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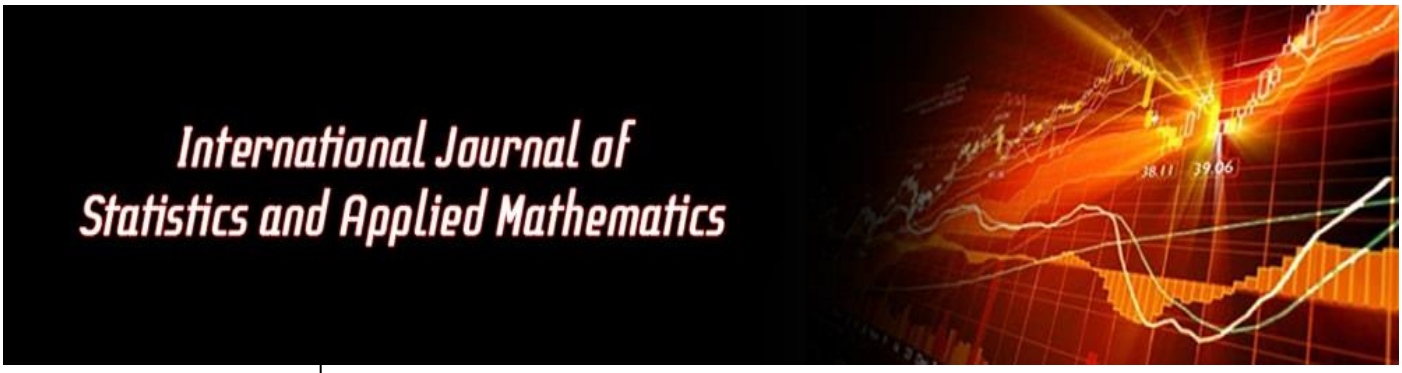


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# Growth and instability in vanya silk production in India: An econometric analysis

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**Abstract**
**Aim:** To examine the growth and instability in tasar, eri and muga silk production.
**Methodology:** The time series data on tasar, eri and muga silk production for the period 1991-92 to 2021-22 were considered for the study. The study period was divided into two parts namely, Period I (1991-2005) and Period II (2006-2021), in order to understand the growth status of vanya silk over a period. The exponential growth function based Compound Annual Growth Rate (CAGR) and the Cuddy-Della Valle index was used for computation of growth rate and instability index in silk production, respectively.
**Results:** Eri (CAGR=5.87%) and Muga silk (CAGR=3.98%) recorded positive growth rates whereas Tasar silk (CAGR= -0.20%) had a negative growth during Period I. Further, all vanya silks, tasar (CAGR=13.66%), eri (CAGR=12.08%) and muga (CAGR=6.29%) recorded positive and higher growth rates during Period II. Tasar (CAGR=10.74%), eri (CAGR=9.31%), muga (CAGR=4.39%) and total vanya (CAGR=9.53%) recorded a positive and higher growth compared to mulberry (CAGR=2.53%) during the overall period, 1991-2021. Tasar and eri silk production exhibited higher instability of the series during Period II compared to Period I, whereas muga possess lower instability index value in period II compared to period I. Tasar (C-D=44.89), eri (C-D=16.01) and muga (C-D=12.84) series possessed a higher instability compared to mulberry (C-D=6.78) during the overall period, 1991-2021.
**Interpretation:** The findings of the current study reveals that, the growth rate of tasar , eri and muga silks in period II was higher compared to period I, which means, all vanys silks are growing in positive trend over the years. Further, among vanya silk production, the tasar silk production shows higher growth rate compared to eri and muga silk production in overall study period. The result of the instability analysis shows that, tasar silk production possess higher instability (greater fluctuations), followed by eri silk production possess medium level of volatility and muga silk production possess lesser instability or more consistent in production over the years.

**Keywords:** Vanya silk, exponential growth function, instability, cuddy-della valle index, R Square.

## Introduction
Vanya sericulture is an age old tradition, practiced mainly by the tribal's in India and provides moderate earnings in different lean seasons of the year when they do not have any work in agriculture and other allied activities. Further, this sector remained obscure for a long time as an exclusive craft of tribal and hill folks inhabiting the Central and North-Eastern India. It is in the recent past that this tribal tradition assumed importance and attracted attention at national level, Roychoudhury (2006) [17]. The rich production potentialities within the country, steady demand for vanya silk products outside, eco-friendly nature of the production and processing activities and high women participation promoted commercial exploitation of this craft, which culminated in the transformation of this age old tradition to an industry of immense potentiality, Ahmed (2015) [1]. The agro-climatic condition of India is suitable for commercial exploitation of four varieties of silk: mulberry; muga, eri and oak tasar. To augment the situation, the Government of India has also launched three projects: United Nations Development Program (UNDP), Eri Silk Development Project (ESDP) and Catalytic Development Program (CDP), Sharma (2019) [21].

India is the second largest producer of raw silk in the world with the annual production of 34903 MT during 2021-22 (Sericulture Statistics Compendium, 2022) [20] and has the unique distinction of producing all the four types of silk *viz.*, mulberry, tasar, muga and eri. The Vanya Silk production accounted about 9085 MT during 2021-22 which contributes around 26% of the total silk production in India. Among the vanya silks, the eri silk, with the production of 7364 MT, accounted for 21.10% of total silk production followed by tasar (4.21%) and muga (0.73%) silks. Vanya silk production which was around 254 MT during 1950 gradually increased to 4748 MT during 2010-11 registering about 18 fold increase over 6 decades and now around 9085 MT during 2021-22, Halagundegowda *et al*. (2022) [7].

Regarding the importance of the study, vanya sericulture development in the country has gone through considerable changes in recent years and the sector is considered as an important one in sericulture economy, since it provides substantial employment opportunities for the rural and tribal areas, Bhattacharya *et al*. (2004) [4]. Even though many of the problems are existing in the silk industry they are, the prevailing price instability in the cocoon and raw silk markets, lack of quality of silk cocoon, high degree of dependency on import of raw silk for running the domestic processing units is there throughout the year, in order to meet our domestic and international markets, Bhat and Choure (2014) [3].

Crop Instability is a very essential characteristic of sericulture production and the entire silk production activities is dependent on weather conditions, cocoon yield levels and raw silk productions are subject to the significant variations over time, Anjum and Madhulika (2018) [2]. The instability in sericulture is on the rise due to several factors such as erratic rainfall pattern, low irrigation coverage, increase in temperature and severity of natural disasters. Considering all these factors and to achieve the goal of becoming the India as global leader in silk production and to promote the silk export and trade earnings for betterment of national earnings, there is a need to reorient the policy initiatives for vanya production and avoid the relay on only mulberry production (as the vertical production has stagnated), and it's time to concentrate on vanya silk production. Keeping all these factors, the study aims to understand the pattern of growth and instability in vanya silk production over a period of time has become imperative, Ingle *et al*. (2022) [8].

## Materials and Methods

The time series silk production data were collected separately for mulberry, tasar, eri and muga for the study period between 1990-91 and 2020-21 from various publications of Central Silk Board, Central Office, Bengaluru, India. The study period was divided into two parts namely, Period I (1991-2005) and Period II (2006-2021), in order to understand the growth status of vanya silk production over a period of time and to compare the performance of three different type of vanya silk production over the study period.

### Growth Rate Analysis

In the present study, the compound growth rate was computed for production of variety of silk by using the exponential growth function of the form

$$Y_t = a, b^t \quad (1)$$

Where,
$Y_t$ = Dependent variable for which growth rate is estimated
a = Intercept
b = Regression coefficient
t = Time variable

The compound growth rate is obtained for the logarithmic form of equation (1) as below:

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

Thus compound growth rate (g) in % is computed as

$$g = [(\text{antilog of } b) - 1) * 100] \quad (3)$$

Significance of growth rate was judged by Student's t-test.

### Instability Analysis

The present study applies the Cuddy Della Valle index (C-D index) for measuring the instability and here, the C-D index first detrends the given series and gives a more clear direction about the instability. The use of coefficient of variation as a measure to show the instability in any time series data has some limitations. If the time series data exhibit any specific trend, the variations measured by CV can be overestimated, that is if the production grow or decline at a constant rate, the instability estimated using CV would exhibit higher values. As against that, C-D index attempts to detrend the CV by using coefficient of determination ($R^2$). A low value of C-D index indicates the low instability in production and *vice-versa.*

C-D index was originally developed by Cuddy and Valle (1978) [6] for estimating the instability in time series data that is characterized by trend. The estimable form of the equation is as follows:

$$CV = \frac{\sigma}{\mu} \times 100 \quad (4)$$

Where,
σ = Standard deviation of the variable
μ= Mean value of the variable

In the formula, CV is multiplied by the square root of the difference between the unity and coefficient of determinations ($R^2$) in the cases where $R^2$ is significant. This can be expressed in a formula as follows:

$$\text{Index Instability (CD)} = CV\sqrt{(1 - R^2)} \quad (5)$$

The instability index between 0 and 15 could be classified as low instability; greater than 15 but less than 30 as medium instability and greater than 30 as high instability.

## Results and Discussion

Tasar silk is a wild silk, which accounts for about 4.2% of the total silk production in India during 2021-22. India produces both tropical and temperate tasar silks, of which tropical silk production is exclusive to India. The major tropical tasar silk producing states in India are Jharkhand, Chhattisgarh, Odisha, Bihar, Uttar Pradesh, Madhya Pradesh, West Bengal, Telangana, Maharashtra and Andhra Pradesh. The temperate tasar silkworms are reared on oak plants found in abundance in the sub-Himalayan belt of India covering the states of Manipur, Uttarakhand, Himachal Pradesh, Assam, Arunachal Pradesh, Mizoram and Nagaland (Jayaram *et al*. 2012) [9]. State-wise tasar silk production for the period between 2016-17 and 2021-22 is shown in Table 1. Jharkhand is the largest producer of tasar silk, followed by Chhattisgarh and Odisha.

**Table 1:** Performance of Tasar silk production (MT)

| State | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 |
|---|---|---|---|---|---|---|
| Andhra Pradesh | 1 | 4 | 5 | 5 | 1 | 2 |
| Assam & BTC | | | | | 0.002 | 0.007 |
| Bihar | 44 | 36 | 38 | 46 | 47 | 41 |
| Chhattisgarh | 353 | 523 | 340 | 472 | 293 | 217 |
| Jharkhand | 2630 | 2217 | 2372 | 2399 | 2184 | 1051 |
| Madhya Pradesh | 26 | 18 | 18 | 6 | 9 | 1 |
| Maharashtra | 27 | 19 | 23 | 19 | 4 | 7 |
| Manipur | 5 | 5 | 5 | 5 | 4 | 4 |
| Mizoram | 0.017 | 0.052 | 0.053 | 0.147 | 0.026 | 0.02 |
| Nagaland | 0.077 | 0.002 | 0.063 | 0.023 | 0.031 | 0.09 |
| Odisha | 116 | 106 | 123 | 130 | 101 | 102 |
| Telangana | 7 | 5 | 10 | 8 | 3 | 5 |
| Uttar Pradesh | 22 | 22 | 22 | 18 | 23 | 24 |
| Uttarakhand | 0.022 | | 0.038 | 0.030 | 0.089 | 0.09 |
| West Bengal | 37 | 35 | 25 | 30 | 19 | 12 |
| Total | 3268 | 2988 | 2981 | 3136 | 2689 | 1466 |

The production of eri silk is rooted in the life and culture of the people of North-east India and the Assam state is the largest producer of eri silk, followed by Meghalaya, Nagaland and Manipur (Table 2). Apart from North-east India, the eri silkworm is reared for the production of silk in West Bengal, Odisha, Uttar Pradesh, etc., and the eri silk contributed approximately 21.10% of the total silk production in India during 2021-22 (Sericulture Annual Report, 2022) [19].

**Table 2:** Performance of Eri silk production (MT)

| State | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 42 | 50 | 54 | 58 | 40 | 50 |
| Assam | 2705 | 3549 | 3563 | 3680 | 3834 | 4034 |
| BTC | 914 | 1096 | 1201 | 1369 | 1414 | 1432 |
| Bihar | 10 | 10 | 9 | 8 | 14 | 13 |
| Madhya Pradesh | | | | | | |
| Manipur | 363 | 290 | 320 | 347.44 | 211 | 323 |
| Meghalaya | 872 | 1007 | 1104 | 1103 | 1121 | 1138 |
| Mizoram | 11 | 8 | 8 | 8 | 5 | 7 |
| Nagaland | 669 | 602 | 606 | 588 | 258 | 310 |
| Orissa | 6 | 7 | 5 | 5 | 1 | 5 |
| Punjab | | | | | 0.20 | 0.07 |
| Sikkim | 3 | | | | | |
| Uttar Pradesh | 36 | 37 | 37 | 33 | 47 | 50 |
| Uttarakhand | 3 | 2 | 0.4 | 1 | 0.2 | 0.21 |
| West Bengal | 4 | 3 | 4 | 3 | 2 | 3 |
| Total | 5637 | 6661 | 6910 | 7204 | 6946 | 7364 |

Muga silkworm is polyphagous in nature and reared naturally in outdoor conditions. Though many north-eastern states are involved in the production of muga silk, Assam is an unassailable leader in its production and has obtained GI tag for muga silk and the production of muga raw silk is very less in comparison to other silks produced in India Pavithra *et al.* (2022) [12]. The major muga silk producing states in India are Assam, Meghalaya, Arunachal Pradesh, Manipur, Mizoram, Nagaland and West Bengal. State-wise muga silk production for the period between 2016-17 and 2021-22 is shown in Table 3.

**Table 3:** Performance of Muga silk production (MT)

| State | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 1 | 1.5 | 3 | 2.5 | 2 | 2 |
| Assam & BTC | 139 | 157 | 193 | 198 | 198 | 211 |
| Manipur | 1 | 1 | 2 | 2.13 | 1 | 1 |
| Meghalaya | 27 | 30 | 34 | 35 | 37 | 39 |
| Mizoram | 0.26 | 0.76 | 1 | 2 | 0.30 | 2 |
| Nagaland | 1 | 1 | 1 | 0.43 | 0.33 | 0.24 |
| Sikkim | 0.17 | - | - | - | - | - |
| West Bengal | 0.20 | 0.19 | 0.16 | 0.08 | 0.05 | 0.01 |
| Total | 170 | 192 | 233 | 241 | 239 | 255 |

India's total raw silk production, which comprises all variety of silks such as mulberry, tasar, eri and muga, increased from 11763 MT in 1991-92 to 34903 MT in 2021-22, registering a compound growth rate of 3.67% per year (Table 4). The production of tasar silk showed the highest growth rate (10.74%) among the vanya silk, followed by eri (9.31%), and muga (4.39%). The total vanya silk production had a positive growth (9.31%) compared to total silk production (3.67%) over a period of 30 years Pramod *et al.* (2022) [14].

**Table 4:** Growth and instability of silk production in India

| Type of silk | Raw silk production (MT) | | | CAGR (% ) (1991-92 to 2021-22) | C-D Index (1991-92 to 2021-22) |
|---|---|---|---|---|---|
| | 1991-92 | 2005-06 | 2021-22 | | |
| Mulberry | 10658 | 15445 | 25818 | 2.53** | 6.78 |
| Tasar | 329 | 308 | 1466 | 10.74** | 44.89 |
| Eri | 704 | 1442 | 7364 | 9.31** | 16.01 |
| Muga | 72 | 110 | 255 | 4.39** | 12.84 |
| Total Vanya | 1105 | 1860 | 9085 | 9.53** | 22.10 |
| Total Silk | 11763 | 17305 | 34903 | 3.67** | 9.33 |

****** Significance @ 1% level of significance.

Parameters such as growth and instability are always proportionately related to each other and in a time series input structure, if growth of any random variable is increasing across the time component, the instability for the same random variable also increases in general circumstances. Tasar silk production recorded a higher instability index of 44.89 during the study period, compared to eri (16.01) and muga (12.84) and the total vanya silk production series witnessed a higher instability rate of 22.10 compared to mulberry (6.78) and total silk production (9.33) during overall period (1991-2021). The results obtained are in close agreements with the finding of Bhat and Choure (2014) [3] and concluded that, the Tasar silk shows higher growth rate and has higher instability in production in entire study period (1980-81 to 2012-13).

The growth rates of different types of silk production during first period, second period and overall period are given in Table 5. The total raw silk production grew modestly at 2.02% during Period I and recorded a higher growth rate of 5.34% during Period II. Similarly, the total vanya silk production, also recorded a higher growth rate of 12.30% during the second period compared to the first period (4.39%). Further, the vanya silk production recorded higher growth rates during both the periods compared to mulberry silk production, which means that the vanya silk production has greater opportunity to grow compared to mulberry silk production. The similar findings can be observed in Ingel *et al.* (2022) [8], while comparing the growth status of different parameters of silk, such as silk production, silk export quantity and silk export value, where silk production has greater growth rate compared to other two parameters in the study period and in the same pattern, present study shows, vanya silk production (tasar silk and eri silk production has greater growth rate) higher growth rate compared to mulberry silk growth rate. The reason could be, greater importance has been given to Vanya silk production from last ten years (recent years), by including various schemes such as cluster promotion programmes, given more importance to R & D issues in vanya sector under various schemes.

**Table 5:** Growth rates of silk production of different sectors

| Type of silk | CAGR (%) | | |
|---|---|---|---|
| | Period I (1991-92 to 2005-06) | Period II (2006-07 to 20021-22) | Overall Period (1991-92 to 2021-22) |
| Mulberry | 1.82** | 3.67** | 2.53** |
| Tasar | -0.20 ** | 13.66** | 10.74** |
| Eri | 5.87** | 12.08** | 9.31** |
| Muga | 3.98** | 6.29** | 4.39** |
| Total Vanya | 4.39** | 12.30** | 9.53** |
| Total Silk | 2.02** | 5.34** | 3.67** |

** Significant @ 1% level of significance.

While closely analyzing the variety-wise growth rates during first and second periods, it was observed that eri and muga silks registered positive growth rates among the vanya silks during the study periods, while tasar silk recorded a negative growth in Period I and a positive growth in Period II, the similar findings can be observed in Kumar and Jain (2013) [11], while analyzing the district wise growth of agriculture productivity, where some districts shows greater growth for value output compared to the area and yield for the study period. Adopting improved technologies developed by the research institutes and the infrastructure facilities created under Catalytic Development Programmes (CDP) during IX Plan to XII Plan periods and Silk Samagra schemes could be attributed for positive growth in silk production of all varieties.

The growth rates were also computed for all the sectors of silk for both the study periods. The total vanya silk production recorded a higher growth rate (12.30%) during second period compared to first period (4.39%). The eri silk production followed the same pattern like total vanya silk production. Further, Eri silk production recorded a positive and higher growth rate during the second period (12.08%) compared to the first period (5.87%), which is due to the thrust given in last two decades to boost the vanya silk production in North-eastern states. The similar findings can be highlighted in the study Jayaram *et al.* (2012) [9], there was a higher growth rate in agriculture crop production and significant fall in the mulberry area and production, and there is shift in cropping pattern occurs from mulberry to other crops. In the similar way, the vanya production also shows increasing growth rate from last two decades.

Muga silkworms are reared in forest under natural conditions and geographically tagged to the state of Assam in India. Muga silk has higher demand and is always more expensive compared to other types of silks. It is known for its extreme durability and has a natural yellowish-golden tint with a shimmering, glossy texture. It was previously reserved for royal use. The muga silk production showed a higher growth rate in the second period (6.29%) compared to the first period (3.98%), Rakesh (2014) [15]. The growth of vanya silk over the period of time has shown increasing trend since last three decades and is shown in Fig.1, which shows that both eri and tasar represented an increasing trend over the periods whereas the muga silk production revealed saturated growth rate and the total vanya silk production raised from 1105 MT during 1991-92 to 9085 MT during 2021-22.

The result emphasize that the vanya silk has more potential to grow and can capture the share of mulberry production in future days, similar findings can be observed in Joshi *et al.* (2021) [10], examined the growth status of several crops in Nepal, however, except potato, vegetables and sugarcane, all other crops are declining in growth under overall study period. Further, the same pattern of result can be observed here, tasar, eri, muga and total vanya production shows positive and significant growth rate compared to mulberry growth rate. Practically, the total vanya production always less compared to mulberry production, but vanya silk has more potential and immense growth opportunity to take more share in total silk production provided there must be horizontal and vertical expansion has to be planned in coming days.

That means, there should be more emphasis on research and development activities, breeding work on disease tolerant host plant variety and insect breeds under insect-host improvement programme, proper method of transfer of technology, extension activities and training, stress more on systematic plantation rather than forest based rearing in tasar, focus more on area expansion in all vanya silk growing states, increase the productivity by using recent evolved technology, increase the number size of rearing in eri and muga (number of DFLS/farmer), use castor based rearing in eri, molecular breeding on disease resistant and pest resistant insect breeds, appropriate package of practices, active cluster programmes, proper plantation management activity, improved rearing technologies, effective disease and pest control measures, development and spread of innovations at an affordable price to farmers, provide the regulated cocoon marketing system in vanya growing states, proper pricing strategies has to be adopted, maintain the supply response chain in balanced and equilibrium manner, etc.

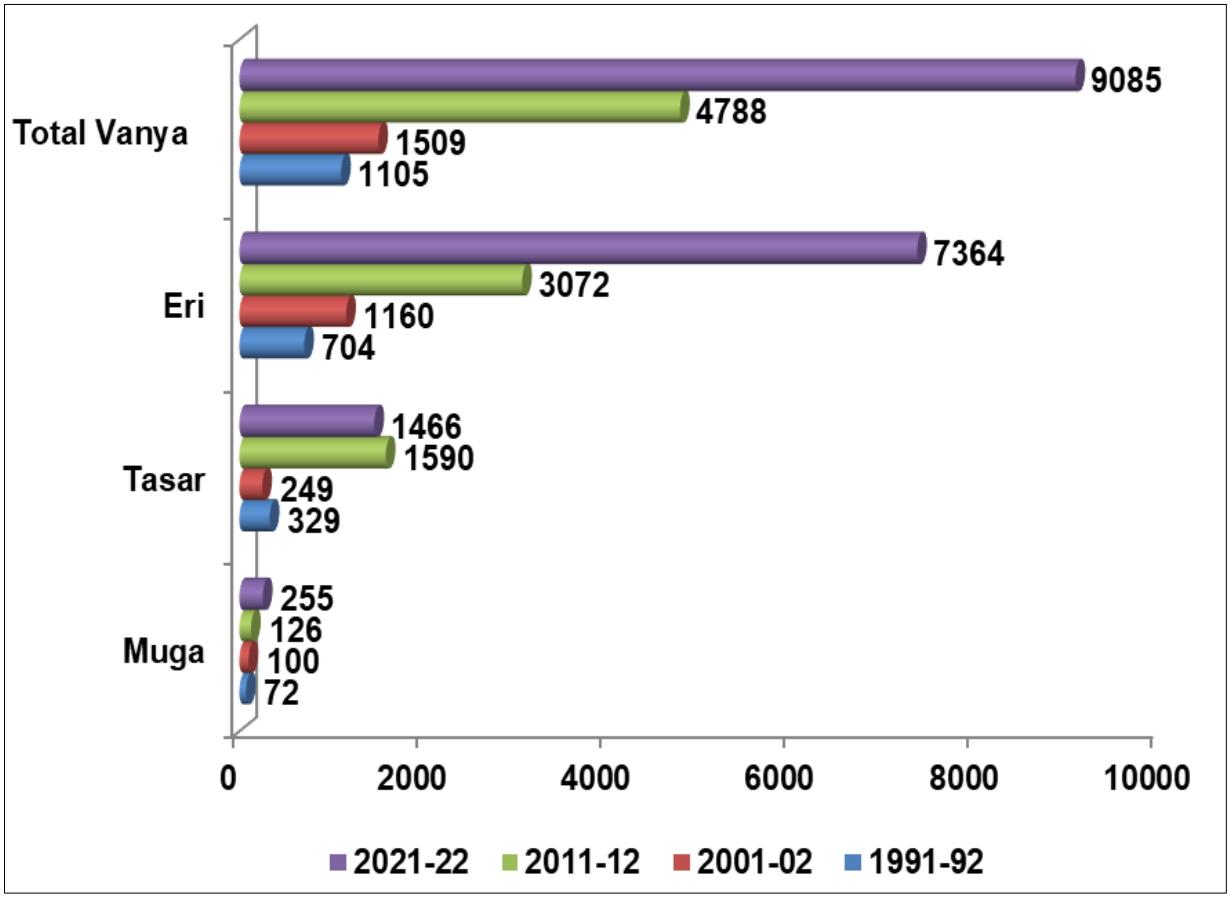


**Fig 1:** Performance of vanya silk production across different periods.

Irregular and sudden variations in production of raw silk creates unfavorable impact on the overall growth of Indian silk industry as fluctuating income to the domestic producers causes uncertainty on investment decisions. The C-D index was used to compute the instability in the production of tasar, eri and muga silk during first and second periods and the results are presented in Table 3, however, Rana *et al.* (2021) [16] also used the instability index for assessing the instability of spices over the study period and findings shows that, the spices were found highly instable in terms of area, production and productivity over time.

There was increase in the instability value for tasar and eri silks during the second period compared to the first period and *vice versa* for mulberry and muga silks. The increased inconsistency in tasar and eri silk production in the second period compared to the first period may be attributed to the demand-supply gap existed among various stages of the stakeholders of silk industry in recent periods. The muga silk production witnessed more or less similar kind of fluctuations in both first period and the second period. This indicates that the production of muga silk stabilized over the period of time and the growth also saturated for the past ten years remaining more or less in the same range.

Sanjay *et al.* (2018) [18] revealed in their study, instability in area was higher when compared to production and productivity, while assessing the instability by considering area, production and productivity of cotton. Similarly, in this study there was less consistent (more instability) in production of tasar silk compared to other vanya sectors.

**Table 6:** Instability analysis of silk production of different sectors

| Type of silk | C-D Index | | |
|---|---|---|---|
| | Period I (1991-92 to 2005-06) | Period II (2006-07 to 20021-22) | Overall Period (1991-92 to 2021-22) |
| Mulberry | 5.18 | 4.59 | 6.78 |
| Tasar | 18.43 | 31.03 | 44.89 |
| Eri | 6.00 | 10.21 | 16.01 |
| Muga | 10.74 | 9.43 | 12.84 |
| Total Vanya | 8.07 | 15.18 | 22.10 |
| Total Silk | 4.54 | 5.19 | 9.33 |

Overall, tasar silk production recorded higher instability (44.89) compared to other types of silk and the tasar silk production increased significantly from 308 MT in 2005-06 to an all-time high production of 2819 MT in 2015-16, but dropped to 1466 MT in 2021-22 due to heavy rainfall, pest and disease incidence. Covid-19 pandemic also affected the Indian sericulture as reported by Chamuah *et al* (2021) [5]. A significant increase in tasar silk production was mainly reported in Jharkhand, which is a traditional belt for tasar and here, tasar possess higher growth rate and higher instability value compared to other vanya silks. Further, as a thumb rule, higher growth of any random variable always associates with higher instability Pichad *et al.*, (2014) [13].

The eri silk production showed medium level of instability (16.89). This may be attributed no extreme fluctuations in the production of eri silk and the eri growers are tribal farmers. The number of crops reared per year and the number DFLS reared per crop may vary across the states. Muga silk production recorded less instability (12.84) compared to tasar and eri silks, which indicates that the muga silk production was consistent across the time component and possessed less volatility with slow incremental rate. The stagnation in muga silk production over the period was the major reason for lower volatility of the series. Further, Tewari *et al.* (2017) [22] revealed that, there is high instability in production and productivity as compared to area under wheat, in the same way, the tasar silk has greater instability in production compared to eri and muga silk production.

The study was conducted to analyse the growth and instability aspects of major vanya silks such as tasar, eri and muga for the period of 1991-92 to 2021-22. Further, tasar, eri and muga silks recorded positive growth during the overall study period (1991-92 to 2021-22) whereas eri and muga grew at positive rates during both the periods, but the tasar silk recorded negative growth rate during first period and positive growth rate during second period. The negative growth rate of tasar during first period may be attributed to inappropriate pattern of production, which heavily depends on forest plantation and no systematic plantation, higher pest and disease stress, etc.

The tasar, eri and muga silk production grew at higher rates during the second period compared to the first period. Further, the growth rates of total vanya silk production were higher than the growth rates of mulberry silk production, which indicates that the contribution of vanya silk in total silk production is taking lead over the period of time and has immense growth opportunities.

The instability analysis of vanya silk production provides the volatility of the series across the time flow, here eri and tasar silks showed increasing pattern of instability values. The muga silk production recorded more or less similar instability value during both the study periods, which implies slow growth rate and almost stagnated growth of silk production across the year. The result of instability analysis for the entire period 1991-92 to 2021-22 shows that, tasar silk production has greater variations in the silk production, then eri silk production possess medium level of volatility and muga silk production possess lesser instability value.

- Finally, the study reveals that, the growth rate of tasar, eri and muga silk production in period II was higher compared to period I, which means, all vanys silk production are growing in positive trend over the years. Specifically, the tasar shows higher growth rate compared to eri and muga silk in overall study period,
- Further, the total vanya silk production grew at a positive rate over the period of time (except covid pandemic period) compared to mulberry growth rate.
- The instability analysis reveals that, tasar silk production shows higher instability (less consistency in production) followed by eri silk (medium instability) and muga silk production shows lesser instability (more consistent). The tasar silk production possesses more fluctuations and higher variability compared to other vanya silk production.

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**Add-on Information**

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**References**

1. Ahmed SA, Singh NI, Sarkar CR. Role of forest biodiversity in conservation of non-mulberry (Vanya) silk in India, Munis Entomology & Zoology. 2015;10(1):342-357.
2. Anjum S, Madhulika. Growth and Instability analysis in Indian agriculture, International Journal of Multi-disciplinary Research and Development. 2018;5(11):119-125.
3. Bhat TA, Choure T. Study of Growth and Instability in Raw Silk Production and Marketing in India, European

Journal of Business and Management. 2014;6(14):108-111.
4. Bhattacharya A, Singh BK, Das PK. Biodiversity of wild silk moths in Assam (North-East India), Annals of Forestry. 2004;12(2):208-216.
5. Chamuah P, Borah D, Donaj S. A Review on Effect of Covid-19 on Indian Sericulture Sector, International Journal of Social Sciences. 2021;10(2):173-179.
6. Cuddy JD, Valle PD. Measuring the Instability of Time Series Data, Oxford Bulletin of Economics and Statistics. 1978;40(10):79-84.
7. Halagundegowda GR, Kumaresan P, Sathish Gowda CS, Mohan Kumar TL, Muttanna, Khan GA. Performance of global trade of Indian silk in post-liberalization era, biological forum: An International Journal. 2021;13(4):582-588.
8. Ingle SP, Bagde NT, Rohma FA, Asha BK. Analysis of growth and instability of silk production in India, Journal of Pharmacognosy and Photochemistry. 2022;11(4):195-201.
9. Jayaram H, Kumaresan P, Qadri SM. An analysis of pattern of growth and instability in sericulture in Karnataka, Indian Journal of Sericulture. 2012;51(1):43-49.
10. Joshi P, Gautam P, Wagle P. Growth and instability analysis of major crops in Nepal, Journal of Agriculture and Food Research. 2021;6:1-6.
11. Kumar A, Jain R. Growth and Instability in Agricultural Productivity: A District Level Analysis §. Agricultural Economics Research Review. 2013;26(conf):31-42.
12. Pavithra SR, Mishra R, Pramod GU, Baviskar PP, Kalpana K, Ahmad N. Growth and instability in production and trade of cotton in India: A macro level approach, The Pharma Innovation Journal. 2022;11:304-307.
13. Pichad SP, Wagh HJ, Kadam MM. Growth in area, production and productivity of chickpea in Amravati district. International Research Journal of Agricultural Economics and Statistics. 2014;5(2):289-92.
14. Pramod GU, Mishra RR, Ahmad N. Growth & Instability of International Trade of Sugar in India. Economic Affairs. 2022 Feb 1;67(1s):113-8.
15. Rakesh S. Growth and Instability in agricultural production in Haryana: A district level analysis, International Journal of Scientific and Research Publication. 2014;4(7):1-12.
16. Rana MJ, Islam S, Kamruzzaman M. Growth and instability in area, production and productivity of major spices in Bangladesh. Journal of Agriculture and Food Research. 2021 Dec 1;6:100216.
17. Roychoudhury N. Sericulture in forestry – Vanya Silk, Vaniki Sandesh. 2006;30(2):8-12.
18. Sanjay Seidu M, Kundu KK. Growth and Instability in Cotton Cultivation in Northern India, Economic Affairs. 2018;63(2):433-440.
19. Sericulture Annual Report. Note on Sericulture, Central Silk Board; c2022. p. 18-19.
20. Sericulture Statistics Compendium. Sericulture & Silk Industry Statistics, Central Silk Board; c2022. p. 11-15.
21. Sharma K. A Review on Vanya – The wild silkworms, International Journal of Research and Analytical Reviews. 2019;6(2):341-358.
22. Tewari H, Singh HP, Tripathi U. Growth and instability in wheat production: A region wise analysis of Uttar Pradesh, India. International Journal of Current Microbiology and Applied Sciences. 2017;6(9):2537-44.