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Returns to Scale and Elasticity of Natural Rubber Production in Kerala, India.

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Abstract:

In India, the state of Kerala has a positive approach on the cultivation of rubber and it provides gigantic contribution in country's gross national income. Eventually, the rubber cultivators have been passing through various positive and negative upshots. The study primarily focussed to analyse natural rubber production in Kerala, India and it observed returns to scale, determinants and elasticities of natural rubber production. Both primary and secondary data applied in the present study. The primary data were gathered through structured questionnaires from 384 respondents. For the data collection random sampling technique were applied. The secondary data is carried out a time span of 34 years. The secondary data were analysed through curve estimation and regression model. From the curve estimation model found that three different stages of production namely, increasing returns, constant returns and diminishing returns especially in the time series data. The coefficient magnitude of natural rubber's production function estimated from primary data and in which applied multiple regression model. The result summary explained the elasticity of natural rubber production is in the stages of diminishing returns. The study found that the most of the determinants have positive significant effect on natural rubber production in Kerala.

Keywords: natural rubber, production, returns to scale, elasticity, growth trend, Kerala, India.

1.1.Introduction

In India, Rubber is a significant plantation product and it is one of the main incomes contributing sector in the total agricultural production. India is the fifth largest producer and the third largest consumer of natural rubber in the international economy (International Rubber Study Group, 2017) (Rubber Board, 2019). It has a directly and indirectly influenced on the socio-economic conditions of huge number of people in the country in terms of employment, livelihood support and export earnings. Mainly because of high aggregate consumption (in 2008-09 it was 871,720 tonnes and increased to 1,211,940 tonnes in 2018-19), import of rubber touched a record 582,351 tonnes in 2018-19 but at the same time the export of rubber only 4,551 tonnes. In the rubber market confronted a huge import – export gap. India's natural rubber production fallen by from 864,500 tons in 2008 to 651,000 tonnes in 2018-19.

Natural Rubber (NR) is one of the prime commodities of the South Indian state of Kerala, which is the foremost producer of rubber among the states in India. India's total rubber production, Kerala contributes 90 percentage (Rubber Board Statistics, 2019). Kerala economy is the leading

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position in rubber market even though Kerala economy domestic supply of rubber has not been able to meet up with consumption demand, there is therefore the need to examine what are the factors that affect the rubber production. Therefore, to understand this crisis more properly and to identify the present scenario of the rubber farmers in Kerala the study is to examine the long- run production trend and analysed different constraint factors among farmers in Kerala.

1.2 Objective of the study

1. To analyse the long run growth trend natural rubber production in Kerala
2. To determine the applicability of returns to scale in natural rubber production
3. To examine various constraint determinants of natural rubber production in Kerala.

1.3 Theoretical Background

In economics, theory of production was analysed in short and long run through law of variable proportion and law of returns to scale respectively. These theorems mainly focussed to explain the technical relationship between various inputs or raw materials and output. Through these theorems the economists develop mathematical derivation and diagrammatical presentation. Through the input- output relations generated different levels of returns. According to Alfred Marshall, "*the law of variable proportion represents short run production function it can be expressed as* $Q = f(N, \overline{K, L, T})$*, where Q is the quantity produced N is the variable factor i.e., labour and K,L, T are capital, land and technology respectively and in this theorem assume that these variables are constant in the short-run*". In the long- run explained through law of returns to scale and in the input – output relation this theorem assume that all inputs are varying. Another important production function is the *Cobb – Douglas production function* with constant returns. In general, the Cobb-Douglas production function is useful in both macro level as well as micro level to analyse the input and output relationships.

1.4. Method and Methodology

Both primary and secondary data included for the sample analysis. The authenticated secondary sources used in this study like Rubber Board statistics, Economic Survey (various issues), Journals, Newspapers etc. The secondary data is carried out a time span of 34 years. In this study, time as taken as an independent variable and identified a non-linearity in the time series data. Thus, in this context here applied 11 different curve estimation regression models are tested. The models are listed below:

(1) Linear	$E(Yt)=\beta 0+\beta 1t$
(2) Logarithmic	$E(Yt)=\beta 0+\beta 1\ln(t)$
(3) Inverse	$E(Yt)=\beta 0+\beta 1/t$
(4) Quadratic	$E(Yt)=\beta 0+\beta 1t+\beta 2t2$
(5) Cubic	$E(Yt)=\beta 0+\beta 1t+\beta 2t2+\beta 3t3$
(6) Compound	$E(Yt)=\beta 0\beta t1$
(7) Power	$E(Yt)=\beta 0t\beta 1$

(8) S	$E(Yt)=\exp(\beta 0+\beta 1/t)$
(9) Growth	$E(Yt)=\exp(\beta 0+\beta 1t)$
(10) Exponential	$E(Yt)=\beta 0e\beta 1t$
(11) Logistic	$E(Yt)=(1u+\beta 0\beta t1)-1$
Source: (IBM, 2020)	

In the study, two districts are selected for primary data analysis from Kerala namely, Kottayam and Ernakulam. The sample area was selected on the basis on the size of cultivated land area. Kottayam and Ernakulam are major rubber growing districts in the state of Kerala and it being a traditional rubber growing region (Rubber Board, 2019). Well-structured questionnaires were used to acquire appropriate statistics from 384 respondents from sample area. The primary data were analysed using frequency distribution, percentage distribution and by employing Multiple Regression Model.

1.5. Result Analysis and Interpretation:

1.5.1. India's Natural Rubber (N R) Production trend: Long -run time series analysis

For empirical analysis, here used time -series data (1985-86 to 2018-19) of natural rubber production of India. The long- run total production trend of natural rubber in India analysed through 11 different types of regression models (Revathi, 2019). Model summary and parameter estimates are described in Table 1.

Table I -Model Summary and Parameter Estimates

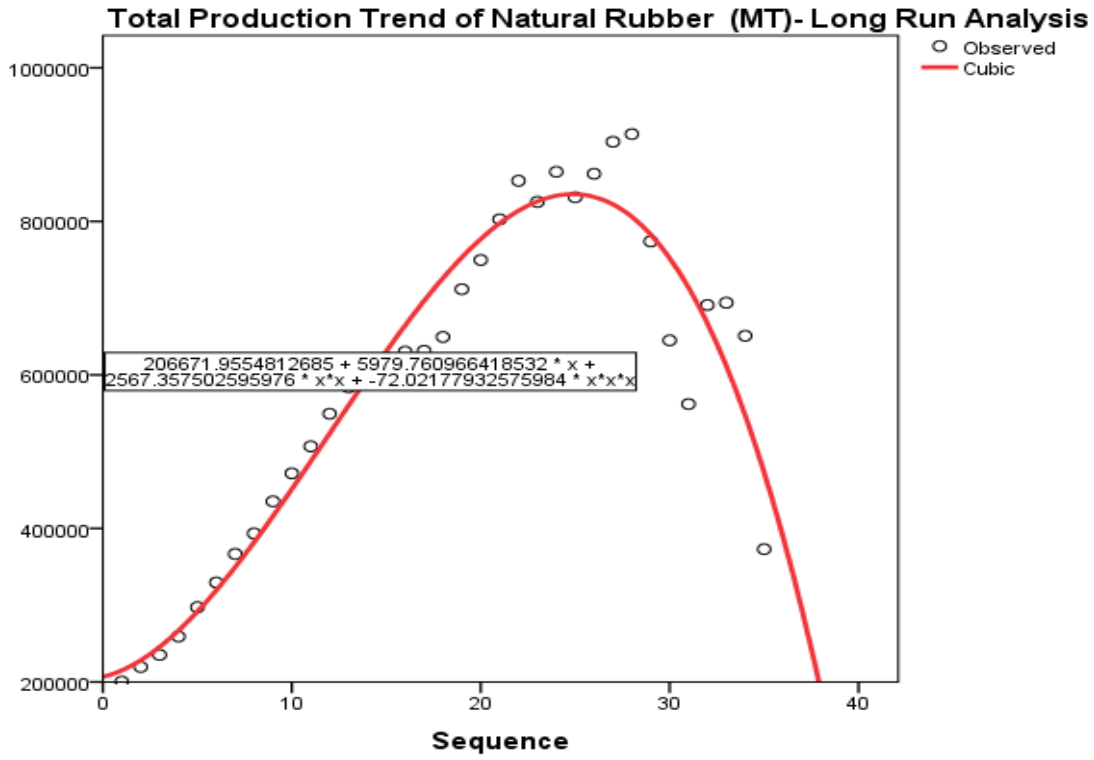
Dependent Variable: Production (MT)									
Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	.531	37.376	1	33	.000	317842.961	15190.667		
Logarithmic	.674	68.291	1	33	.000	56371.613	203195.080		
Inverse	.421	24.041	1	33	.000	681574.667	-762154.794		
Quadratic	.858	97.011	2	32	.000	24399.236	62776.136	-1321.819	
Cubic	.934	147.155	3	31	.000	206671.955	5979.761	2567.358	-72.022
Compound	.556	41.257	1	33	.000	308992.112	1.032		
Power	.779	116.509	1	33	.000	169453.736	.444		
S	.565	42.795	1	33	.000	13.422	-1.794		
Growth	.556	41.257	1	33	.000	12.641	.032		
Exponential	.556	41.257	1	33	.000	308992.112	.032		
Logistic	.556	41.257	1	33	.000	3.236E-006	.969		

As is evident from Table 1, R - square value in the **cubic regression** related to other models is very high and it clearly proved the goodness of fit of **"F test".** The estimated parameter values mentioned in this model helps to explain the returns of rubber production in the long run.

The **observed value of rubber production of India in the long run** is explained in the following regression form:

$= 2667.9554812685 + 5979.76966418532x + 2567.35752595976x^2 + -72.02177932575984x^3$ ……. (1)

The observed regression values are used for diagrammatical explanation of natural rubber production explained in the Figure 1



Here applied a long run time series analysis but the estimated diagram similar to law of variable proportions.

"The law of variable proportion was propounded by Alfred Marshall and neo-classical economists for analysing short run production trend. The main tenant of this law is that only one variable is varying and keeping the other factors are given. In this law, the total production trend is illustrated through three stages, namely, increasing returns, diminishing returns and negative returns. The production returns show that the efficiency of fixed factors as related to additional units of the variable factor. This theorem is applied to short-run analysis of production trend."

Thus, here in the long run all variables are varying and even though the production trend of natural rubber passing through three stages. In the first stage, total production trend of natural rubber increases at a cumulative rate up to a point and up to that point the outline of total output curvature is upward; in the second stage it moves to the saturated stage and in the third stage here identified that

the natural rubber production faced deeply diminishing trend. Thus, one of the theoretical challenging result of the study is that the slope of the derivation and its curve in the long run application and it in contradiction of "Law of Returns to Scale".

1.5.2. Constraint Determinants of natural rubber production

In the study output level of each cultivator is considered as dependent variable in Kilogram (Kg) at time t. The independent variables are labour, input cost, fertilizer subsidy, land (in acres) experiences of farmers, credit, and inter cropping. Thus, below mentioned production function has applied to explore the factors that influence rubber production in the study area of Kerala.

$$Qt = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The independent variables are labour, input cost, fertilizer subsidy, land (in acres), Experience of farmer, credit, inter cropping.

Table 2

Reliability analysis on the various determinants of production function

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.610
Bartlett's Test of Sphericity	Approx. Chi-Square	4091.797
	Sig.	.001
Source: computed from primary data	5 percent level of significance	

Ho: there is a no significant relationship between determinants of production function and output of rubber in the short-run.The model summary of multiple regression shows the overall predictability of the regression model. In the model summary result shows adjusted R^2 value is 0.713 and it depicts that all independent determinants of production function have 71.3 percent influence on the output. Therefore, it is inferred that the determinants of production function have an effect on the level of output. Analysis of variance shows that, a very appropriate statistically significant result with p-value is 0.000. Thus, test report supported research hypothesis. This shows that the determinants of production function are closely associated and have a significant positive effect on the output of natural rubber in Kerala.

The coefficient values of independent variables are mentioned in the table 3

Table 3

Coefficients of natural rubber production

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	.999	.052		19.200	.000
Labour	.086	.013	.314	6.458	.000
Fertiliser subsidy	.131	.011	.511	11.607	.000
Intercrop	.026	.017	.081	1.593	.004
Land	.133	.011	.520	11.910	.000
Credit	.101	.012	.383	8.093	.000

Input cost	.020	.018	.055	1.076	.004
Farmer's Experience	.122	.012	.473	10.484	.000

a. Dependent Variable: Output

The production function of natural rubber was analysed through sample data and statistical result is presented in Table 3. The result stated that there is a positive association between output of natural rubber and all other independent variables. This suggests that, all these independent variables as more and more are used, there will be an upsurge in total output of rubber. Among independent variables three variables are significant at 5% level.

1.5.3. Elasticity of natural rubber production:

To identify the elasticity rubber production mainly consider three variables namely, land, labour and input cost (Sriyalatha, 2018). The natural rubber production's elasticity and returns to scale mentioned in the table

Table 4
Elasticity of Rubber Output/Production and Returns to Scale (RTS) of Natural Rubber

Variables of natural rubber production	Elasticity
Land	.520
Labour	.314
Input Cost	.055
Returns to Scale (RTS)	0.889

Table 4 indicates that the input elasticity of the variables related to natural rubber. From the model summary identified that land, labour and input cost have positive coefficient. The study revealed that all coefficient values related to input are less than unity elasticity (Es <1). Thus, elasticity value indicates that in the short run rubber production attained diminishing returns to scale. Thus, the rubber cultivators in the short run moving to the third stage of production.

1.6. Conclusion

The time series data of natural rubber production explains a controversial result and in which attained three returns namely, increasing returns, constant returns and diminishing returns. From the short-run sample data analysis identified that there are several constraint factors that determine for the production level of the natural rubber production. In the long run analysis considered India as general and short run analysis only focused on Kerala. All variables in the study were attained significant result.

Bibliography

1. Amarnath Tripathi and A R Prsad. (2009, November). Agricultural development in India since Independence: A Study on Progress,Performance and Determinants. *Journal of Emerging Knoweledge on Emerging Markets, 1*(1), 9

2. Armstrong & Scott. (2012). Illusions in Regression Analysis. International Journal of forecasting (Forthcoming), 28 (3), 689.

3. Biswas, S. P. (2014). *The role of trade - led economic growth in fostering development: lessons for the post 2015 development agenda.* World Trade Organisation, Economic Research and Statistics Division.

4. George, J. G., & Chandrashekar, H. M. (2014). Growth and trends in production and marketing of natural rubber in Kerala, India. *Int J Curr Res Aca Rev*, *2*(8), 53-61.

5. Rubber Board. (2019). *Rubber Board Statistics.* Kottayam: Rubber Board , Kerala.

6. IBM. (2020). Curve estimation. *Data analysis, Linear Regression*. IBM.

7. International Rubber Study Group. (2017). *Natural rubber.* International Rubber Study Group.

8. Revathi, K. S. (2019). *Economic facet and export performance of black pepper and cardamom in the WTO epoch with reference to Kerala, India.* Kottayam: M G University.

9. Liyanage, S., & JACOB, C. K. (1992). Diseases of economic importance in rubber. In *Developments in crop science* (Vol. 23, pp. 324-359). Elsevier.

10. Nair, S. T. G. (2019). Recession effect in pricing efficiency of rubber futures: the emerging market's experience. *Journal of Agribusiness in Developing and Emerging Economies*.

11. Nguyen, B. T. (2013). Large-scale altitudinal gradient of natural rubber production in Vietnam. *Industrial Crops and Products*, *41*, 31-40.

12. Thomas, S. (2017). Natural Rubber Based Research and Developments in Indian Rubber Industry. *NIPPON GOMU KYOKAISHI*, *90*(3), 72-76.

13. Sriyalatha, M. (2018, September). Factors Affecting Natural Rubber Production: Case Studyof Small Rubber Farmers In Kalutara District, Sri Lanka. *IOSR Journal of Business and Management (IOSR-JBM), 20*(9), PP 64-73.

14. Teniwut, Y. K., Marimin, M., & Indrasti, N. S. (2017). Spatial intelligent decision support system for
15. increasing productivity on natural rubber agroindustry by green productivity approach. *International Journal of Productivity and Performance Management*.