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Growth and instability in Indian groundnut: An analysis of area, production, yield and exports

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Abstract
Groundnut is a major oilseed crop around the world. It is one of the most important food and cash crops of India. This study examines growth and instability in area, production, yield and exports using secondary data. Growth and instability in area, production, and yield were analyzed for three sub-periods: Period I (1992-93 to 2001- 02), Period II (2002-03 to 2011-12) and Period III (2012-13 to 2021-22) along with the overall period (1992-93 to 2021-22). Export quantity and value were analyzed for 2013- 14 to 2022-23. Data were analyzed using compound annual growth rate (CAGR) and the Cuddy-Della Valle Index (CDVI). At the national level during the overall period, Groundnut exhibited a negative CAGR in area (-1.72%) but positive growth in production (0.54%) and yield (2.30%). Groundnut production showed higher instability (21.33%) than area (8.73%) and yield (18.69%) with Gujarat recording the highest volatility in production (42.17%) and yield (39.07%). Groundnut exports grew in quantity (0.44%) and value (4.92%) with Bangladesh experiencing highest growth in quantity (99.89%) and value (92.39%). However, exports to Malaysia, Thailand, Russia and China declined due to aflatoxin concerns and increased competition.

Keywords: Compound annual growth rate, export, groundnut, instability

Introduction
Groundnut, a major oilseed crop is known as the 'King' of oilseeds and is cultivated worldwide. It is also referred to as peanut or monkey nut (Bhusanar *et al.*, 2023) [2]. As one of the most important food and cash crops in India, groundnut plays a crucial role in addressing the country's edible oil deficit while serving as an essential source of protein (Sunil and Singh, 2021) [14].

Groundnut Cultivation
In 2022, groundnut was cultivated on 30536 thousand hectares worldwide, producing 54.24 million tonnes. India ranked first in cultivated area with an 18.68 per cent share of the world acreage followed by China (14.54%) and Nigeria (11.13%). In terms of production, China was the leading producer contributing 33.79 per cent of the world's total production followed by India (18.68%). Asian countries like India and China collectively contribute over 50 per cent of the world's groundnut production (FAOSTAT, 2023a) [8].
In 2021-22, area under groundnut cultivation in India was 5.75 million hectares with a production of 10.11 million tonnes. Gujarat ranked first among Indian states with a 44.41 per cent share of production followed by Rajasthan (16.81%) and Tamil Nadu (9.39%) (DES, 2023).

Groundnut Exports
In 2022, India ranked second globally in both groundnut production and exports. Argentina was the leading exporter with exports of 630 thousand tonnes in 2022, a significant increase from 125.06 thousand tonnes in 2018. India exported 579.29 thousand tonnes in 2022 (FAOSTAT, 2023b) [9].
Indonesia and Vietnam emerged as key destination markets for Indian groundnuts, collectively representing over 57 per cent of India's total groundnut exports in 2022 (FAOSTAT, 2023b) [9].

Methodology

The secondary data were collected to analyse growth and instability in the area, production and yield for the 30 years period from 1992-93 to 2021-22 which was further divided into four periods: 1992-93 to 2001-02 (Period I), 2002-03 to 20011-12 (Period II), and 2012-13 to 2021-22 (Period III) and 1992-93 to 2021-22 (Period IV). Growth and instability of exports were studied for the period 2013-14 to 2022-23. The states were selected based on their average groundnut production from 2018-19 to 2012-23. Ten major groundnut export destination countries were selected based on the average export from 2018-19 to 2012-23. Data related to the area, production, yield, export quantity and export value of groundnut were collected from the Centre for Monitoring Indian Economy (CMIE).

Compound annual growth rate

The compound growth rates of major groundnut producing states were measured by fitting an exponential function for the variables *viz*., area, production and yield while India as a whole was considered to analyse the compound growth rate of export quantity and export values.

Y = a btUt

Where;

- Y = Area (Million Hectares), Production (Million tonnes), Yield (Kg. /Hectare), Export quantity (Metric tonne), Export value (Lacs)
- a = Intercept
- b = Regression co-efficient t = Time variable
- U = Error term

The compound growth rate was obtained from the logarithmic form of the exponential equation as below

Log y = Log a + t Log b

The value of log b in equation (2) was computed using the formula,

$$\log b = \frac{N\sum t(\log Y) - (\sum t)(\sum \log Y)}{N\sum t^2 - (\sum t)^2}$$

Where;
N = Number of years.

t −(**N**)

Then, the per cent compound growth rate (g) was calculated by using the relationship

g = {antilog of (logb) -1} x 100

Where; g = Compound growth rate per annum in per cent.
Student't' test was used to determine the significance of the growth rates obtained for which the following formulation was employed.

t = Log b/SE (Log b)

The calculated 't' values, from equation (5), were compared with the table 't' values and the significance was tested for 1 and 5 per cent probability levels.

Cuddy Della Valle index

Instability for area, production, yield, export quantity and export value were calculated using the coefficient of variation and Cuddy Della Valle Index.
Cuddy Della Valle Index was calculated as follows:

$$\text{Coefficient of Variation (CV)} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

$$\text{Cuddy–Della Valle Index (CDVI)} = \text{CV} \times \sqrt{1 - \bar{R}^2}$$

Where, CV= Coefficient of variation (σ /$\bar{X}$)
$\bar{R}$2= Adjusted coefficient of multiple determination.

Result and Discussion

Growth Rates in Groundnut Area, Production and Yield

Table 1 represents the compound growth rates of area, production and yield of major groundnut producing states as well India as whole for the overall period of 1992- 93 to 2021-22 which were further divided into three different sub periods.
During period- I (1992-93 to 2001-02), the compound growth rates of area for groundnut crop were found negative in most states, except West Bengal (7.56%). Most other major states experienced negative growth with Tamil Nadu showing the steepest decline in area (-6.09%) followed by Andhra Pradesh (-3.63%) and Maharashtra (- 3.81%). In terms of production only West Bengal and Rajasthan showed the positive and significant growth rate of 10.84 per cent and 2.41 per cent respectively. In terms of yield West Bengal showed highest growth rate of 3.05 per cent followed by Rajasthan 2.80 per cent.
During Period-II (2002-03 to 2011-12), Rajasthan emerged as the leading state with significant positive growth in area (5.58%), production (11.89%) and yield (5.98%). Gujarat showed negative area growth (-1.73%) but showed positive growth in production (3.66%) and yield (5.49%). In terms of yield highest positive growth was observed by Tamil Nadu (6.53%) despite negative growth in its area (-4.75). At all India level it showed improvement compared to Period-I with production growth of 2.48 per cent despite continued negative area growth (-1.41%).
In Period-III (2012-13 to 2021-22), highest growth in area (8.47%) and production (11.34%) was observed in Rajasthan followed by Gujarat 3.89 per cent in area and 10.85 per cent in production. Gujarat also showed highest growth rate in terms of yield (6.70%).
During the overall study period (1992-93 to 2021-22), Rajasthan showed significant positive growth in area (4.30%), production (8.19%) and yield (3.73%). West Bengal also showed positive growth in area (4.93%) and production (8.02%) and yield (2.94%). Gujarat despite negative area growth (-0.55%) showed positive production growth (3.55%) and highest growth in yield (4.12%) compare to other states in this period.
It is observed from the table that groundnut at the whole India level during the overall study period showed a negative growth in area (-1.72%) while positive growth in production (0.54%) and yield (2.30%). The growth rate in production was increased from Period-I (-2.89%) to Period-III (5.60%), similarly growth rate in yield also increased from Period-I (0.02%) to Period-III (4.90%).

However, despite Rajasthan's positive growth in area and production during Period-III and the overall study period, its total groundnut cultivation remained significantly lower than that of Gujarat. In 2021-22, Rajasthan had 795.9 thousand hectares under cultivation and produced 1696.8 thousand tonnes whereas Gujarat's area was more than double (1987.5 thousand hectares) with production (4489.6 thousand tonnes). Similarly, West Bengal showed second highest growth rate in production after Rajasthan but produced only 188.9 thousand tonnes in 2021-22. This highlights that while some states showed high growth rates their overall contribution to national production remained relatively small.

The present study findings are in line with Senthilnathan *et al.* (2023) [13] who found during their sub-study period (2000-01 to 2021-22) and overall study period (1950-51 to 2021-22) a negative compound annual growth rate (CAGR) in area cultivated with groundnuts. They attributed this decline primarily to a significant decrease in the area under cultivation while noting that yield effects accounted for 79 per cent of the change in production, contrasting sharply with the mere 7.76 per cent contribution from area changes.

Similarly, Suthar *et al.* (2024) [15] analysed growth and instability in groundnut production from 2002-03 to 2019-20 across major producing states. Their findings indicated a negative CAGR in groundnut area in Gujarat, Andhra Pradesh and Tamil Nadu. In Gujarat, groundnut area decline at a rate of 1.564 per cent per annum with a low instability rate of 9.690 per cent. Tamil Nadu experienced an even steeper decline at 4.109 per cent per annum while Andhra Pradesh registered significant decreases in both area (5.540%) and production (4.289%). The authors noted that extreme weather events such as cyclones and droughts negatively impacted groundnut production.

Kolar *et al.* (2020) [10] also found similar result on their study of examining growth and instability in major producing states from 1995-96 to 2017-18. They reported negative growth in groundnut area across Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Tamil Nadu. In Karnataka, the shift of crop area towards cash crops like sugarcane and cotton was identified as a key reason for decreased groundnut cultivation, compounded by droughts and insufficient monsoon rains that adversely affected oilseed production.

Paled *et al.* (2024) [12] also found a declining trend in groundnut area across major producing states during their study period from 1996-97 to 2020-21. They noted a shift in cropping patterns away from oilseeds like groundnut towards more commercially viable crops such as soybean and cotton due to higher profitability. Their analysis revealed that during this period groundnut area declined significantly at a CAGR of 1.70 per cent, attributing this trend to various biotic and abiotic constraints alongside competition from other crops.

Table 1: Compound growth rates in area, production and yield of groundnut in India and major producing states (% / annum)

Sr. No.	State Name	Period-I (1992-93 to 2001-01) CAGR			Period-II (2002-03 to -2011-12) CAGR			Period-III (2012-13 to 2021-22) CAGR			Overall (1992-93 to 2021-22) CAGR		
		A	P	Y	A	P	Y	A	P	Y	A	P	Y
1	Gujarat	-0.87**	-0.50	0.37	-1.73**	3.66	5.49*	3.89**	10.85	6.70*	-0.55**	3.55	4.12*
2	Rajasthan	-0.39**	2.41**	2.80**	5.58**	11.89**	5.98**	8.47**	11.34**	2.64**	4.30**	8.19**	3.73**
3	Tamil Nadu	-6.09**	-3.09	3.19	-4.75**	1.48**	6.53**	1.48**	2.79**	1.29**	-4.57**	-1.68**	3.03**
4	Andhra Pradesh	-3.63**	-5.07*	-1.49**	-2.55**	-1.84	0.73*	-4.15**	-1.80**	2.44**	-4.09**	-4.41**	-0.33**
5	Madhya Pradesh	-2.53	-1.54	1.01**	-0.62**	5.77**	6.43**	4.76**	6.61**	1.77**	0.01	2.41	2.40
6	Karnataka	-3.08**	-4.79**	-1.77**	-1.80**	0.45**	2.29**	-0.79**	2.36**	3.17**	-3.05**	-3.10**	-0.05**
7	Maharashtra	-3.81**	-4.61**	-0.83**	-3.56**	-2.29**	1.32**	-0.06**	0.67**	0.73**	-2.89**	-2.74**	0.15**
8	Telangana							-4.10**	-0.12**	4.15**			
9	West Bengal	7.56**	10.84**	3.05**	6.31**	8.04**	1.62**	-0.62**	-0.66**	-0.04**	4.93**	8.02**	2.94**
10	Uttar Pradesh	-1.91**	-3.74**	-1.86**	0.25**	3.75**	3.49**	-0.56**	2.52**	3.10**	-1.43**	-0.69**	0.75**
11	All India	-2.91**	-2.89**	0.02**	-1.41**	2.48**	3.95**	1.45**	5.60**	4.09**	-1.72**	0.54**	2.30**

Note: 1. CGR - Compound Growth Rate; 2. A- Area, P- Production and Y-Yield; 3. * and ** indicate significance at 5% and 1% levels, respectively.

Instability Analysis in Groundnut Area, Production and Yield: The instability indices for area, production and yield of groundnut across India and its major groundnut producing states are presented in Table 2.

During period I (1992-93 to 2001-02), the instability index for groundnut area ranged from 3.73 to 18.01. Gujarat showed highest stability in area (3.73) while highest instability was observed in Rajasthan (19.77). In terms of production, highest instability was observed in Gujarat (52.69) and Andhra Pradesh (27.53) while least instability was observed in Madhya Pradesh (8.77). In terms of yield highest instability was observed in Gujarat with an index of 52.17 and lowest in West Bengal (5.25).

During Period II (2002-03 to 2011-12), Gujarat and Madhya Pradesh maintained low area instability with indexes of 3.17 and 3.87 respectively, suggesting consistent cultivation practices while highest instability in terms of area (15.80) and production (49.97) was observed in Andhra Pradesh. Lowest instability in yield (4.65) was observed in Tamil Nadu.

During period III (2012-13 to 2021-22), lowest instability in production (4.10) and yield (12.07) was observed in Odisha. In terms of production, lowest instability was observed in Gujarat with index of 12.97, down from 36.90 in period I. Gujarat also improved yield stability, reducing the instability index from 28.04 in Period-I to 12.51 in Period-III.

During overall period (1992-93 to 2021-22), highest instability in area was observed in Rajasthan (22.60) followed by Madhya Pradesh (17.17) while Gujarat showed highest production (42.17) and yield (39.07) instability among other states during this time.

At the national level, groundnut showed moderate instability in area (8.73) but higher instability in production (21.33) and yield (18.69).

Table 2: Instability analysis in area, production and yield of groundnut in India and major producing states (% / annum)

Sr. No.	State Name	Period-I (1992-93 to 2001-01) CDVI			Period-II (2002-03 to -2011-12) CDVI			Period-III (2012-13 to 2021-22) CDVI			Overall (1992-93 to 2021-22) CDVI		
		A	P	Y	A	P	Y	A	P	Y	A	P	Y
1	Gujarat	3.73	52.69	52.17	3.17	41.74	39.08	12.17	34.53	31.50	10.16	42.17	39.07
2	Rajasthan	18.01	28.22	17.01	9.80	25.40	22.67	4.58	9.46	6.42	22.60	28.40	16.77
3	Tamil Nadu	4.47	30.40	28.10	10.83	11.43	4.65	8.75	14.26	11.22	8.75	14.26	11.22
4	Andhra Pradesh	4.63	27.53	24.86	15.80	49.97	36.78	15.99	27.91	37.55	12.90	34.06	31.57
5	Madhya Pradesh	4.20	8.77	8.75	3.87	20.81	17.77	16.46	17.62	7.14	17.17	27.39	15.09
6	Karnataka	8.19	19.48	15.31	11.22	25.16	17.74	12.11	20.73	14.90	10.88	27.32	19.55
7	Maharashtra	6.26	10.61	9.00	10.24	11.26	9.95	10.83	17.93	9.53	11.16	16.25	9.33
8	Telangana							16.47	16.95	9.25			
9	West Bengal	10.18	12.61	5.25	15.37	17.35	5.77	7.47	7.81	7.91	15.19	17.64	8.33
10	Uttar Pradesh	9.09	13.67	16.54	8.69	17.65	17.03	4.03	12.39	13.58	12.14	23.68	18.31
11	All India	2.72	12.35	12.27	7.10	24.04	20.24	9.06	18.50	16.22	8.73	21.33	18.69

Note
1. CDVI - Cuddy Della Valle Index (%)
2. A- Area, P- Production and Y-Yield

Growth and Instability in Indian Groundnut Exports

Table 3 represent values of compound annual growth rate and instability index of quantity and value of Indian groundnut exports to major export destination during the period of 2013-14 to 2022-23.

In terms of quantity of groundnut exports, highest CAGR during study period was observed in Bangladesh (99.89%) followed by Nepal (37.58%), UAE (14.32%) Vietnam (8.03%) and Indonesia (2.31%). Similarly, highest CAGR in terms of value of groundnut exports were observed in Bangladesh (92.39%) followed by Nepal (42.39%), UAE (19.54%), Vietnam (13.71%) and Indonesia (6.93%).

In case of India's groundnut export to Thailand, despite negative CAGR in quantity (-2.68%) a positive CAGR was observed in terms of value (2.25%).

It was also observed from the table that China, Malaysia and Russia were three countries where the CAGR was found to be negative for both quantity and value of groundnut exports. These were the countries with highest instability as well. Compound annual growth rates in terms of value were -1.15, -1.76 and -3.73 per cent respectively for China, Malaysia and Russia. CAGRs in terms of area were -5.35, -5.95 and -7.77 per cent for the same countries, respectively.

In terms of value highest instability was observed in China (128.95) followed by Russia (54.98) and Malaysia (32.94). Similarly highest instability in terms of quantity was observed in China (124.16), Russia (55.36) and Malaysia (27.67). Vietnam showed positive growth rate in terms of quantity and value but had instability indices of 64.66 for quantity and 65.68 for value.

India's groundnut exports were observed to have declined by eight per cent between April 2013 and February 2014. This decline was primarily driven by significant carryover stocks in global markets which were caused by bumper crops in major producing countries such as Argentina, United States and China. Carryover stocks of approximately 1.04 million tonnes were held by the United States while around 0.43 million tonnes were maintained by Argentina during 2013-14. Groundnuts were offered at more competitive prices by these countries which increased competition for Indian exports. Additionally, China's domestic groundnut production was reported to have reached 17 million tonnes in 2013-14, leading to a reduction in its reliance on imports and further impacted India's export volumes.

The Argentine currency was observed to have depreciated by 36 per cent against the US dollar (from 5.12 in April 2013 to 7.99 in April 2014). This depreciation enabled Argentine exporters to offer groundnuts at more competitive prices, affecting Indian exporters adversely (BS, 2014a). Though, Vietnam showed positive CAGR of 8.03 per cent during the study period, it had banned imports of Indian groundnuts from April 2015 to January 2016 due to quality concerns (BS, 2016a). Similarly, Indonesia restricted imports from India after detecting aflatoxins in consignments and mandated additional certification for pesticide residues, increasing the cost per container (BS, 2016b) [6]. The European Union and Malaysia also tightened regulations to control aflatoxin levels in imported groundnuts (BS, 2014b) [4].

The frequent rejections of shipments and import bans imposed by various countries due to poor quality, particularly high levels of aflatoxins, have contributed to the high fluctuations in India's groundnut exports. These challenges highlighted the need for greater attention to quality control measures to harness the full export potential of Indian groundnuts. Addressing these quality issues could help stabilize export volumes and improve India's competitiveness in the global groundnut market (AAU, 2020). Meghna et at. (2023) [1, 11] concluded similar views emphasizing the importance of quality measures to achieve higher returns in international markets.

Table 3: Compound annual growth rates (CAGR) and instability in quantity and value of Indian groundnut exports to major destinations.

Sr. No.	Countries	(2013-14 to 2022-23) Quantity		Value	
		CAGR (%)	CDVI	CAGR (%)	CDVI
1	Indonesia	2.31**	10.61	6.93**	12.88
2	Vietnam	8.03	64.66	13.71	65.68
3	Philippines	-2.77**	10.97	1.24**	15.92
4	Malaysia	-5.95*	27.67	-1.76*	32.94
5	Thailand	-2.68	49.66	2.25	53.14

6	China	-5.35	124.16	-1.15	128.95
7	UAE	14.32**	25.07	19.54**	31.41
8	Nepal	37.58	34.34	42.39	32.77
9	Bangladesh	99.89	50.93	92.99	54.45
10	Russia	-7.77	55.36	-3.73	54.98
11	World	0.44**	16.52	4.92**	21.25

Note: * and ** indicate significance at 5% and 1% levels, respectively.

Conclusion

The study reveals that Groundnut showed a negative growth rate in area but positive growth in production and yield at the national level. States like Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra and Uttar Pradesh exhibited negative growth in both area and production. While Gujarat and Rajasthan achieved higher yield growth, production instability remained high, particularly in Gujarat. This highlights the need to bridge significant yield gap between states like Karnataka and Gujarat and expand the area under cultivation by including non-traditional areas in order to stabilize and enhance groundnut production.

Indian groundnut exports to the world experienced positive growth rates in both quantity and value during the study period. Bangladesh showed the highest growth in both quantity and value. However, exports to countries like Malaysia, Russia and Thailand declined due to quality concerns, particularly aflatoxin contamination. Among India's export destinations China recorded the highest instability in groundnut exports. Thus, there is a need to strengthen quality control mechanisms to align with importing countries standards to maintain India’s reputation as a reliable exporter and enhance competitiveness in global market.

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