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Food Spice Ginger: An Economic Analysis of Growth Trends in India

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ABSTRACT

Background: In this paper, the temporal data were used to evaluate the growth trends of ginger in India. With particular interest are the insights that bring out the inherently important roles that Karnataka, Madhya Pradesh and Orissa can and should play in dynamics constituting the regional profile in ginger cultivation country-wide, considering either the area covered or production levels. These results have gone a long way in throwing valuable insights into the dynamics of ginger cultivation in India and brought out patterns and challenges confronted by this vital spice in the context of the country's agricultural landscape.

Methods: The secondary data on ginger area, production and productivity from various sources from 2000-01 to 2022-23 were collected. The statistical analysis techniques included mean, standard deviation, regression and CAGR. In this paper, the performance of ginger has been examined through the estimation of growth rates and instability indices.

Result: The findings of CAGR were positive and statistically significant for 23 years, reflecting that ginger cultivation is continuously growing. In the last 23 years, from 2000-01 to 2022-23, India's mean area under ginger cultivation was 140.88 thousand hectares, with a mean production of 956.81 thousand metric tons and a productivity of 6.08 metric tons per hectare. The growth rate in ginger production has been more or less double that in area and productivity taken together during the last sixteen years in India. Ginger production was the highest on the instability index, contributing 72.34 per cent variation, productivity with 47.30 per cent variation and area with 27.61 per cent variation. Different changes computed by the instability index measuring ginger productivity have been relatively less variable over the years than productivity and area indicators. Despite ginger production demonstrating the maximum degree of instability over time, it is neither a one-way traffic affair in terms of area nor productivity.

Key words: CAGR, Ginger, Trends.

INTRODUCTION

India, renowned as the "home of spices," holds a prominent global position as the top producer, consumer and exporter of spices, contributing to approximately 70 per cent of the world's spice production (Buragohain *et al.*, 2022). Virtually every state in India engages in the cultivation of one or more spices, with Rajasthan and Gujarat standing out by contributing around 80 per cent of India's total spice production, earning the title of the "Seed Spice Bowl of India" (Verma, 2015). The diverse climate across India creates an ideal environment for cultivating a wide variety of spices, making it the country with the highest number of spice varieties globally (Kumar *et al.*, 2018). India is also the major producer and consumer of ginger worldwide, with nearly half of the global production originating from India (Madan, 2016).

Ginger, scientifically known as *Zingiber Officinale Rosc*., belongs to the *Zingiberaceae* family and is one of the oldest known spices (Nair, 2019). This versatile crop, cultivated in tropical and subtropical regions, yields two primary products: fresh ginger and dried ginger (Pakrashi, 2003; Acharya *et al.*, 2016). While fresh ginger is consumed as a vegetable, dried ginger is the predominant form in international trade. The global market witnesses the trade of various ginger products, including pickled ginger, preserved ginger, crystallized ginger and ground ginger. Beyond its culinary applications, ginger has a rich history of medicinal use (Chauhan, 2022; Laelago, 2023; Mohammed *et al.*, 2024). It contains amino acids, shogaols, gingerols, fiber, essential oils and minerals (Khan, 2016). Widely utilized for its flavoring and medicinal properties, ginger has been a staple in traditional medicines such as Ayurvedic, Chinese, Unani and Tibetan medicine (Heinrich, 2012; Radian *et al.*, 2024). Its immune-

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modulatory, anti-hyperglycemic, anti-emetic, antioxidant, anticancer and anti-inflammatory attributes make ginger a versatile ingredient with a wide range of health benefits (Camacho and Brescia, 2009; Ahmad *et al.*, 2006; Malu *et al.*, 2009; Al-Amin *et al.*, 2006; Afshari *et al.*, 2007). In 2023, India alone contributed 43.87 per cent to the total global ginger production, solidifying its position as the leading exporter of ginger globally (www.tridge.com). Key destinations for Indian ginger exports include the USA, Morocco, Spain, Bangladesh, the UK, Saudi Arabia and the UAE (Vasisht, 2016). The central ginger-producing states in India are Kerala, Assam, Meghalaya, Arunachal Pradesh and Orissa, collectively accounting for over 60 per cent of the country's ginger production (Mishra *et al.*, 2012). The particular objective of the research was to evaluate the trend of ginger acreage, output and productivity in India.

MATERIALS AND METHODS

The study relied on secondary sources for its data, specifically obtaining information on ginger's area, production and productivity from the India Stat website covering 23 years, from 2000-01 to 2022-23. CAGR and CV techniques were used to analyze productivity trends in ginger production (Sharma, 2015; Borah *et al.*, 2025).

Compound annual growth rate (CAGR)

The CAGR in area, production and productivity of ginger was estimated by using the exponential growth function of the following form;

$$Y = abt\ EU$$

Where,
Y = Dependent variable (area/production/productivity).
A = Intercept term.
b = (1 + r).
Where,
'r' = The compound growth rate.
t = Time trend.
u = Random error term.
To represent the following model in logarithmic form

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

Log a and log b values were acquired using the methods of ordinary least squares and the percentage CAGR was determined using the following relationship:

$$CAGR\ (\%) = [\text{Antilog of (Log b) } -1] \times 100$$

The Student's t-test was employed to determine the relevance of the growth rate (Bhutia, 2022).

Coefficient of variation (CV)

This relative measure of dispersion-a measure of relative variability-when expressed as a percentage, is known as the coefficient of variation, CV. It describes relative variability and, therefore, is helpful to compare the extent of variation from one series of data to another, even if the means are very different. It is beneficial in fields where variability between data sets needs to be compared on a relative scale for different datasets (Sanderson *et al.*, 2002).

This analysis used the coefficient of variation to check the variation and stability of growth rates over the years. It gives an elaborate picture of how data points spread out around the mean, hence showing the consistency and reliability of the data. Calculating the coefficient of variation is easy and involves the use of a formula outlined by Becker (1988):

$$CV = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

It does this by dividing the SD by the mean value of a dataset and then multiplying it by 100 to convert it into a percentage. The CV, hence, provides a normalized measure about dispersion, one that can be used coherently to compare variability across datasets with different units/ scales. It would be essential to give agricultural data relative stability or instability. If the CV for productivity is lower compared to the coefficient of variation for the area and production, then it means that the productivity in the period under scrutiny has been more stable. On the other hand, an extensive CV for production may indicate extreme variation in total output, which may be influenced by conditions such as weather, pests, or markets.

The use of CV in this analysis will allow for a nuanced understanding of the underlying trends in the data. It will allow for the identification of which aspects of ginger cultivation are more prone to variability and which ones are relatively stable. Such information becomes crucial in developing focused strategies for enhancing the stability and predictability of ginger production. For example, suppose it depicts a high variability in production. In that case, measures can be oriented towards better management of pests and diseases, improving the weather forecasting system and adopting resilient crop varieties that might help cushion the fluctuations, as commented by Karthick (2015).

It can also convey the relative variability to policymakers to base policy decisions on and allocate resources accordingly. In this regard, policymakers will put more emphasis on those areas with higher variability so that intervention can be done to stabilize the most volatile aspects of ginger cultivation. This kind of approach ensures efficient use of resources and will yield better results for farmers and the agricultural sector at large.

RESULTS AND DISCUSSION

The findings of the study are an attempt at a detailed examination of the outcomes drawn from the study, particularly on the significant findings concerning the production and productivity of ginger. The findings of the present research are presented in a systematic way under two broad key domains: production and productivity. Through the careful analysis of the compound annual growth rate concerning the area, production and productivity of ginger in India, the trends and dynamics are understood

completely. This long-duration analysis of 23 years starting from 2000-01 up to 2022-23 is covered in this analysis and the results are furnished in a systematic way in Table 1. The growth patterns and trends in ginger cultivation and yields are very clearly stated in Table 1.

The Ginger Cultivation Pattern remains the same in India for an extended period of 23 years, from 2000-01 to 2022-23. The average area under ginger cultivation during this period was 140.88 thousand hectares. Against this huge cultivated area, the average annual production of ginger was 956.81 thousand metric tons, which proves continuous interest in ginger cultivation within the country. During this period, the average productivity recorded was 6.08 metric tons per hectare, which is an index of efficiency and yield on the cultivated land. This long period spans a host of agricultural, environmental and economic factors affecting ginger cultivation in India and throws up valuable lessons on the trends and dynamics over a period of more than two decades.

The most astounding observation in this case of India is that ginger production increased at the highest growth rate of 8.71 per cent per annum. This high growth was followed by a healthy expansion in the cultivation area with a growth rate of 5.64 per cent per annum. Thirdly, the productivity of ginger also showed remarkable advancement, recording a growth rate of 3.65 per cent per annum. All these growth rates, relating to cultivation area, production, or productivity, were significant and positive at both 1 per cent and 5 per cent levels of probability.

This signifies a robust and meaningful trend in the upward trajectory of ginger cultivation in India, emphasizing the positive momentum and the agricultural sector's noteworthy contributions to the nation's economic landscape. The findings underscore the resilience and adaptability of ginger cultivation practices, showcasing their ability to evolve positively over time (Karthick, 2015).

When considering the instability index, it is noteworthy that the highest degree of variation was observed in ginger

Table 1: Growth in area, production and productivity of ginger in India.

Years	Area (In ' 000 Hectare)	Production (In ' 000 MT)	Productivity (In MT/Hectare)
2000-01	83.40	303.40	3.6
2001-02	84.60	317.90	3.8
2002-03	85.90	307.40	3.6
2003-04	85.10	301.90	3.5
2004-05	95.30	359.00	3.8
2005-06	110.60	391.20	3.5
2006-07	106.10	393.40	3.7
2007-08	104.10	382.60	3.7
2008-09	143.90	610.40	4.2
2009-10	142.10	679.30	4.8
2010-11	167.40	702.00	4.2
2011-12	155.10	755.60	4.9
2012-13	136.30	682.60	5.0
2013-14	132.60	655.10	4.9
2014-15	141.70	760.30	5.4
2015-16	164.00	1109.00	6.8
2016-17	168.00	1076.00	6.4
2017-18	168.00	1345.36	8.01
2018-19	167.39	1851.09	11.06
2019-20	178.15	1868.35	10.49
2020-21	204.50	2219.81	10.85
2021-22	210.01	2503.32	11.92
2022-23	205.89	2431.52	11.81
Mean	140.88	956.81	6.08
STDEV	38.90	692.16	2.88
R^2	0.81	0.84	0.89
CAGR	5.64* (-0.0032)	8.71* (-0.0046)	3.65* (-0.0051)
CV	27.61	72.34	47.30

Source: Spices Board, India and Ministry of Agriculture and Farmers Welfare, Govt. of India.

Note: Figures in the parentheses indicate standard error.

*Significant at one per cent level of probability.

**Significant at a five per cent level of probability.

production, indicating a substantial 72.34 per cent fluctuation. Following closely, the productivity exhibited a significant variation of 47.30 per cent, while the variation observed in the cultivation area amounted to 27.61 per cent.

These variations highlight the dynamic nature of ginger cultivation, showcasing the volatility in production, productivity and cultivation area over the specified period. The observed fluctuations, particularly in production, underscore the potential impact of various factors, such as environmental conditions, market dynamics and agricultural practices, on the stability of ginger farming in the Indian context. The very different practices of cultivation pose very relevant information with respect to the intrinsic problems and possible opportunities for the stakeholders associated with the ginger sector.

Table 2 provides a comprehensive overview of the distribution of ginger cultivation across Indian states during the 2022-23 period. Notably, Karnataka emerged as the leading state in terms of ginger cultivation area, contributing the highest share at 19.43%, followed closely by Madhya Pradesh at 16.26% and Orissa at 8.59%. In the production aspect, Madhya Pradesh claimed the top position with a significant share of 22.39%, showcasing its prowess in ginger output. Following closely, Karnataka secured the second position with a substantial production share of 20.56%, while Orissa attained the third position with a notable contribution of 9.36%. These state-wise insights illuminate the regional dynamics of ginger cultivation in India, highlighting the prominent roles played by Karnataka, Madhya Pradesh and Orissa in both area coverage and production levels.

An in-depth analysis has been conducted to understand the growth trends in the area, production and productivity of ginger over a 23-year period, from 2000-01 to 2022-23. Secondary information on the area and production of ginger from all these approved data sources was collected. This extensive investigation yields rather revelatory results, high favorable growth rates across areas, production and productivity of ginger cultivation. The compound growth rates for both area and production, as well as for the productivity of ginger, were computed in the present study. These growth rates were positive and statistically significant at a 1% level of probability in most cases. This implies that the confidence in the observation of these trends ought to be of a high order; the rises in area, production and productivity are not due to random fluctuations but indicate a genuine upward trend of ginger production over the analyzed period (Sanderson *et al.*, 2002).

Results of the analysis on growth rate give very encouraging outcomes. Positive growth in the area under ginger cultivation means more land allocation to ginger cultivation; this may be perceived as having better profitability, better support from agricultural policies, or betterment in farming techniques that make ginger cultivation more attractive to the farmers for production. Such an increase in production would mean a consequent increase in the total output of ginger. The increase in production may have been due to several general factors, which include improved agricultural practices, the adoption of high-yield varieties, better management of pests and diseases and possibly more favorable weather in the course of subsequent years.

This is most noticeable in the growth of productivity that the yield of ginger per unit area indicates, in that farmers are becoming efficient in cultivation. The primary reason for such an efficiency gain is in the development of farming technologies, followed by good extension and dissemination of knowledge to farmers and the adoption of improved seed varieties and fertilizers.

However, the present study has also flagged some issues, especially in the aspects of instability and variability

Table 2: Major state-wise share in area and production of ginger in India 2022-23.

State	Area (In ' 000 Hectare)	Per cent share	Production (In ' 000 MT)	Per cent share
Madhya Pradesh	33.49	16.26	544.53	22.39
Karnataka	40.00	19.43	500.00	20.56
Orissa	17.68	8.59	227.48	9.36
Assam	18.56	9.01	173.25	7.13
West Bengal	12.55	6.09	137.21	5.64
Maharashtra	9.16	4.45	131.47	5.41
Gujarat	5.04	2.45	111.30	4.58
Sikkim	15.28	7.42	81.80	3.36
Meghalaya	10.16	4.93	67.11	2.76
Kerala	3.22	1.56	65.64	2.70
Mizoram	8.56	4.16	60.13	2.47
Uttaranchal	4.51	2.19	44.92	1.85
Telangana	2.04	0.99	21.20	0.87
Arunachal Pradesh	3.64	1.77	19.20	0.79
Andhra Pradesh	0.52	0.25	2.80	0.12
Total including others	205.90	100.00	2431.52	100.00

Source: Spices Board, India and Ministry of Agriculture and Farmers Welfare, Govt. of India.

of ginger cultivation. Instability analysis revealed that productivity remained less variable compared to the area and production. This is an important inference because, although yield per unit area was relatively stable, it may not have caused distress, unlike the area under cultivation or total production, which has experienced significant fluctuations over the years.

The highest instability was in production, whereby the total output was subject to more fluctuations. Fluctuations in production can be caused by a variety of factors, which may include some of these: changes in climatic conditions, pests and diseases affecting crops and livestock, changes in the market and changes in farmers' behavior. For example, a bad year or a major pest attack would drastically reduce production and thereby contribute to high instability.

Variability also followed that of production in human areas under cultivation, but the degree was less compared to production. This could be attributed to changes in the land use pattern, crop preference dynamics among the farmers and economic factors in relation to the profitability of ginger compared to other crops.

An understanding of these instabilities is important for the development of strategies to minimize their impacts. For instance, production instability can be lessened by improving pest and disease management, increasing farmers' access to weather information and promoting resilient crop varieties. Similarly, better market access and price stabilization mechanisms for farmers could reduce instabilities related to the area under cultivation.

CONCLUSION

In the case of ginger, an analysis of the trends during the last 23 years shows a significant positive growth trend in area, production and productivity. Results also point out the instability in production and the variability of the area under ginger cultivation. These challenges, if focused on, open up a clear case for the formulation of targeted interventions by policymakers and relevant stakeholders toward sustaining and improving growth in the ginger sector. Such efforts are likely to lead to improved farmer incomes, food security and agricultural development at large. The conclusions that emerge from this study are very informative to any operator or actor in the ginger value chain, from farmers and agricultural extension officers to policymakers and market analysts. Such findings can be of immense use to the ginger sector, further expanding it and finally making it remain one of the important and very profitable crops in the future.

Conflict of interest

All authors declare that they have no conflict of interest.

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