



Research Article

GROWTH AND INSTABILITY ANALYSIS OF PRODUCTION OF MAJOR VEGETABLES IN UTTARAKHAND

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Abstract: The study was conducted to examine the growth rates and variability of major vegetable crops in Uttarakhand. The time series data from 2012-13 to 2021-22 was analysed and compound annual growth rates (CAGR) and Cuddy Della Valle Index (CDVI) were computed for the five vegetable crops having maximum production in Uttarakhand. The growth rates for area were positive for all vegetables. A significant increase in production was observed for all crops, except potato, whose production fell. The results of instability index revealed a low level of instability in area, production and yield of vegetables in the study area. Decomposition analysis was carried out to know the individual effects of area, yield and their interaction on production growth. Area effect was found to be largely responsible for any changes in production for all vegetables. Yield effect and interaction effect did not have much of an effect on the production.

Keywords: Vegetables, Growth rate, Instability, Cuddy Della Valle Index, Decomposition analysis

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Introduction

Agriculture is the principal sector of Indian economy, employing 45.6 per cent of the workforce [1]. The share of agriculture and its allied sectors in the total GVA was 18.8 per cent in 2021-22. A higher growth in allied sectors has been observed as compared to the crop sector. As a result of the rising importance of the allied sectors, the committee on doubling farmers' income has declared dairying, livestock, poultry, fisheries and horticulture as the engines of high growth. Thus, recommending a focussed policy for this with a concomitant support system [2]. Vegetables are rich in vitamins, minerals and dietary fibre and their consumption provides plenty health benefits. They are important source of antioxidant vitamins A, C and E.

India is the second largest producer of vegetables after China with a production of 40.2 million tonnes from an area of 2.84 million hectares. The vegetable production of Uttarakhand stood at 1030.34 thousand MT from an area of 98.87 thousand hectares [3]. Uttarakhand has different agro-climatic conditions, slopes and physiographic zones. The geographical attributes give the state the advantage of producing off season vegetables, that fetch a good price. With a contribution of about 23.4 per cent to the state domestic product, agriculture is a predominant sector in the state economy as well. With a net irrigated area of 3.45 lakh hectares, the agriculture sector in the state continues to be highly dependent on rainfall. Vegetable growers in the hilly regions of Uttarakhand face various problems. The major ones are high commission rates of middlemen, non-availability of nearby market, fluctuating market rate and high transportation charges [4]. The state's Department of Horticulture and Food Processing has adopted various technologies for enhancing production, productivity and quality of horticultural commodities by adopting cluster approach. These include the setting up of nurseries, tissue culture labs, distribution of planting material, area expansion, vegetable seed production, etc. [5]. The special topography of the state endows it with natural potential for development of horticulture. Unfortunately, this potential remains untapped for the most part. This could pave the path of prosperity for the farmers instead of the current picture of economic outmigration [6]. The study was conducted to analyse the production performance of major vegetables in Uttarakhand with the specific objective to examine growth and variability in area, production and yield.

Materials and Methods

Top five crops in Uttarakhand based on production were selected. These are: potato, tomato, vegetable pea, radish and onion.

Time series data of ten years from 2012-13 to 2021-22 regarding area under cultivation, production, and productivity of major vegetables in Uttarakhand were collected from the Mandi Directorate, Government of Uttarakhand.

Compound Annual Growth Rate (CAGR)

CAGR reveals the tendency of a variable to increase, remain constant or decrease over a long period of time. It was estimated by exponentially fitting the time series data for area, production and yield against time using the method given by Gujarati, 1988. The equation is as follows [7]:

$$Y_t = ae^{bt} \quad (1)$$

Where,

Y_t is area/ production/ yield in year t

a is intercept

b is regression coefficient

t is year taking values 1,2,3,...,n.

Transforming equation (1) in log linear form:

$$\log Y_t = \log a + bt \quad (2)$$

The estimate of 'b' is in semi log form. So, to convert it into original form of Y_t transformation was done as:

$$b = \log(1+r)$$

taking anti log on both sides

$$\text{Antilog}(b) = 1+r$$

$$r = (\text{antilog } b) - 1$$

In percentage,

$$\text{CAGR} = [(\text{antilog } b) - 1] * 100 \quad (3)$$

The significance of the regression coefficient was tested using t-test.

Decomposition of output growth

The relative contribution of area and productivity to total output change was measured using Minhas component analysis (1964).

It was later redeveloped by Sharma (1977), which has been used by several research workers to study the growth performance of crops. The formula used is as follows [8]:

$$P_n - P_o = (Y_n - Y_o) A_o + (A_n - A_o) Y_o + (A_n - A_o) (Y_n - Y_o)$$

$$\Delta P = A_o \Delta Y + Y_o \Delta A + \Delta A \Delta Y$$

Change in production = Yield effect + Area effect + Interaction effect

Where,

P_n , A_n and Y_n are production, area and yield, respectively under individual crops in the current period,

P_o , A_o and Y_o are production, area and yield, respectively of individual crops in the base period.

So, a change in production can be decomposed into component effects viz. yield effect, area effect and interaction effect because of change in area and yield.

Instability index

Instability analysis coupled with growth analysis better helps in understanding the wide fluctuations in output. Fluctuating output affects prices and disposable income of farmers.

The magnitude of variability in area, production and yield was measured through computing coefficient of variation (CV%) as follows [9, 10]:

$$CV = (\sigma / \bar{x}) * 100$$

Where,

σ is standard deviation of variable

$\bar{x}$ is mean value of the variable.

As the simple CV contains a trend component, Cuddy Della Valle Index (CDVI) was generated which overcomes this problem.

$$\text{Instability index (CDVI)} = CV * (1 - R^2)^{0.5}$$

Where, R^2 is the coefficient of determination from a time trend regression adjusted for number of degrees of freedom.

Results and Discussion

Growth in area, production and yield of major vegetables in Uttarakhand

Under this section, the trends in area, production and yield of total vegetables in Uttarakhand have been depicted in the [Fig-1].

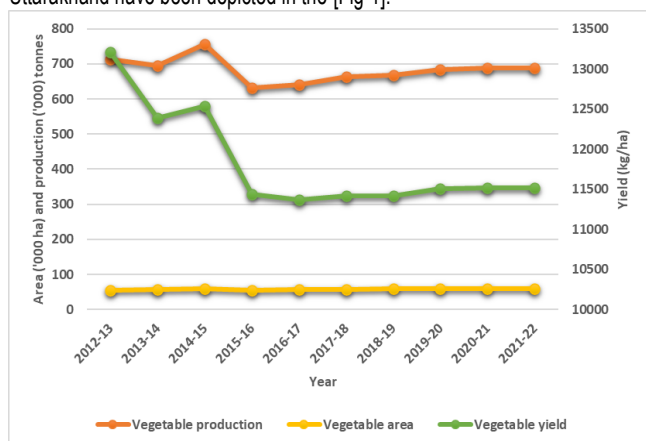


Fig-1 Trends in area, production and yield of major vegetables in Uttarakhand

Production of major vegetables was recorded highest in the year 2014-15 at 756.51 thousand tonnes, then showed a sharp decline and later increased at a very small rate. The major reason for the decline in production was the huge fall in yield of vegetables. Highest productivity was witnessed in the year 2012-13. Highest drop in the yield of vegetables from the previous year was observed in 2015-16, after which it has remained more or less stable. Area under these vegetables has also remained stagnant over the study period.

CAGR of area under cultivation, production and yield of major vegetables in Uttarakhand was calculated by exponentially fitting the data of area, production and productivity of major vegetables in Uttarakhand against time. The CAGR of area, production and yield of major vegetables are presented in [Table-1].

A steady and small increase in the area under the vegetables is reflected by the positive growth rate of all five vegetables considered for the study.

Out of which, the growth rates for area under vegetable pea, radish and onion were found to be statistically significant. Highest growth rate was seen for area of onion, followed by vegetable pea and radish. A decline in yield was seen for potato, tomato and radish. Among the selected crops, only vegetable pea was found to have a positive and significant yield growth rate, which was also the highest among the crops under study. A non-significant, marginal rise in the area coupled with a significant decline in productivity resulted in a small but significant decline in production of potato in the study period.

Table-1 Growth rates in area, production and yield of major vegetables in Uttarakhand

Crops	Compound Annual Growth Rate (Percentage)		
	Area	Production	Yield
Potato	0.44	-1.94*	-2.55**
Tomato	0.69	0.44	-0.25
Vegetable pea	1.50**	3.04**	1.51**
Radish	1.29**	1.11*	-0.17
Onion	1.80**	2.32**	0.49

The growth rates of production were significant for all the vegetables except tomato. Vegetable pea had the highest growth rate for production, followed by onion, radish and tomato. The positive growth rates of area and production are indicative of a promising vegetable production scenario. The CAGR for yield was lower than that of production and area for almost all vegetables. Similar results were obtained by Bidyasagar *et al.* in their analysis of area, production and yield of major vegetables in Assam [11]. Chaudhari *et al.* in their study of trends and variability in area, production and productivity of vegetables in Gujarat, India also found that the CAGR for area and production of vegetables were positive and significant, while that of productivity was non-significant [12].

Decomposition Analysis

The production growth was partitioned into area, yield and partition effects, calculated for each crop. The results presented in [Table-2] indicate the contribution of area and yield to the total growth in production. A perusal of the table reveals that a negative area effect was recorded only for potato crop. This negative area effect nullified the positive yield effect and was reflected in the negative CAGR of production of potato. This implies a reduction in area under cultivation of potato crop in Uttarakhand.

Table-2 Decomposition of growth in production of major vegetables in Uttarakhand

Crops	Per cent contribution		
	Area effect	Interaction effect	Yield effect
Potato	-47.30	10.03	137.27
Tomato	90.00	0.62	9.38
Vegetable pea	53.62	6.70	39.68
Radish	315.84	-25.16	-190.68
Onion	109.05	-1.47	-7.58

The positive area effect was mainly responsible for growth in production of tomato, radish and onion. It implies that the increase in production of these crops has been mainly due to increased area under them. This could be greatly due to the concerted effort of vegetable farmers to raise the production of these crops due to their increased demand [13]. For potato and vegetable pea, the positive yield effect indicates a breakthrough in productivity. A positive and substantial yield effect points towards technological advancements like use of improved varieties, better irrigation facilities and increased fertilizer consumption [14]. For vegetable pea, both, area effect and yield effect were responsible for production growth.

Instability in area, production and yield of major vegetables

Under this section, the Cuddy Della Valle Index was calculated for area, production and yield of the vegetables. The instability index gives an idea regarding the variability and fluctuations in area, production and yield of the crops under study. Instability in area, production and yield of major vegetables in Uttarakhand are presented in [Table-3]. Production instability was more than area and yield instability for all vegetables except vegetable pea, for which variation in area was maximum. Highest fluctuations in production were observed for tomato followed by potato, indicated by their higher instability indices. Among the crops studied, most stable production was of vegetable pea.

Table-3 Instability in area, production and yield of major vegetables in Uttarakhand

Crops	Instability Index		
	Area	Production	Yield
Potato	3.11	6.56	5.40
Tomato	3.17	7.22	4.50
Vegetable pea	3.10	2.43	1.22
Radish	2.92	3.96	3.27
Onion	3.24	3.49	2.98

In terms of area, highest variability was seen in onion, followed by tomato and potato. Area under radish in Uttarakhand reported the least fluctuations throughout the study period. All the vegetables experienced similar levels of instability in area. Yield instability was reported highest for potato followed by tomato. The yield of vegetable pea remained more or less stable for the study period. Overall, low instability was observed in area, production and yield for vegetables. Similar results were obtained by Shreyana *et al.* in their study of Growth performance and instability of major vegetables of Rajasthan [15]. Suvagiya *et al.* also reported low degree of variation in production of tomato in Gujarat [16].

Conclusion

Small growth rates of area indicate toward the scope of expanding area under vegetables. The favourable climatic conditions of the state for vegetable cultivation should be utilised to boost farmers' income. To reduce the dependency of production growth solely on area expansion, technological interventions are required in the form of advanced technologies, high yielding varieties and irrigation facilities. Less fluctuations have been observed in area while production shows more fluctuations. This may be due to heavy dependency of hill farmers on rainfall for irrigation. Thus, better policies are required to help expand the area under vegetables and their yield to increase the overall vegetable production in Uttarakhand.

Application of research: This research will aid in policy formulation regarding vegetables in Uttarakhand

Research Category: Growth and instability,

Abbreviations: CAGR-Compound Annual Growth Rate
CDVI-Cuddy Della Valle Index

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Cultivar / Variety / Breed name:

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