GROWTH OF TOTAL FACTOR PRODUCTIVITY OF MAJOR SEED SPICES IN GUJARAT

ABSTRACT

The present investigation entitled "Growth of Total Factor Productivity of Major Seed Spices In Gujarat" was carried out to study the growth of input, output indices and total factor productivity of major seed spices of Gujarat. The Tornqvist-Theil index was employed to calculate the total output index, total input index and total factor productivity index. The total output indices were derived using 2011-12 as the base period and adjusted to obtain the TOI for major seed spices. In cumin, the growth rate of TFP indices was positive, approximately 1.09 per cent per annum. In fennel, the TFP indices exhibited a negative growth rate of approximately -3.96 per cent per annum. In coriander, the TFP indices demonstrated a significant growth rate of 1.94 per cent per annum, indicating moderate TFP growth for coriander in Gujarat.

Keywords: Tornqvist-Theil index, Base period, Total output indices

Introduction

India has long been renowned as the land of spices. The term "spices" encompasses natural plants, vegetable products or mixtures, whether in whole or ground form, used to enhance flavour, aroma and zest in food preparation. No other nation matches India in the diversity and volume of spice production.India's dominance in spice production can be attributed to its favourable environmental conditions. The moderate Indian climate provides an ideal setting for the cultivation of a wide range of spices. Spices hold significant economic importance in India, serving both domestic consumption and export markets. Apart from flavouring foods, spices are extensively utilized in various sectors such as medicine, pharmaceuticals, perfumery and cosmetics. The country exports substantial quantities of spices to numerous other nations, contributing to its export earnings.

Seed spices serve multiple purposes, not limited to enhancing the flavour and seasoning of food; they are also utilized in various cosmetic, perfumery and pharmaceutical applications. With increasing global health consciousness, there is a growing demand for organically produced seed spices due to their lack of chemical residues and associated health risks.

Spices have held significant importance since ancient times, dating back to approximately 5000 years before Christ. The spice trade boasts a legacy spanning 5000 years, highlighting

the enduring significance of spices. They remain among the most economically and commercially significant agricultural crops globally (Thummar *et al.*, 2019). Gujarat stands out as a leading producer of seed spices, particularly fennel, coriander, cumin and dill. Notably, in the arid Kachchh region of Gujarat, these crops thrive even in saline soils with limited water availability, owing to their lower water requirements compared to traditional crops.

The total factor productivity (TFP) stands as the most encompassing measure of aggregate or sectoral productivity. It quantifies the ratio of the index of total output to the index of total factor inputs, encapsulating the influence of both technical advancements and alterations in input levels. (Chand *et al.*, 2011). Therefore, the trend in TFP indicates whether production growth is occurring in a manner that is both cost-effective and sustainable. (Dhandhalya *et al.*, 2019).It serves as a valuable tool for analyzing and comprehending agricultural productivity growth enabling the separation of the impact of inputs from factors such as technology, infrastructure and farmer's knowledge. Over the past four decades, numerous studies on agricultural productivity in India have employed the TFP approach.

Methodology

Area of study

Gujarat is the leading state in production of seed spice in whole India. It shares 9.127 per cent share of annual spices production of India in the year 2021-22 (Source: Department of Agriculture, Cooperation and Farmers Welfare, GOI Year) and Gujarat is a major state in export of seed spices in whole world. So, the major seed spices producing districts of Gujarat was selected purposively on basis of their highest triennium average area of cultivation in Gujarat.

Selection of crops

The present study was carried out for major seed spice crops grown in Gujarat. For this study cumin, fennel and coriander crops were selected. Cumin, fennel and coriander was selected based on highest triennium average of area and the data availability of input indices.

Table 1: Triennium average of area and production of seed spices in Gujarat (2019-20 to 2021-22)

Crop	Area		Production	
	Area (“00”ha.)	% Share of area	Production (“00”MT)	% Share in production
Cumin	**4209.79**	**62.38**	**3321.04**	**31.71**
Coriander	**1177.50**	**17.45**	**1785.30**	**17.05**

Fennel	**406.54**	**6.02**	**722.33**	**6.90**
Ajwain	165.00	2.44	170.80	1.63
Fenugreek	79.70	1.18	151.00	1.44
Other spices	590.90	8.76	4227.89	40.37
Total spices	6749.10	100.00	10473.00	100.00

(Source: Directorate of Agriculture, Department of Agriculture, Farmer's welfare and Cooperation, Gandhinagar. Available at www.dag.Gujarat.gov.in. GOG, 2019-20 to 2021-22)

Analytical procedure

As per the objectives of the study the following different statistical techniques was applied:

Total factor productivity analysis

In the present study, the Tornqvist Theil index was used for computing the total output index, total input index and total factor productivity index. These indices are calculated as follows:

Total output index (TOI)

$TOI_t / TOI_{t-1} = \pi_j (Q_{jt}/Q_{jt-1})^{(R_{jt} + R_{jt-1})1/2}$ …….(1)

$TOI_{t.}$ = Total output index in t^{th}year

$TOI_{t-1.}$ = Total output index in $(t-1)^{th}$year

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

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

$R_{jt.}$ = The percentage of total revenue generated by the j^{th} crop in the current year (t)

R_{jt-1} = The proportion of revenue generated by the j^{th} crop in the total revenue in the previous year (t-1)

Where,

R_{jt}will be calculated as follows:

R_{jt} = Value of j^{th} crop output in t^{th}year / Aggregate crop output value in t^{th} year

$$R_{jt} = Q_{jt} \times P_{jt} / \sum_{j=1}^{n} Qjt \times Pjt$$

Where,

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

P_{jt} = Post farm harvest price of j^{th} crop in t^{th} year

Thus, total output indices was worked out taking 2011-12 as the base period and was multiplied to arrive TOI for major seed spices. The output index included the main product as well as by product. Farm harvest price (FHP) was used to aggregate the output.

Total input index (TII)

TII_t = Total input index in t^{th}year

TII_{t-1} = Total input index in $(t-1)^{th}$year

$Xi_{t.}$ = The amount of the i^{th} input utilized in the cultivation of the j^{th} crop in the current year (t)

$Xi_{t-1.}$ = The quantity of the i^{th} input employed in cultivating the j^{th} crop in the previous year (t-1)

Si_t = The proportion of input 'i' in the total input expenditure in the t^{th}year.

Si_{t-1} = The proportion of input 'i' in the total input expenditure in the $(t-1)^{th}$ year

$$TII_t / TII_{t-1} = \pi_i (X_{it}/X_{it-1})^{(S_{it} + S_{it-1})1/2} \quad \text{…….(2)}$$

Where, incomplete ??????????

Data on input quantities are only accessible for certain inputs, namely seed, fertilizer, manure, human labour and bullock labour. Therefore, input quantity indices was worked out directly for each of them. However, data for inputs such as irrigation charges, insecticides, machine labour, rental value of land and other expenses paid out was only available in terms of value. Therefore, an indirect approach was employed to calculate their quantity indices. First, their value indices was prepared which was then divided with respective price indices. Due to non-availability of such regional price indices, all India wholesale price indices for pesticides, pump driven irrigation and all commodities was used under the assumption that the price of proxy inputs represents the price of these inputs and the relative price structure remaining the same. Input was aggregated using their farm rental prices. (Kumar and Mruthyunjaya, 1992; Kumar and Rosegrant, 1994; Chand *et al.,* 2011)

S_{it} was calculated as follows:

S_{it} = Value of i^{th} crop input in t^{th}year / total input cost in t^{th} year

$$S_{it} = X_{it} \times P_{it} / \sum_{i=1}^{n} X_{it} \times P_{it} \quad \text{.....(3)}$$

Where,

X_{it}= Quantity of i^{th} input in t^{th} year

P_{it} = Farm rental price of i^{th} input in t^{th} year

Thus, input indices for individual inputs was prepared taking 2011-12 as the base year and was multiplied to arrive at the total input index of crop.

Total factor productivity index (TFPI)

TFPI was computed as the ratio of total output index (TOI) to total input index (TII).

$$TFPI_t = (TOI_t / TII_t) \times 100 \quad \text{…….(4)}$$

Results and Discussion

The present study computed the total factor productivity (TFP) growth of major seed spices in Gujarat and analyzed the factors influencing it at the state level. The analysis included two outputs (main product and by-product) and ten inputs (human labour, bullock labour, seed, manure, fertilizers, irrigation, insecticide/pesticide, miscellaneous costs, depreciation and rental value of land) to construct output and input indices. To explore potential policy implications for enhancing productivity of major seed spices in Gujarat which significantly contributes to the state economy, it is crucial to understand the growth patterns of these seed spices output and input. The study analyzed 12 years of data on spices output and input, covering the period from 2010-11 to 2022-23.

Negative growth occurs when TFP growth is less than zero. Stagnant growth is characterized by TFP growth that is positive but less than 0.5 per cent. Low growth is defined as TFP growth ranging from 0.5 to 1 per cent. Moderate growth is identified when TFP growth is greater than 1 per cent but does not exceed 2 per cent. High growth is observed when TFP growth surpasses 2 per cent.(Chand *et al.*, 2011)

Table 2 delineate the total input, total output and total factor productivity (TFP) indices for cumin from 2010-11 to 2022-23. The output indices of cumin oscillated between 116.48 per cent in 2011-12 to 108.08 per cent in 2022-23 while the input indices fluctuated between 108.78 per cent in 2011-12 to 91.80 per cent in 2022-23. Over the study period, the output indices surpassed 100 per cent in all 12 years, whereas the input indices exceeded 100 percent in 4 years. The TFP index, which is the ratio of the output index to the input index, consistently surpassed 100 per cent in all the years from 2011-12 to 2022-23. The annual compound growth rates of total output indices and total input indices were per cent -0.07 and -1.15 per cent respectively. However, the growth rate of TFP indices was positive, approximately 1.09 per cent per annum. This positive TFP growth was attributed to the relatively moderate growth rate of total outputs compared to total inputs in these years.

It is observed that there is considerably lower seed rate requirement per hectare in the study period, decreasing manure and fertilizer requirement, reduced cost of bullock pair days, falling cost of depreciation and manure and increase in value of rental value of land that led to increase in output indices considerably and simultaneously decreasing the value of input indices which led to moderate growth of TFP in the study period. It is plausible that the enhanced performance of cumin crops can be attributed to the introduction of distinct

varieties such as MC-43 in 1970, GC-1 in 1982, GC-2 in 1992, GC-3 and GC-4 in 2003 which have undergone evolutionary refinement under the auspices of Gujarat Agricultural Universities. This notion finds corroboration in the findings of Gami (2013), wherein it was elucidated that from 1990-91 to 2011-12, there was a notable augmentation in the output, input and total factor productivity (TFP) indices of cumin with growth rates standing at 2.31 per cent, 0.66 per cent and 1.64 per cent per annum, respectively.

Table 3 delineate the total input, total output and total factor productivity (TFP) indices for the fennel spanning the years 2010-11 to 2022-23. During this period, the output indices for the fennel oscillated between 103.39 per cent in 2011-12 to 100.00 per cent in 2022-23. The input indices fluctuated from a low of 100.37 per cent in 2011-12 to a high of 145.08 per cent in 2022-23. Over these 12 years, the output indices surpassed the 100 percent mark in 8 instances whereas the input indices exceeded this benchmark in all 12 years. The variance in input indices was also considerably narrower compared to that of the output indices.

Furthermore, the total factor productivity indices remained above 100 percent in 4 instances of the entire study period, indicating that the input indices were equally higher than the output indices from 2015-16 to 2022-23. The annual compound growth rates for the total output indices and total input indices were -0.50 per cent and 3.61 per cent respectively. In contrast, the TFP indices exhibited a negative growth rate of approximately -3.96 per cent per annum. This decline in TFP growth was attributable to the relatively accelerated growth rate of total inputs in comparison to total outputs from 2015-16 to 2022-23.

This decrease in fennel yield in Gujarat can primarily be attributed to the escalating man-days required of hired laborers, accelerating cost of irrigation and manures requirement for the field. Furthermore, the implementation of advanced technologies like drip irrigation and improved farm management practices should be incorporated for productivity enhancement in the state.

Table 4 exhibit the total input, total output and total factor productivity (TFP) indices for coriander crop spanning the period from 2010-11 to 2022-23. During this period, the output indices for coriander ranged from 101.28 per cent in 2011-12 to 100.16 per cent in 2022-23. The input indices varied between 96.09 per cent in 2011-12 to 80.94 per cent in 2022-23. Output indices exceeded 100 percent in 5 out of the 12 years, whereas all input indices remained below 100 percent.

Table 2: **Input, output and TFP indices of cumin in Gujarat for the year 2010-11 to 2022-23**

Year	Total input index	Total output index	TFP
2010-11	100.00	100.00	100.00
2011-12	108.78	116.48	107.08
2012-13	97.55	112.20	115.02
2013-14	99.31	124.09	124.95
2014-15	98.43	115.21	117.05
2015-16	102.92	115.06	111.79
2016-17	100.31	120.44	120.07
2017-18	101.90	115.37	113.22
2018-19	91.32	116.96	128.08
2019-20	93.56	129.64	138.56
2020-21	92.50	124.56	134.66
2021-22	93.84	112.20	119.57
2022-23	91.80	108.08	117.74
CGR	**-1.15**	**-0.07**	**1.09**

The total factor productivity (TFP) index defined as the ratio of the output index to the input index, remained above 100 percent except for the year 2012-13. This indicates that input indices were lower than output indices in 11 of the 12 years, with 2012-13 being the exception preferably due to increase in the rental value of land in this year. The annual compound growth rates of the total output indices and total input indices were 1.34 per cent and -0.59 per cent per annum respectively. In contrast, the TFP indices demonstrated a significant growth rate of 1.94 per cent per annum, indicating robust TFP growth for coriander in Gujarat.

Table 3:Input, output and TFP indices of fennel in Gujarat for the year 2010-11 to 2022-23

Year	Total input index	Total output index	TFP
2010-11	100.00	100.00	100.00
2011-12	100.37	103.39	103.01
2012-13	111.20	117.22	105.41
2013-14	117.31	119.57	101.93
2014-15	110.30	118.81	107.72
2015-16	133.72	98.13	73.38
2016-17	136.94	100.35	73.28
2017-18	136.43	130.57	95.70
2018-19	153.63	116.53	75.85
2019-20	146.34	94.95	64.89
2020-21	147.76	99.86	67.58
2021-22	149.15	124.41	83.41
2022-23	145.08	100.00	68.93
CGR	**3.61**	**-0.50**	**-3.96**

Table 4:Input, output and TFP indices of coriander in Gujarat for the year 2010-11 to 2022-23

Year	Total input index	Total output index	TFP
2010-11	100.00	100.00	100.00
2011-12	96.09	101.28	105.40
2012-13	88.13	68.25	77.45
2013-14	84.25	94.62	112.32
2014-15	76.77	92.74	120.81
2015-16	79.93	91.14	114.02
2016-17	73.98	96.51	130.46
2017-18	85.27	96.85	113.58
2018-19	82.65	100.09	121.10
2019-20	82.51	104.81	127.02
2020-21	86.66	105.55	121.80
2021-22	82.33	87.74	106.58
2022-23	80.94	100.16	123.74
CGR	**-0.59**	**1.34**	**1.94**

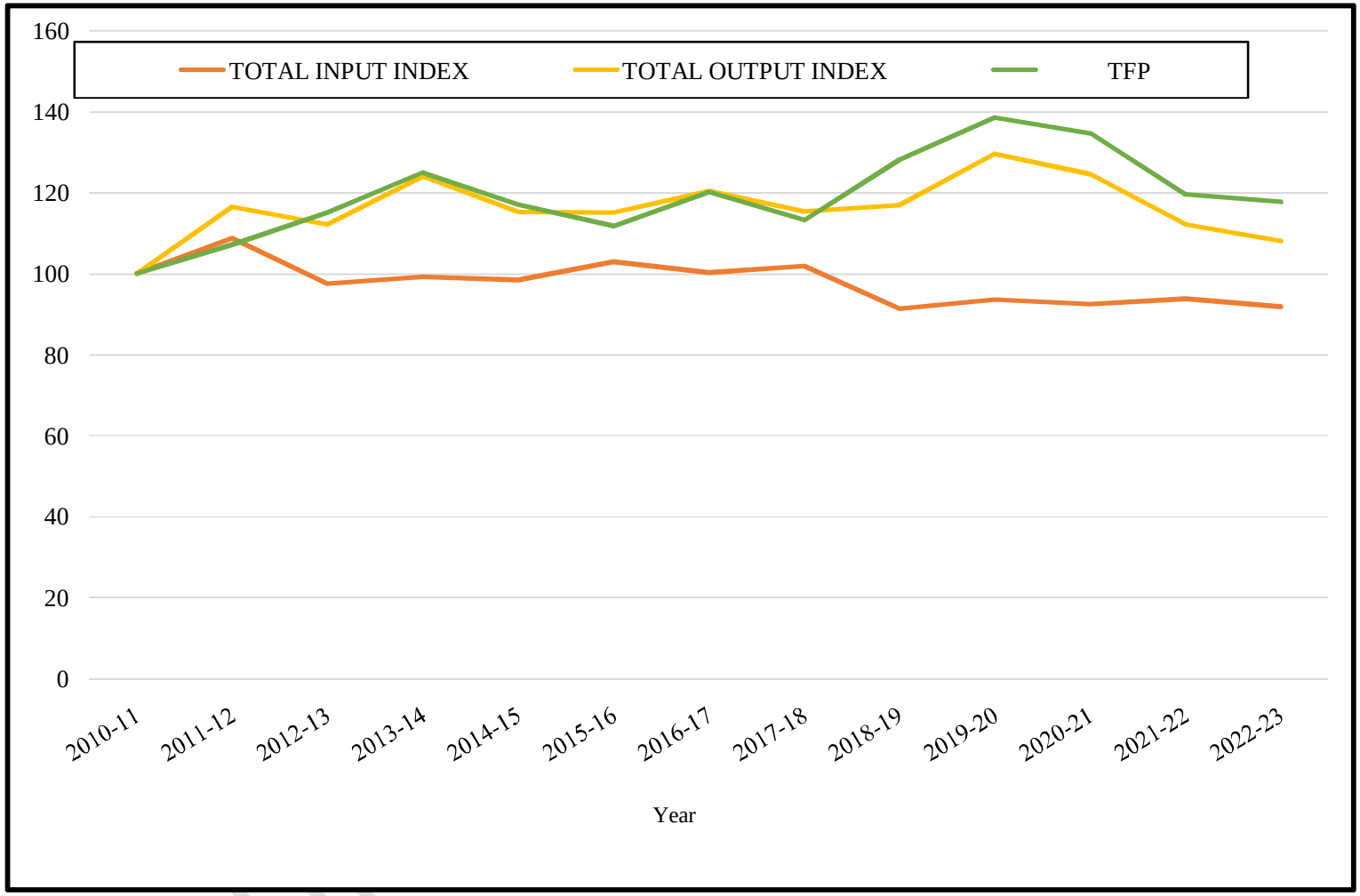

Figure.1: Input, output and TFP indices of cumin in Gujarat for the year 2010-11 to 2022-23

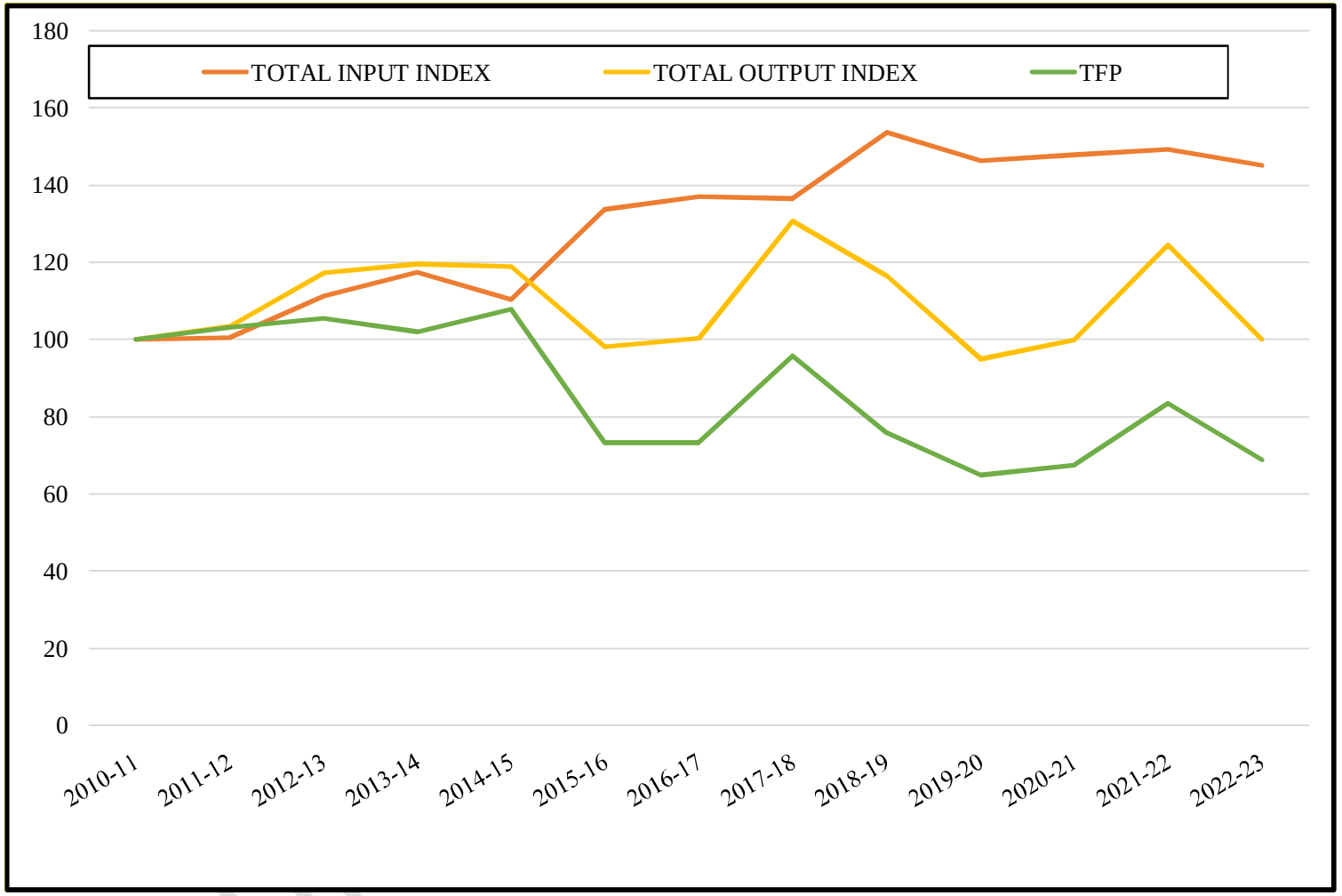

Figure.2: Input, output and TFP indices of fennel in Gujarat for the year 2010-11 to 2022-23

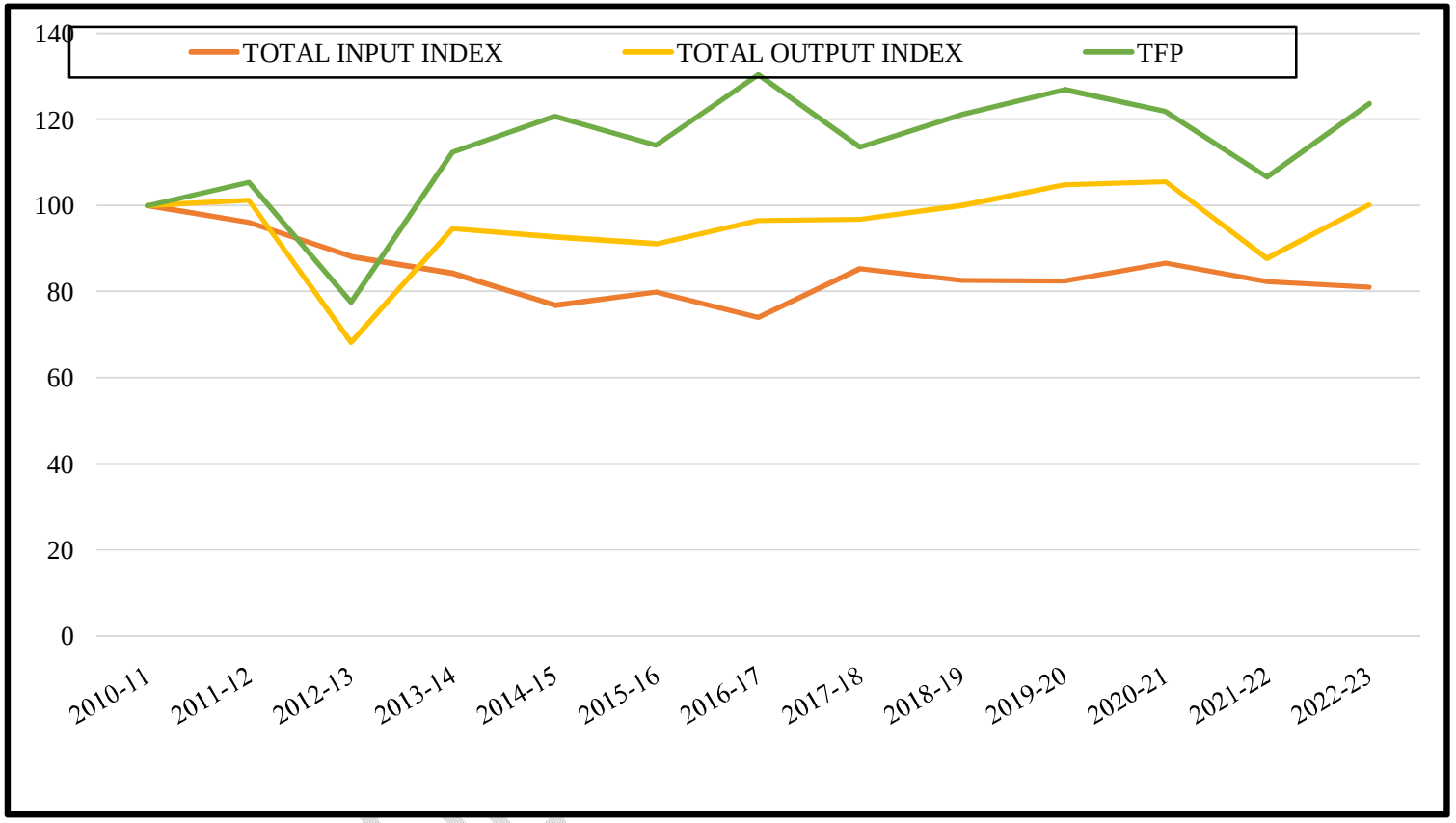

Figure. 3: Input, output and TFP indices of coriander in Gujarat for the year 2010-11 to 2022-23

Conclusions

The study of total input, total outputand total factor productivity (TFP) indices for cumin, fenneland coriander from 2010-11 to 2022-23 reveals varying trends in productivity growth. Cumin and coriander exhibited positive TFP growth, driven by higher growth rates of outputs relative to inputs. Conversely, fennel showed a decline in TFP growth due to the accelerated growth rate of inputs compared to outputs.

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