International Journal of Multidisciplinary Research and Modern Education (IJMRME)
Impact Factor: 7.315, ISSN (Online): 2454 - 6119
(www.rdmodernresearch.org) Volume 5, Issue 1, 2019

TREND AND GROWTH RATE OF LAC PRODUCTION IN PURULIA DISTRICT, WEST BENGAL

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Cite This Article: Ashis Kr. Mukherjee & Moumi Laha, "Trend and Growth Rate of Lac Production in Purulia District, West Bengal", International Journal of Multidisciplinary Research and Modern Education, Volume 5, Issue 1, Page Number 111-117, 2019.

Abstract:

Lac is a sticky resinous substance secreted by tiny variety of lac insects. Lac cultivation is the oldest and most visible economic activity in Purulia district since time immemorial. In Purulia there is plenty of host trees, thus the district is famous for lac production A large part of total Lac production in west Bengal comes from the Purulia district. Lac cultivation was once the main economic activity of the district and it was the main source of income for villagers because the land and its texture and climate were not congenial for traditional cultivation of paddy etc. But in recent years production of Lac is not satisfactory. Data on lac production over the period 1982-83 to 2011-12 have been considered in this analysis. The total period of time is divided into three parts (10 years each) and trend and growth rate of lac production in Purulia district has been shown. Further trend coefficient of lac production has also been put into focus. The result however highlights that both the trend of lac production and growth rate over this 30 years have shown a declining trend. For calculation of growth rate of lac production in Purulia, semi-log model has been considered and it clearly shows that the growth rate is negative. Several economic, technological, structural and climatic factors are responsible for this declining trend and growth rate. Among these factors we have shown the effect of mean maximum temperature on lac production particularly summer season during this period and getting a conclusion that there exists a negative relationship between these two variables.

Introduction:

Lac is a natural resin of animal origin.it is secreted by an insects, known as lac insect. In order to obtain lac, these insects are cultured and the technique is called lac-culture.The insects live as a parasite, feeding on the sap of certain trees and shrubs. The important trees on which the lac insects breed and thrive are-kusum, Palas, Babul, Ber, khair, etc. Lac cultivation involves proper care of host plants, regular pruning of host plants, propagation, collection and processing of lac.The cultivation of Lac involves very simple operations. In general, Lac cultivation involves climbing on trees for pruning, tying of broodLac bundles on host trees at different places, harvesting and spraying of pesticides are done by male labourers, while bundling and selection of broodLac, collection of Phunki, and collection of harvested Lac sticks, scraping of Lac encrustation from twigs etc. are carried out by females for which manual and power operated mechanical scrapers have been developed. Lac is used for various purpose such as-varnishes, for making jewellery, coating cable insulation, toys, sealing wax etc. Lac cultivation is the oldest and most visible economic activity in Purulia district since time immemorial. In Purulia there is plenty of host trees, thus the district is famous for lac production. Ninety percent of Lac is produced on Palash, Beer and Kusum trees. Lac cultivation was once the main economic activity of the district and it was the main source of income for villagers because the land and its texture and climate were not congenial for traditional cultivation of paddy etc. The natural forests of the district are mostly of mixed nature and restricted to north-west part of the district covering Ajodhya Hills and Pancheet Hills of north-east. These types of thick jungles are the favourite haunts of the Lac-insect and it is found in large numbers in the forest-clad tracts of this district.So Lac production is very much profitable for this district. Over the period of time the prominence of Lac cultivation has lost its position as main economic activity due to several climatic, technological, structural and economic factors and now plays the role of supporting economic activity. In Purulia district, the main region of Lac cultivation is Tulin, Jhalda, Baghmundi, Manbazar, Bandowan, Garhjaipur, Raghunathpur and adjacent places.

Objectives:

The main objectives of our study are as follows

- To analyse the trend ofLac production from 1982-83 to 1991-92.
- To analyse the trend of Lac production from 1992-93 to 2001-02.
- To analyse the trend of Lac production from 2002-03 to 2011-12.
- To analyse the trend Coefficient of lac Production over the Years.
- To analyse the Growth Rate of Lac Production in Purulia District.
- To analyse the effect of mean maximum temperature on Lac production.

Study Area:

Our study area is at Purulia. The district is located in the western side of west Bengal. This district is between 22°42'35" and 23°42'0" north latitude and 85°49'25" and 86°54'37"east longitude. The geographical area of the district is 6259 km². This district is bordered on the east by Bankura, Paschim Medinipur districts, on the north by Bardhaman district of West Bengal state and Dhanbad district of Jharkhand state, on the west by Bokaro and Ranchi districts of Jharkhand state and on the south by West Singhbhum and East Singhbhum districts of Jharkhand state. The district is an integral part of Chhotonagpur plateau. The district headquarter situated in Purulia town itself, having three administrative sub division and two agricultural subdivision having headquarter one at Purulia town and another one at Raghunathpur . The total geographical area of the district is 6259 sq. kms (Census 2001). Out of which the Urban and Rural areas are 79.37 sq. kms (1.27%) (Municipalities & Non-Municipalities) and 6179.63 sq. kms (98.73 %) respectively. Purulia is the westernmost district of West Bengal. It acts as a gateway between the developed industrial belts of West Bengal and the hinterlands in Orissa, Jharkhand, Madhya Pradesh and Uttarpradesh.

Data & Methodology:

The paper is based on secondary data sources. Any change in weather particularly temperature would affect the production of the Lac. To show how mean maximum temperature affect Lac production, we use time series monthly data of mean maximum temperature covering the period 1982-2011. The climate data and Lac production data were collected from the secondary sources like District Statistical Handbooks, Economic Reviews and Statistical Abstract of different years. Apart from these, a number of articles published in various national and international journals have also been consulted for the purpose. Here we consider average of mean maximum temperature for the monthsApril,May and June. We use mean maximum temperature as independent variable and Lac production as dependent variable. In order to estimate the impact of the climatic variables on production of Lac, we have planned to estimate a linear model. This model helps us to measure the change in lac production (Y) for a given absolute change in the value of the regressor.Here, we used ordinary least square technique to determine the relationship between the Lac production and climatic variables, namely mean maximum temperature for the Lac cropping zone of Purulia. For the present study the following model has been used.

$$Y_t=\alpha_0+\alpha_1X_1+U_t$$

Where, Y_t= total Lac production (in metric tonnes). X_1 = average of mean maximum temperature in the month of April, May, June (in centigrade) α_1 ,α_2 = the regression coefficients. α_0 = intercept term, and U_i = error term. We also calculate growth rate of lac production using semi-log model of the form

$$Y_t=Y_0(1+r)^t$$

Where r = compound rate of growth of Y.

t = Time, Y_0= Initial production

Again,to calculate the changes in the growth rate of lac production the formula for Compound Annual Growth Rate (CAGR) has been used. The growth rates have been expressed as percentages.

CAGR can be calculated by using the formula,

$$CAGR= (t_n/t_{n-1})^{1/t_n\ -t_0}-1$$

Where t_{n-1} = value in the initial period

t_n = value in the final period

t_n-t_{n-1} = number of years.

We also use different statistical tools like, t-test, F-test etc, different types of charts and diagram.

Result & Discussion:

Trend of the production of lac from 1982-83 to 1991-92: In this study the main aim is to highlight the production scenario of lac in Purulia district. We start the period from 1982-83 to 2011-12. Total lac production of Purulia in comparison with that of West Bengal has been given here. Side by side annual growth rate of lac production is also taken under consideration in the table below. Here we consider the study period from 1982-83 to 1991-92. In that period production varies from 488 M.T to 2205 M.T. In the following table we show the year wise total lac production of Purulia district and annual growth rate of production in percentage figure.

Table 1: Production Statistics from 1982-83 to 1991-92

Year	Purulia	West Bengal	India	% of West Bengal	% of India
1982	488	523	13420	93.31	3.897
1983	497	532	11605	93.42	4.584
1984	1005	1025	12955	98.05	7.912
1985	1745	2070	18175	84.3	11.39
1986	1440	1800	20340	80	8.85
1987	945	1070	14600	88.32	7.329
1988	1255	1390	15000	90.29	9.267
1989	2205	2295	17345	96.08	13.23
1990	1518	1725	18000	88	9.583

1991	950	1020	10810	93.14	8.788

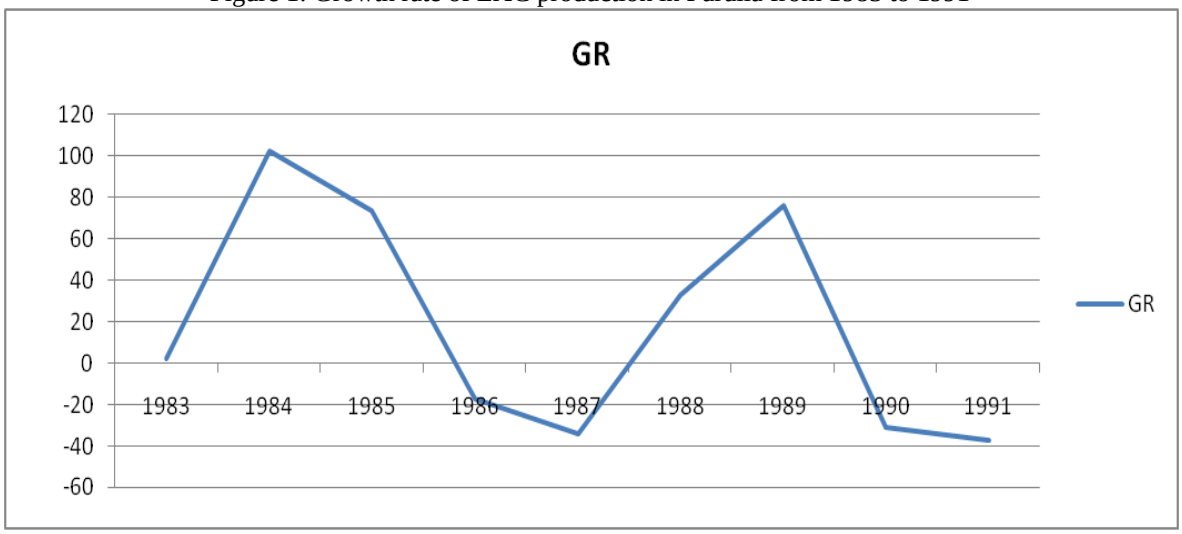
The year wise data of LAC production vis-a-vis percentage of state level and country level production reveals that highest production in all respect was in the year of 1989. During the time period 1982 to 1991, 80-98% of the state lac production comes from the district Purulia. In 1989, 2205 metric tonnes LAC was produced in Purulia which is 96.08% of the total state production and 13.23% of the nation.

Table 2: Growth Rate of Lac Production from 1982-83 to 1991-92

Year	Purulia	Growth Rate
1982	488	--
1983	497	1.84
1984	1005	102.21
1985	1745	73.63
1986	1440	-17.48
1987	945	-34.37
1988	1255	32.80
1989	2205	75.70
1990	1518	-31.15
1991	950	-37.42

From 1982-83 to 1986-87, production increases continuously but in the year 1987-88 production decreases near about 34.5%. In this year 945 M.T LAC was produced. Although in 1988-89 production increases and reaches 1255 metric tonnes. In this year the rate of growth of LAC production is near about 33%. But increasing tendency is short lived and the production started decreasing. In 1991-92 the rate of growth of production decreases 37.42%. In the following chart we present diagrammatically the growth rate over the study period. It helps for better understanding the fluctuation nature of production.

Figure 1: Growth rate of LAC production in Purulia from 1983 to 1991



Trend of the production of lac from 1992-93 to 2001-02: In the Table, the analysis is concentrated for the study period from 1992-93 to 2001-02. Within this time period the Lac production varies from 955 M.T to 2795 M.T. Here we show the year wise total Lac production of Purulia district and annual growth rate of production in percentage figure.

Table 3: Production Statistics from 1992-93 to 2001-02

Year	Purulia	West Bengal	India	% of West Bengal	% of India
1992	1365	1455	11685	93.81	11.68
1993	2795	3560	20520	78.51	13.62
1994	2525	3245	22460	77.81	11.24
1995	958	1238	20080	77.38	4.771
1996	1480	2830	19840	52.3	7.46
1997	1998	2278	15846	87.71	12.61
1998	1850	2070	10355	89.37	17.87
1999	955	985	11956	96.95	7.988
2000	1121	1260	20600	88.97	5.442
2001	1228	1350	20450	90.96	6.005

The year wise data of Lac production reveals that highest Lac production in Purulia was 2795 metric tonnes which is 78.51% of total state production and 13.62% of the nation in the year 1993.However maximum

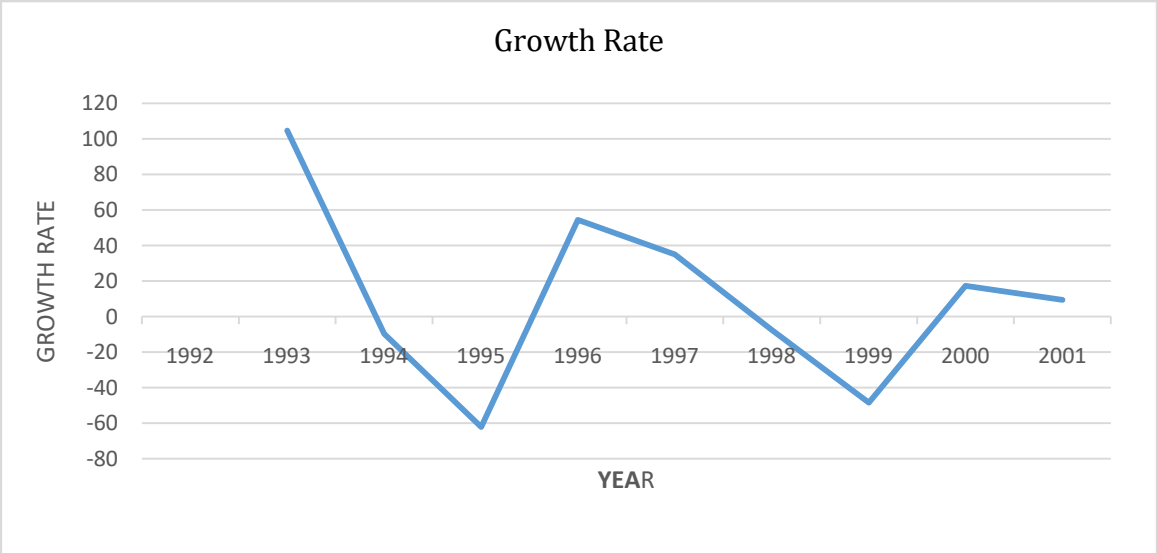
share of Purulia's lac production to state (WB) was 96.95% in the year 1999 and in case of India it was 17.87% in 1998.During the time period 1992 to 2001, 50% to 96% of the state lac production comes from the district Purulia.

Table 4: Growth Rate of Lac Production from 1992-93 to2001-02

Year	Purulia	Growth Rate
1992	1365	
1993	2795	104.76
1994	2525	-9.66
1995	958	-62.06
1996	1480	54.49
1997	1998	35
1998	1850	-7.41
1999	955	-48.38
2000	1121	17.38
2001	1228	9.54

From 1992 to 1994, production increases continuously but in the year 1995 production decreases near about 62%. In this year 958M.T LAC was produced. Although from 1996 to 1998 production increases and reaches 1850 metric tonnes. In 1997 the rate of growth of LAC production is near about 35%. But increasing tendency is short lived and the production decreases to 955M.T and growth rate decreases to 48% in 1999. But in 2000 the rate of growth of production increases 17.38%. In the following chart we present diagrammatically the growth rate over the study period. It helps for better understanding the fluctuation nature of production.

Figure 2: Growth rate of LAC production in Purulia from 1992-93 to 2001-02



Trend of the production of lac from 2002-03 to 2011-12: In the Table, the analysis is concentrated for the study period from 2002-03 to 2011-12. Within this time period the Lac production varies from 40 M.T to 1256M.T. Here we show the year wise total Lac production of Purulia district and annual growth rate of production in percentage figure.

Table 5: Production Statistics from 2002-03 to 2011-12

Year	Purulia	West Bengal	India	% of West Bengal	% of India
2002	746	835	17500	89.34	4.263
2003	1129	1270	20500	88.9	5.507
2004	1256	1395	21300	90.04	5.897
2005	842	926	18000	90.93	4.678
2006	365	1240	23229	29.44	1.571
2007	110	1140	20640	9.649	0.533
2008	95	830	17175	11.45	0.553
2009	40	855	16495	4.678	0.242
2010	120	1435	9035	8.362	1.328
2011	70	1400	17900	5	0.391

The year wise data of Lac production reveals that highest Lac production in Purulia was 1256metric tonnes which is 90.04% of total state production and 5.897% of the nation in the year 2004.However maximum share of Purulia's lac production to state (WB) was 90.93% in the year 2005 and in case of nation it was

5..897% in 2004.In the initial period from 2002 to 2005, 80 to 90% of state lac production comes from Purulia district. However in the following year the share of lac production decreases drastically for both state and nation.

Table 6: Growth Rate of Lac Production from 2002-03 to 2011-12

Year	Purulia	Growth Rate
2002	746	
2003	1129	51.34
2004	1256	11.25
2005	842	-32.96
2006	365	-56.65
2007	110	-69.86
2008	95	-13.64
2009	40	-57.89
2010	120	200
2011	70	-41.67

From 2002 to 2004, production increases continuously but from the year 2005 production decreases drastically. In 2003 and 2004 growth rate was 51.34% and 11.24% respectively. Although the growth rate was pretty much low in these two years but positive. In the following year, from 2005 onwards the growth rate shows a negative trend, except in the year 2010, which is 200%. In 2007 the rate of growth lac production decreases near about 69% and in 2011 it falls to 42%. In the following chart we present diagrammatically the growth rate over the study period. It helps for better understanding the fluctuation nature of production.

Figure 3: Growth rate of LAC production in Purulia from 2002-03 to 2011-12

Trend Coefficient of Production Over the Years from 1981-82 to 2011-12: The growth of Lac production over the years may be studied by fitting a straight line trend equation to the time-series data covering the period 1982-83 to 2011-12. Let the trend equation be in the form:

$$Y = a + bt$$

Where, Y = Production and t = Time,
a , b are the parameters.

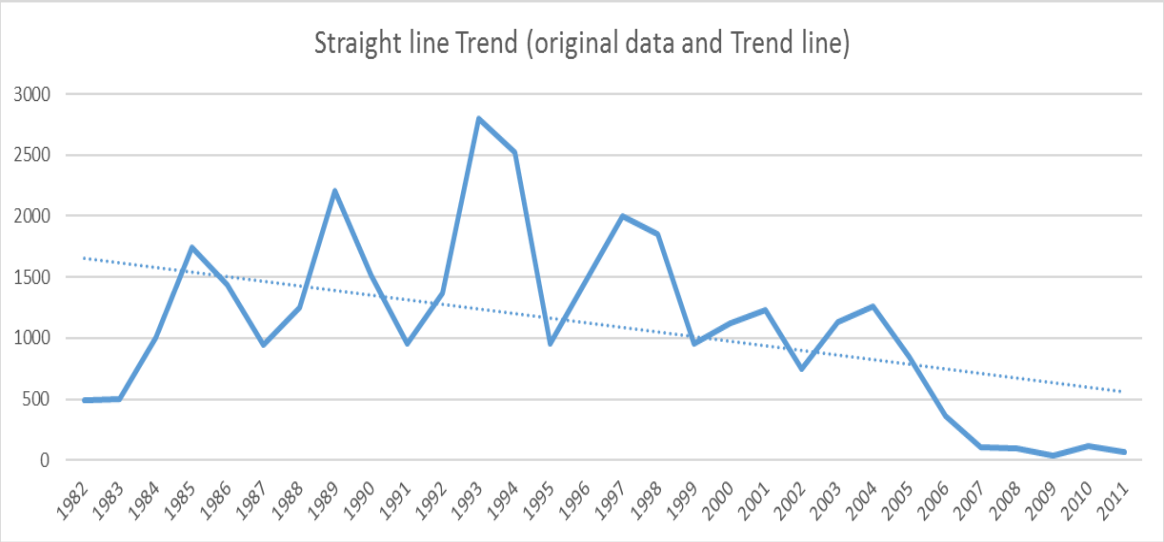
The parameters can be determined by the method of Ordinary Least Square.To explain the trend in Lac production in Purulia district, we fit a straight line trend by the method of least square.
Regress Y_t on t we get the following trend equation,

$$Y=1103.2-18.85X$$

S.E (119.46) (6.900)
t - value (9.235) (-2.732)
p - value (0.000) (0.010)

The slope of the line is -18.85. We know that the slope represent the change in the value of Y (Lac production) for a unit increase in X. Since slope is negative the annual decrease in the production of Lac is 18.85 units. So the condition of Lac production in this district is very poor. If the trend continues then from the above result we say that in 2025 (t=57) estimated Lac production is near about 28.75 metric tonnes, which is very very low for the district. The trend line and the original data be shown in the following figure. Since slope is negative the trend line is downward sloping.

Figure 4: Straight Line Trend Equation (Original and Trend Line)



Over the period of 30 years from 1982-83 to 2011-12, a linear declining trend in Lac production is observed, the trend coefficient being -18.85, shows negative relationship between production(Y) and time(X). Thus the figure clearly shows that production decreases as time goes on.

Growth Rate Calculation of Lac Production in Purulia District: To calculate the growth rate of Lac production in Purulia district we use the following model:

$$Y_t=Y_0(1+r)^t$$

Where r = compound rate of growth of Y.

Taking logarithm both side,

$$\text{In } Y_t=\text{In}Y_0+t \text{ In}(1+r).....(i)$$

Let $\beta_1 = \text{In}Y_0$ and $\beta_2=\text{In}(1+r)$

Then from (i) we can write $\text{In}Y_t = \beta_1 + \beta_2 t$

Adding the disturbance term we obtain,

$$\text{In}Y_t = \beta_1 + \beta_2 t + U_t$$

This model is called semi-log model. For descriptive purpose a model in which the regress and is logarithmic will be called a log-lin model.

Let Y_t= Lac production, t= time variable, Ut= random error term.

Now regressing $\text{In}Y_t$ on t we get the following estimated equation,

$\text{In}Y_t$= 2.874 - 0.0167 t

S.E	(0.072)	(0.0042)	
t-value	(39.90)	(-4.01)	
p-value	(0.000)	(0.000)	R^2= 0.36

In this model the slope coefficient measures the constant proportional or relative change in Y for a given absolute change in the value of the regress or. That is,

β_2= (relative change in regress and)/ (absolute change in regress or)

From the above regression result we say that the production of Lac in Purulia district decline at the rate of 1.67 percent.

We find that,

$$\text{In}Y_0 = 2.874$$

Or, $Y_0 = 17.71$.

That is, at the beginning of 1982 the estimated Lac production was about 17.71 metric tonnes. The slope coefficient of 0.0167 of the growth model gives the instantaneous rate of growth.

We can write,

$$\text{In}(1+r) = -0.0167$$

Or, (1+r) = 0.9834

Or, r = - 0.01656

That is over the study period the compound rate of growth of Lac production was about 1.656 percent per year. This growth rate is slightly lower than the instantaneous growth rate.

Effect of Temperature on Lac Production: Impact of temperature on lac production during the period 1882-83 to 2011-2012 has been analysed in this paper, which reveals that due to high temperature, production of lac decreases in this district. The district has a sub-tropical climate and is characterized by high evaporation and low precipitation. Temperature is very high in summer and low in winter – it varies from 3.8^{o}C in winter to 52^{o}C in summer, causing dryness in moisture. The scientists say that a high temperature during the summer months is

crucial as these months coincide with the pre sexual and sexual maturity of lac insect. Increase in temperature leads to high mortality rate in lac insects. According to scientists a high temperature disturbs gender ratio among lac bugs. Let us study the effectiveness of temperature on lac production, particularly during summer season, i.e. the month of April, May, and June in this district. Here we consider the data of lac production and the average mean maximum temperature of the months April, May and June. Considering lac production as dependent variable (Y) and average mean maximum temperature (X) as independent variable we regress Y on X and get the following result. The estimated regression equation is

$$Y = 6772.46 - 155.89\ X$$

S.E	(3260.48)	(89.58)
t-Value	(2.077)	(-1.740)
p-Value	(0.047)	(0.093)

Since the slope coefficient is negative implies that with the increase in temperature, production of lac decreases. From the above result we can say that if mean maximum temperature increases by one degree then production of lac decreases by 155.89 metric tons.

Conclusions:

The main findings of the study are:

- From the year 1982-83 to 1986-87, production of lac increases continuously but in the year 1987-88 production decreases near about 34.5%. In that period production varies from 488 M.T to 2205 M.T.
- In the year 1993-94 Lac production is highest in Purulia. It was 2795 metric tonnes which is 78.51% of total state production and 13.62% of the nation in the year 1993.From 1992 to 1994, production increases continuously but in the year 1995 production decreases near about 62%.
- The year wise data of Lac production from 2002-03 to 2011-12 reveals that highest Lac production in Purulia was 1256 metric tonnes which is 90.04% of total state production and 5.897% of the nation in the year 2004.
- Over the period of 30 years from 1982-83 to 2011-12, a linear declining trend in Lac production is observed, the trend coefficient being -18.85, shows negative relationship between lac production and time.
- Over the study period the compound rate of growth of Lac production was about 1.656 percent per year.
- It is find that with the increase in temperature production of lac decreases. If mean maximum temperature increases by one degree then production of lac decreases by 155.89 metric tons.

As a whole we can conclude that actually Purulia had a virtual monopoly in the production of lac and since 1982 to 2001 it has a favourable increase in lac production, though the ups and downs in the growth rate are repeating in regular interval. But it is observed that during last 10 years i.e, from 2002 to 2010, Purulia's yield has shown adverse decline. It should be noted that in 2011, Purulia's lac production drop to 70 M.T. and growth rate falls near about 42%. However 2010, has shown a great improvement in the growth rate, which is 200%.Thus the analysis highlights the fluctuations and irregularity in the growth rate and declining trend of lac production in Purulia district over this last 30 years of data analysis. Moreover there is no sustainability in production from year to year and production scenario here is under great degradation. The declining trend and high fluctuation in growth rate might be due to several factors. Among various factors our analysis concentrated on mean maximum temperature and it negativelyeffected the lac production. Due to high temperature during summers, the mortality rate of lac insects and worms have increased, which might be one of the cause of declining production. The unpredictable fluctuating production of lac leads to unstable price and thereby hampered the interest of lac growers, industry and trade as a whole. Thus we can say with passing time, Purulia district is somewhere loosing its monopoly over lac production and if this trend continues then the district can no longer be described as a major lac producing district.

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