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## Growth and total factor productivity change of cumin in Gujarat

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**Abstract**

This paper has analysed the growth in TFP of cumin crop and temporal change in economic aspect in Gujarat state from 1995-96 to 2015-16 [4]. The Tornqvist Theil Index has been used to calculate the total output index, total input index and TFP index. Two outputs and ten inputs have been used to construct output and input indices. The results revealed that during 1995-96 to 2015-16 the area, production and yield of cumin in Gujarat were increased at remarkable rate of 6.4, 10.24 and 3.58 per cent per annum. It has also registered moderate growth rates of output indices and TFP indices about 2.94 and 1.46 per cent per annum, respectively in last two decades. The growth in TFP remained low about 0.99 per cent per annum during 1995-96 to 2004-15, this improved considerably about 1.51 per cent per annum during 2004-15 to 2015-16. This was contributed by the release of high yielding varieties in Gujarat i.e. MC-43 in 1970, GC-1 in 1982, GC-2 in 1992 and GC-4 in 2003, evolved by the Gujarat Agricultural Universities, which are performing well in the state. Similar results was also reported by Gami and Dhandhalya (2013) that the output, input and TFP indices of cumin were increased at the rate of 2.31, 0.66 and 1.64 per cent per annum during 1990-91 to 2011-12. Net income of cumin crop was increased during second period i.e. 2005-06 to 2015-16 by 121 per cent and 7.66 per cent in case of without and with deflation, respectively. It essential that growth in TFP needs to be sustained and further improvement, through varietal improvements, irrigation developments and adopting proper agronomical practices.

**Keywords:** Cumin, TFP growth, research, investment, return, Gujarat

**Introduction**

Agriculture and allied sectors have been the most important drivers in the economic development of the developing countries including India. Although agriculture is the most important sector in the Indian economy, the patterns of the agricultural activities vary widely across the regions of the country as well as within the states. This is mainly because of the wide variation in the soil type, rainfall pattern, monsoon variation and so on. Unlike the industrial production, agriculture suffers from high volatility in the production as it complexly depends on the natural parameters like rainfall. India has always been known as land of spices. The term spices refer to such natural plants or vegetable products or mixtures in whole or ground form and are used for imparting flavour, aroma and piquancy to and for seasoning of foods. Spices may consist of different parts such as floral parts (clove, saffron), or fruits (cardamom, chillies) or berries (black pepper) or seeds (cumin, celery, coriander) or rhizome (ginger, turmeric) or roots (horse radish) or leaves (mints, tejpat) or kernal (nutmegs) or aril (mace) or bark (cinnamons) or bulbs (garlic, onion) or any other part of spice plants. There are about 70 spices grown in different parts of the world. In India, however, the major spices are pepper, cardamom, ginger, turmeric and chillies. India is also the largest consumer of spices. Commercial cultivation in India is undertaken on 27 spices besides the herbal spices. In India, spices crops occupies about 3.67 million ha area and production touched to 8.12 million tonnes in 2016-17, of which Gujarat contributed about 14.34 per cent area (0.53 million ha) and 11.37 per cent in production (0.92 million tonnes). Spices crops have vast potentialities of export earnings. During the year 2016-17 about 948 thousand tonnes of spices and spice products worth of Rs. 17665 crores have been exported from the country (Spices Board, 2017) [3]. Cumin (*Cuminum cyminum*) is grown throughout India covering an area of about 690 thousand ha and production of about 445 thousand tones of which Gujarat contributed about 54 per cent in area (370 thousand ha) and 62 per cent in production (280 thousand tones) in 2013-14. Thus, Gujarat emerged as the highest cumin producing state in India contributing more than half of nation's production. It is imperative to look at current research efforts and their accuracy in order to address emerging regional research needs. Faced with limits to further expansion of cultivated land and slowing returns to further input intensification productivity growth assumes a central role in meeting the challenges of the future.

The most comprehensive measure of aggregate or sectoral productivity is TFP. TFP is measured as the rate of index of total output to index of total factor inputs and encompasses the impact of technical change as well as change in the level of all inputs. Thus, TFP trend indicates whether production growth is taking place in a cost effective and sustainable manner or not. In view of the above, the present study was undertaken with the specific objectives *viz.*, to measure the temporal changes in area, production and productivity of fennel crop of Gujarat; to estimate the growth of Total Factor Productivity and to analyse the temporal changes in economic aspects of fennel crop in Gujarat.

### Methodology and database

The study covers Gujarat state, located on the Western cost part of India, which has one third of coastline of the country and ranks second in spice crop production. Commensurate with the objectives, total factor productivity (TFP) and growth rates of inputs and output were worked out. The data on inputs, output and prices of spice crop collected under the scheme on "Farm cost studies" and the "Scheme for creating permanent machinery for studying the cost of cultivation/production of principal crops grown in Gujarat state" Department of Agricultural Economics, Junagadh Agricultural University, Junagadh. Period consider under study from 1995-96 to 2015-16 this period is divided into two period i.e. period-1 from 1995-96 to 2004-05 and period-2 from 2005-06 to 2015-16. The Tornqvist Theil index was used for computing the total output index, total input index and total factor productivity index. The Divisia indices have two important attractive properties: (i) they satisfy the time reversal and factor reversal test for index numbers, and (ii) it is a discrete of the components, so that aggregate could be obtained by the aggregation of sub-aggregates (Kumar *et al*, 2008). An index of total factor productivity (TFP) compares changes in output with changes in aggregate inputs. In the present study also, the Tornqvist Theil index was used for computing the total output index, total input index and total factor productivity index. These indices were calculated as follows:

### Total Output Index (TOI):

Total output indices were constructed using the Tornqvist Theil index approach as follows:

$$TOI_t / TOI_{t-1} = \prod_j (Q_{jt} / Q_{j,t-1})^{(R_{jt} + R_{j,t-1})/2}$$

### Total Input Index (TOI):

$$TII_t / TII_{t-1} = \prod_j (X_{it} / X_{i,t-1})^{(S_{it} + S_{i,t-1})/2}$$

Where,

$Q_{jt}$  = Output of  $j^{\text{th}}$  crop in  $t^{\text{th}}$  year.

$Q_{j,t-1}$  = Output of  $j^{\text{th}}$  crop in  $(t-1)^{\text{th}}$  year.

$R_{jt}$  = Output share of  $j^{\text{th}}$  crop in total revenue in  $t^{\text{th}}$  year.

$R_{j,t-1}$  = Output share of  $j^{\text{th}}$  crop in total revenue in  $(t-1)^{\text{th}}$  year.

$X_{it}$  = Quantity of  $i^{\text{th}}$  input used in  $j^{\text{th}}$  crop in  $t^{\text{th}}$  year.

$X_{i,t-1}$  = Quantity of  $i^{\text{th}}$  input used in  $j^{\text{th}}$  crop in  $(t-1)^{\text{th}}$  year.

$S_{it}$  = Share of input 'i' in total input cost in  $t^{\text{th}}$  year.

$S_{i,t-1}$  = Share of input 'i' in total input cost in  $(t-1)^{\text{th}}$  year.

In the case of TFP for a single crop, revenue share refers to the share of main product and by-product in total revenue from the crop, while output includes main product and by-product. Thus, total output and input indices for cumin crop were prepared taking 1995-96 as the base year. The input data available only in value terms has been converted into quantity

indices by dividing with its respective price indices. Input has been aggregated using their farm rental prices.

### Total Factor Productivity Index (TFPI)

Total factor productivity indices was computed as the ratio of total output index (TOI) to total input index (TII).

$$TFPI_t = (TOI_t / TII_t) \times 100$$

The estimation of input, output and TFP growth rates for any specified was done by fitting an exponential (or semi-log) trend equation to the three-yearly moving averages of input, output and TFP indices, respectively.

### Economic aspect

The study were used the cost of cultivation data during 1995-96 to 2015-16 compiled from various sources and publications for profitability analysis of cumin crop. The CACP uses different cost concepts for estimating costs and returns. In the present study, the cost  $C_2$  was considered for computing profitability. The cost  $C_2$  in CACP data covers all the variables and fixed costs. To see how the costs and returns have been changed in real terms, costs was deflated by the Consumer Price Index for Agricultural Labourers (CPIAL) with 1995-96 as base (Narayanamoorthy, 2013)<sup>[6]</sup>. The profitability was computed in the form of income measures.

**The income measures:** These was worked out to compute profitability;

1. Farm business income = Gross return - Cost  $A_1$
2. Family labour income = Gross return - Cost B
3. Net income = Gross return - Cost  $C_2$
4. Intensive income = Net income + Rental value of owned land + Interest of fixed capital
5. Farm investment income = Farm business income - Imputed value of family labour

Where,

Cost A = All operating costs *i.e.* human labour, bullock labour, seeds, manures, fertilisers, irrigation, insecticides and pesticides, miscellaneous costs, *etc.*

Cost B = Cost A + interest on value of fixed capital (excluding land) + rental value of owned land

Cost  $C_1$  = Cost B + imputed value of family labour

Cost  $C_2$  = Cost  $C_1$  plus 10 per cent of cost  $C_1$  as a managerial charges

### Results and Discussions

Gujarat economy is basically considered to be crop economy. For the rural economy in general, small and marginal farmers in particular, the crop diversification has been largely considered as a ray of hope for their economic gift. The change in cropping pattern is attributed mainly avoiding risk and uncertainty due to climatic and biological vagaries and also maximising total farm output.

### Temporal changes in area, production and productivity

Table 1 represents the temporal changes in area, production and productivity of cumin crop in Gujarat. The change in area, production and productivity of cumin crop in Gujarat was examined for the period from 1995-96 to 2016-17. It can be seen from the table that the average area under cumin crop was also increased significantly from 10.8 thousand hectares in 1994-97 to 27.3 thousand hectares in 2014-17. The percentage increased in area in first decade was 82.76 per

cent, while in second decade it was 37.87 per cent. Similarly, in case of production of cumin crop was increased in all the decades. The production of cumin crop was increased by 100 per cent in first decade and in second decade by 118.58 per

cent. In case of productivity of cumin crop was increased in all the decades. The productivity of cumin crop was increased by 9.72 per cent in first decade and in second decade by 57.93 per cent.

**Table 1:** Temporal changes in area, production and productivity of cumin crop in Gujarat from 1995-96 to 2016-17.

Period	Particulars	Absolute change over previous decade	Percentage change over previous decade
<b>Area ('000 ha)</b>			
1994-97	108	--	--
2004-07	198	90	82.76
2014-17	273	75	37.87
<b>Production ('000 tonnes)</b>			
1994-97	49	--	--
2004-07	99	49	100
2014-17	216	117	118.58
<b>Productivity (kg/ha)</b>			
1994-97	456	--	--
2004-07	500	44	9.72
2014-17	790	290	57.93

*Source:* Director of Horticulture, Gujarat State, Gandhinagar, 2017.

### Growth rates of area, production and productivity of cumin crop

The results of compound annual growth rates of area, production and productivity of cumin crop in Gujarat are given in Table 2. The growth rates in area, production and productivity of cumin in Gujarat found positive and statistically highly significant i.e. 6.40, 10.24 and 3.58 per cent per annum, respectively during 1995-96 to 2016-17. The cumin area and production recorded positive growth rate of 7.05 and 7.51 per cent per annum, respectively during 1995-96 to 2004-05. In second decade positive growth rates were observed for area, production and productivity but not statistically significant. Thus, in last decade there was considerable improvement in productivity of cumin crop in Gujarat.

**Table 2:** Compound annual growth rates of area, production and productivity of cumin crop in Gujarat for the period 1995-96 to 2016-17.

Crop	Period	Area	Production	Productivity
Fennel	1995-96 to 2004-05	7.05**	7.51**	0.34
	2005-06 to 2016-07	3.44	8.64	5.01
	1995-96 to 2016-17	6.40**	10.24**	3.58**

**Note:** \*\* and \* Significant at 1 per cent and 5 per cent level.

### Growth in output, input and TFP indices of cumin

Measurement of productivity is an important and necessary step to understand in context of agricultural economics. There are various measures such as labour productivity, capital productivity, etc. Among them total factor productivity is a comprehensive measure of productivity and has gained acceptance as such among government officers, policy makers, productivity specialists and economists. The

production changes were pertained to the time series of 1995-96 to 2015-16 for cumin crop in Gujarat state, India. This period is further dividing into sub-periods viz., 1995-96 to 2004-05 and 2005-06 to 2015-16. The compound annual growth rates of total output indices and total input indices are 2.94 and 1.46 per cent per annum, respectively whereas, growth rate of TFP indices was increased at the rate of 1.46 per cent per annum. It may be inferred from these results that faster rate of total output growth than total input growth resulted in positive growth of total factor productivity. The decade wise results of output indices, input indices and TFP of cumin crop are also presented in Table 3. During the Period – 1 the compound annual growth rate of total output indices increased at the rate of 0.90 per cent per annum and total input indices was declined at the rate of -0.09, as a result of which total factor productivity of cumin crop increased at the lower rate of 0.99 per cent per annum. During the Period-2 the compound annual growth rate of total output index at a remarkable rate of 4.26 per cent per annum and total input indices increased at the rate of 2.70 per cent per annum. As a result of which, total factor productivity of cumin crop increased at the rate of 1.51 per cent per annum. TFP increases at higher rate during second period as compare to first period, which implies that technological change creates positive effects on production of cumin crop. This might be due to the cumin varieties MC-43 in 1970, GC-1 in 1982, GC-2 in 1992 and GC-4 in 2003, evolved by the Gujarat Agricultural Universities, which are performing well in the state. Similar results was also reported by Gami (2013) that the output, input and TFP indices of cumin were increased at the rate of 2.31, 0.66 and 1.64 per cent per annum during 1990-91 to 2011-12.

**Table 3:** Annual growth rate in input use, output and TFP for cumin crop in Gujarat: 1995-96 to 2015-16 (in per cent)

Period	Output Growth	Input growth	TFP growth	Share of TFP in output growth
<b>Based on three - year moving averages</b>				
1995-96 to 2004-05	0.90	-0.09	0.99	109.70
2005-06 to 2015-16	4.26	2.70	1.51	35.60
1995-96 to 2015-16	2.94	1.46	1.46	49.63

### Temporal changes in economic aspects of cumin crop

Table 4 and 5 represents temporal changes in economic aspects of cumin crop without and with deflation in Gujarat

state during 1995-96 to 2015-16. The results revealed that the farm business income has increased during second period as compared to first period and for overall period also, which is

Rs. 34,421. Family labour income was increased during second period as compared to first period and for overall period too, which is Rs. 28,344. Net income during first period was Rs. 13416 during second it was Rs. 29,677 and for overall period was Rs. 22,286. Intensive income during first, second and overall periods were Rs. 17,456, Rs. 37,450 and Rs. 28,364, respectively. Farm investment income was increased during second period as compared to first and for overall period, which is Rs. 30,386. The results of change in economic aspects with base period 2010-11 are given in Table 5. Farm business income was increased during second period as compared to first period and for overall period i.e. Rs.

40,625. Family labour income was increased during second period as compared to first period and for overall period i.e. Rs. 33,106. Net income during first, second and overall periods were Rs. 25,464, Rs. 27,417 and Rs. 26,530, respectively. Intensive income during first period was Rs. 33,422, during second period it was Rs. 34,569 and for overall period it was Rs. 34,048. Farm investment income was increased during second period as compared to first and for overall period, i.e. Rs. 35,900. Net income was increased during second period by 121 per cent and 7.66 per cent in case of without and with deflation, respectively.

**Table 4:** Temporal changes in economic aspect (without deflation) of cumin crop in Gujarat state during 1995-96 to 2015-16 (Rs./ha).

Periods	Farm business income	Family labour income	Net income	Intensive income	Farm investment income
First	19694 (100)	15651(100)	13416 (100)	17459 (100)	17460 (100)
Second	46695 (137)	38921(148)	29677 (121)	37450 (114)	41158 (135)
Overall	34421	28344	22286	28364	30386

**Table 5** Temporal changes in economic aspect (with deflation) of cumin crop in Gujarat state during 1995-96 to 2015-16 (Rs./ha).

Periods	Farm business income	Family labour income	Net income	Intensive income	Farm investment income
First	37771(100)	29814(100)	25464(100)	33422(100)	33423(100)
Second	43002(13.8)	35850(20.24)	27417(7.66)	34569(3.43)	37979(13.63)
Third	40625	33106	26530	34048	35900

## Conclusion

The study has used farm-level data collected under the Cost of Cultivation Scheme for the period from 1995-96 to 2015-16 and analysed using Tornqvist-Theil Index for constructing aggregate output and aggregate input of the crop. The analysis of growth in TFP of cumin in Gujarat shows it has registered a low productivity growth during 1995-96 to 2004-05. Vitality increased, during 2005-06 to 2015-16 and registered positively significant growth in TFP throughout last two decades, though it is frequently constrained by adverse weather and moisture stress. This might be due to the cumin varieties MC-43 in 1970, GC-1 in 1982, GC-2 in 1992 and GC-4 in 2003, evolved by the Gujarat Agricultural Universities, which are performing well in the state. The cumin crop is also found to be giving good returns to the cultivators. It is essential that more public and private investments on technology improvement and development of irrigation infrastructure in the state through a favourable policy environment to sustain and further increase in TFP growth.

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