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Production performance and potential of major spices of Northeast Region, India

[1]Raplang Lapasam, [2]S Basanta Singh and [3]Ram Singh

[1]Ph.D. Scholar, School of Social Sciences, CPGS-AS, CAU, (I), Umiam, Meghalaya, India

[2]Director Instruction, CAU, Imphal, Manipur, India

[3]Professor, Agricultural Economics, CPGS-AS, CAU (I), Umiam, Meghalaya, India

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Corresponding Author: Raplang Lapasam

Abstract

India's North East region is known as a significant spice hub. The study was carried out to analyze the growth rate, instability in area and production of spices in NER of India and evaluated the effect of area, yield and their interaction in increasing the production. The result shows that the almost all the states have a positive significant growth rate of spice production in the NER and as well as low to medium instability index. The decomposition analysis showed that the yield effect is more responsible for increasing production of ginger, black pepper and large cardamom with contribution of 49.83 percent, 60.34 percent and 43.36 percent respectively, while for turmeric the area effect (59.9%) has more contribution than the yield effect. With the right emphasis on infrastructure and targeted research, the full potential of the region's spice can be tapped. Focusing on agro-processing units is crucial for post-harvest management and value addition of products and it is also advised to set up farmer cooperatives and groups both locally and regionally.

Keywords: Spices, CAGR, instability, decomposition and NER

Introduction

Spices are high-value commercial crops with low volume, significantly contributing to the agricultural economy of the country Singh *et al.*, 2020 [15] and a highly traded agricultural commodity globally (Thomas and Sanil, 2019) [20]. Spices play a significant role in the economy, domestically and internationally, with India being a major player in production, consumption, and export, contributing significantly to the global market (Sarma *et al.*, 2014; Pradhan, 2018) [12, 9]. As the abode of rich spices, India has an age-old trade drive with ancient Chinese and Roman civilizations (Chaitra & Sonnad, 2019) [1]. The International Organization for Standardization lists 109 spices, of which 75 are produced in India and 54 are exported (Joshi *et al.*, 2015) [7]. Spices like ginger, turmeric, cinnamon, and garlic have been found to possess various pharmacological activities, including anti-inflammatory, antioxidant, antibacterial, and antiviral effects (Broek *et al.*, 2018) [22]. Almost all the states in the country produce one spice or another and in 2020-21, India produced around 106.79 lakh MT from an estimated area of 45.28 lakh ha. Among the different states, Rajasthan occupies the largest spice area due to the cultivation of seed spices, followed by Gujarat, Madhya Pradesh, Uttar Pradesh, Karnataka, Andhra Pradesh, Kerala, *etc*. (Spice Statistics at a Glance, 2021). India's NER comprises of eight states; they include Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. The Northeast region's diverse agro-climatic and geophysical features provide ample crop cultivation opportunities (Devi and Raj, 2021) [2]. Assam is the leading producer of spice in the Northeast, followed by Sikkim, Mizoram and Meghalaya. The Northeast Region of India is renowned for its high market demand and export potential of major spices like large cardamom, ginger, turmeric, black pepper, chilli, and bay leaf (Momin *et al.*, 2018) [8]. The region is also well-known for its unique spice crops such as *Lakadong* turmeric, Bird's eye chilli, Nadia ginger and Naga King chilli (Selvan *et al*., 2009) [13]. India is the world's largest producer of large cardamom, with more than 85 percent of production in India coming from Sikkim alone (Jha *et al.*, 2017) [6]. The spice production in the NEHR holds excellent potential for commercialization and value-addition (Ralte and Ekhe, 2022) [11] of various value-added products such as oil and oleoresins, powdered form, paste made from ginger and turmeric, pepper and ginger in brine, turmeric curcumin, as well as capsanthin and capsaicin from chillies (Singh *et al.*, 2024) [16]. Majority of the spices grown in the Northeast region are for domestic consumption, however it is a key contributor to rural household cash incomes. There is wide scope for exports of spices in the region such as ginger, turmeric and large cardamom which were grown organically (Sharma, 2015) [14]. Northeast Region has great potential for cultivating high-value spices, which could greatly increase the income of the small-scale farmers. Therefore, this study was carried out to examine the performance of spice production in Northeast Region and decomposition analysis to analyzed the factors increasing the production of spice.

Materials and Methods

The study was based on the secondary data collected for the period of 10 years. The major of the Northeast region such as ginger, turmeric, black pepper and large cardamom were selected for the study based on the availability of secondary data. Data on area and production of the major spices were collected from Spices Statistics at a Glance (2021), Spices Board of India and other state government websites and published source.

Statistical analysis

Compound annual growth rate analysis

$$Log\ y = \log a + t \log b$$

Where,
Log y = area, production, productivity, export quantity and export value.
a = intercept
b = regression coefficient
t = year

The percent compound growth rate (g) was derived using the relationship,

$$G = (Anti\log of\ b - 1)\ x\ 100$$

Cuddy-Della Valle instability index

In order to measure the instability associated with the rate of increase in area and production of major spices crops in the Northeast Region, Adjusted Instability Index proposed by Cuddy-Della Valle is used.

$$Instability\ Index = \text{CV} * \sqrt{1 - R^2}$$

Where,
Ix = Instability index
CV = Coefficient of variation
R^2 = Coefficient of determination
The ranges of the instability are as follows:
0 to 15 = Low instability
> 15 < 30 = Medium instability
> 30 = High instability

Decomposition analysis

The effect of area, productivity and their interaction in increasing the production as given by Sharma (2015) [14] was used. The change in production was taken as the effect of three factors such as yield effect, area effect and interaction effect.

$$\Delta P = \Delta A Y_O + \Delta Y A_O + \Delta A \Delta Y$$

Where,
A_o, P_o, Y_o = Area, Production and Productivity in the base year
A_n, P_n, Y_n = Area, Production and Productivity in the current year.
$\Delta A = A_n - A_o$
$\Delta Y = Y_n - Y_o$
$\Delta A Y_o$= Area effect
$\Delta Y A_o$= Yield effect
$\Delta A \Delta$= Interaction effect
Change in production = Yield effect + Area effect + Interaction effect.

Results and Discussion

Table 1 provides the calculated CAGR and Instability Index on the area and production of spices from 2011-12 to 2020-21 for various states in the Northeast Region of India.

Arunachal Pradesh: The area under spice cultivation in Arunachal Pradesh has decreased by 10.81 percent annually, while production has increased significantly by 5.07 percent annually. The instability index for area was low (4.55) while production showed medium instability (16.11) respectively.

Assam: The cultivation of spice in Assam showed that both the area and production have showed a significant positive growth rate with CAGR values of 2.54 percent (area) and 2.74 percent (production). The instability index depicted a low instability in both area (8.63) and production (8.1). This indicates steady growth in both area and production of spices in Assam.

Manipur: The area under spice cultivation in Manipur has decreased slightly with a negative CAGR of 4. 27 percent and whereas production has significantly increased with CAGR values of 14.73 percent. The instability index showed medium to high instability both area and production.

Meghalaya: The spice cultivation in Meghalaya has a negative growth rate of both area and production with a CAGR of -1.92 percent and -0.86 percent respectively. While the instability index showed low instability for both area and production. Similar findings were reported by Gupta (2022) [3].

Mizoram: Both area (3.55%) and production (4.03%) have shown positive growth rates, while the instability index showed low instability in area and medium instability in production (20.72).

Nagaland: Similar to Meghalaya, Nagaland also has a negative growth rate of both area and production with a CAGR of -0.28 percent and -3.23 percent respectively. The instability index showed medium to high instability both area (20.99) and production (47.44).

Sikkim: Both area and production have increased, with slightly higher growth rates for production compared to area, as indicated by the positive CAGR values and also low instability index.

Tripura: Both area and production have shown consistent growth, with production increasing at a faster pace (CAGR of 6.66%) compared to the area under cultivation. Similarly, the instability index also showed low instability for both area and production.

Northeast: Overall, the Northeast region shows moderate growth in both area and production of spices, with CAGR values of 2.65 percent and 2.38 percent, respectively.

Likewise, a low instability index for both area and production of spices. The instability index for the area is lowest in the Northeast combined and highest in Nagaland. This shows that there is erratic growth in the area and production of spices in Nagaland, which means that there is presence of high volatility for the same.

Table 1: CAGR and Instability Index of area and production of major spices in NER during 2011-12 to 2020-21

States	Area ('000 ha)		Production ('000 MT)	
	CAGR (%)	Ix	CAGR (%)	Ix
Arunachal Pradesh	5.07 ***	4.55	-10.81^{NS}	16.11
Assam	2.54 ***	8.63	2.74***	8.1
Manipur	-4.27 ***	16.56	14.73**	40.93
Meghalaya	-1.92 ***	5.47	-0.86***	8.21
Mizoram	3.55	3.68	4.03***	20.72
Nagaland	-0.28***	20.99	-3.23***	47.44
Sikkim	6.56^{NS}	7.11	8.83*	12.24
Tripura	2.42***	6.16	6.66***	20.52
Northeast	2.65 ^{NS}	2.83	2.38**	4.98
India	4.25*	5.92	6.95*	10.27

*, **, *** indicates 10%, 5% and 1% level of significance.
***Source*:** Spice Statistics at a glance, (2021).

Ginger: The CAGR and instability index of area and production of ginger in Northeast Region from 2011-12 to 2020-21 were calculated and presented in Table 2. It was evident that almost all the states of the region showed a positive and significant growth in area under ginger except Arunachal Pradesh (-8.65%). Similar observation was also reported by Singh *et al.*, (2022) [17]. The highest growth rate in area was seen Manipur (9.09%) followed by Sikkim (7.82%), Mizoram (2.85%), Assam (1.53%), Tripura (0.70%), Meghalaya (0.68%) and Nagaland (0.44%), respectively. Similarly, the same trend was observed in case of production where all the states of the region experienced a positive and significant growth rate except Arunachal Pradesh (-14.3%) and Nagaland (-1.36%). The reason for the declining growth rate in both states may be due to rhizome diseases and soft rot that have affected almost all NER regions (Rahman *et al.*, 2009) [10]. This prompts farmers to abandon ginger cultivation and switch to other commercial crops. The highest growth rate was observed in Manipur (48.51%), Tripura (11.9%), Mizoram (10.09%), Sikkim (6.84%), Assam (4.49%) and Meghalaya (1.81%), respectively. The reason for the high positive growth of ginger in Manipur can be accredited due to the establishment of MOMA (Manipur Organic Mission Agency) for ginger. The instability index was low to medium instability for all the states in NER and Northeast overall, and highest with the exception of Manipur. This shows that the growth rate of ginger in Manipur was unstable and irregular as shown in Table 2.

Table 2: Growth and Instability Index of area and production of Ginger in NER during 2011-12 to 2020-21

States	Area ('000 ha)		Production ('000 MT)	
	CAGR (%)	Ix	CAGR (%)	Ix
Arunachal Pradesh	-8.65**	19.89	-14.3**	26.52
Assam	1.53***	4.91	4.49*	5.83
Manipur	9.09***	17.75	48.51*	80.52
Meghalaya	0.68***	2.03	1.81***	5.61
Mizoram	2.85*	3.86	10.09**	19.03
Nagaland	0.44***	13.46	-1.36***	17.12
Sikkim	7.82 ^{NS}	6.91	6.84*	11.44
Tripura	0.70^{NS}	3.49	11.9**	19.81
Northeast	2.10**	3.52	4.6*	5.98

*, **, *** indicates 10%, 5% and 1% level of significance.
***Source*:** Spice Statistics at a glance, (2021).

Turmeric: The CAGR and instability analysis of Turmeric for all the states in the NER is presented in Table 3. The result showed that all the states attained a positive growth rate in area except Arunachal Pradesh (-2.21%). The high production costs may be one of the causes encouraging the farmers to switch to crops with lower production costs. The highest significance growth rate in area was observed in Nagaland (26.07%) followed by Sikkim (21.22%), Manipur (7.70%), Mizoram (6.27%), Meghalaya (5.14%), Tripura (3.83%) respectively. Similarly, Sikkim (18.73%) recorded the highest significant growth rate in production of turmeric followed by Nagaland (15.37%), Mizoram (12.72%), Meghalaya (7.84%), Tripura (6.67%) and Assam (6.30%). Similar observation was also reported by Singh *et al.*, (2022) [17]. The increase in growth can be due to the increase in area during the reference period and implementation of different schemes for horticulture sector (Temsusenla and Konwar, 2022) [19]. While Manipur experienced a negative growth rate of -02.9 percent in production of turmeric. The negative growth can be due to the lack of availability of good planting material or farmer shifting to other commercials crops. The instability index for both area (30.82%) and production (100.93%) were highest in Nagaland and lowest instability index in Northeast as a whole for area (1.36%) and (1.76) in production which shows that the production of turmeric became stable with the passage of time.

Table 3: Growth and Instability Index of area and production of Turmeric in NER during 2011-12 to 2020-21

States	Area ('000 ha)		Production ('000 MT)	
	CAGR (%)	Ix	CAGR (%)	Ix
Arunachal Pradesh	-2.21^{NS}	17.96	0.56***	12.41
Assam	1.08 ***	2.81	6.30^{NS}	6.06
Manipur	7.70**	18.85	-02.9 ***	1.76
Meghalaya	5.14^{NS}	4.84	7.84*	8.76
Mizoram	6.27*	6.77	12.72***	22.79
Nagaland	26.07**	30.82	15.37***	100.93
Sikkim	21.22^{NS}	25.75	18.73*	31.70
Tripura	3.83 **	8.48	6.67**	13.59
Northeast	4.49^{NS}	1.36	5.78*	7.88

*, **, *** indicates 10%, 5% and 1% level of significance.
***Source*:** Spice Statistics at a glance, (2021)

Black Pepper

In Table 4, the CAGR and instability Index of the area and production of black pepper in the Northeast were calculated. The study revealed that Tripura (4.58%) and Meghalaya (1.64%) had the highest positive significant growth in area. Similarly, Assam (5.55%) followed by Tripura (5.28%) experienced highest growth rate in production, both of which are insignificant. Nagaland had a negative significant growth in both area (-6.69%) and production (-14.45%). The declining growth in area can due to small scale of cultivation and decrease in the area leading to the decrease in production. The area and production growth rates in the overall Northeast Region were 1.11 percent and 5.01 percent respectively. In production Nagaland (73.33%) has the highest instability Index, followed by Tripura (38.27%). In area the Northeast Region as a whole (29.91%) had the highest instability index respectively, while the other states had low to medium instability.

Table 4: Growth and instability index of area and production of black pepper in NER during 2011-12 to 2020-21

States	Area ('000 ha)		Production ('000 MT)	
	CAGR (%)	Ix	CAGR (%)	Ix
Assam	1.14*	7.19	5.55 NS	12.80
Meghalaya	1.64***	2.15	5.13**	8.16
Nagaland	-6.69***	11.01	-14.45*	73.33
Tripura	4.58*	17.32	5.28 NS	38.27
Northeast	1.11*	29.91	5.01 NS	11.30

*, **, *** indicates 10%, 5% and 1% level of significance.
***Source*:** Spice Statistics at a glance, (2021)

Large cardamom

The CAGR and instability index of area and production of large cardamom in the NER states is presented in Table 5. It was observed that Nagaland and Sikkim reported a positive growth rate for both area and production under large cardamom. Higher growth rate was seen in Nagaland for production (6.84%) and Sikkim showed higher rate for area (4.47%). Similar result was also observed by Gurung and Choubey (2021) [4]. Area and production growth rates in Northeast combined were non-significant at 4.31 percent and 5.92 percent respectively. The instability Index ranged from 1.06 to 18.87 and revealed low to medium instability. The overall instability index indicates how the production of large cardamom stabilized over time. The largest supplier of large cardamom in India is Sikkim and the farming methods used there are entirely organic.

Table 5: Growth and Instability Index of area and production of Large Cardamom in NER during 2011-12 to 2020-21

States	Area ('000 ha)		Production ('000 MT)	
	CAGR (%)	Ix	CAGR (%)	Ix
Nagaland	3.48**	6.39	6.84***	9.60
Sikkim	4.47 NS	3.85	5.56 NS	1.06
Northeast	4.31 NS	3.36	5.92 NS	4.72

*, **, *** indicates 10%, 5% and 1% level of significance.
Source: Spice Statistics at a glance, (2021).

Decomposition analysis

Decomposition analysis was calculated and is shown in Table 6 to determine the proportion contribution of area and yield to the production of spices in the Northeast region. The study showed that all three effects are positive for spices. As a result, area, yield, and their interactions had a favourable impact on the growth of the region's spice production. However, the yield effect had a more significant impact in increasing production in ginger, black pepper, and large cardamom, with respective yield effects of 49.83 percent, 60.34 percent and 43.36 percent respectively. This is may be the result of effective management techniques. However, in the case of turmeric the yield effect only accounts for 26.67 percent of the production of turmeric, the area effect contributes a significant 59.9 percent of the total increase in production. Similar observation was also reported by Singh *et al.*, (2022) [17].

Table 6: Decomposition analysis of area, yield and their interaction towards increasing production of major spice crops of NER during 2011-12 to 2020-21

Crops	Area Effect	Yield Effect	Interaction Effect	Total Effect
Ginger	42.15	49.83	8.02	100.00
Turmeric	59.9	26.67	13.43	100.00
Black Pepper	29.47	60.34	10.19	100.00
Large Cardamom	37.75	43.36	18.89	100.00

Conclusion

Spices is an important commercials crop in the all the states of the Northeast Region and many small and marginal farmers depend their livelihood on spices. Therefore, to harness the full potential of spices production in region, government policies should emphasis more on infrastructural development and targeted research to maximize the region's potential for premium spice production. Public – private collaboration should be encouraged to increase scientific knowledge in production of important spices across the region. It is also suggested that focus on agro-processing units is crucial for post-harvest management and value addition of spice products that have high potential for exports. Training exposure and setting of farmer co-operatives like FPOs and groups both locally and regionally are recommended to be motivated and for sustaining the livelihood of the farmers in the region.

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