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Growth Analysis and Instability in Fruits Area, Production, Productivity and Exports in India

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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

The study focused on growth rate and instability in area, production productivity and export of fruits in India and Tamil Nadu. The present study used the secondary data collected from secondary sources. The area under fruits in Tamil Nadu and India both are increased (2.08 and 1.94 per cent) in the current year, over the base year. The compound growth rate also significantly increased (0.10 and 0.23 per cent). The production and productivity of fruits decreased in Tamil Nadu and increased in India while the compound growth rate was also negative in Tamil Nadu and positive in India. The area and its interaction effect with area were found to be responsible for decrease in the production of fruits in Tamil Nadu. The similar finding was also found in case of India the yield effect (91.84 %) followed by area effect and interaction effect of area (6.38 and 1.78 %) were found to be major contributor for increase in production of fruits. Among the three measures of instability, two measures varying confirmed that the change in production of fruits is high rather than area and

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productivity. The growth rate of fruits export was revealed that the compound growth rate was 0.290 in volume of export and 7.87 in value of export respectively. The increasing growth rate in value of export might be to the high instability in value of fruits exported and the instability in volume might be due to the high instability index (32.77) in production of total fruits in India.

Keywords: *Interaction effect; yield effect; instability; growth rate; export; fruits.*

1. INTRODUCTION

“India's diverse climate ensures availability of all varieties of fresh fruits and vegetables. According to National Horticulture Database published by National Horticulture Board, during 2015-16, India produced 90.2 million metric tonnes of fruits and 169.1 million metric tonnes of vegetables. The area under cultivation of fruits stood at 6.3 million hectares while vegetables were cultivated at 10.1 million hectares. Amongst fruits, the country ranks first in production of Banana (25.7%), Papayas (43.6%) and Mango (40.4%). Fruits and vegetables account for nearly 90% of total horticulture production in the country. India is now the second largest producer of fruits and vegetables in the world and is the leader in several horticultural crops, namely mango, banana, papaya, cashew-nuts, areca nut, potato and okra” [1]. The major fruits growing states are Maharashtra, Tamilnadu, Karnataka, Andhra Pradesh, Uttar Pradesh and Gujarat. The production share of different states for 2017-18, the year showed that Andhra Pradesh (15.63 per cent), Maharashtra (12.05 per cent), Uttar Pradesh (10.82 per cent) and Tamil Nadu (5.83 per cent) [2].

During 2018-19, India exported fruits and vegetables worth of Rs.10236.93 crores which comprised of fruits worth Rs.4817.35 crores (47%). Grapes, Pomegranates, Mangoes, Bananas, Oranges account for larger portion of fruits exported from the country. The major destinations for Indian fruits and vegetables are Bangladesh, UAE, Netherland, Nepal, Malaysia, UK, Sri Lanka, Oman and Qatar. Though India's share in the global market is still nearly one per cent only, there is increasing acceptance of horticulture produce from the country. Furthermore, “the consumption of fruits and vegetables is associated with reduced risk of micronutrient deficiencies and non-communicable diseases. The most recent Global Burden of Disease Analysis estimated that 4.9 million deaths per year were attributable to low fruit intake and 1.8 million were attributable to insufficient vegetable intake” [3]. Hence, the

present study is attempted with the following specific objectives;

- To analyse the growth of area, production and productivity of fruits in India and Tamil Nadu.
- To estimate the contribution of area and yield towards change in production in India and Tamil Nadu.
- To study the growth and instability in area, production and productivity of fruits in India
- To analyse the growth and instability in export of fruits in India.

2. METHODOLOGY

The time series data on area, production and productivity and export of fruits in India and Tamil Nadu were collected from publication of National Horticultural Board (NHB), APEDA (Agricultural Processed Food Products and Export Development Authority), Agricoop (Agriculture Co operation and Farmers Welfare, agricoop.nic.in) Tamil Nadu statistical Hand Books, reports, Journal, periodicals and News Paper etc.

2.1 Compound Growth Analysis

Growth rate was calculated for area, production, productivity and export of fruits in India in the present study. Growth rates are measures of performance of economic variables. They are not developed to predict; but describe the trends in variables over time. Hence, they are commonly used as indicators of trends in the time series data. Compound growth rate was estimated with the help of the following exponential model.

$$Y = a b^t e$$

Where, Y = Dependent variable for which growth rate is estimated.

a = Intercept.

b = Regression coefficient.

t = Time variable.

e = Error term.

The logarithmic form of the above equation estimated the compound growth rate

$$\log Y = \log a + t \log b$$

The compound growth rate (g) was estimated by using

$$g = [\text{Anti log of (b)} - 1] * 100$$

2.2 Decomposition Analysis

Decomposition is a technique to discern out the effect of technology or environmental damage or any other impact on production. The following decomposition model [4] was used for estimation of contribution of area and yield towards change in production (positive/negative) is expressed as:

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

Change in production = Area Effects + Yield Effects + Interaction Effects.

Area Effects: percentage share of area in total production

$$AE = \frac{(A_n - A_0)Y_0}{P_n - P_0} \times 100$$

Yield Effect: Percentage of share of average yield in total production

$$YE = \frac{(Y_n - Y_0)A_0}{P_n - P_0} \times 100$$

$$\text{Interaction Effect: } IE = \frac{(A_n - A_0)(Y_n - Y_0)}{P_n - P_0} \times 100$$

Where,

A_0 = Triennium average of area in base year

A_n = Triennium average of area in current year

P_0 = Triennium average of production in base year

P_n =Triennium average of production in current year

$Y_0 = P_0/A_0$

$Y_n = P_n/A_n$

2.3 Measure of Instability

"There are a number of techniques available to measure the index of instability [5,6]. In this study the instability in area, production, productivity and Export of major fruit crops were measured in relative terms by the Cuddy-Della Valle index

which is used in recent years by a number of researchers as a measure of variability in time series data" [7,8].

a) Cuddy-Della Valle Index

"The simple coefficient of variation over estimates the level of variability in time-series data characterized by long-term trends whereas the Cuddy-Della Valle index corrects the coefficient of variation. The instability index IX, is given by the expression" [9,10]:

$$IX = C.V \times \sqrt{(1 - R^2)}$$

Where,

CV = coefficient of variation (in percent)

R^2 = coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

b) Coppock Index: Instability was also analysed using Coppock's Index which is calculated as the antilog of the square root of the logarithmic variance using the following formula

$$\text{Coppock Index} = (\text{Antilog}) \sqrt{v \log - 1} * 100, \\ V \log = \frac{1}{(N-1)} \sum (\log p_{t+1} - \log_t - M)^2$$

$$c) M = \frac{1}{(N+1)} \sum (\log p_{t+1} - \log_t)$$

"Coppock's Instability index is a close approximation of the average year to year percentage variation adjusted for trend and the advantage is that it measures the instability in relation to the trend in area. A higher numerical value for the index represents greater instability" [11,12].

3. RESULTS AND DISCUSSION

The results of the study was presented and discussed in two sections (i.e) Area, Production and Productivity of fruits and Export of fruits.

3.1 Area, Production and Productivity of Fruits

3.1.1 Growth rate

The time series data on area, production and productivity of fruits in India and Tamil Nadu were analysed and presented in Table 1 and

Table 1. Growth of area, production and productivity of fruits in India and Tamil Nadu during the period (2008 – 2018)

Particulars	The base year (TE 2008)	The current year (TE 2018)	Absolute change	Relative Change	Standard deviation	Co- efficient of variance	Compound growth rate
Area (000 ha)							
India	6271.3	6339.43	122.6	1.947	351.10	5.39	0.2302
Tamil Nadu	294	300.32	6.12	2.080	21.64	7.120	0.1000
Production (000 t)							
India	71619	93486	21866.26	30.53	9761	11.78	3.94
Tamil Nadu	7288.70	6165	-1122.87	-15.40	1282.01	18.59	-1.98
Productivity (000 t)							
India	11.40	14.62	3.20	28.03	1.51	11.86	3.70
Tamil Nadu	24.77	20.53	-4.27	17.12	3.47	15.34	-1.58

trend line also shown in Figs. 1 and 2 for Tamil Nadu and India. It could be observed from the data that the area under fruits in Tamil Nadu was increased by 2.08 per cent in the current year (300.31 thousand ha) over the base year (294 thousand ha) with the fluctuation of 7.12 per cent and showed slightly significant increase in the area with the deceleration of compound growth rate by 0.100 per cent per year during the period from 2008-18.

In the country, similar trend was observed and area was found to increase by 1.947 per cent in the current year (6339.43 thousand ha), over the base year (6271.3 Thousand ha) with the fluctuation of 5.39 percent and showed significant increase with the compound growth rate of 0.230. The production of fruits in Tamil Nadu was found to be decreased by 1122.87 in the current year (6165 thousand ha) over the base year (7288.70 thousand t) with the fluctuation of 18.59 per cent and showed a compound growth rate of -1.98 per cent per year.

Thus, the production of fruits was found to be increased by 21866.26 per cent in the current year (93486 thousand t) over the base year (71619 thousand t) with the fluctuation of 11.78 per cent and showed an increase in production with deceleration in compound growth rate of 3.94 per cent per year which was found to be highly significant. In case of yield of fruits it was found to be increased by 17.12 (24.77 to 20.53 kg/ha) present with the fluctuation 15.34 and 11.86 per cent in case of Tamil Nadu and India respectively. The compound growth rate was

found to increase in India but decreased in Tamil Nadu.

3.1.2 Decomposition of growth components

The relative contribution of area, yield and their interaction in production of fruits during the period is presented in Table 2.

It is observed from the data the yield effect (111.18 %) followed by interaction effect (2.32 %) of area and yield were found to be major contributor towards production of fruits in Tamil Nadu. The area effect (-13.50%) was found to be negative which showed that the area was not found to be responsible for decrease in production of fruits in Tamil Nadu. Although, the area and its interaction effect with area were found to be responsible for decrease in the production of fruits in Tamil Nadu. The similar finding was also found in case of India; the yield effect (91.84 %) followed by area effect and interaction effect of area (6.38 and 1.78 %) were found to be major contributor for increase in production of fruits.

3.2 Measure of Instability in Area, Production and Productivity of Fruits in India and Tamil Nadu

Instability analysis on the area, production and productivity of fruits for period of ten years was carried out. Instability measures such as coefficient of variation, Cuddy-della valle index and Coppock index were determined and presented in Table 3.

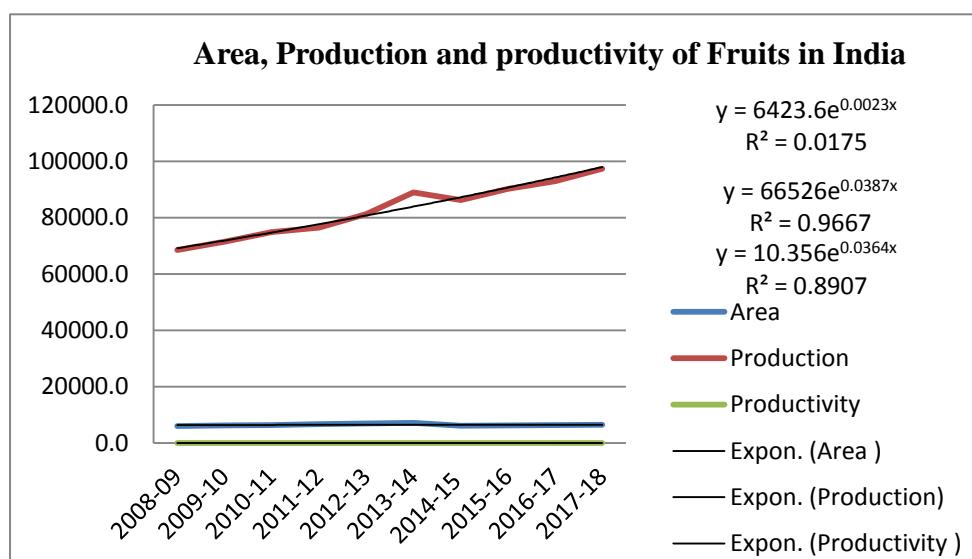
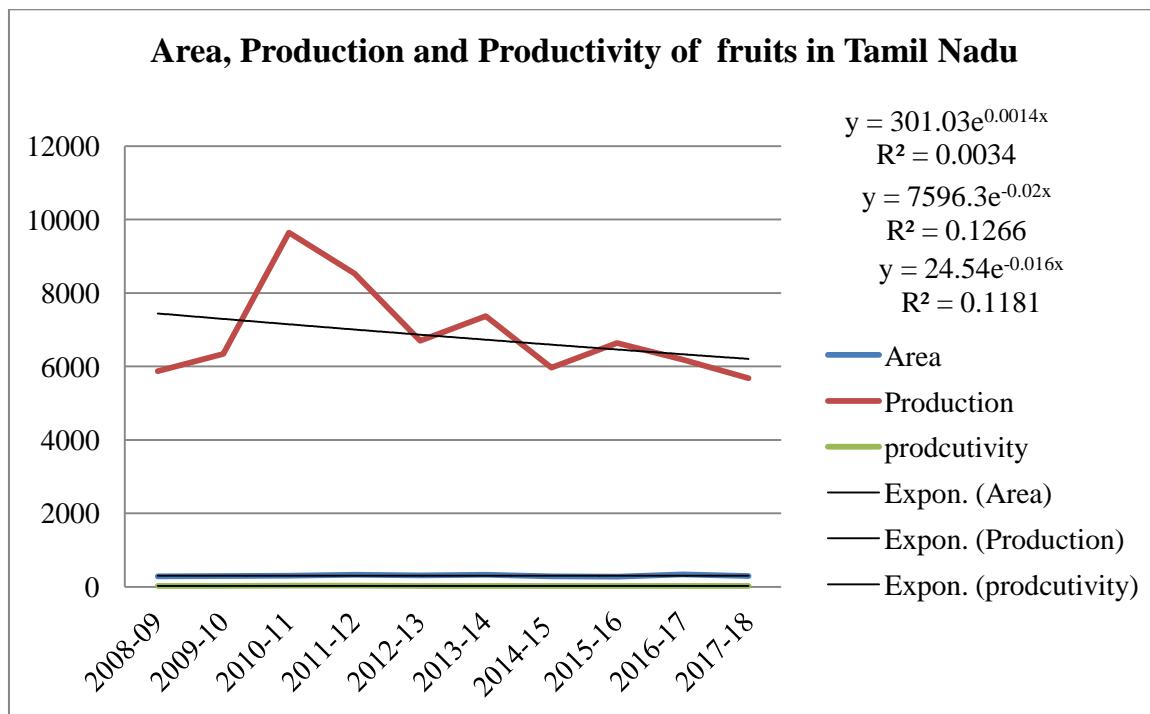


Fig. 1. Growth of area, production and productivity of fruits in India

**Fig. 2. Growth of area, production and productivity of Tamil Nadu****Table 2. Contribution of area, production and productivity of fruits (%) in India and Tamil Nadu**

S.No	Particulars	Tamil Nadu	India
1	Area effect	-13.50	6.38
2	Yield Effect	111.18	91.84
3	Interaction Effect	2.32	1.78
	Total	100.00	100.00

Table 3. Measure of instability in area, production and productivity of fruits in India and Tamil Nadu

S.No	Measure of Instability	India			Tamil Nadu		
		Area	Production	Productivity	Area	Production	Productivity
1	CV	5.3	11.78	11.86	7.12	18.59	15.34
2	Cuddy – Della Valle Index	0.53	1.17	1.18	5.69	14.87	12.27
3	Coppock Index	5.7	3.1	3.7	10.93	21.18	20.39

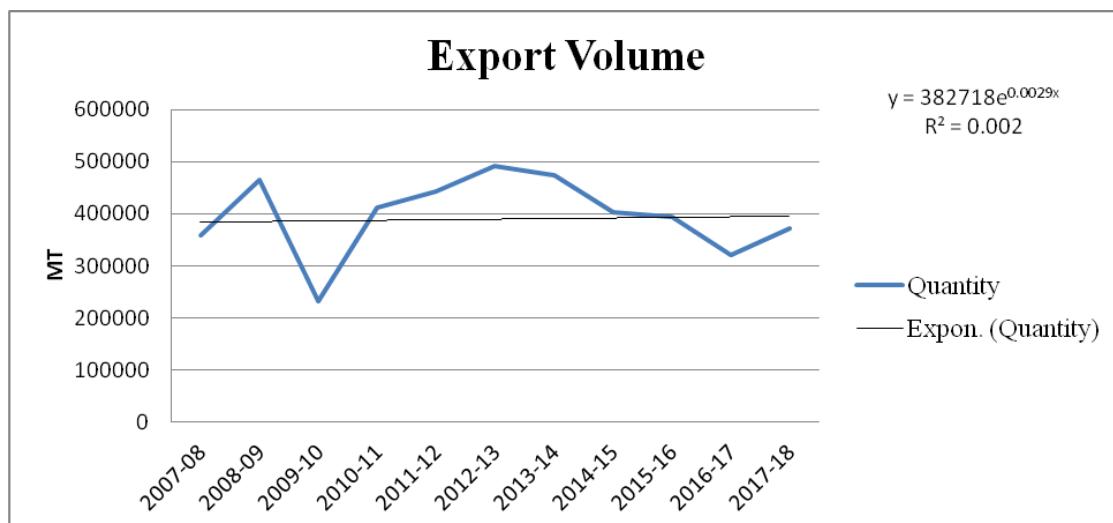
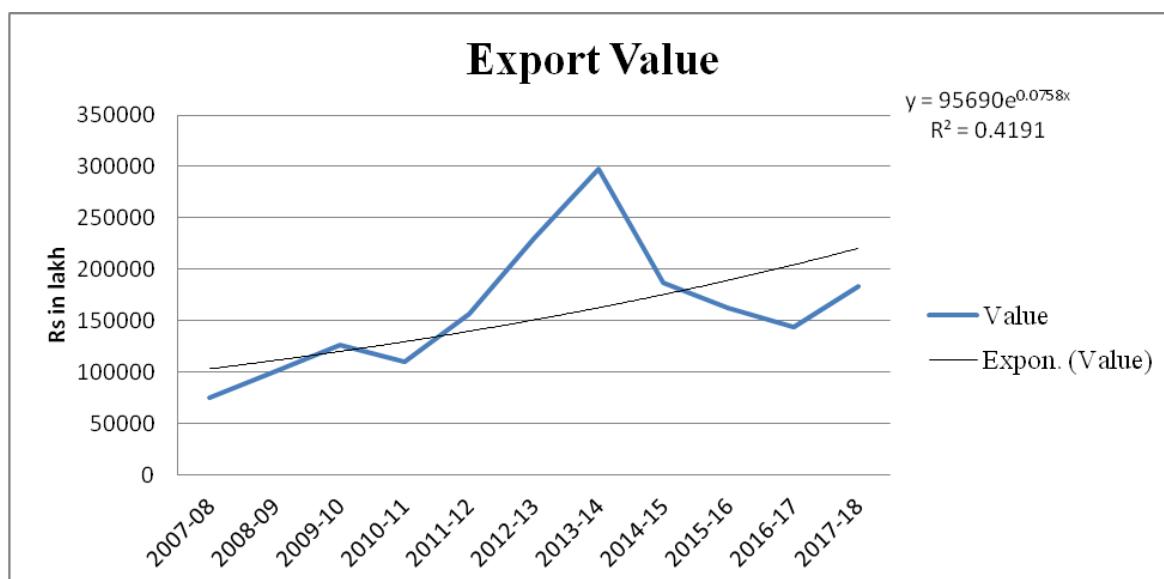
The fluctuation in agriculture measured with the help of simple co-efficient of variation (CV) but often contains the trend component and thus over times the level of instability in time series data characterized by long term trend. To overcome this problem, this study used Cuddy-Della and Coppocks instability Index which corrects the co-efficient of variation.

The estimated Cuddy – Della Valle instability indices for India as well as Tamil Nadu

were found to be higher in production and productivity (1.17 & 1.18 in India and 14.87 & 12.27 in Tamil Nadu) followed by area. The co-efficient of variation (CV) results also similar to Cuddy-Della Valle index. Coppock Index found to be more in area in India whereas followed by productivity and production. In Tamil Nadu, Coppock Index was found to be more in production (21.18) followed by productivity and area.

Table 4. Measure of instability in export of fruits in India

S.No	Measure instability	Volume	Value
1	CV	19.04	38.97
2	Cuddy – Della Vella Index	15.04	30.78
3	Coppock Index	39.38	32.77
4	CGR	0.290	7.87

**Fig. 3. Growth of export volume in India****Fig. 4. Growth of export value in India**

A) Export of fruits

Three instability indices were estimated for volume and value of fruits for time series data in export of fruits. The results were presented in Table 4.

The instability both in terms of quantity and value of fruits exported was assessed through co-

efficient of variation (CV), Cuddy Della Vella Index and Coppock Index. It could be seen from Table 4 that the CV was 19.04 in volume and 38.97 in value. The Cuddy – Della Vella Index was 15.04 in volume and 30.78 in value respectively. The Coppock's index was 39.38 and 32.77 of volume and value respectively. It also indicated that the value of fruits exported

was fluctuating widely during the study period of 10 years i.e., 2008-09 to 2017-18. The growth rate of fruits export was computed and the results revealed that the compound growth rate was 0.290 in volume of export and 7.87 in value of export respectively. The increasing growth rate in value of export might be due to the high instability in value of fruits exported and the instability in volume might be due to the high instability index in production of total fruits in India.

4. CONCLUSION

The present study was undertaken with a view to analysing trend, growth and stability of fruits in India and Tamil Nadu. The area of fruits in Tamil Nadu and area and production in India only were found to be increased with increase in productivity at slightly significant rate in the country. Among the three measures of instability, two measures varying confirmed that the change in production of fruits is high rather than area and productivity. It also indicated that the value of fruits exported was fluctuating widely during the study period of 2008-09 to 2017-18. The growth rate of fruits export revealed that the compound growth rate was 0.290 in volume of export and 7.87 in value of export respectively. The increasing growth rate in value of export might be due to the high instability in value of fruits exported and the instability in volume might be due to the high instability index in production of total fruits in India.

The fruit growing farmers need to be properly educated about the techniques of growing of fruit crop with minimum cost. Efficient crop management could increase the profit of local farmers by reducing the production cost. The fluctuation in the production of fruits and instability in export volume may be reduced by providing training on storing the fruits and production of value added products. Governments also formulate the policy to support fruit growers by announcing minimum support price and by providing cold storage facilities at minimum cost and subsidies for exporting fruits to other countries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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