P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 7; July 2024; Page No. 435-441

Received: 05-05-2024
Accepted: 09-06-2024

Indexed Journal
Peer Reviewed Journal

An empirical investigation of growth and instability in groundnut crop: A three stage spatio-temporal analysis

[1] P Archana, [2] R Vijayakumari, [3] MD. Ali baba, [4] P Radhika and [5] D Srinivasa Chary

[1] Ph.D., Scholar, Department of Agriculture Economics, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

[2] Deputy Director of Research, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

[3] Scientist, OFR Centre, AICRP, IFS, Hyderabad, Telangana, India

[4] Professor & Head, School of Agri Business Management, PJTSAU, Hyderabad, Telangana, India

[5] Associate Professor, Dept of Statistics and Mathematics, PJTSAU, Hyderabad, Telangana, India

DOI: https://doi.org/10.33545/26180723.2024.v7.i7f.834

Corresponding Author: P Archana

Abstract

Groundnut-The king of oilseeds, a principal economic crop has its spread across the world for growing under different agroclimatic-locations. The crops' widespread cultivation and its competitive market presence at the globe level, is for its multifarious utility. Realising the peanut's overall predominance among oilseeds, it is vital to capture the fluctuations of the output, its sources of growth and variance to understand the groundnut growth scenario. Thus, this paper employs Compound Annual Growth Rates, Cuddy Della Valle Index and Hazell's decomposition method in III-stages (World, India and Telangana) for 3-decades (1992-2022). The world peanut had shown positive growth rates and low instabilities. The African countries (Nigeria, Sudan) exhibited (Area > yield) growth thus, they must emphasize on productivity improvement. But, countries like India, Indonesia witnessed decline in area growth. India, the major peanut cultivator is losing its acreage, but production growth is substantiated by increased productivity. The declining area growth rates in the country were obvious through its low acreage growth in major states whose yield instabilities were higher than in area (except Tamil Nadu and Rajasthan). This is due to predominant *Kharif* Groundnut cultivation that hinders productivity. Although Telangana's groundnut (*Rabi* crop) is improving its yield growth rate next to Gujarat, but was not among major states for its low acreage under cultivation. Changes in mean yield and yield variance were responsible for production growth and production variance of groundnut, in the state and the country. Hence, it is imperative to focus on increasing acreage and decreasing yield instabilities via crop specific policy implications for India and Telangana.

Keywords: Groundnut, CAGR, instability and decomposition analysis

Introduction

Groundnut, *Arachis hypogaea* also known as monkey nut, peanut and earth nut was found across Asian, American and African continents with its cultivation in 120 countries under different agro-climatic regions. The crop is native to South America and was later disseminated to different countries (Singh, 2011) [14]. The commercial cultivation is adopted in India, China, USA, Senegal, Indonesia, Nigeria, Sudan, Brazil and Argentina. The world's groundnut production totalled 50.5 million tonnes during 2021 with China, India, Nigeria, USA and Sudan occupying a share of 36, 13, 9, 6 and 5 percent share respectively. (USDA, 2021). India, the world's largest groundnut cultivator (6.1 million hectares) is producing 9.952 million tonnes. But the productivity was not very great (1631.5 kg/ha) and is lower than that of China and USA. (FAOSTAT, 2021).

Groundnut is cultivated for its exceptional economic, nutritional and agroecological characteristics. It has higher nutritive value with 26% vegetable protein more than meat on a equal weight basis and 40% fat (twice than Soyabean). It contains 40 to 49% of oil with high calorific value. Biswas and Bhattacharjee, (2019). Apart from the nutritional aspects, it is drought tolerant, soil erosion resistant, nitrogen fixer and good fodder crop for its haulm and oilcake fed for cattle. Hence, it is considered as an important oilseed crop.

Groundnut being one of the significant oilseed crops in the country, nearly 28.3% share of oilseeds is from groundnut with a production of 102.09 lakh tonnes during 2021. Among the nine oilseeds, it is the third largest in terms of area and production after Soybean, Rapeseed & Mustard. In terms of productivity, groundnut is second in rank with a yield of 1703 kgs/ ha and 88 percent of oil comes from three major oilseeds with highest percent share from Groundnut (37%). As there is a dearth of oilseeds production in the country and in turn the net oil availability from domestic production, on these lines emphasising groundnut cultivation is needed.

Groundnut is cultivated in India spatially across different states including Gujarat, Rajasthan, Madhya Pradesh,

Maharashtra, Andhra Pradesh, Telangana, Karnataka and Tamilnadu majorly. Among the States, Gujarat is the major contributor in terms of area and production with a larger share of 35.5 and 40.42 percent respectively.

According to the quinquennial averages (2017–2022), Gujarat, Rajasthan and Tamil Nadu are the highest producing states of groundnut. However, Telangana is second to Tamil Nadu in terms of groundnut average productivity. Although Telangana, occupies a meagre share in terms of area and production. Its productivity is 2.29 tonnes/ha, higher than the major producing states like Gujarat, Andhra Pradesh, Rajasthan and Karnataka. Although *Kharif* Groundnut is grown in the other main states, 90 percent of the groundnut grown in Telangana is *Rabi* groundnut. So, under this context, it is imperative to examine historical growth rates in area, production and yield, their instabilities and sources of growth of the groundnut crop at global, national and state level.

Materials and Methods

This study was essentially carried out spatio-temporally (III-stages, 3-decades) with three different analyses to evaluate the growth performance of groundnut crop. The III-stages include major-countries (world), major-states (India) and erstwhile districts (Telangana). For lucidity, the study period of 30 years (1992-93 to 2021-2022) was classified into three periods, Period -I (1992-93 to 2001-02); Period -II (2002-03 to 2011-12) and Period-III (2012-13 to 2021-22).

The secondary data regarding area, production and yield at the global level was obtained from FAOSTAT. The country level data was compiled from Directorate of Economics and Statistics; GoI, Agricultural Statistics at a glance. The data for districts up to 2017 was obtained from ICRISAT-DLD data (unapportioned data base - current district boundaries, 2015-16). Telangana Statistical Abstract -2022, 2021; 2020 were referred for recent years' data. As Andhra Pradesh and Telangana were bifurcated, the time series data of all the years was separated according to current geographic boundaries of the states to get a precise analysis.

Firstly, the compound annual growth rates in area, production and yield of groundnut were calculated by fitting the exponential growth function form (Angles, 2001) as given below:

$$Y^t = A\ B^t\ U^t$$

Where; Y^t is area, production, yield in year "t";

A=intercept; B=regression coefficient; t=time in years and U_t=error term in year "t" Now, Equation (i) is converted into log form and CAGR is calculated by the formula; G = {(Antilog of B)–1} ×} ×100; and was tested for its significance by t-test. Secondly, the magnitude of instabilities were measured using Cuddy- Della Valle index given as $I_x = CV\sqrt{1 - R^2}$ Where, I_x = Instability index, CV= Co-efficient of variation, R^2= Coefficient of multiple determination obtained from the time series. Finally, efforts were added to decompose the components of production growth and variance using Hazell's decomposition model.

Results and Discussion

Growth performance of the World and its major countries: The growth rates were analysed for the whole world and its major countries. The persual of CAGR figures in Table 1 uncloaks that the growth rates in area, production and yield observed a dip in Period -II. Later, area and production took an inclination in Period -III with a pronounced increase in area growth (2.36%). The deceleration from Period -I to Period II can be ascertained from the findings by Birthal *et al*, (2010) [3] who found that the consecutive droughts during the period found effected groundnut cultivation in major groundnut producing states increased competition from crops like Bt-cotton, soyabean and maize. The overall period witnessed a positive growth in production with area growth higher than yield.

In Period-I, Sudan and Nigeria had highest growth rates in production favoured by increased area growth. The China's increase in growth rate of groundnut production was due to increased area growth rate and yield growth rate. This increased rate in yield was highest among the major countries and also highest of the three decades considered for China. This increasing trends in the period was due to the combined efforts of adoption of improved agronomical practices, improved varieties and encouraging government policies collectively supported higher groundnut production as ascertained by Yao, (2004) [16] in his findings. The area and production had shown negative growth rates for India and USA during the period.

The Period-II witnessed non-significant yield (except Indonesia, USA) and production rates. Nigeria is the only country remained with positive area growth (4.75%) but negative yield rate (-2.88%). These are in line with results of Verter, (2017) [15], who reported by 2008, the country took a back seat and was out of the global peanut market, which is visible through declined growth rates from Period-I to II.

In Period-III, the Sudan and Nigeria stood up again with highest growth rate in production which is contributed more by area than by yield growth. These results were in tune with Ndjeunga *et al*., (2010) [10] for Nigeria. Senegal's ascent in yield growth rate (7.49%) in the period can be attributed to the market liberalisation of groundnut sector in 2010 as ascertained by Ndiaye *et al*, (2018) [9].

In overall period, all countries exhibited positive growth rates in area (except India, Indonesia and USA). The increase in yield growth was observed prominent for Sudan, India and USA. The yield improvements due to technology transfers of TMO (India) and large-scale cultivation (USA) were responsible for the yield growth rates of the respective countries as reported by Singh, (2011) [14]. Sudan and Nigeria have higher area and production rates. Verter, (2016) findings support high peanut production in Nigeria.

Instability of groundnut in the world and its major countries

The instability measures of area, production and yield of groundnut crop in the world and its major countries are delved out from Table 1. The fluctuations in area, production and yield of world groundnut were of higher degree in Period-II, relative to other two periods. The world instability figures for the overall period (area-4.53%, yield-4.59%) were observed low. China and Indonesia expressed lower magnitude of instabilities in area, production and yield for all the periods and overall period. For India, the instability was observed in area and production in both

Period-II, III and overall period. These results vary little with Kalpana, (2017) [4] who reported high instability (area, production, yield) in Period-II (2000-2014) than in Period-I (1985-1999). For USA, overall instability was observed high for area and production. Nigeria exhibits overall instability in production and yield. The contrary results were obtained by Sadiq *et al.*, (2020) [12] who reported high instability in the production was due to high area instability for the period 1961-2017. Both Sudan and Senegal exhibited instabilities in all three variables for the whole period.

Components of change in growth and instability of groundnut (World)

The contribution of different components for changes in average production were presented in Table 2. Between Period-I to II, the increase in the mean yield (69.88%) accounted a larger share for the increase in groundnut production followed by increase in mean area (26.07%). The converse is the situation for the changes between next two periods where yield effect contributes more. It can be deduced that yield effect and area effect contributed more for the change in groundnut production for (Period-II over I) and (Period-III over II) respectively.

The components of changes for variance in production were depicted in Table 3. The Changes in yield variance (81.93%), area–yield Covariance (72.07%) contributes more for the groundnut production variance (Period-II over I). Changes in area variance (115.21%) was responsible for the production variance (Period-III over II). The negative sign of this statistics in table indicates stability, while a positive sign implies the instability for the crop production.

Table 1: CAGR and Cuddy Della instability of area, production and yield of groundnut in the major counties of the world

Country	Particulars	PERIOD-I (1992-2002)			PERIOD -II (2002-2012)			PERIOD –III (2012-2022)			OVERALL (1992-2022)		
		Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
China	CGAR	4.90^{3}	9.05^{3}	3.95^{3}	-1.97^{2}	0.35 ^{NS}	2.37^{NS}	0.01 ^{NS}	0.94^{3}	0.94^{3}	1.04^{3}	2.89^{3}	1.83^{3}
	Instability	5.44	9.17	5.70	6.61	6.07	5.91	1.86	2.59	1.22	9.85	11.67	5.36
India	CGAR	-2.75^{3}	-2.315^{NS}	0.45^{NS}	-0.64^{NS}	1.99^{NS}	2.65^{NS}	-0.06^{NS}	3.90^{NS}	3.97^{1}	-1.92^{3}	0.27^{NS}	2.23^{NS}
	Instability	2.51	0.13	12.93	5.86	22.12	19.49	8.60	19.80	16.57	7.27	20.40	18.64
USA	CGAR	-3.55^{3}	-2.51^{1}	1.07^{NS}	-1.45 ^{NS}	0.51 ^{NS}	1.99 **	2.99 ^{NS}	3.3^{NS}	0.3^{NS}	-0.47^{NS}	1.65^{3}	2.14^{3}
	Instability	6.03	10.56	7.97	11.43	14.15	6.07	14.19	16.81	5.86	14.48	17.98	7.57
Indonesia	CGAR	-0.01^{NS}	0.75^{NS}	0.85^{NS}	-0.8 ^{NS}	0.69^{NS}	1.55^{3}	-4.40^{3}	-3.64^{3}	0.83*	-1.87^{3}	-0.63^{2}	1.26^{3}
	Instability	6.36	6.82	7.11	5.52	5.42	0.85	11.07	10.48	3.95	11.93	13.23	4.80
Nigeria	CGAR	9.31^{3}	11.30^{3}	1.85 ^{NS}	4.75^{3}	1.74^{NS}	-2.88^{2}	6.36^{3}	6.26^{3}	-0.10 ^{NS}	3.59^{3}	3.71^{3}	0.12 ^{NS}
	Instability	17.33	10.21	17.98	3.50	11.78	9.56	4.35	10.71	9.35	14.61	16.36	17.15
Sudan	CGAR	18.64^{3}	17.4 ^{3}	-1.08 ^{NS}	-4.61^{1}	-3.49^{NS}	1.17^{NS}	7.42^{3}	10.65^{3}	5.53^{2}	5.06^{3}	5.73^{3}	3.01^{3}
	Instability	20.73	21.51	13.98	25.21	26.92	19.19	14.95	21.75	12.90	37.18	39.76	21.56
Senegal	CGAR	-2.10 ^{NS}	1.02 ^{NS}	3.19 ^{NS}	-1.22^{NS}	-0.07^{NS}	1.16^{NS}	2.35^{1}	10.03^{2}	7.50^{3}	1.01^{2}	2.24^{2}	1.22^{2}
	Instability	13.09	19.57	16.63	23.71	43.33	26.31	13.07	29.05	18.53	19.73	40.19	25.12
World	CGAR	1.45^{3}	4.20^{3}	2.71^{3}	0.96^{1}	1.79^{2}	0.81^{1}	2.36^{3}	2.53^{3}	0.16 ^{NS}	1.26 ^{3}	2.48 ^{3}	1.20^{3}
	Instability	1.24	6.73	3.34	3.77	9.65	6.83	2.66	3.35	2.02	4.53	5.30	4.59

Note: 3, 2, 1 and NS indicates significant at < 1, 5,10 percent level of significance and non-significant respectively.

Table 2: Components of change in the average production of groundnut in World

S. No.	Sources of Change	Symbol	I Period-II Period	II Period - III Period
1	Change in mean yield	$\Delta \bar{Y}$	-34.26	11.54
2	Change in mean area	$\Delta \bar{A}$	-24.84	23.78
3	Change in yield variance	$\Delta V (Y)$	81.93	-26.10
4	Change in area variance	$\Delta V (A)$	-17.66	115.21
5	Interaction between changes in mean yield and mean area	$\Delta\bar{A}\ \Delta\bar{Y}$	-1.43	0.54
6	Change in area–yield Covariance	$\Delta cov (A\ Y)$	72.07	-19.10
7	Interaction between changes in mean area and yield variance	$\Delta\bar{A}\ \Delta V(Y)$	11.82	-10.98
8	Interaction between changes in yields and area variance	$\Delta\bar{Y}\ \Delta V(A)$	-7.22	15.87
9	Interaction between changes in mean area and yield and changes in area–yield covariance	$\Delta\bar{A}\ \Delta\bar{Y}\ \Delta cov(AY)$	19.48	-5.19
10	Change in residual	ΔR	0.12	-5.57

Table 3: Components of change in the variance of production of groundnut in World

S. No.	Sources of Change	Symbol	I Period-II Period	II Period - III Period
1	Change in mean yield	$\Delta \bar{Y}$	-34.26	11.54
2	Change in mean area	$\Delta \bar{A}$	-24.84	23.78
3	Change in yield variance	$\Delta V (Y)$	81.93	-26.10
4	Change in area variance	$\Delta V (A)$	-17.66	115.21
5	Interaction between changes in mean yield and mean area	$\Delta\bar{A}\ \Delta\bar{Y}$	-1.43	0.54
6	Change in area–yield Covariance	$\Delta cov (A\ Y)$	72.07	-19.10

7	Interaction between changes in mean area and yield variance	$\Delta\bar{A}\ \Delta V(Y)$	11.82	-10.98
8	Interaction between changes in yields and area variance	$\Delta\bar{Y}\ \Delta V(A)$	-7.22	15.87
9	Interaction between changes in mean area and yield and changes in area–yield covariance	$\Delta\bar{A}\ \Delta\bar{Y}\ \Delta cov(AY)$	19.48	-5.19
10	Change in residual	ΔR	0.12	-5.57

Compound annual growth rates

The growth rates computed for India and major states were furnished in Table 4. The results bear out that, initially in Period-I, the decadal trends show significant decline (-2.748%) in area growth. This decline is growth is supported by Reddy *et al*., (1992) [11] in his findings. Later, Period-II witnessed no phenomenal increase with non-significant growth rates. The declined trends are due to the failure of monsoons in two top groundnut cultivators (Gujarat and Andhrapradesh) of the country as reported by Madhusudhana, (2013) [7]. The Period-III registered significant increase in yields (3.90%). The overall period showed significant decline in area (-1.923%). The production was contributed more by yield rather than area. These results are in corroboration with Meena, (2017) [8] who observed similar growth rates for Groundnut during 1996-2014. Inspite of the fluctuations in area and production the productivity has strengthened in the last 2 decades which are the results of Technology mission and its subsequent emphasis on oilseed production that has become obvious in later decades.

The results in Table 4 disclose that in Period-I, area witnessed negative growth rates for all the states. Only, Tamilnadu witnessed significant growth in yield (2.96%). Telangana and Tamilnadu observed negative growth rates in production. In Period-II, the scenario of negative growth in area was similar but with a slower pace. Telangana registered highest rate in yield growth (8.09%), production (7.54%) and negative changes in area as observed by Shruthi *et al.*, (2017) [13]. Rajasthan production rate (9.66%) was highest for the period. In Period-III, Rajasthan is the only state with the positive and significant growth rates in all variables and registered highest in area and production. Bairwa *et al*., (2021) [1] observed similar findings for groundnut in Rajasthan. Andhrapradesh (6.81%) and Telangana (5.17%) witnessed higher growth rates in yield. The overall study period ascertains that growth rates were decelerating in area for all states, whereas soaring up for Rajasthan. Gujarat and Telangana registered higher growth rates in yield. The declining rates in yield for Karnataka and AndhraPradesh requires special attention, was stressed by Meena, (2017) [8]. The production boosted positively and significantly for Rajasthan and Gujarat.

Instability of groundnut in India and its major states

The India's instability estimates in Table 4 made it evident that groundnut instability increased from Period I -III. The period -II exhibited highest instabilities in production and yield. These results are in line with Kalpana, (2017) [4]. The overall production instability was (20.40%) and observed higher for yield than area. The country's instabilities in groundnut production compels to investigate state-level instabilities.

Table 4: CAGR and Cuddy Della instability of area, production and yield of groundnut in the major states of India.

States	Particulars	PERIOD-I (1992-2002)			PERIOD -II (2002-2012)			PERIOD –III (2012-22)			OVERALL (1992-2022)		
		Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Telangana	CGAR	-5.65^{3}	-4.75^{2}	0.96^{NS}	-0.51^{NS}	7.54^{3}	8.09^{2}	-4.99^{2}	-0.08^{NS}	5.17^{3}	-4.16^{3}	-0.19^{NS}	4.15^{3}
	Instability	5.82	15.38	14.83	7.48	15.97	10.46	13.16	16.51	3.92	14.28	22.05	38.29
Tamil Nadu	CGAR	-5.63^{3}	-2.84^{2}	2.96^{3}	-4.65^{3}	-0.73^{NS}	4.11^{3}	0.23^{NS}	0.86^{NS}	0.63^{NS}	-4.77^{3}	-2.46^{3}	2.42^{3}
	Instability	5.67	8.93	4.12	10.21	14.47	8.52	9.76	15.26	10.98	13.50	18.43	11.23
Karnataka	CGAR	-2.02^{2}	-2.19^{NS}	-0.17^{NS}	-0.36^{NS}	-0.01^{NS}	0.35^{NS}	-1.20^{NS}	2.48^{NS}	3.73^{1}	-3.09^{3}	-3.28^{3}	-0.20^{NS}
	Instability	5.36	15.83	13.88	9.21	25.41	22.09	11.41	19.55	13.87	10.47	28.19	21.74
Gujarat	CGAR	-0.88^{2}	0.43^{NS}	1.33^{NS}	-0.52^{NS}	2.93^{NS}	3.48^{NS}	2.61^{NS}	8.67^{NS}	5.90^{NS}	-0.60^{2}	3.86^{3}	4.49^{3}
	Instability	2.48	52.00	52.96	2.90	38.36	36.81	13.13	39.22	34.43	9.44	43.83	40.51
Andhra Pradesh	CGAR	-3.00^{3}	-3.61^{NS}	-0.63^{NS}	-0.50^{NS}	0.38^{NS}	0.89^{NS}	-5.19^{3}	1.27^{NS}	6.81^{1}	-3.26^{3}	-3.55^{3}	-0.30^{NS}
	Instability	9.82	26.97	10.28	41.16	51.15	41.25	13.36	25.39	31.69	12.72	36.97	34.95
Rajasthan	CGAR	0.23^{NS}	2.50^{NS}	2.26^{NS}	4.53^{3}	9.66^{2}	4.91^{NS}	8.49^{3}	11.12^{3}	2.45^{2}	4.00^{3}	7.96^{3}	3.81^{3}
	Instability	16.85	27.83	15.60	8.70	23.97	22.33	17.57	5.38	2.75	22.82	38.54	16.57
India	CGAR	-2.75^{3}	-2.32^{NS}	0.45^{NS}	-0.64^{NS}	1.99^{NS}	2.65^{NS}	-0.07^{NS}	3.90^{NS}	3.97^{1}	-1.92^{3}	0.27^{NS}	2.23^{NS}
	Instability	2.51	0.13	12.93	5.86	22.12	19.49	8.60	19.80	16.57	7.27	20.40	18.64

Table 5: Components of change in the average production of groundnut in India

S. No.	Sources of Change	Symbol	I Period- II Period	II Period - III Period
1	Change in mean yield	ΔY	306.50	265.61
2	Change in mean area	ΔA	-152.28	-119.04
3	Interaction between changes in mean yield and mean area	$\Delta Y \Delta A$	-59.64	-46.28
4	Change in area–yield Covariance	ΔCOV (A, Y)	5.42	-0.29

Table 6: Components of change in the variance of production of ground nut in India

S. No	Sources of Change	Symbol	I Period-II Period	II Period – III Period
1	Change in mean yield	$\Delta \bar{Y}$	4.31	36.95
2	Change in mean area	$\Delta \bar{A}$	-15.08	-93.55
3	Change in yield variance	$\Delta V (Y)$	146.71	216.87
4	Change in area variance	$\Delta V (A)$	-13.73	7.76
5	Interaction between changes in mean yield and mean area	$\Delta\bar{A}\ \Delta\bar{Y}$	2.84	-2.59
6	Change in area–yield Covariance	Δ cov (A Y)	36.42	-5.31
7	Interaction between changes in mean area and yield variance	$\Delta\bar{A}\ \Delta V(Y)$	-51.54	-68.99
8	Interaction between changes in yields and area variance	$\Delta\bar{Y}\ \Delta V(A)$	-12.86	7.20
9	Interaction between changes in mean area and yield and changes in area–yield covariance	$\Delta\bar{A}\ \Delta\bar{Y}\ \Delta Cov(AY)$	4.39	-0.78
10	Change in residual	ΔR	-1.46	2.44

The results witnessed that Gujarat registered highest production and yield instability in all three decades. Alike Gujarat, Andhra Pradesh exhibits higher yield and production fluctuations and were evident in Period-II. Andhra Pradesh instability results are in line with Khambhampaty, (2020) [5]. These findings were also in corroboration by Singh, (2011) [14] who reported that these states' yields fluctuated due to their kharif groundnut cultivation that limits productivity. For overall period, Rajasthan registered higher area instabitilies than yield. Similar results were found by Kolar *et al*., (2020) [6]. For Telangana, the area and production instabilities increased and yield instabilities decreased from Period I -III. Tamil Nadu observed relatively lower instabilities in all and overall period. Instability of groundnut among the states conclude that fluctuations were high in yield than area. This can be due to the 70% of groundnut cultivation was under Kharif- groundnut. Singh, (2011) [14] However, converse situation exists for Rajasthan where area instabilities were higher.Table 5 reveals that the increase in mean yield by 306.50 percent and 265.61 percent caused the growth in groundnut production for (Period-II over I) and (Period-III over II) respectively. This infers that yield effects has a greater contribution towards the increase in groundnut production in India. The components of changes in production variance are depicted from Table 6. Change in variances of yield accounts for the substantial shares for the production instability of groundnut followed by Change in mean yield (31%, 36.95%) for two periods (Period-II over I; Period-III over II) respectively.

Growth performance of Telangana and its erstwhile districts: Telangana is highly productive in groundnut cultivation with an average yield of 2.29 tonnes/ ha. Among the oilseeds cultivated, groundnut occupies second position in terms of area share (37.87%) and registers highest productivity. Hence, groundnut production performance was evaluated for the state.

Compound annual growth rates: For Telangana, the overall period shows positive and negative growth rate in yield (4.15%) and area (-4.19%) respectively. This declining and inclining growth in area and yield was similar in all periods. The CAGR results obtained were presented in Table 7. The results depict that in Period-I, Nizamabad has highest growth rates in all three variables followed by Adilabad. However, non-significant growth rates were observed in yield and negative in production for other districts. Period-II affirmed that Mahabubnagar has highest yield (12.59%) and production (15.63%) growth rates. Rangareddy in production and Warangal in yield rates. The results of Mahabubnagar are in line with Bayya, (2017) [2]. The area rates were declining in this period too. In period-III, area growth rates were significantly declining for all districts. The yield has achieved a double-digit growth rates in the period, a phenomenal growth substantiating the decline in area. However, Mahabubnagar stood with highest yield rate (37.53%) for the period. Overall period shows negative growth rates in area and positive growth rates in yield. The rate of decline in area was observed low for Rangareddy (-1.26%) and Mahabubnagar (-1.72%) districts for the study period. Mahabubnagar has highest yield (10.69%) and production rate (3.89%) for the entire period.

Table 7: CAGR and Cuddy Della instability of area, production and yield of groundnut in districts of Telangana.

Districts	Particulars	PERIOD-I (1992-2002)			PERIOD -II (2002-2012)			PERIOD –III (2012-22)			OVERALL (1992-2022)		
		Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Adilabad	CGAR	6.91^{3}	10.61^{3}	3.45^{NS}	-0.96^{NS}	1.70^{NS}	2.69^{NS}	-3.17^{NS}	3.07^{NS}	28.66^{3}	-4.49^{3}	-1.10^{NS}	7.01^{3}
	Instability	15.31	24.61	22.52	36.23	28.36	0.14	40.51	34.98	28.12	39.35	40.64	63.78
Khammam	CGAR	-16.59^{3}	-14.11^{3}	2.98^{2}	2.57^{NS}	4.93^{1}	2.30^{NS}	-11.50^{3}	-7.48^{2}	16.40^{3}	-7.64^{3}	-5.19^{3}	4.67^{***}
	Instability	0.42	0.45	0.34	12.81	8.92	9.78	12.15	16.75	12.30	18.20	23.48	16.66
Medak	CGAR	0.10^{NS}	2.36^{NS}	2.26^{NS}	-11.93^{3}	-10.20^{3}	1.97^{NS}	-0.59^{NS}	9.49^{NS}	32.48^{3}	-8.59^{3}	-6.72^{3}	5.50^{3}
	Instability	29.90	38.83	67.41	15.21	24.61	13.66	19.24	17.30	30.87	32.25	49.07	37.66
Karimnagar	CGAR	-10.40^{3}	-9.68^{3}	0.80^{NS}	-3.67^{2}	-3.25^{NS}	0.43^{NS}	-21.09^{3}	-19.52^{3}	28.26^{3}	-10.59^{3}	-8.96^{3}	6.13^{3}
	Instability	5.76	15.12	15.94	11.55	20.52	17.14	19.75	22.37	35.20	24.04	26.81	67.04
Nalgonda	CGAR	-4.05^{3}	-7.97^{2}	-4.08^{NS}	-4.31^{3}	0.61^{NS}	5.14^{1}	-10.39^{3}	-4.93^{3}	27.24^{NS}	-6.85^{3}	-3.90^{3}	6.64^{3}
	Instability	6.02	20.69	18.63	10.34	17.69	12.99	20.02	29.87	34.84	14.64	26.42	70.92
Mahabubnagar	CGAR	-4.51^{3}	-3.01^{NS}	1.57^{NS}	2.70^{NS}	15.63^{3}	12.59^{3}	-2.01^{NS}	3.51^{NS}	37.53^{3}	-1.72^{3}	3.89^{3}	10.69^{3}
	Instability	10.35	23.95	23.84	13.69	25.03	15.51	13.16	17.80	42.53	20.03	30.81	83.09
Nizamabad	CGAR	7.89^{2}	15.24^{2}	6.82^{2}	-9.03^{2}	-5.98^{NS}	3.35^{NS}	-19.05^{3}	-17.55^{3}	12.29^{3}	-12.54^{3}	-10.78^{3}	3.90^{3}

	Instability	21.82	36.69	22.67	43.77	51.85	22.57	26.54	36.08	15.26	39.84	58.91	31.68
Warangal	CGAR	-6.86[3]	-4.87[3]	2.14[NS]	-4.16[3]	1.64[NS]	6.05[3]	-11.75[3]	-9.07[3]	32.48[3]	-6.63[3]	-2.83[3]	8.92[3]
	Instability	5.39	11.14	12.67	5.59	11.14	7.90	19.76	17.61	37.31	15.42	17.78	72.65
Rangareddy	CGAR	-2.59[NS]	-0.35[NS]	2.30[NS]	4.07[NS]	7.44[2]	3.23[NS]	-8.99[2]	-3.47[NS]	18.72[3]	-1.26[2]	2.06[3]	5.49[3]
	Instability	16.04	28.62	20.43	23.88	24.12	20.68	27.92	31.89	33.72	27.23	32.87	44.48
Telangana	CGAR	-5.65[3]	-4.75[2]	0.96[NS]	-0.51[NS]	7.54[3]	8.09[2]	-4.99[2]	-0.08[NS]	5.17[3]	-4.16[3]	-0.19[NS]	4.15[3]
	Instability	5.82	15.38	14.83	7.48	15.97	10.46	13.16	16.51	3.92	14.28	22.05	38.29

Table 8: Components of change in the average production of groundnut in Telangana

S. No	Sources of Change	Symbol	I Period- II Period	II Period - III Period
1	Change in mean yield	ΔY	-273.13	386.42
2	Change in mean area	ΔA	254.47	-177.11
3	Interaction between changes in mean yield and mean area	ΔYΔA	122.08	-91.12
4	Change in area–yield Covariance	ΔCOV (A, Y)	-3.43	-18.20

Table 9: Components of change in the variance of production of groundnut in Telangana

S. No.	Sources of Change	Symbol	I Period- II Period	II Period – III Period
1	Change in mean yield	Δ $\bar{Y}$	4.31	36.95
2	Change in mean area	Δ $\bar{A}$	-15.08	-93.55
3	Change in yield variance	ΔV (Y)	146.71	216.87
4	Change in area variance	ΔV (A)	-13.73	7.76
5	Interaction between changes in mean yield and mean area	Δ$\bar{A}$ Δ$\bar{Y}$	2.84	-2.59
6	Change in area–yield Covariance	Δcov (A Y)	36.42	-5.31
7	Interaction between changes in mean area and yield variance	Δ$\bar{A}$ ΔV(Y)	-51.54	-68.99
8	Interaction between changes in yields and area variance	Δ$\bar{Y}$ ΔV(A)	-12.86	7.20
9	Interaction between changes in mean area and yield and changes in area–yield covariance	Δ$\bar{A}$ Δ$\bar{Y}$ Δcov(AY)	4.39	-0.78
10	Change in residual	ΔR	4.31	36.95

Instability of groundnut in Telangana and its erstwhile districts

It is evident form the Table 7 that area instabilities were increasing from period-I to III in almost all districts. Period-III observed highest yield instabilities. For overall period, the magnitude of instabilities were higher for yield than area in all districts of the state (except Khammam) and thus contributed for the production instabilities. Mahabubanagar has highest yield variability (83.09%) and Nizamabad with highest area variability.

Components of change in growth and instability of groundnut (Telangana)

Change in mean area is the dominant factor that influencing the mean production of groundnut (Period-II over I) followed by Interaction between changes in mean yield and mean area. Change in mean yield accounts for the highest share in groundnut production (Period-III over II) as furnished in Table 8. The variation in the groundnut production (Period-II over I) was predominantly due to the Changes in yield variance; area–yield Covariance. Change in yield variance, Change in mean yield effects more on the production variance of the crop in Period-III over II as evident from Table 9.

Summary and Conclusion

The world witnessed positive growth rate in production (2.48%) for groundnut in the past 3 decades. This overall increase is contributed slightly higher by area growth rates than yield. However, the decomposition analysis says yield effect in (Period-II over I) and area effect in (Period-III over II) contributed more for growth and variance in groundnut production. The major countries observed positive and significant growth rates in area (except India, Indonesia and USA). The increasing growth rates in yield were observed for Sudan, India and USA. However, the world groundnut observed lowest of growth rates in Period-II. Similarly, the instabilities were apparent in the same period. China and Indonesia had witnessed relatively lower instabilities. At the national level, all the major states (except Rajasthan) had showed declination in area growth, which was reflected in the country's growth rate (-1.93%). For the overall period, Gujarat instabilities were relatively higher and TamilNadu showcased lower instabilities. The magnitude of instabilities for all the states remained higher for yield than area and is converse for Rajasthan. India displayed higher instability in yields. Inspite of the fluctuations in area and production, the productivity of the country has strengthened in the last two decades that can be attributed to efforts of Technology mission and its subsequent emphasis on oilseeds production. This is vivid with decomposition results where, rise in mean yield and change in yield variances accounted for substantial shares towards growth and production instability of Indian groundnut. For Telangana State, the magnitude of decline in area growth (-4.19%) and increase in yield growth (4.15%) were found closer. All the districts exhibited negative area rates (lowest-Mahabubnagar) and positive yield rates (highest-Mahabubnagar). The yield instabilities were higher than area for all the districts (except Medak). Mahabubnagar was noticed with highest yield variability and Nizamabad with highest area variability. The recent decade over the past witnessed that, yield effect contributed more for growth and variance of groundnut production in the state. From the study, it is concluded that researchers and policy makers should continue to emphasize on increasing productivity in African countries and arrest

the area decline in India, USA and Indonesia. India can control the decline in area under groundnut and yield instabilities by promoting more acreage increase under Rabi groundnut growing areas like Telangana and other states to balance the availability and demand of groundnut in India to fill the oilseeds demand-supply lag.

Acknowledgement
I would like to express my sincere gratitude to the Indian Council of Social Science Research (ICSSR) for their financial support funded through Full-Term Centrally-Administered Doctoral Fellowship for 2022-23. The funding provided by ICSSR has been instrumental in facilitating the research process and enabling a comprehensive study.

References

1. Bairwa CK, Balai HK, Meena GL, Yadav A, Prasad D. Variability and Sources of Output Growth in Major Oilseeds of Rajasthan. Economic Affairs. 2021;66:71-77.
2. Bayya PK. Growth and Instability of Groundnut Crop in Mahbubnagar District of Telangana State, India. International Journal of Research in Economics and Social Sciences. 2021;7(9):537-548.
3. Birthal PS, Rao P, Nigam SN, Bantilan MCS, Bhagavatula S. Groundnut and Soybean Economies in Asia: Facts, Trends and Outlook. International Crops Research Institute for the Semi-Arid Tropics. Patancheru, Andhra Pradesh, India, 2010, 92.
4. Kalpana PA. Study on Change and Instability of Groundnut Crop in India. Journal of Advanced Research in Applied Mathematics and Statistics. 2017;2(1&2):31-35.
5. Khambhampaty S. Change and Instability in Area and Production of Groundnut Crop in Andhra Pradesh. Agricultural Situation in India. 2020;52:05.
6. Kolar P, Awasthi PK, Sahu A. Growth Performance of Oilseeds Among Leading States in India. Economic Affairs. 2020;65(2):219-224.
7. Madhusudhana B. A Survey on Area, Production and Productivity of Groundnut Crop in India. IOSR Journal of Economics and Finance. 2013;1(3):01-07.
8. Meena M. Production and Export Competitiveness of Indian Groundnut – A Policy Analysis Matrix (PAM) Approach. Unpublished Thesis. Junagadh Agricultural University, Junagadh, Gujarat, India; c2017.
9. Ndiaye G, Fang S, Mukete B. Analysis of Market Liberalization and the Groundnut Sector in Senegal. International Journal of Applied Agricultural Sciences. 2018;4(3):43-51. DOI: 10.11648/j.ijaas.20180402.13.
10. Ndjeunga J, Ibro A. Groundnut Trends and Prospects in West and Central Africa. A Report of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Unpublished Paper; c2010.
11. Reddy PS, Basu MS, Khaleque MA, Hoque MS, Naazar Ali, Malik SN, *et al*. Status of Groundnut Research and Production in South Asia. Groundnut - A Global Perspective: Proceedings of an International Workshop, 25-29 Nov 1991, ICRISAT Center, Patancheru 502 324, Andhra Pradesh, India. 1992;133-147.
12. Sadiq MS, Singh IP, Ahmad MM, Umar SM. Resurrecting Nigeria's Groundnut Pyramid. Sri Lanka Journal of Food and Agriculture. 2020;6(2):33-42. DOI: http://doi.org/10.4038/sljfa.v6i2.87.
13. Shruthi G, Rao GD, Devi YL, Masih J. Analysis of Area, Production and Productivity of Groundnut Crop in Telangana. Agriculture Science Digest. 2017;37(2):151-153.
14. Singh AL. Physiological Basis for Realizing Yield Potentials in Groundnut. Advances in Plant Physiology, Scientific Publishers, Jodhpur, India. 2011;12(6):131-242.
15. Verter N. The Performance of Groundnut Products in the World: A Case of Peanut Pyramid in Nigeria. Conference: Enterprise and Competitive Environment, Brno, 2017, 1.
16. Yao G. Peanut Production and Utilisation in the People's Republic of China. Department of Anthropology, University of Georgia, U.S.A. Peanut in Local and Global Food Systems Series, Report No.4; c2004.