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TREND OF TASAR SILK INDUSTRY IN INDIA – A STATISTICAL APPROACH

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ABSTRACT

The present study was attemped to analyse the growth trend and forecast of tasar raw silk production for the period 1951-2018. The Compound growth rate was calculated for different plan period from 2002 onwards. The data were collected from various secondary sources and analysed using suitable statistical tools and techniques to study the performance of tasar silk industry at different point of time after validation. The compound growth rate for tasar raw silk production for the period 1951-2019 and 2009-19 were recorded 4.6 and 14.10 percent. As per plan wise analysis, highest CGR was recorded in 11th plan period in comparison to others. Based on the assumptions and suitable model parameter estimates, Holt's Linear Exponential model was found selected for future forecast of raw silk production. The forecast of tasar silk production for the year 2019-30 would be 7031 MT which may change in respect of different time frame. The finding of this study will be helpful for government policy makers, exportsrs, producers and importing countries.

*Keywords***:** Production, Growth Rate, Exponential model, Forecasting, Raw Silk.

Introduction

India is the second largest producer of Tasar silk after China and earns about 15 to 40 crore (Rupees) of foreign exchange annually, amounting 2 to 3 percent of India's total silk export earnings. Tasar culture is practiced by nearly 3.00 lakh tribal families in Jharkhand, Orissa, Chhattisgarh, West Bengal, Andhra Pradesh, Uttar Pradesh, Maharashtra, Madhya Pradesh and Bihar. Though the involvement of tribal families in Tasar culture is reducing day by day due to various reasons, it gives gainful employment and remunerative additional income to the tribes. The use of tasar fabrics is increasingly becoming popular among the non-tribal. Tasar silkworm is polyphagus and rearing is carried on nature grown forest plantation belonging to genus *Terminalia*, viz. *T. arjuna, T. tomentosa* as also *Shorea robusta* (Sal.), the silkworm reared is *Antheraea mylitta* Drury (Indian tropical tasar) which is wild in nature. Some races of Tasar silkworms like Sarihan, Raily, Modal, Laria etc. produce cocoons in nature by feeding on Sal tree leaves and the cocoons are collected by the tribals from forest. The tribal conduct rearing of semi domesticated tasar races like Daba and Sukinda, on Asan and Arjuna plantation. While there is very less human effort in the production of wild tasar cocoons, in case of semi domesticated races like Daba and Sukinda, the production of cocoons and raw silk depends on the availability of food plants, quality of silkworm seed, protection from pests and predators, control of silkworm diseases, extension support provided by the department and the technologies adopted as also the subsequent market support provided, and linkages developed for reeling/spinning, weaving, marketing and the demand for finished products.

Among the four varieties of silk produced in India, Mulberry accounted for 71.50 percent (25344 metric tons), Tasar 8.4 percent (2981 metric tons), Eri 19.48 percent (6910 metric tons) and Muga 0.66 percent (233 metric tons) of the total raw silk production of 35468 metric tons during 2018-19. The silk production has been reduced in the country during 2020-21 due to disruptions caused by the Covid-19 pandemic. The total raw silk production in the country during 2020-21 was 33,739 MT which was 5 percent lesser than the production achieved during the previous year 2019-20 and registered around 86.5 percent of achievement against the annual silk production target for the year 2020-21. The vanya silk which includes Tasar, Eri and Muga silks, have reduced by 13.8, 3.7 and 0.8 percent respectively during 2020-21 over 2019-20. The estimated employment generation under sericulture in the country was 8.7 million persons during 2020-21 compared to 9.4 million persons in 2019-20 indicating a reduction of 7.4%.

Though the tasar silk production has shown increasing trend during recent years, still there are many issues pertaining to seed production, rearing technology, human resource development and transfer of technology which have to be taken up to increase the production rate. Research snd Development in the field of Tasar Culture span over 50 years, yet several inherent problems and issues still continue to retard the growth of the industry. Though the steady increase has been observed in Tasar silk production in the country over the years, yet there exists tremendous potential of furthering the silk production. Based on the available forest resources, the remaining potentials have to be utilized in the country.

Some of the studies on growth trend of Indian silk production and trade have been carried out by different authors at different point of time in recent past (Thangavelu

et al., 2000; Lakshmanan 2007; Rai *et al*., 2008 & 2012; Ganapathy *et al*., 2014; Mote *et al*., 2014). The present study is based on long term data of more than 60 years from 1950-51 onwards to study the growth trend and forecasting of silk production using time series analysis particularly Exponential Smoothing Techniques and ARIMA models. So far no attempt has been made in silk industry, particularly in the tasar sector to visualize the historical trend and forecasting of long term data. However, several past studies on Indian agriculture have used different types of linear and nonlinear time series models for forecasting the production of commodities (Misra *et al*., 2013; Dhekale *et al*., 2014; Sivapathasundaram and Bogahawatte, 2012; Farooq *et al*., 2013; Kumar and Anand, 2011; Amin *et al*., 2014; Senthamarai Kannan *et al*., 2013; Mote and Sananse, 2014; Sahu *et al*., 2015). Hence, the present investigation will be quite informative and useful for planners and programme executors in projecting the present scenario of sericulture industry in long prospective.

The present study thus attempts to understand the levels and trends of production of Tasar silk in relation to different developmental programme, technology intervention and market demand. Presently, Jharkhand state is a role model in Tasar silk production for other tasar producing states in India which need to be studied in a comprehensive way in terms of income generation and socioeconomic status of farmers.

Material and Methods

The main aim is to provide a brief description of the materials which provide the necessary database for this study and to highlight the important statistical tools employed in the analysis.

Method of data collection

In order to evaluate the objectives of the study, the data for tasar silk production, export, and import for Major States and India, were collected from secondary sources to study the growth, instability and forecasting of production and trade of tasar silk at national level. The data pertaining to various aspects were collected from the following secondary sources: Central Silk Board, Bangalore (Statistical Biennials, Annual Reports, Technical Reports, Journals, etc.,), Central Tasar Research and Training Institute, Ranchi (Jharkhand), Ministry of Textiles website (http://www.texin.nic.in), DGCIS (Directorate General of Commercial Intelligence and Statistics), Central Silk Board website (http://www.csb. gov. in), www.indiastat.com, International Sericulture Commission website (http://www.inserco.org/ newsite) and International trade Centre website (http://www. intracen.org) .The time series data collected on tasar raw silk , production, for the period 1951-52 to 2018-19 was used for statistical analysis at different time intervals after validation.

Statistical tools / techniques used for data analysis

Keeping in view of the objectives of the study, following statistical tools and models have been employed.

• Descriptive statistics

• Compound Growth rate (CGR)

• Variability / Instability Index analysis

• Time series exponential smoothing techniques: Linear Holt-Winter's Exponential Smoothing for forcasting silk production

Result and Discussion

The data pertinent to the present study were collected from various secondary sources. The year wise raw silk production data for the period 1951-2019 and import & Export data for the period 2018-2019 are listed in appendix I & II. The growth trend analysis and forecasting of silk production were carried out using appropriate statistical techniques and depicted under result and discussion.

3.1 Raw silk production

The descriptive statistics of Indian silk industry for the period 1951 to 2019 is presented in table 3.1.1. The mean, minimum and maximum raw silk production of mulberry during 1951 to 2019 was 8667 metric tons, 625 metric tons and 25344 metric tons which increases 5.44 percent per annum. The mean, minimum and maximum raw silk production of tasar during 1951 to 2019 was 583 metric tons, 123 metric tons and 3259 metric tons which increases 4.68 percent per annum. The mean, minimum and maximum raw silk production of Eri during 1951 to 2019 was 1075 metric tons, 56 metric tons and 6910 metric tons which increases 6.23 percent per annum. The mean, minimum and maximum raw silk production of Muga during 1951 to 2019 was 80 metric tons, 24 metric tons and 233 metric tons which increases 2.42 percent per annum. The mean, minimum and maximum raw silk production, including all varieties during 1951 to 2019 was 10406 metric tons, 894 metric tons and 35468 metric tons which increases 5.41 percent per annum. Silk production has achieved remarkable growth during recent times. Silk production increased from 800 metric tons in 1950-51 to 35000 metric tons in 2018-19 at a compound growth rate of 5.41 per cent per annum. Country's raw silk production is expected to reach by more than 60,000 metric tons by 2029-30 as projected through forecasting models. The data of silk components donot show normality as Kolmogorov-Smirnov and Shapiro-Wilk test was significant at 1 percent level. It indicates the tendency to increase the production in the future course of time. Based on the compound growth rates for tasar silk indicated in table 3.1.2, 11th plan period is better in comparison to others.

The Tasar raw silk production at the end of each plan period for India and its major states has been recorded in table 3.1.3. The national production follows cubic polynomial trend during 1st to 12th plan period data. It is interesting to note that the national production has shown significant increase from 11th plan period onwards, which may be the contribution of developmental programmes like Catalytic Development Programme (CDP), Swarnajayanti Gram Swarojgar Yojona (SGSY), Vanya Cluster Promotion Programme (VCPP), Mahila Kisan Sashaktikaran Pariyojana (MKSP) and Tribal Sub Plan (TSP) etc. Among all tropical Tasar states, only Jharkhand has played major role in increasing the silk production with 70-80 percent share from 2012-13 onwards. The overall statistical analysis reveals that the trend of Tasar silk production in the recent past is highly encouraging which supply most of the raw materials for export products in the non-mulberry silk category.

Data for Cocoon and Raw Silk production for last ten years from 2009-10 to 2018-19 at national level was collected from annual reports of Central Silk Board, Bangalore. The production trend increases over years during last ten years except 2014-15, 2017-18 and 2018-19 (Fig. 3.1.1). During 2018-19, the raw silk production was recorded

2981 metric tons, which decreased by 0.23 percent over previous year 2017-18 (2988 metric tons). The highest growth rate was recorded for raw silk 14.10 percent, followed by 11.50 percent in cocoon production (Table-3.1.4).

State wise raw silk production for recent five years from 2015-16 to 2018-19 and its percentage share shown in table 3.1.5 depicts that Jharkhand is leading state with 79.57 percent share in total Tasar raw silk production followed by Chhattisgarh (11.41 percent), Odisha (4.13 percent), Bihar (1.27 percent) and remaining 3.62 percent by other tropical states. During 2018-19, Tasar Raw Silk production in Jharkhand was recorded 2372 metric tons, followed by Chhattisgarh 340 metric tons and Odisha 123 metric tons. The raw silk production in Andhra Pradesh including Telengana, Bihar, Jharkhand, Maharashtra and Odisha has increased by 66 percent, 5.56 percent, 6.99 percent, 21.05 percent and 16.04 percent in 2018-19 in comparison to the previous year 2017-18 whereas, the production in Chhattisgarh and West Bengal has decreased by 34.99 percent and 28.57 percent, this resulted in reducing the production level at the national level.

Subsequently the compound growth rate for cocoon and raw silk production for tropical states has been calculated using exponential function for the 10th Plan (200-07), 11th Plan (2007-12), 12th Plan (2012-17) and Overall period (2002-19) depicted in table-3.1.6 shows that Jharkhand state has performed better in increasing the production of cocoon and raw silk in comparison to other states during the plan periods which may be due to positive and significant impact of Research and Development schemes implement by Government of India. However the cocoon and raw silk production in all states during plan periods have shown similar pattern with positive and negative growth rate except few cases.

Table 3.1.1 : Descriptive analysis of raw silk production in India (1951-2019).

Descriptive Statistics	Raw Silk Production (metric tons)				
	Mulberry	Tasar	Eri	Muga	Total
Mean	8667.18	583.26	1075.49	80.32	10406.25
Std. Deviation	7110.83	766.58	1599.54	40.047	9107.16
Minimum	625.00	123.00	56.00	24.00	894.00
Maximum	25344.00	3259.00	6910.00	233.00	35468.00
Skewness	0.444	2.514	2.283	1.554	0.869
Kurtosis	-1.140	5.143	4.749	2.820	-0.083
Shapiro-Wilk test	0.882[**]	0.544[**]	0.648[**]	0.866[**]	0.875[**]
K-Smirnov test	0.182[**]	0.385[**]	0.262[**]	0.175[**]	0.170[**]
CGR%	5.440	4.680	6.230	2.420	5.410

Table 3.1.2: Plan-wise growth rate of silk components

Plan period	Mulberry		Non-mulberry				Total raw silk (ton)
	Area	Raw silk	Tasar	Eri	Muga	Total NM	
1st (51-56)	-	11.27	15.04	4.78	9.12	10.77	11.12
2nd (56-61)	-	0.95	4.63	-3.34	-15.11	-1.58	0.37
3rd (61-66)	-	3.33	5.2	8.41	1.46	5.91	3.95
4th (69-74)	3.53	5.67	-2.21	-8.71	0.54	-4.01	3.74
5th (74-78)	3.04	6.73	1.91	-17.99	-3.96	-1.52	5.38
6th (80-85)	4.68	8.13	10.32	14.52	2.72	11.04	8.4
7th (85-90)	6.01	8.6	0.04	10.3	1.84	4.94	8.23
8th (92-97)	-3.92	-0.07	-9.72	3.48	3.92	0.07	-0.06
9th (97-02)	-3.91	2.4	-4.51	7.08	9.56	4.78	2.6
10th (02-07)	-0.27	2.45	4.18	2.42	2.4	2.72	2.48
11th (07-12)	-0.43	2.35	26.25	13.94	1.48	16.72	4.6
12th (12-17)	3.07	2.5	12.68	11.83	7.25	12.03	4.91

Table 3.1.3 : Plan-wise Tasar raw silk production for major states and India (tons)

Plan Period	BIH/ JHA	MP / CHH	ODI	WB	AP / TN	MHA	INDIA
1st plan (1951-56)	52.6	68.0	135.0	6.9	0.00	0.00	141.0
2nd Plan (1956-61)	76.8	77.3	16.8	7.3	0.32	0.73	179.2
3rd Plan (1961-66)	106.8	125.0	15.5	13.4	0.34	0.90	262.0
Tra. Period (1966-69)	89.5	135.0	21.5	7.9	0.78	1.62	256.3
4th Plan (1969-74)	128.0	110.0	12.0	6.0	1.00	0.00	257.0
5th Plan (1974-78)	300.0	99.0	23.0	9.0	1.00	0.00	434.0
Tra. Period (1978-80)	300.0	40.0	19.0	9.0	1.00	0.00	384.0
6th Plan (1980-85)	290.0	41.0	72.0	12.0	4.00	2.00	444.0
7th Plan (1985-90)	267.0	115.0	62.0	15.0	3.00	2.00	465.0
Tra. Period (1990-92)	222.0	16.0	68.0	18.0	1.00	0.00	329.0
8th Plan (1992-97)	135.0	33.0	43.0	18.0	3.00	0.00	235.0
9th Plan (1997-2002)	95.0	79.0	17.4	14.0	1.00	0.95	211.0
10th Plan (2002-07)	131.0	126.0	35.0	27.0	16.00	7.0	428.0
11th Plan (2007-12)	1057.0	352.0	86.0	44.0	1.00	12.0	1590.0
12th Plan (2012-17)	2674.0	379.0	116.0	37.0	8.00	27.00	3268.0

Source: Statistical Biennials 1972, Central Silk Board

Table 3.1.4 : Trend of Tasar cocoon and raw silk production in India (2009-19)

Year	Cocoon production			Raw silk production		
	Qty. (Lakh number)	% Change	Growth Index	Qty. (Metric tons)	% Change	Growth Index
2009-10	7500	-	100.0	803	-	100.0
2010-11	10300	37.33	137.3	1166	45.21	145.2
2011-12	15000	45.63	200.0	1590	36.36	198.0
2012-13	15600	4.00	208.0	1729	8.74	215.3
2013-14	21032	34.82	280.4	2619	51.47	326.2
2014-15	21253	1.05	283.4	2432	-7.14	302.9
2015-16	22871	7.61	304.9	2819	15.91	351.1
2016-17	23674	3.51	315.7	3268	15.93	407.0
2017-18	22435	-5.23	299.1	2988	-8.57	372.1
2018-19	23336	4.02	311.1	2981	-0.23	371.2
CGR (%)	11.50			14.10		

*Source: Annual Reports, Central Silk Board*

Table 3.1.5: State-wise Tasar raw silk production (tons) in India (2015-19)

States	2015-16	2016-17	2017-18	2018-19	Change (%)	Share (%)
AP	1.0	8.0	9.0	15.0	66.67	0.50
Bihar	41.0	44.0	36.0	38.0	5.56	1.27
Chhattisgarh	254.0	353.0	523.0	340.0	-34.99	11.41
Jharkhand	2281.0	2630.0	2217.0	2372.0	6.99	79.57
MP	56.0	26.0	18.0	18.0	0.00	0.60
Mharashtra	21.0	27.0	19.0	23.0	21.05	0.77
Odisha	107.0	116.0	106.0	123.0	16.04	4.13
Uttar Pradesh	20.0	22.0	22.0	22.0	0.00	0.74
West Bengal	34.0	37.0	35.0	25.0	-28.57	0.84
India	2819.0	3267.0	2988.0	2981.0	-0.23	

Source: Annual Reports, Central Silk Board,

Table 3.1.6: State-wise compound growth rate of Tasar cocoon and raw silk production in India (2002-19), (Cocoon: Lakh no., Raw Silk: metric tons)

States	10th Plan (2002-07)		11th Plan (2007-12)		12th Plan (2012-17)		Overall (2002-19)	
	Cocoon	Raw silk	Cocoon	Raw silk	Cocoon	Raw silk	Cocoon	Raw silk
AP	-5.29	-5.89	17.83	-28.26	10.75	65.35	-1.65	-2.05
BIH	8.45	6.58	24.57	18.32	37.51	39.43	10.8	9.66
CHH	11.74	11.44	15.74	12.92	-4.17	-0.66	6.94	10.32
JHA	2.13	5.92	41.51	48.28	11.15	16.04	19.35	21.22
MP	20.11	17.98	28.03	22.87	-18.33	-18.06	7.08	5.71
MHA	-17.21	-4.9	32.06	25.39	13.62	16.47	5.05	5.59
ODI	-7.58	-8.31	10.97	12.51	10.89	3.35	6.39	4.96
UP	5.92	5.92	22.42	20.11	1.91	11.47	-2.36	12.43
WB	-0.81	0.00	15.30	8.70	-5.95	-6.68	0.87	-0.57
INDIA	3.34	4.27	30.26	30.01	8.70	13.58	13.28	14.83
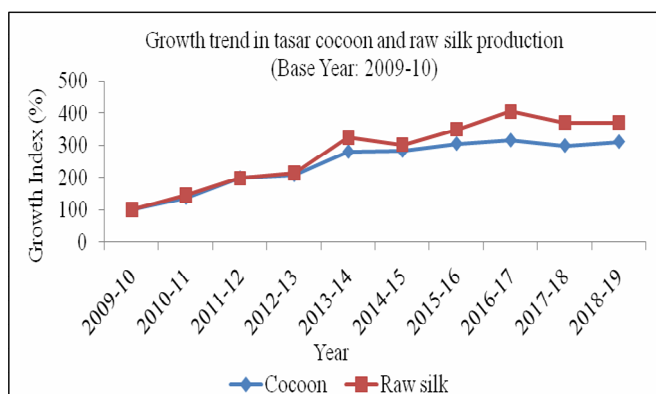
Fig. 3.1.1 : Growth trend in tasar cocoon and raw silk production

3.2 Tasar Seed Production

Tasar seed production for the period 1995-96 to 2014-15 was recorded in table-3.2.1 at National and BSM&TC level. Based on the trend analysis it was found that seed production at national level was in increasing and decreasing in nature during 1995-96 to 2005-06 and further it increases from 2006-07 to 2014-15 which shows polynomial (quadratic) trend. The current seed production was recorded 333.10 lakh which is higher than the period 2013-14 (317 lakh). Whereas seed production at BSMTC level is not in static position but it shows polynomial (cubic) trend. The Share of BSMTC for Tropical Tasar seed production was recorded in table-3.2.1 and it shows highest contribution with 38 percent during 2005-06 followed by 31 percent during 2007-08. The current share of BSMTC in seed production at

national level is 10.30 percent which need to be upgraded while putting systematic efforts with proper management and policy and programme at state levels. Such type trend will increase the wider gap in seed production in future course of time. Hence, seed farmers, NGOs, State Govt. agencies should come forward to narrow down this gap of seed production through suitable strategies to enhance the more and more cocoon production at national level for foreign exchange.

The envisaged target estimated by BTSSO, Bilaspur for Tasar raw silk production by the end of the year 2029-30 is 6000 metric tons (Table 3.2.2). Since the nature grown cocoons contribute to about 30 percent of total production, the production target for reared variety is taken as 3900

metric tons by the end of the period. Thus, the requirement of commercial seed would be about 10.00 crore dfls. The year-wise estimated requirement of Tasar seed (Basic, Nucleus and Commercial) is given below. BTSSO would continue to provide the nucleus seed to the States.

The Central Silk Board has a chain of Basic Seed Farms supplying basic seeds to the States. Its commercial seed production centre augment efforts of the States in supplying commercial silkworm seed to farmers. The table 3.2.3 indicates the total quantity of seed production during the year 2016-17, 2017-18 and 2018-19. The seed production in Tasar and Muga has declined in the year 2018-19 in comparison to 2017-18.

Table 3.2.1 : Tasar seed production at National and BSMTC level (Lakh No.)

Year	National Level	Tropical tasar seed supplied by BSMTC	Oak tasar seed supplied by BSMTC	% share of BSMTC for tropical tasar seed
1995-96	90.34	13.40	0.33	14.83
1996-97	102.52	13.75	0.45	13.41
1997-98	123.35	15.55	0.52	12.61
1998-99	89.00	11.96	0.75	13.44
1999-00	154.69	10.91	0.35	7.05
2000-01	58.09	10.46	0.38	18.01
2001-02	58.20	15.63	0.46	26.86
2002-03	91.00	18.03	0.53	19.81
2003-04	84.30	20.06	0.50	23.80
2004-05	84.90	20.30	1.45	23.91
2005-06	54.00	20.53	1.15	38.02
2006-07	95.10	23.07	1.61	24.26
2007-08	100.20	30.81	1.15	30.75
2008-09	140.00	33.12	1.62	23.66
2009-10	142.90	29.17	1.40	20.41
2010-11	205.30	31.49	1.31	15.34
2011-12	265.00	34.76	1.36	13.12
2012-13	294.00	39.11	0.63	13.30
2013-14	317.00	37.89	0.55	11.95
2014-15	333.10	34.31	0.58	10.30

Source: Central Silk Board

Table 3.2.2: Projected seed production by BTSSO Bilaspur

Year	Proposed Raw silk production (tons)	Production from the reared variety (70 %)	Expected Requirement of seed (Lakh dfls)		
			Nucleus*	Basic	Commercial
2016-17	3285	2299.5	9.18	91.75	550.50
2017-18	3450	2415	9.64	96.36	578.15
2018-19	3650	2555	10.19	101.94	611.67
2019-20	3900	2730	10.89	108.93	653.56
2020-21	4150	2905	11.59	115.91	695.46
2021-22	4460	3122	12.46	124.57	747.41
2022-23	4650	3255	12.99	129.87	779.25
2023-24	4840	3388	13.52	135.18	811.09
2024-25	5015	3511	14.01	140.07	840.41
2025-26	5200	3640	14.52	145.24	871.42
2026-27	5400	3780	15.08	150.82	904.93
2027-28	5600	3920	15.64	156.41	938.45
2028-29	5800	4060	16.20	161.99	971.96
2029-30	6000	4200	16.76	167.58	1005.48
Mean	4671	3270	13.05	130.47	782.84
SD	886.97	620.89	2.48	24.77	148.64
CV%	18.99	18.99	18.99	18.99	18.99
CGR%	4.30	4.30	4.30	4.30	4.30

Source: BTSSO, Central Silk Board, Bilaspur, Chhattisgarh

Table 3.2.1: Seed production in India (2016-19), Unit: Lakh No.

Particulars	2016-17		2017-18		2018-19	
	Target	Achievement	Target	Achievement	Target	Achievement
Mulberry	450.00	430.37	440.00	388.35	440.00	483.04
Tasar	47.43	48.00	51.08	52.81	51.66	51.86
Muga	8.13	6.87	8.07	7.08	8.16	5.33
Eri	5.54	4.78	6.00	6.88	6.0	7.22
Total	511.06	490.62	505.15	455.12	505.82	547.45

Source: http://csb.gov.in (Note on Sericulture April 2020)

3.3 Export of Vanya (Tasar) Silk

Among the non-mulberry silk, only the tasar silk fabrics are exported from India. There is practically no export of Eri and Muga silk products inspite of their better fiber qualities and textile properties. Non-mulberry (Tasar) export and its share in natural silk export (Table-3.3.1) speaks much about the dismal performance of non-mulberry silk export in the recent years and its share ranged from 2.46 to 11.33 percent in the total natural silk export from India. The Non-mulberry (Tasar) silk goods exported from India to other countries was recorded a worth of Rs. 70.86 crore during 2004-05 and it reached up to the level of 121.94 crore during 2013-14 with a compound growth rate of 5.58 percent annually which shows significant achievement during last 10 years. The unit value realization is not encouraging; as compared to mulberry sector; for export of value added products lack in the non-mulberry category. The share of non-mulberry export in the silk export basket is in fluctuating nature.

The highest 11.3 percent contribution of Non-mulberry silk export was registered during 2011-12, but subsequently the export trend does not indicate any favourable trend, may be due to poor workmanship, lack of product diversity, insufficient supply and poor publicity etc. Presently, the foreign exchange earnings from silk goods was recorded Rs. 2031.88 crore, which has increased by 23.18 percent than previous year 2017-18 (Rs.1649.48 crore). Overall the share of Non-mulberry (Tasar silk) goods accounts less than 15 percent during 1960 to 2018 in foreign exchange earning which needs to be visualized in terms of machineries, quality of yarn, adequate supply of raw materials and market support systems in relation to China at international level. The export earing from tasar silk has been depicted in appendix-II.

Table 3.3.1: Vanya (tasar) silk export and its share in total silk export (2004-14)
(Quantity: tons, Value: Ten million)

Year	Tasar silk goods		Total export of silk		Share of tasar silk (%)	
	Qty	Value	Qty	Value	Qty	Value
2004-05	215.23	70.86	11226.53	2879.56	1.92	2.46
2005-06	616.54	118.62	12686.37	3194.20	4.86	3.71
2006-07	630.06	143.21	11671.27	3338.35	5.40	4.29
2007-08	552.05	118.92	10276.44	2727.87	5.37	4.36
2008-09	931.64	208.67	8497.86	3178.19	10.96	6.57
2009-10	570.82	211.53	9228.61	2892.44	6.19	7.31
2010-11	396.72	192.54	7261.66	2863.76	5.46	6.72
2011-12	363.59	266.60	6234.22	2353.33	5.83	11.33
2012-13	4772.96	202.85	53781.44	2303.53	8.87	8.81
2013-14	2869.00	121.94	53694.01	2425.16	5.34	5.03

Source: www.data.gov.in (open Government data platform India)

3.4 Forecasting of Tasar Raw Silk Production:

The forecasting of Tasar raw silk production, for the period 1951-2017 was carried out using Exponential smoothing techniques. The raw silk data for the period 2019 to 2021 has not been taken under study of forecasting model due to drastic change during covid 19 period. After confirming the trend of the given series, data was processed through Expert modeler in SPSS package to find out best forecasting model among Exponential smoothing. The Holt's double exponential smoothing techniques were found to the most appropriate. The Mean Absolute Percentage Error

(19.17) was least for α = 0.511 and γ = 0.830 (table 3.4.1 and table 3.4.2) . The forecasts are obtained for the subsequent twelve years from 2017-18 to 2029-30 taking 2016-17 as base year, 95 percent probability limits are also found out (Table 3.4.3). The trend of observed and predicted values are represented in the fig. 3.4.1. The forecasted value for the base year 2016-17 was lower than observed production but it increases for subsequent period's upto 2029-30. The forecasted Tasar raw silk production for the year 2017-18, 2023-24 and 2029-30 would be 3516, 5273 and 7031 metric tons with increasing trend (Table 3.4.3).

Table 3.4.1: Model fit statistics of the fitted Holt Exponential model for tasar silk production

Model fit statistics							
R^2	RMSE	MAPE	MAE	MaxAPE	MaxAE	BIC	Ljung- Box Q
0.962	127.326	19.170	80.956	80.860	482.561	9.820	6.851

Table 3.4.2: Model parameters (Holt's Linear Exponential) for tasar silk production

	Estimate	SE	T	Sig.
Alpha (Level)	0.511	0.119	4.290	0.000
Gamma (Trend)	0.830	0.318	2.612	0.011

Table 3.4.3 : Model validation and forecast of tasar silk production upto 2019-30

Year	Observed	Predicted	UCL	LCL
2014-15	2450	2933	3183	2678
2015-16	2819	3029	3280	2775
2016-17	3268	3175	3430	2925
2017-18		3516	3770	3261
2019-20		4101	4592	3611
2021-22		4687	5559	3815
2023-24		5273	6619	3928
2025-26		5859	7750	3968
2027-28		6445	8944	3946
2029-30		7031	10193	3869
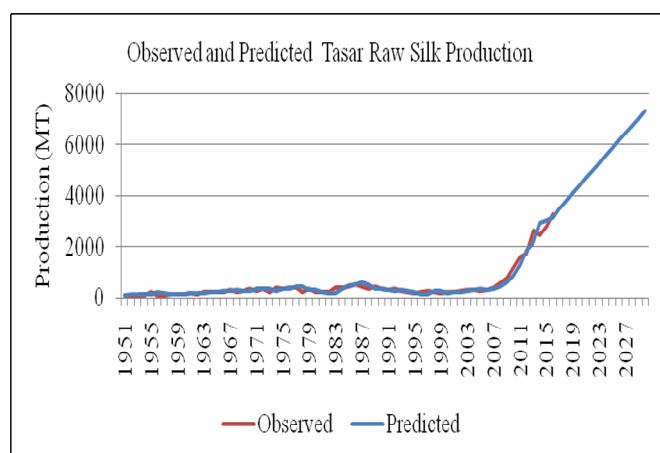
Fig. 3.4.1 : Obs. and Pred. Tasar raw silk production

Suggestions

Studies on statistical approach in relation to growth components of tasar silk production reveal that during the period of study at different pointof times there is significant growth in tasar silk industry specially after 2009 onwards. Yet, the constraints are many faceted. Considering the many complex problems which entrench the industry, the opportunities, funds, infrastructure *interalia* and some biological problems are required attention. Special attention needs to be given for tasar development as it arrests the deforestation and also provides gainful employment opportunities to tribal population and also utilization of vast tracts of natural forest resource. There is tremendous potential for enhancing Vanya silk since the silkworm food plants are naturally available in Jharkhand, Chhattisgarh, Orissa and North-Eastern states. Tasar in India has not achieved standardization, in any of its components viz., breed, seed and feed with the wholesome approach on enlarging the production base of Tasar silk. Therefore, standardization and quality improvement will be in the forefront that would minimize the quality and quantity gap that exists in the present context. The Growth Trend Analysis and Forecasting of silk production and its trade carried out in this study will be very much useful to programme and policy makers to increase the income of farmers and employment generation in sericulture industry at regional and national level.

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Appendices
Appendix-I: Raw Silk Production in India (1951-2019)

Unit: metric ton

Year	Mulberry	Non-Mulberry				Total Raw silk
		Tasar	Eri	Muga	Total NM	
1951-52	625	124	100	45	269	894
1952-53	773	123	102	50	275	1049
1953-54	885	127	99	45	271	1156
1954-55	1062	132	104	55	291	1353
1955-56	1098	263	127	71	461	1559
1956-57	1130	142	130	83	355	1486
1957-58	1164	141	143	86	370	1535
1958-59	1200	160	143	94	397	1597
1959-60	1159	180	112	80	372	1531
1960-61	1185	179	110	39	328	1513
1961-62	1308	202	132	53	386	1695
1962-63	1388	176	137	45	359	1747
1963-64	1390	235	194	49	478	1868
1964-65	1567	231	204	57	492	2058
1965-66	1545	262	201	57	520	2065
1966-67	1629	264	208	68	540	2169
1967-68	1637	317	200	72	589	2226
1968-69	1781	256	213	69	539	2320
1969-70	1823	287	218	73	578	2401
1970-71	2319	371	161	63	595	2914
1971-72	2046	314	168	72	554	2600
1972-73	2215	361	143	66	570	2785
1973-74	2421	257	141	75	473	2894
1974-75	2434	402	115	41	558	2992
1975-76	2541	360	123	43	526	3067
1976-77	2686	423	106	53	582	3268
1977-78	3186	434	56	35	525	3711
1978-79	3752	281	120	24	425	4177
1979-80	4193	384	183	45	612	4805
1980-81	4593	265	135	48	448	5041
1981-82	4801	257	147	44	448	5249
1982-83	5214	284	213	37	534	5748
1983-84	5681	418	270	54	742	6423
1984-85	6895	444	279	55	778	7673
1985-86	7029	464	352	52	868	7897
1986-87	7905	548	392	55	995	8900
1987-88	8455	463	522	58	1043	9498
1988-89	9683	358	565	45	968	10651
1989-90	10805	465	589	57	1111	11916
1990-91	11486	380	624	70	1074	12560
1991-92	10658	329	704	72	1105	11763
1992-93	13000	382	726	60	1168	14168
1993-94	12550	299	766	76	1141	13691
1994-95	13450	257	798	74	1129	14579
1995-96	12884	194	745	86	1025	13909
1996-97	12954	235	864	73	1172	14126
1997-98	14048	312	814	62	1188	15236
1998-99	14260	242	970	72	1284	15544
1999-00	13944	194	974	85	1253	15197
2000-01	14432	237	1089	99	1425	15857
2001-02	15842	249	1160	100	1260	17102
2002-03	14617	284	1316	102	1418	16035
2003-04	13970	315	1352	105	1458	15428
2004-05	14620	322	1448	110	1558	16178
2005-06	15445	308	1442	110	1552	16997
2006-07	16525	350	1485	115	1600	18125

2007-08	16245	428	1530	117	1647	17892
2008-09	15610	603	2038	119	2157	17767
2009-10	16322	803	2460	105	2565	18887
2010-11	16360	1166	2760	124	2884	19244
2011-12	18271	1590	3072	126	3198	21469
2012-13	18715	1729	3116	119	3235	21950
2013-14	19476	2619	4237	148	4385	23861
2014-15	21390	2434	4726	158	4884	26274
2015-16	20478	2819	5060	166	8045	28523
2016-17	21203	3259	5629	171	9059	30262
2017-18	22066	2988	6661	192	9841	31907
2018-19	25344	2981	6910	233	10124	35468

Source: Statistical Biennials & Annual Reports of Central Silk Board

Appendix-II: Import and Export of silk in India (1981-2019)
Unit: Quantity (metric ton), Value (Rs. Crore)

Year	Import of Raw Silk		Export of silk goods earning (Rs. Crore)	Export of tasar silkgoods earning (Rs. Crore)
	Quantity (MT)	Value (Rs. Crore)		
1981-82	641	100.12	69.73	6.86
1982-83	880	98.14	79.31	6.62
1983-84	930	111.33	96.30	8.56
1984-85	1505	109.01	125.33	10.26
1985-86	1767	140.81	159.21	8.15
1986-87	1670	110.60	200.01	6.55
1987-88	1790	122.70	251.79	8.42
1988-89	1770	120.15	327.92	8.84
1989-90	1600	105.11	392.48	8.07
1990-91	1598	101.76	435.94	9.09
1991-92	2076	147.42	670.98	11.02
1992-93	2768	223.29	712.00	11.42
1993-94	4892	268.65	786.22	28.81
1994-95	5403	326.42	926.96	41.23
1995-96	4149	302.78	845.16	25.31
1996-97	2911	215.05	876.47	17.23
1997-98	2760	218.33	904.42	16.22
1998-99	2824	259.36	1003.76	18.25
1999-00	5018	412.74	1239.53	22.02
2000-01	4713	475.15	1277.20	19.00
2001-02	6808	624.73	2359.56	23.00
2002-03	9054	647.15	2294.05	79.99
2003-04	9258	628.41	2779.19	57.30
2004-05	7948	607.21	2879.56	70.86
2005-06	8383	779.71	3194.2	118.62
2006-07	5565	673.37	3165.69	143.21
2007-08	7922	734.31	2727.87	118.92
2008-09	8392	903.06	3165.69	208.67
2009-10	7341	933.70	2892.44	130.03
2010-11	5820	927.59	2863.76	94.41
2011-12	5683	1111.53	2353.33	68.04
2012-13	4959	1238.56	2303.53	202.85
2013-14	3260	896.44	2480.89	215.00
2014-15	3489	970.82	2829.94	187.00
2015-16	3529	1006.16	2495.99	158.00
2016-17	3795	1092.26	2093.42	
2017-18	3712	1218.14	1649.48	
2018-19	2785	1041.40	2031.88	

Source: DGCI&S Kolkata, Indian silk, central silk board.