Growth performance of Groundnut in India-An Instability and Decomposition analysis

Abstract

Measuring the trends of growth and variability in agricultural production is important to understand how outputs change over time. The present study analyzed the growth and instability index of groundnuts. The study depends on secondary data, which was collected from the Ministry of Agriculture and Farmers Welfare[1]for the period 1950-2022. The entire study period is divided into three sub-periods: 1950-51 to 1969-1970, 1971-1972 to 1999-2000 and 2000-2001 to 2021-2022. The compound annual growth rate, instability Index and decomposition analysis were used for the analysis.The compound annual growth rates for production, area, and yield are -0.14 percent, 1.05 percent, and 1.2 percent, respectively, groundnut production and yield are increasing and the area in India has changed throughout time. The decomposition of groundnut production in area, yield, and interaction effect showed that the yield effect was responsible for increasing the production of groundnut in India followed by the interaction effect and area effect. The results revealed that the level of instability was high in yield while it was lowest in area.The findings showed thatthe annual growth rate of productivity of groundnuts also shows an increasing trend during the recent period due to the availability of high-yielding cultivars and the deployment of innovative cultivation technologies. From the result, it is concluded that including the non-traditional areasincreases the area under cultivation to sustain and improve groundnut production.

Key words:Groundnut production, Decomposition, Environmental damage, Cultivation

1.Introduction

Oilseed production occupies an important position in the Indian agriculture economy, next to cereals[2]. Recently, oilseeds have attracted more attention due to the increasing demand for healthy vegetable oils, livestock feeds, medicines and biofuels[3]. India is the fourth largest oilseed producer in the world, next to the USA, China, and Brazil, contributing 10% of the world's oilseed production, 6-7% of the global production of vegetable oil, and nearly 7% of protein meal[4]. India is fortunate to have a variety of oilseeds grown in its distinctive rich agro-climatic zones[13]. It has ideal conditions to grow a variety of oilseeds throughout the year. This sector has an important place in the Indian agricultural sector covering an area of

about 27.1 million hectares, with a total production of over 33 million tonnes in the year 2019-20 [2]. Among the nine oilseed crops grown in the country, seven are edible oils (groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger seed) and two are non-edible oils (castor seed and linseed)[5]. The data on area, production and productivity of oilseed crops in India shows that of the nine oilseed crops, three crops viz.; groundnut, rapeseed-mustard and soybean contribute 86.42 percent in area and 90.95 percent in the production of total oilseed. The non-edible oilseeds constitute only 4.67 percent of the total area and 5.53 percent of the total production of all oilseeds, implying the role played by the edible oilseed cultivation of India[6].

Among the oilseed crops, Groundnut is one of the most important food and cash crops of India[14]. Groundnut is called as king of oilseed crops as well as poor man's cashew nut[7]. It plays an important role in reducing India's oil deficit. Groundnut is particularly valued for its protein content of 26 percent protein. Groundnut covers 327 lakh hectares worldwide with a production of 539 lakh tonnes with a productivity of 1648 kg per hectare [8]. India ranks first in Groundnut area under cultivation and is the second largest producer in the world with 101 lakh tonnes with productivity of 1863 kg per hectare in 2022-23. In Kharif 2022-23, groundnut production was 83.69 lakh tonnes in an area of 45.53 lakh hectares [1].Groundnut is mainly grown in the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Rajasthan. India is the second largest exporter of groundnut in the world followed by Argentina with 16.34 percent of the world groundnut exports with 0.63 million tonnes worth Rs 53810 million during the year 2020-21. It is exporting groundnut to over 132 countries throughout the world. Indonesia, Vietnam, Malaysia, Philippines are the major importers of groundnut from India.The crop can be grown successfully in areas with a minimum of 500 mm of rainfall and a maximum of 1250 mm of rainfall. Groundnut is primarily grown as a rain-fed Kharif crop, nearly 80% of production comes from Kharif crop[9].

Sharma et al. (2014) [10] studied Growth and Instability in Area, Production and Productivity of Groundnut in Rajasthan: A District Level Analysis. The study period examined the years 1980–1981 to 2010–2011. In Rajasthan, a district-wise analysis of the groundnut crop's growth rate and instability showed that the compound annual growth rate in terms of area and production was highest between 2001 and 2010, while the rate in terms of productivity was highest between 1981 and 1990. The changes in area had a greater impact on changes in production as Compared to changes in yield.

Chandra Mohan Misra (2017) [11] studied "Trends in Area, Production, and Productivity of Groundnut in India: Issues and Challenges "According to the data, India is one of the top three groundnut producers in the world. The three main producing states in the country are Gujarat, Madhya Pradesh, and Tamil Nadu. The analysis revealed that there has been a consistent fluctuation in the area and production over the years and across the states.

Satyam Raj*et.al*., (2023) [12] investigated the Dynamics of production and trends of groundnut and soybean in India and over the period from 2000-2001 to 2019-2020. The results of CAGR analysis showed -1.91%, 0.30%, 1.49% and 4.54%, 4.95% and 0.39% growth in area, production and yield of Groundnut and Soybean respectively. Instability analysis showed more instability (58.68%) in the yield of groundnut over the last three decades. To identify the factors for low production of Groundnut and Soybean, multiple regression analysis was utilized. For groundnut among all the factors, Area, Yield, and Export were found statistically significant at 5% level whereas import and MSP were found to be insignificant and for soybean, Area and Yield were found statistically significant at 5% level of significance whereas Export, import and MSP were found to be insignificant.

Hence, the present study is attempted with the following specific objectives;

1. To analyse the growth of area, production and productivity of Groundnut in India.
2. To estimate the contribution of area and yield towards change in the production of groundnut in India.
3. To study the instability of area, production, and productivity of Groundnut in India

2.Methodology

The area, production and productivity of groundnut (*Arachis hypogea*) for the period of 1951-2022 have been collected from Annual report 2021-22 by the Ministry of Agriculture and Farmers Welfare, Government of India[1].

2.1 Compound Annual Growth Rate

The growth rate was calculated for the area, production, and productivity of groundnuts in India in the present study. The compound Growth Rate was used (Exponential model).

$Y = a^{bt}$

Where,

Y - Dependent variable for which growth rate is estimated,

a - Intercept, b - Regression coefficient, t - Time variable

The logarithmic form of the above equation estimated the compound growth rate

$\log Y = \log a + t \log b$

The compound growth rate (g) was estimated by using

g = [Anti log of (b) – 1] * 100

2.2 Decomposition analysis

Decomposition is a technique to discern the effect of technology environmental damage or any other impact on production. The following decomposition model was used for the estimation of the contribution of area and yield towards change in production (positive/negative) and is expressed as:

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

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

Area Effect: Average percentage of total production in terms of area.

$$AE = \frac{(A_n - A_0)Y_0}{P_n - P_0} \times 100$$

Yield Effect: Average yield as a percentage of total production.

$$YE = \frac{(Y_n - Y_0)A_0}{P_n - P_0} \times 100$$

Interaction Effect:

$$IE = \frac{(A_n - A_0)(Y_n - Y_0)}{P_n - P_0} \times 100$$

Where,

A_0= Triennium average of area in base year

A_n= Triennium average of area in current year

P_0= Triennium average of production in base year

P_n=Triennium average of production in current year

$Y_0 = P_0/A_0$

$Y_n = P_n/A_n$

2.3. Measure of Instability

Agricultural instability can be measured by different methods, such as the coefficient of variation (CV), dispersion, Cuddy Della Valle Index (CDVI), Coppock Instability index, etc.

a) Cuddy-Della Valle index

The cuddy-Della index is very easy to obtain and the most commonly used measure for instability in time series data.Hence, it is a better measure to capture instability in agricultural production. A low value of this index indicates low instability in data and a high value of this index indicates high instability in data. CDVI was developed by Cuddy and Valle (1978) for measuring the instability in time series data that is characterized by trends. The value of Cuddy-Della Valle index is indicated as low instability if the value is between 0-15 %, medium instability if the value is between 15-30 % and high instability if the value is more than 30 % .

The instability index IX isgiven by the expression: IX $=C.V \times \sqrt{(1-\bar{R}^{2})}$

Where, CV = coefficient of variation (in percent),

R^2 = coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

b) Coppock Index:

Instability was also analyzed using Coppock's Index which is calculated as the antilog of the square root of the logarithmic variance using the following formula

Coppock Index = (Antilog) $\sqrt{vlog-1}$ *100,

$$V\log = \frac{1}{(N-1)}\sum(logp_{t+1} - log_t - M)^{2}$$

$$M = \frac{1}{(N+1)}\sum(logp_{t+1} - log_t)$$

Coppock's Instability index is a close approximation of the average year-to-year percentage variation adjusted for trend and the advantage is that measures the instability in relation to the trend in the area. A higher numerical value for the index represents greater instability.

3. RESULTS AND DISCUSSION

3.1 Area, Production and Productivity of Groundnut

The decadal average of area, production and productivity of groundnut from 1950-2020 were shown inFig. 1.Groundnut was cultivated in 5.37 million ha during the period 1950-60 and the area was decreased to 5.05 million ha during 2011-2020. The productivity of groundnut steadily increased from 741.7 kg/ha to 1528.6 kg/ha from 1950 to 2020 respectively.

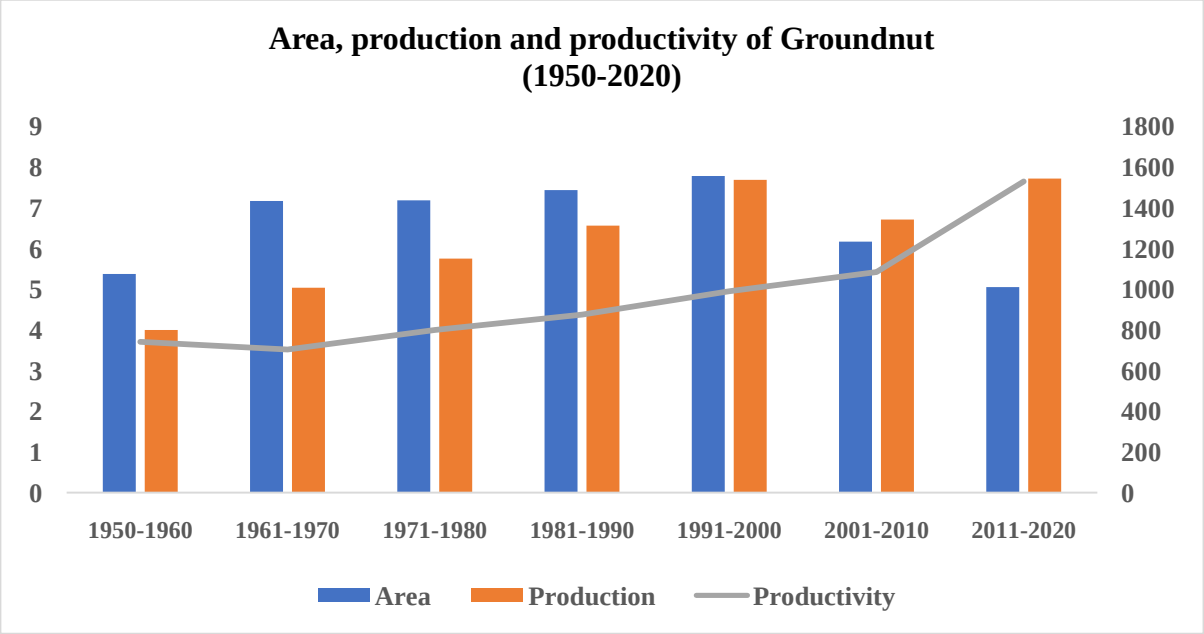

Fig.1.TREND ANALYSIS OF AREA, PRODUCTION AND PRODUCTIVITY OF GROUNDNUT (1950-2020)

3.2 Compound Annual Growth Rate (CAGR) of Groundnut

The time series data on area, production and productivity of groundnuts in Indiawere analyzed and presented in Table1.

Table1.CAGR of area, production and productivity of groundnuts in India

Crop	Period I 1950-51to1969-	Period II 1971-72 to	Period III 2000-01 to	Overall 1950-51 to2021-

	70	1999-00	2021-22	22
Area	2.91	0.31	-1.23	-0.14
Production	2.48	1.41	1.96	1.05
Productivity	-0.41	1.09	3.23	1.2

The period-wise compound growth rates of area, production and productivity were worked out and presented in Table1. The data presented in Table 1 revealed that during the period I area, productionshowed a positive growth rate (2.91 per cent, 2.48 per centrespectively.) and productivity showed a negative growth rate(-0.41 per cent) while during the period II area, production and productivity showed positive growth rate (0.31 per cent, 1.41 per cent and 1.09 per cent respectively.) and in period III and overall period, growth rates of area were negative (-1.23 per cent and -0.14 per cent) with production (1.96 per cent and 3.23 per cent) and productivity (1.05 per cent and 1.2 per cent) being positive for both the periods. The negative growth in area might be due to decrease in groundnut area under cultivation..

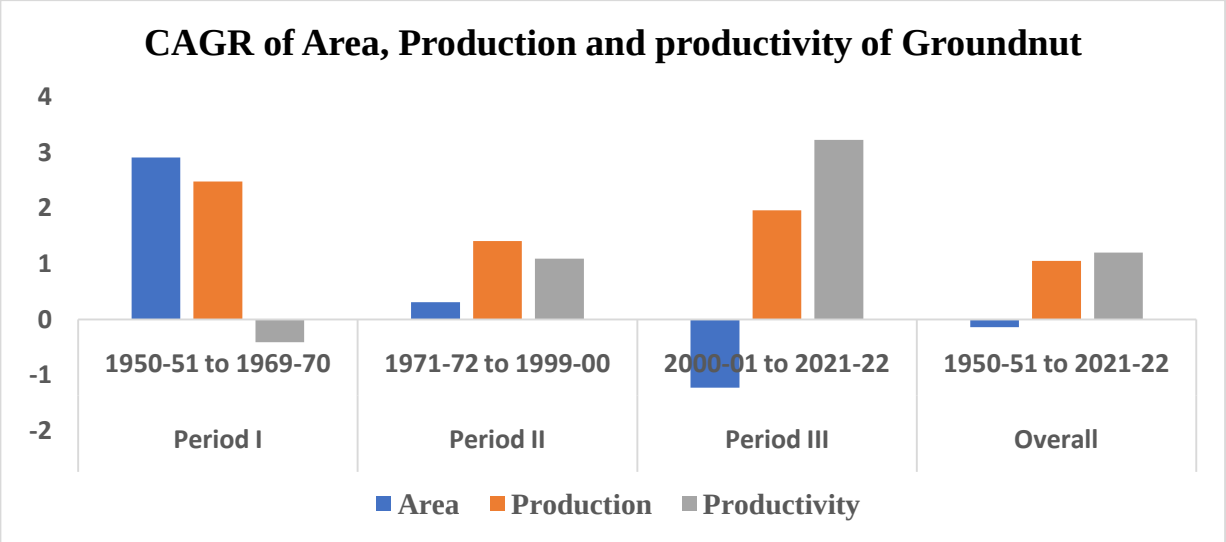

Fig.2. CAGR of area, production and productivity of groundnuts in India

3.3. Decomposition analysis of groundnut

The total change in the production of groundnut was decomposed into three effects (i.e) area effect, yield effect and interaction effect during the period 1950-2022. The results are presented in Table 2.

Table 2. Decomposition analysis of groundnut

(in percentage)

Particulars	**Period I 1950-51 to1969-70**	**Period II 1971-72 to 1999-00**	**Period III 2000-01 to 2021-22**	**Overall (1950-2022)**
Area effect	86.71	-6.75	-15.8	7.76
Yield effect	8.67	109.1	130.82	79
Interaction effect	4.61	-2.35	-15.01	13.23

Decomposition analysis in groundnut productionof area, yield and their interaction for changing production of groundnut for three periods and overall period was estimated and presented in Table3. It is evident from Table3 that during the period I Area effect(86.71 percent) was the most responsible factor for changing productionwhereas the yield effect was 8.67 per cent and the interaction effect was 4.61percent while during period II yield effect was the most responsible factor for changing production in India i.e. 130.82 percent whereas but area effect and interaction effect were found to be negative i.e. -6.75 and -2.35 per cent respectively. Similar results were seen during period III with a yield effect of 130.82 per cent as the most responsible factor but the area effect and interaction effect were found to be negative i.e. -15.8 and -15.01 per cent respectively. Inthe case of the overall period,Yieldeffect was seen as the most responsible factor for changing the production in India i.e. 503.97 per cent with the Interactioneffect being 13.23 per cent andarea effect 7.76 per cent. For the overall period in India, the Yield effect (79 per cent) contributed the highest to production compared to the area and interaction effect(7.76 per cent and 13.23 per cent) in groundnut under study.

3.4 **. Measure of instability in area, production and productivity of groundnut in India**

Instability analysis on the area, production and productivity ofgroundnut for a period of 1950-2022 was carried out. Instability measures such as coefficient of variation. Cuddy-della Valle index and Coppock index were determined and presented in Table 3.

The fluctuation in agriculture is measured with the help of a simple coefficient of variation (CV) but often contains the trend component and thus over times the level of instability in time series data characterized by long-termtrends. To overcome this problem, this study used Cuddy-Della and Coppock's instability Index which corrects the coefficient of variation.

Table 3. Measure of instability in area, production and productivity of groundnut in India

S.No	Particulars	Instability Indices	Period I 1950-51 to1969-70	Period II 1971-72 to 1999-00	Period III 2000-01 to 2021-22	Overall (1950-2022)
1	Area	CV	17.5	7.55	11.96	16.811
		CDVI	6.91	7.1	9.08	16.68
		CI	53.08	48.6	50.45	52.69
2	Production	CV	18.21	20.41	23.76	28.57
		CDVI	12.5	16.42	20.65	19.45
		CI	53.33	53.87	55.95	57.69
3	Productivity	CV	10.37	15.98	26.27	33.79
		CDVI	10.38	12.89	17.16	20.41
		CI	49.96	52.02	56.84	58.03

Period-wise coefficient of variation, Cuddy Della Valle Instability Index and Coppock index of area, production and productivity of groundnut in India was estimated and presented in Table 3. It is seen from Table 3 that, CDVI of the area was lowest (6.91 per cent ,7.1 per cent,9.08 per cent and 16.68 per cent respectively) than production (12.5 per cent, 16.42 per cent,20.65 per cent and 19.45 per cent respectively) and productivity (10.38 per cent, 12.89 per cent,17.16 per cent and 20.41 per cent respectively) during the period I, period II,period III and overall period respectively.Coppock Index was found to be more in productivity(58.03 per cent) in India whereas followed by area(52.69 per cent) and production(57.69 per cent).

4. Conclusion

The present study has analysed the growth of area, production and productivity of Groundnut in India for the period of 72 years from 1950 to 2022 and its contribution of area and yield towards change in the production of groundnut in India. Decomposition analysis also used to study the effect of technology on environmental damage or any other impact on production. The instability of groundnut area, production and productivity measured by Cuddy Della Valle Index (CDVI), Coppock Instability index. The results of the study

indicated that the compound growth rate of area under crop was negative whereas it shows a positive trend in production and productivity.The negative growth in the area might be due to a decrease in groundnut area under cultivation. Yield effect (79 per cent) was seen to be responsible for change in the production of groundnuts in India compared to an area(7.76 per cent) and interaction effect(13.23 per cent) therefore, it is necessary to provide high-yielding varieties to the farmers.The level of instability was higher in yield while it was lowest in Area. Policies and programmes should concentrate on increasing the area under cultivation to include non-traditional areas to increase groundnut production.

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