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RESEARCH PAPER

Dynamics of Low Volume High Value Spices Crop in North-East Region of India

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ABSTRACT

In this paper an attempt has been made to estimate the effects of cropped area and year on production of Chilli, Ginger and Turmeric spice crops in the north-east region of India, the secondary data for the period of 1985-1986 to 2024-2025 were compiled, to evaluate the impact of all crops; three regression equations for each of the crops have been fitted by the method of least squares. To examine the significance of the estimated regression equations, analysis of variance is carried out for each of the crops viz; Chilli, Ginger and Turmeric separately.

HIGHLIGHTS

- The overall coefficient of variation for spice crops was 70.00 per cent.
- To grow the spices is less riskiness in the north-east region of India.
- Overall production and productivity of the spice crops were increasing.
- Productivity can be increased by taking appropriate production technologies.

Keywords: Impact, chilli, ginger, turmeric, year, cropped area

Spice crops are aromatic or pungent vegetables substances used for flavouring food and have several medicinal properties. Spice crops are valued for medicinal properties for example antioxidant properties of turmeric, anti obesity properties of ginger. Even some spice crops like turmeric, saffron etc are used as natural coloring in food industry. Spice crops are also good source of mineral and vitamins (Bey and Sharma, 2024)b. Hence spice crops become integral part of our daily diets. Most of the spice crops are native of our country hence, India is known as the land of spice crops. As the average productivity of low in India many of the spice crops viz; chilli is about 1,642.53 kg / ha, ginger is about 5,010.12 kg / ha and turmeric is 4,999.34 kg / ha (Bey and Sharma, 2024)a. India is the largest producer, consumer and exporter of spice crops. The present annual production of spice crops in India is about 5.74 mt from an area of 3.08 mha (Bey and Sharma, 2024)b.

The north-east region of India region occupies about 1.41 mha area with production of 1.81 mt of spice crops (Anon. 2026). India is the largest producer and exporter of pepper, ginger, turmeric, seed spice crops etc. The agro-climatic condition of India including north-east region of India hill region is very suitable and all spice crops i.e., tropical to temperate are being grown (Anon. 2023.b). Major spice crops are being grown in north-east region of India region are chilli, ginger, turmeric, large cardamom, black pepper etc. North-east region of India region is coming forward in organic production of ginger and turmeric and exporting

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about 60.00 to 70.00 per cent production outside the region and neighbouring countries. Share in national market of ginger, turmeric, chilli, large cardamom and black pepper are 40.00, 12.00, 4.00, 90.00 and 5.00 per cent respectively (Anon. 2026).

It has been observed that there are wide fluctuations year to year in the production and productivity of Chilli, Ginger and Turmeric crops in north-east region of India, which may be attributed mainly due to variations in area under crops (Anon. 2023.a). Therefore, it is important to evaluate the factors governing the production of ginger and turmeric. Keeping these views an attempt has been made to estimate the impacts of area and year on the production of Chilli, Ginger and Turmeric in north-east region of India during 1985-1986 to 2024-2025. (Anon. 2026).

METHODS

Time series secondary data were collected for year wise area and production of Chilli, Ginger and Turmeric from different sources viz; National Horticulture Board, Directorates of State Governments, Basic Statistics of North-east region of India Region, Directorate of Economics and Statistics at Shillong, Meghalaya for the state level data for the period of 1985-1986 to 2024-2025 (Sharma and Kalita, 2004; Debbarma and Sharma, 2024). A linear regression equation of production on area and year for major spice crops viz; Chilli, Ginger and Turmeric were fitted to the data. The Multi-collinearity was found to be significant between cropped area and time in year. Therefore, separate regression equations were fitted between production of Chilli, Ginger and Turmeric with years to find out the effects of year on production independently approach was adopted (Sharma and Kalita, 2008; Sharma, 2014; Khodang and Sharma, 2022).

DATA ANALYSIS

Accordingly, in the present study also Compound Growth Rates were computed for area, production and productivity of Chilli, Ginger and Turmeric crops based on the Linear function for the periods (Dhakre and Sharma, 2009; Sharma, 2013; Sharma, 2018). The compound growth rates were computed as follows:

Linear trend equation: $Y = a + bx$

Where, x is the time variable, y is the variable for which growth rate is calculated and b is the regression co-efficient of Y on x. Now, Compound Growth percentage will be:

$$(\text{CGR } \%) = (b - 1) \times 100$$

The significant of growth rates was tested by applying student 't' test

Whereas: $t = g / SE\,(r)$, with $(N–2)$ *d. f.* where r is the growth and N is the total number of years considered under study.

$$SE\,(r) = 100\, b / 0.4329 \sqrt{[\,(\Sigma \log r^2) - (\Sigma \log Y)^2 / N - (\log b)^2 \Sigma x^2]\,/\,(N–2)\,\Sigma x^2}$$

To measure the magnitude of variability in area, production and productivity for the total period, the co-efficient of variation (%) was computed. Further the instability index was also calculated to examine the instability in area, production and productivity of major spice crops in the North-east region of India Region of India by using the following formula:

$$\textit{Instability Index}\ (I) = (I - R^2) \times CV^2$$

An attempt was also made to study the effects of area, productivity and their interaction towards increasing production by using y the following formula:

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

Whereas: $\Delta A = A_n - A_0$

$$\Delta Y = Y_n - Y_0$$

$$\Delta P = A_n - A_0$$

A_o, P_o and Y_o representing the area, production and productivity in the base year and A_n, P_n and Y_n the corresponding area, production and productivity in the current year. The first, second and third on the right side of above equation represent area, productivity and interaction effect, respectively.

The periods 1985-1986 to 2024-2025 was divided into two parts viz, (i) 1985-1986 to 2004-2005. (ii) 2005-2006 to 2024-2025 and contribution of area, productivity an their interaction to total different

production of the crop were worked out separately for each of the sub-periods and for the total period.

Regression equations is:

$$Y = A_1 + b_1 X_1 + b_2 X_2 + u_1 \quad \ldots(1)$$

Whereas: Y = Production of Chilli or Ginger or Turmeric in tonnes (t).

X_1 = Grossed cropped area of Chilli or Ginger or Turmeric in hectare (ha).

X_2 = Year.

A = Intercept.

U = Random disturbance term.

b_1 and b_2 are the partial regression coefficients of the respective explanatory variables. The functions were estimated by the method of ordinary least squares applied to the data. The Result was estimated from the regression equation (1) and finally complied in the Table 1 and Table 2.

Data Base

The present study is based entirely on secondary sources. The secondary data regarding area, production and productivity of major spice crops like - Chilli, Ginger and Turmeric spice crops were obtained. The study entails a temporal as well as spatial analysis of the growth of production, area and productivity of various spice crops grown in north-east region of India Region of India among with the disposal of spice crops to the interstate as well as terminal markets. In the present study, an attempt has been made to compare the difference in growth of area and production of major spice crops. The time series data on area, production and productivity of major spice crops like - Chilli, Ginger and Turmeric crops for the period 1985-86 to 2024-2025 were obtained from various publications of Government of India (Anon. 2026).

Analytical Framework

To analyze the trend of area, production and productivity of Chilli, Ginger and Turmeric the following different functional forms were selected:

1. Linear function $Y = a + bx$
2. Quadratic function $Y = a + bx + cx^2$
3. Exponential function $Y = a.\ b^x$

Whereas: Y = Area, production and productivity of spice crops

X = Time variable

The functional form having the highest Co-efficient of Determination (R^2) is selected for fitting the trend (Sharma and Kalita, 2004; Sharma and Kalita, 2008; Sharma, 2012a; Sharma, 2015; Talang *et al.* 2024). Along with this, growth rates of area, production and productivity of the spice crops were computed.

RESULTS AND DISCUSSION

Table 1 reveals that the different functional forms viz; linear, quadratic and exponential coefficients of determination (R^2) were computed and are presented in the table; the R^2 values of linear function for all three aspects, viz; area, production and productivity for all the spice crops were higher (ranging from 13.67 to 92.43 per cent) than quadratic (3.64 to 56.07 per cent) and exponential (5.47 to 82.54 per cent) functions except in some aspects in some spice crops. Hence the linear functional form was selected for fitting trend of area, production and productivity of Chilli, Ginger and Turmeric crops based on the best fitted trend of production. Similar research findings were reported by Sharma (2012)a; Sharma (2012)b; Jamir and Sharma (2021).

Table 2 reveals that the 'b' value in the linear functional forms for area, production and productivity, which were positive on Chilli and Ginger, which indicates the better prospects / contribution towards the spice crops as well as better scopes in the future; except turmeric, this implies the acceleration of growth of area, production and productivity of the spice crops. The growth of area, production and productivity of turmeric was decreasing during the periods viz; 1985-1986 to 2004-2005 and 2005-2006 to 2024-2025. However, the '*b*' value for area of turmeric area, production and productivity during 1985-1986 to 2004-2005 and 2005-2006 to 2024-25 were found to be negative; reflecting the retardation of growth of area, production and productivity, respectively. Similar research findings were reported by Choudury *et al.* (2017); Bey and Sharma (2024)c.

Table 3 reveals that the overall compound growth rates was found to be maximum ranging from 6.57 to minimum of 0.99 times as returns against the investment, which was found to be positively

Table 1: R^2 value of Linear, Quadratic & Exponential function for major spice crops of north-east region of India (1985-86 to 2024-2025)

Crops	Aspects	Linear	Quadratic	Exponential
Chilli	Area	72.35	43.26	53.82
	Production	61.89	42.12	52.94
	Productivity	33.35	23.54	31.42
Ginger	Area	82.43	56.07	79.53
	Production	79.52	48.87	70.12
	Productivity	13.67	3.64	5.47
Turmeric	Area	59.85	37.15	50.16
	Production	92.43	54.67	82.54
	Productivity	88.54	52.67	80.24

Table 2: Results of the fitted linear function trend for major spice crops of north-east region of India (1985-86 to 2024-2025)

Sl. No.	Crops	Aspects	1985-86 to 2004-05		2005-06 to 2024-25		1985-86 to 2024-25	
			a	*b*	*a*	*b*	*a*	*b*
1	Chilli	Area	1.3127	0.1144	4.3272	0.0637	7.5246	0.0323
		Production	1.0773	0.3231	6.7646	0.0786	9.5331	0.8715
		Productivity	1.7865	0.1234	2.8212	0.0323	5.515	1.1529
2	Ginger	Area	2.8781	0.1431	3.9212	0.1981	3.267	1.0021
		Production	3.3421	0.2987	7.5321	0.1675	1.505	0.0341
		Productivity	2.8712	0.1231	3.8712	0.0456	2.348	-0.0874
3	Turmeric	Area	-44.350	0.002	2.144	-0.002	-28.793	-0.7413
		Production	-15.469	0.001	0.125	0.000	-6.941	-0.4341
		Productivity	-22.771	40.175	-2.310	-0.638	-11.969	-0.5966

Table 3: Compound Growth Rate (CGR) (%) of Area, Production and Productivity of major spice crops in north-east region of India

Sl. No.	Crops	Aspects	CGR %		
			85-86 to 04-05	05-06 to 24-25	85-86 to 24-25
1	Chilli	Area	1.81*	0.41^{NS}	1.28*
		Production	3.54**	1.06*	2.92**
		Productivity	1.89*	1.42*	1.68*
2	Ginger	Area	1.98*	0.32^{NS}	5.59**
		Production	3.73**	1.01^{NS}	6.57**
		Productivity	1.95*	1.22^{NS}	0.99*
3	Turmeric	Area	-0.53	-0.41^{NS}	1.48*
		Production	0.67^{NS}	-0.44^{NS}	5.26**
		Productivity	-0.57^{NS}	-0.13^{NS}	3.89**

Note: *** Significant at 1 per cent probability level, * Significant at 5 per cent probability level, NS - Non-Significant.*

significant at 5 per cent on area, production and productivity of major spice crops viz; Chilli, Ginger and Turmeric; except on the Chilli productivity it was found to be significant at 10.00 per cent level of probability, whereas the record shows that the growth of area, production and productivity of the spice crops during the period of 1985-1986 to 2004-2005 and 2005-2006 to 2024-25 were also found to be positive and significant, this assumption clearly shows better contribution toward the gross returns during the periods of study. Except some of the period it was found to be negative, which shows less contribution towards on turmeric spice crop towards the net return; especially during the year

1985-1986 to 2004-2005 and 2005-2006 to 2024-2025. Similar line of findings were reported by Sharma (2012); Sharma (2018); Bey and Sharma (2024)d.

Further table reveals that the assumption on overall compound growth rates were seemed to be positively significant and recorded for the growth of area, production and productivity of the spice crops, this assumption seemed recorded for the period from 2005-2006 to 2024-2025, while it has positive response towards the net return during the period 1985-1986 to 2004-2005. Similar findings were reported by Sharma (2013); Sharma (2018).

Variation and instability in Area, Production and Productivity

Table 4 reveals that the co-efficient of variation (%) of area, production and productivity of the spice crops were worked out for the period of 1985-1986 to 2024-2025. Data further reveals that growing of Chilli and Ginger both spice crops were having the scope, whereas the turmeric crops growing were found to be riskiness during the period viz; 1985-1986 to 2004-2005, 2005-2006 to 2024-25 and even overall period 1985-1986 to 2024-25 in the north-east region of India as revealed by the negative with lower coefficient of variations. The coefficients of variation (CV) of area, production and productivity of the spice crops were not more than 24.00 per cent, even the raising of spice crops in the north-east region is not riskiness, which has coefficients of variation of less than -2.721 per cent, respectively. Similar research findings were reported by Bey and Sharma (2024)d.

Whereas, the results of the instability indices depicted that the instability indices for area, production and productivity for various spice crops in the north-east region were positive (23.235) and thereby indicating further scope in the future by growing more of Chilli and Ginger, whereas the negative response (-4065.58) will be more riskiness in the days to come. Similar research work reported by Sharma and Kalita (2004); Dhakre and Sharma (2009); Sharma (2012); Sharma (2015); Bey and Sharma (2024)b.

Measurements of Effects

Table 5 reveals to determine how the relative contributions of area, productivity and their

Table 4: Co-efficient of variation (%) in area, production and productivity of major spice crops in north-east region of India

Sl. No.	Crops	Aspects	1985-86 to 2004-05		2005-06 to 2024-25		1985-86 to 2024-25	
			CV (%)	Ins. Ind.	CV(%)	Ins. Ind.	CV (%)	Ins. Ind.
1	Chilli	Area	6.12	0.20	3.13	2.421	5.045	0.012
		Production	15.21	0.68	19.17	9.212	9.312	0.556
		Productivity	8.92	3.71	21.11	12.161	7.589	23.235
2	Ginger	Area	1.16	0.65	3.59	2.57	3.697	0.4832
		Production	1.23	0.56	1.75	1.3164	1.525	0.3521
		Productivity	1.38	1.55	2.18	2.745	2.748	2.887
3	Termeric	Area	0.97	-4213.45	-0.48	-202.35	-2.721	-805.02
		Production	1.05	-1670.52	1.01	-1306.84	0.694	-482.01
		Productivity	1.18	-4065.58	1.43	-2794.92	1.969	-1896.62

Table 5: Effect of change in area, productivity and their interaction on differential production of major spice crops of north-east region of India

Crops	Aspects	Differential production (ΔP)	Area effect ($Y_0 \Delta A$)	Productivity effect ($A_0 \Delta Y$)	Interaction ($\Delta A \Delta Y$)
Chilli	1985-2005	242813.38	85869.04	308004.40	129433.14
	2006-2025	201809.24	121566.40	295158.20	84139.71
	1985-2025	1769671.15	166403.44	304847.40	264049.20
Ginger	1985-2005	54540.98	18401.60	-5272.64	-12516.80
	2006-2025	1326.45	1048.32	21330.56	3919.54
	1985-2025	1564350.80	21690.54	-295.53	-827.68
Turmeric	1985-2005	522.47	427.15	415.40	349.45
	2006-2025	1049.24	858.18	1979.75	1682.88
	1985-2025	107537.22	1178.47	1017.36	2514.07

Table 6: Production function of chilli, ginger & turmeric for north-east region of India (1985-1986 to 2024-2025)

Sl. No.	Crops	Constant	Regression Co-efficient of		R^2
			X_1	X_2	
1	Chilli	2.567823	1.192843* (0.31346)	0.086231NS (0.17234)	0.5134298*
2	Ginger	3.673412	3.920954** (0.421671)	0.192094* (0.102567)	0.6956215**
3	Turmeric	0.674532	0.032451NS (0.03497)	0.145322NS (0.145606)	0.176520NS

Chilli SE of estimate = 0.42356, Ginger SE of estimate = 0.532045 & Turmeric SE of estimate = 0.062309.

interaction were responsible for the increased the spice crops production of the north-east region during each of the period viz; 1985-1986 to 2004-2005, 2005-2006 to 2024-2025 and even 1985-1986 to 2024-2025 (as the overall time period). The changes in production were partitioned separately in various effects. The situation of major spice crops in overall time period in the north-east region is seems to be good. The production of all major spice crops were increasing, which was due to increase in area as well as interaction of area and productivity too, except in turmeric spice crop. The interaction of area and productivity of Chilli and Ginger both spice crops were showing the increasing trends over the time period; which has indicated by the positive values, although the interaction of area and productivity on turmeric during 1985-1986 to 2024-25 were found negative and decreasing trends, but for the overall time periods it was seen to be follow towards the increasing trend. Similar findings were reported by Sharma (2014); Bey and Sharma (2024)b.

Table 6 reveals that the Co-efficient of multiple determinations (R^2) for the ginger was found to be 0.6956215. This indicates that 69.56 per cent of the total variation in the production of ginger for the period under report was explained by gross cropped area (X_1) and average year (X_2). The partial regression coefficients of X_1 and X_2 for the elasticities of production of ginger was positive significant at 1 per cent level of significance. The ANOVA for multiple linear regressions was evaluated and coefficient of multiple determinations (R^2) was found to be highly significant at 1 per cent level of significance (Sharma, 2013).

Table 6 reveals that the co-efficient of multiple determinations (R^2) for the turmeric crop was 0.176520, this reflects that only 17.65 per cent of the total variation in the production of turmeric crop was explained by the gross cropped area (X_1) and average rainfall (X_2) for the elasticity of production of turmeric was positive, which was found to be non-significant, in this case even the R^2 was also found to be non-significant. Also, the co-efficient of multiple determinations (R^2) for ginger with respect to the years was found to be 3.920954, which was found to be significant and further evaluated through analysis of variance and found to be highly significant at 1 per cent level, in this case regression co-efficient *b*2 is significant at 1 per cent level of significance. The partial regression co-efficient of X_3 for the elasticities of production of turmeric was 0.674532 and found to be non-significant. (Debbarma and Sharma, 2024)

Table 6 reveals that R^2 for turmeric with respect to the time was 0.176520, that mean only 17.65 per cent of the variance in the production of turmeric in the north-east region was explained by X_3 which was non-significant with positive return. In case of turmeric, further study is required to find out an efficient function and factors which are responsible for the production and productivity of turmeric crop in the north-east region of India (Chaoudury *et al.* 2017).

Table 7: ANOVA for regressions

Sl. No.	Crops	Sources	D. F.	MSS	F-Ratio
1	Chilli	Regression	2	1.92616	11.42483**
		Residual	28	0.168109	
2	Ginger	Regression	2	1.95234	12.23487**
		Residual	28	0.187823	
3	Turmeric	Regression	2	0.00088	0.231837NS
		Residual	28	0.003797	

Figures in parenthesis are standard errors of respective regression co-efficient.

*** Significant at 0.1 per cent, * Significant at 0.5 per cent, NS - Non Significant.*

R^2 - Coefficient of multiple determinations.

Table 7 reveals the value of analysis of variance (ANOVA) which indicate that turmeric is having decline trend and found to be non-significant,

whereas chilli and ginger have further better scope in the days to come (Jamir and Sharma, 2021).

CONCLUSION & POLICY RECOMMENDATIONS

The above discussion highlighted the fact that the growth of area, production and productivity for all the major spice crops in the north-east region were positive and some were it was statistically significant too, the coefficient of variation for almost all the spice crops were less than 70.00 per cent and thereby it indicating the less riskiness for the cultivation of spice crops in the north-east region of India in the days to comes. Further, the production and productivity of the spice crops were increasing during overall periods, which was due to the combine effect of area, production and productivity. Therefore, keeping the area as constant, the productivity can be further increased by taking appropriate production technologies.

Therefore, it may be concluded that the linear effects of area under spice crops was due to the production and year contribute significantly to the variation in production of ginger only, while the linear effects of cropped area, rainfall and year has non-significant contribution in the total variation on the turmeric crop. So, in case of turmeric, further study is required to find out an efficient function and factors which are responsible for the production and productivity of turmeric in the north-east region of India. Finally, we may draw a conclusion that in light of the above results, there is an urgent need to bring more area under the ginger crops by adopting the extensive cultivation methods or introduce of improved variety of ginger.

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