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# Application of Hazell Decomposition Model in Potato Production : A Case Study of Karnataka

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**Abstract**

Potato is one of the most important root vegetable grown across the world. Potatoes are also considered tubers which are rich in vitamins, nutrients, minerals and less quantity of calories. It is considered as one of the healthiest vegetables available for human beings. The current study is confined to potato crop grown in Karnataka. To examine the growth and instability in area, production and productivity of potato for a period of 30 years (1991-2020) data was used. Exponential growth rate, coppock's instability index and hazell's decomposition analyses were employed to analyze the data. During the study period, there exhibits decreasing growth in area (-0.79%), production (-0.97%) and productivity (-0.92%). The instability analysis revealed that area under potato cultivation was more instable than production and productivity. Hazell's decomposition analysis reported that increase in the mean average production was mainly due to change in the mean yield (115.75 %). Change in area variance (289.63 %) and change in co-variance area and yield (73.48%) contributed to the variability in the potato production.

*Keywords* : Instability index, Decomposition analysis, Growth rate, Productivity, Potato

Potato (*Solanum tuberosum*) is one of the most important root vegetable in the world, originated from Peru-Bolivia in the South Africa. It seems to have been brought to India by Portuguese in the early 17th Century. In the beginning, it was grown as a cool season crop in plain and hilly areas, later on it was spread across India at different agro climatic conditions. Potato is very rich in vitamins, nutrients and minerals and consists less quantity of calories. An average sized potato is composed of 80 per cent water and 20 per cent of solids. In India, potato is known by different names like, alu, bataka, bangaladumpa, urulaikilangu etc. In Karnataka it is known as *alugadde*.

Potato is climate sensitive crop mainly grown for its tubers; temperature of 24$^0$C is suitable for vegetative growth and 20$^0$C for tuber growth. Hence potato is cultivated as rabi crop in hilly region and as a *kharif* crop in the tropical and subtropical regions (Singh *et al.,* 2018). Potato is suitable to cultivate in various type of soils like, loamy soil, sandy loam, silt loam and clay soil with well fertility and drainage. Potato cultivation requires acidic soil with a pH range 4.8 to 5.4 (Sandu *et al.,* 2018).

India is one of the largest producer and consumer of potato in world after China. During 2020, India's potato area had occupied 22.03 lakh hectares. Uttar Pradesh (6.20 lakh ha), West Bengal (4.55 lakh ha) and Bihar (3.27 lakh ha) were the three states which occupied greater share in area. The total production of potato in India stands at 561.73 lakh metric tonnes. Uttar Pradesh is the largest potato producing state with production of about 158.11 lakh metric tonnes and contributes around 28 per cent to the total production. The other major producing states are West Bengal, Bihar, Gujarat and Madhya Pradesh. Also, West Bengal contributes about 26 per cent to the total production in the country. The average productivity

of potato in India was 25.50 Mt/ha and West Bengal possess the highest productivity of 33 Mt/ha. The area under potato cultivation in Karnataka has increased by 65.23 per cent from 1990 to till date. Currently, Karnataka produces 4.51 lakh metric tonnes of potato, on an area of 29,740 hectares with an average productivity of 15.90 tonnes per hectare. Chikkaballapura, Hassana, Kolara, Chikkamagaluru and Belgaum districts are the leading producers, which together contributes about 80 per cent to the state's output (Anonymous, 2021).

Keeping in view of the existing situation of potato cultivation in the country, an attempt was made here to emphasize on potato prospects for India as a whole and Karnataka state in terms of extent of instability in area along with instability in production and yield for over two decades and for the entire period. Concurrently, the components of change in the average production of potato as well as variance of production of potato are addressed in this paper.

## METHODOLOGY

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 1991 to 2020. Growth and instability of area, production and productivity of potato crop were computed for the period 1991-2020. Furthermore, for clear understanding of the growth and instability, the study period was bifurcated into two periods of 15 years each *i.e.,* Period I (1991-2005) and Period II (2006-2020).

### Tools Used for Analysis

### 1. Exponential Growth Model

For computing the growth in area, production and productivity of potato in Karnataka from 1991 to 2020 exponential growth model was used, which is described below.

$$Y = ab^t e \text{.....(1)}$$

Where,

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

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 :

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

The per cent compound growth rate was derived using the relationship

$$g = (\text{Anti ln of b-1}) \times 100$$

### 2. Coppock's Instability Index

Coppock's Instability Index (CII) is a close approximation of the average year-to-year percentage variation adjusted for trend (Kaur and Singhal, 1988).

$$\text{C.I.I} = [\text{Anti log } \sqrt{\log V} - 1] \times 100$$

$$\text{Log } V = \frac{[Log\ (Xt + 1/Xt) - m]2}{N - 1}$$

Where,

$X_t$ = Area/production/yield in the year 't'

M = Arithmetic mean of the difference between the logs of $X_{t+1}$, $X_t$ etc.

N = Number of years

Log V = Logarithmic variance of the series

Coppock's instability index is a close approximation of the average year to year percentage variation adjusted for trend. A higher numerical value of the index represents greater instability.

### 3. Hazell's Decomposition Analysis

The sources of growth and instability of potato production was calculated by Hazell's decomposition model (Hazell, 1984). The area and yield data of potato 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.

The Hazell's decomposition procedure produces the four components of change in average production and that shows the sources of growth of potato production (Table 1). Four components of change in average

production are change in mean yield, change in mean area, interaction between changes 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.

TABLE 1

Components of change in average production of potato

| Sources of change in average production | Symbol | Components of change |
|---|---|---|
| Change in mean yield | $\overline{\Delta Y}$ | $\overline{A1}\,\overline{\Delta Y}$ |
| Change in mean area | $\overline{\Delta A}$ | $\overline{Y_1}\,\overline{\Delta A}$ |
| Interaction between changes in mean yield and mean area | $\overline{\Delta Y}, \overline{\Delta A}$ | $\overline{\Delta Y}, \overline{\Delta A}$ |
| Change in area - yield covariance | $\Delta\, cov(AY)$ | $\Delta\, cov\,(A,Y)$ |

*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 potato production (Table 2). The components of change in production variance are divided into four categories.

TABLE 2

Components of change in variance of production of potato

| Sources of change | Symbol | Components of change |
|---|---|---|
| Change in mean yield | $\bar{\Delta}Y$ | $\bar{2}\,(A\bar{1}\ \Delta Y \operatorname{cov}(A1, Y1) + \bar{}\{2Y\bar{1}\ \Delta\bar{Y} - \Delta Y)^2\}\ V(A1)$ |
| Change in mean area | $\bar{\Delta}A$ | $\bar{2}Y1\ \bar{\Delta}A \operatorname{cov}(A1, Y1) + \bar{}\{2\,A\bar{1}\ \Delta\bar{A} - \bar{}(\Delta A)^2\}\ V(Y1)$ |
| Change in yield variance | $\Delta V(Y)$ | $(\bar{A_1}^2)\,\Delta V(Y)$ |
| Change in area variance | $\Delta V(A)$ | $(\bar{Y_1}^2)\,\Delta V(A)$ |
| Interaction between changes in mean yield and mean area | $\Delta\bar{A}, \Delta\bar{Y}$ | $\bar{2}\,\Delta\bar{Y}\ \Delta A \operatorname{cov}(Y_1 A_1,)$ |
| Change in area-yield covariance | $\Delta \operatorname{cov}(A,Y)$ | $\{\bar{2}A_1\,\bar{Y}_1 - 2 \operatorname{cov}(A_1 Y_1,)\}\ \Delta \operatorname{cov} - [\Delta \operatorname{CoV}(A,Y)]^2$ |
| Interaction between changes in mean area and yield variance | $\Delta A, \bar{\Delta} V(Y)$ | $[\bar{2}A_1\,[2A1\ \bar{\Delta}A + (\Delta A)^2]\ \Delta V(Y)$ |
| Interaction between changes in yields and area variance | $\Delta Y, \bar{\Delta} V(A)$ | $[\bar{2}Y_1\ \Delta\bar{Y} + (\bar{\Delta Y})^2]\ \Delta V(A)$ |
| Interaction between changes in mean area and yield and changes in area-yield covariance | $\bar{\Delta}A, \bar{\Delta}Y$ $\Delta \operatorname{cov}(AY)$ | $(\bar{2}Y_1\ \Delta\bar{A} + 2A_1\ \Delta\bar{Y} + \bar{2}\ \Delta\bar{A}\ \Delta Y)\ \Delta \operatorname{cov}(A, Y)$ |
| Change in residual | $\Delta R$ | $\Delta v(A,Y)$ - Sum of the other components |

*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

### Growth in Area, Production and Productivity of Potato in Karnataka

Compound growth rates were calculated for the area, production and productivity of potato in Karnataka for period I (1991-2005), period II (2006-2020) and whole period (1991-2020). Table 3 depicts the results of CAGR, it shows that during period I, the growth in area under potato rose to 7 per cent per annum and productivity decreased to 6.19 per cent per annum and was significant at 5 per cent. In period II, growth rate in area under potato production was -8.61 per cent per annum and potato productivity was 5.44 per cent per annum. Area, production and productivity of potato for the whole period (1991-2020) registered negative growth but were non-significant. Das *et al.* (2021) also found the similar results while studying the growth performance of Indian tea.

Table 3

Compounded growth rate of area, production and productivity of potato in Karnataka

| Particulars | Area | Production | Productivity |
|---|---|---|---|
| Period I (1991-2005) | 7.00 ** (0.00006) | -0.67 | -6.19 ** (0.010) |
| Period II (2006-2020) | -8.61 ** (0.00008) | -1.09 | 5.44 ** (0.007) |
| Whole period (1991-2020) | -0.79 | -0.97 | -0.92 |

*Note* : Figures in the parenthesis indicate'b'values,
** indicates significance at 5 per cent level

### Instability in Area, Production and Productivity of Potato in Karnataka

Instability of area, production and productivity was estimated with the help of Coppock's instability index and is presented in Table 4. The instability in area was recorded higher during period II (83.48) than period I and the whole period. Production and productivity in period I reported greater instability than period II and the whole period. During whole period (1991-2020), production and productivity reported lower instability of 48.47 and 55.95, respectively. For the whole period, instability was higher in area than production and productivity. Instability in area and production in period II (2006-2020) was more compared to period I (1991-2005). Instability in yield is higher than area in period I contributing more to production instability. Instability in area was mainly as a consequence of crop diversification, whereas, disease outbreak and climate change influenced more on instability in production and productivity. Byaligoudra *et al.* (2019) reported similar results.

Table 4

Coppock's instability index of area, production and productivity of potato in Karnataka

| Particulars | Area | Production | Productivity |
|---|---|---|---|
| Period I (1991-2005) | 58.91 | 57.26 | 65.40 |
| Period II (2006-2020) | 83.48 | 55.97 | 61.68 |
| Whole period (1991-2020) | 65.75 | 48.47 | 55.95 |

### Components of Change in Average Potato Production in Karnataka

Hazell's decomposition analysis was used to study the components of change in mean area, yield and production between the two periods *i.e.,* period I (1991-2005) and period II (2006-2020) for potato in Karnataka. The results of the analysis are presented in Table 5. The analysis shows that major component of variation in average production of potato in Karnataka was due to change in the mean yield (115.75 per cent), followed by interaction between change in mean yield and change in mean area (1.68). Change in mean area (-10.40) and change in area-yield co-

TABLE 5
Components of change in production of potato

| Description | Percentage |
|---|---|
| Change in mean area | -10.40 |
| Change in mean yield | 115.75 |
| Interaction between change in mean yields and change in mean area | 1.68 |
| change in area- yields co-variance | -7.03 |
| Total | 100 |

variance (-7.03) had a negligible impact on mean production. Pavithra *et al.* (2021) reported similar results in their study on application of Hazell's decomposition model in ragi production.

**Components of Change in Production Variability**

Table 6 shows the components of change in production variability; greater contribution was by change in area variance, which was about 289.63 per cent followed by change in co-variance area and yields which accounts about 73.48 per cent. The major decrease in the variance of production was due to change in mean yield (-52.43 %), interaction between change in mean yield and area variance (-86.07 %) and change in yield variance (-114.43 %).The results obtained in respect of components of change in production variability are in line with the results reported by Nayak *et al.* (2021).

TABLE 6
Components of change in production variability of Potato

| Description | Percentage |
|---|---|
| Change in mean yield | -52.43 |
| Change in mean area | 1.84 |
| Change in yield variance | -114.43 |
| Change in area variance | 289.63 |
| Interaction between change in mean yields and change inmean area | 1.47 |
| Change in co-variance area and yields | 73.48 |
| Interaction between change in mean area and yield variance | -3.35 |
| Interaction between change in mean yield and area variance | -86.07 |
| Interaction between change in mean area and yield and change in area-yield covariance | -10.11 |
| Change in residual | -0.02 |
| Total | 100 |

Growth rate of area, production and productivity of potato during the study exhibits declining trend, whereas in period I growth of area under potato production increases significantly and productivity in period II rose significantly. Instability is the decision parameter in development dynamics, instability in area, production and productivity of potato. In Karnataka, area under potato is highly instable than production and productivity. The results of the decomposition change in average potato production in Karnataka revealed that change in the average potato production was influenced more owing to change in mean yield. Among the 10 components of change in the variance in the potato production, the change in the area variance is the major reason for instability in potato production in Karnataka. The study findings recommends the need for research efforts to concentrate on high yield varieties, production techniques, improved varieties of potato which will have important role in improving the potato production.

The results of instability index and decomposition analysis revealed that area under potato is highly instable than production and productivity of potato in Karnataka. Change in mean yield of potato is predominantly influencing the change in average potato production and that change in area variance is the prime reason for instability in potato production and change in yield variance is primarily stabilizing the stability of potato production in Karnataka.

**Policy Recommendations**

- Promote yield increasing technology like HYV, expansion area under irrigation
- Large scale promotion of stabilization measures like crop insurance which can enhance the per unit production as well as stabilize the area and yield of potato and

- The Government agencies like SAU, KSNDMC, Extension units, etc., have to provide timely and accurate climate related information to the farmers

## REFERENCES

ANONYMOUS, 2021, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Government of India.

BYALIGOUDRA, A. L., APARNA, B., VANI, N. AND NAIDU, M. G., 2019.Growth and instability of major millets in Andra Pradesh, India. *International Journal of Current Microbiology and Applied Sciences,* **8** (7) : 985 - 993.

DAS, A., RAJU, R., SIDDAYYA AND SENDHIL, R., 2021, Export of tea from India in the post WTO era : Performance and determinants. *Indian Journal of Economics and Development,* **17** (3) : 519 - 526.

HAZELL, P. B. R., 1984, Sources of increased instability in Indian and US cereal production. *American Journal of Agricultural Economics,* **66** (3) : 302 - 311.

KAUR, N. AND SINGHAL, M., 1988, India's export instability. *Margin,* **21**: 54 - 61.

NAYAK, A., LOKESHA, H., GRACY, C. P. AND GEETHA, 2021, Instability and decomposition analysis of sesamum crop production in Karnataka and India. *International Journal of Agriculture, Environment and Biotechnology,* **14** (3) : 349 - 355.

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.

SANDHU, S. K., KINGRA, P. K. AND KAUR, S., 2018, Effect of climate change on productivity and disease scenario of potato. *Journal of Agricultural Physics,* **18** (2) : 141 - 157.

SINGH, D. K., PANDEY. N. K., KHARMNUID, P. AND RANA, R. K., 2018, Adoption pattern and economic impact of potato variety kufrikhyati in Uttar Pradesh. *Journal of Agrisearch,* **5** (3) : 211 - 214.