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Compound growth rate, instability index and price behaviour of tomato in Chhattisgarh plains

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Abstract

The present study was conducted to analyze the growth rate & instability index in area, production and productivity of tomato and to study the seasonal and cyclic variation in prices of tomato in Chhattisgarh plains. The Chhattisgarh plain zone was selected only because it covers the major vegetable area and production (more than 60 per-cent) of the Chhattisgarh state. The study is based on secondary data and was collected for the period of 19 years for growth rate and CDVI, for price variation data was collected for the period of 7 years from 2017-18 to 2023-24. In the Chhattisgarh plains, the CAGR of area, production, and productivity were found to be 3.91 per-cent, 8.36 per-cent, and 4.28 per-cent, respectively, in the case of tomatoes. The area was indicating stable growth, and the production and productivity were indicating a medium level of instability in the tomato crop. The seasonal price indices regarding tomato were found that the inflation in price starts in the month of July and became highest in September to November than the price starts decline and become lowest in the month of February and march.

Keywords: Growth rate, instability index, AGMARKNET, behaviour of prices, tomato

Introduction

Horticulture is an integral part of agriculture. As the State and the whole country is moving towards modernization, the agricultural sector also changed from traditional to modern agriculture. The changing dietary pattern of the population made diversification in agriculture necessary as a result horticultural crops gained priority in the cropping pattern, which shifted from traditional to high-value crops. Vegetables are widely acknowledged as an essential component of the human diet. One of the most significant sources of food and nutritional security is vegetables. Vegetables should make up around 45 per-cent of the total volume of food consumed per person per meal in a balanced diet. Numerous vegetable crops have significant medicinal benefit in the treatment of specific illnesses.

India ranked second after China in vegetable production. India produces 212908 thousand metric tonnes of vegetables out of 11358 thousand hectares area occupied under it. Vegetables are always been a better choice of crop diversification because of good productivity and much higher returns from a unit area. The diversification in favour of these crops improves exports, reduce trade deficit, besides creating more direct and indirect employment. Tomatoes are rich in antioxidants like lycopene, which promote heart health and protect against certain cancers. They also provide vitamin C, which boosts immunity and supports skin health. In addition to antioxidants and vitamin C, tomatoes are a good source of vitamin A, which supports vision and skin health. They also contain potassium and folate, which help regulate blood pressure and support cell function.

The Chhattisgarh state contributes production around 1070.05 thousand MT (5.24 per-cent) of tomato production of the country. The area of tomato in Chhattisgarh state was 61.63-thousand-hectare (7.26 per-cent) area with 17.36 MT/ha productivity.

Methodology

Chhattisgarh state is divided into 3 agro-climatic zones *viz* Chhattisgarh plain, Bastar plateau and northern hills Out of the three agro-climatic zones, the Chhattisgarh plain zone was selected only because it covers the major area and production of tomato (more than 60 per-cent) in the Chhattisgarh state. Chhattisgarh plain zone which covers 15 districts out of which Bilaspur, Durg, Rajnandgaon were selected randomly for collection of data from respective APMCs. The study was based on secondary data which was obtained from the website of Government of Chhattisgarh, Directorate Horticulture and Farm Forestry, Chhattisgarh for area, production and productivity of vegetables and Agricultural Marketing Information Network for monthly price of selected vegetables for three district APMCs.

The data was collected for the period of 19 years from 2004-05 to 2022-23 for the growth rate. Besides that, data was also collected for the period of 19 years for 10 districts and 12 years for 5 districts (new districts carved out in 2012) under the Chhattisgarh plain zone for CDVI and for seasonal and cyclic variation in price, data were collected

for the period of 7 years from 2017-18 to 2023-24. The above data were analyzed using following techniques:

Compound Annual Growth Rate

To compute the growth rate of area, production and productivity of tomato in Chhattisgarh state, the following mathematical model will be used:

$$Y = aBt \qquad \qquad \text{……………(1)}$$

$$\text{Log } Y = \log a + t \log B$$

Where,
Y= Area/ production /productivity
a= Constant
B= Regression coefficient
t= time in year
Compound annual growth rate (per-cent) = (Antilog B-1)100

Cuddy Della Valle's Instability Index (CDVI)

Despite it is used to measure instability of tomato which is close to approximation of the average year to year per-cent variation adjusted for trend. The algebraic form of it is;

$$CDVI = CV\sqrt{(1-R^2)}$$

Where,
CV = Simple Estimates of coefficient of variation in per cent and
R^2 = Coefficient of determination from a time trend regression (linear) adjusted by the number of degree of freedom.
The ranges of CDVI are:
Low instability= 0-15
Medium instability= 15-30
High instability= Above 30

Seasonal variation in price

Seasonal variations were calculated by ratio to moving average method of Multiplicative model:

$$Y = T \times S \times C \times I$$

where,
Y = Result of the four elements,
T = Trend,
S = Seasonal component,
C = Cyclical component
I = Irregular component.

Cyclic variation in price

Cyclical indices were calculated for prices of tomatoes from the multiplicative model of time series.

$$\text{Cyclical index} = \frac{original\ price\ (yearly)}{estimated\ trend\ value} \times 100$$

Trend values

Linear, quadratic, 3rd degree polynomial and exponential trends are fitted.

Linear model

$$Tt = a + bt$$

where, a and b are the constants or regression coefficients and 't' is time period.

Results and Discussion

1. Compound annual growth rate (CAGR)

Compound annual growth rate of tomato talk about the change in area, production and productivity over time. The area, production and productivity of tomato were found to be increasing over the year in the Chhattisgarh plains zone. It can be seen from the table 1 that in the Chhattisgarh plains, the CAGR of area, production, and productivity for tomato crop were found to be 3.91 per-cent, 8.36 per-cent, and 4.28 per-cent, respectively. It indicates that over the year the area is increasing significantly at the rate of 3.91 per-cent in Chhattisgarh plains, The production is also increasing significantly at the rate of 8.36 per-cent in Chhattisgarh plains. It is found that the production has increased at the highest rate as compared to area and productivity. The productivity was also increasing significantly at the rates of 4.28 per-cent in Chhattisgarh plains.

Table 1: compound annual growth rate of tomato, brinjal and potato in Chhattisgarh plains.

Particular	Area	Production	Productivity
CAGR of tomato	3.91*	8.36*	4.28*

Note: * Significance at 1 per-cent level, ** Significance at 5 per-cent level

Similar kind of result were also shown by Tegar *et al.* (2016) [4] they found that Tomato appeared to be most growing vegetable as CGR for area, production and productivity of tomato worked out to be 9.01, 22.33 and 12.22 per cent respectively with high coefficient of variation.

2. Instability in area, production and productivity of Tomato

It is observed from the Table 2 that, during 2004-05 to 2022-23. The Cuddy Della Valle's instability with regard to area (5.52 per-cent) was lowest in Mungeli district, with regards to production (6.44 per-cent) was lowest in Rajnandgaon district and in terms of productivity (0.87 per-cent) was lowest in Balod district among the Tomato growing district of Chhattisgarh plains zone. The Cuddy Della Valle's instability was highest in Gariyaband district with regards to area (245.62 per-cent) and production (77.36 per-cent) it was because of new formulation of districts and for productivity the Cuddy Della Valle's instability was found more instable in Mahasamund district (38.74 per-cent).

Table 2: District wise instability index of Tomato (2004-05 to 2022-23)

S. No	Districts	Particular	Area	Production	Productivity
1	BILASPUR	CDVI	55.14	33.60	26.85
2	DHAMTARI	CDVI	12.18	24.17	37.87
3	DURG	CDVI	27.30	28.31	24.80
4	JANGIR-CHAMPA	CDVI	9.76	21.87	22.63
5	KABIRDHAM	CDVI	11.11	12.77	12.33
6	KORBA	CDVI	13.87	15.24	10.45
7	MAHASAMUND	CDVI	21.24	47.22	38.74
8	RAIGARH	CDVI	6.01	18.05	18.34
9	RAIPUR	CDVI	31.57	27.13	11.63
10	RAJNANDGAON	CDVI	7.85	6.44	6.41
New districts which were formed in 2012 (2011-12 to 2022-23)					
1	BALOD	CDVI	8.12	8.48	0.87
2	BALOD BAZAR	CDVI	48.00	36.76	23.18
3	BEMETARA	CDVI	14.48	41.21	37.21
4	GARIYABAND	CDVI	245.62	77.36	24.67
5	MUNGELI	CDVI	5.52	17.44	18.92

CDVI- Cuddy Della Valle's Instability Index (0-15: low, 15-30: medium and above 30: high)

Similar findings were also presented by Sethi *et al.* (2022) [3], who discovered that the instability in area, production and yield of selected vegetables and total vegetables was found very low which indicated that area under vegetables has increased steadily.
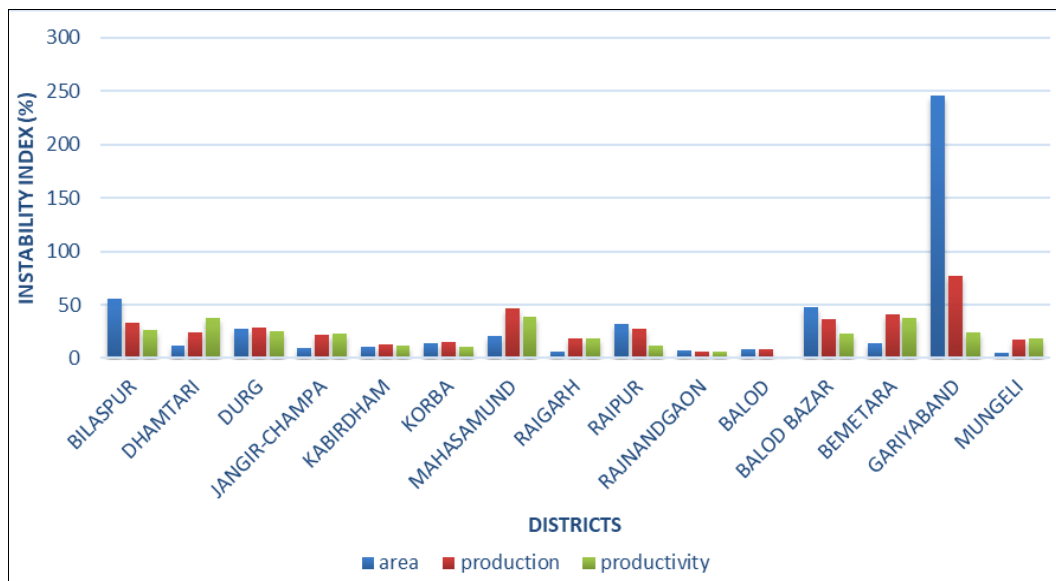

Fig 1: Instability in area, production and productivity of Tomato

It could be seen from the table 2 that in terms of area, Raigarh, Rajnandgaon, Jangir Champa, Dhamtari, Kabirdham, Korba, Balod, Bemetara, and Mungeli districts were more stable with low range (0-15) instability, and Durg and Mahasamund were found in medium range (15-30), and the highest range (above 30) of instability was found in the Bilaspur, Raipur Balod Bazar, and Gariyaband districts of the Chhattisgarh plains. In the case of production, Kabirdham, Rajnandgaon, and Balod districts were found to be more stable with low instability (0-15), and Jangir Champa, Dhamtari, Durg, Korba, Raigarh, Raipur, and Mungeli districts were found in the medium range (15-30), whereas Bilaspur, Mahasamund, Bemetara, Balod Bazar, and Gariyaband districts of Chhattisgarh plains were found to have a higher range of instability (above 30), and in terms of productivity, Rajnandgaon, Raipur, Korba, and Balod districts were the most stable. The

lower range of instability indicates that these districts were having more potential, and it encouraged policymakers to implement new projects in the area.

3. Seasonal indices of prices of tomato in major APMC's of C.G plains
The table 3 revealed that the seasonal indices regarding tomato prices found that the inflation in price starts in the month of June and was highest in July for all districts and then gradually decreases in price and lowers in the months of January to March. The price index for the month of July (197.67) was highest, followed by October (152.39) and June (142.36). The price index was lowest in the month of March (40.47) in Bilaspur district. The price index for the month of July (192.55) was highest, followed by June (173.18) and October (157.76).

Table 3: seasonal indices of price of tomato

Months	Bilaspur	Durg	Rajnandgaon
January	53.22	35.71	42.11
February	45.88	38.39	34.32
March	40.47	38.99	31.14
April	43.19	45.30	43.42
May	75.62	99.58	91.15
June	142.36	173.18	170.97
July	197.67	192.55	198.92
August	126.59	133.71	137.77
September	107.64	99.91	114.10
October	152.39	157.76	143.03
November	134.37	119.40	128.40
December	80.59	65.53	64.66

Gholap *et al.* (2021) [2] shown similar kind of results, observing that the monthly seasonal indices for arrivals were higher immediately after harvesting. The price indices were lower during peak arrivals months and vice versa. CV of real prices was found to be more than arrivals.
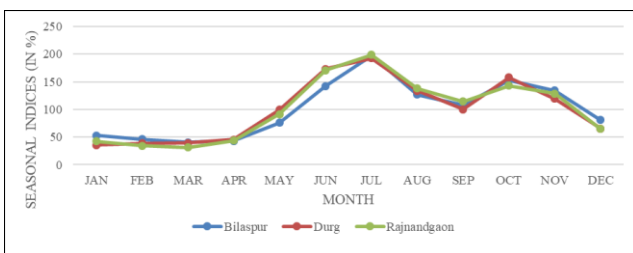

Fig 2: Seasonal indices for price of Tomato in Bilaspur, Durg and Rajnandgaon APMCs

The price index was lowest in the month of January (35.71) in Durg district, and the price index for the month of July (198.92) was highest, followed by June (170.97) and October (143.03). The price index was lowest in the month of March (31.14) in Rajnandgaon district. Gholap *et al.*
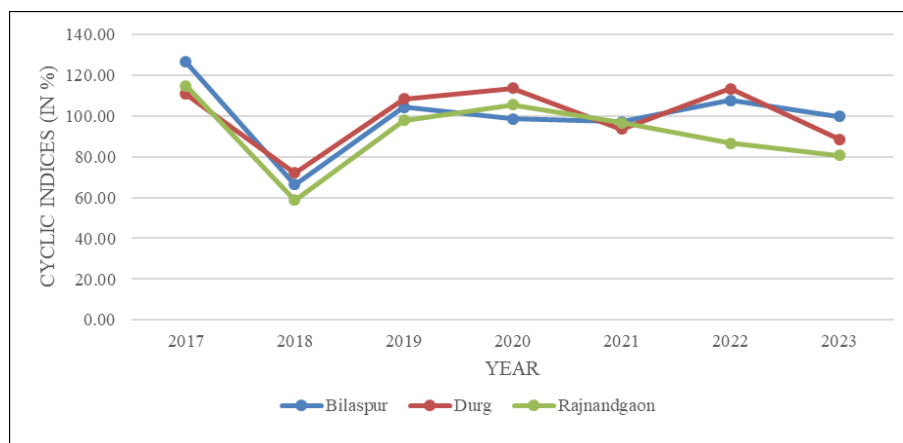
(2021) [2] shown similar kind of results, observing that the monthly seasonal indices for arrivals were higher immediately after harvesting. The price indices were lower during peak arrivals months and vice versa. CV of real prices was found to be more than arrivals.

4. Cyclical indices of prices of tomato in major APMC's of C.G plains

It is observed from Table 4 that the cyclical variations in the prices of tomato in the selected districts, The higher price indices were noted in the years 2017 (126.51), 2020 (133.55), and 2017 (114.70) in Bilaspur, Durg, and Rajnandgaon districts, respectively. The lower price index was noted in 2018 (66.42, 71.99, and 58.74 in Bilaspur, Durg, and Rajnandgaon districts, respectively). The rise in prices might be attributed to less production due to bad weather and stock in the hands of middlemen. However, the price has declined over the year from 2020 to the present date.

Table 4: cyclical indices of price of tomato

Year	Bilaspur	Durg	Rajnandgaon
2017	126.51	110.74	114.70
2018	66.42	71.99	58.74
2019	104.17	108.30	97.74
2020	98.68	113.55	105.42
2021	97.16	93.44	96.77
2022	107.53	113.46	86.75
2023	99.73	88.48	80.60

Similar kind of results were observed by Benke *et al.* (2016) [1], who discovered that Cyclical fluctuations were found to be more pronounced than seasonal fluctuations in prices. This showed that when maximum production is there, prices decreased and increased during the pre-harvest month. The C.V. was seen lowest for green gram crop.

Fig 3: Cyclic indices for price of Tomato in Bilaspur, Durg and Rajnandgaon APMCs

Conclusion
Result showed that over the period the area, production and productivity of vegetables were increasing significantly. In the Chhattisgarh plains, the CAGR of area, production, and productivity of tomato were found to be 3.91 per-cent, 8.36 per-cent, and 4.28 per-cent, respectively.
In Chhattisgarh plains zone maximum districts were found

to be stable in terms of area, production and productivity but however many districts had high instability in area, production as well as productivity. Balod, Bemetara, Jangir-Champa, Korba, Mungeli and Raigarh districts have more stability in terms of tomato. The lower range of instability indicates that these districts were having more potential, and it encouraged policymakers to implement new projects in

the area.

The seasonal indices regarding tomato prices found that the inflation in price started in the month of June and was highest in July for all districts and then gradually decreased in price and lowered in the months of January to March

For tomato crop the higher price indices were noted in the years 2017, 2020, and 2017 in the Bilaspur, Durg, and Rajnandgaon districts, respectively. The lower price index was noted in 2018 in all three districts.

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