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Growth Dynamics and Export Potential of India's Poultry Sector: A Comprehensive Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

India ranks as the third largest egg producer and fifth largest producer of poultry meat globally. Commercial poultry farms accounts about eighty-five percent of countries' egg production, the remaining comes from household/backyard poultry. Poultry production plays a significant part in the socio-economic life of India's rural population. This research focused on growth trends, instability in egg and poultry meat production and export trend, instability and Markov chain model was used to identify the market share of importing countries and stable importers of Indian poultry products. The state wise analysis revealed that the Uttar Pradesh registered highest growth rate among the top ten egg producing states for the study period. The export of poultry products has positive growth. Oman and Maldives are reliable market partners for India's poultry product over the period.

Keywords: Production; export; growth rate; instability index; Markov chain.

1. INTRODUCTION

Poultry known as the short living birds, they raised for their egg, meat and feathers. They provides income for rural households, it encourage to start small venture in this business from backyard production. The poultry means in this papers inclusive of desi fowls, improved fowls, desi ducks and improved ducks. The cheap animal source of protein [1] has a moderate calorie suitable from infant to adults across the world and also it has good source of vitamin and minerals [2]. Eggs and Poultry meat are far more economical sources of protein for middle-income households as well as those living below the poverty line [3]. Egg a diet significantly increased after COVID-19. Increased domestic consumption in India results in low poultry exports. India meets its domestic and export need through the consumption of egg in regular diet significantly increased when people felt its importance protein of in human life at the time of Covid-19 pandemic, three poultry segments: 1. Layers(egg), 2. Broilers (meat), 3. Backyard / Family Production (both egg and meat). Commercial poultry farms and backyard/household contributed 85.40 percent (118.16 billion) and 14.60 per cent (20.20 billion) of countries egg production [4]. The production of egg improved substantially from the year 1999-2000 onwards and it reached 138.38 billion in 2022-23and becomes third largest producer of egg and fifth in poultry meat production. Poultry sector contributes Rs.350 billion (1.2 per cent) to the India's GDP. From 1950 to 2022, the per capita availability of eggs increased gradually from 5 to 101 eggs per annum. In 2023, India climbed to second largest exporter of fresh white egg after the USA, with a value of $53 million. Landes et al. [5] stated that per capita poultry consumption is greater in southern India because city dwellers earn more money. Although chicken meat is not strongly related with religious activities such as beef and pork consumption, its demand might fluctuate owing to religious and cultural duties observed on specific days, weeks, and months of the year [6,7,8].

Protein energy malnutrition (PEM) is a major public health problem in India, especially among those below the poverty line. The National Academy of Medical Sciences recommended, dietary allowance of protein as 0.8 grams per kilogram of body weight per day for sedentary people and Athletes, marathon runners, and bodybuilders may need 1.5 to 2 grams per kilogram of body weights per day, depending on age and activity type. Around 80 per cent of the Indian population doesn't meet their daily protein requirements and 90 per cent are unaware of their daily protein needs. According to official estimates, the per-capita consumption over 30 days for chicken was 178 g in rural India and 239 g in urban India, and for eggs only 1.94 in rural India and 3.18 in urban India (GOI, 2014). To enlighten the status of Indian poultry sector, this study aims to estimate the India's growth trend and instability of egg and poultry meat production and export growth trend and trade direction of Indian poultry products.

2. METHODOLOGY

The study is based on time series data of India's poultry production and export. State wise egg and poultry meat production data collected for the period 2003-04 to 2022-23 from various editions of the Basic Animal Husbandry Statistics released by the Department of Animal Husbandry and Dairying. The data sorted for the analysis based on the high to low production in quantity. The top ten importing countries were selected based on the total quantity and value for the period of 2003-04 to 2022-23 and selected

for the analysis. The export data collected from APEDA portal.

2.1 Growth Rate Analysis

The growth rate for production of egg and poultry meat and India's export quantity, value were analysed by using Compound Annual Growth Rate (CAGR). Agarwal [9] employed the compound annual growth rate in to study the India's Trade performance of Poultry Products, the same technique employed in this study,

$$y = {}^{t}e$$

Take the natural logarithm, it becomes log y = t log b + error

It can be written as ln(Y) = ln (b)

where, t –time variable, Y- growth rate of variables and b1- regression coefficient of t on Y.

The Compound Annual Growth Rate (CAGR) is obtained as a following way

CAGR (%) = (Antilog b-1) x 100

2.2 Cuddy-Della Valle Instability Index (Ix)

The Instability Index was computed to examining the degree of instability for production of egg, poultry meat and poultry products export from India. The Cuddy-Della index is the most commonly employed tool for measuring the instability of time series data and is widely accepted. John Cuddy and Della Valle created the indices in [10] to quantify the instability of time series data. This index is an improved measure than coefficient of variation (CV) as it is inherently adjusted for trend, often observed in time series data. This index is measured in per cent, it means nothing but corrected CV. Similarly, the study was used by [11] to study the instability in India's meat export.

$$Ix\ (\%)\ =\ C.Vx\sqrt{(1-adj.R^2)}$$

where,

Ix – Instability Index, C.V. – Coefficient of Variation, adj.R^2 – Adjusted R^2

2.3 Markov Chain Analysis

The first order Markov chain technique was used to examine the direction of trade in chicken products. The transitional probability matrix P must be estimated in order to perform the Markov chain analysis. The entries P_{ij} of the matrix P represent the chance that exports will shift from i^{th}country to j^{th}country over time. The diagonal members of the matrix calculate the chance that a country's export share will be retained, indicating an importing country's loyalty to a certain country's product. Shree et. al., [12] utilised a similar technique to investigate the direction of trade for India's poultry product exports.

3. RESULTS AND DISCUSSION

3.1 Egg and Poultry Meat Production in India

The results of CAGR were presented in Table 1, indicated that all the states have positive growth rate in egg production and were statistically significant. The CAGR was calculated for two decades, 2003-04 to 2022-23, with each period consisting of ten years. Telangana (TL) and Andhra Pradesh (AP) states were divided in 2014. Since the data was obtained from 2004 to 2022, to achieve consistency, reduce noise, and to avoid instability, these two states' data were merged from 2014-15 to 2022-23, as well as to comprehend the magnitude of combining CAGR calculated as a distinct state.

The results for combined period shown that the states Uttar Pradesh has high positive growth rate in egg production (10.00) followed by Karnataka (9.37), West Bengal (9.23) and least growth rate recorded by Punjab (3.52). Combined Andhra Pradesh and Telangana, Tamil Nadu and West Bengal states were accounts 80.7 billion numbers of egg production with 58.54 per cent of total production. The pace of growth in major contributing states were constant over the period from 2003 to 2022 and it also witnessed that the other six states egg production faster in the period II (2013-2022). The instability index shows the fluctuations in the production. Haryana (18.13) have highest instability among these states followed by Odisha (15.67) and Kerala (13.35). Analysing the two periods, the first period growth rate and instability both was high in all of the states but in the second period instability were reduced more than half of the first period in many states that indicates the egg production has significant growth in period II than period I. According to [13] the Indian poultry industry has grown remarkably over the years, with growth rates for layers and

broilers @ 6–8 per cent and 8–10 per cent, respectively. In the post-COVID-19 period, the policy of adapting backyard poultry as an alternative source of income not only increases poultry production but also ensures the availability of animal protein to the poorer sections of society, improves their purchasing power, and protects against labour "reverse migration" [1].

Next to egg, the broiler chicken (poultry meat) is the main source of animal protein produced in a short period. The awareness on protein requirement and importance of nutrient to prevent malnutrition of human, increase the demand for animal meat production [14]. The growth and instability of the Indian poultry meat production given in Table 2.

Table 1. Growth and Instability for major egg producing states of India (2003 to 2022)

States	Period I (2003-04 to 2012-13)		Period II (2013-14 to 2022-23)		Combined (2003 to 2022)	
	CGR	Ix	CGR	Ix	CGR	Ix
Combined AP & TL	4.50**	2.42	8.68**	2.31	6.22**	6.70
Haryana	14.66**	23.36	7.61**	1.67	7.39**	18.13
Karnataka	9.81**	7.14	9.30**	2.66	9.37**	4.39
Kerala	6.41**	9.29	-1.45**	2.20	4.13**	13.35
Maharashtra	3.55**	5.18	4.68**	1.65	4.65**	3.53
Odisha	11.17**	9.72	5.25**	13.35	3.91**	15.67
Punjab	0.82**	6.54	4.69**	3.33	3.52**	8.61
Tamil Nadu	11.99**	11.89	4.60**	2.61	7.26**	7.53
Uttar Pradesh	7.10**	13.45	10.67**	6.43	10.00**	9.68
West Bengal	6.01**	5.58	12.71**	3.84	9.23**	9.92
India	5.43**	3.67	7.45**	0.16	6.37**	16.22

Period II (2013-14 to 2022-23)

Andhra Pradesh	3.72**	20.57
Telangana	104.42^{NS}	47.79

*** figures in parenthesis denotes significant at 1 per cent level*
^{NS} figures in parenthesis denotes non-significant

Table 2. Major states of poultry meat production in India (2003 to 2022)

States	Period I (2003-04 to 2012-13)		Period II (2013-14 to 2022-23)		Combined (2003 to 2022)	
	CGR	Ix	CGR	Ix	CGR	Ix
Combined AP & TL	10.08**	1.56	8.67**	10.80	9.47**	2.08
Haryana	13.13**	7.18	12.82**	6.24	8.90**	21.59
Karnataka	28.19**	24.30	13.36**	10.83	20.46**	16.57
Kerala	38.65**	126.36	7.81**	6.06	22.98**	39.31
Maharashtra	6.83**	2.09	9.95**	8.67	8.54**	13.28
Orissa	5.17**	3.92	6.06**	2.40	6.63**	4.71
Punjab	14.54**	13.56	2.40**	13.36	7.32**	12.80
Tamil Nadu	-0.39*	7.27	4.14**	12.82	3.01**	6.55
Uttar Pradesh	2.54**	16.21	6.24**	7.81	6.18**	20.66
West Bengal	8.02**	3.40	10.80**	4.14	8.38**	12.30
India	8.92**	1.65	10.83**	11.75	8.24**	10.88

Period II (2013-14 to 2022-23)

Andhra Pradesh (AP)	5.32**	19.47
Telangana (TL)	46.31**	35.74

*** figures in parenthesis denotes significant at 1 per cent level*
** figures in parenthesis denotes significant at 5 per cent level*

The growth rate and instability of combined AP & TL, was at9.47 per cent growth and low instability for combined period but it was quite opposite when it was estimated for bifurcated states. AP has 5.32 per cent growth with instability index of 19.47, but Telangana has non-significance growth with 46.31 per cent growth rate and instability was 35.74. All states have a positive growth rate at the 1 per cent significance level. It shows that the significant increase in egg and poultry meat production over the year throughout the country.

The increase in per capita income in rural area was witnessed increase in per capita meat consumption after 2000. Devi et al. [15] reported that the monthly expenditure on meat consumption by households of participants in MGNREGA was Rs. 303 (10.37 per cent) and non-participants Rs. 169 (8.05 per cent). Kumar and Joshi [16] found that MGNREGA beneficiaries spent more than non-beneficiaries on egg, meat and fish. The growth of meat production in India indicated that the CGR was 8.24 per cent for combined period.

The state wise growth rate for combined period stated that Kerala and Karnataka recorded highest growth rate over 20 per cent but high instability index indicated unstable/inconsistent production and its share in nations production is increased. The growth rate of major contributor states like Maharashtra (8.54 per cent), Haryana (8.90 per cent), Tamil Nadu (3.01 per cent) and West Bengal (8.24 per cent) these states have consistent in the poultry meat production and it's observed from the instability index value of these states. Comparing the Period I and II instability index were reduced, it means that the production of poultry meat continuously increased significantly in the period II. It evident that the poultry meat production and meat consumption in rural areas increased post MGNREGA implementation, and also it indicates that participants' households spend 2.32 percent more per month than the non-participants' households [15].

3.2 Export of Poultry Products from India

Export data was collected from APEDA. The export of poultry products from India has potential impact in overall exports. It gained much attention early 2000. The export of poultry products was gone well till 2015 afterwards the export was decreased leisurely. The export of poultry products in terms of quantity it has falling off since 2019.It was found that India is net exporter of total poultry products [9].

The Table 3, revealed that except Maldives and Oman all other importing countries import showed a negative growth rate it also witnessed by the high instability indices of these importing countries. Among top 10 countries only 2 countries Oman and Maldives have positive significant growth. Maldives growth rate was 14.09 per cent and2.91 per cent for Oman, Even India's growth rate was negatively significant. The Instability Index also proves that the export of poultry products has significant negative trend over the years. Maldives registered lowest instability index 22.23 followed by Oman (49.99) and the UAE (191.86) has least instability index.

Table 3. Poultry products growth and instability for India's Export (2003-04 to 2022-23) (Quantity)

Country	Period I (2003-04 to 2012-13)		Period II (2013-14 to 2022-23)		Combined (2003 to 2022)	
	CGR	Ix	CGR	Ix	CGR	Ix
Afghanistan	275.01*	72.37	-77.96 ^{NS}	93.11	-24.24*	148.10
Bahrain	3.59**	42.01	-30.27**	60.86	-12.86**	50.57
Kuwait	-62.74^{NS}	92.47	95.18**	48.45	-17.73**	181.61
Liberia	26.62**	47.70	-67.66 ^{NS}	120.30	-38.22*	74.16
Maldives	22.53**	25.00	11.69**	15.82	14.09**	22.23
Oman	-9.57	47.39	-1.95**	43.60	2.91**	49.99
Qatar	-73.27 ^{NS}	57.53	335.49**	78.46	-5.98*	136.14
Saudi Arabia	4.91 ^{NS}	105.83	-41.14 ^{NS}	226.86	-20.53**	88.24
Sierra Leone	83.73*	90.68	-37.52 ^{NS}	142.53	-19.17*	123.69
UAE	-55.80 ^{NS}	87.12	23.05**	243.47	-18.33**	191.86
India	-2.44**	39.26	-3.22**	29.56	-4.87**	36.78

*** figures in parenthesis denotes significant at 1 per cent level*
** figures in parenthesis denotes significant at 5 per cent level*
^{NS} figures in parenthesis denotes non-significant

The reason for the export decline might be due to increase in the cost of production and increase in the per capita consumption of egg and poultry meat. The average person's intake of eggs climbed from 62 in 2015 to 95 in 2022, and their consumption of chicken meat increased from 2.49 kg in 2015 to 4.8 kg in 2022(National Action Plan for Egg & Poultry-2022, DAHD, 2017). The cost of production was increased due to sharp rise in poultry feed price/ raw material cost. India and the Philippines, along with increased price of feed ingredients including additives like vitamin D and threonine (Avinews 2020). The poultry feed raw materials were imported, because of a fall in domestic production. According to [17] the exports of the chicken meat had picked up sharply as reflected by the high growth rates (over 28% and 25%, respectively pre and post WTO) reported for the period 1994 to 2009. Due to the spread of the bird flu in the mid of 2000–2009.The other reason may be some of the importing countries imports poultry products from some other countries which offer lesser price than India.

The export of poultry products in value aspect the countries has been selected based on the value they import from India. The major importing countries growth and instability index was furnished in Table 4. Among these countries, Maldives (22.21 per cent), Oman (13.89 per cent) and Bahrain (4.53 per cent) have positive significant growth during the period and three countries has non-significant growth and rest were negatively significant growth. The Instability also proven that these countries were inconsistent in the import of poultry products from India. Maldives (22.87) has least instability followed by Indonesia (29.53), Oman (47.27) and Afghanistan (137.96) has least instability among these countries. The overall growth rate of Indian poultry export was 5.41 per cent with the instability of 23.91 per cent.

3.3 The Direction of Trade for Poultry Product Export from India

Markov chain analysis is a unique tool to analyse the direction of trade. The analysis was made for the period2013-14 to 2022-23. The Markov chain results presented in Table 5, it is evident that Oman, Qatar and Maldives are the potential importing countries of India poultry products, as it is reflected by the probability of retention of (0.838, 0.831 and 0.743) i.e., the retention share for the study period of these countries 83.8, 83.1 and 74.3 per cent respectively. Other than these importing countries Liberia, (50.3 per cent), Afghanistan (21.6 per cent) have retained a significant share in import. UAE, Kuwait, Bahrain, Saudi and Sierra Leone have not retained significantly and it shows that they lost their share with rest of the countries.

Oman lost its share 13.5 per cent to Maldives also it gained 100 per cent from Bahrain and UAE. Kuwait lost its share 100 per cent to Qatar and gained 15.9 per cent from Japan. Similarly, all other countries under study also have some share of profit and loss to other countries. The steady state probability indicates that the export level of the importing countries. Based on the

Table 4. Poultry products growth and instability for India's export to major countries (2003-04 to 2022-23)(Value)

Country	Period I (2003-04 to 2012-13)		Period II (2013-14 to 2022-23)		Combined (2003 to 2022)	
	CGR	Ix	CGR	Ix	CGR	Ix
Afghanistan	51.93**	184.63	-45.08 ^{NS}	197.36	-8.58**	137.96
Bahrain	1.29**	74.79	-2.10**	95.80	4.53**	73.14
Germany	0.71**	37.13	-7.87**	192.56	-10.05**	61.07
Indonesia	1.95**	128.17	0.32**	39.57	14.06**	29.53
Japan	-0.85**	49.03	-0.62**	50.74	1.25**	53.97
Kuwait	-33.09^{NS}	135.71	8.06**	150.54	-3.95**	134.48
Maldives	2.15**	244.30	0.39**	90.00	22.21**	22.87
Oman	0.60**	60.38	0.48**	35.86	13.89**	47.27
Saudi Arabia	0.63**	65.46	-7.84**	126.63	-1.76**	91.08
UAE	-7.45**	159.15	1.21**	116.76	-1.14**	118.44
India	0.31**	38.99	0.08**	27.16	5.41**	23.91

*** figures in parenthesis denotes significant at 1 per cent level*
** figures in parenthesis denotes significant at 5 per cent level*
^{NS} figures in parenthesis denotes non-significant

Table 5. Transitional probability matrix for India's export of poultry products (Quantity)

Countries	Oman	Maldives	Afghanistan	UAE	Kuwait	Liberia	Bahrain	Qatar	Saudi	Sierra Leone
Oman	**0.838**	0.135	0.000	0.000	0.005	0.000	0.020	0.000	0.002	0.000
Maldives	0.155	**0.743**	0.000	0.031	0.022	0.000	0.000	0.048	0.000	0.001
Afghanistan	0.342	0.000	**0.216**	0.000	0.000	0.200	0.000	0.000	0.099	0.143
UAE	1.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000
Kuwait	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	1.000	0.000	0.000
Liberia	0.000	0.145	0.169	0.000	0.000	**0.503**	0.122	0.000	0.061	0.000
Bahrain	1.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000
Qatar	0.000	0.000	0.000	0.063	0.082	0.000	0.000	**0.831**	0.010	0.014
Saudi	0.319	0.000	0.000	0.000	0.000	0.000	0.681	0.000	**0.000**	0.000
Sierra Leone	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
SSP	**0.459**	**0.243**	**0.006**	**0.022**	**0.026**	**0.002**	**0.012**	**0.223**	**0.004**	**0.004**

**SSP – Steady State Probability*

Table 6. Transitional probability matrix for India's export of poultry products to major importing countries (Value)

Countries	Oman	Maldives	Afghanistan	UAE	Kuwait	Bahrain	Saudi	Indonesia	Germany	Japan
Oman	**0.796**	0.118	0.000	0.000	0.037	0.000	0.000	0.017	0.000	0.031
Maldives	0.000	**0.611**	0.000	0.000	0.000	0.000	0.000	0.389	0.000	0.000
Afghanistan	0.000	0.000	**0.259**	0.000	0.000	0.000	0.000	0.000	0.741	0.000
UAE	0.256	0.000	0.000	**0.000**	0.000	0.422	0.000	0.000	0.322	0.000
Kuwait	0.000	0.000	0.000	0.000	**0.141**	0.000	0.000	0.297	0.000	0.562
Bahrain	1.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000
Saudi	0.255	0.027	0.072	0.000	0.000	0.397	**0.162**	0.087	0.000	0.000
Indonesia	0.321	0.000	0.000	0.260	0.000	0.000	0.000	**0.171**	0.000	0.248
Germany	0.000	0.000	0.023	0.000	0.000	0.006	0.232	0.000	**0.290**	0.449
Japan	0.000	0.159	0.000	0.000	0.000	0.000	0.476	0.259	0.000	**0.106**
SSP	**0.464**	**0.175**	**0.005**	**0.033**	**0.020**	**0.033**	**0.048**	**0.127**	**0.020**	**0.074**

**SSP – Steady State Probability*

current export trend Oman's share on Indian Poultry export will be 45.9 per cent next to that Maldives with 24.3 per cent and Qatar 22.3 per cent in the future.

The major importing countries in terms of value of the poultry products export from India for the period (2013-14 to 2022-23) such as Oman, Maldives, Afghanistan, UAE, Kuwait, Liberia, Bahrain, Qatar, Pakistan and Sierra Leone. It is evident from the Table 5, Oman is the better market among the importers of poultry products from India as reflected by high probability of retention of 0.838 i.e., the probability that Oman retains its export share over the study period was 83.8 per cent followed by Maldives (0.742) and Afghanistan (0.458). Thus, Oman was the most reliable and loyal market for poultry products export.Oman lost its export share to Maldives (13.6 per cent) and it gained shares from UAE (100 per cent), Bahrain (100 per cent). Kuwait lost 100 per cent to Qatar. Similarly, all other countries under study also have some share of profit and loss to other countries.

The steady state probabilities showed that if the trend continues like this, in future 46.4 per cent would go to Oman, 17.5 per cent would go to Maldives and Indonesia would get 12.7 per cent and 24.4 per cent would go to other countries.

4. CONCLUSION

The poultry sector in India is emerging enormously. Since, this form of proteins is much affordable by the many people than any other meat and any other forms. The egg production in India is widely spreader to many states. Major producing states are Andhra Pradesh, Tamil Nadu and Telangana. The poultry meat production also increased over the years. The internal market demand also increased every year and that's the primary reason for the growth of this sector. The export of poultry product from India has significant growth since, early 2000. Among the importing nations Oman and Maldives been trustable markets, because they have significant growth, low instability and high retention in the study period in export quantity aspect. Qatar also has high retention but its instability index also high. In export value aspect Maldives, Indonesia and Oman been the reliable markets for Indian poultry product. To reduce the negative externalities of international trade in poultry products, production of poultry feed raw materials like maize, soy bean should be increased, incentives and support services should be structured to allow commercial feed producer to participate in the trade directly and reap the benefits of emerging opportunities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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