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Dynamics of sugarcane: Growth, instability, cost and returns

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Abstract

Sugarcane is a major cash crop in India and plays a crucial role in the country's economy. It provides direct and indirect employment possibilities along the sugarcane value chain, including cultivation, harvesting, transportation, processing and marketing. It is one of the primary sources of income for millions of farmers. The sugar business provides money and supports livelihoods, which aid in rural development and the reduction of poverty. There are many uses for sugarcane by products such as bagasse, molasses and press mud etc. The trends showed an increasing trend by 0.8%, 2.04%, 1.22% in area, production and productivity respectively. The instability indices for area, production and productivity for sugarcane in India were 7.90, 9.65 and 4.49 which indicates less risk in growing sugarcane crop in future. It was found that at the overall period, the area, production and productivity of sugarcane was highly consistent and stable. It was observed that the cost of cultivation of sugarcane per acre was Rs. 90327.54 out of this, 50.76 percent was variable cost. The average fixed cost per acre was Rs. 40617 which accounted for 89.94 percent of total cost of cultivation. The major items of fixed cost incurred by the farmers were, rental value of land accounting for Rs. 40000.00 per acre. The average yield of sugarcane was 60.8 tonne per acre. The average price realized by farmer respondents was Rs. 2833.33 per tonne of sugarcane. The gross returns on sugarcane production were Rs. 172266.5. Total cost was Rs. 90327.54 per acre. Hence, the net returns were Rs. 81938.96, due to high yield and better management practices adopted by the sugarcane growers. The analysis of cost and returns indicates that the net return per rupee of expenditure in sugarcane production was Rs. 1.91. As the ratio is above unity, the cost of cultivation could be considered as a profitable venture. In India's economy, agriculture, food production, energy sector, and cultural practices, sugarcane has a wide range of uses. It is an essential crop that supports the expansion, rural development, and sustainable agriculture of the nation.

Keywords: Trend, indices, area, production, productivity, cost and returns

Introduction

Saccharum officinarum, the scientific name for sugarcane, is a tall perennial grass in the Poaceae family. It is commonly grown for its high sugar content, which is extracted and utilised as a main source for the production of sugar, molasses, and several other sweetening goods. One of the most significant economic crops in many tropical and subtropical areas of the world is sugarcane. Sugarcane agriculture has been practised for a very long time; it is said to have originated in Southeast Asia. It soon spread to nations like India, China, Egypt, and Greece through trade routes and people migration to other areas of the world. Sugarcane was also brought to the Americas by European explorers and colonisers, where it flourished as a valuable cash crop during the colonial period. The distinctive feature of sugarcane plants is their long, jointed stalks, which can grow up to 6 metres (20 feet) in height. The juice from the thick, fibrous stalks has a significant amount of sugar in it. The plant's intricate root system aids in the soil's absorption of nutrients and water. Sugarcane is a lucrative and adaptable crop that has contributed significantly to human history and is still a key component of the world sugar industry. It is a widely grown plant with numerous uses in numerous industries because of its tall stalks, high sugar content, and various by-products.

Objective of the study

1. To analyse the growth in area, production and productivity of sugarcane crop in India.
2. To analyse the cost and returns of sugarcane crop in Belagavi District of Karnataka.

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Methodology

The secondary data was collected from Department of Agricultural and Farmers Welfare, Ministry of Agriculture and Farmers welfare, Government of India report. The study uses data from 2001–2002 to 2020-21 to examine the growth and volatility in the area, production, and productivity of sugarcane in Karnataka.

Compound annual growth rate analysis

The compound annual growth rate of sugarcane area, production and productivity in Karnataka and India is calculated using an exponential function of the form.

$$Y_t = A B^t u_t \quad (1)$$

Where,

Y_t = area, production and productivity of sugarcane in Karnataka and India

t = Year 1,2,.....,n

u_t = disturbance term for the year 't'

The equation (1) was transformed into a log linear form and written as

$$\text{Log } Y_t = \text{Log } A + t \text{ log } B + \text{log } u_t \quad (2)$$

Compound Annual Growth Rate was calculated as $g^{\wedge} = (b - 1) * 100$

Where,

g^{\wedge} = Estimated Compound Annual Growth Rate (%)

b = Antilog of B

Cuddy Della Valle Instability Index

Cuddy and Valle (1978) created the Cuddy- Della Valle index to measure the instability in time series data that is characterized by trend. The co-efficient of variation was calculated using the expression to investigate the stability of sugarcane crop area, production and productivity. The Cuddy Della Valle Index is used to measure the instability in this study. The Cuddy Della Valle index de-trends the given series first, indicating the direction of instability. The use of the coefficient of variation as a measure of instability in time series data has significant drawbacks. If the time series data show any trend, the variation assessed by coefficient of variation can be overstated, i.e., if coefficient of variation is used to quantify instability, the region with expanding output at a constant rate will score high in instability. In contrast, the Cuddy-Della Valle index uses coefficient of determination to de-trend the coefficient of variation.

The coefficient of variation (CV) is a statistical measure of data points' dispersion around the mean in a data series. The coefficient of variation is a useful statistic for assessing the degree of variation between two data series, even if the means are radically different. It indicates the ratio of the standard deviation to the mean.

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{\text{Mean}} * 100$$

The co-efficient of variation (%) was calculated to determine the extent of fluctuation in sugarcane crop area, production and productivity in terms of area and quantity over time. The instability index was also calculated to look at the volatility of

sugarcane crop area, production and productivity in Karnataka and India in terms of area and quantity over time using the following formula:

$$\text{Instability Index (I)} = \text{CV} * \sqrt{1 - \text{Adj } R^2}$$

Where,

CV = Coefficient of Variation

Adj R^2 = Coefficient of determination

The ranges of CDVI (Sihmar, 2014) are given as follows:

Low instability = between 0 and 15

Medium instability = greater than 15 and lower than 30

High instability = greater than 30

Sampling procedure

Selection of sample district

Belagavi district is well known for the production of sugarcane. It is one among the foremost important sugarcane growing district in Karnataka. Belagavi district stands 1st in area and production of sugarcane cultivation. Hence, Belagavi district has been purposively selected for the study.

Selection of sample taluk

Among the ten taluks in Belagavi district Athani and Chikkodi taluk stands 1st and 2nd in area and production of sugarcane cultivation respectively, hence these taluks were purposively selected for the study.

Nature and source of data

To examine the main objectives of the study, necessary primary data related to the production of sugarcane crop were collected from the sampled 60 sugarcane growers through personal interview method. Pre-tested schedule was used to collect information from the respondents or farmers. The data collected from the respondents include some area under sugarcane, cost of cultivation and returns.

Period of the study

The reference year of the study was 2021-22 and therefore the collection of the data was carried out during the period of January 2023.

Analytical tools and techniques

To fulfil the objectives of the study, based on the nature and extent of information, the subsequent techniques were utilized. Descriptive statistics tools were used.

Cost concepts in sugarcane

The total costs incurred towards cultivation of sugarcane by farmers were divided into three broad categories:

- a. Variable costs
- b. Fixed costs

Variable costs

The costs incurred on variable inputs such as human labour, cost of seedlings, farm yard manure, fertilizers, pesticides and interest on working capital.

The computations of various terms of variable cost elements are as follows:

1. **Seedlings:** The price of purchased seedlings was on the basis of the actual amount paid by the farmer.
2. **Farm yard manure:** The existing price per load of a

tractor was used to assign the value of farm yard manure produced on the farm.

- 3. Fertilizers and plant protection chemicals:** The cost of fertilizers and plant protection chemicals was on the basis of the actual prices paid by the farmers.
- 4. Labour:** The cost of hired labour was worked out at the existing wage rates paid per day (8hours) in the study area for men, women and machine labour during the study period.
- 5. Interest on working capital:** The working capital consists of the expenditure on machinery labour, human labour, seedlings, farm yard manure, fertilizers and plant protection chemicals. Interest on working capital was calculated at the rate of 7.5 percent per annum it is the rate at which commercial banks advance short term loans.

Fixed costs

These include depreciation on machinery and farm implements, land revenue, rental value of land and managerial cost.

Depreciation charges: Depreciation on each of the capital equipment and machinery owned by the respondent farmers was calculated, based on the purchase value using the straight-line method. Thus, the

Annual depreciation = Purchase Value-Junk value/ Useful life of the asset

The average life of an asset as indicated by each farmer was used in the computation of the depreciation. The average value of an asset after its economic life was considered based on the value furnished by the respondents. The deprecation cost of each equipment was apportioned to the crop, based on its percentage use.

Land revenue: Land revenue was charged at the rates levied by the government.

Rental value of land: It is taken based on yearly basis and based on the type of crops own.

Cost of cultivation

It is the sum of variable costs and fixed costs and expressed on per acre basis.

Total cost (TC)

Total cost is the sum of total variable cost (TVC) and total fixed cost (TFC).

- 1. Gross returns (GR):** Per acre gross returns were calculated by using the following formula.

$$\text{Gross Returns (GR)} = \text{yield} \times \text{price}$$

- 2. Net returns over variable costs:** It is the gross returns minus variable costs.

$$\text{Net returns over variable costs} = \text{GR} - \text{TVC}$$

- 3. Net returns over cost of cultivation:** It is the gross returns minus variable costs plus fixed costs.

$$\text{Net returns over cost of cultivation} = \text{GR} - (\text{TVC} + \text{TFC})$$

Returns per rupee of investment: Worked out by taking the ratio of gross return divided by total cost.

Returns per rupee of investment = Gross returns /Total cost

B:C Ratio

The benefit-cost ratio formula is the discounted value of the project's benefits divided by the discounted value of the project's costs:

BCR = Discounted value of benefits/ discounted value of costs.

Results and Discussion

Table 1: Trends in area, production, productivity of sugarcane crop in India during 2001-02 to 2020-21.

Sl. No.	Year	Area	Production (million tonnes)	Productivity (t/ha)
1	2001-02	44.1	297.2	67.4
2	2002-03	45.2	287.4	63.6
3	2003-04	39.4	233.9	59.4
4	2004-05	36.6	237.1	64.8
5	2005-06	42	281.2	66.9
6	2006-07	51.5	355.5	69
7	2007-08	50.6	348.2	68.9
8	2008-09	44.2	285	64.6
9	2009-10	41.7	292.3	70
10	2010-11	48.8	342.4	70.1
11	2011-12	50.4	361	71.7
12	2012-13	50	341.2	68.3
13	2013-14	49.9	352.1	70.5
14	2014-15	50.7	362.3	71.5
15	2015-16	49.3	348.4	70.7
16	2016-17	44.4	306.1	69
17	2017-18	47.4	379.9	80.2
18	2018-19	50.6	405.4	80.1
19	2019-20	46	370.5	80.5
20	2020-21	48.6	399.3	82.2
	CAGR	0.8058	2.0439	1.2284
	Mean	46.57	329.32	70.47
	SD	4.25	49.13	6.06
	R ²	0.25	0.58	0.73
	CV	9.12	14.92	8.60
	CDVI	7.90	9.65	4.49

*significant at 1 percent level of significance

**significant at 5 percent level of significance

***significant at 10 percent level of significance

The table 1 depicted the trends in area of sugarcane crop in India showed a increasing trend by 0.8 percent which is due to increase modern farming techniques such as precision agriculture, mechanization, and better irrigation systems. The trends in production of sugarcane crop in India showed an increasing trend by 2.04percent as it is the function of area and productivity. The productivity of sugarcane crop in India showed a positive trend by 1.22 percent as the demand for sugarcane and its by-products, such as sugar and ethanol, increases, farmers may expand their cultivated areas to meet the market demand. This expansion of sugarcane cultivation contributes to overall increases in production and productivity. The adoption of modern technology, such as satellite imagery, drones, and data analytics, has allowed farmers to make informed decisions about crop management. This technology helps in monitoring crop health, identifying stress factors, and taking timely corrective actions, leading to improved yields. The instability indices for area, production and productivity for sugarcane in India were 7.90, 9.65 and 4.49 which indicates less risk in growing sugarcane crop in future. It was found that at the overall period, the area, production and productivity of

sugarcane was highly consistent and stable. The area under sugarcane cultivation is increasing in India, the productivity and quality of sugarcane can vary across regions and farms. Factors such as proper crop management, pest control, disease management, and market access also play crucial roles in determining the success of sugarcane cultivation.

Table 2: Cost of cultivation of sugarcane (n=60) (Rs./acre)

Sl. No.	Costs	Value	Percentage (%)
1.	Variable Cost		
a	Seedlings (Rs.)	5568.36	12.14
b	FYM (Rs.)	9036.56	19.71
c	Fertilisers (Rs.)	13457.5	29.35
d	PPC (Rs.)	4436.48	9.68
e	Human labour (Rs.)	8758.66	19.10
f	Machine labour (Rs.)	1395.39	3.04
g	Total Working Capital	42652.95	
h	Interest of Working capital @ 7.5%	3198.971	6.98
	Total Variable Cost	45851.92	100.00
2.	Fixed Cost		
a	Depreciation	580.5	1.31
b	Land revenue	36.5	0.08
c	Land rent	40000	89.94
d	Total FC	40617	
e	Interest of fixed capital @ 9.5%	3858.615	8.68
	Total Fixed Cost	44475.62	100

It was observed that the cost of cultivation of sugarcane per acre was Rs. 90327.54 out of this, 50.76 percent was variable cost. The major variable cost was of fertiliser cost *i.e.*, Rs. 13457.50 (29.35%) followed by FYM cost, (Rs. 9036.56), human labour (Rs. 8758.66), seedling (Rs. 5568.36), PPC (Rs.4436.48), interest of working capital (Rs. 3198.97), machine labour (Rs. 1395.39), marketing cost (Rs. 24.05) and plant protection chemicals (Rs. 693.66), respectively.

Hence the results clearly indicate that the share of variable cost to the total cost was high. The other major components of variable cost is the fertiliser and farm yard manure. This was because now a days the sugarcane growers are more focused on high yield. So, the farmers put more of ferlisers.

The average fixed cost per acre was Rs. 40617 which accounted for 89.94 percent of total cost of cultivation. The major items of fixed cost incurred by the farmers were, rental value of land accounting for Rs. 40000.00 per acre which formed (89.94%) it is due to the value of land in use. The depreciation charges of pump sets and other implements accounted for Rs. 580.5 (1.31%) and land revenue Rs. 36.5 per acre (0.08%), managerial cost was taken at 9.50 percent of the working capital *i.e.*, Rs. 3858.62 per acre (8.68%) based on the interest charged by the banks in the study area.

Yield and returns

Table 3: Yield and returns from marigold cultivation (n=60)

Sl. No.	Particulars	Values
1.	Yield (ton)	60.8
2.	Price (Rs. /ton)	2833.33
3.	Gross return (Rs. /acre)	172266.5
4.	Total cost (Rs.)	90327.54
5.	Net return (Rs.)	81938.96
6.	Benefit cost ratio	1.91

The average yield, gross and net returns per acre of sugarcane among the sample farmers are represented in Table 3. The table indicated that the average yield of sugarcane was 60.8 tonne per acre. The average price realized by farmer respondents was Rs. 2833.33 per tonne of sugarcane. The gross returns on sugarcane production were Rs. 172266.5. Total cost (which include TVC+TFC) was Rs. 90327.54per acre. Hence, the net returns were Rs. 81938.96, due to high yield and better management practices adopted by the sugarcane growers.

The analysis of cost and returns indicates that the net return per rupee of expenditure in sugarcane production was Rs. 1.91. As the ratio is above unity, the cost of cultivation could be considered as a profitable venture.

Conclusion

Number of factors have contributed to an increase in sugarcane productivity and area output. Precision agriculture, mechanisation, and improved irrigation systems, among other improvements in farming methods, have increased productivity and efficiency. High-yielding sugarcane cultivars that are disease-resistant and more adapted to the environment have been developed as a result of research and development initiatives. Growth and yields have been optimised through better crop management techniques such soil testing, nutrient management, and pest control. The use of technology has made it possible for farmers to make wise judgements and move quickly to increase productivity. Examples include satellite images and data analytics. Investment in cutting-edge farming machinery and high-quality inputs has also been encouraged by government support in the form of credit facilities, subsidies, and incentives. Additionally, the development in overall production and productivity has been aided by the expansion of farmed areas brought on by an increase in consumer demand for sugarcane and its by-products. Together, these elements along with regional differences and regulations have contributed to rising sugarcane productivity and area production.

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