices and better water and soil management, so that instability in productivity will come down and sugarcane production is improved. As we have seen, the drought situation is also a responsible factor for instability. So there is a need to deal with this issue through the adoption of some sustainable technologies like the use of micro-irrigation equipment, mulching, etc. It is also necessary to make efforts for the adoption of recommended sustainable practices or sustainable sugar initiatives at government level and extension agents through demonstration for improving sugarcane production levels at a low production cost.

End Notes

[i] Indian Sugar cycle: 2-3 years of high production, followed by 2-3 years of low production, and vice versa.

[ii] The change in sugarcane production occurs due to a number of factors such as area, yield, price, rainfall etc. but here only area and yield, major factors, have been taken into consideration. Because price and rainfall do not directly affect sugarcane production, either they directly affect the area under sugarcane or yield level. So, generally, production is a multiplication of Area and Yield.

[iii] The Cuddy-Della Index is an appropriate measure of variability when a variable shows some trend which may be linear or non-linear. It takes into account the time trend in a variable which is not captured in the Coefficient of Variation.

References

Aladdin, M and C Tisdell (1986). Decomposition Methods, Agricultural Productivity Growth and Technological Change: A Critiquesupported by Bangladeshi Data.*Oxford Bulletin of Economics and Statistics*, 48 (4):353-72.

Chand, R and S Raju (2008). Instability in Andhra Pradesh Agriculture – A Disaggregate Analysis. *Agricultural Economics Research Review*, 21 (July-Dec.): 283-88.

Chand, R, S Raju, S Garg and L Pandey (2011). Instability and Regional Variation in Indian Agriculture. *National Centre for Agricultural Economics and Policy Research Policy Paper No. 26.* Pp 1-157. New Delhi.

Chidoko, C and L Chimwai (2011). Economic Challenges of Sugarcane Production in the Lowveld of Zimbabwe. *International Journal of Economic Research*, 2 (5): 1-13.

Commission for Agricultural Costs and Prices (CACP) (2013). *Price Policy for Sugarcane for the 2013-2014 Season*. Department of Agriculture and Co-operation, MoA, GoI: 1- 107.

Cuddy and Dell (1978). Measuring the Instability of Time Series Data. *Oxford Bulletin of Economics and Statistics*, 40 (1): 79-85.

Devraj Zha, G, H Kumar and A Khare (2006). An Analysis of Growth and Instability of Chickpea Production in Madhya Pradesh. *Agricultural Situation in India*, 63 (4): 251-60.

Digonzelli, P, R Romero, L Alonso, J Ullivarri, H Quinteros, J Scandaliaris and S Fajre (2011). Assessing a Sustainable Sugarcane Production System in Tucuman, Argentina. *Rev. Ind. Y Agric. De Tucuman*, 88 (1): 1-12.

Directorate of Economics and Statistics (DES). Ministry of Agriculture, Govt of India. https://eands.dacnet.nic.in/. Accessed on 10.06.2016.

Kumbhar, M (2009). *Crisis in Sugar Co-operative in Maharashtra*. Pp 1-5. http://www.academia.edu/1459885/Crisis_in_Sugar_Cooperatives_in_Maharashtra. Accessed on 01.08.2016.

Lalitha, K (2001). Contribution of Various Factors on Sugarcane Productivity. *Karnataka Journal of Agricultural Science,* 14 (3): 691-95.

Mehta, Niti (2013). An Investigation Into Growth, Instability and Role of Weather in Gujarat Agriculture: 1981-2011. *Agricultural Economics Research Review*, 26 (Conference Number): 43-55.

Ministry of Agriculture (2014). Agricultural Outlook and Situation Analysis Report. *Quarterly Agricultural Outlook Report*, Oct- Dec.: 1-74.

Nanware, A and V Gund (2013). Impact of Drip Irrigation on Sugarcane Productivity in Drought Prone Area. *Research Front*, 1 (1): 79-84.

Parmar, Suman (2012). Study of Growth, Instability and Supply Response of Commercial Crops in Punjab: An Econometric Analysis. *Abhinav,* 1 (5): 49-53. http://agrioutlookindia.ncaer.org/events/QAOR_Jan-Mar%202014.pdf. Accessed on 12.03.2016.

Rangaswami, P (1978). Supply Response of Sugarcane and Its Product in Uttar Pradesh. *Research Study* (Agricultural Economics Research Center, Delhi University), 78 (2): 1-66.

Samui, R, P Kulkarni and N Vaidya (2005). On Growth and Fluctuations of Production, Area and Yield of Sugarcane in the Districts of Maharashtra. *Agricultural Situation in India*, 62 (3): 41-52.

Samui, R (2014). A Critical Evaluation of Sugarcane Yield Variation as Influenced by Climatic Parameters in Uttar Pradesh and Maharashtra States. *Time Journal of Agriculture and Veterinary Science,* 2 (1): 63-69.

Sihmar, R (2014). Growth and Instability in Agricultural Production in Haryana: A District Level Analysis. *International Journal of Scientific and Research Publication*, 4 (7): 1-12.

Tripathi, A and A Prasad (2009). Agricultural Development in India Since Independence: A Study on Progress, Performance and Determinants. *Journal of Emerging Knowledge on Emerging Markets*, 1 (1): 63-92.

World Bank and Government of India (1998). *Inter-Sectoral Water Allocation, Planning and Management.* New Delhi:Allied Publishers Ltd. Pp 1-165.

Recent Working Papers

377 Contributory Pension Schemes for the Poor: Issues and Ways Forward
D Rajasekhar, Santosh Kesavan and R Manjula

378 Federalism and the Formation of States in India
Susant Kumar Naik and V Anil Kumar

379 Ill-Health Experience of Women: A Gender Perspective
Annapuranam Karuppannan

380 The Political Historiography of Modern Gujarat
Tannen Neil Lincoln

381 Growth Effects of Economic Globalization: A Cross-Country Analysis
Sovna Mohanty

382 Trade Potential of the Fishery Sector: Evidence from India
Veena Renjini K K

383 Toilet Access among the Urban Poor – Challenges and Concerns in Bengaluru City Slums
S Manasi and N Latha

384 Usage of Land and Labour under Shifting Cultivation in Manipur
Marchang Reimeingam

385 State Intervention: A Gift or Threat to India's Sugarcane Sector?
Abnave Vikas B and M Devendra Babu

386 Structural Change and Labour Productivity Growth in India: Role of Informal Workers
Rosa Abraham

387 Electricity Consumption and Economic Growth in Karnataka
Laxmi Rajkumari and K Gayithri

388 Augmenting Small Farmers' Income through Rural Non-farm Sector: Role of Information and Institutions
Meenakshi Rajeev and Manojit Bhattacharjee

389 Livelihoods, Conservation and Forest Rights Act in a National Park: An Oxymoron?
Subhashree Banerjee and Syed Ajmal Pasha

390 Womanhood Beyond Motherhood: Exploring Experiences of Voluntary Childless Women
Chandni Bhambhani and Anand Inbanathan

391 Economic Globalization and Income Inequality: Cross-country Empirical Evidence
Sovna Mohanty

392 Cultural Dimension of Women's Health across Social Groups in Chennai
Annapuranam K and Anand Inbanathan

393 Earnings and Investment Differentials between Migrants and Natives: A Study of Street Vendors in Bengaluru City
Channamma Kambara and Indrajit Bairagya

394 'Caste' Among Muslims: Ethnographic Account from a Karnataka Village
Sobin George and Shrinidhi Adiga

395 Is Decentralisation Promoting or Hindering the Effective Implementation of MGNREGS? The Evidence from Karnataka
D Rajasekhar, Salim Lakha and R Manjula

396 Efficiency of Indian Fertilizer Firms: A Stochastic Frontier Approach
Soumita Khan

397 Politics in the State of Telangana: Identity, Representation and Democracy
Anil Kumar Vaddiraju

398 India's Plantation Labour Act - A Critique
Malini L Tantri

399 Federalism and the Formation of States in India: Some Evidence from Hyderabad-Karnataka Region and Telangana State
Susant Kumar Naik

400 Locating Armed Forces (Special Powers) Act, 1958 in the Federal Structure: An Analysis of Its Application in Manipur and Tripura
Rajiv Tewari

401 Performance of Power Sector in Karnataka in the Context of Power Sector Reforms
Laxmi Rajkumari and K Gayithri

402 Are Elections to Grama Panchayats Party-less? The Evidence from Karnataka
D Rajasekhar, M Devendra Babu and R Manjula

403 Hannah Arendt and Modernity: Revisiting the Work *The Human Condition*
Anil Kumar Vaddiraju

404 From E-Governance to Digitisation: Some Reflections and Concerns
Anil Kumar Vaddiraju and S Manasi

405 Understanding the Disparity in Financial Inclusion across Indian States: A Comprehensive Index for the Period 1984 – 2016
Shika Saravanabhavan

406 Gender Relations in the Context of Women's Health in Chennai
Annapuranam K and Anand Inbanathan

407 Value of Statistical Life in India: A Hedonic Wage Approach
Agamoni Majumder and S Madheswaran

408 World Bank's Reformed Model of Development in Karnataka
Amitabha Sarkar

409 Environmental Fiscal Instruments: A Few International Experiences
Rajat Verma and K Gayithri

410 An Evaluation of Input-specific Technical Efficiency of Indian Fertilizer Firms
Soumita Khan

411 Mapping Institutions for Assessing Groundwater Scenario in West Bengal, India
Madhavi Marwah

412 Participation of Rural Households in Farm, Non-Farm and Pluri-Activity: Evidence from India
S Subramanian

413 Inequalities in Health Outcomes: Evidence from NSS Data
Anushree K N and S Madheswaran

414 Urban Household Enterprises and Lack of Access to Production Loans
Shika Saravanabhavan and Meenakshi Rajeev

Price: ₹ 30.00 ISBN 978-81-7791-297-5

INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
(ISEC is an ICSSR Research Institute, Government of India and the Grant-in-Aid Institute, Government of Karnataka)
Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: reimeingam@isec.ac.in; Web: www.isec.ac.in