Original Research Article

Sources of output growth and variability of natural rubber in India

Abstract

Natural rubber is one of the most significant polymers for the human society. One which supplies raw materials for the many sectors i.e., industrial, medical, agriculture, automobiles, aircraft, railways, textile industries, sports, and engineering sectors, and even for the construction of buildings and roads, etc. Due to its multifarious uses, the consumption of natural rubber in the world as well as in India has been increasing steadily. Hence based on the importance of the crop, the present study examined the sources of output growth and variability of natural rubber in India using secondary data for the period of 2007-08 to 2021-22 with the help of statistical and econometrical tools i.e., compound annual growth rate, decomposition model, and Cuddy - Della Valle index (CDVI). Growth in the area of natural rubber in India has increased with a positive and highly significant rate of 4.23 percent per annum, while negative and significant growth was observed in production and productivity of the same. Decomposition analysis indicated that the area effect was the prime contributor to the increase in the production of rubber. Variability of natural rubber in the area, production, and productivity was found to be 5.36, 11.16, and 3.21 percent, respectively for India.

Keywords: Polymer, CDVI, Decomposition model, Agriculture, Variability.

Introduction

In India, the plantation of natural rubber was started by the British. There is hardly any need to dwell on the economic importance of rubber plantations in India. It is one of the most significant polymers for human society and supplies raw materials for the production of many sectors i.e., industrial, medical, agriculture, automobiles, aircraft, railways, textile industries, sports goods, and engineering sector, and even for the construction of building and roads, etc. The consumption of rubber in the world and in India has been increasing steadily due to its multifarious uses to which rubber can be put (Goswami and Challa, 2007). It is widely used in vehicle tires, medical gadgets, toys, clothing, pacifiers, surgical gloves, and plane. It is obtained

from the latex of trees, which is a yellowish milky fluid made up of carbohydrates, proteins and alkaloids, and other substances. (Anuja *et al.* 2012)

It is a commercial plantation crop from the tree species, *Hevea brasiliensis.* These are generally grown in tropical humid climate conditions. Malaysia, Thailand, China, Indonesia, and India are the natural rubber producer countries of the world (Kannan, 2013). According to the report of National Rubber Policy, India (2019), the total production and consumption of natural rubber were around 12.40 million tonnes and 12.60 million tonnes, respectively in the world. It is a globally traded good and the prices of its influenced inter alia by trends in economic growth, production in major producing countries, and demand in major consuming countries. Domestic natural rubber prices generally follow the trade in the international market and are, therefore, subject to price fluctuation.

India is currently the world's sixth-largest producer of natural rubber with the highest production (7, 75,000 tonnes in 2021-22). The production capacity of India is around 9, 00,000 tonnes. India is the 2nd largest consumer globally with current consumption of around 1.1 million tonnes. Sheet rubber, block rubber, and latex account for 47, 43, and 8 percent respectively in natural rubber consumption. The total area under rubber production is around 826,660 ha in India. Kerala and Tamil Nadu states are traditional rubber-growing states of India which produce around 81percent of total production. On the other hand, the northeastern states viz. Tripura, Assam and Meghalaya, Odisha, West Bengal, as well as Southern states Karnataka and Maharashtra, are the major non-traditional rubber growing states of the country. The most preferred form of processed rubber is Sheet rubber which accounts approx 70 per cent of total processed rubber. Block rubber and latex cover approx 17 and 12 per cent respectively of total rubber production in the country (Rubber Board of India, 2019).

Material and methods

The present study was undertaken in India based on secondary data collected from statistics and the planning department of the rubber board. The time series data of area, production, and productivity of natural rubber had been taken for the last 15 years from 2007-08 to 2021-22. Suitable tools viz. Compound growth rate, Decomposition model, Coefficient of variation, and

Cuddy Della Valle index (CDVI) were applied for the study. The details of methods of analysis using the following statistical and econometrical models are presented as under.

A) Compound Growth Rate

Compound annual growth rates are estimated to know the growth pattern in area, production, and productivity of natural rubber in India. The growth rate was estimated by using the exponential trend model (Balai *et al*., 2021b).

Exponential trend equation: $Y = ab^x$

The compound growth rate was obtained from the logarithmic form of the equation as below:

Log Y = log a +x log b

CGR (r) = [(Anti log of b) – 1] x 100

Where

Y = area/production/yield

a = Intercept

b = regression coefficient

x = Year

CGR (r) = Compound growth rate

SE (CGR) = Standard error of Compound growth rate

The standard error of Compound growth rate is calculated by using the following formula

$$SE\ (CGR) = \frac{100b}{ln10}\ x\ SE\ (ln\ b)$$

B) Decomposition Analysis

This model was used for the estimation of the contribution of area, yield, and their interaction towards (increase /decrease) change in the production of natural rubber in India. The decomposition analysis was first time presented by Minhas and Vaidyanathan (1965). They calculated the change in agricultural production by segregating the changes into three major different factors: area, yield, and their interactions. They have applied the additive method for working out the effects of the three same factors (Kumar *et al*., 2019). A similar model suggested and used by many researchers (Sahu *et al*. 2020; Bairwa *et al*., 2021; Balai *et al*. 2021a).

Production (P) = Yield effect (YE) + Area effect (AE) + Interaction effect (IE)

a) Area effect: This **s**hows the percentage share of the area in the total production.

$$AE = \frac{(A_t - A_0)Y_0}{P_t - P_0} \text{ X } 100$$

b) Yield effect: This shows the percentage share of yield in the total production.

$$YE = \frac{(Y_t - Y_0)A_0}{P_t - P_0} \text{ X } 100$$

c) Interaction effect: This shows the percentage share of area and yield interaction in the total production.

$$IE = \frac{(Y_t - Y_0)(A_t - A_0)}{P_t - P_0} \text{X } 100$$

Where

$A_t, P_t \; and \; Y_t$ are the area, production and yield of Rubber for the current year.

$A_0, P_0 \; and \; Y_0$ are the area, production and yield of Rubber for the base year.

C) Instability

Cuddy and Della Valle in 1978 modified the coefficient of variation to accommodate the trend present in the data, which was commonly present in economic time series data. This method was superior to the scale dependent measures such as standard deviation (Kolar *et al.,* 2020).

$$\boldsymbol{Instability\ Index\ (CDVI) = C.V.* \sqrt{(1 - R^2)}}$$

Where

CV= Coefficient of determination

R^2 = Coefficient of determination

The ranges of instability (Sihmar, 2014; Kolar *et al*., 2020; Balai *et al.,* 2021b) are as follows:

Low instability	=	Between 0 to 15
Median instability	=	Greater than 15 and lower than 30
High instability	=	Greater than 30

Results and Discussion

Compound growth rate in area, production and productivity of natural rubber was presented in the table 1. It was revealed that the positive and highly significant growth rate was observed in area at the rate of 4.23 per cent per annum. Similar result was reported by Lekshmi and George (2003); George and Chandrashekar (2013), whereas production and productivity of rubber declined significant with the magnitude -4.05 and -4.72 per cent per annum, respectively. Lack of technology (shortage of skilled labour leads to reduction in application of fertilizers and other inputs result improper maintenance of trees) lack of high yielding verities, as well as climatic conditions of India are the major hindrance in the cultivation of natural rubber. All the above-mentioned factors have reduced the production and productivity of natural rubber in India. Similar results reported by Raju (2016).

Table 1: Compound growth rate in area, production and productivity of natural rubber in India from 2007-08 to 2021-22

Year	Area(ha)	Production(tones)	Productivity(kg/ha)
2007-08	635,400	825,345	1,799
2008-09	661,980	864,500	1,867
2009-10	686,515	831,400	1,775
2010-11	711,560	861,950	1,806
2011-12	734,780	903,700	1,841
2012-13	757,520	913,700	1,813
2013-14	7,78,400	7,74,000	1,629
2014-15	7,95,135	6,45,000	1,443
2015-16	8,10,800	5,62,000	1,437
2016-17	8,18,000	6,91,000	1,553
2017-18	8,20,900	6,94,000	1,458
2018-19	8,22,000	6,51,000	1,453
2019-20	8,22,300	7,12,000	1,459
2020-21	8,23,000	7,15,000	1,442
2021-22	8,26,660	7,75,000	1,472

b value	0.018	- 0.018	- 0.021
CAGR(%)	4.23*	-4.05**	-4.72*
Standard error	0.002	0.007	0.003
p-value	0.000001	0.023	0.000022

Source: Source: Author's own calculation based on compiled time series data

**Significant at 1%level of probability, **significant at 5 percent level of probability*

Although the area of natural rubber in India had increased from 635,400 ha (2007-08) to 826,660 ha (2021-22), but the production and productivity had drastically declined from its base year to the current year. Which was 8, 25,345 tonnes (2007-08) to 775,000 tonnes (2021-22) of production and productivity from 1799 to 1472 kg/ha. According to Experts of the Indian Rubber Board (2012), Indian rubber farms are facing the problem of lower productivity, largely due to the smaller size of land holdings, many farmers are worried about the insufficient price for the products, market failure, shortage of labour, and an approximately 50 percent of the cost of production spent on labourers (Kannan, 2013).

Decomposition analysis

For estimating the contribution of area and yield towards increase/decrease in production of natural rubber the simple decomposition model was used in which contribution of productivity is the part of production due to increased natural rubber acreage over the base year productivity. The contribution of interaction is the part of production due to increased yield in the increased natural rubber acreage. The analyzed data regarding decomposition of output growth of natural rubber in India was presented in Table 2 and Figure 1. It was observed that the area contributed positive and increasing the production of natural rubber as well as its effect on the total natural rubber production in India with 451.18 percent. The contribution of yield and interaction effect towards increased wheat production showed a negative response of -343.20 and 7.98 percent, respectively. It might be due to unavailability of skilled labour and improved technology as well as the improper maintenance of trees (Raju, 2016). It is indicated that only the area was the main source of output growth of natural rubber in the country.

Table 2: Decomposition of output growth in natural rubber of India (2007-08 to 2021-22)

S. No.	Particulars	Decomposition (%)

1.	Area Effect	451.18
2.	Yield effect	-343.20
3.	Interaction Effect	-7.98

Source: Author's own calculation based on compiled time series data

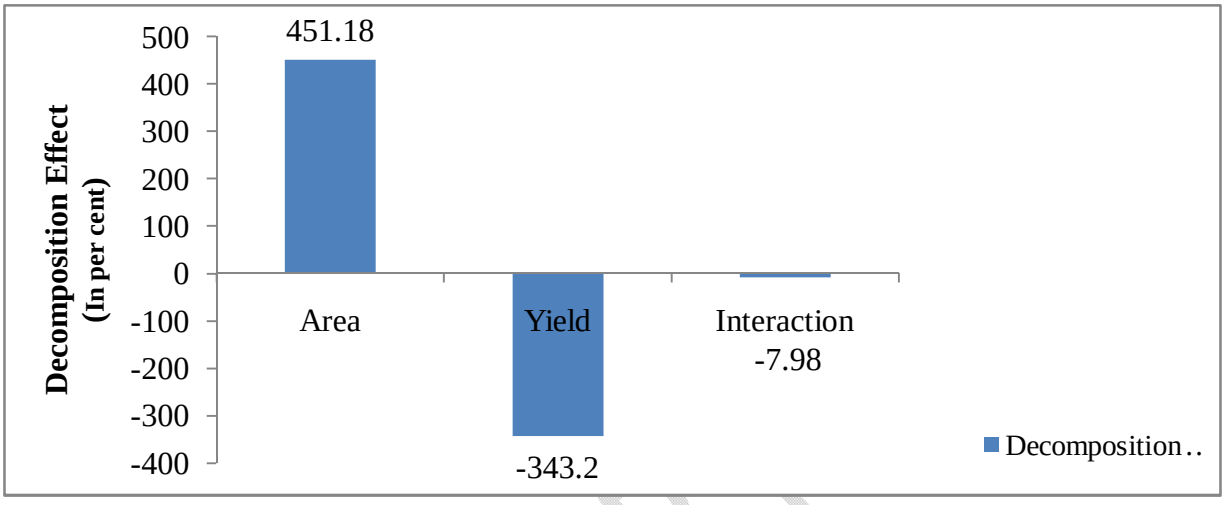

Figure 1: Decomposition of output growth in natural rubber of India (2007-08 to 2021-22)

Instability

The instability index was calculated by Cuddy-Della Valle Index for area, production, and productivity of natural rubber in India and presented in Table 3 and Figure 2. Results showed that in the variation in area, production and productivity of natural rubber registered low instability but the variation in production (11.16%), was higher than the variation in area (3.21%) and productivity (5.36%) of natural rubber of India.

Table 3: Instability in Area, Production and Productivity of natural rubber in India (2007-08 to 2021-22)

S. No.	Particulars	Instability (%)
1.	Area	3.21
2.	Production	11.16
3.	Productivity	5.36

Source: Author's own calculation based on compiled time series data

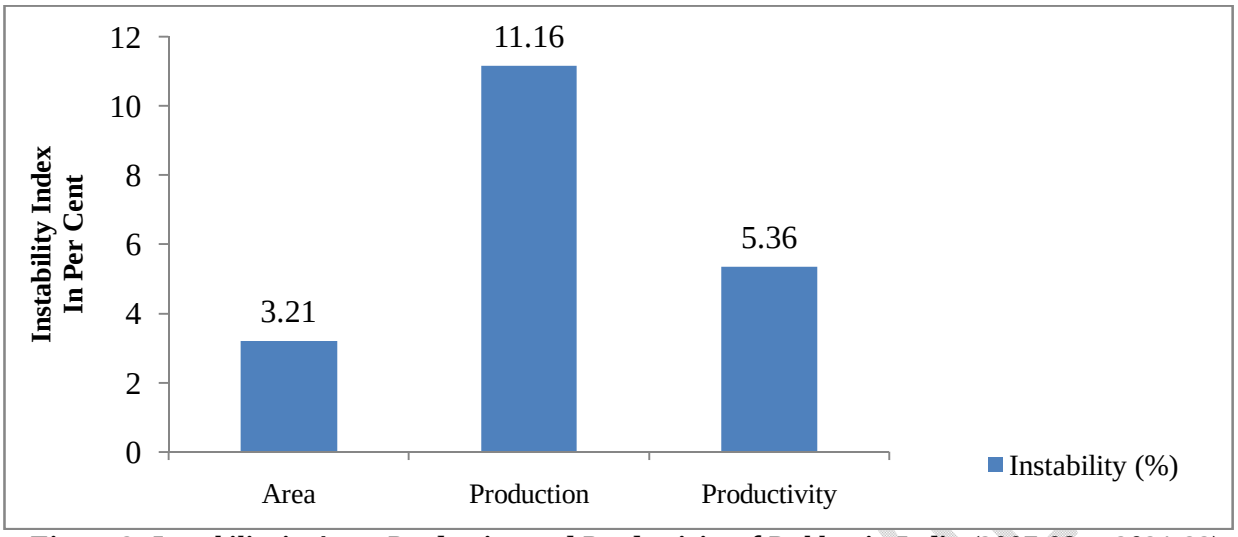

Figure 2: Instability in Area, Production and Productivity of Rubber in India (2007-08 to 2021-22)

Conclusion

The natural rubber sector of India is relatively different from the other major producing countries like Indonesia, Malaysia, and Thailand which mainly export natural rubber. India apart from being the major producer is also the major consumer of natural rubber (George and Chandrashekar, 2013). The analysis of sources of output growth and variability of natural rubber in India leads to conclude that the production and yield of natural rubber in the country had declined from its base year to the current year. Apart from these, positive and significant growth rate was noticed in the area with 4.23 percent per annum, while negative and significant growth were observed in production and productivity of natural rubber from 2007-08 to 2021-22. With the help of decomposition analysis it can be concluded that area effect is the prime contributor to increase the production of natural rubber in the country. The CDVI model indicated that during the study period low instability was reported in area, production, and productivity of natural rubber in India.

Recommendations

According to many researchers (Lekshami *et al.*, 1996; Kannan, 2013; Raju, 2016), the production of natural rubber in India is influenced by unavailability of skilled labour, indigenous rubber prices, and lack of improved technology. Therefore, the study suggests that the Government should conduct from time to time appropriate trainings regarding improved

technology to the farmers and increase the procurement price for natural rubber at an appropriate and reasonable rate. This will be encouraging the rubber growers to grow more and enhance the area under the same.

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