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Bharat Kumar Marmat

Department of Agricultural
Statistics, Applied Mathematics
& Computer Science, University
of Agricultural Sciences,
Bangalore, Karnataka, India

Mohan Kumar TL

Department of Agricultural
Statistics, Applied Mathematics
& Computer Science, University
of Agricultural Sciences,
Bangalore, Karnataka, India

Prathima CM

Department of Agricultural
Statistics, Applied Mathematics
& Computer Science, University
of Agricultural Sciences,
Bangalore, Karnataka, India

N Marappa

Department of Genetics and
Plant Breeding, University of
Agricultural Sciences, Bangalore,
Karnataka, India

TM Ningaraju

Department of Plant
Biotechnology, University of
Agricultural Sciences, Bangalore,
Karnataka, India

Shankar BP

Division of Diagnostic
Pathology, Institute of Animal
Health and Veterinary
Biologicals, Hebbal, Bengaluru,
Karnataka, India

Corresponding Author:

Mohan Kumar TL

Department of Agricultural
Statistics, Applied Mathematics
& Computer Science, University
of Agricultural Sciences,
Bangalore, Karnataka, India

Statistical analysis of growth rate in egg production and per capita availability of eggs in India and its states

Bharat Kumar Marmat, Mohan Kumar TL, Prathima CM, N Marappa, TM Ningaraju and Shankar BP

Abstract

The present study focuses on the estimation of Simple Growth Rate (SGR) and Compound Growth Rate (CGR) for the data on egg production and its per capita availability of eggs by fitting linear and exponential functions at all India data for the period of 60 years (1961-62 to 2020-21) and State-wise for the period of 30 years (1991-92 to 2020-21). The CGR for egg production in India from 1961-62 to 2020-21 was found to be 6.08 per cent. The highest CGR for egg production (7.97%) was observed from 1981-82 to 1990-91, and the lowest CGR (4.05%) was observed from 1971-72 to 1980-81. The CGR for the per capita availability of eggs in India was found to be 4.07 per cent during the study period. The highest CGR in per capita availability of eggs (5.73%) was observed from 2011-12 to 2020-21, whereas the lowest (1.58%) was observed from 1971-72 to 1980-81. The highest SGR and CGR in egg production were found to be 8.21 and 10.93 per cent, respectively in Haryana followed by Tamil Nadu at 7.42 and 8.42 per cent respectively. The lowest (negative) egg production SGR and CGR were found in Sikkim at -2.41 and -2.89 per cent followed by Jammu and Kashmir at -0.36 and -0.92 per cent respectively. All the states of India have shown positive growth rates (both SGR & CGR) in egg production except Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in egg production. Similarly, the highest and most significant positive SGR and CGR in per capita availability of eggs were found to be 7.06 and 8.85 per cent, respectively in Haryana by Tamil Nadu at 6.66 and 7.51 per cent. The highest decline in the per capita availability of eggs was found in Sikkim at the rate of 3.72 per cent of SGR and 4.18 per cent CGR, which is followed by Jammu and Kashmir at -2.04 and -3.12 per cent respectively. All the states of India have shown positive growth rates (both SGR & CGR) in the per capita availability of eggs except Assam, Bihar, Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in the per capita availability of eggs.

Keywords: Livestock, poultry, egg production, per capita availability, simple growth rate, compound growth rate, India.

1. Introduction

The livestock sector is one of the fastest-growing agricultural sectors in India. Livestock are domesticated animals raised in agriculture to provide labour forces and commodities like milk, eggs, meat, fur, leather, and wool (Anonymous, 2020) [1]. The livestock and fisheries sectors are critical to the country's socio-economic growth and national economy. About 20.5 million humans depend on livestock for their livelihood. It provides livelihood to two-thirds of rural communities. It also provides work, employment and business to about 8.8 per cent of the population in India. The livestock sector contributes 4.11 per cent of Gross Domestic Product (GDP) and 25.6 per cent of total Agriculture GDP and a Gross Value Added (GVA) of 5.1 per cent both at present day and constant prices for the livestock sector throughout 2019-20. Demand for livestock products is increasing quickly as the growth of population increases in developing countries (Anonymous, 2020) [1].

Poultry is a significant livestock activity that contributes to food security because eggs and chicken meat are important and rich sources of protein, vitamins, and minerals. Many Indian families, particularly in educated urban areas, have begun to accept eggs as a regular supplement to their vegetarian diet. According to forecast surveys, as the current younger generation enters adulthood, the acceptance and demand for eggs and chicken meat are anticipated to expand many-fold over the next two to three decades (Rao, 2015) [2].

The egg is the main component of the human diet serving as a dietary source of protein, fat, and other nutrients. Egg protein is highly digestible and of good quality, with a biological value of 94 on a scale of 100. Furthermore, eggs are high in iron, phosphorus, trace minerals, vitamins A, E, and K, as well as all B vitamins, including B12. Eggs are low in calories, with a medium-sized egg containing roughly 77 calories. The nutritive value of egg protein is 12.9 grams, Iron 2.3 milligrams, Calcium 54 milligrams per 100 grams, and Phosphorus 99 milligrams per 100 grams (Godbert *et al.* 2019) [3].

The total egg production in the country also increased from 1832 million number during 1950-51 to 1,14,383 million numbers during the year 2019-20 accounting for more than a 6000 per cent increase in total egg production and giving rise to per capita availability of 86 number/annum (Anonymous, 2021) [4] which is less than the minimum quantity recommended by the Indian Council of Medical Research (ICMR) (180 eggs per head per annum).

India ranks third largest egg producer in the world, and Andhra Pradesh, Tamil Nadu and Maharashtra are the top egg producer states in India. Andhra Pradesh is the largest producer of eggs in India, which contributes around 18.7 per cent of the country's total egg production, followed by Tamil Nadu (18.3%) and Telangana (13.3%). Other states that contributed more than 5 per cent of the country's egg production are West Bengal, Tamil Nadu, Haryana and Kerala. Andhra Pradesh has the highest per capita availability of eggs (346) followed by Tamil Nadu (246), Haryana (209), Punjab (180), Karnataka (89) and West Bengal (79). The per capita availability of eggs in only these six states was more than the national average (Anonymous, 2021a) [5].

Growth rates are widely used in agriculture because they have important policy implications (Prajneshu and Chandran, 2005) [6]. Growth rate analysis plays a pivotal role in informing strategic decision-making, driving financial performance, and enhancing competitive advantage in today's dynamic business environment. It empowers businesses to adapt to changing market conditions, capitalize on growth opportunities, and achieve long-term sustainability and success. The estimation growth rate is essential for making informed decisions, planning for the future, allocating resources efficiently, evaluating performance, managing risks, and advancing knowledge in various disciplines (Jain, 2018) [7]. It provides valuable insights that drive decision-making processes and facilitate progress and development in both the public and private sectors. Therefore, keeping the above facts in view the present study was conducted to analyse the simple and compound growth rates in egg production and per capita availability of eggs for the data on all India level and state levels. By leveraging growth rate analysis, farmers, policymakers, and stakeholders can make informed decisions that drive economic growth, alleviate poverty, and ensure food security for present and future generations.

2. Materials and Methodology

In the present study, the secondary data confined to the Egg Production (million number) and per capita availability of Eggs (number/annum) for all India for the period of 60 years (1961-62 to 2020-21) and State-wise for the period of 30 years (1991-92 to 2020-21) were collected from the Directorate of Economics and Statistics, Govt. of India and

www.indiastat.com_website. Further, the same was used to estimate the Simple Growth Rate (SGR) and Compound Growth Rate (CGR) by fitting the following functions:

2.1 Simple Growth Rate (SGR)

The SGR was computed by fitting a simple linear model given.

$$Y_t = a + bt + e_t$$

Where,

' Y_t ' is the egg production and per capita availability at the time t

' T ' is the time in years, the independent variable.

' A ' is an intercept.

' B ' is the linear regression coefficient.

' e_t ' is an error term.

Then the SGR percentage rate is now calculated as follows (Sananse and Maidapwad, 2009) [8].

Simple Annual Growth Rate in Percentage (SAGR %)

$$= \frac{\hat{b}}{\bar{Y}} \times 100$$

2.2 Compound Growth Rate (CGR)

Compound Growth Rates (CGR) were computed by fitting the exponential model (Prajneshu and Chandran, 2005) [6] given by:

$$Y_t = ab^t e_t$$

The above equation can be transformed into linear form using logarithmic as follows:

$$\ln Y_t = \ln(a) + t * \ln(b) + \ln(e_t)$$

Where,

' Y_t ' is the egg production and per capita availability at the time t

' T ' is the time in years, the independent variable.

' A ' is an intercept/ average production.

' B ' is the exponential regression coefficient and.

' e_t ' is an error term.

The Compound Growth Rate in Percentage (CGR %) can be expressed as.

$$\text{CGR per cent} = [\text{Antilog}(\widehat{\ln b}) - 1] \times 100.$$

3. Results and Discussion

To know the summary of the egg production and per capita availability of eggs in India, the descriptive statistics such as mean, Standard Deviation (SD), Coefficient of Variation in Percentage (CV%), kurtosis and skewness, were computed for the 60 years of data on Egg production and per capita availability of eggs which is presented in Table 1. The mean production of eggs during the study period (1961-62 to 2020-21) was found to be 32,634 with SD 30, 820 million eggs, and CV (%) was 94.44 per cent, which indicated a huge variation

in the production of eggs from 1961-62 to 2020-21. The same pattern was observed in the case of per capita availability of eggs, the mean per capita availability of eggs was 31 eggs per annum with SD 22 eggs per annum and CV (%) was 69.16 per cent. The data on the production of eggs and per capita availability of eggs seems to be platykurtic and positively skewed which are demonstrated by the coefficient of kurtosis and coefficient of skewness respectively for egg production (0.77 and 1.25) and per capita availability of eggs (0.31 and 1.05) presented in Table 1.

Table 1: Descriptive statistics for egg production and per capita availability of eggs for all India data from 1961-62 to 2020-21

Measures	Eggs	
	Production (Million number)	Per Capita Availability (number/annum)
Mean	32634	31
Median	21542	26
SD	30820	22
CV	94.44	69.16
Kurtosis	0.77	0.31
Skewness	1.25	1.05

SD: Standard Deviation, CV: Coefficient of Variation (%)

Table 2: Period-wise comparison of egg production and per capita availability of eggs in India

Periods	Eggs			
	Production (Million number)		Per Capita Availability (No.'s/annum)	
	Mean	CV (%)	Mean	CV (%)
Period-I (1961-62 to 1970-71)	4510 ^e	20.44	9 ^e	15.06
Period-II (1971-72 to 1980-81)	8760 ^{de}	12.31	14 ^e	7.05
Period-III (1981-82 to 1990-91)	16089 ^d	22.48	21 ^d	16.64
Period-IV (1991-92 to 2000-01)	27499 ^c	15.44	29 ^c	9.79
Period-V (2001-02 to 2010-11)	49349 ^b	17.55	44 ^b	12.76
Period-VI (2011-12 to 2020-21)	89594 ^a	21.12	70 ^a	17.18
Overall Period	32634	94.44	31	69.16
F-Value	133.49*		154.46*	
CD	7902.95		5.18	

CV=Coefficient of Variation (%), CD=Critical Difference at 5% level of significance, *Significant at 5% level of significance.

To know the temporal (decadal) variation in egg production and per capita availability of eggs, all India data (over the 60 years data from 1961-62 to 2020-21) is divided into six different periods namely Period-I (1961-62 to 1970-71), Period-II (1971-72 to 1980-81), Period-III (1981-82 to 1990-91), Period-IV (1991-92 to 2000-01), Period-V (2001-02 to 2010-11), and Period-VI (2011-12 to 2020-21) then CV (%) values are computed and compared the mean value over different time-period using one-way ANOVA.

The period-wise average egg production and per capita availability of eggs and CV (%) are computed for all India data and the results are presented in Table 2. The result from Table 2 revealed that there is a significant difference in average production and per capita availability of eggs over different periods under consideration at a 5 per cent level of significance.

The average egg production during the study period (from 1961-62 to 2020-21) was found to be 32,634 million eggs with a CV of 94.44 per cent. Further, the highest average egg production (89,594 million eggs) was found during Period-VI (2011-12 to 2020-21) followed by Period-V (2001-02 to 2010-11) and the lowest average egg production (4,510 million eggs) was found during Period-I (1961-62 to 1970-71), which is statistically on par with Period-II (1971-72 to 1980-81) egg production of 8760 million eggs. However, the highest CV (22.48%) in egg production was observed during Period-III with average egg production of 16,089 million eggs and the lowest CV (12.31%) was observed during Period-II with mean egg production of 8,759 million eggs. The computed average egg production and CV (%) over different periods are plotted in Fig. 1 and 2 for better visualisation.

The average per capita availability of eggs during the study period (from 1961-62 to 2020-21) was found to be 31 eggs per annum with a CV of 69.16 per cent. Further, the highest average per capita availability of eggs (70 eggs per annum) was found during Period-VI (2011-12 to 2020-21) followed by 44 eggs in Period-V (2001-02 to 2010-11) and the lowest average per capita availability of eggs (9 & 14 eggs per annum) was found during Period-I & II. However, the highest CV (17.18%) in per capita availability of eggs was observed during Period-VI with an average per capita availability of eggs of 70 eggs per annum and the lowest CV (7.05%) was observed during Period-II with an average per capita availability of eggs of 14 per annum. The computed average per capita availability of eggs and CV (%) over different time period are plotted in Fig. 3 and 4 for better visualisation.

The Simple Growth Rate (SGR) and Compound Growth Rate (CGR) were estimated for all India-level egg production and per capita availability of eggs for the overall period under consideration *i.e.* from 1961-62 to 2020-21 (60 years of overall data) and six different periods namely Period-I (1961-62 to 1970-71), Period-II (1971-72 to 1980-81), Period-III (1981-82 to 1990-91), Period-IV (1991-92 to 2000-01), Period-V (2001-02 to 2010-11), and Period-VI (2011-12 to 2020-21) of 10 years each and the results are presented in Table 3, and the same results are plotted in Fig. 5.

Results from Table 3 revealed that the SGR of egg production in India from 1961-62 to 2020-21 was found at the rate of 4.93 per cent, which is non-significant, demonstrating that statistically no significant growth was achieved in egg production during the study period. The highest SGR per cent in egg production was observed during Period-III (7.38%) whereas the lowest SGR per cent in production (3.83%) was observed during Period-II. In the case of per capita availability of eggs from 1961-62 to 2020-21 was found at the rate of 3.71 per cent, which is significant at a 5 per cent level indicating that statistically significant achievement is done with respect to per capita availability of eggs. The highest SGR of per capita availability of eggs was observed during Period-VI (5.58%) whereas the lowest per capita availability of eggs (1.50%) was observed during Period-II.

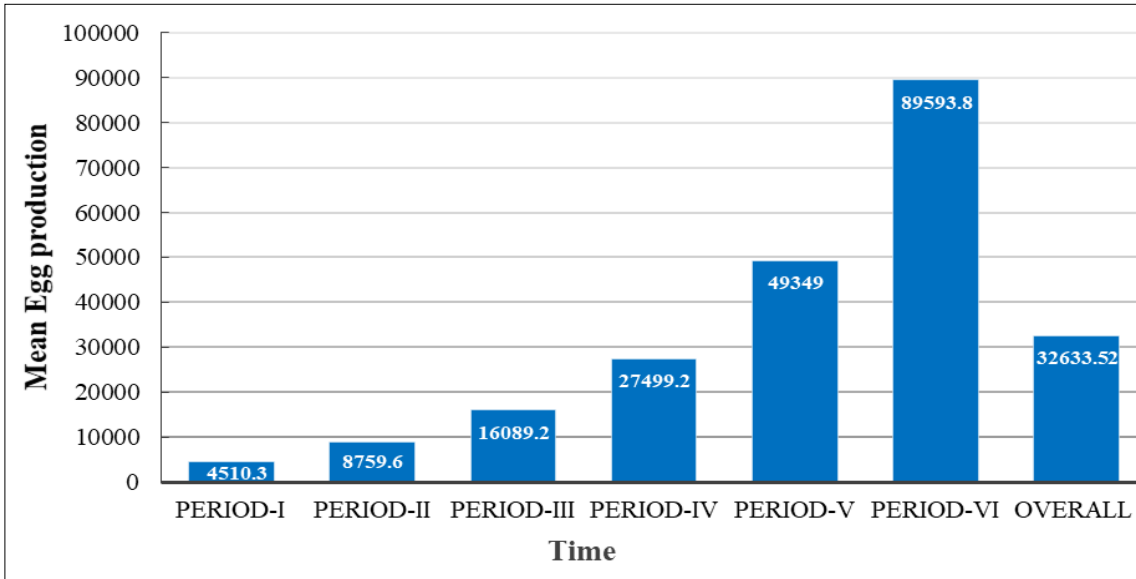


Fig 1: Period-wise mean production of eggs in India

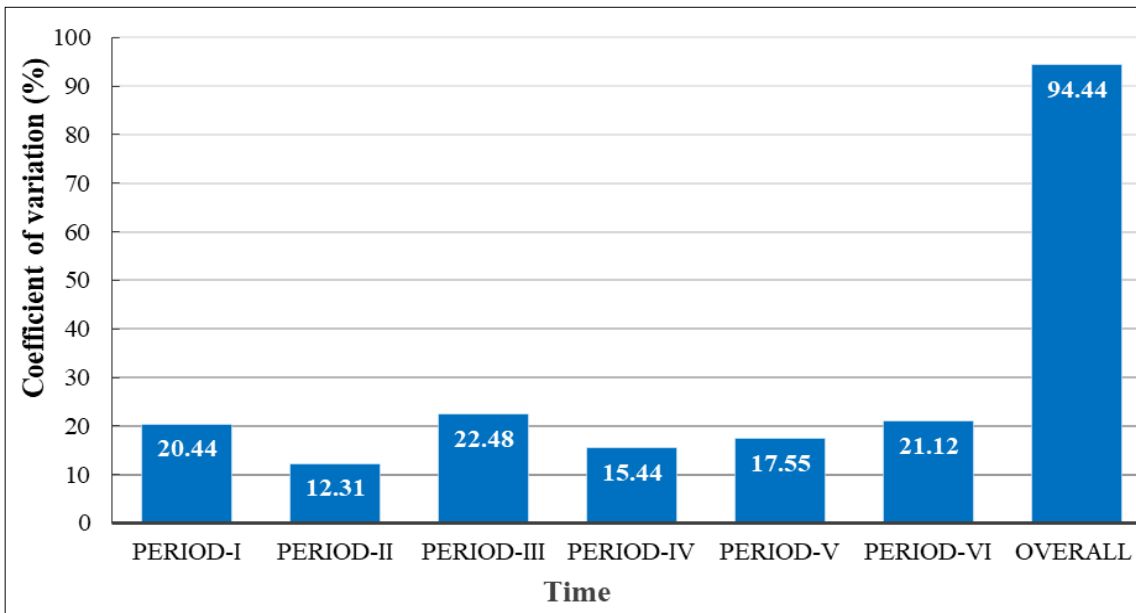


Fig 2: Period-wise Coefficient of Variation (CV %) of egg production in India

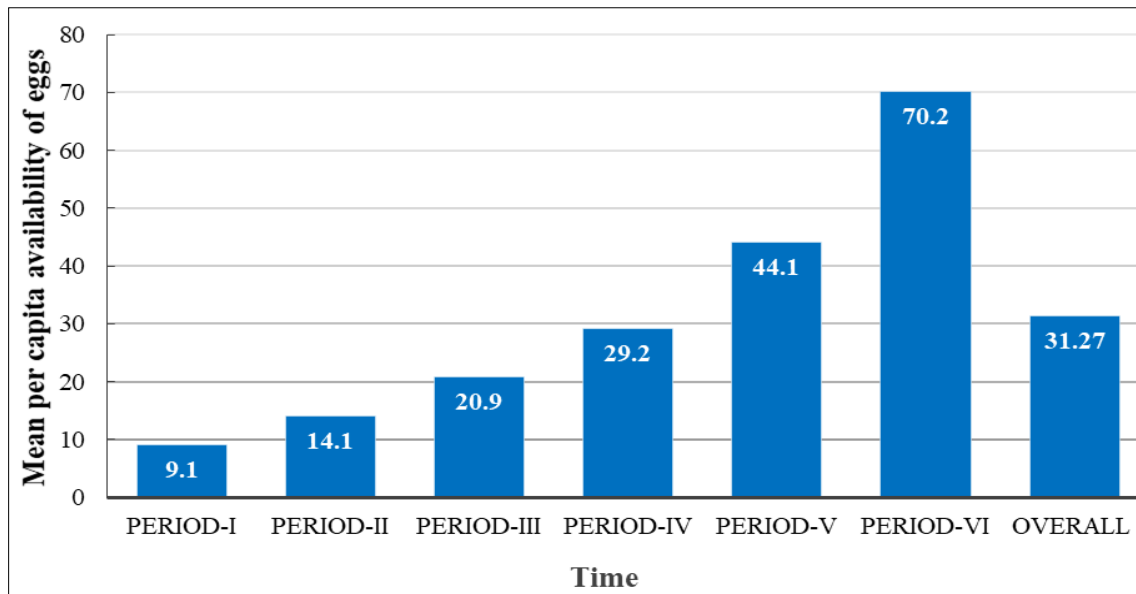


Fig 3: Period-wise mean of per capita availability of eggs in India

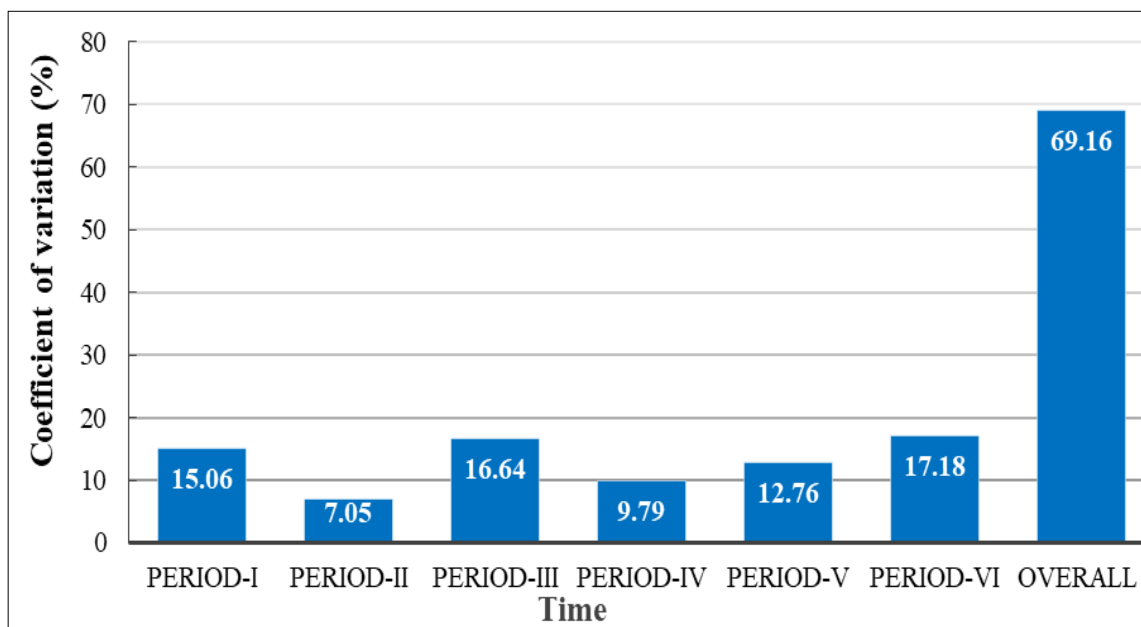


Fig 4: Period-wise coefficient of variation (CV %) of per capita availability of eggs in India

Table 3: Simple Growth Rate (SGR) and Compound Growth Rate (CGR) of production and per capita availability of Eggs in India during 1961-62 to 2020-21

Time	Egg Production (Million number)		Egg Per Capita availability (Number/ Annum)	
	SGR	CGR	SGR	CGR
Period I (1961-62 to 1970-71)	6.71 ^{NS}	6.98 ^{**}	4.86 ^{**}	5.02 ^{**}
Period II (1971-72 to 1980-81)	3.83 ^{NS}	4.05 ^{**}	1.50 ^{**}	1.58 ^{**}
Period III (1981-82 to 1990-91)	7.38 ^{NS}	7.97 ^{**}	5.42 [*]	5.73 ^{**}
Period IV (1991-92 to 2000-01)	4.84 ^{NS}	4.89 ^{**}	2.82 [*]	2.82 ^{**}
Period V (2001-02 to 2010-11)	5.74 ^{NS}	5.91 ^{**}	4.16 ^{NS}	4.25 ^{**}
Period VI (2011-12 to 2020-21)	6.86 ^{NS}	7.04 ^{**}	5.58 ^{NS}	5.68 ^{**}
Overall	4.93 ^{NS}	6.08 ^{**}	3.71 [*]	4.07 ^{**}

Note: NS: Non-Significant, ^{**}Significant at 1% level of Significance, ^{*}Significant at 5% level of Significance

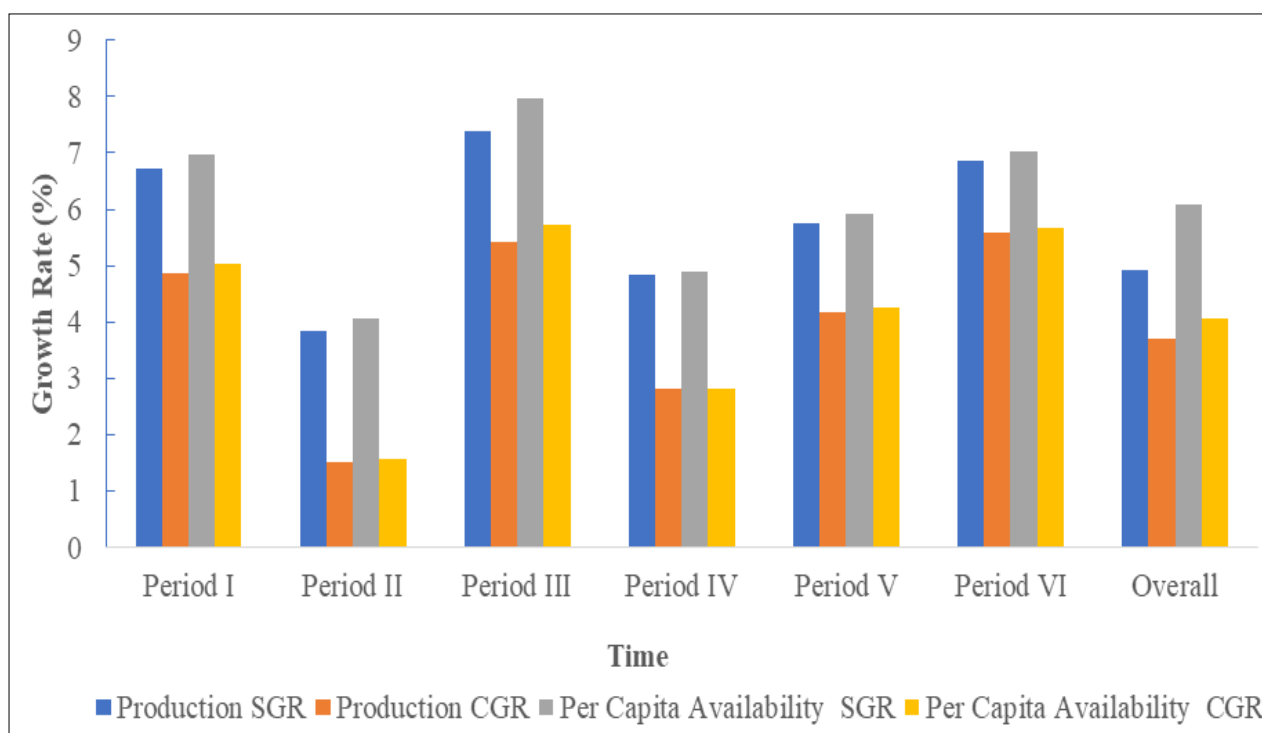


Fig 5: The computed SGR and CGR values for Production and Per Capita Availability of Egg in India during 1961-62 to 2020-21.

Results from Table 3 indicated that the CGR for the production of eggs in India from 1961-62 to 2020-21 was found to be 6.08, which is significant at a 1 per cent level of

significance. The highest CGR for egg production was observed during the same Period-III (7.97%) whereas the lowest CGR production of eggs (4.05%) was observed during

Period-II. In the case of per capita availability of eggs in India from 1961-62 to 2020-21 was found to be 4.07 per cent, which is significant at 1 per cent. The highest CGR per capita availability of eggs was observed during Period-VI (5.73%) whereas the lowest per capita availability of eggs (1.58%) was observed during Period-II.

Similarly, the SGR and CGR of egg production and per capita availability of eggs are computed for different states of India for the overall period under consideration *i.e.* from 1991-92 to 2020-21 (30-year whole) and three different periods *viz.* Period-I (1991-92 to 2000-01), Period-II (2001-02 to 2010-11) and Period-III (2011-12 to 2020-21) of 10 years each and the results are presented in Tables 4 & 5.

The highest SGR and CGR in egg production were found to be 8.21 and 10.93 per cent, respectively in Haryana, however, the egg production growth rate is non-significant, which is followed by Tamil Nadu at 7.42 and 8.42 per cent respectively. The lowest (negative) egg production SGR and CGR were found in Sikkim at -2.41 and -2.89 per cent, and they are found to be non-significant, which is followed by Jammu and Kashmir at -0.36 and -0.92 per cent respectively. All the states of India have shown positive growth rates (both SGR & CGR) in egg production except Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in egg production.

In Andhra Pradesh state, egg production showed a significant CGR at the rate of 6.10 per cent during the overall period under the study, Period-I has a higher growth rate than Period-II & III. In Arunachal Pradesh, egg production showed a significant CGR at the rate of 3.23 per cent during the overall period under the study, Period-I has a higher growth rate and less in Period-II. In Assam state, egg production showed a significant positive CGR at the rate of 0.25 per cent during the overall period under the study, egg production declined at the rate of 1.15 per cent during Period-II whereas Period-I had a higher growth rate. In Bihar state, egg production showed a significant positive CGR at the rate of 0.42 per cent during the overall period under the study, egg production declined at the rate of 3.06 per cent during Period-I whereas Period-III had a higher growth rate and less in Period-II. In Chhattisgarh state, egg production showed a significant positive CGR at the rate of 5.80 per cent during the overall period under the study, whereas Period-III had a higher growth rate and less in Period-II. In Goa state, egg production showed a significant positive CGR at the rate of 5.81 per cent during the overall period under the study, egg production declined at the rate of 1.71 per cent during Period-III whereas Period-III had a higher growth rate and less in Period-II. In Gujarat state, egg production showed a significant positive CGR at the rate of 6.61 per cent during the overall period under the study, egg production declined at the rate of 1.64 per cent during Period-I whereas highest in Period-II. Haryana state has the highest positively significant CGR at the rate of 10.93 per cent during the overall period under the study as compared to all the other states. The highest growth rate was achieved during Period-II at the rate of 19.21. In Himachal Pradesh, egg production was significantly increased at the rate of 1.59 during the study period even though decline in egg production during Period-III at the rate of 0.29. In Jammu and Kashmir state, egg

production declined at the rate of 0.92 from 1991-92 to 2020-21, which is more in the last decades (Period-III). Similarly, in Jharkhand state, egg production declined at the rate of 0.60 from 2001-02 to 2020-21, which is more in Period-II then after production increased at the rate of 6.61 in Period-III. In Karnataka state, egg production continuously increased significantly at the rate of 5.79 per cent from 1991-92 to 2020-21 which is more (8.54%) during the Period-III. In Madya Pradesh, egg production continuously increased significantly at the rate of 1.63 per cent from 1991-92 to 2020-21 from a negative to positive growth rate whereas production was more (14.43%) during the Period-III. In Maharashtra state, egg production continuously increased significantly at the rate of 3.67 per cent from 1991-92 to 2020-21 which is more (4.61%) during the Period-III. In Manipur state, egg production increased significantly at the rate of 2.79 per cent from 1991-92 to 2020-21 which is more (5.49%) during the Period-II and declined production (-1.04%) during Period-III. In Meghalaya state, egg production increased significantly at the rate of 1.60 per cent from 1991-92 to 2020-21 which is more (2.75%) during Period-I and less during Period-III. In Mizoram state, egg production increased significantly at the rate of 2.69 per cent from 1991-92 to 2020-21 which is more (12.12%) during the Period-III. In Nagaland state, egg production continuously declined from positive to negative at the rate of 0.29 per cent from 1991-92 to 2020-21 which is more (-3.38%) during the Period-III. In Orissa state, egg production increased significantly at the rate of 6.77 per cent from 1991-92 to 2020-21 which is more (13.23%) during the Period-II. In Punjab state, egg production continuously increased significantly at the rate of 3.19 per cent from 1991-92 to 2020-21 which is more (5.79%) during the Period-III. In Rajasthan state, egg production continuously increased significantly at the rate of 5.66 per cent from 1991-92 to 2020-21 which is more (7.72%) during the Period-III. In Sikkim state, egg production declined at the rate of 2.89 per cent from 1991-92 to 2020-21, more decline was found (-10.28%) during Period-III followed by Period-I but egg production increased at the rate of 3.34 per cent during Period-I. In Tamil Nadu, a significant increase in egg production was found at the rate of 8.42 per cent from 1991-92 to 2020-21 which is more (14.26%) during Period-II and less during Period-I. Since the Telangana state was formed in 2014, data was used from 2013-14 to 2020-21, during this period, a significant increase in egg production was found at the rate of 6.82 per cent. In Tripura, egg production increased significantly at the rate of 7.26 per cent from 1991-92 to 2020-21. Period-I showed the highest production (16.01%) and period-II lowest production. In Uttar Pradesh, egg production increased significantly at the rate of 6.23 per cent from 1991-92 to 2020-21. Period-III showed the highest production (8.97%) and period-II lowest production. In Uttarakhand egg production increased significantly at the rate of 8.45 per cent from 2001-02 to 2020-21. Period-II showed the highest production (11.01%) and period-III lowest production. In West Bengal, egg production increased significantly at the rate of 4.89 per cent from 1991-92 to 2020-21. Period-III showed the highest production (11.17%) and period-I lowest production.

Table 4: Simple Growth Rate (SGR) and Compound Growth Rate (CGR) of State-wise egg production from 1991-92 to 2020-21.

State		Eggs Production (Million number)			
		Period-I	Period-II	Period-III	Overall Period
Andhra Pradesh	SGR	10.19	4.17	0.39	4.61 ^{NS}
	CGR	9.96	4.26	0.51	6.10 ^{**}
Arunachal Pradesh	SGR	6.42	1.04	5.34	3.09 ^{**}
	CGR	6.3	1.05	5.4	3.23 ^{**}
Assam	SGR	1.83	-1.15	1.3	0.24 ^{NS}
	CGR	1.86	-1.17	1.29	0.25 ^{**}
Bihar	SGR	-2.23	3.41	15.99	1.02 ^{NS}
	CGR	-3.06	3.43	15.89	0.42 ^{**}
Chhattisgarh [#]	SGR	NA	4.7	5.72	5.61 ^{NS}
	CGR	NA	4.66	5.82	5.80 ^{**}
Goa	SGR	2.56	3.2	-1.71	5.88 ^{**}
	CGR	2.51	3.4	-1.48	5.81 ^{**}
Gujarat	SGR	-1.43	15.74	3.17	6.22 ^{NS}
	CGR	-1.64	17.71	3.3	6.61 ^{**}
Haryana	SGR	7.05	15.45	6.46	8.21 ^{NS}
	CGR	6.85	19.21	6.55	10.93 ^{**}
Himachal Pradesh	SGR	1.95	2.65	-0.31	1.57 ^{NS}
	CGR	1.95	2.55	-0.29	1.59 ^{**}
Jammu & Kashmir ^{###}	SGR	8.54	2.56	-15.64	-0.36 ^{NS}
	CGR	9.04	2.54	-14.02	-0.92 ^{NS}
Jharkhand [#]	SGR	NA	-4.94	6.58	-0.63 ^{NS}
	CGR	NA	-5.59	6.61	-0.6 ^{NS}
Karnataka	SGR	5.15	5.55	8.16	5.94 ^{NS}
	CGR	5.29	5.23	8.54	5.79 ^{**}
Kerala	SGR	1.78	0.37	1.16	0.94 ^{NS}
	CGR	1.83	0.65	1.39	0.85 ^{**}
Madhya Pradesh	SGR	0.25	-0.08	12.56	2.21 ^{NS}
	CGR	-0.38	0.01	14.43	1.63 ^{**}
Maharashtra	SGR	4.17	2.42	4.49	3.62 ^{NS}
	CGR	4.31	2.37	4.61	3.67 ^{**}
Manipur	SGR	0.97	5.48	-1.06	2.48 ^{NS}
	CGR	0.98	5.49	-1.04	2.61 ^{**}
Meghalaya	SGR	2.7	1.13	0.9	1.53 [*]
	CGR	2.75	1.14	0.9	1.60 ^{**}
Mizoram	SGR	11.23	3.76	2.65	2.69 [*]
	CGR	12.12	3.87	2.71	3.23 ^{**}
Nagaland	SGR	3.58	3.42	-5.01	-0.07 ^{NS}
	CGR	3.63	3.8	-3.38	-0.29 ^{NS}
Orissa	SGR	5.54	12.27	1.19	5.63 ^{NS}
	CGR	6.15	13.23	1.10	6.77 ^{**}
Punjab	SGR	3.56	1.75	5.57	3.16 ^{NS}
	CGR	3.69	1.85	5.79	3.19 ^{**}
Rajasthan	SGR	6.04	0.65	7.36	5.62 ^{NS}
	CGR	6.39	0.68	7.72	5.66 ^{**}
Sikkim	SGR	-2.48	2.97	-11.57	-2.41 ^{NS}
	CGR	-3.25	3.34	-10.28	-2.89 ^{NS}
Tamil Nadu	SGR	4.12	12.58	6.28	7.42 ^{NS}
	CGR	4.12	14.26	6.66	8.42 ^{**}
Telangana ^{##}	SGR	NA	NA	NA	6.60 ^{NS}
	CGR	NA	NA	NA	6.82 ^{**}
Tripura	SGR	14.60	7.54	8.31	6.28 ^{NS}
	CGR	16.01	8.5	8.72	7.26 ^{**}
Uttar Pradesh	SGR	4.54	3.75	8.73	6.39 ^{NS}
	CGR	4.69	3.87	8.97	6.23 ^{**}
Uttarakhand [#]	SGR	NA	9.15	6.02	7.23 ^{NS}
	CGR	NA	11.01	6.46	8.45 ^{**}
West Bengal	SGR	1.92	4.11	10.65	5.35 ^{NS}
	CGR	1.97	4.05	11.17	4.89 ^{**}

Note: NA-Not Available, NS: Non-Significant, **Significant at 1% level of Significance, *Significant at 5% level of Significance.

1. Chhattisgarh, Jharkhand, and Uttarakhand data is available only from 2001-02 to 2020-21 (since these States were formed in 2000).
2. Telangana data is available from 2013-14 to 2020-21 (since this State was formed in 2014),
3. Before 2019, there were 29 States and 7 Union Territories in India. In 2019, Jammu and Kashmir was bifurcated into 2 union territories *i.e.*, Jammu and Kashmir, and Ladakh.

Similarly, the highest and most significant positive SGR and CGR in per capita availability of eggs were found to be 7.06 and 8.85 per cent, respectively in Haryana which is followed by Tamil Nadu at 6.66 and 7.51 per cent respectively. The highest decline in the per capita availability of eggs was found in Sikkim at the rate of 3.72 per cent of SGR and 4.18 per cent followed by Jammu and Kashmir at -2.04 and -3.12 per cent of SGR and CGR respectively. All the states of India have shown positive growth rates (both SGR & CGR) in the per capita availability of eggs except Assam, Bihar, Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in the per capita availability of eggs.

In Andhra Pradesh state, the per capita availability of eggs showed a significant CGR at the rate of 7.16 per cent during the overall period under the study, Period-I has a higher growth rate than Period-II & III. In Arunachal Pradesh, the per capita availability of eggs showed a significant CGR at the rate of 1.42 per cent during the overall period under the study, Period-I has a higher growth rate and less in Period-II. In Assam state, the per capita availability of eggs showed a negative CGR at the rate of 1.22 per cent during the overall period under the study, the per capita availability of eggs declined at the rate of 2.92 per cent during Period-II whereas Period-I had a higher growth rate. In Bihar state, the per capita availability of eggs showed a negative CGR at the rate of 0.65 per cent during the overall period under the study, the per capita availability of eggs declined at the rate of 1.00 per cent during Period-I whereas Period-III had a positive growth rate at 14.09 as compared to Period-II (1.35%). In Chhattisgarh state, the per capita availability of eggs showed a significant positive CGR at the rate of 3.86 per cent during the overall period under the study, whereas Period-III had a higher growth rate and less growth rate in Period-II. In Goa state, the per capita availability of eggs showed a significant positive CGR at the rate of 4.69 per cent during the overall period under the study. In Gujarat state, the per capita availability of eggs showed a significant positive CGR at the rate of 4.78 per cent during the overall period under the study, the per capita availability of eggs declined at the rate of 3.53 per cent during Period-I whereas the highest positive growth rate at 16.48 in Period-II. The per capita availability of eggs in Haryana state has the highest positively significant CGR at the rate of 8.85 per cent during the overall period under the study as compared to all the other states. The highest growth rate was achieved during Period-II at the rate of 16.83. In Himachal Pradesh, the per capita availability of eggs was significantly increased at the rate of 0.50 per cent during the study period even though a decline in the per capita availability of eggs during Period-III at the rate of 1.07. In Jammu and Kashmir state, the per capita availability of eggs declined at the rate of 3.12 from 1991-92 to 2020-21, which is more in the last decades (Period-III). Similarly, in Jharkhand state, the per capita availability of eggs declined at the rate of 2.48 from 2001-02 to 2020-21, which is more in Period-II then after the per capita availability of eggs increased at the rate of 4.63 per cent during Period-III. In Karnataka state, the per capita availability of eggs continuously increased significantly at the rate of 4.43 per cent from 1991-92 to 2020-21 which is more (7.23%) during the Period-III. In Madhya Pradesh, the per capita availability of eggs

continuously increased significantly at the rate of 0.76 per cent from 1991-92 to 2020-21 from a negative to positive growth rate whereas the per capita availability of eggs was more (12.36%) during the Period-III. In Maharashtra state, the per capita availability of eggs continuously increased significantly at the rate of 2.09 per cent from 1991-92 to 2020-21 which is more (3.30%) during the Period-III. In Manipur state, the per capita availability of eggs increased significantly at the rate of 0.70 per cent from 1991-92 to 2020-21 which is more (4.02%) during Period-II and declined during Period-I & III. In Meghalaya state, the per capita availability of eggs decreased continuously at the rate of 0.43 per cent from 1991-92 to 2020-21, more decline was found (0.99%) during Period-III as compared to other periods. In Mizoram state, the per capita availability of eggs increased significantly at the rate of 1.279 per cent from 1991-92 to 2020-21 which is more (8.11%) during Period-I and less in Period III. In Nagaland state, the per capita availability of eggs declined at the rate of 1.93 per cent from 1991-92 to 2020-21, except Period-II (2.66%) other periods had negative per capita availability of eggs. In Orissa state, the per capita availability of eggs increased significantly at the rate of 5.42 per cent from 1991-92 to 2020-21 which is more (11.82%) during the Period-II. In Punjab state, the per capita availability of eggs continuously increased significantly at the rate of 1.80 per cent from 1991-92 to 2020-21 which is more (4.71%) during the Period-III. In Rajasthan state, the per capita availability of eggs increased significantly at the rate of 3.45 per cent from 1991-92 to 2020-21, Period-II had a negative growth rate of 1.47 per cent whereas the Period-III had highest growth rate of 6.0 per cent. In Sikkim state, the per capita availability of eggs declined at the rate of 4.18 per cent from 1991-92 to 2020-21, more decline was found (-10.43%) during the Period-III followed by Period-I but the per capita availability of eggs increased at the rate of 2.04 per cent during Period-I. In Tamil Nadu, a significant increase in the per capita availability of eggs was found at the rate of 7.51 per cent from 1991-92 to 2020-21 which is more (13.32%) during the Period-II and less during Period-III. Since the Telangana state was formed in 2014, data was used from 2013-14 to 2020-21, during this period, a significant increase in the per capita availability of eggs was found at the rate of 5.97 per cent. In Tripura, the per capita availability of eggs increased significantly at the rate of 5.98 per cent from 1991-92 to 2020-21. Period-I showed the highest per capita availability of eggs (14.45%) and period-II had lowest the per capita availability of eggs. In Uttar Pradesh, the per capita availability of eggs increased significantly at the rate of 4.41 per cent from 1991-92 to 2020-21. Period-III showed the highest production (7.46%) and period-II had the lowest per capita availability of eggs. In Uttarakhand, the per capita availability of eggs increased significantly at the rate of 6.82 per cent from 2001-02 to 2020-21. Period-II showed the highest per capita availability of eggs (10.24%) and period-III had lowest the per capita availability of eggs. In West Bengal, the per capita availability of eggs increased significantly at the rate of 3.61 per cent from 1991-92 to 2020-21. Period-III showed the highest production (10.24%) and period-I had the lowest per capita availability of eggs.

Table 5: Simple Growth Rate (SGR) and Compound Growth Rate (CGR) of State-wise per capita availability of eggs during 1991-92 to 2020-21

State		Per Capita Availability (Number/ Annum)			
		Period-I	Period-II	Period-III	Overall Period
Andhra Pradesh	SGR	9.40	3.12	6.85	5.92**
	CGR	9.48	3.14	6.90	7.16**
Arunachal Pradesh	SGR	4.07	-0.15	3.47	0.20*
	CGR	3.97	-0.16	3.49	1.42**
Assam	SGR	0.41	-2.83	0.00	-1.19 ^{NS}
	CGR	0.42	-2.92	0.13	-1.22 ^{NS}
Bihar	SGR	0.04	1.48	14.30	-0.36 ^{NS}
	CGR	-1.00	1.35	14.09	-0.65 ^{NS}
Chhattisgarh [#]	SGR	NA	2.97	3.53	3.82**
	CGR	NA	2.88	3.51	3.86**
Goa	SGR	0.69	0.09	0.05	4.75**
	CGR	0.64	1.45	0.69	4.50**
Gujarat	SGR	-3.26	14.91	1.21	4.69**
	CGR	-3.53	16.48	1.24	4.78**
Haryana	SGR	4.09	13.84	4.68	7.06**
	CGR	3.91	16.83	4.69	8.85**
Himachal Pradesh	SGR	1.27	1.32	-1.14	0.50**
	CGR	1.27	1.29	-1.07	0.50**
Jammu & Kashmir ^{###}	SGR	4.16	0.95	-15.67	-2.04 ^{NS}
	CGR	4.21	0.93	-14.08	-3.12 ^{NS}
Jharkhand [#]	SGR	NA	-6.41	4.70	-2.74 ^{NS}
	CGR	NA	-5.59	4.63	-2.48 ^{NS}
Karnataka	SGR	3.72	4.32	6.98	4.69**
	CGR	3.79	4.04	7.23	4.43**
Kerala	SGR	1.30	-0.54	1.04	0.25 ^{NS}
	CGR	1.32	-0.13	1.22	0.23**
Madhya Pradesh	SGR	2.79	-1.79	10.98	1.04**
	CGR	2.04	-1.81	12.36	0.76**
Maharashtra	SGR	1.73	0.82	3.24	2.15**
	CGR	1.75	0.78	3.30	2.09**
Manipur	SGR	-0.59	4.08	-2.78	0.68**
	CGR	-0.55	4.02	-2.66	0.70**
Meghalaya	SGR	-0.30	-0.11	-1.04	-0.42 ^{NS}
	CGR	-0.30	-0.11	-0.99	-0.43 ^{NS}
Mizoram	SGR	8.14	2.55	1.00	1.04**
	CGR	8.11	2.58	1.01	1.27**
Nagaland	SGR	-2.43	2.41	-5.41	-1.52 ^{NS}
	CGR	-2.44	2.66	-3.54	-1.93 ^{NS}
Orissa	SGR	3.27	10.90	0.29	4.67**
	CGR	3.39	11.82	0.26	5.42**
Punjab	SGR	1.59	0.45	4.56	1.84**
	CGR	1.63	0.46	4.71	1.80**
Rajasthan	SGR	2.67	-1.46	5.81	3.65**
	CGR	2.78	-1.47	6.00	3.45**
Sikkim	SGR	-4.92	1.82	-11.85	-3.72 ^{NS}
	CGR	-5.99	2.04	-10.43	-4.18 ^{NS}
Tamil Nadu	SGR	3.53	11.80	2.07	6.66**
	CGR	3.61	13.32	2.67	7.51**
Telangana ^{##}	SGR	NA	NA	NA	5.80**
	CGR	NA	NA	NA	5.97**
Tripura	SGR	13.48	6.45	7.20	5.25**
	CGR	14.45	7.22	7.48	5.98**
Uttar Pradesh	SGR	3.10	1.94	7.28	4.74**
	CGR	3.16	1.96	7.46	4.41**
Uttarakhand [#]	SGR	NA	7.43	4.57	5.95**
	CGR	NA	8.88	4.83	6.82**
West Bengal	SGR	0.48	3.07	9.83	4.10**
	CGR	0.48	4.05	10.24	3.61**

Note: NA-Not Available, NS: Non-Significant, **Significant at 1% level of Significance, *Significant at 5% level of Significance.

- Chhattisgarh, Jharkhand, and Uttarakhand data is available only from 2001-02 to 2020-21 (since these States were formed in 2000).
- Telangana data is available from 2013-14 to 2020-21 (since this State was formed in 2014),
- Before 2019, there were 29 States and 7 Union Territories in India. In 2019, Jammu and Kashmir was bifurcated into 2 union territories *i.e.*, Jammu and Kashmir, and Ladakh.

The present study concludes that egg production showed a positive growth rate in India, as well as all the states of India except Jammu & Kashmir, Jharkhand, Nagaland and Sikkim which have a negative growth rate in egg production. Similarly, the per capita availability of eggs also showed a positive growth rate in India, as well as all the states of India except Assam, Bihar, Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in the per capita availability of eggs. This study is supported by Ramesh *et al.* (2021) ^[9] who found a positive growth rate in the area, production and productivity of cotton crops in Dharwad district of Karnataka. This study result was supported by the findings of Shwetha *et al.* (2022) ^[10] reported a growth rate of production and productivity of cotton crops marked a significant increase after the introduction of Bt cotton across the cotton growing States of India.

4. Conclusion

The Simple Growth Rate (SGR) and Compound Growth Rate (CGR) of egg production and its per capita availability of eggs were estimated by fitting linear and exponential functions for the data on egg production (million number) and its per capita availability of eggs (numbers per annum) at all India and state level. The average egg production during the study period (1961-62 to 2020-21) was found to be 32,634 million eggs with CV (%) was 94.44 per cent, which indicated a huge variation in the production of eggs from 1961-62 to 2020-21. The same pattern was observed in the case of per capita availability of eggs, the average per capita availability of eggs was 31 eggs per annum with CV (%) was 69.16 per cent. The CGR for the production of eggs in India from 1961-62 to 2020-21 was found to be 6.08, which is significant at a 1 per cent level of significance. The highest CGR for the production of eggs (7.97%) was observed during the same Period-III (1981-82 to 1990-91), whereas the lowest CGR production of eggs (4.05%) was observed during Period-II (1971-72 to 1980-81). In the case of per capita availability of eggs in India from 1961-62 to 2020-21 was found to be 4.07 per cent, which is significant at 1 per cent. The highest CGR per capita availability of eggs (5.73%) was observed during Period-VI (2011-12 to 2020-21) whereas the lowest per capita availability of eggs (1.58%) was observed during Period-II (1971-72 to 1980-81).

The highest SGR and CGR in egg production were found to be 8.21 and 10.93 per cent, respectively in Haryana followed by Tamil Nadu at 7.42 and 8.42 per cent respectively. The lowest (negative) egg production SGR and CGR were found in Sikkim at -2.41 and -2.89 per cent followed by Jammu and Kashmir at -0.36 and -0.92 per cent respectively. All the states of India have shown positive growth rates (both SGR & CGR) in egg production except Jammu & Kashmir, Jharkhand, Nagaland and Sikkim states, which have a negative growth rate in egg production. Similarly, the highest and most significant positive SGR and CGR in per capita availability of eggs were found to be 7.06 and 8.85 per cent, respectively in Haryana by Tamil Nadu at 6.66 and 7.51 per cent respectively. The highest decline in the per capita availability of eggs was found in Sikkim at the rate of 3.72 per cent of SGR and 4.18 per cent CGR, which is followed by Jammu and Kashmir at -2.04 and -3.12 per cent of SGR and CGR respectively. All the states of India have shown positive growth rates (both SGR & CGR) in the per capita availability of eggs except Assam, Bihar, Jammu & Kashmir, Jharkhand,

Nagaland and Sikkim states, which have a negative growth rate in the per capita availability of eggs.

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