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**RESEARCH PAPER**

# Application of Hazell decomposition model on turmeric production variability in Karnataka

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**Abstract:** Turmeric is one of the most important tuberous rhizomes or underground stem grown across the world. Turmeric is also considered Rhizome which are rich curcumin content, which is responsible for many of its medicinal properties such as Antioxidant, Anti-inflammatory, Antitumor, Anti-carcinogenic, Anticoagulant and Antifungal. It is considered as greatest natural medicine available for human beings. The current study is confined to Turmeric crop grown in Karnataka. To examine the growth and instability in area, production and productivity of Turmeric for a period of 24 years (2001-2023) data was used. Exponential growth rate, Cuddy valley instability index and hazell's decomposition analyses were employed to analyse the data. During the study period, there exhibits increasing growth in area (6.22%), production (7.48%) and productivity (1.18%). The instability analysis revealed that area under turmeric cultivation was moderately unstable than production and productivity. Hazell's decomposition analysis reported that increase in the mean average production was mainly due to change in area-yield co-variance (7.86%). Change in mean area (89.87%) and change in mean yield (2.69%) contributed to the variability in the turmeric production.

**Key words:** Decomposition analysis, Growth rate, Instability index, Productivity, Turmeric

## Introduction

India is called the "Spices Bowl of the World" to produce a variety of spices with superior quality. Turmeric (*Curcuma longa*) is native to Asia and India. The tuberous rhizomes or underground stems of turmeric are used from antiquity as condiments, a dye and as an aromatic stimulant in several medicines. Turmeric is a very important spice in India, which produces nearly the whole world's crop and uses 80 per cent of it. Presently, it is cultivated in China, Taiwan, Indonesia, Sri Lanka, Australia, Africa, Peru and West Indies. Turmeric usage dates back nearly 4000 years, to the Vedic culture in India, when turmeric was the principal spice and also of religious significance (Sajjan *et al*., 2018). It is much revered by Hindus and associated with fertility. In today's India, turmeric is still added to nearly every dish, be it meat or vegetables. Turmeric has been used in Indian systems of medicine for a long time.

The global production of turmeric is around 11 lakh tonnes per annum. India dominates the world production scenario contributing 80 per cent followed by China (8%), Myanmar (4 %), Nigeria (3%) and Bangladesh (3%). In the year 2023-24, in India, the area under turmeric cultivation was 292,830 hectares, with a total production of 1,063,220 metric tonnes and a productivity of 3.63 MT/ha. Maharashtra ranked first in production with 310,010 tonnes, followed by Odisha with 73,750 tonnes, while Karnataka stood in third position with 66,830 tonnes (Anon, 2024).

In Karnataka, during 2022-23, Chamarajanagar ranked first in turmeric production with 56,164 tonnes, followed by Belgaum with 37,850 tonnes, Bagalkot with 15,981 tonnes, Mysore with 5,919 tonnes, and Bidar with 825 tonnes. (Anon, 2023).

In 2022-23, India had exported 1.70 lakh tonnes of turmeric compared to 1.53 lakh tonnes in the previous year. Major turmeric importing countries from India are Bangladesh (34,523 tonnes), UAE (18,980 tonnes), Iran (12,223 tonnes), Morocco (10,663 tonnes), USA (7,009 tonnes) and Malaysia (6,829 tonnes) (APEDA, 2023).

## Material and methods

The current research was carried out for the state of Karnataka. The required secondary data on district wise area, production and productivity was collected from Directorate of Economics and Statistics (DES) from 2000 to 2023. Growth and instability of area, production and productivity of Turmeric crop were computed for the period 2000 to 2023. Furthermore, for clear understanding of the growth and instability, the study period was bifurcated into two periods of 12 years each *i.e*., Period I (2000-2011) and Period II (2012-23).

**Exponential growth model**: For computing the growth in area, production and productivity of Turmeric in Karnataka from 2000 to 2023 exponential growth model was used, which is described below

$$\mathbf{Y = ab^t e}$$

Where, Y=Dependent variable for which the growth rate is estimated (area, production and productivity of Turmeric)

a = Intercept

b = Regression coefficient

t = Time variable

e = Error term

The compound growth rate was obtained from the logarithmic form of the equation (1) as below:

$$\mathbf{Ln\ Y = ln\ a + ln\ b}$$

The per cent compound growth rate was derived using the relationship

**g = (Anti ln of b-1) x 100**

**Cuddy-Della Valle Index**

Is obtained for the CV and the following form of CV is,

$$\mathbf{CV} = \frac{\text{standard deviation}}{\text{mean}} \ \mathbf{X\ 100}$$

CDVI is estimated as follows,

$$\mathbf{CDVI = CV\ x} \sqrt{1 - \bar{R}^2}$$

where,

CV is the coefficient of variation in percentage

$\bar{R}^2$ is the coefficient of determination from the regression adjusted for its degrees of freedom.

Cuddy Della Index indicates the real direction of the instability and is better measure to find out the instability in major agricultural export. If the index values are below 15 per cent, then it is categorized as low instability, if the value lies between 15 to 30 per cent, then it is categorized as medium instability and more than 30 per cent, is categorized as high instability (Cuddy and Della, 1978).

**Hazell's decomposition analysis**

The sources of growth and instability of Turmeric production was calculated by Hazell's decomposition model (Hazell, 1984). The area and yield data of Turmeric were detrended and these detrended series were used as the basic data for decomposition of change in average production and changes in variance of groundnut production.

Table 1. Components of change in average production

| Sources of Change | Symbol | Components of change |
|---|---|---|
| Change in mean yield | $\Delta\bar{Y}$ | $\bar{A}\Delta\bar{Y}$ |
| Change in mean area | $\Delta\bar{A}$ | $\bar{Y}\Delta\bar{A}$ |
| Interaction between change in mean area and mean yield | $\Delta\bar{A}, \Delta\bar{Y}$ | $\Delta\bar{A}\Delta\bar{Y}$ |
| Change in area– yield Covariance | $\Delta$Cov (A, Y) | $\Delta Cov(A, Y)$ |

Source: Hazell, 1982

The Hazell's decomposition procedure produces the four components of change in average production and that shows the sources of growth of Turmeric production (Table 1). Four components of change in average production are change in mean yield, change in mean area, interaction between changes in mean yield and mean area and change in area-yield variance. These are four major sources of change which are grouped into pure effect, interaction effect and variability effect.

**Pure effect:** Change in mean yield and change in mean area are called pure effects and it arises even if there were no other source of change.

**Interaction effect:** Interaction between changes in mean yield and mean area is interaction effect, which arises from the simultaneous occurrence of changes in mean yield and mean area.

**Variability effect:** This will arise from changes in the variability of areas and yields.

**Decomposition of change in variance of production**

The Hazell's decomposition procedure also produces ten components of change in variance of the production that shows the source of instability of Turmeric production (Table 2). The components of change in production variance are divided into four categories

Table 2. Components of change in the variance of production

| Source of change | Source of change | Components of change |
|---|---|---|
| Change in mean yield | $\Delta \bar{Y}$ | $2\ (\bar{Y}a-\bar{Y})\ CoV(A, Y) + [2\bar{Y}a\ \bar{Y} - \bar{Y} - \bar{Y}\ \bar{Y}]\ V(A)$ |
| Change in mean Area | $\Delta \bar{A}$ | $2\ \bar{Y}\ \bar{A}a\ \ CoV(A, Y) + [2\ \bar{A}a\ \ \ \bar{A}-\bar{A}\ (\Delta\ \bar{A}\bar{A})]\ V(Y)$ |
| Change in yield variance | $\Delta V (Y)$ | $(\bar{A})^2\ \Delta\ V(Y)$ |
| Change in area variance | $\Delta V(A)$ | $(\bar{Y})^2\ \Delta\ V(A)$ |
| Interaction between changes in mean yield and mean area | $\Delta\bar{Y}, \Delta\bar{A}$ | $2\ \bar{Y}\bar{A}\ \Delta\bar{Y}\ \Delta\bar{A}\ CoV(Y, A)$ |
| Interaction between changes in mean area and yield variance | $\Delta\bar{A}, \Delta V(Y)$ | $(2\ \bar{A}a\ \bar{A}-\bar{A}a - \bar{A} + \Delta\bar{A})\ \Delta V(Y)$ |
| Interaction between changes in mean yield and area variance | $\Delta\bar{Y}, \Delta V (A)$ | $[2\bar{Y}\ \bar{Y}a - \Delta\ \bar{Y}\ \bar{Y}]\ \Delta V (A)$ |
| Interaction between changes in mean area and yield and changes in area-yield covariance | $\Delta\bar{A}, \Delta\bar{Y}, \Delta\ CoV(A, Y)$ | $\Delta\bar{A}\ \Delta\bar{Y}\ \Delta\ CoV(A, Y) + \Delta\bar{Y}\ \bar{Y} + 2\ \Delta\bar{A}\ \Delta\bar{Y} - \ \Delta\ CoV(A, Y)$ |
| Change in residual | $\Delta$ R | $= \Delta$ V(AY) - sum of the other components |

Source: Hazell, 1982

**Average production components:** These are similar to that of components of average production *i.e*. components 1,2,5 and 6 (Table 2).

**Variance components:** This consists of change in yield and area variance, components 3 and 4 (Table 2).

**Interaction components:** Components 7, 8 and 9 included in Table 2.

Residual: This will be very small or zero as all other components completely explains the total variability (Table 2)

**Results and discussion**

Compound growth rates were calculated for the area, production, and productivity of Turmeric in Karnataka for Period I (2000-2011), Period II (2012-2023) and the whole period (2000-2023). Table 3 presents the CAGR results. During Period I, the area under Turmeric cultivation grew significantly at 12.22 per cent per annum, while production increased at 13.54 per cent per annum, both significant at the 1 per cent level. However, productivity showed a marginal increase of 1.17 per cent per annum, which was not significant.

In Period II, the area under cultivation continued to increase, but at a slower pace of 3.32 per cent per annum, while production rose by 5.47 per cent per annum—both significant at the 1 per cent level. Productivity improved at a rate of 2.09 per cent per annum, significant at the 10 per cent level.

Over the entire period (2000–2023), the area, production, and productivity of Turmeric grew at 6.22 per cent, 7.48 per cent, and 1.18 per cent per annum, respectively. While the growth in area and production significant at the 1 per cent level, productivity growth was significant at the 10 per cent level results are in line with Jainuddin *et al*. (2019).

The instability in area, production, and productivity of turmeric in Karnataka was assessed using the Cuddy-Della Valle Index (CDVI) and is presented in Table 4. The results show that instability in area was highest during Period I (2000–2011) with a value of 35.27, followed by the whole period (2000–2023) at 25.78 and lowest in Period II (2012–2023) at 16.81. This suggests that fluctuations in the area under turmeric cultivation were more pronounced in the earlier period, likely influenced by crop diversification and shifts in land use.

Similarly, production instability was highest in Period I at 38.81 and declined to 25.95 over the whole period and 17.95 in Period II, indicating improved consistency in turmeric output in the recent decade. Productivity instability followed the same pattern, being highest in Period I at 16.74, declining to 12.51 in the whole period and reaching its lowest in Period II at 7.78. Overall, the findings suggest that Period I experienced higher instability across all three variables—area, production, and productivity—compared to Period II. The decrease in instability in the recent period points to better production practices, technological interventions, and possibly more favourable market or climatic conditions. The higher instability in productivity during Period I likely contributed significantly to the instability in production, whereas instability in area was influenced more by changes in cropping patterns. Additionally, production and productivity were affected by climate variability disease outbreaks and market price fluctuation.

Hazell's decomposition analysis was used to examine the components of change in the mean area, yield and production of turmeric in Karnataka between the years 2000-2001 and 2023-24. The results of the analysis are presented in Table 5. The analysis

Table 3. Compounded growth rate of area, production and productivity of Turmeric in Karnataka

| Particulars | Area (Ha) | Production (Tonnes) | Productivity (Tonnes /Ha) |
|---|---|---|---|
| Period I (2000-11) | 12.22*** | 13.54*** | 1.17NS |
| Period II(2012-23) | 3.321*** | 5.47*** | 2.09* |
| Whole period (2000-23) | 6.22*** | 7.48*** | 1.18* |

Note:*** significant at one percent level of probability
*Significant at 10 percent level of probability
NS - non-significant

Table 4. Cuddy-Della Valle Index of area, production and productivity of Turmeric in Karnataka

| Particulars | Area (Ha) | Production (Tonnes) | Productivity (Tonnes /Ha) |
|---|---|---|---|
| Period I (2000-11) | 35.27 | 38.81 | 16.74 |
| Period II(2012-23) | 16.81 | 17.95 | 7.78 |
| Whole period (2000-23) | 25.78 | 25.95 | 12.51 |

Table 5. Components of change in production of Turmeric

| Description 2000-2001 to 2023-24 | Year | % change |
|---|---|---|
| Change in mean Area | -236398.00 | 89.87 |
| Change in mean yield | -7101.78 | 2.70 |
| Interaction between change in mean yields and change in mean area | 1155.01 | -0.44 |
| Change in area- yields cov | -20690.10 | 7.87 |
| Change in mean gross | -263034.00 | 100.00 |

Table 6. Components of change in production variability of Turmeric Source of changes

| Description | Symbol | Percentage |
|---|---|---|
| Change in mean yields | $\Delta \bar{Y}$ | -8.4E-08 |
| Change in mean areas | $\Delta \bar{A}$ | -1.4E-06 |
| Change in yield variance | $\Delta V(Y)$ | -0.00019 |
| Change in area variance | $\Delta V(A)$ | -0.00015 |
| Interaction between changes in mean yield and mean area | $\Delta\bar{Y}, \Delta\bar{A}$ | 1.14E-05 |
| Change in area-yield covariance | $\Delta$ Cov (A,Y) | -0.0002 |
| Interaction between changes in mean area and yield variance | $\Delta \bar{A}, \Delta V(Y)$ | 0.026431 |
| Interaction between changes in mean yield and area variance | $\Delta\bar{Y}, \Delta V(A)$ | 0.00125 |
| Interaction between changes in mean area and yield and change in area-yield covariance | $\Delta \bar{A}, \Delta \bar{Y}, \Delta$ Cov (A,Y) | -0.23676 |
| Change in residual | $\Delta R$ | 100.2096 |
| Total | | 100 |

indicates that the major component of the decline in average turmeric production was attributed to the change in mean area, which accounted for 89.87 per cent of the total reduction. This suggests that a significant portion of the decline in production stemmed from a contraction in the area under turmeric cultivation.

The change in mean yield contributed only 2.70 per cent, indicating that yield remained relatively stable over the period and had a limited effect on overall production decline. The interaction between changes in area and yield had a marginal and slightly negative effect, accounting for -0.44 per cent of the total change. Results are in line with Pavithra *et al*. (2021). Additionally, the change in price–yield covariance contributed 7.87per cent, highlighting the role of market price volatility in influencing production levels. While not the dominant factor, it underscores the importance of stable market conditions in maintaining consistent output.

In summary, the decomposition results emphasize that the reduction in turmeric production in Karnataka during this period was primarily driven by area contraction, with a secondary influence from price–yield dynamics, while yield-related factors and interaction effects played a relatively minor role.

Table 6 shows the components of change in production variability; the greatest positive contribution came from the interaction between changes in mean area and yield variance, which accounted for about 0.026 per cent, followed by interaction between changes in mean yield and area variance (0.00125%). The major decrease in the variability of production was due to change in mean yield (-8.4E-08%), change in mean area (-1.4E-06%) and change in area–yield covariance (-0.0002%). The results are in line with Kumar and Sreenivasmurthy (2022).

The growth rate of area, production, and productivity of turmeric during the study exhibits a declining trend, particularly due to the instability observed across different components. In period I, growth in area under turmeric increased significantly, while productivity rose significantly in period II. Instability is a crucial decision-making parameter in assessing agricultural development. In Karnataka, the area under turmeric is more unstable than production and productivity.The decomposition of change in average turmeric production revealed that the decline was influenced primarily by change in mean area, while yield had a relatively marginal role. Among the ten components of variability, the interaction effects (especially those involving variance terms) played a significant role in influencing production variability. The study suggests the need for research interventions to develop climate-resilient, high-yielding turmeric varieties and enhanced agronomic practices, which will play an important role in stabilizing and improving turmeric production.

The results of the Cuddy-Della Valle instability index and decomposition analysis clearly show that area instability is more pronounced than production and productivity variability. Change in mean area remains a dominant factor in the average production trend, while interaction terms involving variances are central in explaining production instability. These findings underscore the importance of targeted strategies to reduce area fluctuation and enhance resilience in turmeric cultivation across Karnataka.

**Conclusion**

The analysis reveals that turmeric cultivation in Karnataka experienced strong growth in Period I, with area and production growing at 12.22 per cent and 13.54 per cent per annum, respectively, though this pace declined in Period II (3.32% and 5.47%). The Cuddy-Della Valle Index shows higher instability in area (35.27) and production (38.81) during Period I compared to Period II (16.81 and 17.95). Hazell's decomposition analysis indicates that the major component of decline in average production was due to change in mean area (-236398 or 89.87%), while mean yield contributed only 2.70 per cent. The interaction between mean yield and area had a small negative effect (-0.44%), while price–yield covariance accounted for 7.87 per cent, highlighting the effect of market volatility.

**References**


Anon, 2024, Agricultural statistics at a glance, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers welfare, Government of India.

Anon, 2023, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Government of India.

APEDA 2023, Agricultural and Processed Food Products Export Development Authority, Ministry of Commerce and Industry, GOI. Retrieved 15-03-2023 from https://apeda.gov.in

CuddyJ D A and Della Valle P A, 1978, Measuring the instability of time series data. Oxford bulletin of economics and statistics, 40(1):79-85.https://doi.org/10.1111/j.1468-0084.1978.mp40001006.x

HazellP B R, 1984, Sources of increased instability in Indian and US cereal production. *American Journal of Agricultural Economics*, 66(3): 302-311. https://doi.org/10.2307/1240797

Jainuddin S M, Suhasini K and Lavanya T, 2019, Determinants of growth and instability of groundnut production in Karnataka: Evidence from Hazell's Decomposition Model. *Economic Affairs*, 64(3): 649-661.

Kumar H H and Sreenivasmurthy, 2022, Application of Hazell decomposition model in potato production: A case study of Karnataka. *Mysore Journal of Agricultural Sciences*, 56(4): 1-15.

Pavithra K N, Gaddi G M and Pooja, 2021, Application of Hazell's decomposition model in ragi production: A case study of Karnataka. *Mysore Journal of Agricultural Sciences*, 55(4): 247-252.

Sajjan S S, Naik B K, Chowti S P, Kolageri N R and Israel K. S, 2018, Growth performance of area, production and productivity of turmeric in India: *An Economic Analysis,* 351-353