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Research Article

Production of fisheries in India and Andhra Pradesh – Growth and Instability Analysis

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ABSTRACT

The present study was undertaken to analyze the production trends of fisheries in India and Andhra Pradesh. This study is mainly based on time series data and the secondary data on production of inland, marine and total fisheries of India and Andhra Pradesh were collected from various sources viz., Handbook of Fisheries – 2020, Department of Fisheries – Government of Andhra Pradesh, Annual Reports and Agricultural Statistics at a Glance. The performance of fisheries in India and Andhra Pradesh was examined by using statistical tools like Compound Annual Growth Rate (CAGR) and Instability Indices such as Coefficient of Variation (CV), Cuddy-Della Instability Index (CD II) and Coppock's Instability Index (CII). The results revealed that, in India and Andhra Pradesh, total fish production grew from 56.56 and 5.90 lakh tonnes in 2000-01 to 141.64 and 41.74 lakh tonnes in 2019-20. Production has climbed 2.5 times in India and seven times in Andhra Pradesh. In India, the production of marine, inland and total fish production were increasing significantly with 1.79, 6.85 and 4.89 per cent per annum, respectively. In Andhra Pradesh, the corresponding figures were 6.84, 11.36 and 10.33 per cent per annum, respectively. The results of Cuddy Della Valle and Coppock's Instability Index, inland fish production fluctuated the most, followed by total and marine fish production in India and Andhra Pradesh.

Keywords: *Compound Annual Growth Rate (CAGR), Coefficient of Variation (CV), Cuddy-Della Instability Index (CDII) and Coppock's Instability Index (CII).*

INTRODUCTION

The importance of fisheries in a country cannot only be measured by the contribution to the GDP; it must also be considered that fisheries resources and products are essential components of human nutrition and employment.

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Fisheries play an important role in a country with a coastline of over 8,000 kilometers, an Exclusive Economic Zone (EEZ) of over 2 million square kilometers, and abundant freshwater resources. Currently, fisheries and aquaculture contribute 1.07 percent to the national GDP, whereas agriculture and related sectors provide 5.30 percent, with an average annual value of output of ₹ 43720.98 crore with quantity of 11,49,510 tonnes for the year 2020-21 (MPEDA).

India is the world's third-largest fish producer and the world's second-largest aquaculture fish producer. India accounts for nearly seven per cent of global fish production. The country is also home to more than 10 per cent of the world's fish biodiversity and is one of the 17 countries with the most biodiversity. (Anon, 2020) Fisheries and related activities employ around 14 million people. The state of Andhra Pradesh produces the maximum fish in the country, followed by West Bengal and Gujarat. The total fish production in India during 2019-20 is estimated to be 14.16 million metric tonnes, of which nearly 73.69 per cent (10.43 million metric tonnes) is from inland sector and the rest around 26.31 per cent (3.72 million metric tonnes) is from marine sector.

From a production standpoint, inland fisheries and aquaculture are the most important components of India's fisheries sector. Freshwater and brackish water aquaculture are both practiced. Although ornamental fish farming is a non-food activity, it has a bright future and is expected to contribute to the fisheries sector's total growth in the coming years. Freshwater aquaculture has surpassed the other sub-sectors in fish production as a major contributor. The inland fishery has risen in absolute terms, but the sector's full potential has yet to be realized due to its diversity and dynamic nature. Rivers and canals, floodplain lakes, ponds and tanks, reservoirs, and brackish water resources are all examples of inland resources that provide excellent potential for livelihood development. In previous years, public and private investments in developing it as a growth tool were negligible.

World scenario

Food and Agricultural Organization (FAO) after every two years released world fisheries statistics in the form of the State of World Fisheries and Aquaculture (SOFIA), as per 2020-21 statistics, total fish production was 178.50 million metric tonnes in which 96.40 million tonnes from capture fisheries (marine 84.4 MMT and inland 12.0 MMT) and 82.10 million tonnes from aquaculture (marine 30.8 MMT and inland 51.3 MMT). In the world, major marine capture fish producing countries were China (15 %), Peru, Indonesia (8 % each), Russian federation, USA (6 % each) and India (4 %). Likewise major inland capture fish producing countries were China (16 %), India (14 %), Bangladesh (10 %), Myanmar (7 %) and Cambodia (4 %). The total world's population in 2020 was 7.79 billion and the per capita apparent consumption was 20.3 kg. Fish food consumption grew from 9.0 kg in 1961-62 to 20.3 kg in 2019-20 at an average growth rate of about 1.5 per cent per year.

Across the world, the fisheries and aquaculture sectors are major source of employment. In 2019-20, an estimated 59.5 million people were engaged in the primary sector of fisheries and aquaculture. In total, about 20.5 million people were employed in aquaculture and 39.0 million in fisheries. As per Handbook on Fisheries Statistics 2020, fish and fish products export were about 67.10 million metric tonnes (live weight equivalent) with a share of 37.60 percent in exports of total production entering international trade as various forms such as frozen fish, frozen shrimp, cuttle fish, squid and dried items.

MATERIALS AND METHODS

The study is based on secondary data for the last 20 years, *i.e.* from 2000-01 to 2019-20 for India and Andhra Pradesh. The Indian fish production data are largely drawn from Handbook on Fisheries Statistics – 2020

(Government of India), whereas Andhra Pradesh production data were collected from various secondary sources such as India Agri Stat, Commissioner of Fisheries, Vijayawada, Government of Andhra Pradesh, State Annual reports etc.

Analytical tools

Growth rate analysis

For computing compound annual growth rate of production of inland, marine and total fisheries in India and Andhra Pradesh, the exponential function of the following form was used.

$$Y = a\, b^t\, e^U \quad \ldots\ldots (1)$$

Where, Y = Dependent variable (Production)

a = Intercept term

b = Regression coefficient

('a' and 'b' are the parameters to be estimated)

t = time period

e^U = Error term

The equation (1) was transformed into log linear form and written as;

$$\log Y = \log a + t \log b + Ut \quad \ldots\ldots (2)$$

Equation (2) was estimated by using Ordinary Least Squares (OLS) technique.

Compound growth rate (g) was then computed

$$g = (b - 1) \times 100 \quad \ldots\ldots (3)$$

Where, g = Compound growth rate in per cent per annum

b = Antilog of log b

The standard error of the growth rate was estimated and tested for its significance with 't' test statistic.

Instability Index:

The coefficient of variation was used to measure the variability in production. The coefficient of variation or index of instability was computed by using the following formula.

$$CV = \frac{\text{Standard deviation } (\sigma)}{\text{Mean } (\bar{X})} \times 100$$

Linear trends were fitted to the original data of production for the period of 20 years from 2000-01 to 2019-20. The trend coefficients were tested for their significance. Whenever the trend of series found to be significant; the variation around the trend rather than the variation around mean was used as an index of instability.

Cuddy and Della Instability Index (CD II):

The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend. That is coefficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (R^2), in the cases where R^2 was significant to obtain the Instability Index.

$$\text{Instability Index} = \frac{\text{Standard deviation } (\sigma)}{\text{Mean } (\bar{X})} \times 100 \times \sqrt{1\text{-}R^2}$$

Coppock's Instability Index (CII): Trend free measure of variability which is a close approximation of the average year to year percentage variation adjusted by trend (Kaur & Singhal, 1988) (Coppock, 1962).

$$\text{Instability index} = \frac{\sum[\log((X_{t+1})/(X_t))-m]^2}{n}$$

Coppock's instability index (CII) = Antilog ($\sqrt{V}$log-1) ×100

Where, X_t = Area/ Production/ Yield

T = Number of years

m = Mean of the difference between logs of X_{t+1}, X_t

log V = Logarithmic variance of the series

RESULTS

The Table shows the increase pattern in fisheries production in India and Andhra Pradesh during a twenty-year period, from 2000-01 to 2019-20. According to the statistics, India's average total fish production was 87.55 lakh metric tonnes, with marine fish representing for 36.95 percent (32.35 lakh metric tonnes) and inland fish accounting for 63.05 percent (55.20 lakh metric tonnes). Similarly, the average total fish production in Andhra Pradesh was 17.36 lakh metric tonnes, with inland fish production accounting for 13.69 lakh metric tonnes (78.86 %) and marine fish production accounting for 3.66 lakh metric tonnes (21.14 percent).

As seen in Table, it was noticed that, India's marine, inland, and total fish production were all expanding at a substantial rate of 1.79, 6.85, and 4.89 percent per year, respectively. The similar figures in Andhra Pradesh were 6.84, 11.36, and 10.33 percent each year, respectively. In India, the coefficients of variation in marine, inland, and total fish output were respectively 11.13, 41.33, and 29.98 percent. Similarly, the similar statistics in Andhra Pradesh were 40.55, 69.95, and 63.11 percent, respectively.

The findings of an analysis of the instability index for marine, inland, and total fish output in India and Andhra Pradesh revealed that the state of Andhra Pradesh has experienced more fluctuations than India. According to Cuddy & Della Valle and Coppock's instability index, inland fish output (5.84 and 3.00 percent) was the most unstable in India, followed by total fish (5.19 and 2.27 percent) and marine fish production (3.34 and 3.33 percent). In Andhra Pradesh, the instability index was highest in inland fish output (13.99 and 0.16 percent), total fish (12.62 and 0.14 percent), and marine fish production (11.47 and 0.14 percent). Andhra Pradesh contributes almost 20 per cent of overall Indian fish production, with 24.80 per cent of inland production and 11.31 percent of marine fish production.

DISCUSSION

The findings revealed a positive compound annual growth rate (CAGR) in inland fish output, which was higher than total and marine fish production in India and Andhra Pradesh. Productivity growth accounted for a significant increase in both inland and marine production. In the last two decades, enhanced production and farming technology, production through integrated multitrophic aquaculture systems, introduction of genetically modified species like Penaeus vannamei, induced fish breeding, and composite carp culture have all contributed to substantial production. Over the last few years, aquaculture production in India and Andhra Pradesh has increased gradually. Total fish production in India and Andhra Pradesh increased from 56.56 and 5.90 lakh tonnes in 2000-01 to 141.64 and 41.74 lakh tonnes in 2019-20. According to the estimates, production has increased 2.5 times in India and seven times in Andhra Pradesh. The three Indian main carps

(IMCs), catla (*Catla catla*), rohu (*Labeo rohita*), and mrigala (*Cirrhinus mrigala*), account for the majority of carp production in the state. Carps, catfishes, murrels, and other finfishes are farmed for the domestic market, whereas giant freshwater prawn (*Macrobrachium rosenbergii*) is the sole species from the freshwater industry that is exported. In the recent years, after the introduction Penaeus vannamei (white legged shrimp), the production of giant freshwater prawn has plummeted.

The findings of an analysis of the stability index for marine, inland, and total fish production in India and Andhra Pradesh. The results showed that, according to Cuddy Della Valle and Coppock's instability index, inland fish production fluctuated the most, followed by total and marine fish production in India and the state. Output enhancement initiatives, species diversification tactics, integrated multitrophic aquaculture systems, and genetically modified species such as white legged shrimp (*P. vannamei*) in the research area are likely to have contributed to the increased instability in inland production.

Table: Trends in fish production in India and Andhra Pradesh (2000-01 to 2019-20)
(Lakh tonnes)

Sl. No	Years	India			Andhra Pradesh			Share of Andhra Pradesh to Indian fish production (%)		
		Marine	Inland	Total	Marine	Inland	Total	Marine	Inland	Total
1	2000-01	28.11 (49.70)	28.45 (50.30)	56.56	1.83 (30.95)	4.07 (69.05)	5.90	6.49	14.31	10.43
2	2001-02	28.30 (47.52)	31.26 (52.48)	59.56	2.05 (30.31)	4.71 (69.69)	6.76	7.24	15.07	11.35
3	2002-03	29.90 (48.23)	32.10 (51.77)	62.00	2.49 (30.02)	5.79 (69.98)	8.28	8.31	18.05	13.35
4	2003-04	29.41 (45.96)	34.58 (54.04)	63.99	2.64 (27.94)	6.81 (72.06)	9.45	8.97	19.69	14.76
5	2004-05	27.79 (44.08)	35.26 (55.92)	63.05	2.11 (24.70)	6.42 (75.30)	8.53	7.58	18.22	13.53
6	2005-06	28.16 (42.85)	37.56 (57.15)	65.72	2.19 (24.56)	6.72 (75.44)	8.91	7.77	17.90	13.56
7	2006-07	30.24 (44.02)	38.45 (55.98)	68.69	2.40 (28.03)	6.17 (71.97)	8.57	7.94	16.04	12.48
8	2007-08	29.20 (40.97)	42.07 (59.03)	71.27	2.55 (25.23)	7.55 (74.77)	10.10	8.73	17.95	14.17
9	2008-09	29.78 (39.10)	46.38 (60.90)	76.16	2.91 (23.24)	9.62 (76.76)	12.53	9.78	20.73	16.45
10	2009-10	31.04 (38.81)	48.94 (61.19)	79.98	2.93 (22.45)	10.13 (77.55)	13.06	9.44	20.69	16.33
11	2010-11	32.50 (39.48)	49.81 (60.52)	82.31	2.89 (21.10)	10.80 (78.90)	13.68	8.88	21.67	16.62
12	2011-12	33.72 (38.91)	52.94 (61.09)	86.66	4.33 (27.03)	11.70 (72.97)	16.03	12.85	22.10	18.50
13	2012-13	33.21 (36.74)	57.19 (63.26)	90.40	4.14 (22.92)	13.94 (77.08)	18.08	12.48	24.37	20.00
14	2013-14	34.43 (35.94)	61.36 (64.06)	95.79	4.38 (21.71)	15.80 (78.29)	20.18	12.73	25.75	21.07
15	2014-15	35.69 (34.79)	66.91 (65.21)	102.60	4.75 (24.03)	15.03 (75.97)	19.78	13.32	22.46	19.28
16	2015-16	36.00 (33.45)	71.62 (66.55)	107.62	5.20 (22.11)	18.32 (77.89)	23.52	14.44	25.58	21.85
17	2016-17	36.25 (31.71)	78.06 (68.29)	114.31	5.80 (20.97)	21.86 (79.03)	27.66	16.00	28.00	24.20
18	2017-18	37.56 (29.57)	89.48 (70.43)	127.04	6.05 (17.54)	28.45 (82.46)	34.50	16.11	31.79	27.16
19	2018-19	38.53 (28.39)	97.20 (71.61)	135.73	6.00 (15.03)	33.91 (84.97)	39.91	15.57	34.89	29.40
20	2019-20	37.27 (26.31)	104.37 (73.69)	141.64	5.64 (13.51)	36.10 (86.49)	41.74	15.13	34.59	29.47
Mean		32.35	55.20	87.55	3.66	13.69	17.36	11.31	24.80	19.83
Standard Deviation		3.60	22.81	26.25	1.49	9.58	10.96			
C.V (%)		11.13	41.33	29.98	40.55	69.95	63.11			
CAGR (%)		1.79** [0.0013]	6.85** [0.0019]	4.89** [0.0017]	6.84** [0.0045]	11.36** [0.0048]	10.33** [0.0044]			
R^2		0.91	0.98	0.97	0.92	0.96	0.96			
Cuddy Della Valle II		3.34	5.84	5.19	11.47	13.99	12.62			
Coppock II (%)		3.33	3.00	2.27	0.14	0.16	0.14			

Note: Figures in the parentheses indicate percentage to the respective total ** Significant at one per cent probability level [ ] standard error

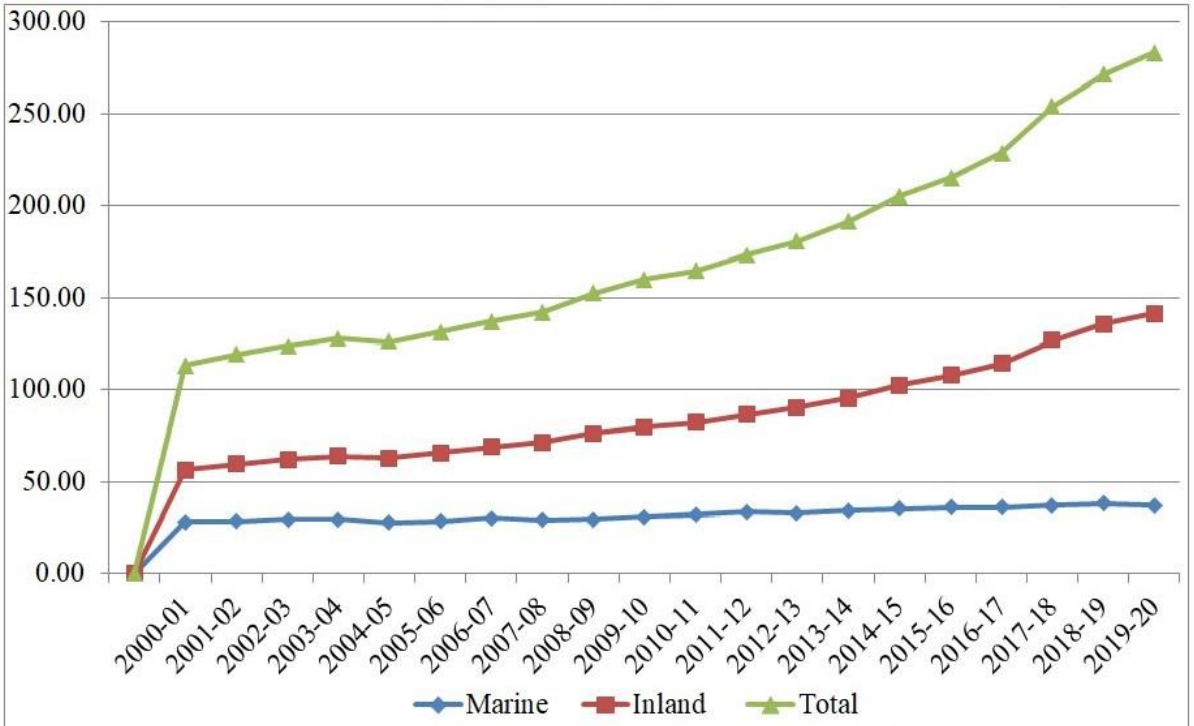

Fig a: Trends in marine, inland and total fish production in India

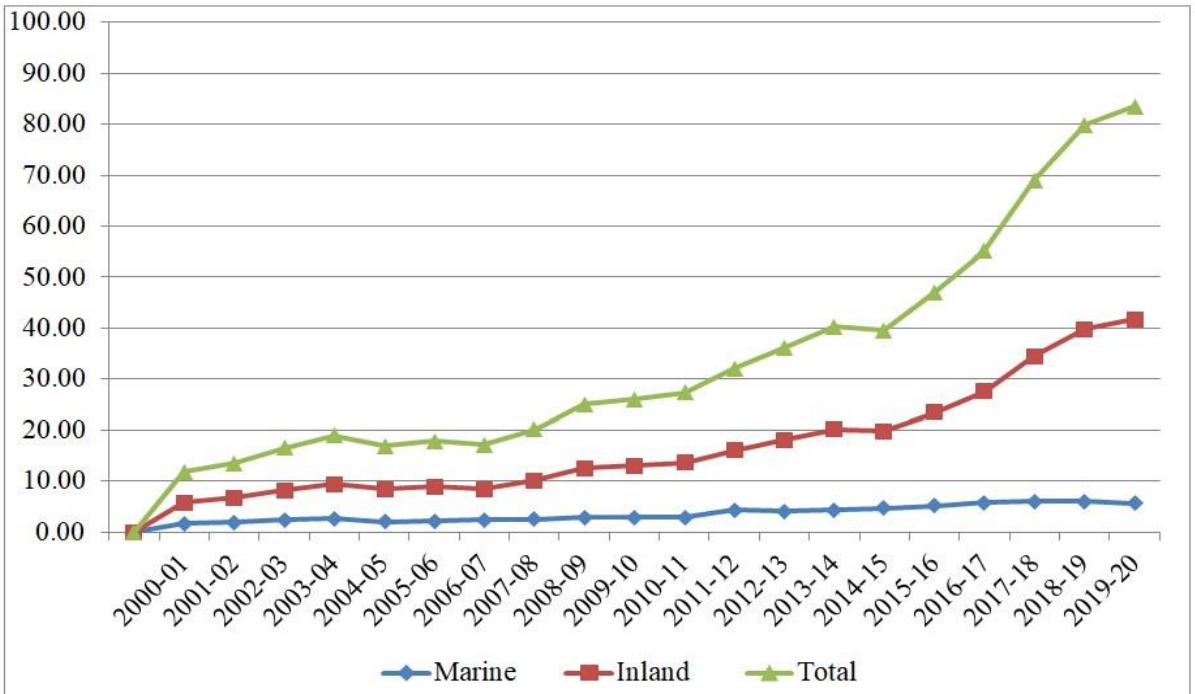

Fig b: Trends in marine, inland and total fish production in Andhra Pradesh

CONCLUSION

Aquaculture, particularly fisheries, is an important component of Indian food production, providing people with nutritional security, livelihood support, and gainful work. India is one of the world's top fish producers, accounting for 7.58 percent of global production and providing 1.24 percent of India's Gross Value Added (GVA) and 7.28 percent of agricultural GVA (2019-20). Andhra Pradesh is the country's leader in inland fish output and

third in marine fish production. In recent years, Andhra Pradesh has made major contributions to the country's fish basket through an effective strategy in both coastal and freshwater aquaculture and marketing. Fisheries sector in Andhra Pradesh shows as one of the growth engines for the achievement of double digit growth, because the state is blessed with potential and diversified water resources. Aquaculture production in India and Andhra Pradesh has gradually expanded over the previous few years. In India and Andhra Pradesh, total fish production grew from 56.56 and 5.90 lakh tonnes in 2000-01 to 141.64 and 41.74 lakh tonnes in 2019-20. Production has climbed 2.5 times in India and seven times in Andhra Pradesh. In India the production of marine, inland and total fish production were increasing significantly with 1.79, 6.85 and 4.89 per cent per annum, respectively. In Andhra Pradesh, the corresponding figures were 6.84, 11.36 and 10.33 per cent per annum, respectively. The results of Cuddy Della Valle and Coppock's instability index, inland fish production fluctuated the most, followed by total and marine fish production in India and the state.

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