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## Export performance of litchi in India

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### Abstract

The objective of the study was to analyse the export performance of Litchi in India. The secondary time series data for the last 20 years i.e., 2001-02 to 2020-21 regarding area, production, productivity, export quantity and export value were collected from various sources like APEDA, NHB and DGCIS. The entire twenty-year period was equally divided into two periods i.e., period I (2001-02 to 2010-11) and period II (2011-12 to 2020-21). The collected data were analysed with the help of statistical tools like CGR, CV and Coppock's instability Index in order to fulfil the objectives of the study. The study indicated that compound growth rate of area was positive and significant throughout the study period. The compound growth rate of production was positive and significant in period II (3.78) and overall period (3.52). The growth rate of productivity in period II (1.40) and overall period (0.15) was observed to be positive and non-significant. The compound growth rate of export quantity (13.01) and export value (3.03) of litchi in India was positive and non-significant in period I. The compound growth rate of export quantity and export value of litchi in India was negative both in period II and overall period. The variability area and production of litchi were highest in overall period as shown by coefficient of variation and Coppock's instability index. For productivity it was highest during the period I. The variability of export quantity and export value of litchi was found to be highest during the period II as indicated by both coefficient of variation and Coppock's instability index.

**Keywords:** Export, compound growth rates, instability and coppock's instability index

### Introduction

Agriculture continues to support Indian economy. It provides food for ever growing population of India and raw materials for industries which are required for employment generation. Agriculture sector accounts for 18.8 percent of GVA. Export is a critical activity for every country's economic development to advance. In recent years, India's exports have shifted away from tea and coffee and toward grains, spices, fruits, and vegetables. Since India's liberalisation, its foreign commerce has increased by a factor of ten, with major structural modifications in product and geographic mix. In the first two decades after liberalisation, the removal of quantitative constraints as well as a large reduction in tariff levels across product lines encouraged the rise of foreign commerce.

Horticulture has emerged as a promising agricultural enterprise for accelerating economic growth over the years. Its role in the country's nutritional security, poverty alleviation, and job creation programmes is growing in importance. It not only provides farmers with a wide range of crop diversification options, but it also provides ample scope for sustaining many Agro industries, which generate massive employment opportunities. Fruits and vegetables can generate 20-30 times more foreign exchange per unit area than cereals, which take up most of our land. Fruits and vegetables are an important source of nutrients.

Litchi (*Litchi chinensis* Sonn.) is one of the most important members of Sapindaceae family that has over 2000 species and 150 genera. Litchi is a long-lived Evergreen tree that produces its new leaves, flowers, and fruit on the terminal shoots. The red-skinned fruit contains single seed, surrounded by juicy sweet aromatic aril or flesh. The fruit from the tree is 5 cm long and 4 cm wide. The inedible skin of a litchi is pink-red and roughly textured. Its flesh is white and sweet tasting. Litchi can be eaten right out of the skin. Cultivars with large fruit, small seeds and distinctive flavour sought after in the marketplace. Litchi fruit is well-known for its high quality, pleasant flavour, and eye-catching red colour.

Litchi fruit contains approximately 60 percent juice, 8 percent rag, 19 percent seed, and 13 percent rind, depending on the variety and climate in which it is grown. Carbohydrates, organic acids, vitamins, pigments, protein, and fat are the primary chemical constituents.

Litchi is primarily produced in China and India. According to the International Society for Horticultural Science (ISHS), in 2018-19, Southeast Asian countries accounted for 19 percent of the global litchi market. Madagascar accounted for 35 percent of the global exports, followed by Vietnam and China, with 19 percent and 18 percent, respectively. According to National horticulture database, India, in 2016, the area under cultivation of litchi was 90,000 hectares, and it increased to 96,000 hectares by 2019. Similarly, litchi production was at 559,000.0 metric tonne in 2016, and it increased to 721,000.0 metric tonne by 2019. Bihar, West Bengal, Jharkhand, Assam, Chhattisgarh, and Punjab are the major litchi producing states in the country. Litchi is one of the prominent fruits grown in India. Due to the increasing demand, the production and the area of cultivation are facing inclining trend from 2016. As a result, it is critical that we investigate market potential and develop an effective export marketing strategy and policy in order to improve the export trade in Litchi, taking into account the crop's importance to the Indian economy and its challenges.

### Objectives

1. To estimate Growth and Instability in area, production, productivity, export quantity and export value of Litchi.
2. To work out the Trend in area, production, productivity and prices of Litchi.
3. To study Export competitiveness of Litchi.

### Methodology

#### Period of study

Secondary data was collected for a period of twenty years, from 2001-02 to 2020-21. The study period was divided into two: period I (from 2001-02 to 2010-11), period II (from 2011-12 to 2020-21), and the overall period (from 2001-02 to 2020-21).

#### Nature and sources of data

The data used in this study was gathered from secondary sources. Secondary data was gathered from secondary sources to achieve several objectives linked to Litchi export in India. The information was taken from a variety of government sources, such as the Ministry of Commerce, Government of India, Indiastat, DGCIS, APEDA (Agricultural and Processed Food Products Export Development Authority) and NHB (National Horticulture Board).

#### Analytical tools and techniques

To arrive at relevant findings, the data acquired from secondary sources was subjected to appropriate analytical techniques. The following analytical methods and procedures were used to achieve the study's unique goal based on the nature and quantity of data availability.

1. Estimation of Growth rate
2. Coefficient of variation and Instability index

#### Estimation of Growth rate

The study's first objective was to evaluate Litchi's growth in terms of area, production, productivity, and export in India. The growth rates of area, production, productivity and export of Litchi in India was studied using compound growth rates.

The growth rate was estimated using following model

$$Y = a.b^t \quad (1)$$

Where,

Y = Dependent variable for which growth rate is to be estimated (Area/Production/ Productivity/Export Quantity / Export value)

a = Intercept

b = Regression Coefficient

t = Time Variable

This equation was estimated after transforming (1) as follows,

$$\text{Log } y = \text{log } a + t \text{ Log } b \quad (2)$$

Then the percent compound growth rate (g) was computed using the relationship.

$$\text{CGR (g) \%} = [\text{Antilog (log } b) - 1] \times 100 \quad (3)$$

The significance of the regression coefficient was tested using the student's 't' test.

#### Coefficient of Variation (CV)

The coefficient of variation (CV) was calculated by the formula.

$$\text{Coefficient of variation (CV) \%} = \frac{\sigma}{\bar{x}} \times 100$$

Where,

$\sigma$  = Standard deviation,

$\bar{x}$  = Arithmetic mean and

CV = Coefficient of variation.

$$\text{Standard deviation } (\sigma) = \sqrt{\frac{\sum(x-\bar{x})^2}{n}}$$

Where,

X = Variable

n = Number of observations.

#### Coppock's Instability Index (CII)

Aside from the coefficient of variation, another measure of instability is the coefficient of instability. The fluctuation around the trend is measured by the coefficient of variation. The Coppock Instability Index (CII) is a near approximation of the average year-to-year percentage adjusted for trend rather than absolute variation.

$$Vlog = \frac{\sum \left( \log \frac{X_{t+1}}{X_t} - m \right)^2}{N}$$

$$\text{The instability index} = [\text{Antilog}(\sqrt{Vlog}) - 1] \times 100$$

Where,

$X_t$  = Area/ production /productivity/ export in year t

N = Number of years minus one

m = Arithmetic mean of the difference between the log of  $X_t$  and  $X_{t-1}$ ,  $X_{t-2}$  etc.

$V \log$  = Logarithmic variance of the series.

## Results and Discussion

The data gathered from various sources was examined and interpreted with the objectives of the study in mind. The obtained results are displayed and discussed below.

### Growth rates in area, production, and productivity of litchi

For estimating compound growth rates in area, production and productivity of litchi, the exponential growth function was utilised. In terms of area, production, and productivity, the performance of litchi from India was assessed for the time periods I (2001-02 to 2010-11), II (2011-12 to 2020-21) and overall (2001-02 to 2020-21). The results are shown in Table 1.

**Table 1:** Period-wise Compound growth rates of area, production, and productivity of Litchi (2001-02 to 2020-21)

Particulars	Area	Production	Productivity
<b>Period I (2001-02 to 2010-11)</b>			
CGR	4.192***	1.938	-2.098
t Value	8.744	1.462	-1.284
<b>Period II (2011-12 to 2020-21)</b>			
CGR	2.344***	3.787***	1.409
t Value	14.517	4.691	1.509
<b>Overall period (2001-02 to 2020-21)</b>			
CGR	3.352***	3.522***	0.158
t Value	20.96	8.985	0.319

**Note:** \*\*\* - denote significance at 1% level

\*\* - denote significance at 5% level

Table 1. Shows that throughout Period I, area and production grew at rates of 4.192 percent per year and 1.938 percent per year, respectively. As a result, they exhibit positive growth. But period I productivity showed a negative growth rate of -2.098 percent annually. In comparison to the CGR for area, which was found to be statistically significant at the 1 percent level.

In the Period II, area, production, and productivity grew at rates of 2.344 percent per year, 3.787 percent per year and 1.409 percent per year, respectively. The CGR for productivity was shown to be statistically insignificant in comparison to the CGR for area and production, which were both found to be statistically significant at the 1 percent level.

The 20 years growth rates of litchi area and production in India were 3.352 percent per year and 3.522 percent per year, respectively, and were significant at the 1 percent level. The CGR for productivity was shown to be statistically insignificant in the overall period.

The growth in area and production of litchi is due to its increasing demand and profitability. However, its productivity has been stagnant on the account of poor fruit setting/retention in hot, dry spring and biennial bearing due to poor nutrient management.

The analysis of the compound growth rates of area and production across the study years produced positive and substantial results that point to a sizable market for litchi exports from India. However, in this study, a decline in litchi productivity was seen during period I and remained statistically non-significant for the duration of this study.

### Growth rates in export quantity and export value of litchi

For estimating compound growth rates in export quantity and value of litchi, the exponential growth function was utilised. The results of the evaluation of the performance of litchi from India in terms of export quantity and export value for the study period

is shown in following table 2.

**Table 2:** Period-wise Compound growth rates of export quantity and export value of Litchi (2001-02 to 2020-21)

	Export Quantity	Export Value
<b>Period I (2001-02 to 2010-11)</b>		
CGR	13.013	3.030
t Value	1.399	0.794
<b>Period II (2011-12 to 2020-21)</b>		
CGR	-12.860	-0.230
t Value	-0.946	-0.018
<b>Overall Period (2001-02 to 2020-21)</b>		
CGR	-10.376**	-4.444
t Value	-2.442	-1.464

**Note:** \*\*\* - denote significance at 1% level

\*\* - denote significance at 5% level

Table 2. Shows that the growth rates of export quantity and export value in period I were 13.01 percent and 3.03 percent, respectively. This shown that the growth rate of litchi export quantity is 4.2 times that of litchi export value. The compound growth rate of export quantity and export value was found to be statistically insignificant in the period II, export quantity and export value of litchi were statistically insignificant. They witnessed a negative growth rate of 12.86 percent and 0.23 percent, respectively.

The 20-year average growth rate of litchi export quantity is negatively significant and growth rate of export value was not statistically significant. Litchi is specific to the climatic requirements and its highly perishable nature adds to the trade limiting factors. The domestic price of the litchi, which is higher than the international price was also the factor that contributed to the decline in export quantity.

### Degree of instability of Litchi

Coefficients of variation (CV) frequently include the trend component to make it easier to grasp the magnitude and pattern of changes in the level of area, production, productivity, export quantity, and export value of litchi in India. Coppock's Instability Index (CII) provides a good estimate of the average percentage change from year to year when the trend is considered.

**Table 3:** Instability indices of area, production, and productivity of litchi (2001-02 to 2020-21)

Particulars	Area	Production	Productivity
<b>Period I (2001-02 to 2010-11)</b>			
Mean	64.76	430.44	6.72
SD	8.448	54.207	1.144
CV%	13.046	12.593	17.036
CII%	41.92	41.75	42.97
<b>Period II (2011-12 to 2020-21)</b>			
Mean	89.83	621.95	6.89
SD	6.375	82.073	0.608
CV%	7.097	13.324	8.827
CII%	39.51	41.95	40.25
<b>Overall Period (2001-02 to 2020-21)</b>			
Mean	77.295	526.195	6.085
SD	14.780	119.568	0.896
CV%	19.122	22.723	13.173
CII%	44.89	46.14	41.67

Table 3. Reveals that there was stability in the area and productivity during period II compared to period I as indicated

by lower coefficient of variation in period I. But production was relatively stable during period I compared to period II as indicated by relatively lower coefficient of variation.

Area and production showed higher instability in overall period with 19.12 and 22.72 percent of coefficient of variation respectively when compared to the period I and period II. In Productivity the instability is more in Period I when comparing the period II and overall period.

The instability of area and production were observed to be the highest during the overall period at 19.12 and 22.72 percent of coefficient of variation respectively. The instability of productivity was observed to be the highest during the period I. The lowest instability of area and productivity was observed in period II at 7.097 percent and 8.827 percent, respectively. The lowest instability of production was observed in period I which was 12.593 percent.

Table 3. Shows that in period I, productivity has the maximum variability, at 42.97 percent, while area and production have relatively lower variability, at 41.92 percent and 41.75 percent, respectively.

In period II, production had the maximum variability of 41.95 percent, while area and productivity had lower variability of 39.51 percent and 40.25 percent, respectively. Thus, it became clear from the discussion that the overall period had an increase in instability in area and production of litchi comparing to period I and period II. While litchi's productivity showed more variability in period I compared to period II and overall period.

**Table 4:** Instability indices of export quantity and export value of Litchi (2001-02 to 2020-21)

Particulars	Export quantity	Export value
<b>Period I (2001-02 to 2010-11)</b>		
Mean	784.42	108.71
SD	539.22	36.05
CV%	68.74	33.16
CII%	84.81	51.39
<b>Period II (2011-12 to 2020-21)</b>		
Mean	276.10	78.78
SD	329.75	64.24
CV%	119.43	81.54
CII%	136.84	104.39
<b>Overall Period (2001-02 to 2020-21)</b>		
Mean	530.26	93.74
SD	507.18	52.97
CV%	95.64	56.51
CII%	134.84	83.89

Table 4. showed that the amount of litchi exported displayed considerable variability, with coefficients of variation at 68.74 percent and 95.64 percent in Period I and overall period, respectively, while it was highest in Period II with coefficient of variation at 119.43 percent.

Similar to export quantity, export value exhibits substantial variability in period I and the overall period with 33.16 percent and 56.51 percent, respectively. Period II had the biggest export value variability, at 81.54 percent. As compared to period II and overall period, period I showed less variability in both export quantity and value. Period II had the highest levels of variability for both export quantity and export value.

Table 4. Also shows that in period I, export quantity and export value have less variability, at 84.81 percent and 51.39 percent respectively, comparing to period II and overall period.

In period II, export quantity and value both have the highest levels of variability, at 136.84 and 104.39 percent, respectively,

compared to the overall period, where they show 134.84 and 83.89 percent, respectively. Evidently instability was more pronounced in period II than period I and overall period.

**Table 5:** Coppock's Instability Index of Area, Production, and Productivity of litchi in India (2001-02 to 2020-21)

<b>Coppock's Instability Index (CII) in %</b>			
Particulars	Area	Production	Productivity
Period I (2001-02 to 2010-11)	41.92	41.75	42.97
Period II (2011-12 to 2020-21)	39.51	41.95	40.25
Overall period (2001-02 to 2020-21)	44.89	46.14	41.67

Table 5 shows that in period I, productivity has the maximum variability, at 42.97 percent, while area and production have relatively lower variability, at 41.92 percent and 41.75 percent, respectively.

In period II, production had the maximum variability of 41.95 percent, while area and productivity had lower variability of 39.51 percent and 40.25 percent, respectively. In overall period production showed highest variability of 46.14 percent followed by area with 44.89 percent and productivity with 41.67 percent.

Thus, it became clear from the discussion that the overall period had an increase in instability in area and production of litchi comparing to period I and period II. While litchi's productivity showed more variability in period I compared to period II and overall period.

#### **Coppock's Instability Index of export quantity and export value of litchi in India**

The Coppock's instability index was calculated for the export quantity and value of the litchi for the overall study period (2001-02 to 2020-21), which was separated into three periods: period I (2001-02 to 2010-11), period II (2011-12 to 2020-21) and overall period (2001-02 to 2020-21).

**Table 6:** Coppock's Instability Index of export quantity and export value of litchi in India (2001-02 to 2020-21)

<b>Coppock's Instability Index (CII) in %</b>		
Particulars	Export quantity	Export value
Period I (2001-02 to 2010-11)	84.81	51.39
Period II (2011-12 to 2020-21)	136.84	104.39
Overall period (2001-02 to 2020-21)	134.84	83.89

Table 6. Shows that in period I, export quantity and export value have less variability, at 84.81 percent and 51.39 percent respectively, comparing to period II and overall period.

In period II, export quantity and value both have the highest levels of variability, at 136.84 and 104.39 percent, respectively, compared to the overall period, where they show 134.84 and 83.89 percent, respectively. Evidently instability was more pronounced in period II than period I and overall period. Export of litchi from India in period II shows higher variability due to factors like acute encephalitis syndrome (AES) concerns especially during 2011 and 2014 (Anonymous, 2014), poor post-harvest management, lack of infrastructure facilities and highly perishable nature of fresh fruit makes it harder for exporters (Sanjay, 2009) <sup>[8]</sup>.

#### **Trend analysis of Litchi**

The trend equations were fitted to assess the area, production, productivity, export quantity and export value. Depending upon its better fit, it was analyzed by the production function *viz.*, linear, logarithmic, inverse, quadratic, cubic, compound, power, growth, exponential, logistic the trends.

### Trend in area, production, productivity, domestic prices and international prices of litchi

Results are analysed and presented in table 4.11 under different categories namely trends in the area, production, productivity, export quantity and export value for the data over the period from 2001-02 to 2020-21.

**Table 7:** Trend in area, production, productivity, domestic prices and international prices of litchi (2001-02 to 2020-21)

Sr. No.	Particulars	Function	R <sup>2</sup>	Coefficients		
				b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>
1	Area	Cubic	0.981*	20.48	-1.69	0.047
2	Production	Cubic	0.969*	143.81	-13.01	0.393
3	Productivity	Cubic	0.932*	2.55	-0.262	0.008
4	Domestic price	Cubic	0.935*	550.21	-16.02	0.037
5	International price	Power	0.887*	3.28	-	-0.104

Note: \* = significance at 5 percent level

Knowing the overall performance, parametric trends model was used to trace the movement of the series (Table 7). Among the competing models, a variety of models have been explored. Based on the R<sup>2</sup> and the importance of the coefficients, the best fitted models are chosen.

For trend analysis of litchi area, range of R<sup>2</sup> varies from 0.282 - 0.981 where maximum value of R<sup>2</sup> i.e., 0.981 is for cubic trend which is best suited. In trend analysis of production of litchi range of R<sup>2</sup> varies from 0.281 to 0.969 where maximum value of

R<sup>2</sup> i.e., 0.969 is best suited for cubic trend. In trend analysis of productivity of litchi range of R<sup>2</sup> varies from 0.407 to 0.932 where maximum value of R<sup>2</sup> i.e., 0.932 is best suited for cubic trend. In trend analysis of domestic prices of litchi range of R<sup>2</sup> varies from 0.257 to 0.935 where maximum value of R<sup>2</sup> i.e., 0.935 is best suited for cubic trend. In trend analysis of international prices of litchi range R<sup>2</sup> varies from 0.237 to 0.887 where maximum value of R<sup>2</sup> i.e., 0.887 is best suited for power trend.

Among the competitive parametric models, cubic models are shown to be the best fit for area, production, productivity, and domestic prices, with the exception of international prices, for which the power model was suited. R<sup>2</sup> of area, production, productivity, domestic prices, and international prices were significant at five percent level.

### Export competitiveness of Litchi

The Nominal Protection Coefficient was used to analyse export competitiveness (NPC). In a free trade environment, the nominal production coefficient clarifies whether a country has a comparative advantage in the export of the good. The NPC ratio affects the level of competition. Markets are considered to be highly competitive when the NPC ratio is less than 0.5, moderately competitive when the NPC ratio is between 0.5 and 1, and non-competitive when the NPC ratio is larger than 1. The export competitiveness of litchi was analysed using Nominal Protection and it is presented in table 8.

**Table 8:** Nominal Protection Coefficient (NPC) of litchi (2001-02 to 2020-21)

Sr. No.	Period	Year	Domestic Prices (Rs/quintal)	International Prices (Rs/quintal)	NPC
1	Period I	2001-02	2824	4691	0.60
		2002-03	3607	2882	1.25
		2003-04	2418	1392	1.73
		2004-05	2448	1286	1.90
		2005-06	1853	1302	1.42
		2006-07	2197	989	2.22
		2007-08	2328	3937	0.59
		2008-09	3033	1008	3.00
		2009-10	3197	1630	1.96
		2010-11	3268	1145	2.85
Average (Period I)					1.75
2	Period II	2011-12	3439	1211	2.83
		2012-13	3947	1494	2.64
		2013-14	4713	4909	0.96
		2014-15	5432	2238	2.42
		2015-16	4714	5568	0.84
		2016-17	5783	8471	0.68
		2017-18	5382	5355	1.00
		2018-19	5781	9080	0.63
		2019-20	5228	3381	1.54
		2020-21	3361	3999	0.84
Average (Period II)					1.44
Average (overall period)					1.59

Table 8. Reveals that, over the course of 20 years, the NPC value of exports of litchi was calculated to be 1.59, demonstrating the fruit's lack of international competition and demonstrating that the commodity is not protected on international level. The average NPC values were 1.75 and 1.44, respectively, when it was studied for the two distinct sub-periods in periods I and II, which also suggests non-competitiveness for both periods. Table 4.12 makes clear that NPC has consistently been greater than unity, primarily as a result of domestic prices that are higher than global prices.

The fact that the NPC values were discovered to be rising indicated that global prices had decreased relative to domestic prices, indicating that litchi export was not competitive in overseas markets. Hence, the hypothesis i.e., litchi has better competition in international market is rejected.

### Conclusion

1. The growth rate in area and production of litchi in India was found to be positive and significant during the overall period. The growth rate in productivity was non-significant

during the entire period under study. It indicated the need to give emphasis the research on high yielding varieties.

2. The export quantity of litchi was decreasing due to the factor that the domestic price is higher than the international price or price difference between domestic and international price is very low.
3. The growth rate of export quantity and export value was found positive and non-significant during period I and negative and non-significant during period II and overall period.
4. As regards the area, production, productivity, export quantity and export value of litchi in overall period shows 19.12 percent, 22.72 percent, 13.17 percent, 95.64 percent and 56.51 percent of coefficient of variation, respectively.
5. The variability of export quantity of litchi as measured by the Coppock's instability index is 134.84 percent during overall period which is not considered as a good sign.
6. There was an increase in trend in area, production, productivity, domestic price and international price of litchi during overall period and it was found to be positive. Among the competitive parametric models, for all the cases cubic models are found best fitted except international price for which power model was best fitted, based on  $R^2$  and significance of coefficient.
7. The NPC value of litchi showed that, the value in period I was 1.75 and in period II was 1.44 and for overall it was 1.59 which indicates India litchi was non-competitive in international market.

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