

To analyse the trend in the productivity of Indian natural rubber and the effect of supply response by employing Nerlove's Model

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Abstract

This study attempts to examine the productivity of natural rubber in India. Besides, the total productivity of natural rubber, state-level productivity is also analysed. The impact of supply response on productivity is investigated using Nerlove's model. Natural rubber productivity in India underwent a declining trend from 1986 to 2016. This declining trend was also seen on a state-by-state basis, including Kerala which produces 78% of India's total output. The current productivity is increased by 0.896 units with a unit increase in the previous period productivity and a unit increase in the change in price, with an incremental increase of 0.016 units for the supply response.

Keywords: Productivity, Nerlove's Model

1. Introduction

India ranks third position in the global ranking regarding the productivity of natural rubber. During 2010-11, the country's productivity was 1806 per hectare. However, in 2015-16, it was decreased to 1437 per hectare. Price volatility, weather adversity, high wages, shortage of skilled tappers, and evasion of manures are some of the reasons for the shrinkage productivity of natural rubber (The Statistics and Planning Department, 2016). During 2010-11, the traditional region has 1887 of productivity per hectare. During 2015-16, it has been decreased to 1015 per hectare. In the non-traditional region, 1194 was the productivity per hectare during 2010-11, but it was reduced to 965 per hectare during 2015-16. Among the state-wise productivity, Tamil Nadu has the highest, 1241 per hectare during 2015-16. (The Statistics and Planning Department, 2017).

2. Literature Review

Anuja, Kar, Mathur, and Jha (2012), studied the area, production, and productivity of natural rubber in India and the role of Rubber Producers' Societies (RPS) in providing standard inputs to increase production and productivity. Smallholdings rather than estates have occupied natural rubber, the backbone of the plantation sector. The past four decades witnessed the decline of estates share to smallholders having less than two hectares. The study is based on exploratory and analytical, which involves both qualitative and quantitative methods. Factor analysis technique was employed for the study. These are significant findings. RPS will help the farmers to act as a mediator in between producers and tyre companies and even exporting agencies. This will help the natural rubber producers to encourage replanting and new planting due to profitable farming.

Mathew (1999), analysed the area, production and productivity of Indian natural rubber. As a perennial crop due to price fall, the crop shift in short-run will not happen, but farmer's indifference in the application of fertilizers and cultural practices will happen. This will impact production and productivity. This fact is very well reflected in the estimates. The shifting of the cropping pattern will happen only in the long run. Secondary data is used for the descriptive study. Time series analysis is employed in the research. After the implementation of liberalized policies due to price fall, the farmer's were indifferent in applying fertilizers and following agro-management practices which negatively affected the production and productivity of Indian natural rubber.

Rajesh (2015) evaluates the area, production and productivity of natural rubber in India as well as the state of Kerala. This study explains the area, production and productivity of Indian natural rubber based on traditional and non-traditional region. A comparative study of natural rubber between 2000-01 and 2010-11 is taken for the study. Based on the secondary data, descriptive research is employed. Time series analysis is used in explaining the area, production and productivity of natural rubber. The growth of natural rubber during the study period shows that this sector plays a pivotal role in the agricultural economy.

3. Objectives

1. To analyse the trend in the productivity of natural rubber in India
2. To examine the influence of supply response of natural rubber on its productivity

4. Materials and Methods

The present study is analytical and it is based on secondary data. The data were taken from The Indian Rubber Statistics (IRS) published by The Statistics and Planning Department, The Rubber Board. The data given by The Rubber Board during the period 1986-2016 were collected and analysed for finding the objectives of the study. The trend in the productivity of Indian natural rubber was studied. To analyse the impact of supply response on productivity, Nerlove's model is used for the study.

5. Results and Discussion

Analysis of trend in productivity

For studying the trend in productivity, the annual growth rate and phase growth rate of the total productivity, productivity in the traditional and non-traditional region, and state-wise productivity during the period 1986-2016 were analysed. This period was divided into six phases consisting of five years in each phase.

Total productivity of Indian natural rubber

Table 1 and figure 1 dealt with the entire productivity of Indian natural rubber during 1986-2016. The data showed a declining trend across the period. The highest rate of growth can be evident during 1993-1994. In this period, the growth rate was 7.89%. During 2014-2015, the rate of growth became negative. In this period, the growth rate tremendously declined to -11.42%. While examining the various phases, during 1991-1996 (the second phase) showed the highest growth rate. The rate of growth was highly negative in 2011-16 (sixth phase) period. In the first phase (1986-1991), the growth rate reached 16.20% with an average annual growth of 3.83%. In the second phase (1991-1996), the growth rate increased to 25.84% compared to the first phase. The average rate of growth during this period was 5.74%. The third phase (1996-2001) showed a diminishing trend. The rate of growth was 4.86%, with an average annual growth of 2.10%. In the fourth phase (2001-2006), the rate of productivity growth increased to 13.96% with an average annual growth of 2.67%. During 2006-2011 (fifth phase), the rate of growth diminished to negative, i.e., -3.89% with an average annual growth of 0.19%. In the sixth phase (2011-2016), the growth rate of production became highly negative, i.e., -21.94% and the average growth rate also declined to -4.31%.

The declining trend in the entire productivity of Indian natural rubber may be due to rubber grower's reluctance in continuous tapping and the evasion of fertilizers with the response to volatility and fall in the price of natural rubber. The decision taken by farmers to reduce tapping due to high labour cost forced the tappers to quit from the job and went for other occupations to secure their livelihood. The lack of skilled tappers also may be the factor behind the reduction in the productivity of Indian natural rubber (Viswanathan and Rajasekharan, 2001; Pareed and Kumaran, 2017).

Table 1: Total productivity of Indian natural rubber

Year	Phase	Total Productivity	Annual Growth rate	Growth rate (phase)
1986-87	I	926		16.20
1987-88		944	1.94	
1988-89		974	3.18	
1989-90		1029	5.65	
1990-91		1076	4.57	
1991-92	II	1130	5.02	25.84
1992-93		1191	5.40	
1993-94		1285	7.90	
1994-95		1362	6.00	
1995-96		1422	4.41	
1996-97	III	1503	5.70	4.86
1997-98		1549	3.06	
1998-99		1563	0.90	
1999-00		1576	0.83	
2000-01		1576	0	
2001-02	IV	1576	0	13.96
2002-03		1592	1.02	
2003-04		1663	4.46	

2004-05		1705	2.53	
2005-06		1796	5.34	
2006-07	V	1879	4.62	-3.89
2007-08		1799	-4.26	
2008-09		1867	3.78	
2009-10		1775	-4.93	
2010-11		1806	1.75	
2011-12	VI	1841	1.94	-21.94
2012-13		1813	-1.52	
2013-14		1629	-10.15	
2014-15		1443	-11.42	
2015-16		1437	-0.42	

Source: Indian Rubber Statistics, The Rubber Board (Ministry of Commerce and Industry, Government of India)

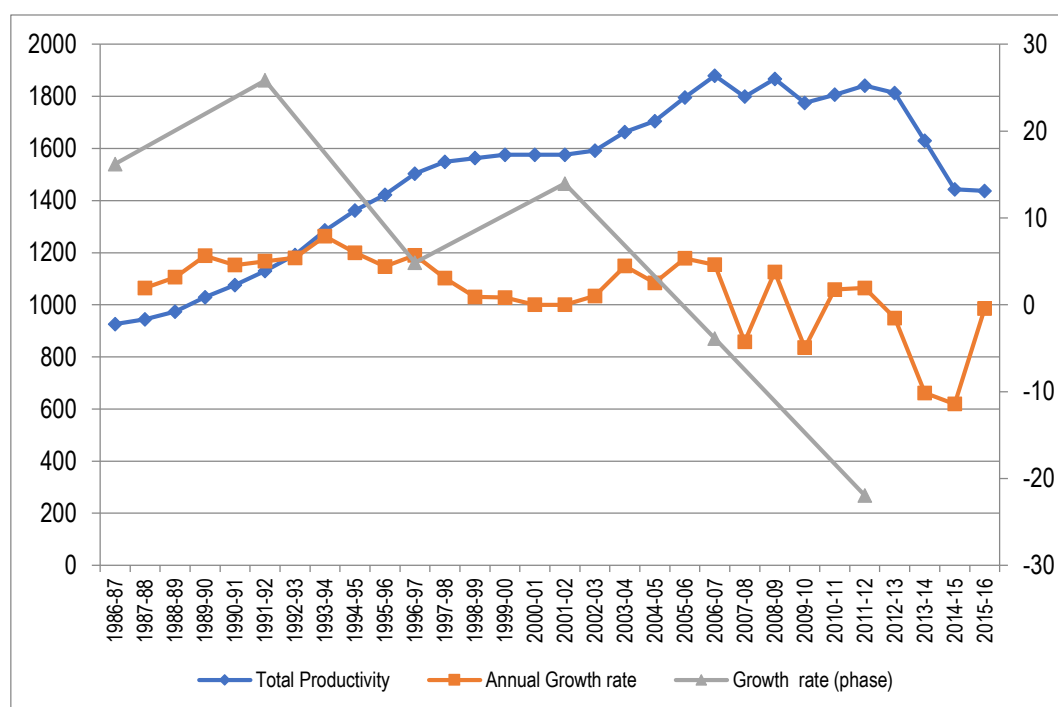


Fig. 1: Total Productivity of Indian NR, Annual Growth rate and Phased Growth rate

State-wise productivity of Indian natural rubber

Productivity- Kerala

Table 2 inspects the distribution of the productivity of Kerala during 1986-2016. During 2015-16, among the states, Kerala holds the first rank in the entire productivity. The highest rate of growth in Kerala is evident in 1993-1994. The rate of growth during this period is 8.40%. The lowest rate of growth can be witnessed in 2014-2015. During this period, the growth rate was -13.04%. Compared to other phases, the second phase (1991-1996) of Kerala showed the highest rate of growth, and the sixth phase showed the least growth, which is highly negative. In the first phase, the rate of growth was 16.77% with an average annual growth rate of 3.97%. While comparing with the first phase, in the second phase (1991-1996), the growth rate increased to 26.69%. The average rate of growth during this period was 5.99%. The third phase (1996-2001) showed a diminishing trend. The rate of growth declined to 5.43%, with an average annual growth of 2.26%. In the fourth phase (2001-2006), the rate of growth in productivity increased to 15.69% with an average of 2.98%. The fifth phase (2006-2011) depicted a negative phase. The rate of growth shrank to -3.27%, and the average annual growth was 0.42%. In the sixth phase (2011-2016), the growth rate became highly negative. The rate of growth decreased to -23.36% with an average annual growth of -4.63%.

Table 2: State-wise productivity of Indian natural rubber - Kerala

Year	Phase	State-wise productivity- Kerala	Annual Growth rate	Growth rate (phase)
1986-87	I	924		16.77
1987-88		942	1.95	
1988-89		967	2.65	
1989-90		1025	6.00	
1990-91		1079	5.27	
1991-92	II	1139	5.56	26.69
1992-93		1203	5.62	
1993-94		1304	8.40	
1994-95		1389	6.52	
1995-96		1443	3.89	
1996-97	III	1529	5.96	5.43
1997-98		1583	3.53	
1998-99		1599	1.01	
1999-00		1612	0.81	
2000-01		1612	0	
2001-02	IV	1612	0	15.69
2002-03		1635	1.43	
2003-04		1715	4.89	
2004-05		1765	2.92	
2005-06		1865	5.67	
2006-07	V	1960	5.09	-3.27
2007-08		1876	-4.29	
2008-09		1948	3.84	
2009-10		1851	-4.98	
2010-11		1896	2.43	
2011-12	VI	1931	1.85	-23.36
2012-13		1903	-1.45	
2013-14		1695	-10.93	
2014-15		1474	-13.04	
2015-16		1480	0.40	

Source: Indian Rubber Statistics, The Rubber Board (Ministry of Commerce and Industry, Government of India)

Productivity- Tamil Nadu

Tamil Nadu holds the second rank in the productivity of Indian natural rubber (Table 3). This state is included in the traditional region of natural rubber. A decreasing trend is evident in Tamil Nadu during 1986 -2016. During 2015-16, the state has the productivity of 1462 kilogram per hectare. The highest growth rate is evident in 1995-1996 period. During this period, the rate of growth was 16.33%. The rate of growth seems to be highly negative in 2014-2015, i.e., -13.04%. While going through the growth rate of different phases, the second phase (1991-1996) showed the highest growth rate among the whole phases. The growth rate was highly negative in the sixth phase (2011-2016). During the first phase (1986-1991), the rate of productivity growth was 7.28% with an average annual growth of 1.84%. In the second phase (1991-1996), the growth rate increased to 21.71%, and the average annual growth was 4.15%. During the third phase (1996-2001), the rate of growth declined to 8.87% with an average annual growth of 2.56%. In the fourth phase (2001-2006) the growth decreased to 2.65% with an average annual growth of 0.52%. The fifth phase (2006-2011) showed negative growth. The rate of growth was -0.30% with an average annual growth of 0.14%. In the sixth phase, the growth rate of production steeply declined to -10.80%, and the average annual growth rate was -2.17%.

Table 3: State-wise productivity of Indian natural rubber – Tamil Nadu

Year	Phase	State-wise productivity- Tamil Nadu	Annual Growth rate	Growth rate (phase)
1986-87	I	1071		7.28
1987-88		1080	0.84	
1988-89		1153	6.76	
1989-90		1188	3.04	
1990-91		1149	-3.28	
1991-92	II	1147	-0.17	21.71
1992-93		1177	2.62	
1993-94		1205	2.38	
1994-95		1200	-0.41	
1995-96		1396	16.33	
1996-97	III	1454	4.15	8.87
1997-98		1475	1.44	
1998-99		1533	3.93	
1999-00		1580	3.07	
2000-01		1583	0.19	
2001-02	IV	1582	-0.06	2.65
2002-03		1582	0	
2003-04		1589	0.44	
2004-05		1584	-0.31	
2005-06		1624	2.53	
2006-07	V	1640	0.99	-0.30
2007-08		1617	-1.40	
2008-09		1612	-0.31	
2009-10		1633	1.30	
2010-11		1635	0.12	
2011-12	VI	1639	0.24	-10.80
2012-13		1640	0.06	
2013-14		1645	0.30	
2014-15		1554	-5.53	
2015-16		1462	-5.92	

Source: Indian Rubber Statistics, The Rubber Board (Ministry of Commerce and Industry, Government of India)

Productivity- Karnataka

Karnataka ranked third in productivity of Indian natural rubber during 2015-2016 and has 1443 kilogram per hectare. A decreasing trend can be evident in productivity in Karnataka during 1986-2016 (Table 4). The highest rate of growth can be evident during 1988-1989, i.e., 15.50% and the lowest growth rate can be seen in the period 2014-2015, i.e., -5.38%. While considering the various phases, the highest growth rate is evident in the first phase, and the lowest rate of growth is shown in the sixth phase. In the first phase (1986-1991), the rate of production growth was 17.11% with an average annual growth of 4.27%. In the second phase (1991-1996), the growth rate decreased to 9.44%, and the average annual growth was 2.39%. During the third phase (1996-2001), the rate of growth again decreased to 5.95% with an average annual growth of 2.37%. In the fourth phase (2001-2006), the growth rate showed a similar trend. The growth rate decreased to 4.87%, with an average annual growth of 0.98%. In the fifth phase (2006-2011) the growth rate increased to 12.47% with an average annual growth of 2.90%. The sixth phase witnessed a negative trend. The growth rate of productivity steeply declined to -5.99%, and the average annual growth rate was -0.19%.

Table 4: State-wise productivity of Indian natural rubber – Karnataka

Year	Phase	State-wise productivity- Karnataka	Annual Growth rate	Growth rate (phase)
1986-87	I	818		17.11
1987-88		858	4.89	
1988-89		991	15.50	
1989-90		996	0.50	
1990-91		958	-3.82	
1991-92	II	985	2.82	9.44
1992-93		1005	2.03	
1993-94		1026	2.09	
1994-95		1057	3.02	
1995-96		1078	1.99	
1996-97	III	1143	6.03	5.95
1997-98		1172	2.54	
1998-99		1174	0.17	
1999-00		1194	1.70	
2000-01		1211	1.42	
2001-02	IV	1212	0.08	4.87
2002-03		1211	-0.08	
2003-04		1225	1.16	
2004-05		1249	1.96	
2005-06		1271	1.76	
2006-07	V	1299	2.20	12.47
2007-08		1280	-1.46	
2008-09		1406	9.84	
2009-10		1460	3.84	
2010-11		1461	0.07	
2011-12	VI	1535	5.07	-6.00
2012-13		1539	0.26	
2013-14		1542	0.19	
2014-15		1459	-5.38	
2015-16		1443	-1.10	

Source: Indian Rubber Statistics, The Rubber Board (Ministry of Commerce and Industry, Government of India)

Productivity- Andaman and other states

Andaman and other states are included in the non-traditional region. North-east states are included in this region. Table 5 showed a decreasing trend in productivity during 1986-2016. The highest growth rate is depicted during the period 1998-1999, i.e., 21.90%. The lowest rate of growth seemed to be negative, i.e., -21.42% during 2015-2016. While considering the various phases, the second phase (1991--1996), showed the highest and the sixth phase (2011-2016) seemed to be the lowest rate of growth. In the first phase (1986-1991), the growth rate was 22.74%, with an average of 5.89%. In the second phase (1991-1996), the growth rate was accelerated to 26.32% with an average annual growth of 5.89%. The third phase (1996-2001), showed a decreasing trend. During this period, the rate of growth declined to 10.76% with an average annual growth of 3.90%. In the fourth phase (2001-2006), the growth rate was steeply declined to 1.99%, and the average annual growth rate was 0.29%. In the fifth phase (2006-2011), the growth rate of productivity again declined to 0.46% with an average of 1.33%. The sixth phase (2011-2016) followed a similar trend, and the rate of growth became negative. The growth rate diminished to -21.42%. The average annual rate of growth was -1.47% during this period.

The diminishing trend in state wise productivity of Indian natural rubber maybe because of farmers' response to its continuous volatility and fall in price. The stoppage of entire tapping in some areas, the decline of continuous tapping days in some other areas, the lack of skilled tappers, the reluctance of planters in maintaining rubber trees by providing fertilizers and controlling weeds are the implications due to the instability and fall in the price of natural rubber. (Chandy, George, and Raj, 2010; Pareed and Kumaran, 2017).

Table 5: State-wise productivity of Indian natural rubber – Andaman and other states

Year	Phase	State-wise productivity- Andaman and other states	Annual Growth rate	Growth rate (phase)
1986-87	I	554		22.74
1987-88		612	10.47	
1988-89		746	21.90	
1989-90		678	-9.12	
1990-91		680	0.29	
1991-92	II	661	-2.79	26.32
1992-93		674	1.97	
1993-94		777	15.28	
1994-95		756	-2.70	
1995-96		835	10.45	
1996-97	III	911	9.10	10.76
1997-98		945	3.73	
1998-99		972	2.86	
1999-00		1006	3.50	
2000-01		1009	0.30	
2001-02	IV	1002	-0.69	2.00
2002-03		989	-1.30	
2003-04		981	-0.81	
2004-05		970	-1.12	
2005-06		1022	5.36	
2006-07	V	1079	5.58	0.46
2007-08		1071	-0.74	
2008-09		1172	9.43	
2009-10		1107	-5.55	
2010-11		1084	-2.08	
2011-12	VI	1181	8.95	-17.36
2012-13		1195	1.19	
2013-14		1198	0.25	
2014-15		1242	3.67	
2015-16		976	-21.42	

Source: Indian Rubber Statistics, The Rubber Board (Ministry of Commerce and Industry, Government of India)

Analysis on supply response of Nerlovian model on area, production and productivity

For studying the supply response in the productivity of Indian natural rubber Nerlove's Supply Response Theory was based and for describing the same, multiple regression model was used. Supply response analysis of Nerlove (1958) tradition was performed on output and tapped area administering the specification followed by (Soekartawi, 1983) assuming away the presence of surrogate for non-price factors.

Supply response of Nerlovian model on productivity

In an attempt to examine the effect of change in price (ΔP_t) and productivity in the previous period (R_{t-1}) on productivity in the current period, a regression model with the following specification was used.

$$R_t = \psi_0 + \psi_1 \Delta P_t + \psi_2 R_{t-1} + \omega_t \quad (1)$$

The model was statistically significant ($p < 0.01$). R_t increased by 0.896 units with a unit increase in R_{t-1} ($p < 0.01$). A unit increase in change in price (ΔP_t), increased productivity by 0.016 units ($p = 0.016$) (Table 6 and Table 7).

Table 6: Regression model of productivity: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.978	.956	.953	61.40209

Table 7: Regression model of productivity: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
	(Constant)	167.246	58.427		2.862	.008
	ΔP_t	.016	.006	.106	2.579	.016
	R_{t-1}	.896	.039	.959	23.261	.000

7.2 Conclusion

The study examined the trend in productivity of natural rubber in India during 1986- 2016. A declining trend was found in the entire productivity of natural rubber during the period.

Kerala leads in productivity of natural rubber, and at the same time, the state along with Tamil Nadu, Karnataka, Andaman and other states witnessed a downfall in productivity. While analysing the supply response, the current productivity is increased by 0.896 units with a unit increase in previous period productivity and a unit increase in change in price increased the productivity by 0.016 units.

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