



## Prognostication of mulberry silk cocoon prices in Kaliachak (West Bengal) market

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### ABSTRACT

West Bengal is a traditional silk production centre and stands 3<sup>rd</sup> in Indian mulberry silk map. The cocoon marketing centres are situated in Malda (Kaliachak, Chanchal, Mothabari & Amrity), Murshidabad (Sagarpara, Panchgram & Berhampore) and Birbhum (Bhadrapur) region; however these markets are not as organised as cocoon markets in southern India. Kaliachak market is a major and very active through-out the year. Typically, marketing channels in the state include "seed rearers -registered seed producers (RSPs/DoS/CSB) - commercial rearers - middlemen -reelers/societies (cocoon markets)". If silk cocoon fails to fetch remunerative price, commercial rearers usually reel the cocoons on their own and market the silk (end product). In the interest of commercial rearers in Malda region, current study aimed at discerning and forecasting mulberry silk cocoon prices in Kaliachak market. Data pertaining to cocoon prices and arrivals across the seasons (2016-2019) were collected and analyzed. The cocoon bidding prices were found highest in favourable seasons (Rs. 316±50) as compared to cocoons produced in unfavourable seasons (Rs. 189±30). The relationship between cocoon arrivals and cocoon prices were found to be positive and significant. The prominence of seasonality in cocoon prices was observed with negative CGR (-2.96%), which was confirmed with traditional time-series analysis. Mulberry cocoon price up to Agrahayani 2019 season in Kaliachak market were projected using quadratic trend equation [highest R<sup>2</sup> (0.87) & least RMSE (4.04)].

**Keywords:** Forecast, Kaliachak market silk cocoon price, seasonality, traditional time-series

In the world, silk is the supreme sophisticated textile having unparalleled splendour, accepted sheen, essential affinity for dyes, soft touch and high durability. It is known as the "Queen of Textiles" all over the world. The origin of Sericulture and Silk production are closely associated with the emergence of China as one of the great civilization. World raw silk production was 159648 MT in 2018. At present, China leads the world with silk production of 120000 MT followed by India with silk production of 35261 MT (Anonymous, 2019).

In India, the lead silk contributing states with good established regulated cocoon markets are located in southern part. The proper marketing arrangement is one of the key traits for the success of any developmental programme. Generally, it attracts the farmers to practice sericulture. Because of organised and regulated cocoon markets farmers used to get remunerative prices, enough cocoons to reelers and silk to weavers (Prabhakara, 1988). It also prohibits middlemen's interventions.

In the country, the Karnataka is the maiden state to establish cocoon markets to protect the interests of the silkworm rearers in 1962 under the Karnataka Silkworm Seed Cocoon & Silk Yarn Act (1959) and it started functioning in letter and spirit from 1972. Silk cocoons being perishable should be sold soon after harvesting. In regulated cocoon market, the farmer brings cocoon

to market & displays in the market lawn. The potential buyers or reelers usually gather around the cocoon lots & judge the cocoon qualities. The sale of cocoon takes place through open auction method. The incharge of market will organize for auctioning of cocoons. Buyers bid their value and when the rate of cocoons get stabilized, auctioneer calls three times & ends the bidding with the third & final call in favour of the uppermost bidder. When seller or farmer agrees with the bid rate or price, the produce will be sold to the uppermost bidder. Later, the produce or cocoons are packed for weighment. Afterward the buyers take the ownership of produce or cocoon and settle the amount at payment counter. The market incharge will settle the payment to the seller or farmer on the day itself. In 1988, Prabhakara estimated the price transmission elasticities (close to unity) for Ramnagara & Vijayapura cocoon markets and revealed that these markets are ideal & price spread was found to be realistic.

In West Bengal, mulberry is grown in 16 districts. Malda, Murshidabad and Birbhum are leading areas (Anonymous, 2018). Mulberry varieties such as Kajali, Bombai, S-1 and S-1635 are popular in Bengal. Since, last two decades, the cocoon and silk production has shown significant increase (Manjunatha *et al.*, 2018) even under hard climatic conditions, cultivation on

marginal lands, rearing with nistari based breeds/ hybrids and fewer marketing facilities.

In the state, cocoon marketing centres are located at Kaliachak, Chanchal, Mothabari, Amrity, Sagarpara, Panchgram, Berhampore & Bhadrapur (Anonymous, 2019) regions of West Bengal but these markets are not found to be as organized as cocoon markets of South India. Typically, cocoons of seed rearers in West Bengal are being procured by RSPs/DoS/CSB. While, cocoons produced in commercial seasons are sold by rearers at nearby cocoon markets to reelers or societies via middlemen otherwise they perform reeling on their own & place silk in the market. Moreover, the commercial rearers are not obtaining remunerative prices for their produce (mulberry silk cocoon) irrespective of breeds/hybrids and seasons as it ranged between Rs. 140 to 180 per kg of reeling cocoons during 2010

(Anonymous, 2010) & Rs. 140 to 150 during 2019 (Anonymous, 2019). It reveals that cocoon prices are not much fluctuating. Currently, the world silk economy is facing price instability. With this and in the interest of commercial sericulture rearers, the present study attempts to forecast mulberry cocoon prices in the Kaliachak cocoon market as it is one of the major and most active market across seasons in a year and located 20km away from Malda town.

### MATERIALS AND METHODS

The study was carried out using secondary data pertaining to cocoon prices and arrivals which were collected from the Kaliachak market for the period Dec-2016 to May-2019. The crop seasons & cocoon marketing months considered for the study are given below:

Seasons (Hybrids)	Crop Seasons	Marketing Months
Favourable (BxB / MxB)	Agrahayani (Nov.)	Dec. (1 <sup>st</sup> week / whole month)
	Falguni (Jan.-Feb.)/ Chaitra (Feb.-March)	March (1 <sup>st</sup> to 3 <sup>rd</sup> week) April (1 <sup>st</sup> to 2 <sup>nd</sup> week)
	Unfavourable (MxM / MxB)	Baisakhi (March-April)
Jaistha (May-June)/ Shravani (June-July)		June (last week) to July (whole month)
Bhaduri (Aug.)/ Aswina (Aug. -Sept.)		Sep. (whole month)

Data was analysed using suitable statistical techniques like descriptive statistics, Pearson-product moment correlation, traditional methodology of time series etc. The growth rate (CGR) of cocoon prices using exponential model (Ajay et al, 2016). The time series analysis with traditional decomposition procedure was performed for forecasting the cocoon prices. The steps followed are given below:

- Graphical representation of cocoon prices to delineate trend, cyclic and seasonal components
- Computation of seasonal indices to identify & remove seasonal component
  - 1) Computation of odd or even numbered moving average (MA) depending upon the seasonality. Its computation smoothen the data.

$$MA_i = \left. \begin{matrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{matrix} \right\} = \frac{Y_1 + Y_2 + \dots + Y_n}{n}$$

Where, n is number of seasons or quarters in i<sup>th</sup> MA for all time (n may be odd or even, if even, estimate center MA values further with calculated MAs)

- 2) Computation of relative values (RVs) i.e.,

$$RV_i = \frac{Y_i}{MA_i} \times 100$$

- 3) Using RVi's, seasonal indices (SIs) are obtained for all the time period

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Year	S1	S2	S3	S4	S5	
1			RV1	RV2	RV3	
2	RV4	RV5	RV6	RV7	RV8	
3	RV9	RV10	RV11			
Average	$\bar{S}_1$	$\bar{S}_2$	$\bar{S}_3$	$\bar{S}_4$	$\bar{S}_5$	$\sum_i^n \bar{S}_i > n \times 100$ (confirms seasonality)
SI	$\bar{S}_1 \times CF$	$\bar{S}_2 \times CF$	$\bar{S}_3 \times CF$	$\bar{S}_4 \times CF$	$\bar{S}_5 \times CF$	$CF = n \times 100 \sum_i^n \bar{S}_i$

*n* is number of seasons per quarter

4) Computation of deseasonalized series using

$$\text{formula i.e., } Y_t^* = \frac{Y_t}{SI_t} \times 100$$

- Fitting of linear or non-linear trend equations for deseasonalized time series

Linear	$Y = b_0 + b_1 t$
Logarithmic	$Y = b_0 + b_1 \log t$
Inverse	$Y = b_0 + \frac{b_1}{t}$
Quadratic	$Y = b_0 + b_1 t + b_2 t^2$
Cubic	$Y = b_0 + b_1 t + b_2 t^2 + b_3 t^3$
Power	$Y = b_0 t^{b_1}$
Compound	$Y = b_0 b_1^t$
S-curve	$Y = e^{b_0 + \frac{b_1}{t}}$
Logistic	$Y = \frac{1}{\frac{1}{u} + b_0 b_1^t}$ u is upper boundary value
Growth	$Y = e^{b_0 + b_1 t}$
Exponential	$Y = b_0 e^{b_1 t}$

Where, Y : Price of cocoon per kg; t-time/ season;  $b_0$ ,  $b_1$ ,  $b_2$  are co-efficients

- Projections were made with best fit equation/model (highest  $R^2$  & least RMSE). The projects were later adjusted by multiplying with respective SI to obtain realistic estimates.

**RESULTS AND DISCUSSION**

The correlation between arrivals and prices of mulberry cocoons in Kaliachak market during 2016-2019 were found to be positive and significant in both favourable (0.29; Agrahayani & Falguni-Chaitra) and unfavourable season (0.30; Baisakhi, Jaista-Shravani & Bhadhuri-Aswini; Table 1). It indicated that the arrival of cocoons and its bidding in each seasons are more or less of same pattern (horizontal “S” shape). The price per kg of cocoon was always maximum in the favourable season (Rs.316±50) as compared to unfavourable season (Rs.189±30). The maximum price in the favourable season reflects the arrivals of good quality cocoons (Bi hybrids & ICB) as compared to unfavourable season.

The trend pertaining to cocoon prices (per kg) across the seasons in Kaliachak market was found to be decreasing during 2016-2019 (Fig 1). Negative CGR (-2.96%) was observed due to more arrivals of cocoon over the seasons. Seasonal variation in prices of cocoons made notable influence as evident by Alvarez *et al.* (2010) and Prabhakara (1988). The seasonality was prominent in the mulberry silk cocoon prices which was confirmed with traditional decomposition of time series analysis through fitting of quadratic equation for de-seasonalized prices (Table 2&3). Mulberry cocoon price was projected up to Agrahayani 2019 season in Kaliachak market using best time-series quadratic trend model having highest  $R^2$  (0.87) & least (4.04) RMSE, besides, coefficients in model were significant (Table 2 to 4 & Fig. 1). Projects of cocoon prices using selected model was found to be realistic.

The prices of mulberry silk cocoon were directly depends on seasonal arrivals of the produce in Kaliachak market of West Bengal. It is maximum during favourable

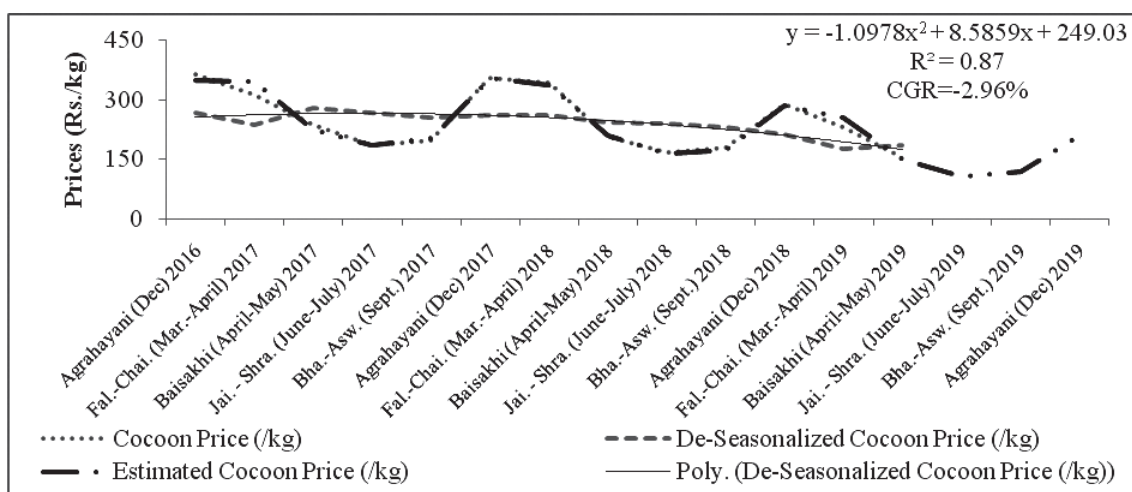


Fig.1:Trend and forecast of cocoon prices in Kaliachak market [2016-2019]

Table 1: Season-wise correlation between cocoon arrivals and prices in Kaliachak market

Rearing Seasons & Breeds/ Hybrids	Marketing Seasons	Cocoon Prices (Rs. per kg)	Arrivals (kg)	Correlation Co-efft. (r)
Favourable(BxB / MxB)	Agraphayani (Dec) 2016	364.37	411.1	0.24
	Fal.-Chai. (Mar-April) 2017	311.82	435.2	0.33
	Agraphayani (Dec) 2017	354.75	584.4	0.76*
	Fal.-Chai. (Mar-April) 2018	344.00	479.1	0.61
	Agraphayani (Dec) 2018	289.00	516.3	0.46
	Fal.-Chai. (Mar-April) 2019	231.50	422.4	0.75*
	<b>Total/Avg.±SD</b>	<b>315.90 ±49.80</b>	<b>2848.39</b>	<b>0.29*</b>
Unfavourable(MxM / MxB)	Baisakhi (April-May) 2017	238.12	538.7	0.25
	Jai. - Shra. (June-July) 2017	186.75	443.7	0.34
	Bha.-Asw. (Sept) 2017	198.98	230.6	0.51
	Baisakhi (April-May) 2018	206.61	305.7	0.34
	Jai. - Shra. (June-July) 2018	167.49	238.9	0.49
	Bha.-Asw. (Sept) 2018	179.99	235.3	0.52
	Baisakhi (April-May) 2019	156.75	532.1	0.18
	<b>Total/Avg.±SD</b>	<b>189.28 ±30.30</b>	<b>2525.05</b>	<b>0.30*</b>

\* Significant at 5%; Avg. (n)10 per season

Table 2: Estimation of seasonal indices by relative values & seasonality test

Year	Fal.-Chai. (Mar-April)	Baisakhi (April-May)	Jai. - Shra. (June-July)	Bha.-Asw. (Sept)	Agraphayani (Dec)	Seasonality
2017		91.58	72.36	75.22	137.38	
2018	135.24	82.46	70.55	83.70	141.00	
<b>Avg.</b>	<b>135.24</b>	<b>87.02</b>	<b>71.45</b>	<b>79.46</b>	<b>139.19</b>	<b>512.36*</b>
Sea. Indices(SI)	131.97	84.92	69.73	77.54	135.83	0.98 [CF]

\* Confirmation of seasonality [as the sum is > 500]; CF – Correction Factor of seasonality

**Table 3: Estimation of trend in cocoon prices in Kaliachak market**

t	Marketing Seasons [t]	Cocoon prices (per kg) [Y <sub>t</sub> ]	5 Period Moving Average [MA <sub>5</sub> ]	Rel. Value [Y <sub>t</sub> /MA <sub>5</sub> x 100]	Sea. Indices (SI)	De-Sea. Cocoon Prices (per kg) [Y <sub>t</sub> /SI x 100]	Est. Cocoon Prices** (per kg) [Ŷ <sub>t</sub> ]
1	Agrahayani (Dec) 2016	364.37			135.8	268.2	348.40
2	Fal.-Chai. (Mar-April) 2017	311.82			132.0	236.3	345.50
3	Baisakhi (April-May) 2017	238.12	260.0	91.6	84.9	280.4	224.96
4	Jai. - Shra. (June-July) 2017	186.75	258.1	72.4	69.7	267.8	185.35
5	Bha.-Asw. (Sept) 2017	198.98	264.5	75.2	77.5	256.6	205.12
6	Agrahayani (Dec) 2017	354.75	258.2	137.4	135.8	261.2	354.58
7	Fal.-Chai. (Mar-April) 2018	344.00	254.4	135.2	132.0	260.7	337.02
8	Baisakhi (April-May) 2018	206.61	250.6	82.5	84.9	243.3	210.17
9	Jai. - Shra. (June-July) 2018	167.49	237.4	70.5	69.7	240.2	165.55
10	Bha.-Asw. (Sept) 2018	179.99	214.9	83.7	77.5	232.1	174.60
11	Agrahayani (Dec) 2018	289.00	204.9	141.0	135.8	212.8	286.19
12	Fal.-Chai. (Mar-April) 2019	231.50			132.0	175.4	256.08
13	Baisakhi (April-May) 2019	156.75			84.9	184.6	148.77
14	Jai. - Shra. (June-July) 2019				69.7		107.48
15	Bha.-Asw. (Sept) 2019				77.5		119.52
16	Agrahayani (Dec) 2019				135.8		209.36

\*\* Estimated based on quadratic trend equation

**Table 4: Identification of best fit model for projecting mulberry silk cocoon prices**

Equations	Model Summary				Parameter Estimates		
	R <sup>2</sup>	F Sig.	RMSE	Constant (b <sub>0</sub> )	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>
Linear	0.674	0.00058	5.78688	287.442	-6.782*		
Logarithmic	0.425	0.01573	7.68242	287.516	-27.408*		
Inverse	0.198	0.12723	9.07222	226.333	55.744		
<b>Quadratic</b>	<b>0.868</b>	<b>0.00004</b>	<b>4.04529</b>	<b>248.997</b>	<b>8.596*</b>	<b>-1.098*</b>	
Cubic	0.869	0.00026	4.49053	251.052	7.103	-0.841	-0.012
Compound	0.659	0.00075	0.02697	293.437	0.97*		
Power	0.409	0.01856	0.03438	293.028	-0.12*		
S curve	0.188	0.13931	0.04045	5.412	0.243		
Growth	0.659	0.00075	0.02697	5.682	-0.03		
Exponential	0.659	0.00075	0.02697	293.437	-0.03*		
Logistic	0.659	0.00075	0.02697	0.003	1.03*		

\*Significant at P = 0.05 ; Values/letters in bold indicates best model

season (Agrahayani, Falguni&Chaitra), as the climate favours for mulberry sericulture in the state. The prices were predicted for Agrahayani 2019 season using quadratic trend. Further, the growth rate of the cocoon prices were found to be negative during the period of the study (2016-2019). It is also observed that the cocoon prices were found to be on lower side as compared to south markets of India. It draws the attention of policy/decision to retain stakeholders of sericulture sector in the same line for its sustainable development,

as marketing infrastructures & facilities, price behaviour & its flow play pivotal role in the developmental aspects.

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