# Economic analysis of growth, instability and resource use efficiency of sugarcane cultivation in India: an econometric approach



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# Economic analysis of growth, instability and resource use efficiency of sugarcane cultivation in India: an econometric approach

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## Abstract

**Objectives:** To find out the growth, as well as instability in area, production and productivity of sugarcane farming and to assess the resource use efficiency in major sugarcane growing states of India and trade performance of sugar.
**Methods/Statistical analysis:** Investigation is based on secondary data of area, production and productivity of sugarcane in major sugarcane growing states of India for the period from 2000-01 to 2015-16. Efficiency of sugarcane production was estimated using plot level data obtained from website of Cost of Cultivation Scheme, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India for the year, 2014-15. Compound growth rates, instability indices using formula suggested by Cuddy- Della Valle, and resource use efficiency using Data Envelopment approach (DEA) were computed.
**Findings:** At national level area, production and productivity of sugarcane went up during the period of investigation. Similar result was also observed in case of growth rates of sugarcane crop which were found positive and encouraging. The area under sugarcane was found stable in the states like Uttar Pradesh, Uttrakhand and Gujarat on the other hand the yield of sugarcane recorded almost stable in Uttar Pradesh, Uttrakhand and Tamil Nadu. Technical efficiency at national level in sugarcane production was found to be 66% which indicated that the production of crop may further be raised by 34% with the available technology. Allocative mean efficiencies indicated that costs may be reduced by 40% through using optimum combination of inputs keeping in mind their prices while selecting their quantities. The cost efficiency (CE) asserted that farmers may potentially reduce their overall cost of sugarcane production, upto 60% to harvest the existing level of output at least cost. Undoubtedly, the export of sugar from India has increased during the period of investigation.
**Applications/Improvements:** State government initiatives were found appreciable making sugarcane cultivation more remunerative. Proper use of scarce resources may make it more productive and profitable and realizing the objective of doubling income and uplifting standard of cultivators.
**Keywords:** Sugarcane, Data Envelopment Approach, Resource Use Efficiency, Technical Efficiency, Allocative Efficiency, Cost Efficiency.

## 1. Introduction

High yielding varieties of the crops, erratic fertilizer uses and irrigation has brought remarkable changes in the India's agricultural scenario. India's ultimate irrigation potential (UIP) has enhanced about 7.7 times, from 19.5 to 139.90 million hectares upto 2012 (Water related statistics, 2013) and foodgrain production reached from 50 million tones to 252.22million tones in 2015-16. For achieving this we have paid a huge cost in the form of depletion of water table, abrupt changes in climatic conditions resulting in a big challenge to sustainability. No doubt, due to Green Revolution India has got self-sufficiency in food grain production.

Regional disparity was observed in spread of the revolution; mainly Punjab and Haryana were leading the way i.e., its effects were noticed mainly in north India. More than 90% of available water in India has been used to meet the irrigation needs of the country, leaving 10% for industry and the domestic sector. The utilization of groundwater sources has played a vital and expanding role in transforming India from food scarce to food surplus nation. The states initiatives of rural electrification, credit availability and subsidies for irrigation and fertilizers played a lead role in expansion of green revolution. Further, improved groundwater extraction devices, and a shift to the production of water consuming crops such as sugarcane and paddy, has caused depletion of water table. The distortion in groundwater was results of subsidized electricity and diesel. Extraction of water has been made without keeping pace with demand and future consequences. This has created a threat to sustainability and to the viability of agricultural production and livelihood. Ever rising population and a growing economy demand warrant sustainable use of water keeping in mind the needs of forthcoming generation. Judicious and efficient use of irrigation and other inputs would obviously translate to an increase in the productivity of the crops. Hence, sustainable and optimal use of inputs for production and enhancing farmer's income with right combination of inputs and their relative prices are demand of the present day.

Agriculture is an important part of India's economical framework and at present, it is among the top producers of various agricultural commodities in the world. The sector provides approximately 49 per cent of the total number of jobs available in India and contributes around 17.5% of the GDP (at current prices in 2015-16). As of 2009-10, more than half of the total workforce (53%) of the country, i.e., 243 million persons were employed in agriculture. The share of population depending on agriculture for its livelihood consists of landowners, tenant farmers who cultivate a piece of land, and agricultural labourers who are employed on these farms. Agricultural output has been volatile over the past 10 years, with annual growth ranging from 8.6% in 2010-11 to -0.2% in 2014-15 and 0.8% in 2015-16 [1].

The agriculture sector of India has occupied almost 43 per cent of India's geographical area. Besides its share in national income and employment creation, it also contributes significantly in capital formation, raw material to industries, market for industrial products, earner of foreign exchange, source of revenue [2]. Though food grains continue to possess important place in Indian agriculture, the cash crops have earned notable share in crop portfolio during last decade. The area under pulses and coarse cereals have revealed declining trend, whereas area under paddy has remained almost stagnant on the other hand, area under cash crops like fiber, sugarcane, spices, condiments, fruits and vegetables asserted rising trend. Initiatives like contract farming, co-operatives, promotion of producers' groups and public private linkages were the major factors which could make this happen [3].

Sugarcane has an important position among the various cash crops of the nation. Domestic sugar market is one of the largest in the world. India is second largest producer of sugar after Brazil accounting for 16 percent of world production. Sugarcane is one of the most important crops in the world because of its strategic position and immense uses in daily life of any country as well as industrial uses aimed at nutritional and economic sustenance [4]. Sugarcane contributes about 60% of the total world sugar requirement and rest 40% comes from sugar beet. It is tropical crop that usually takes 8 to 12 months to reach its maturity. Sugarcane production achieved a record of 361 million tonnes in 2011-12, after which it declined to 341 million tonnes in 2012-13 and then again increased to 359 million tonnes in 2014-15 out of this, 266 million tonnes i.e., 74 percent of total sugarcane production was crushed for sugar production in 2014-15 and the remaining could have been used for production of Jaggery, Khandsari etc. [5]. It is the second important cash crop in India, contributing direct and indirect employment to 45 million farmers and large mass of skilled and unskilled workers are also engaged in sugarcane cultivation, harvesting and ancillary activities [6]. Even though sugarcane cultivation occupied about 2.5 percent India's gross cropped area (2014-15) and its products accounted for 6 percent of the total value of agricultural output.

In India, there are two distinct regions for sugarcane cultivation, tropical comprising cane producing southern states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu and subtropical comprising northern states of Bihar, Uttrakhand and Uttar Pradesh. Subtropical region, encompassing 55 percent of total cane area, contributes only 48 percent of total cane production and 35 percent of total sugar production in the country, whereas tropical region covers 41 percent of the cane area, contributes 49 percent of the cane production and 64 percent of sugar production. The average cane productivity in subtropical region was found to be 61 tonnes/hectare and 84 tonnes/hectare in tropical region in the year, 2014-15. The rest of the cane production comes from states not lying in these two regions (Commission for Agricultural Costs and Prices, CACP, 2015). Uttar Pradesh (41.29%) was the largest producer of sugarcane in India, followed by Maharashtra (20.52%) and Karnataka (10.93%) during the year 2015-16. These three states contributed about 72.73 percent of India's total sugarcane production (2015-16), a slight decline from their earlier cumulative average of 73.55 percent (2014-15). Production losses in Karnataka, Tamil Nadu, and Andhra Pradesh and Telangana states were due to low levels of precipitation during 2015-16 and were declared as drought-hit. As per the latest production

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data, (2016-17) sugar production was estimated at 21.9 MMT, down by 8.4 percent from the previous estimate. As a result, total sugar supplies were limited to 32.6 MMT, which was just enough to meet the out-year consumption and stock requirements. For the third time in recent years, Indian sugar production dropped below consumption (25.6 MMT) level [7].

Sugarcane crop production process is complex and depends on various combinations of input uses such as human labour, machine lablour, fertilizers, irrigation, capital and management practices etc. The variations in uses of different combinations of resources affect the production and yield of sugarcane. Required combinations of inputs for cultivation are technology. The variation in sugarcane productivity is the result of inappropriate combinations of input uses. Furthermore, It has been noticed a wide gap between farmer's field and experimental field productivity, indicating the disproportionate application inputs. Resource use efficiency depicts the conversion of different physical inputs and their prices such as human labour, machine labour, animal labour, irrigation hours and fertilizers into output/yield. In this investigation, attempts have been made to find out the growth, as well as instability in area, production and productivity of sugarcane farming and to assess the resource use efficiency in major sugarcane growing states of India.

## 2. Materials and methods

The present investigation is based on secondary data of area, production and productivity of sugarcane in major sugarcane growing states of India for the period from 2000-01 to 2015-16. Efficiency of sugarcane production was estimated using plot level data of sugarcane obtained from website of Cost of Cultivation Scheme, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India for the year, 2014-15.

### 1. Compound growth rate (CGR)

The state wise as well as for the country as a whole, compound growth rates (CGRs) of area, production and productivity of sugarcane were computed using the following formula:

$$\mathrm{CGR} = (\mathrm{Anti\ log\ of\ b} - 1)\mathrm{X}\ 100$$

Where, b is the regression coefficient.

### 2. Estimation of instability index

Instability is the deviation from trend. In various literature researchers have applied the coefficient of variation (CV %) as measures of instability. An instability index was worked out to examine the extent of instability in area, production and yield of the sugarcane for the states under study and nation as a whole. Only CV does not explain suitable trend component inherent in the time series data, hence, the instability index was computed applying measure of variability suggested by Cuddy- Della Valle index [8]. The formula for computation is given as under:

$$\mathrm{Instability\ Index} = \mathrm{CV} * \sqrt{1 - \mathrm{R}^2}$$

$$\mathrm{CV} = \frac{\mathrm{Standard\ deviation\ of\ the\ variable}}{\mathrm{Mean\ of\ the\ variable}} \mathrm{X}\ 100$$

If the estimated coefficient of regression equation is not significant, then the CV itself is taken as instability index.

Where, CV is coefficient of variation and $R^2$ is the coefficient of determination from a time series trend regression adjusted by the number of degrees of freedom.

### 3. Resource use efficiency

Resource use Efficiency, which may be defined as the ability to fetch maximum output per unit of resource properly addressed in achieving optimal production. There are various econometrical tools and methods to assess resource use efficiency like Data Envelopment Analysis (DEA), Stochastic Frontier (SF) production function etc. In the present study, DEA method has been used which is explained here:

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**4. Data Envelopment Analysis (DEA) approach**

Resource use efficiency under different crop production is estimated on the basis of DEA. DEA is a Linear Programming technique for constructing a non-parametric piece wise linear envelop to a set of observed output and inputs data. Efficiency is a measure of how efficiently inputs are applied to produce a given level of output i.e., producing same level of output with optimal level of inputs or more output with the same level of inputs means higher level of efficiency. The technique of DEA has been used to find the relative efficiency score of each farm in relation to farms with minimum input output ratio for all inputs. The score of the most efficient farms being one, the score of each farm will lie between 0 and 1.

In the present study, the DEA approach has been carried out to assess the data for optimizing the performance measure of each production unit and determining the most preferable ones. Unit level data of sugarcane from Cost of Cultivation Scheme for the period 2014-15 for various major sugarcane producing states available at the websites of Directorate of Economics and Statistics, Government of India have been used. The information obtained included the amount of input, costs which were used in crop production such as human labour, animal labour, tractor used (hours), seed quantity (setts), fertilizers used and irrigation hours etc. and the yield as an output. In order to specify the mathematical formulation of model, we assume that we have K farmers using N inputs to produce M outputs.

Inputs are denoted by $x_{jk}$ (j=1,2,….. n) and output are represented by $Y_{ik}$ (i=1,2,3…..m) for each farmer k (k=1,2,…. K). Technical efficiency (TE) of the farmers may be measured as:

$$\mathrm{TE_k} = \sum_{i=1}^{m} u_i y_{ik} / \sum_{j=1}^{n} v_j x_{jk}$$

Where, $Y_{ik}$ is the quantity of i$^{th}$ output produced by k$^{th}$ farmer, $x_{jk}$ is the quantity of j$^{th}$ input used by the k$^{th}$ farmer; $u_i$ and $v_j$ are the output and input weights, respectively. The farmer maximizes the technical efficiency, $TE_k$ subject to

$$\mathrm{TE_k} = \sum_{i=1}^{m} u_i y_{ik} / \sum_{j=1}^{n} v_j x_{jk} \leq 1$$

Where, $u_i$ and $v_j \geq 0$

The above equation indicates that the technical efficiency measure of a farmer can't exceed one, and the input and output weights are positive. The weights are selected in such a way that the farmer maximizes its own technical efficiency which is executed separately. To select optimal weights, the following linear programming model was applied:

Min $TE_k$
Subject to

$$\sum_{i=1}^{m} u_i y_{ik} - y_{ik} + \omega \geq 0$$

Where k=1,2,………..k

$$x_{jk} - \sum_{j=1}^{n} v_j x_{jk} \geq 0$$

$u_i$ and $v_j \geq 0$

The above model shows TE under constant returns to scale (CRS) with an assumption, if $\boldsymbol{\omega}$ =0 and it changes into variable returns to scale (VRS), if $\boldsymbol{\omega}$ is used unconstrained. In the first case, it leads to technical efficiency (TE) and in second case, pure technical efficiency (PTE) is estimated.

**5. Technical Efficiency (TE)**

It can be explained generally as the ratio of sum of the weighted outputs to sum of weighted inputs. The value of technical efficiency varies between zero and one; where a value of one implies that a farmer is the best performer located on production frontier and has no reduction potential any value of TE lower than one indicates that cultivator uses inputs inefficiently.

**6. Cost or Economic Efficiency (CE)**

One can measure both technical and allocative efficiencies to verify the behavioral objectives such as cost minimization or return maximization.

Cost minimization DEA is expressed as:

$$\mathrm{Min}_{YXk^{*}}\, w_k' \, X_k^{*},$$

$$\text{Subject to } -y_k + YY \geq 0,$$
$$X_k^{*} - XY \geq 0,$$
$$Y \geq 0,$$

Where $w_k$ is a vector of input prices for the $k^{th}$ farmer and $X_k^{*}$ (which is calculated by LP) is the cost minimizing vector of input quantities for the $k^{th}$ farmer, given the input prices $w_k$ and the output level $y_k$.
Total cost efficiency (CE) or economic efficiency of the $k^{th}$ farmer can be calculated as:

$$CE= w_k X_k^{*}/w_k X_k$$

That is the ratio of minimum cost to the observed cost.

While the allocative efficiency (AE) is calculated as the ratio of cost efficiency to technical efficiency

$$AE=CE/TE$$

Efficiency analysis is a relative concept relates to production analysis and measures the production with ratio. TE relates the extent to which a farmer produces maximum output from a given combinations of inputs, or uses the minimum amount of inputs to produce a given level of output when the technology depicts constant returns to scale but is likely to differ otherwise. These two explanations of TE are known as output-oriented or input-oriented measures ofefficiency. AE or price efficiency reflects the ability of a farm to use the inputs in optimal proportions, given their respective price EE or CE is distinct from the other two; even though it is the product of TE and AE and shows the ability of a production unit to produce a specified output at minimum cost. An economically-efficient might be both technically and allocatively efficient [9-14].

## 3. Results and discussion

### 1. Sugarcane scenario in India

The area, production and productivity of sugarcane crop as presented in Table 1 indicated that the percentage of acreage under the crop had increased in Uttar Pradesh (8.25%), Maharashtra (70.33%), Karnataka (9.38%), Bihar (143.33%) and India as a whole (13.18%) during TE-2003 toTE-2016.

Rest of the states under study shown decreasing trends in area under crop during the period under investigation but in case of production it was found that Uttar Pradesh, Maharashtra, Karnataka, Bihar, Gujarat and country as whole depicted increase in production and other states under investigation were found in downward direction with respect to production.

Productivity was accessed increasing in all the state except Tamil Nadu during TE-2003 and TE-2016. Overall area, production and productivity of India were found increased. Production losses in Karnataka, Tamil Nadu, and Andhra Pradesh states were due to low levels of precipitation during 2015-16 and were declared as drought-hit. Similar findings were also obtained in a study conducted in Uttar Pradesh and Maharashtra [15].

*Table 1. Sugarcane scenario in India*

| States | Area (000 ha) | | % increase/ decrease | Production (000 tones) | | % increase/ decrease | Productivity (tones/ha) | |
|---|---|---|---|---|---|---|---|---|
| | TE-2003 | TE-2016 | | TE-2003 | TE-2016 | | TE-2003 | TE-2016 |
| Uttar Pradesh | 2040.42 | 2208.67 | 8.25 | 114982.33 | 139520.00 | 21.34 | 56.35 | 63.17 |
| Maharashtra | 582.20 | 991.67 | 70.33 | 45775.17 | 77010.33 | 68.24 | 78.57 | 77.73 |
| Karnataka | 402.27 | 440.00 | 9.38 | 36141.81 | 39426.67 | 9.09 | 89.84 | 89.61 |
| Tamil Nadu | 300.02 | 278.67 | -7.12 | 30281.05 | 27805.67 | -8.17 | 100.93 | 99.78 |
| Bihar | 104.66 | 254.67 | 143.33 | 4573.07 | 13897.67 | 203.90 | 43.70 | 54.57 |
| Gujarat | 187.67 | 186.00 | -0.89 | 4023.07 | 13190.00 | 227.86 | 21.13 | 71.02 |
| Andhra Pradesh | 229.32 | 164.00 | -28.48 | 17054.40 | 12615.00 | -26.03 | 74.37 | 76.92 |
| Haryana | 164.41 | 97.67 | -40.59 | 9363.33 | 7219.67 | -22.89 | 56.95 | 73.92 |
| Punjab | 136.33 | 91.00 | -33.25 | 8563.33 | 6764.67 | -21.00 | 62.96 | 74.33 |
| Uttrakhand | 119.16 | 102.00 | -14.40 | 6560.55 | 6018.33 | -8.26 | 55.06 | 59.00 |
| All India | 4416.00 | 4998.00 | 13.18 | 293515.67 | 353620.33 | 20.48 | 66.47 | 70.75 |

## 2. Growth performance of sugarcane in India

Compound growth rates of area, production and productivity of sugarcane were computed for different sugarcane growing states as well as for the nation as a whole and are presented in Table 2.

*Table 2. Compound growth rate of sugarcane crop (2000-01 to 2015-16) (Percent)*

| States | Area | Production | Productivity |
|---|---|---|---|
| Uttar Pradesh | 0.24 | 0.56 | 0.36 |
| Maharashtra | 2.42 | 2.63 | 0.21 |
| Karnataka | 0.95 | 1.12 | 0.17 |
| Tamil Nadu | 0.20 | 0.14 | -0.06 |
| Bihar | 3.39 | 4.35 | 0.92 |
| Gujarat | -0.06 | 3.19 | 3.25 |
| Andhra Pradesh | -1.30 | -1.15 | 0.15 |
| Haryana | -1.94 | -1.06 | 0.89 |
| Punjab | -1.39 | -0.75 | 0.64 |
| Uttrakhand | -0.47 | -0.45 | 0.02 |
| All India | 0.59 | 0.88 | 0.29 |

It is evident from the table that Bihar, Maharashtra and Karnataka were the top three states indicating growth rates of 3.39, 2.42 and 0.95 per annum, respectively, in case of acreage under sugarcane crop. An increase in early-maturing high-yielding varieties and better returns from cane as compared to other competing crops in the above states may be the reason for bringing more area under the crop. The other states under investigation like Gujarat, Andhra Pradesh, Haryana, Punjab and Uttrakhand depicted negative compound growth rates revealing decline in area under sugarcane. In terms of growth performance of production Bihar (4.35%), Gujarat (3.19%) and Maharashtra (2.63%) occupied the top three positions on the other hand, Andhra Pradesh, Haryana, Punjab and Uttrakhand recorded declining trend in production of the crop as the fact was supported by negative production growth. The decline in production may be due to scarcity of irrigation as in the states of Punjab, Haryana and Uttrakhand water table has gone down and government of these states are discouraging more water consuming crops to cope up with sustainable agriculture. Productivity of the crop for all the states under investigation was found to be positive except for Tamil Nadu which registered negative growth in productivity. The growth performance in respect of area, production and productivity for the nation as a whole was found marching upward.

## 3. Instability indices in sugarcane

The results of instability indices (Table 3) with regard area (3.90), production (6.16) and productivity (1.90) of sugarcane crop were recorded lower, indicating thereby stability in area, production and productivity of the crop at the national level. When compared among states, it was found that the instability in area was recorded lower in Uttar Pradesh (3.61), Uttrakhand (7.51) and Gujarat (9.36) indicating by and large, stable area under sugarcane, whereas production was found comparatively stable in Uttar Pradesh (5.84), Haryana (6.30) and Andhra Pradesh (7.16).

*Table 3. Instability indices of Sugarcane*

| States | Area | Production | Productivity |
|---|---|---|---|
| Uttar Pradesh | 3.61 | 5.84 | 4.21 |
| Maharashtra | 16.21 | 16.01 | 8.65 |
| Karnataka | 21.49 | 26.38 | 8.16 |
| Tamil Nadu | 16.69 | 18.87 | 5.40 |
| Bihar | 20.77 | 28.25 | 9.79 |
| Gujarat | 9.36 | 12.90 | 13.82 |
| Andhra Pradesh | 9.53 | 7.16 | 6.06 |
| Haryana | 17.03 | 6.30 | 8.45 |
| Punjab | 25.33 | 24.60 | 10.48 |
| Uttrakhand | 7.51 | 9.11 | 5.34 |
| All India | 3.90 | 6.16 | 1.90 |

The yield of sugarcane recorded relatively lower instability in Uttar Pradesh, Uttrakhand and Tamil Nadu as these indices being 4.21, 5.34 and 5.40 revealing comparatively stable yield in these states. The findings agree with the findings of a previously conducted study in India [16]. It was also observed from the table that the area and production of sugarcane crop were comparatively more unstable in the states of Maharashtra, Karnataka, Tamil Nadu and Bihar than those states mentioned above.

## 4. Resource use efficiency

Summary statistics for the measures of technical, allocative and economic or cost efficiencies are presented in Table 4. Technical efficiencies at nation as a whole in sugarcane production were found to be 66%, indicating thereby production changes by 34% are possible to increase with the available technology. Allocative mean efficiency for sugarcane was calculated 60%, emphasizing the possibility that farmers could reduce production costs by 40% through using optimum proportions of inputs considering its prices while selectingits quantities. The combined effect of TE and AE shown the average CE score being 40%, this means that according to Farrell's principle, the farmers may potentially reduce their overall cost of sugarcane production, on an average, by 60% to produce the existing level of output at least cost.

*Table 4. Resource use efficiency of major sugarcane growing states of India*

| States | Technical efficiency (TE) | Allocative efficiency (AE) | Cost efficiency (CE) |
|---|---|---|---|
| Uttar Pradesh | 0.79 | 0.67 | 0.53 |
| Maharashtra | 0.70 | 0.49 | 0.34 |
| Karnataka | 0.83 | 0.78 | 0.64 |
| Tamil Nadu | 0.82 | 0.77 | 0.63 |
| Bihar | 0.78 | 0.71 | 0.58 |
| Andhra Pradesh | 0.87 | 0.88 | 0.77 |
| Haryana | 0.92 | 0.85 | 0.78 |
| Punjab | 0.96 | 0.14 | 0.15 |
| Uttrakhand | 0.72 | 0.73 | 0.53 |
| All India | 0.66 | 0.60 | 0.40 |

However, farmer's objective and skill might influence their potential and desire to achieve overall CE or EE. Perusal of the analysis further indicated technical inefficiencies may be estimated 4% for Punjab and 8% for Haryana followed by Andhra Pradesh (13%), Karnataka (17%) and Tamil Nadu (18%). It was further reflected that the allocative mean efficiencies for sugarcane was calculated 88% for Andhra Pradesh, Haryana (85%) and other states fell in the range of 14 to 73% opined the fact in other words that farmers could reduce costs by 12% in Andhra Pradesh, 15% in Haryana and in the other states of the nation in the range of 86% to 27% by using optimum proportions of inputs considering it's prices while selecting it's quantities.

Estimates of Cost efficiencies (CE) of sugarcane for different states under study provide guidance to the farmers that there is scope or possibility to lessen cost by 85% in Punjab and 66% in Maharashtra and also in other states in the range of 28 to 47% under sugarcane production to exploit the scarce resources at least cost. A similar finding was observed in an investigation conducted in Tamil Nadu [17].

## 5. Trade performance and share of sugar export to total GDP

Trade performance and share of sugar export to total GDP of the nation is presented in Table 5. Sugar export is mainly confined to countries like Brazil dominating the group other sugar exporter countries are Thailand, Australia and Mexico. The major proportion of the international trade is raw sugar. Refined sugar share is very few. Global import of sugar reflected more diversification as compared to exports. The major countries importing sugar are the European Union, United States of America, China, Indonesia, Russian Federation, Malaysia and South Korea. The fluctuating nature of sugar production has created declined export of sugar from India.

Sometimes, it is necessary to import the sugar to stabilize the domestic prices of sugar. The export of sugar from India was around 11.53 lakh tones during TE-2003 which raised more than two fold as much as 27.53 lakh tonnes in TE-2016. Similarly, the import also jumped many times to the level of 14.53 lakh tonnes during TE-2016 as compared to only 0.33 lakh tonnes during TE-2003. This is important to mention here that from the point of view of sugar import the year TE-2006 was abnormal year. This kind of trend is noticed in India on account of fluctuating features of sugarcane production in the country. Still India has improved the sugar export in last decades due to various initiatives by the government to increase production. The income from sugar export was amounted ₹1309.59 crores in TE-2003 which further enhanced to 7426.35 crores in TE-2016. The share of sugar export in GDP of the nation was computed 0.064% in TE-2003 which boosted up to 0.12% in TE-2016.

*Table 5. Trade performance of sugar and its share of export to total GDP of the country*

| Particulars | Period | | | |
|---|---|---|---|---|
| | TE-2003 | TE-2006 | TE-2012 | TE-2016 |
| Export (Lakh tonnes) | 11.53 | 5.43 | 15.09 | 27.53 |
| Import (Lakh tonnes) | 0.33 | 4.98 | 8.06 | 14.53 |
| Export value (Crore rupees) | 1309.59 | 645.08 | 4783.34 | 7426.35 |
| Share of sugar export in GDP (%) | 0.064 | 0.022 | 0.094 | 0.120 |

*Source: Computed from report of price policies for sugarcane 2016-17*

## 6. Farmers' gain from sugarcane cultivation

The Commission on Agricultural Costs and Prices (CACP) recommended adopting a hybrid approach *i.e.* a combination of Revenue Sharing Formula (RSF) and Fair and Remunerative Price (FRP) while fixing price of sugarcane. Under this approach farmers' realization from the cane would be higher when sugar prices are on upswing. Further, farmers may avoid getting lower prices than the FRP during the period of downward cycle of sugar prices. In such a situation, the farmers would be paid FRP up front and the difference between FRP and prices determined by RSF would be met by Sugar Stabilization Fund (SSF). This recommendation essentially has three components namely FRP, RSF and SSF and all these were to be implemented as an *'Atomic whole'* for the viability of the sugar industry. The commission recommended that all the three components of hybrid pricing approach should be implemented simultaneously. Such a rational approach for sugarcane pricing would provide a logical solution to the travails of both the cane farmers and the sugar industry.

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*Table 6. Percentage gain to the farmers over state advised price (SAP)*

| States | State advised cane Price (Rs/q) | | Cost $C_2$ (Rs/q) | | Percent gain on SAP over $C_2$ (TE-2016) |
|---|---|---|---|---|---|
| | TE-2003 | TE-2016 (SAP) | TE-2003 | TE-2016 | |
| Uttar Pradesh | - | 280.00 | 61.73 | 165.57 | 40.87 |
| Maharashtra | - | 245.00 | 63.41 | 162.30 | 33.75 |
| Karnataka | - | 254.17 | 55.99 | 134.46 | 47.10 |
| Tamil Nadu | - | 271.67 | 59.77 | 160.63 | 40.87 |
| Bihar | - | 256.67 | - | - | - |
| Gujarat | - | - | - | - | - |
| Andhra Pradesh | - | 252.00 | 71.73 | 175.62 | 30.31 |
| Haryana | - | 298.33 | 74.41 | 193.32 | 35.20 |
| Punjab | - | 286.67 | - | - | |
| Uttrakhand | - | 280.00 | 46.92 | 145.51 | 48.03 |
| All India (FRP) | 63.68 | 248.00 | - | 226.00 | 8.87 |

*Source: CACP reports of various years*

A look at the Table 6 indicated that the percentage gain over state advised price (SAP) and cost $C_2$ ($C_2$ includes A2+FL cost, rental value of owned land and interest on owned fixed capital) was estimated to the highest in Karnataka (47.10%), followed by Uttar Pradesh (40.87) and Tamil Nadu (40.87) during TE-2016. Overall gain on fair and remunerative price (FRP) fixed by government of India was assessed to be 8.87% over the cost $C_2$ during TE-2016.

## 4. Conclusion

From foregoing discussion, it can be inferred that overall area, production and productivity of sugarcane in India went up during the period of study. In case of growth performance Bihar (3.39%), Maharashtra (2.42%) and Karnataka (0.95%) were identified as the top three states in terms of acreage under sugarcane crop,whereas in case of production growth Bihar (4.35%), Gujarat (3.19%) and Maharashtra (2.63%) occupied the highest three positions. In respect of growth rates of productivity of sugarcane for all states under investigation, it was found positive and encouraging. It was also pinpointed that stability in area under sugar cane was recorded in the states like Uttar Pradesh, Uttrakhand and Gujarat on the other hand the yield of sugarcane also emphasized the stability in Uttar Pradesh Uttrakhand and Tamil Nadu states.

Technical efficiency at national level in sugarcane production was found to be 66% which indicated that the production of crop may further be enhanced by 34% with the use of available technology. Allocative mean efficiencies revealed that farmers may reduce costs by 40% through using optimum combinations of inputs alongwith considering their prices and quantities. The cost efficiency (CE) score asserted that farmers may potentially reduce their overall cost of sugarcane production, on an average, by 60% to produce the existing level of output at least cost. State wise analysis indicated technical inefficiencies of 4% for Punjab and 8% for Haryana followed by Andhra Pradesh (13%), Karnataka (17%) and Tamil Nadu (18%). Cost efficiencies (CE) of sugarcane for different states provide guidance to farmers that there is scope to reduce cost by 85% in Punjab and 66% in Maharashtra and other states in the range of 28 to 47% for producing sugarcane at least cost.The export of sugar from India has, increased during the period of investigation. This could have been possible on account of sincere efforts made by Union and state governments. It has also been perceived that state government machinery has also taken appreciable initiatives towards formation and implementation of state advised price (SAP) so as to make sugarcane cultivation more remunerative for farming community. Sugarcane is the prime material for production of all major sweeteners in the country and Government is adopting various initiatives to push up the production of sugarcane. There seems to be an important perspective for development of sugarcane in the country. It is pertinent to explain here that the resource use efficiency i.e., with the proper use of scarce resources such as land, labour, irrigation and fertilizers etc. the cultivation of sugarcane may be made more productive and profitable, which would certainly help in achieving the objective of doubling the farmers' income and also uplifting socio-economic status of poor peasants of India.

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