Original Research Article

Impact of Climate Change on Egg Production in India and Price Behaviour of Eggs in Selected Markets of India

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ABSTRACT

The present study entitled "Impact of Climate Change on Egg Production in India and Price Behaviour of Eggs in Selected Markets of India" aims to study the impact of climatic variables such as temperature, rainfall and relative humidity on egg production in India and various components of prices of eggs in selected markets of India. Multiple regression analysis revealed that temperature has a negative effect and rainfall and relative humidity have a positive effect on egg production in India. Decomposition of prices of eggs to trend, seasonal, cyclical and irregular components was done using Minitab. The data on egg prices from June 2009 to May 2022 was obtained from National Egg Coordination Committee (NECC) website. Bengaluru, Chennai, Delhi and Mumbai are the four markets considered for the study. The average price per 100 eggs is highest in Mumbai (Rs.366.06) followed by Chennai (Rs.360.25), Bengaluru (Rs.348.52) and Delhi (Rs.341.17). the prices of eggs showed wide fluctuations and there is uniformity in prices of eggs across all the selected markets due to organized egg marketing. The prices of eggs in all the selected markets showed a highly significant increasing trend. The annual increase in egg prices was highest in the Mumbai market (Rs.1.57/100 eggs) and lowest in the Delhi market (Rs.1.35/100 eggs). The highest seasonal index was observed during the month of June in Bengaluru and Chennai markets and during the month of July in Delhi and Mumbai markets. In the month of April, the prices of eggs decreased due to their short shelf life because of summer whereas in the month of November the prices of eggs decreased due to an increase in arrivals of eggs. The highest price of eggs during the June and July months is due to an increase in the consumption of eggs. Egg prices do not have any price cycles and irregular variations are observed for all the markets considered under study. Government should take initiative to educate poultry farmers regarding the impact of climate change on egg production as well as prevailing egg prices in the market.

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1. INTRODUCTION

Poultry is one of the major segments in the agricultural sector of India that is growing at the fastest rate than that of agricultural crops. Poultry production increased enormously over the

past four decades due to an increase in commercial production systems as well as technological advancement. The quality and productivity of poultry have improved a lot. Usage of the standardized package of practices and the development of high yielding layers and broilers contributed to the growth in poultry production.[1]

Changing food habits and increasing income levels create demand for poultry products. Per capita consumption of poultry products increased in the recent past. In recent years COVID-19 posed a problem for the poultry sector and consumption of poultry products decreased in the year 2020.

Climate change not only affect the egg productivity but also causes huge losses to poultry layer farmers. Adverse climatic conditions cause reduced growth rate, lower egg production, increased disease threat, and higher mortality and thereby decreasing the profit of layer farmers.

India is one of the leading egg-producing countries in the world. Egg production in India increased from 95 billion eggs in 2017-2018 to over 114 billion eggs in 2019-20 and is expected to reach 136 billion eggs by 2023 whereas poultry meat production increased from 3.7 MMT in 2017-18 to 4.3 MMT in 2019-20 and is expected to increase to 6.2 MMT by 2023. Poultry products in India have good export potential. Oman, Maldives, Russia, Vietnam and Indonesia are major importers of poultry products from India[2]. Andhra Pradesh, Tamil Nadu, Maharashtra, Punjab and Kerala are major egg-producing states in India.

Egg is a nutritious food consisting of protein, essential amino acids, vitamins such as vitamin A, B_6, B_{12}, folate, minerals such as iron, phosphorus, Selenium, Choline and zinc etc. which are crucial for growth and provide good health. Egg provides many health benefits to people of all age groups. It reduces the risk of blindness and cataract in people over the age of 65.

Some of the related literature are presented here.

1.1 Impact of climate change

Adesiji et al.[3] assessed the effect of climate change on poultry production by studying 83 poultry farmers through interviews. The results revealed that the majority of the respondents are aware of climate change and also have knowledge of the negative effect of temperature fluctuation, increased sunshine intensity and global warming on poultry production. The study also proposed the need for awareness programs for poultry farmers to reduce the impact of climate change on poultry production.

Lamarca et al. [4] studied the impact of heat waves on layer poultry farming in the Bastos region of Brazil. The study revealed there is an increase in layer mortality rate due to heat waves in the sheds which are not equipped with air conditioning.

Fatoki et al. [5] examined the effect of climatic variables on egg output in Ogun state of Nigeria for the period from 1990 to 2019. The study revealed that rainfall and relative humidity positive impact on egg production and temperature showed a negative impact on egg production. The study recommended that extension agents should be trained on climate change adaptation strategies in order to build the capacity of poultry farmers and introduce adaptation technologies that will ensure improvement in egg production.

1.2 Price behaviour

Akintola and Adebayo [6] studied the seasonality of market prices of livestock products in Ibadan Metropolis. Monthly prices of beef, chicken, egg and milk for a period of 72 months

were collected i.e., from 1992 to 1997. Results revealed that the highest prices are recorded during festivals. Storage, transportation and improved market structures are recommended in order to stabilize livestock prices.

Karthikeyan and Nedunchezhian[7] analyzed price trends and behavioral patterns of eggs. The data were collected for a period of 4 years i.e., from January 2009 to December 2012. According to the results, the average egg price grew significantly by 28% during the study period. This is due to an increase in the consumption of eggs and an increase in feed costs. The consumption of eggs is high during winter which in turn increases the prices of eggs. The prices of eggs also increase in November and December when demand is high i.e., during Christmas and new year. Lowest price in April due to hot climate.

Yuhuan and Fu [8] analyzed price fluctuations of eggs in China and determine the impact of egg price on the profit of egg producers. The reasons for the decrease in egg prices are the size of layer farms, breeding cost, information technology and the government's environmental protection policy and less consumer disposable income. Some of the suggestions proposed for layer breeding are egg branding operation, paying attention to egg safety and grasping the market situation. Suggestions for farmers are to actively follow market trends take suitable decisions, reduce the loss of spot price volatility and make full use of modern science and technology

Areef et al[9] studied the price behaviour of onions in the Kurnool market. Data from January 20003 to December 2017 were analyzed and the annual increase in onion prices of Rs. 6.22 per quintal per annum was observed. The highest and lowest seasonal indices were observed in August and May respectively.

Sarkar et al[10] analyzed behaviour of market arrivals and prices of mustard in West Bengal. Arrivals are highest during March in Bardhaman, Chakdah and Tufanganj and during February in Bankura and Kandi. Prices are at their peak when arrivals are less. The study suggests the government to devise a suitable agricultural price policy

2. METHODOLOGY

2.1 Markets selected for the study
Bengaluru, Chennai, Delhi and Mumbai were the four markets that have been selected for studying the price behaviour of eggs.

2.2 Nature and Sources of data
Secondary data is used for analysis in the present study. Data on egg production, rainfall, temperature and relative humidity were collected from India stat for the period from 1992-93 to 2019-20. The data on egg prices from June 2009 to May 2022 was obtained from National Egg Coordination Committee(NECC) website.

2.3 Multiple regression analysis
Regression analysis was used to determine the impact of climatic variables on egg production in India.[5]
The implicit form of the regression model is given as;

$$\log Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 - - - -(1)$$

Where:-
  Y = egg Production (lakh no.s)
  b_0 = Constant term
  X_1 = Total annual rainfall/precipitation(mm)

X_2 = Average annual temperature (°C)
X_3 = Average annual relative humidity (%)
X_4 = Time period

2.4 Time series decomposition

Decomposition of time series to a set of components that can be associated to various types of temporal variations is the main aim of time series analysis. Time series decomposition is a very old concept. According to Persons[11] the time series is composed of four types of fluctuations.

(1) Secular trend: Time series show a tendency of increase or decrease over a long period of time

(2) Cyclical movements super-imposed upon the long-term trend. These cycles appear to reach their peaks during periods of industrial prosperity and their troughs during periods of depression, their rise and fall constituting the business- cycle.

(3) A seasonal movement within each year, maybe due to customs, climate etc.,

(4) Irregular variations occur due to changes impacting individual variables or other major events such as wars and national catastrophes affecting a number of variables.[12]

If the four components of time series are dependent then the relationship can be specified as a multiplicative model

$$X_t = T_t C_t S_t I_t \text{--------------(2)}$$

Where, X_t denotes the observed series,

T_t denotes the long-term trend,

C_t denotes the business cycle,

S_t denotes seasonality and

I_t denotes irregular.

3. RESULTS AND DISCUSSION

3.1 Impact of climatic variables on egg production- The changes in climatic variables such as rainfall, temperature and relative humidity causes a change in egg production. As is seen from table, temperature has a negative impact on egg production whereas rainfall, relative humidity and time period have positive impact on egg production. 1% increase in relative humidity increase egg production by 17.8865 whereas 1 mm increase in rainfall increases egg production by 2.3969. The results further revealed that 93.69 per cent variance in egg production is explained by all the factors considered under study. These results are in conformity with the results of Fatoki et al. [5].

Table 1: Results of regression analysis

| Variables	Coefficients
Constant	-70.3050**
Temperature(^{0}c)	-0.0096
Rainfall(mm)	2.3969
Relative Humidity	17.8865**
Time period	0.2002**
R square	0.9369

3.2 Price movement of eggs -The fluctuations in prices of eggs in selected markets of India are observed with the help of graphs. Among all the selected markets the average price of 100 eggs is highest in Mumbai (Rs.366.06) followed by Chennai (Rs.360.25), Bengaluru (Rs.348.52) and Delhi (Rs.341.17) during the period considered under study. There is uniformity in the prices of eggs across all the selected markets due to organized egg marketing.

3.2.1 Price movement of eggs in Bengaluru: The fluctuations in prices of eggs in Bengaluru are depicted in Fig.1. The egg prices in Bengaluru showed wide fluctuations during the entire period considered under study. The price per 100 eggs is the least during the month of August 2009 i.e., Rs.205.58 and highest during the month of June 2021 i.e., Rs.537.17. The average price per 100 eggs for the entire period considered under study is Rs.348.52.
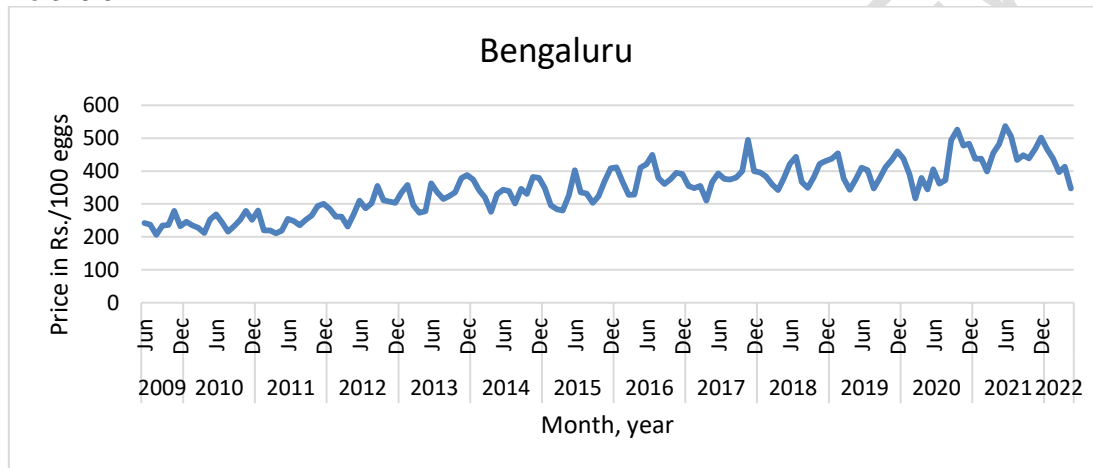
Fig.1 Prices of eggs in Bengaluru

3.2.2 Price movement of eggs in Chennai: The variations in prices of eggs in Chennai are portrayed in Fig.2. Wide fluctuations were observed in egg prices in Chennai ranging from Rs.217.65 in August 2009 to Rs.532.50 in June 2021. The average price of eggs in Chennai during the study period is Rs.360.25 per 100 eggs.
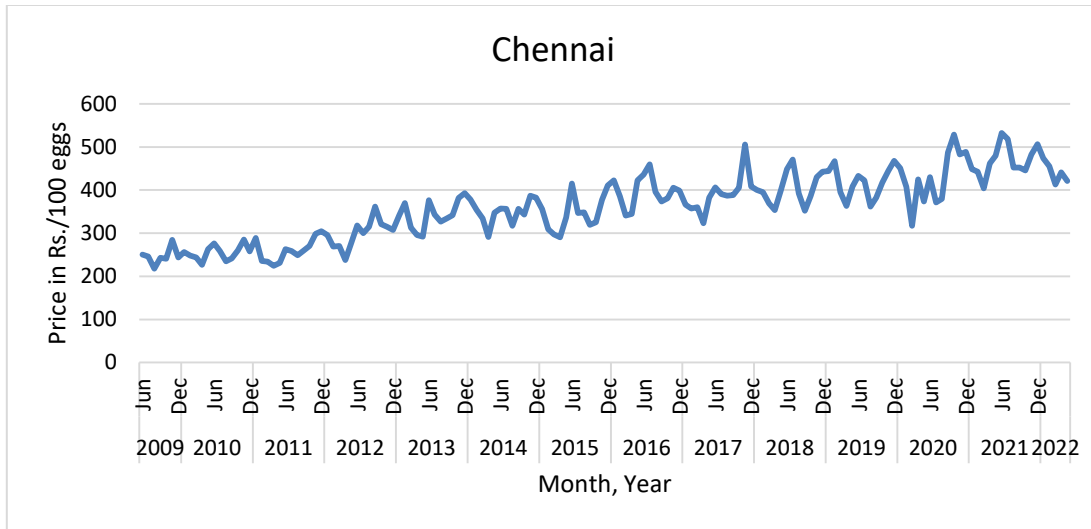
Fig.2 Prices of eggs in Chennai

3.2.3 Price movement of eggs in Delhi: The prices of eggs in Delhi market are depicted in Fig.3. Wide variations were observed in the prices of eggs in Delhi market during the entire period of study. The lowest price of eggs was observed during the month of April 2010 i.e., Rs.194.10 and the highest price was observed during the month of December 2021 i.e., Rs. 540.32. The average price per 100 eggs in Delhi for the entire period considered under study is Rs.341.17.
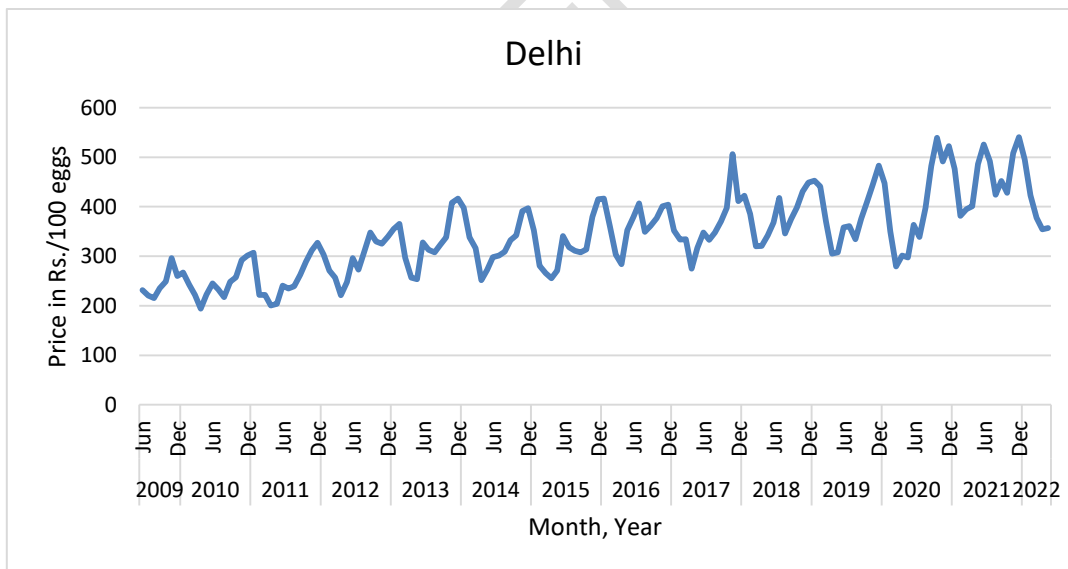
Fig.3 Prices of eggs in Delhi

3.2.4 Price movement of eggs in Mumbai: The variations in prices of eggs in Mumbai are portrayed in Fig.2. Wide fluctuations were observed in egg prices in Mumbai ranging from the lowest Rs.217.23 in April 2011 to the highest Rs.559.10 in June 2021. The average price per 100 eggs in Mumbai during the study period is Rs.366.06.
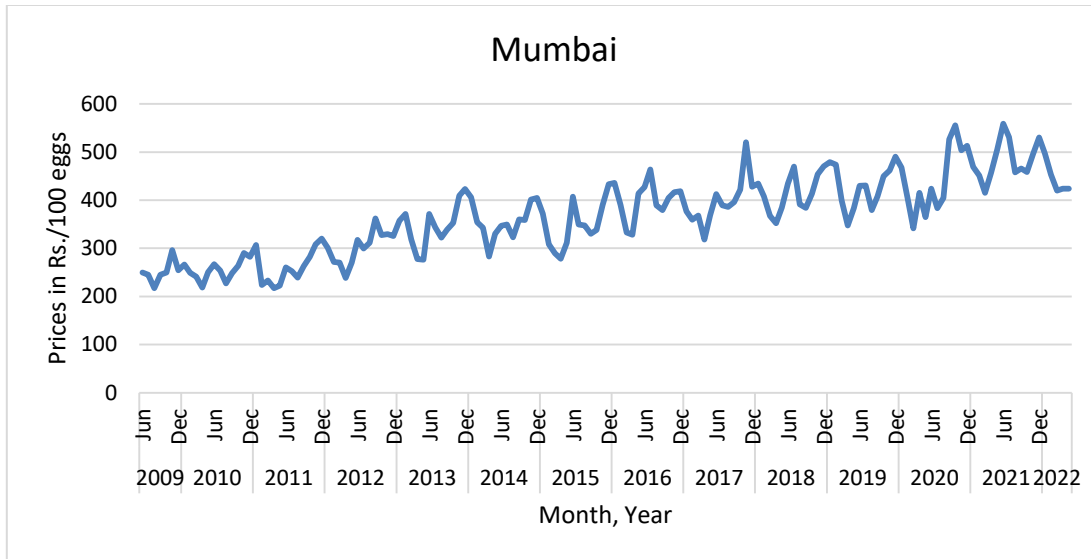
Fig.4 Prices of eggs in Mumbai

3.3 Trend analysis- The prices of eggs in all the selected markets showed a highly significant increasing trend. All the markets are significant at a 1% probability level. The annual increase in egg prices was highest in the Mumbai market (Rs.1.57/100 eggs) and lowest in the Delhi market (Rs.1.35/100 eggs). The adjusted R square indicated the contribution of time to change in prices to the tune of 58 to 77 per cent

Table 2: Trends in prices of eggs in selected markets

Market	Equation	Adj-R Square	p-value
Bengaluru	234.13+1.4572*t	0.74	6.99E-47**
Chennai	243.46+1.4878*t	0.77	1.94E-51**
Delhi	235.47+1.3465*t	0.58	1.47E-31**
Mumbai	242.65+1.5720*t	0.74	1.76E-47**

Note:** represents significance at 1 per cent probability level
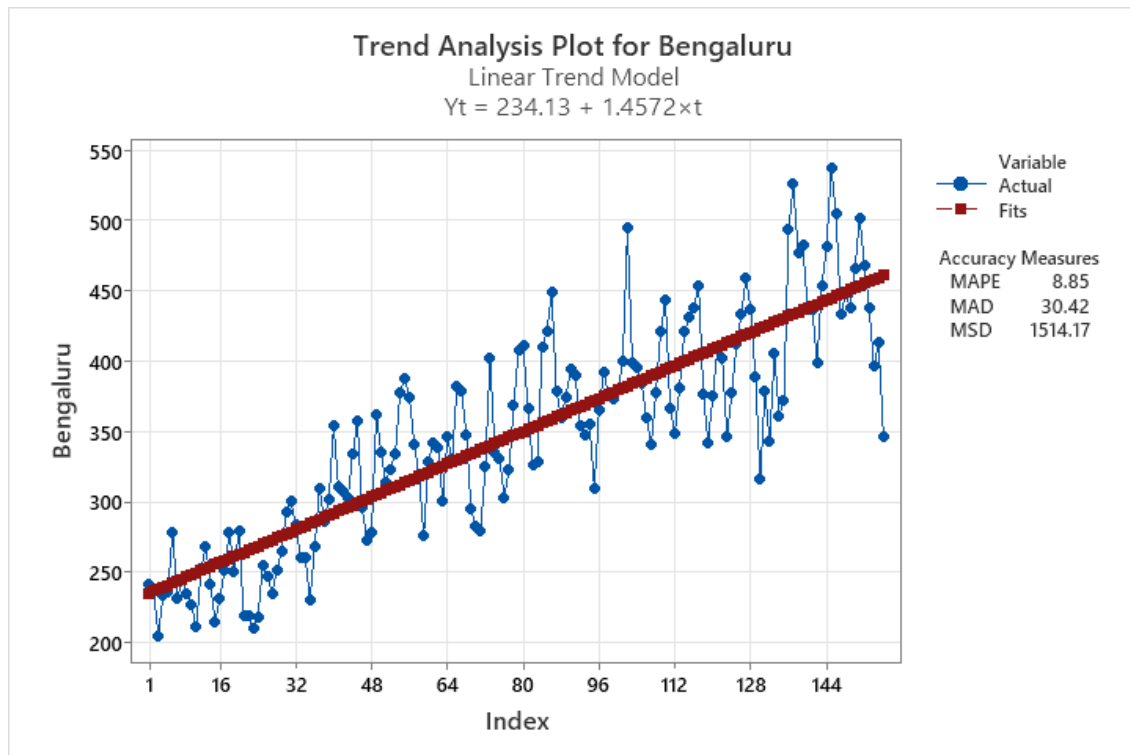
Fig.5 Trend analysis plot for Bengaluru
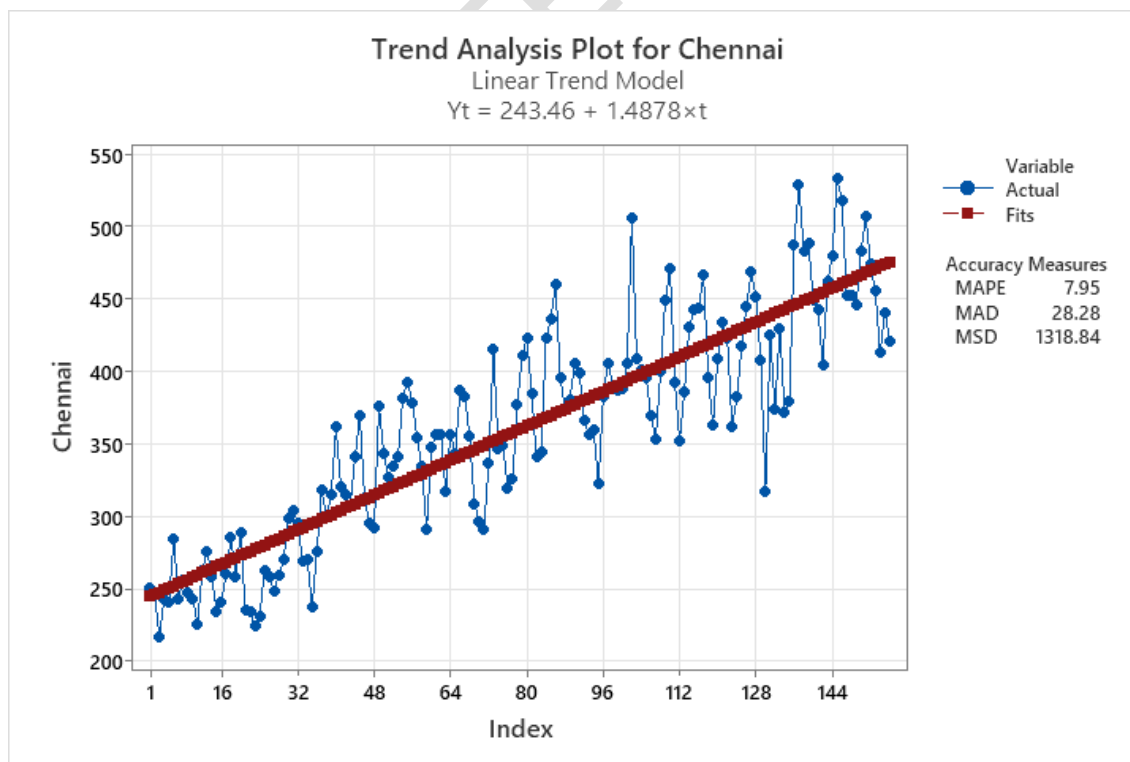
Fig.6 Trend analysis plot for Chennai
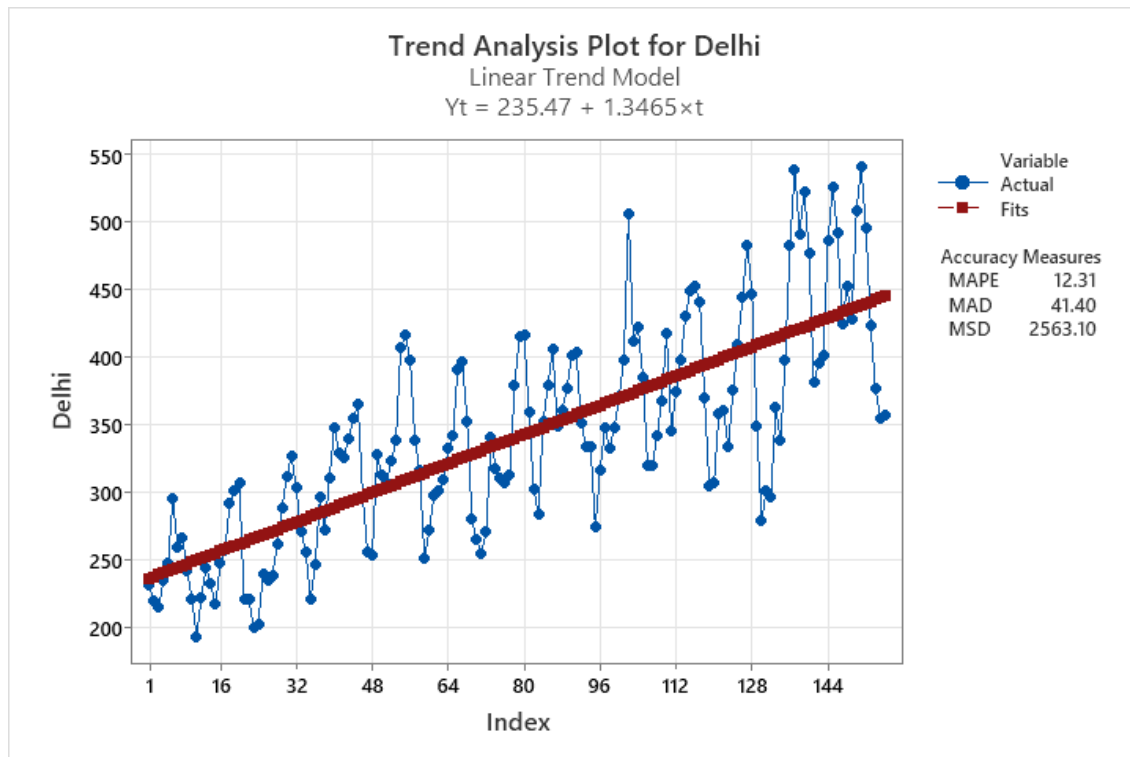
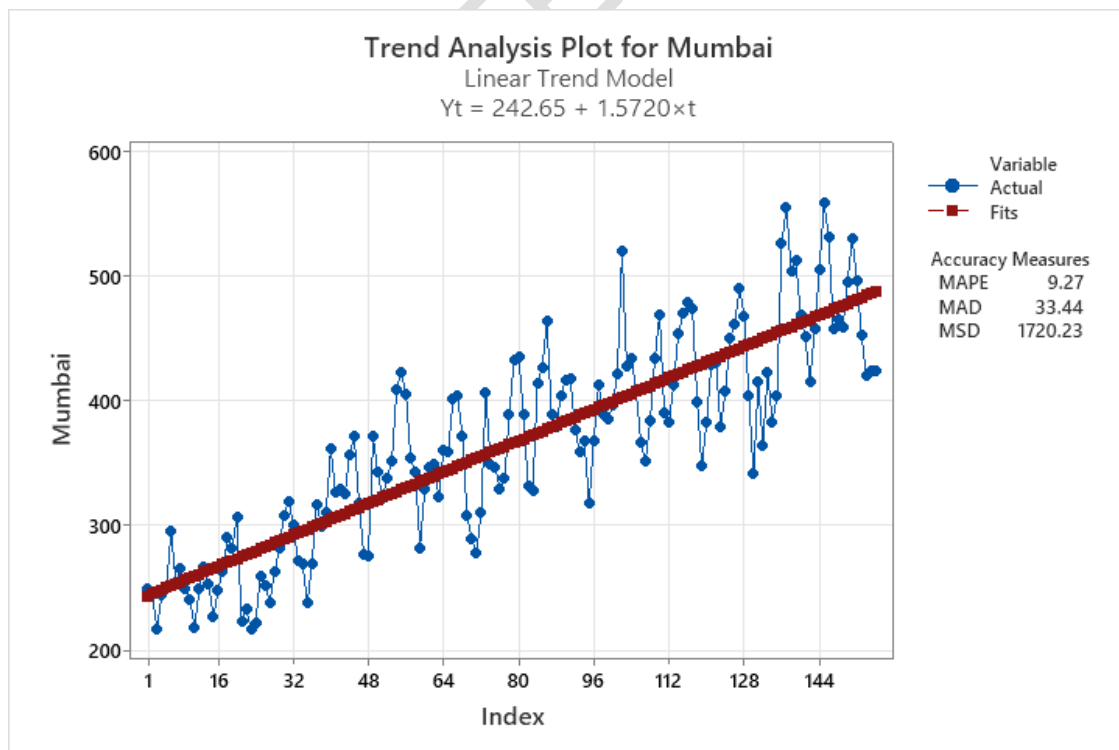**Fig.7 Trend analysis plot for Delhi**


Fig.8 Trend analysis plot for Mumbai

3.4 Seasonal variations of prices of eggs- Seasonal indices of eggs are calculated for the selected markets and the results are presented in Table 3. In Bengaluru and Chennai markets, highest seasonal index (110.04 and 108.53) was observed in June and lowest seasonal index was observed in November (86.58 and 87.92). In Delhi and Mumbai markets, highest seasonal index of 119.76 and 112.12 respectively was found in the month of July and lowest seasonal index of 80.49 and 84.10 respectively was found in the month of November. Seasonal indices of all the markets are presented in graphs (Fig-9 to 12). The prices of eggs decrease both in April and November months. During April the prices of eggs decrease due to short shelf life of eggs because of summer. During November the prices of eggs decrease due to increase in arrivals of eggs. Highest price in June and July months due to increase in consumption of eggs during these months. These results are in conformity with the study of Karthikeyan and Nedunchezhian[7].

**Table 3. Seasonal indices of egg prices in selected markets**

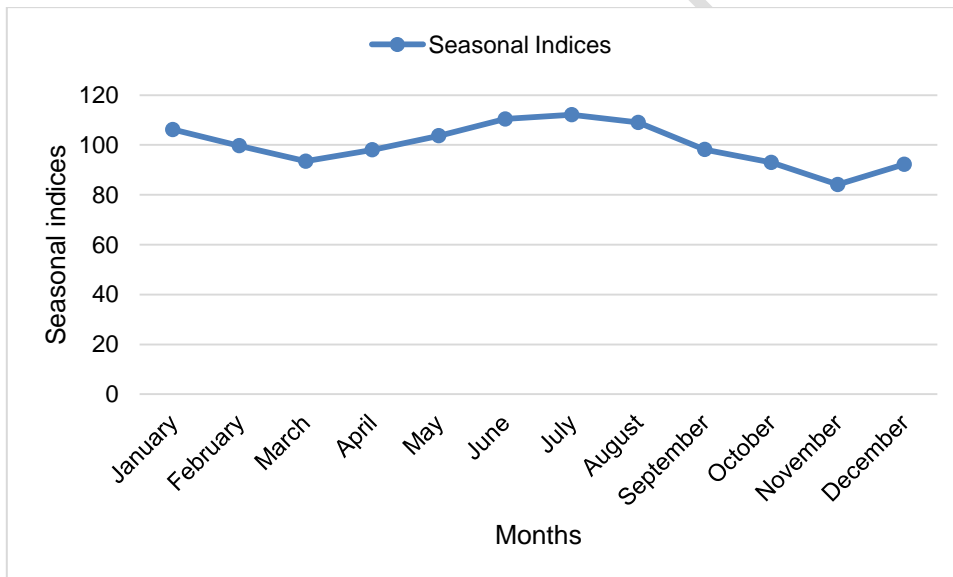| Month	Seasonal Indices			
	Bengaluru	**Chennai**	**Delhi**	**Mumbai**
January	108.33	107.81	99.26	106.15
February	100.32	100.59	94.38	99.70
March	93.88	95.53	94.45	93.45
April	97.16	96.47	100.94	98.05
May	101.35	100.98	106.05	103.70
June	110.04	108.53	116.46	110.39
July	108.19	107.01	119.76	112.12
August	106.30	105.55	112.53	109.00
September	97.96	97.62	99.58	98.17
October	92.41	93.10	90.37	92.96
November	86.58	87.92	80.49	84.10
December	97.49	98.89	85.73	92.22
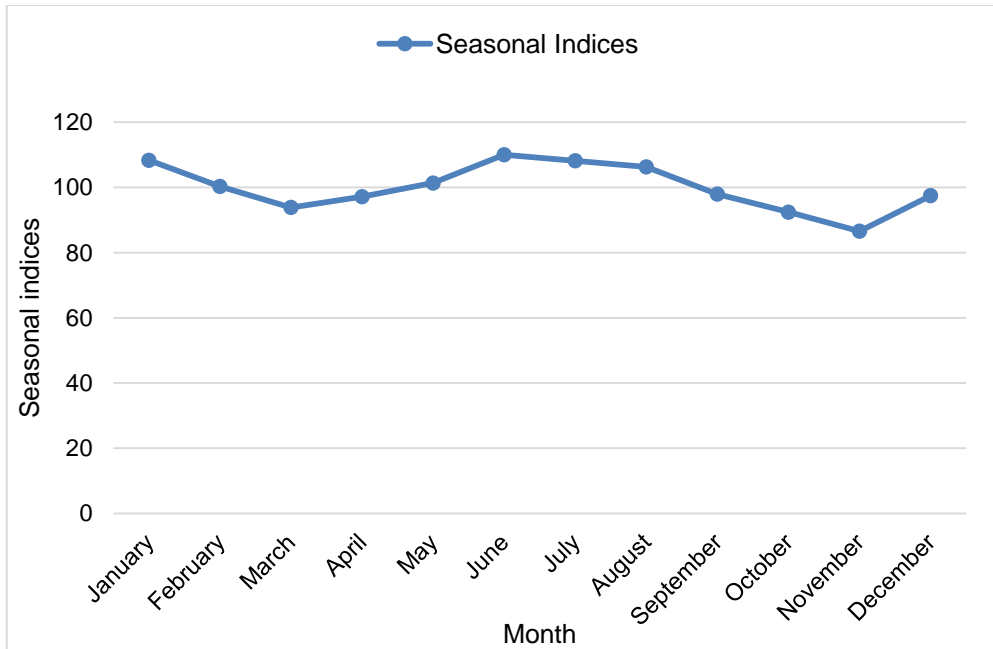
Fig-9: Seasonal indices of prices of eggs in Bengaluru market
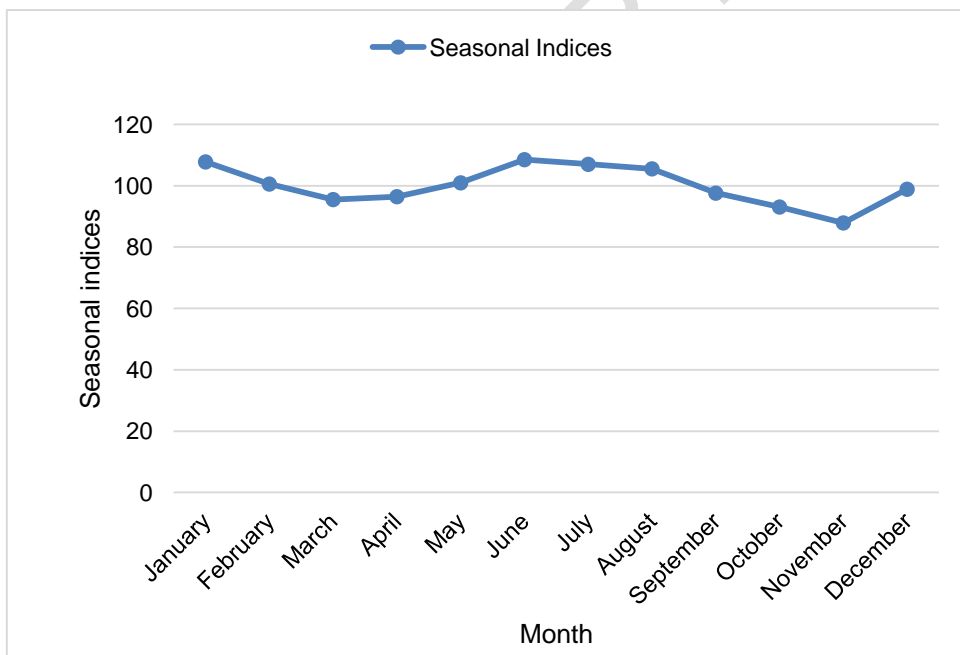
Fig-10: Seasonal indices of prices of eggs in Chennai market
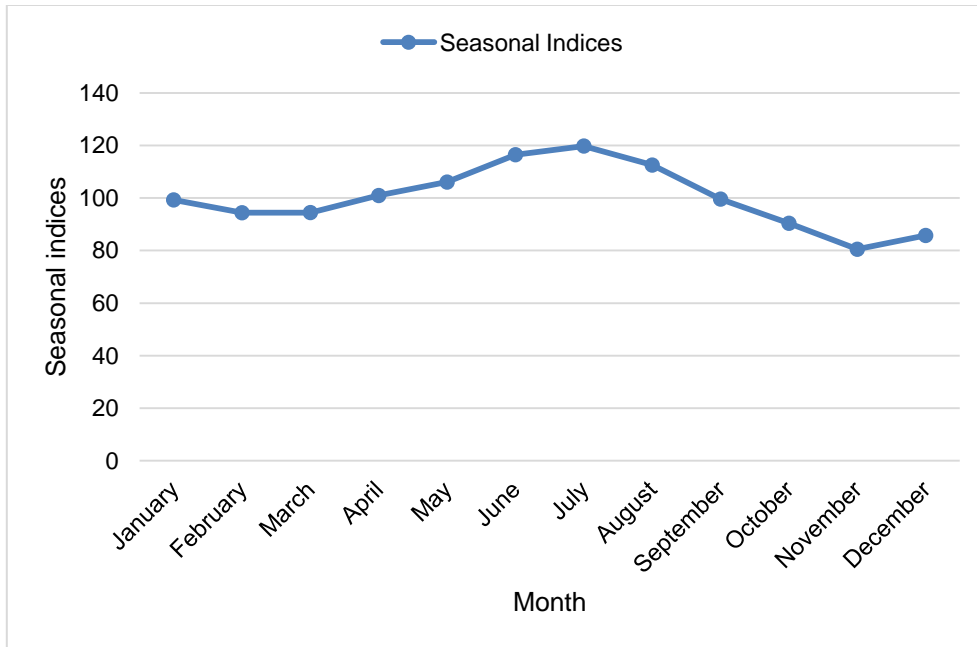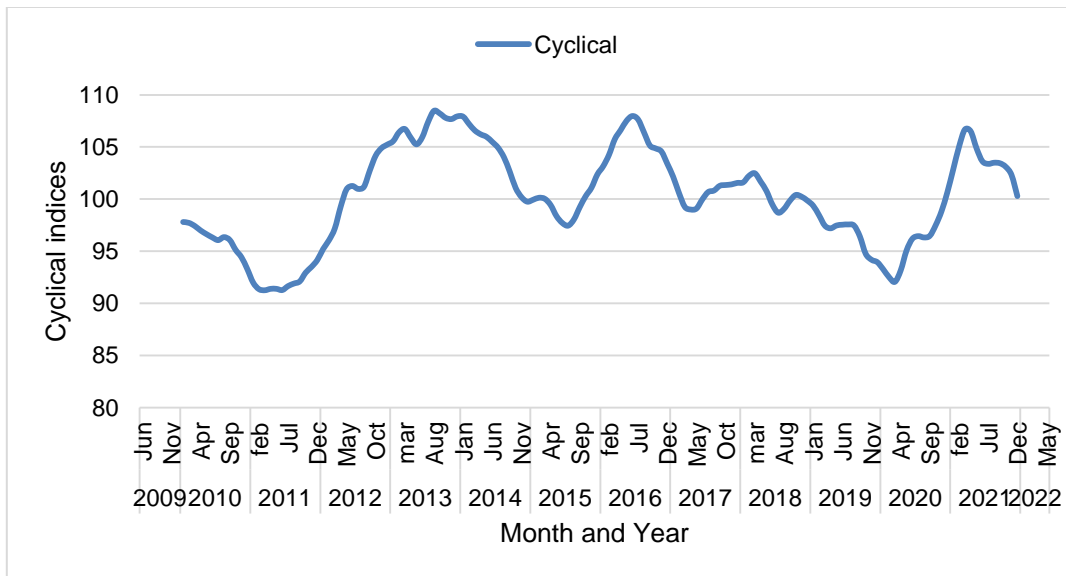
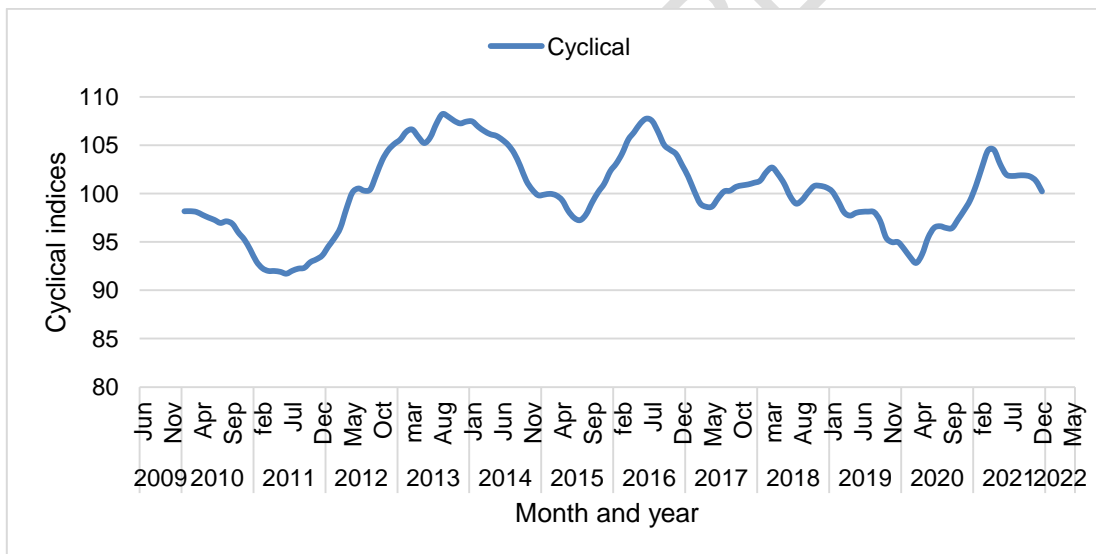**Fig-11: Seasonal indices of prices of eggs in Delhi market**

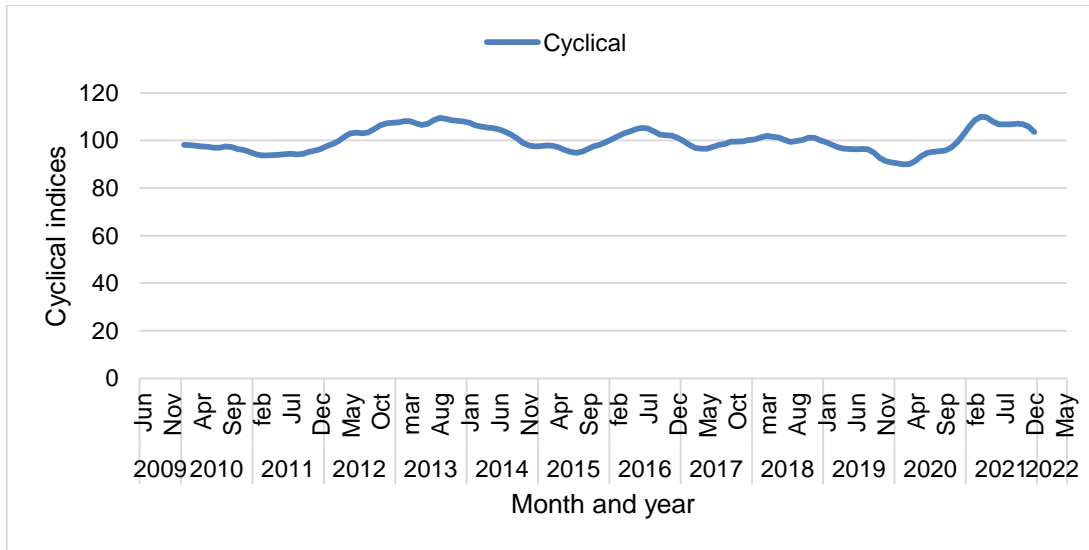**Fig-12: Seasonal indices of prices of eggs in Mumbai market**

3.5 Cyclical variations in prices of eggs- The cyclical variations in prices of eggs are graphically presented from Fig.13 to 16. No price cycles were observed for eggs in all the selected markets of India.
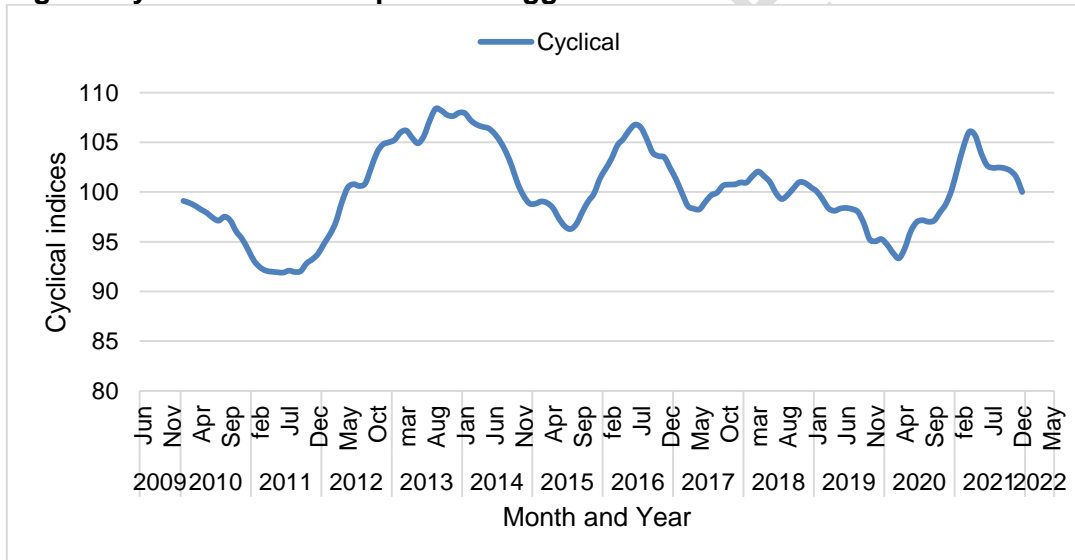
Fig-13: Cyclical indices of prices of eggs in Bengaluru market

**Fig-14: Cyclical indices of prices of eggs in Chennai market**

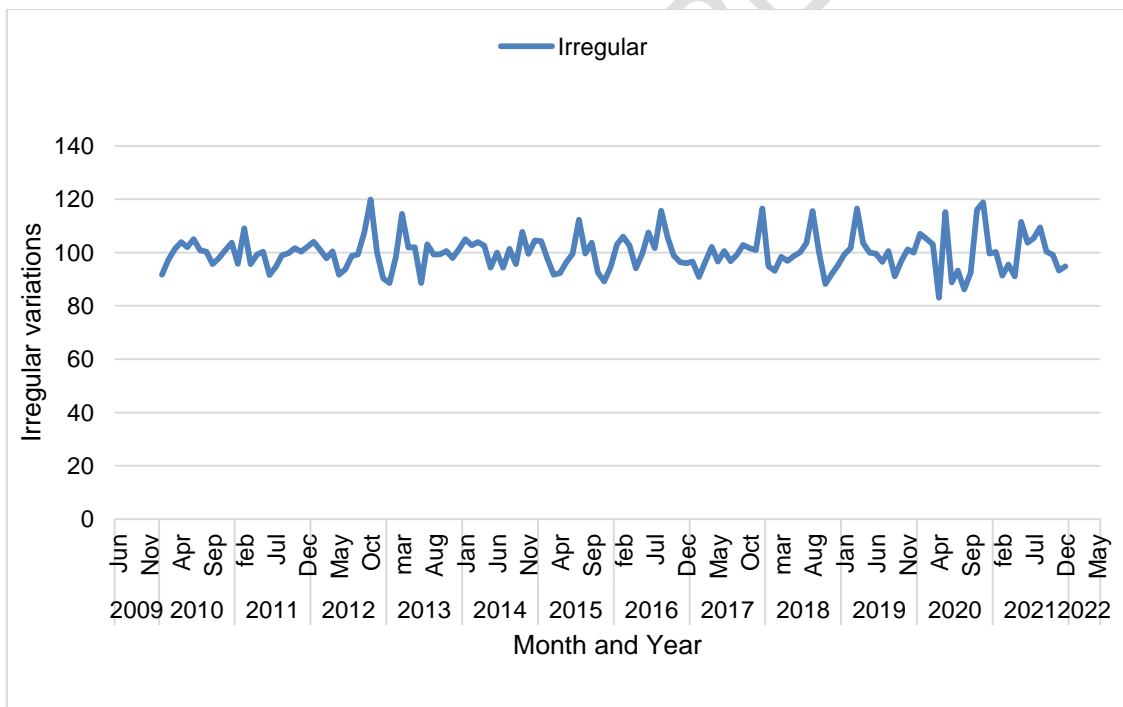**Fig-15: Cyclical indices of prices of eggs in Delhi market**

**Fig-16: Cyclical indices of prices of eggs in Mumbai market**

3.6 Irregular variations in prices of eggs- Irregular variations for all the selected markets are depicted in the form of graphs(Fig-17 to 20). Irregular variations in all the selected markets did not show any definite periodicity in their occurrence.
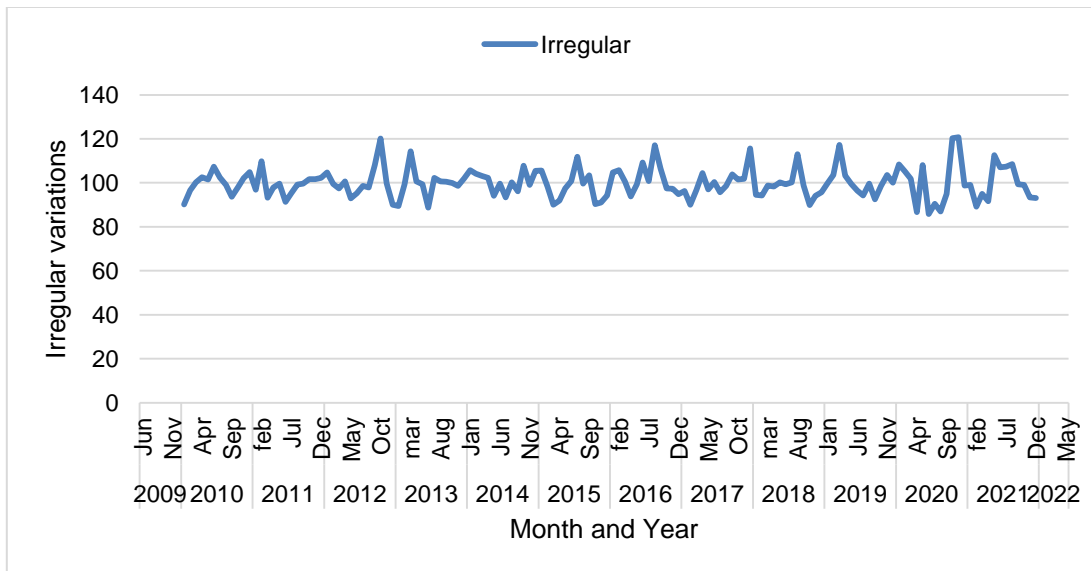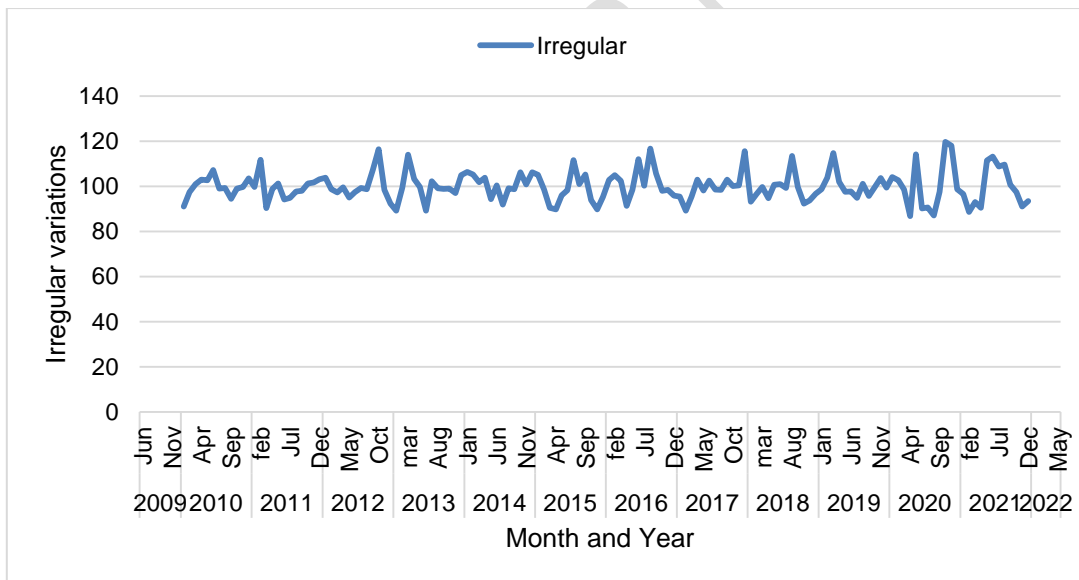
Fig-17: Irregular variations in prices of eggs in Bengaluru market

Fig-18: Irregular variations in prices of eggs in Chennai market
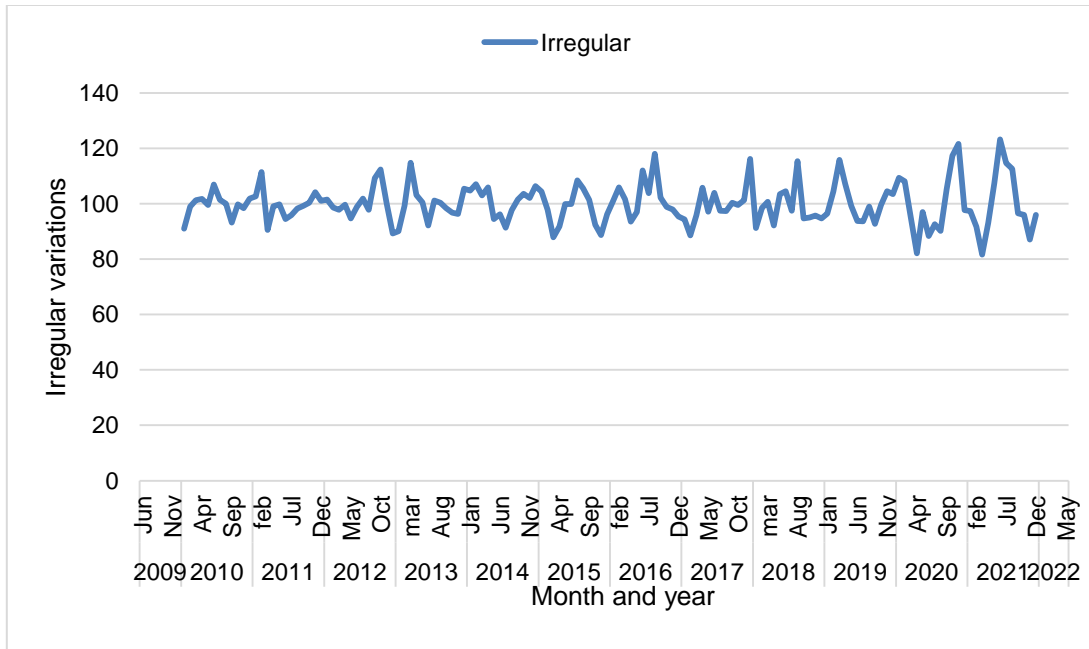
Fig-19: Irregular variations in prices of eggs in Delhi market

Fig-20: Irregular variations in prices of eggs in Mumbai market

4. CONCLUSION

The research findings concluded that, temperature has a negative impact on egg production whereas rainfall, relative humidity and time period have positive impact on egg production. The results further revealed that 93.69 per cent variance in egg production is explained by temperature, rainfall, relative humidity and time period. There is uniformity in prices of eggs across various markets in India due to organized egg marketing. Though the egg prices show wide fluctuations in the study

period, they also show a significant increasing trend. During April the prices of eggs decrease due to short shelf life of eggs because of summer. During November the prices of eggs decrease due to increase in arrivals of eggs. Highest price in June and July months due to increase in consumption of eggs during these months. Price cycles are not observed and irregular variations are conspicuous. There is a need to educate poultry farmers regarding the impact of climate change on egg production as well as prevailing egg prices in the market.

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