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Trends of area, production and productivity of spices in the northeastern region

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Abstract

The present study was undertaken to analyze the trends in area, production and productivity of major spices in the northeastern (NE) region. The study was based on secondary data from 1982-83 to 2011–12. The data was collected from several government publications and web sites. To analyze the trend of area, production and productivity of major spices in NE region, the linear, quadratic and exponential functional forms were used. To fit the trend, exponential functional form was used due to its higher R^2 value as compared to other two forms. Besides these, compound growth rate, coefficient of variation and instability index was also estimated. The effects of area, productivity and their interaction towards increasing production were also estimated. The cultivation of spices was not risky in the NE region as revealed by the lower coefficient of variation. The coefficients of variation (CV) of area, production and productivity of spices were less than 4.16%. The instability indices for area, production and productivity for spices in the NE states were positive, which indicated less variation in growing spices in the region.

Keywords: northeastern region, production, productivity, spices

Introduction

The northeastern (NE) India is connected to the mainland with a narrow corridor and surrounded by Bangladesh and Bhutan. NE region of India comprises of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. It covers an area of 255.08 m ha, which is about 8% of country's land mass. More than 64% (164.101 m ha) of the total geographical area is covered by thick and deciduous forest (Barah 2001).

The NE region enjoys the abundance of natural resources like flora and fauna. The abundant and rich natural resources were neglected in the past, but must be put to efficient use to catalyse the development process. In the absence of concerted efforts, the NE region is unable to provide necessary support system to manage these natural resources for the benefit of the people. If the natural resources are not properly developed and managed, the food security in the predominantly agrarian economy will be endangered.

India is known as the land of spices but the average productivity of low in India many of the spices *viz*., chilli - 3500 kg ha^{-1}, ginger - 4825 kg ha^{-1} and turmeric - 4608 kg ha^{-1}. The present annual production of spices in India is about 5.1 mt from an area of 3.5 m ha (MoA 2012). The NE region occupies about 1.41 m ha area with production of 1.81 mt of spices. The agro-climatic condition of the north east hill region is very suitable and all spices are being grown (IISR 2009). Major spices grown in NE region are chilli, ginger, turmeric, large cardamom, black pepper etc. NE region is coming forward in organic production of ginger and turmeric and is exporting about 60% to 70% production outside the region and neighbouring countries. Share in national market of ginger, turmeric, chilli, large cardamom and black pepper are 40, 12, 4, 90 and 5% respectively (NEC 2013). In this study an attempt was made to accesses the impact of trends on area, production and productivity of spices in the NE region during the last three decades with an objectives of (i) to accesses the trend in area, production and productivity of chilli, ginger and turmeric in the region, and (ii) to find out the compound growth rate, co-efficient of variation and effect of change in area, production and productivity of chilli, ginger and turmeric in the region.

Materials and method

Time series secondary data were collected for area, production and yield of chilli, ginger and turmeric from different Directorates of State Governments, Basic Statistics of NE Region, Directorate of Economics and Statistics at Shillong, Meghalaya during the period of 1982–83 to 2011–12 (NEC 2013). A linear regression equation of production on area and year for major spices crops *viz*., chilli, ginger and turmeric were fitted to the data. The Multicollinearity 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 2013).

Data Base

The present study is based entirely on secondary sources. The secondary data regarding area, production and productivity of major spice crops *viz*., chilli, ginger and turmeric 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 NE region of India among with the disposal of spices 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 spices crops. The time series data on area, production and productivity of major spices crops *viz*., chilli, ginger and turmeric crops for the period 1982–83 to 2011–2012 (area, production and yield during the year 2010–11 and 2011–12 were projected data source by IISR, 2009; MoA, 2012; NEC, 2013) were obtained from various publications of Government of India as well as different websites.

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 $Y = a.\ b^x$.

Where, Y=Area, production and productivity of spices crops; x=Time variable.

The functional form having the highest Co-efficient of Determination (R^2) was selected for fitting the trend. Along with this, growth rates of area, production and productivity of the spices crops were computed.

Accordingly, in the present study also Compound Growth Rates (CGR) were computed for area, production and productivity of chilli, ginger and turmeric crops based on the exponential function for the periods (GoN 2009; Sharma 2013). The compound growth rates were computed as follows:

Exponential trend equation: $Y = a. b^x$.

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 Rate percentage (Dhakre & Sharma 2010; Sharma 2013):

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

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

$$SE\ (r) = 100\ b / 0.4329\ \ddot{O}\ [(S \log r^2) - (S \log Y)^2 / N - (\log b)^2 S x^2] / (N-2) Sx2$$

To measure the magnitude of variability in area, production and productivity for the total period, the co-efficient of variation (%) was computed (Sharma & Kalita 2004; Sharma & Kalita 2008; Sharma 2013). Further the instability index was also calculated to examine the instability in area, production and productivity of major spices crops in the north east region of India by using the following formula:

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

An attempt was also made to study the effects of area, productivity and their interaction towards increasing production by using y the following formula (Similar study was carried out by Sharma & Kalita 2004; Sharma & Kalita 2008; Sharma 2013):

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

Where, $\Delta A = A_n - A_0$; $\Delta Y = Y_n - Y_0$; $\Delta P = A_n - A_0$

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 1982–83 to 2011–2012 was divided into three parts *viz*., (i). Period-I (1982–83 to 1991–92), (ii). Period-II (1992–93 to 2001–02), (iii). Period-III (2002–03 to 2011–12) and finally for the Overall Period (1982–83 to 2011–2012), contribution of area, productivity and their interaction to total different production of the spices crops were worked out separately for each of the sub-periods and for the total period (Similar study carried out by Sharma & Kalita 2004; Sharma & Kalita 2008; Sharma 2013).

Results and discussion

In Table 1 the different functional forms *viz*., linear, exponential and quadratic and the coefficients of determination (R^2) are presented. The R^2 values of exponential function for all three aspects, *viz*., area, production and productivity for major spices in the NE region were higher than linear and quadratic functions. Hence, the exponential functional form was selected for fitting trend of area, production and productivity of major spices in NE region of India. Table 2 revealed that the values of a and b in the exponential functional forms for area, production and productivity were positive and significant for major spices. This indicated that the acceleration in growth of area, production and productivity of the major spices. The growth of area, production and productivity of the major spices were found to decrease in the region during the period of 2002–03 to 2011–12 (Sharma & Kalita 2004; Sharma & Kalita 2008; Sharma 2013). This assumption seemed to be positive from the Table 3, where significant compound growth rates were recorded for the growth of area, production and productivity of spices during 1982–83 to 2011–12. The area of spices showed a negative growth rate during the period of 2002–03 to 2011–12. This might be due to the fact of shifting of area to other commercial crops and or due to adoption of new area under shifting cultivation in the NE region (Sharma & Kalita 2004; Sharma & Kalita 2008; Sharma 2013).

Variation and instability in area, production and productivity

The co-efficient of variation (%) of area, production and productivity of the spices were worked out for the period 1982–83 to 2011–12 (Table 4). It showed that growing of spices was not risky in the NE region as revealed by the lower coefficient of variation, which were less

Table 1. R^2 value of Linear, Exponential and Quadratic function for major spices crops of northeastern region during 1982-83 to 2011-2012

S. No.	Aspects	Linear	Exponential	Quadratic
1.	Chilli			
(a).	*Overall Period (1982-83 to 2011-12)*			
	Area	76.52	83.86	57.95
	Production	56.80	68.45	43.58
	Productivity	28.96	37.75	21.30
(b).	*Period-I (1982-83 to 1991-92)*			
	Area	85.46	76.18	79.67
	Production	60.17	59.89	52.01
	Productivity	09.99	11.90	06.87
(c).	*Period-II (1992-93 to 2001-02)*			
	Area	67.08	92.20	59.99
	Production	80.33	62.01	82.51
	Productivity	49.90	23.18	54.75
(d).	*Period-III (2002-03 to 2011-12)*			
	Area	01.56	01.45	01.80
	Production	09.36	09.09	09.55
	Productivity	08.24	07.66	08.47
2.	Ginger			
(a).	*Overall Period (1982-83 to 2011-12)*			
	Area	81.22	24.68	74.32
	Production	75.48	35.52	63.51
	Productivity	09.42	25.41	02.84
(b).	*Period-I (1982-83 to 1991-92)*			
	Area	59.69	50.88	62.43
	Production	71.37	47.96	87.24
	Productivity	42.16	18.27	59.00
(c).	*Period-II (1992-93 to 2001-02)*			
	Area	85.92	87.23	89.91
	Production	72.77	76.04	75.99
	Productivity	06.84	06.58	07.70
(d).	*Period-III (2002-03 to 2011-12)*			
	Area	30.98	27.52	31.10
	Production	0.87	02.72	0.88
	Productivity	07.76	13.65	07.79
3.	Turmeric			
(a).	*Overall Period (1982-83 to 2011-12)*			
	Area	50.16	50.72	38.77
	Production	88.29	81.47	75.93
	Productivity	83.95	78.38	74.49
(b).	*Period-I (1982-83 to 1991-92)*			
	Area	26.67	37.47	17.44
	Production	89.68	69.48	97.25
	Productivity	77.37	52.16	89.94
(c).	*Period-II (1992-93 to 2001-02)*			
	Area	83.40	64.94	85.72
	Production	86.65	91.06	82.54
	Productivity	52.68	76.53	46.05
(d).	*Period-III (2002-03 to 2011-12)*			
	Area	12.80	12.67	12.23
	Production	11.88	09.90	13.07
	Productivity	16.78	17.45	16.81

Table 2. Results of the fitted trend for major spices (Exponential function) of northeastern region of India during 1982-83 to 2011-2012

S.N.	Aspects	1982-83 to 2011-12		1982-83 to 91-92		1992-93 to 01-02		2002-03 to 2011-12	
		a	b	a	b	a	b	a	b
1.					Chilli				
	Area	4.3024	0.1144	4.3270	0.0637	4.3711	0.0784	4.4142	0.0325
	Production	7.0776	0.2312	7.1494	0.0897	7.2169	0.1524	7.9635	-0.3980
	Productivity	2.7752	0.1168	2.8224	0.0260	2.8458	0.0740	3.5494	-0.4305
2.					Ginger				
	Area	3.898	0.1890	3.9265	0.1022	2.3485	1.5969	2.8903	1.0527
	Production	7.4891	0.2951	7.5291	0.1691	6.3775	1.3607	7.5928	0.3459
	Productivity	3.5911	0.1001	3.6026	0.0669	4.0289	-0.236	4.7026	-0.7068
3.					Turmeric				
	Area	3.9928	0.1105	4.0382	0.0248	4.0630	0.0779	4.6131	-0.3367
	Production	6.7584	0.4196	6.92011	0.1185	7.0846	0.2055	7.0979	0.1805
	Productivity	2.7656	0.3091	2.8828	0.0938	3.0215	0.1276	2.4748	0.5172

Table 3. Compound Growth Rate (%) of area, production and productivity of major spices crops in northeastern region of India

S.N.	Aspects	CGR %			
		1982-83 to 2011-12	1982-83 to 1991-92	1992-93 to 2001-02	2002-03 to 2011-12
1.	Chilli				
	Area	0.10 ^{NS}	0.16 ^{NS}	0.16 ^{NS}	0.01 ^{NS}
	Production	0.13 ^{NS}	0.13 ^{NS}	0.25 *	- 0.09 ^{NS}
	Productivity	0.17 ^{NS}	0.09 ^{NS}	0.39 *	- 0.25 ^{NS}
2.	Ginger				
	Area	0.16 ^{NS}	0.29 ^{NS}	1.10 ^{NS}	0.39 *
	Production	0.14 ^{NS}	0.29 ^{NS}	0.50 **	0.14 ^{NS}
	Productivity	0.11 ^{NS}	0.29 ^{NS}	- 0.20 ^{NS}	- 0.15 ^{NS}
3.	Turmeric				
	Area	0.11 ^{NS}	0.05 ^{NS}	0.35 *	- 0.14 ^{NS}
	Production	0.25 ^{NS}	0.20 ^{NS}	0.44 **	0.04 ^{NS}
	Productivity	0.44 **	0.41 **	0.56 **	0.28 ^{NS}

Note: **Significant at 5% probability level; *Significant at 10% probability level, NS=Not significant

than 4.16%. The instability indices for area, production and productivity for major spices in the NE region were positive with maximum of 8.84% and thereby indicating less riskiness for growing of spices in the region (Sharma 2013). The results also showed that cultivation of turmeric and ginger was more stable as compared to chilli crop in the region as revealed by the higher CV (coefficient of variation) (Sharma & Kalita 2004; Sharma 2013). The CV of area, production and productivity of major spices were more than 4.16%. The raising of turmeric in the region is less risky, which has CV of less than 4.16% (Sharma 2013). The instability indices for area, production and productivity for turmeric, ginger and chilli spices in the region were positive over the period.

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

S. N.	Aspects	1982-83 to 2011-12		1982-83 to 1991-92		1992-93 to 2001-02		2002-03 to 2011-12	
		CV (%)	Ins. Ind.	CV (%)	Ins. Ind.	CV (%)	Ins. Ind.	CV (%)	Ins. Ind.
1.	Chilli								
	Area	1.05	0.19	0.53	0.07	0.59	0.03	0.31	0.10
	Production	1.41	0.63	0.51	0.11	0.84	0.27	0.93	0.78
	Productivity	2.45	3.81	0.85	0.63	0.69	2.20	2.75	6.91
2.	Ginger								
	Area	3.43	8.84	1.14	0.60	3.51	1.57	2.09	3.01
	Production	2.34	3.54	1.02	0.54	1.70	0.69	1.17	1.37
	Productivity	2.10	3.28	1.37	1.53	2.14	4.26	2.32	4.96
3.	Turmeric								
	Area	1.39	0.96	0.32	0.06	1.14	0.46	1.19	1.23
	Production	2.38	1.05	0.65	0.13	1.45	0.19	0.41	0.14
	Productivity	4.16	3.74	1.40	0.94	2.27	1.21	2.01	3.37

Table 5. Effect of change in area, productivity and their interaction on differential production of major spice crops of northeastern region of India

S. No.	Aspects	Differential production (D P)	Area effect (Y_0DA)	Productivity effect (A_0 DY)	Interaction (DA DY)
1.	Chilli				
	1982-83 to 2011-12	29406031.94	5178689	17864607	6362737
	1982-83 to 1991-92	5481022.506	2058197	2998395	424430.4
	1992-93 to 2001-02	11628125	3216535	7193750	1217840
	2002-03 to 2011-12	2.3E+07	2297837	1.9E+07	2086425
2.	Ginger				
	1982-83 to 2011-12	167853917.8	74377192	26136584	67340141
	1982-83 to 1991-92	31620721.65	11563608	14709704	5347410
	1992-93 to 2001-02	2E+08	6E+07	4E+07	5E+07
	2002-03 to 2011-12	68815229.02	18826531	42283673	7705025
3.	Turmeric				
	1982-83 to 2011-12	24702517	4568421	13259039	6875057
	1982-83 to 1991-92	3606865	897368.4	2459039	250457.7
	1992-93 to 2001-02	13389630	5113043	5803704	2472882
	2002-03 to 2011-12	16569819	5457792	8191558	2920469

Measurements of effects

Table 5 revealed the relative effect of contributions of area, productivity and their interaction on increased production of the spices in the NE region during each of the period *viz*., 1982–83 to 1991–92, 1992–93 to 2001–02, 2001–02 to 2011–12 and 1982–83 to 2011–12 as the total period, the changes in production were partitioned separately in various effects. Results also showed that the productions of the spices in the NE region were having an increasing trend, while the production was having decreasing trend during the period of 1992–93 to 2001–02 and 2002–03 to 2011–12,

respectively. This increase in production was due to increase in area as well as interaction of area and productivity of spices crops in the region. These results are in consonance with the study conducted by Padnaban *et al.* (1996), Sharma & Kalita (2004), Sharma & Kalita (2008) and Sharma (2013). The interaction effect of area and productivity in the NE region during 1992–93 to 2001–02, in the case of chilli crop was decreasing as indicated by the negative values. Although the interaction of area and productivity in some periods *viz*., 1982–83 to 2011–12 and 2002–03 to 2011–12 for turmeric was found to increase and for the total period also it was found to be positive with increasing trend with more production.

To determine how the relative contributions of area, productivity and their interaction were responsible for the increased spices production of the region during each of the period *viz*., 1982–83 to 1991–92, 1992–93 to 2001–02, 2002–03 to 2011–12 as well as 2001–02 to 2011–2012 the total period, the changes in production were partitioned separately in various effects. The results revealed that the situation of major spices crops in the region seems to be good. The productions of all the spice crops are increasing which is due to increase in area as well as interaction of area and productivity except for some spices crops. The interaction of area and productivity of chilli and ginger was negative as indicated by the declining trend towards the growth values.

Constraints

The study highlighted the fact that the growth of area, production and productivity for all the spice crops in the region were positive and statistically significant. The coefficient of variation for almost all the crops was less than 4.16% indicating less variation for cultivation in the region. Further, the production and productivity of the spice crops found to increase during the study period, which was due to the combined effect of area and productivity. Therefore, keeping the area as constant, the productivity can be further increased by adopting appropriate production technologies.

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