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## Growth performance and instability of major vegetables of Rajasthan

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### Abstract

For analyzing the production performance of major vegetable crops in Rajasthan the current study was conducted from 2000-01 to 2019-20. The entire study period was divided into three sub-periods viz., Period-I (2000-01 to 2009-10), Period II (2010-11 to 2019-20), and Overall Period (2000-01 to 2019-20). Three major vegetables such as tomato, onion and potato (TOP) were considered for the analysis. The necessary secondary data on the area, production and productivity was gathered from several publications of state government. The study was done by analyzing the growth rate and instability using analytical tools such as Compound Annual Growth Rate, Instability Index (Cuddy-Della-Valle Index). All TOP crops showed higher growth rates in productivity during period-II in Rajasthan. Area under onion and potato revealed higher growth rates during period-I except tomato, which showed negative growth. Potato showed significant and positive growth rates during all the periods, also it revealed 19.9% growth rate in production which was highest compared to other crops. Tomato was more stable crop compared to onion and potato in the state. Instability in onion was due to shifting of farmers towards HYV and volatility in market price.

**Keywords:** Compound annual growth rate, cuddy-della-valle index, vegetable crops

### Introduction

India has achieved self-sufficiency and good degree of stability in the production of food grains, which has created a critical need for providing health security to population by supplying proper nutrition through balanced diet. Vegetables plays an important role in day-to-day life in providing balanced diet. Consumer preferences have also shifted away from cereals and moved towards high-value horticulture produce like fruits and vegetables (Meena, 2013) [13].

India is considered as the fruit and vegetable basket of the world. It holds a unique position in production figures among all the countries being a residence of wide varieties of fruits and vegetables (Vasavada and Shiyani, 2021) [13]. Vegetables are excellent source of vitamins, particularly niacin, thiamin, riboflavin and vitamins A and C. They also supply minerals such as iron and calcium besides proteins and carbohydrates. (APEDA, 2022) [1].

During 2019-20, India produced 188.284 million MT of vegetables and the area under cultivation of vegetables stood at 10.310 million hectares. Major vegetables grown in India are tomato, onion, potato, cauliflower, cabbage, bean, egg plants, cucumber and gherkins, frozen peas, garlic and okra (APEDA, 2022) [1]. Rajasthan state's area under vegetable crops in the year 2019-20 was 178961 hectares and production were 1885210 MT with productivity of 10534 MT Ha. Onion followed by potato and tomato hold maximum potential for creating a market as they account for 65.86%, 12.47 percent and 5.44% of total vegetable production of state. Onion, potato and tomato are produced in an area of 74,596, 12,996 and 18,537 hectares producing 1241783, 235236 and 102592 MT, respectively in the state (Directorate of Economics and Statistics, Department of Horticulture, Government of Rajasthan). The study of expansion and variation will aid to formulate strategies to increase the performance of major vegetable. Accordingly, the present study examined the nature of growth and instability present in area, production, productivity in Rajasthan.

### Material and Methods

For the study principal crops such as tomato, onion and potato (TOP) were selected since they had highest share in area and production in Rajasthan during 2019-20. Secondary data on area, production and productivity of TOP crops were collected from Rajasthan Horticulture

Statistics (Directorate of Horticulture), Pant Krishi Bhawan, Jaipur and other government publications. Twenty years data was analyzed for growth and instability i.e., from 2000-01 to 2019-20. The period was further divided into sub periods: period I (2000-01 to 2009-10), period II (2010-11 to 2019-20) and overall period (2000-01 to 2019-20). For estimation of growth rate CAGR exponential function was used and to assess instability Cuddy-Della-Valle Index was used.

**Compound Growth Rate:** The compound annual growth rate (CAGR) of individual major vegetable crops were calculated by Exponential function.

$$Y = A B^t \dots\dots\dots (1)$$

Where,  
 Y = area/ production/ yield of TOP crops for the year t  
 A = constant,  
 B = regression coefficient,  
 t = time in years

By converting the equation (1) into its natural logarithmic form,  
 $\log Y = \log A + t \log B$

Then, the compound growth rate (r) % per annum is,  
 $r = [(Antilog B) - 1] \times 100$

Test of significance of the compound growth rate were obtained with the help of Student's 't' test.

**Instability Index:** The variability in area, production, productivity of major vegetable crops during the study period were calculated using the formula for Cuddy-Della-Valle index. The co-efficient of variation (CV) was calculated using formula,

$$\text{Coefficient of Variation (\%)} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

Though, CV is one of the simplest measures of the instability, it does not completely explain the variability present in the time series data because of the presence of the trend component. In order to overcome this problem, formula of Cuddy-Della-Vella instability index was used, it is given by the expression:

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

Where,  
 CDVI = Cuddy-Della-Valle Instability Index,  
 CV = Coefficient of variation,  
 $\bar{R}^2$  = Coefficient of multiple determination calculated by time trend regression and adjusted by the number of degrees of freedom.

**Results and Discussion**

**Growth rates in the area, production and productivity of major vegetable crops of Rajasthan**

**Tomato:** Growth rates in area, production and productivity of Tomato have been shown in Table 1. Table indicated during period-I (2000-01 to 2009-10), tomato recorded negative and non-significant growth in all the aspects viz., area, production and productivity. There was a negative growth of -0.13 and -

0.87% per annum in area and productivity respectively followed by -1.01% negative growth in production of tomato. The decline in growth in productivity might be due to attack of insect pest and disease and other climatic factors as reported by Meena (2013) [13]. During period-II (2010-11 to 2019-20), only production and productivity showed positive and significant growth rate of 4.39% and 2.82% per annum, respectively. While, area showed positive non-significant growth rate of 1.52%. During overall study period (2000-01 to 2019-20), there was positive growth rates in area, production and productivity. Tomato production showed a positive and significant growth rate of 4.15%. It was attributed by both significant growth in area by 2.01% per annum and productivity by 2.09% per annum. Similar results were realized by Choudhary and Shekhawat (2022) [3] in the study of growth rate during the period 2001-02 to 2015-16, who reported that the increased area under the crop as well as the productivity increased the production of tomato in Rajasthan.

**Table 1:** Compound growth rates in area, production and yield of tomato in Rajasthan (In %)

Period	Area	Production	Productivity
Period I	-0.13	-1.01	-0.87
Period II	1.52	4.39**	2.82**
Overall period	2.01**	4.15**	2.09**

\*Significant at 5% level of significance, \*\* Significant at 1% level of significance

**Onion:** Growth in area, production and productivity of onion in Rajasthan were presented in Table 2. During the Period-I (2000-01 to 2009-10), all three categories such as area, production and productivity of onion reported significant growth. Area of onion increased by 6.73 percent annually and production showed annual growth rate of 11.02 percent while, growth rate in productivity was 4.02 percent. Growth in production might be largely attributed by significant growth in area during Period-I. Ardeshtna *et al.* (2014) [2] also recorded significant growth rate in area and production of the onion in Gujarat state in the year 2001-02 to 2011- 12. During Period-II (2010-11 to 2019-20), onion showed a positive significant annual growth rate only in production and productivity of 10.53% and 7.17%, respectively. Area under onion during Period-II was found non-significant. Decreased magnitude of growth rate in production was mainly contributed by significant decrease in area during this period compared to first period. The results revealed that during the overall period (2000-01 to 2019-20), onion production showed a positive and significant growth rate of 11.43%. It was attributed by significant growth in area by 5.82% per annum and productivity by 5.30% per annum. These results obtained were in line with the study conducted by Mahmadajaruddin and Mamani (2020) [6].

**Table 2:** Compound growth rates of area, production and yield of onion in Rajasthan (In %)

Period	Area	Production	Productivity
Period I	6.73**	11.02**	4.02*
Period II	3.13	10.53**	7.17**
Overall period	5.82**	11.43**	5.30**

\*Significant at 5% level of significance, \*\* Significant at 1% level of significance

**Potato:** Table 3 reveals the growth rates in potato in Rajasthan. During period-I (2000-01 to 2009-10), potato followed a trend of positive and significant growth rate in area and production. The area of potato showed a growth rate of 16.62% while production showed a growth rate of 19.98%. The growth in productivity of potato was 2.87% during this period. The high growth in the production was mainly due to positive growth in the area and yield. During period-II (2010-11 to 2019-20), there was a positive and significant growth in all aspects viz., area, production and productivity. Potato recorded meagre positive growth rate of 3.66% in area while 12.77% growth rate was seen in production and magnitude of productivity was 8.78% per annum. In overall study period (2000-01 to 2019-20), results revealed that there was positive and significant growth at 1% level of significance in all aspects. Compound annual growth rate in area was 9.62%, growth rate in production was 13.66% with 3.68% per annum growth rate in productivity. Tegar *et al.* (2016) [12] recorded similar trend of CAGR in Brinjal in Chhattisgarh state.

**Table 3:** Compound growth rates of area, production and yield of potato in Rajasthan (In %)

Period	Area	Production	Productivity
Period I	16.62**	19.98**	2.87
Period II	3.66*	12.77**	8.78**
Overall period	9.62**	13.66**	3.68**

\*Significant at 5% level of significance, \*\* Significant at 1% level of significance

#### Instability in the area, production and productivity of major vegetable crops of Rajasthan

**Tomato:** Instability in area, production and productivity of tomato has been depicted in Table 4. Tomato showed low variation during all the periods of study in Rajasthan. During overall period (2000-01 to 2019-20) in area, Cuddy-Dela-Valle index revealed instability of 9.06%, variation was more or less similar during period-I and period-II. Production showed lower variation of 12.40%, 4.27% and 14.82% in period-I, period-II and overall period. Similar low degree of variations was reported by Suvagiya *et al.* (2017) [11] in production of tomato in Gujarat state during 1995 to 2013. Productivity revealed highest variation during period-I (2000-01 to 2019-20) i.e., 11.80%, followed by overall period (11.75%) and period-II (8.00%). Mohapatra and Singh (2018) [8] revealed similar CDVI instability in productivity of cauliflower in Punjab during 2010-17 who reported that lower instability index in productivity was might be due to assured irrigation facilities being available for vegetable crop.

**Table 4:** Instability in area, production and yield of tomato in Rajasthan (In %)

Crops	Period I	Period II	Overall Period
Area	7.86	7.99	9.06
Production	12.40	4.27	14.82
Productivity	11.80	8.00	11.75

**Onion:** Table 5 indicates instability of onion in area, production and productivity. Onion showed low to moderate variation in Rajasthan. Area realized low variations of 10.96%, 14.76% and 13.73% during period-I, period-II and overall period. Patil and Kerur (2016) [9] reported that onion might be affected by volatility in the market price since it was considered to be among irrigated crop, which resulted in instability in the area. Which Highest Cuddy-Della-Valle

instability in production of onion was reported in period-II which was 21.75%. Production of onion showed higher instability values than instability in area and productivity. Instability variation was more in production was might be due to, farmers were more inclined towards high yielding varieties of onion, which might result in success or failure of the crop (Dhakre and Bhattacharya, 2013) [4]. Productivity of onion showed highest variation of 19.30% during overall period, followed by 13.04% in period-II and 12.21% during period-I. Similar results were recorded by Patil and Kerur (2016) [9] who reported that instability in productivity was might be due to shifting of farmers towards HYV of onion.

**Table 5:** Instability in area, production and yield of onion in Rajasthan (In %)

Crops	Period I	Period II	Overall Period
Area	10.96	14.76	13.73
Production	18.72	21.75	20.96
Productivity	12.21	13.04	19.30

**Potato:** Table 6 indicate instability present in area, production and productivity of potato during the study period. Potato reported highest variation in area during period-I (25.61%) whereas CDVI during period-II and overall period were 12.53% and 20.40%, respectively. The lower instability in area during period-II compared to period-I might be due to stabilization of area under potato in Rajasthan. More or similar variations were observed during all the periods in production of potato, period-II reported highest variation of 22.27%. Instability in production during all the periods were might be due to instability observed in the area and yield of potato during that period. Productivity reported highest variation of 24.38% during period-I followed by 22.60% in overall period and 16.33% in period-II. Sharma and Singh (2021) [10] also observed similar results in productivity of potato in Himachal Pradesh.

**Table 6:** Instability in area, production and yield of potato in Rajasthan (In %)

Crops	Period I	Period II	Overall Period
Area	25.61	12.53	20.40
Production	21.37	22.27	22.11
Productivity	24.38	16.33	22.60

#### Conclusion

Tomato crop showed negative growth rates during period-I, this might be due to attack of insect, pest and disease and other climatic factors of Rajasthan. All TOP crops showed higher growth rates in productivity during period-II in Rajasthan. All vegetable crops showed low to moderate instability in area, production and productivity during all the periods. Lower instability index in productivity was might be due consistent higher productivity because of good quality seeds, assured irrigation facilities and improved package of practices being available for vegetable crop. Moderate instability in onion was might be due to shifting of farmers towards HYV of onion and also by volatility in the market price of onion. Overall performance of TOP crops was quite impressive which can be seen by positive growth rate and reduced instability.

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