

## Trends and status of horticultural crops in Karnataka

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**Abstract:** The study analyse growth rates, instability and decomposition of horticultural crops in Karnataka, it offers valuable insights into dynamics of agricultural sector. The Secondary data on area under cultivation, production and productivity were utilised. Compound Annual Growth Rates (CAGR) and Cuddy Della Valle Instability Index (CDVI) were calculated to assess growth patterns and their instability. Fruits and vegetable cultivation showed significant growth over two decades, while spice crops had varying trends and plantation crops witnessed substantial growth. Flower cultivation had mixed growth patterns and medicinal plants displayed diverse trends. Aromatic plant cultivation showcased dynamic growth. Cuddy Della Valle Instability Index values revealed varying degrees of volatility, with fruits and vegetable cultivation demonstrating relatively low instability, spice crops exhibiting low to moderate levels and medicinal plants showing the highest instability values. Aromatic plants displayed moderate instability. The decomposition analysis revealed of area expansion as the dominant driver in the first period, while yield improvements became crucial in the second period due to research and development efforts. The study emphasizes the importance of Karnataka's horticulture sector for its economy and rural livelihoods. Policies need to focus on modern technologies, improved infrastructure and market linkages to enhance productivity, promote market access and on how to mitigate climate and market risks.

**Key words:** Decomposition, Growth rate, Horticultural crops, Instability

### Introduction

Horticulture crops are important constituents of Indian agriculture from the view point of nutritional security, high yield and commercial value, economic viability and ability to generate on-farm and off-farm employment. Post green revolution witnessed a substantial growth in the country's horticulture production. The horticulture sector in Karnataka is gaining importance and stand as a linchpin of the state's agricultural landscape, contributing significantly to its economy and sustaining livelihoods. The diverse agro-climatic conditions and fertile soils of the state have emerged as a key factors for cultivating a wide range of commercially important horticultural crops, that includes fruits, vegetables, plantation crops, ornamentals, medicinal plants, spices, *etc.* Karnataka stands first and dedicates over 26.21 lakh hectares of its area to horticulture, thereby contributing 9.56% to India's total horticultural acreage, while, it ranks seventh in production with 7.19% to the national output. Horticultural crops covered 20.40% of the cultivable land, with plantation crops dominating by occupying 49.44% of the horticultural area in the year 2020-21. The sector's economic impact is profound with its contribution to Karnataka's Gross State Domestic Product (GSDP) at 3.83% while, within the agriculture sector, holding a significant share of 29.55% (Anonymous, 2020). Understanding the trends, growth patterns and dynamics of contribution by horticulture crops is crucial for informed decision-making and policy formulation for sustained future growth. The analysis of data on horticulture crops with area, production and yields, aids stakeholders in developing strategies to improve productivity, encourage sustainability and promote inclusive growth across Karnataka's agricultural landscape. These strategies consider factors like climate variability, technological

advancements, market dynamics for suitable policy intervention.

### Material and methods

Karnataka has a diversified cropping pattern across regions based on rainfall pattern, soil types, and climatic conditions. The paper attempted to study horticultural crops, their trends and status. The secondary data mainly collected from various published sources *viz.*, National Horticulture Board, Annual reports of the Dept. of Horticulture, Govt. of Karnataka, Agricultural Statistics at a Glance and website of Directorate of Economics and Statistics (DES). The historical performance of horticultural crops has been assessed for the State. The study related to the last two decades from 2001-02 to 2020-21. The data was further divided into Period I (2001-02 to 2010-11) and Period II (2011-12 to 2020-21). Generally, the pace of development of any region from the viewpoint of agriculture can be ascertained by measuring growth in the area, production and yield of crops grown in that region. Analytical tools were employed to critically analyse and interpret the results meaningfully. The present study has assessed the compound growth rates of the area, production and productivity of major horticultural crops for the period 2001 to 2020.

### Compound annual growth rates

The compound annual growth rates (CAGR) of area, production and yield of horticultural crops were estimated as follows:

$$Y_t = AB^t e$$

$$\ln Y_t = \ln A + (\ln B)t + \ln e$$

Where,

$$B = (1+r)$$

$Y_t$  = Area/Production/ Yield of major horticultural crops in the  $i^{th}$  period,

$t$  = a time variable (1, 2, 3....., n),

A and B are parameters to be estimated,

$r$  = compound growth rate, and

$e$  = error term

### Cuddy and Della Instability Index

To examine the stability in the growth of horticultural crops across state, the coefficient of variation was estimated using the following procedure.

$$CV = \frac{\sigma}{\mu} \times 100$$

Where,

CV = Co-efficient of variation

$\sigma$  = Standard deviation of the variable

$\mu$  = Mean of the variable.

The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend

$$\text{Cuddy Della Valle Instability Index} = CV \times \sqrt{1-R^2}$$

Where,  $R^2$  = Coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

### Decomposition analysis

The decomposition method of growth trend was first presented by Minhas and Vaidyanathan (1965). They estimated the change in the value of agricultural output by segregating the changes contributed by three major factors (area, yield and interactions). They have used the additive method for working out the effects of the three factors. To estimate the effect of area, yield and their interaction on the overall growth performance of horticulture production was estimated by using the decomposition approach.

The algebraic form of an equation is given below:

$$P = A_0(Y_n - Y_0) + Y_0(A_n - A_0) + \Delta A \Delta Y$$

$$1 = [(Y_0 \Delta A)/P] + [(A_0 \Delta Y)/P] + [(\Delta A \Delta Y)/P]$$

Where,

P = Change in production

$A_0$  = Area in base year

$A_n$  = Area in current year

$Y_0$  = Yield in base year

$Y_n$  = Yield in current year

$\Delta A$  = Change in area ( $A_n - A_0$ )

$\Delta Y$  = Change in yield ( $Y_n - Y_0$ )

In this study, the impact of area, yield and their interaction on the change in production of horticultural crops under investigation was estimated for the study period. To minimize or eliminate any bias, triennium averages of area, production and yield for the respective base and current years of the crops were considered.

## Results and discussion

### Horticulture crops share in Karnataka

The percentage share of mean area, mean production and mean value of various horticultural crops to the total horticultural sector in Karnataka revealed distinctive patterns (Table 1). Nonetheless, growth in the area was not same for all the horticulture crops. Among the crops, fruits and vegetables hold substantial shares, representing 17.87 and 21.07% of the mean area, 36.13 and 44.97% of the mean production and 28.79 and 22.46% of the mean value, respectively. Plantation crops covered the largest proportion of the mean area with 47.31%, contributed only 13.37% to mean production with the highest share of 35.98% to mean value. Spice crops accounted for 12.26% of the mean area, 4.21% of total production and 10.67% of the mean value. Flower crops, medicinal plants and aromatic plants, although occupied smaller areas, collectively contributed to the horticultural sector. Overall, these figures illustrate the diverse landscape of horticultural crops in Karnataka, highlight the significant contributions of fruits and vegetables followed by plantation crops to total production.

### Growth performance of horticultural crops in Karnataka

The growth rates of horticultural crops over the past two decades were presented in Table 2. Period I spanned from 2001-02 to 2010-11, while Period II covers 2011-12 to 2020-21. The overall growth rate was calculated for the period 2001 to 2020.

Fruit cultivation exhibited significant growth over last two decades and in the two distinct periods. There was a notable increase in both area and production of fruits, with a Compound Annual Growth Rate (CAGR) of 4.46 and 5.64%, respectively, both statistically significant at the 1% level in the first period. The fruit production increased due to their adaptability to

Table 1. Share of each crop to the total horticultural sector (2016-2020)

Crop	Mean Area (ha)	Per cent	Mean Production (tonnes)	Per cent	Mean Value (₹ in Lakhs)	Per cent
Fruits	410199	17.87	7222389	36.13	1459476	28.79
Vegetables	483676	21.07	8989944	44.97	1138653	22.46
Spice crops	281399	12.26	842458	4.21	540748	10.67
Plantation crops	1085985	47.31	2672204	13.37	1824136	35.98
Flower crops	32264	1.41	268135	1.34	99481	1.96
Medicinal plants	636	0.03	1708	0.01	1372	0.03
Aromatic plants	1419	0.06	13808	0.07	4587	0.09
Total	2295578	100	19992651	100	5069925	100

Table 2. Growth rates of area, production and productivity of horticultural crops in Karnataka

Crops	Time Period	Area (Lakh ha)	CAGR (%)	Production (Lakh Tonnes)	CAGR (%)	Yield (t/ha)	CAGR (%)
Fruits	Period I	2.88	4.46***	47.69	5.64***	16.57	1.13***
	Period II	3.98	1.22**	68.74	2.03***	17.26	0.80*
	Over all	3.43	3.25	58.21	3.83	16.97	0.57***
Vegetables	Period I	4.02	2.22***	60.21	6.83***	14.97	4.41***
	Period II	4.67	1.74*	85.44	2.88***	18.28	1.13
	Over all	4.35	1.62	72.83	4.02	16.75	2.34***
Spice crops	Period I	2.42	1.29	6.64	8.60***	2.74	7.07***
	Period II	2.44	5.98***	7.85	2.77	3.21	-3.03**
	Over all	2.43	0.83	7.24	2.88***	2.98	2.18**
Plantation crops	Period I	7.50	2.06	4.61	3.76	0.61	2.31
	Period II	9.76	4.89***	18.60	28.14***	1.91	22.14***
	Over all	8.63	2.78	11.60	12.81	1.34	9.91***
Flower crops	Period I	0.23	5.77	1.73	4.58***	7.66	-1.14**
	Period II	0.31	1.76*	2.45	3.96***	7.82	0.98
	Over all	0.27	3.51	2.09	3.71	7.75	-0.19
Medicinal plants	Period I	0.01	20.49***	0.03	5.48	2.59	-12.04**
	Period II	0.01	-16.10***	0.04	-13.55	3.23	3.06
	Over all	0.01	1.47	0.04	0.09	2.95	-1.23
Aromatic plants	Period I	0.01	9.95***	0.11	18.24***	8.87	7.47
	Period II	0.01	-1.19	0.14	-2.50	10.26	-1.33
	Over all	0.01	2.42**	0.12	5.17***	9.62	2.66**
Total Horticulture crops	Period I	17.08	2.44***	120.68	6.32***	7.07	3.80***
	Period II	21.19	3.60***	183.16	4.22***	8.64	0.61
	Over all	19.13	2.36	151.92	4.58	7.94	2.17

varied-agro climatic conditions of the state. Moreover, the increase in demand for fruits, better prices along the value chain, increased income levels. The technological interventions during production and post-harvest management practices favoured the growth in fruit production (Acharya *et al.*, 2012). However, yield growth during this period was comparatively modest (1.13%) and statistically significant. In period II, although the growth rates declined, they remained significant, while the yield growth rate dropped to 0.80%, the production growth rates remained significant at 2.03%. The fruit cultivation maintained a steady pace of expansion, at an average area growth rate of 3.25%, production growth rate of 3.83% and yield growth rate of 0.57%, statistically significant at the 1% level. Introduction of NHM interventions has enhanced the growth in area, production of fruits in the state (Doddamani *et al.*, 2014; Nabi and Bagalkot, 2017) and the state gifted with ten different agro-climatic regions suitable for growing a variety of fruits all-round the year.

The cultivation of vegetables demonstrated robust growth, particularly in Period I, where both area (2.22%) and production (6.83%) experienced significant expansion at the 1% probability level. Moreover, the yield growth during this period was exceptionally high touching 4.41%, also statistically significant. Although the growth rates were slightly decreased in the period II, they remained significant and indicating continued expansion. However, the growth rate of yield reduced to 1.13%, production growth rate remained significant at 2.88%. On the whole, vegetable cultivation showed steady growth, with an average area growth rate of 1.62%, production growth rate of 4.02% and yield growth rate of 2.34% at the 1% level of significance.

Spice crop cultivation displayed varying trends over the two periods. The production (8.60%) and yield (7.07%) in Period I exhibited significant growth rate. The area growth rates were comparatively lower at 1.29%. However, in Period II, the growth rates diverged, with growth in production decreased yet the area experienced a remarkable surge with a growth rate of 5.98%. Notably, the yield growth rate in Period II turned negative, indicating a decline. Overall, spice crop cultivation demonstrated significantly moderate expansion with respective average production and yield growth rates of 2.88% and 2.18%.

Plantation crop cultivation witnessed substantial growth across the study periods. The area, production and yield showed moderate growth rates in Period I. In Period II, the growth rates were significantly accelerated with respect to area (4.89%) and production (28.14%) while the yield growth rate also surged significantly to 22.14%. Overall, plantation crop cultivation experienced steady and significant growth in area, production and yield at 2.78, 12.81 and 9.91%, in that order.

Flower cultivation displayed mixed growth patterns over study periods. Production showed a highly significant growth rate of 4.58% in Period I. However, the yield growth rate turned negatively significant (-1.14%). In Period II, the growth rates slightly decreased and remained significant with area expanding at 1.76% and production at 3.96%. However, the yield growth rate lost its significance. Overall, flower crop cultivation maintained modest growth for area and production at 3.51% and 3.71%, respectively, while the growth in yield (-0.19%) declined and was non-significant.

Table 3. Instability in area, production and productivity of horticultural crops in Karnataka

Crops	Time Period	Area (%)	CDVI Production (%)	Yield (%)
Fruits	Period I	6.41	5.73	2.19
	Period II	3.38	5.26	3.30
	Over all	6.50	6.87	3.00
Vegetables	Period I	3.23	13.06	10.74
	Period II	6.69	7.92	6.44
	Over all	5.23	11.18	9.18
Spice crops	Period I	8.88	18.08	17.30
	Period II	12.28	16.00	11.09
	Over all	15.65	19.75	19.46
Plantation crops	Period I	1.35	23.15	24.74
	Period II	8.35	35.61	39.75
	Over all	7.83	53.86	52.06
Flower crops	Period I	3.94	5.65	3.80
	Period II	7.94	11.56	5.36
	Over all	7.81	8.48	5.46
Medicinal plants	Period I	18.10	44.22	57.11
	Period II	36.48	82.83	70.95
	Over all	59.86	82.99	70.42
Aromatic plants	Period I	16.55	35.26	33.08
	Period II	18.34	22.32	10.54
	Over all	22.01	33.26	23.31
Total	Period I	2.28	7.56	6.50
	Period II	4.24	6.52	5.92
	Over all	4.35	7.37	7.18

Medicinal plant cultivation exhibited diverse growth trends over the observed periods. The significant increase in area (20.49%) was noticed in Period I. However, production showed growth and was not significant. The growth rate in yield turned negatively significant (-12.04%). In Period II, the area saw a significant decline with a growth rate of -16.10%. The production declined with a growth rate of -13.55% and yield exhibited positive growth rates. Overall, cultivation of medicinal plants experienced minimal growth, with a non-significant growth rate of value for area and production, while the yield showed a significant decline at -1.23%.

Aromatic plant cultivation showcased dynamic growth patterns across the observed periods. In Period I, both area and production experienced significant growth rates, with production growth rate of 18.24%. Additionally, the yield growth rate was substantial at 7.47% and was however non-significant. In Period II, the growth rates declined for area, production and yield. Overall, aromatic plant cultivation maintained moderate growth, with a significant growth rate of values for area, production and yield at 2.42, 5.17 and 2.66%, respectively.

Horticulture cultivation encompassed a wide range of crops, each exhibiting distinct growth trends over the observed periods. There was highly significant growth in Period I for both area (2.44%) and production (6.32%), Additionally, the yield also showed a substantial increase of 3.80% highly significant. In Period II, the growth rates remained significant for area expansion at 3.60% and that of production at 4.22%. However, the yield growth rate diminished to 0.61%. Overall, horticulture crop cultivation maintained steady growth for area

(2.36%), production (4.58%) and yield (2.17%). The positive growth and low instability in horticultural crops during the post-NHM period were mainly due to additional area brought under horticultural crops through area expansion component, rejuvenation of old trees with new cultivars, better technologies like integrated nutrient management and integrated pest management activities under the assistance of NHM (Acharya *et al.*, 2012; Satishgowda *et al.*, 2014; Patil and Hosamani, 2018). These comprehensive insights into the growth trends of various crops underscore the complex dynamics within the agricultural sector. Understanding these patterns is crucial for stakeholders to make informed decisions regarding resource allocation, investment strategies, and policy formulation aimed at fostering sustainable agricultural development and ensuring food security.

The Cuddy Della Valle Instability Index values reflect the degree of variability and uncertainty in the area, production and yield of horticultural crops in Karnataka over the study periods (Table 3.) Fruits cultivation demonstrated relatively low instability across area, production and yield. Similarly, vegetable cultivation showed low instability in the area during Period I, but experienced a significant rise in instability in production and yield, indicating levels of uncertainty in these aspects. In Period II and the overall period, low instability was observed in both area and production. Spice crops exhibited low to moderate levels of instability across all parameters throughout the observed periods, with index values consistently exceeding 15, indicating unstable cultivation of spice crops. Plantation crops displayed relatively low instability in the area (8.35%) but experienced substantial fluctuations in production (35.61%) and yield (39.75%), especially during Period II and overall showed high instability in production and yield. Flower crops demonstrated low instability in all parameters. Medicinal plants exhibited the highest levels of instability, with index values surpassing 30 for all parameters showed significant uncertainties in their area, production and yield. Aromatic plants showed moderate instability in the area whereas in production and yield it was moderate to high instability. The horticulture sector together with all crops showed low instability for area, production and yield during the study periods. The instability in area, production and productivity of horticulture crops was reduced after implementation of NHM in the study area depicting the positive impact of NHM (Patil and Hosmani, 2018). Overall, these instability values provide valuable insight into the varied degrees of volatility and unpredictability in the horticultural sector in Karnataka over the specified periods, influenced by factors such as climatic variations, market dynamics and policy interventions.

### Decomposition analysis of horticultural crop production

The decomposition analysis of horticultural crop production in Karnataka reveals a distinct trend in terms of effects of area, yield and their interaction over two periods (Table 4), *i.e.*, 2001-2010 (Period I) and 2011-2020 (Period II), as well as the overall period (2001-2020). During Period I, the dominant driver of production change was the expansion of the cultivated area which contributed as high as 54.36% to the

Table 4. Decomposition of production variability in horticultural crops

Time period	Area Effect (%)	Yield Effect (%)	Interaction Effect (%)
Period I	54.36	35.32	10.31
Period II	7.85	88.67	2.36
Over all	34.04	46.44	19.03

overall increase, while improvements in yield accounted for 35.32%. The interaction effect representing the combined influence of both area and yield changes contributed 10.31% to the production variation. In contrast, Period II witnessed a shift in dynamics with a notable increase in yield effect, which accounted for 88.67% of the production change, indicating substantial improvements in crop productivity over time due to Research and Development efforts. Area effect during this period was comparatively lower at 7.85%, suggesting a lesser role of cultivated area expansion. The interaction effect remained modest at 2.36%. Overall, across the entire (from 2001-2020) period, both area and yield played a significant role in driving production variations, contributing 34.04 and 46.44%, respectively, while their interaction effect accounted for 19.03%. These findings highlight the changing patterns in horticultural crop production in Karnataka and highlight the importance of understanding the distinct interplay between area expansion, yield improvements and their combined effects on overall production dynamics.

### Conclusion

The analysis of growth rates, instability and decomposition of horticultural crops in Karnataka provides valuable insights into the dynamics of the state's agricultural sector. Fruit and vegetable cultivation demonstrated significant growth over the

last two decades and in both distinct periods. Spice crops displayed varying trends, while plantation crops witnessed substantial growth across both study periods. Flower cultivation exhibited mixed growth patterns, and medicinal plants showed diverse growth trends. Aromatic plant cultivation showcased dynamic growth patterns across the observed periods. The instability values for horticultural crops in Karnataka revealed varying degrees of volatility and unpredictability over the study periods. Fruit and vegetable cultivation demonstrated relatively low instability, while spice crops exhibited low to moderate levels. Plantation crops showed substantial fluctuations in production and yield and medicinal plants had the highest instability values. Aromatic plants displayed moderate instability in area, production and yield. The decomposition analysis of horticultural crop production in Karnataka revealed distinct trends across two periods and the overall period. Area expansion was the dominant driver in the first period, while in the second period, yield improvements became crucial due to research and development efforts. The area and yield significantly contributed to production variations. The study emphasizes the importance of Karnataka's horticulture sector for its economy and rural livelihoods. Policymakers should focus on modern technologies, improved infrastructure and market linkages to enhance productivity, promote market access and mitigate climate and market risks.

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