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RESEARCH ARTICLE

AN EMPIRICAL ANALYSIS OF PRODUCTION AND YIELD OF CARDAMOM CULTIVATION IN INDIA

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Abstract: Cardamom, known as the "Queen of Spices," is an important high-value crop cultivated primarily in Kerala, Tamil Nadu, and Karnataka. This study examines the long-term performance of India's cardamom sector by analysing the trends, growth rates, and instability in area, production, and yield from 2000 to 2020. Secondary data were collected from Spices Board publications, government sources, and relevant literature. The study period was divided into two phases Phase I (2000–2010) and Phase II (2011–2020) and analysed using Annual Growth Rate (AGR), linear growth models, coefficient of variation, and the Cuddy–Della Valle Instability Index. The findings reveal substantial fluctuations across all variables, with both positive and negative growth rates throughout the two decades. Trend analysis shows consistently negative β_1 coefficients for area, production, and yield in all phases, indicating a declining tendency over the long term. Instability analysis indicates low instability in area, production, and yield across all periods, though production and yield exhibited comparatively higher variability in Phase II and Phase III. Overall, the results suggest that despite occasional improvement, cardamom cultivation faces persistent challenges related to environmental conditions, disease, and market fluctuations. Strengthened policy support and improved cultivation practices are necessary to enhance sustainability and productivity.

Keywords: Cardamom, Trend Analysis, Production, Yield, Instability, Growth Rate

INTRODUCTION

Cardamom, a major spice often referred to as the "Queen of Spices," has held a prominent place in Indian agriculture for centuries. India is one of the leading producers of cardamom globally, with its cultivation concentrated in the southern states, primarily Kerala, Tamil Nadu, and Karnataka. As one of the most valuable spices in the international market, cardamom plays a significant role in India's agricultural economy, contributing to both domestic consumption and export earnings.

The evolution of India's cardamom cultivation, production, and yield has been shaped by various internal and external factors. A major external influence on Indian agriculture as a whole, including the cardamom sector, was the globalization of the economy, which began with the liberalization policies introduced in 1991. Before this period, India followed protectionist agricultural policies aimed at self-sufficiency, limiting its exposure to global markets. The post-1991 liberalization policies opened up the agricultural sector to international competition, foreign direct investment, and modern technologies, impacting production patterns across the board (Rao, 2012).

Review of Literature

P.Arunachala Vadivu (2022)[1], in their based on Trend Analysis Of Cardamom Area, Production And Yield In India**,** The productivity of cardamom has been showing a declining trend. The decline is due to the environmental changes taking place in Kerala during the last few years. There is a decline of 50 per cent and so the cardamom growers are very much shocked. This can play a significant role in balance of payment problem, unemployment and national economy is affected in general. At this juncture, the researcher has taken the present study. The study reveals that linear, logarithmic, quadratic and exponential trend models estimated that the cardamom production in India is found to be 27.707 thousand tonnes, 22.803 thousand tonnes, 29.624 thousand tonnes and 32.268 thousand tonnes for the year 2024-25 respectively. Hence, there has been a steady increase in the production of cardamom in India. India can reclaim the first place in cardamom trade soon, provided the Indian government pays more attention to cardamom cultivation, marketing activities, export promotional activities and minimum support price to farmers.

Mohan Acharya(2019)[2], A review on status and profitability of large cardamom production in Nepal, This study focuses on the status, strength and problems of large cardamom cultivation in Nepal and also identify profitability of large cardamom farming in Nepal. Numbers of journal articles and reports were consulted as secondary source of data and conclusion were drawn and summarized. Area and production of large cardamom in Nepal is increasing day by day and major production is concentrated in four eastern districts . B/C ratio of cardamom production varies from 1.70 to 3.06 and one fifth of household income in eastern hill of Nepal is attributed by Large cardamom. Price fluctuation, middleman and diseases are identified as major problems. Lack of funding, less access to the data and documents are the limitations of study.

Sanjeeb Kumar Jena, and Sodyong Kri(2019)[3] Cost benefit analysis of large cardamom cultivation in Anjaw district of Arunachal Pradesh, India is the largest seller of large cardamom in the international market and the second largest producer after Nepal. The favourable conditions prevailed in the Himalayan foothill has induced a geometric growth in large cardamom cultivation and trading. With the striking success of this cash cropping in Sikkim, the farming communities of Arunachal Pradesh had shifted to large cardamom farming, commercially, from the traditional subsistence farming with some indications of success. This study has aimed to analyze the cost-benefit-return of the large cardamom cultivation in the Anjaw District of Arunachal Pradesh. The study is empirical in nature and based on the primary data collected from 5 circles of Anjaw District. The data were collected from 200 cardamom growers (40 each from each 5 circles), selected at random through a questionnaire schedule. The earning from commercialized large cardamom cultivation in the study area i.e., Anjaw District of Arunachal Pradesh is very highly remunerative (27.67%) compared to other traditional and cash-crops which is a reason for the popularity of the large cardamom as a substitute for the traditional subsistence farming in these areas.The failure in the subsistence farming in Arunachal Pradesh made the masses diverted from the agrarian activities hampering the balance of employment and livelihood. The CB analysis is a device to confirm the popularity among the agrarian communities for the change and is an instrument for the policy makers to plan for a sustainable development.

Objectives of the Study

1. to trace the movements of cardamom production, an area under cultivation, and productivity of cardamom in India

2. to measure the instability in area, production and yield of cardamom in India.

MATERIAL AND METHODS

The necessary data has been collected from the Spices Board and various journals, books and websites. Published by the Government of India. The study period is divided into two periods as Phase-I (2000-01to 2009-2010) and Phase-II (2010-2011 to 2019-2020). Annual Growth rate, linear Growth rate of cardamom Production, an area under cultivation, and yield. To estimate the Annual Growth Rate (AGR), the following formula was used.

$$AGR = \frac{Y_t - Y_{t-1}}{Y_{t-1}} X100$$

Where AGR = Annual Growth Rate, Y_t= current year, Y_{t-1} = Previous year, t = Time Period. The linear growth model: $Y_t = \alpha+\beta 1$ Years + U_t and the second objective is to study the Instability Analysis: To measure the instability of major spice area, yield, and production, the coefficient of variation (CV) is calculated using the formula:

$$CV = \frac{(\text{standard Deviation})}{Mean} X100$$

Cuddy Della Valle Instability Index

Further to examine the instability in the area, yield and production of cardamom in India measured by Cuddy Della Valle instability index is used. Co efficient of variation is measures instability but it over estimates the level of it in time series data. The Cuddy Della Valle instability index (1978) de trends and shows the exact direction of the instability.

C.V = S.D/Mean

IX = CV*√1-Adj R2

The ranges of CDVI are given as follows Low instability = between 0 and 15

RESULTS

Medium instability = greater than 15 and lower than 30 High instability = greater than 30

Analysis and Interpretation:

Table No:1 Decadal growth rates of Area under Cultivation of Cardamom in India

Decades	AGR	Decades	AGR
2000-01	**8.962264**	**2010-11**	7.538803
2001-02	**-0.8658**	**2011-12**	-8.24742
2002-03	**-3.38428**	**2012-13**	3.820225
2003-04	**8.022599**	**2013-14**	0.47619
2004-05	**-0.41841**	**2014-15**	7.712193

2005-06	**0.630252**	**2015-16**	-14.4
2006-07	**2.505219**	**2016-17**	-1.07477
2007-08	**-16.7006**	**2017-18**	-0.56684
2008-09	**12.45721**	**2018-19**	-3.66983
2009-10	**-1.94586**	**2019-20**	7.286401

Source: Statistics at a Glance for Horticulture 2018

The data on year-over-year percentage changes (Annual Growth Rate or AGR) in cardamom cultivation in India from 2000-01 to 2019-20 highlights substantial fluctuations across two decades. The period from 2000 to 2010 shows marked variability, with notable increases such as an AGR of 8.96% in 2000-01 and 12.46% in 2008-09, alongside sharp declines, like -16.7% in 2007-08. From 2010 to 2020, the trend continues with significant shifts, including a steep drop of -14.4% in 2015-16, and moderate positive growth in years like 2012-13 (3.82%) and 2014-15 (7.71%). The data concludes with a recovery of 7.29% in 2019-20, reflecting an increase in cultivated area. These fluctuations suggest that factors such as market demand, climatic conditions, and policy changes may have significantly influenced cardamom farming in India, resulting in an overall pattern of irregular yet notable growth.

Table 2: Trend of area under of Cardamom in India 2000-2020

Decades Analysis	**Model Summary**			**Parameter Estimate**	
Phase-I 2000-10	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.038673739	0.321837	000	3.826164528	-0.527255696
Phase-II 2011-20	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.002289	0.018351	0.89559	1.665662	-0.11472
Phase-III 2000-20 Total	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.015424	0.281983	0.601896	2.063211	-0.15775

Source: Calculated from secondary data of table 1

The decadal analysis of the area under cardamom cultivation in India from 2000 to 2020, shown through a linear model, presents low explanatory power in all three phases, as reflected by low R-squared values. In Phase-I (2000-10), the model has an R-squared of 0.0387, indicating only a minimal percentage of variation in cardamom cultivation is explained by the model, with a slope coefficient (β1) of -0.5273, suggesting a slight downward trend in cultivated area. Phase-II(2011-20) shows an even lower R-squared of 0.0023, with a slope of -0.1147, indicating a continued but very slight decline in area, and the high p-value (Sig = 0.8956) suggests no significant relationship. Phase-III (2000-20 overall) also yields a low R-squared (0.0154) and a small negative slope of -0.1578, suggesting a negligible overall downward trend. These results indicate that the linear model poorly captures the trend in the area under cardamom cultivation, implying that other factors or non-linear models may better explain the changes over these decades.

Table No: 3 Decadal growth rates of Production of Cardamom in India

Decades	**AGR**	**Decades**	**AGR**
2000-01	35.51402	2010-11	1.78117
2001-02	4.827586	2011-12	-1.25
2002-03	1.315789	2012-13	16.4557
2003-04	8.441558	2013-14	15.65217
2004-05	1.197605	2014-15	12.78195
2005-06	5.325444	2015-16	0.291667
2006-07	-11.7978	2016-17	14.91483
2007-08	-14.6497	2017-18	2.096891
2008-09	15.29851	2018-19	-20.0779

2009-10	1.747573	2019-2020	-9.52592

Source : Statistics at a Glance for Horticulture 2018

The production of cardamom in India from 2000-01 to 2019-20 has experienced considerable year-to-year variability in growth rates (AGR), with periods of both significant increases and sharp declines. In the early 2000s, production saw strong growth, particularly in 2000-01 with a high AGR of 35.51%, though smaller gains and occasional declines followed, such as -11.8% in 2006-07 and -14.65% in 2007-08. From 2010 onwards, production continues this pattern of fluctuation: there were notable increases in 2012-13 (16.46%), 2013-14 (15.65%), and 2016-17 (14.91%), indicating productive years, contrasted by steep declines like -20.08% in 2018-19 and -9.53% in 2019-20. This volatility in production could be influenced by variable factors such as weather conditions, disease, and market demand, leading to an overall pattern of inconsistency in cardamom production over the two decades.

Table 4: Trend of production of cardamom in India 2000-2020

Decades Analysis	**Model Summary**			**Parameter Estimate**	
Phase-I 2000-10	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.232553354	2.424177	0.15809	16.95603186	-2.22435766
Phase-I I 2011-2020	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.239700004	2.522162	0.150919	33.37787361	-1.939730158
Phase-III 2000-2020 Total	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.084238	1.655767	0.214479	10.5545	-0.62261

Source: Calculated from secondary data of table 3

The table presents a trend analysis of cardamom production in India over two decades, divided into three phases: 2000-2010, 2011-2020, and the overall period from 2000 to 2020. In Phase-I (2000-2010), the model shows an R-Square of 0.2325, indicating that about 23.25% of the variation in production can be explained by the linear trend, though with low significance (Sig = 0.158). The constant and β1 parameter estimate values (-2.2244) suggest a slight decline in production over this period. In Phase-II (2011-2020), the R-Square is slightly higher at 0.2397, with a significance level of 0.1509, showing another weak but slightly more consistent negative trend (β1 = -1.9397). For the overall Phase-III (2000-2020), the model's R-Square drops to 0.0842, indicating that only 8.42% of the variation is explained by the model with very low significance (Sig = 0.2145), and a milder negative trend (β1 = -0.6226). This suggests that cardamom production has experienced slight declining trends in each period, with weak predictive power, indicating that other unaccounted factors may influence production levels.

Table No: 5 Decadal growth rates of Yield of cardamom in India (in Tons)

Decades	**AGR**	**Decades**	**AGR**
2000-01	24.60317	2010-11	5.747126
2001-02	5.732484	2011-12	-3.26087
2002-03	4.819277	2012-13	11.79775
2003-04	0.574713	2013-14	15.07538
2004-05	1.714286	2014-15	4.803493
2005-06	4.494382	2015-16	17.08333
2006-07	-13.9785	2016-17	16.37011
2007-08	2.5	2017-18	2.446483
2008-09	2.439024	2018-19	-17.0149
2009-10	3.571429	2019-20	-15.4676

Source : Statistics at a Glance for Horticulture 2018

The table shows the annual growth rate (AGR) of cardamom yield in India from 2000-01 to 2019-20, highlighting considerable fluctuations. The early 2000s saw moderate to low growth, with high volatility, including a major dip in 2006-07 (-13.98). Growth picked up intermittently, with notable peaks in 2012-13 (11.80), 2013-14 (15.08), 2015-16 (17.08), and 2016-17 (16.37), indicating periods of substantial yield improvements. However, the later years, particularly 2018-19 and 2019-20, saw sharp declines (-17.01 and -15.47 respectively), indicating instability and challenges in

sustaining growth. This pattern suggests that cardamom yield is influenced by various factors that result in unpredictable fluctuations, possibly due to climatic variability, pest outbreaks, and market conditions, making yield levels volatile across the years.

Table No: 6 Trend of yield of cardamom in India 2000-2020

Decades Analysis	**Model Summary**			**Parameter Estimate**	
Phase-I 2000-10	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.275192	3.037401	0.119532	12.47422	-1.60494
Phase-II 2011-20	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.220737	2.266116	0.170648	33.61229	-1.92608
Phase-III 2000-20 Total	**R Square**	**F**	**Sig**	**Constant**	**β_1**
Linear	0.056881	1.08561	0.311239	8.214523	-0.42971

Source: Calculated from secondary data of table 5

The table provides a trend analysis of cardamom yield in India from 2000 to 2020, broken down into three phases: Phase-I (2000-2010), Phase-II (2011-2020), and the entire period, Phase-III (2000-2020). In Phase-I, the model shows an R-Square of 0.2752, indicating that 27.52% of the variation in yield can be explained by the linear model, with a significance level of 0.1195, suggesting a weak relationship. The negative β1 parameter (-1.6049) implies a declining yield trend during this period. Phase-II shows a slightly lower R-Square of 0.2207 and significance of 0.1706, with a similar negative trend (β1 = -1.9261), indicating a continued decline in yield but with limited predictive strength. For the entire period in Phase-III, the R-Square drops to 0.0569, and the model's significance is very low (0.3112), with an even milder declining trend (β1 = -0.4297). This suggests that while the yield of cardamom has generally trended downwards over the past two decades, the models have limited explanatory power, indicating that external factors not captured by the model likely play a significant role in yield variations.

Table No:7 Summary of Growth Rate

Linear model the value of β_1								
Area under Cultivation			**Production of cardamom**			**Yield of cardamom**		
Phase I	**Phase II**	**Phase III**	**Phase I**	**Phase II**	**Phase III**	**Phase I**	**Phase II**	**Phase III**
-0.527255696	-0.11472	-0.15775	-2.22435766	-1.939730158	-0.62261	-1.60494	-1.92608	-0.42971

Sources: calculated from secondary data of table 2, 4&6

The table summarizes the growth rate trends for cardamom in India from 2000 to 2020 across three phases (Phase I: 2000-2010, Phase II: 2011-2020, and Phase III: 2000-2020) using a linear model. The β1 values indicate the rate of change for area under cultivation, production, and yield of cardamom, all showing negative trends. In terms of area under cultivation, Phase I had the steepest decline (-0.5273), while Phases II and III saw smaller reductions (-0.1147 and -0.1578, respectively). For production, the trend was consistently negative, with the steepest decline in Phase I (-2.2244) and a slower decrease in Phase III (-0.6226). Yield also followed a similar downward trend, with Phase I showing a β1 of -1.6049, Phase II at -1.9261, and a gentler slope in Phase III (-0.4297). These trends reflect overall declines in cultivation area, production, and yield, suggesting challenges in sustaining growth across all metrics for cardamom over the 20-year period.

Cuddy Della Valle Instability Index

The table presents the Cuddy Della Valle Instability Index (CDVI) for cardamom in India during Phase-I (2000-2010), assessing the stability of area, production, and yield. The coefficients of variation (C.V.) for area, production, and yield are low, indicating minimal fluctuations over the period. The adjusted R-squared (Ad.R2) values are negative, suggesting that the model explains very little of the variation, reflecting limited predictive strength. The CDVI values for area (0.047), production (0.073), and yield (0.048) all fall within the range of low instability. These results imply that, during Phase-I, cardamom cultivation, production, and yield in India were relatively stable, with only minor year-to-year variations.

Table No.8Cuddy Della valley index for cardamom in India (Phase-I)

Variable	C.V	Ad.R^2	CDVI	Inference
Area	0.050	-0.094	0.047	Low instability
Production	0.079	-0.124	0.073	Low instability
Yield	0.051	-0.093	0.048	Low instability

Source: calculation from excel

Table No.9 Cuddy Della valley index for cardamom in India (Phase-II)

Variable	C.V	Ad.R^2	CDVI	Inference
Area	**0.067**	0.398	0.051	Low instability
Production	**0.198**	0.361	0.158	Low instability
Yield	**0.223**	0.454	0.164	Low instability

Source: calculation from excel

The table displays the Cuddy Della Valle Instability Index (CDVI) for cardamom in India during Phase-II (2011-2020), measuring the stability of area, production, and yield. The coefficients of variation (C.V.) show that area (0.067) had low variation, while production (0.198) and yield (0.223) were somewhat more variable. Positive adjusted R-squared (Ad.R2) values for area (0.398), production (0.361), and yield (0.454) suggest a modest explanatory power of the model in this phase. CDVI values for area (0.051), production (0.158), and yield (0.164) indicate low instability across all variables, though production and yield experienced slightly higher variability than the area under cultivation. Overall, Phase-II reflects low instability, suggesting moderate year-to-year consistency in cardamom area, production, and yield in India, despite slight increases in variability compared to Phase-I.

Table No.10 Cuddy Della valley index for cardamom in India (Phase-III)

Variable	C.V	Ad.R^2	CDVI	Inference
Area	0.059	0.151	0.054	Low instability
Production	0.236	0.578	0.153	Low instability
Yield	0.266	0.627	0.162	Low instability

Source: calculation from excel

The table provides the Cuddy Della Valle Instability Index (CDVI) for cardamom in India during Phase-III (2000-2020), evaluating the stability of area, production, and yield over the entire period. The coefficient of variation (C.V.) shows that area under cultivation (0.059) had low variability, while production (0.236) and yield (0.266) exhibited higher fluctuations. The adjusted R-squared (Ad.R2) values are positive and highest for yield (0.627), followed by production (0.578) and area (0.151), indicating a fair degree of model fit, especially for yield. CDVI values for area (0.054), production (0.153), and yield (0.162) suggest low instability across all variables, with production and yield showing slightly more variation than area. Overall, Phase-III reflects generally low instability in cardamom cultivation, production, and yield, with production and yield being relatively more volatile than the cultivation area over the 20-year period.

CONCLUSION

The study highlights that cardamom cultivation in India faces numerous challenges, with declining trends in area, production, and yield over the analyzed period. While the sector has seen moments of growth, these have been offset by declines influenced by environmental changes, market demand, and possibly policy constraints. The findings suggest a need for further interventions in agricultural practices, policy support, and climate adaptation strategies to sustain cardamom cultivation and enhance productivity in the long term.

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