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Growth, instability and sources of output growth of ginger and turmeric: A Statewise analysis in North East region of India

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Abstract
The paper investigates the growth and instability in area, production and yield of ginger and turmeric in North East India based on secondary data during 2001-20.The period was again sub-divided into period-I from 2001-10 and period-II from 2011-2020. Ginger which is one of the major spices crop in the region is growing at a slow pace in all the study period and the highest growth was observed during period-I. Similar result follows in case of turmeric wherein a sluggish growth was shown in all the sub-periods. Instability analysis in area, production and yield of ginger showed that the region experienced low instability in all the sub-periods and the highest stability was shown in period-II. Turmeric showed low instability in area in all the period while production and yield indicates medium to high instability. Further, estimation of source of output growth of ginger revealed that area effect was the dominant factor in period-I and overall period. For turmeric yield effect was the major driving factor for increasing the production in all the sub-period.

Keywords: ginger, turmeric, growth rate, instability, output growth

Introduction
India referred to as the "land of spices" owing to its production of different varieties of major spices in the world, contributing about 20-25% of the world trade in spices. India still continues to be the largest producer, consumer, and exporter of spices in the world and had a virtual dominance in the international spices trade across the globe. According to Bureau of Indian Standards, a total of sixty three different spices are grown extensively in India out of which 20 are classified as seed spices with 36 percent share in area and 17 percent share in production of total spices in India. Ginger and turmeric are one of the keystones of Indian spices widely used for flavouring and medicinal purposes. They are grown as a major commercial spices crop of the country since ancient times.

Ginger is widely grown in different countries of the world with its area and production distributed over countries namely India, Nigeria, China, Nepal, Indonesia, Thailand etc. Annually, the global production of ginger is 3,299,795 tonnes and the crop is mainly imported by UK, USA and Saudi Arabia. Among the different ginger growing countries of the world, India is the largest producer of ginger in the world with 1,109,000 tonnes while Nigeria has the highest area under ginger contributing about 56.23 percent of the world ginger areas followed by India, China, Indonesia and Bangladesh. During 2020, a total volume of 50,410 tonnes valued at Rs. 449.05 crore has been exported as against 18,150 tonnes valued at Rs. 16.02 crore as compared to last year registering an increase of 178 percent in volume and 129 percent in value term. Despite of the COVID-19 pandemic outbreak and consequent recession in the global economy, the export of spices from India continued its upward trend beating the milestone of 3 billion US dollar for the first time in the history of spices export. India is the largest producer, consumer and exporter of turmeric in the world because of its high curcumin content. Globally, the production of turmeric is around 11 lakh tonnes per annum and India with a total production of 938955 thousand tonnes has the lion share in the world production contributing 85.35 percent and 60 percent of the world export. The major turmeric exporting countries are India, Thailand, Taiwan and other Southeast Asian countries, Central and Latin American countries and the major importing countries includes Japan, Sri Lanka, Iran, UAE, US, UK and Ethiopia.

The NER has an immense potential to emerge as a destination for production of spices like ginger, turmeric, large cardamom, black peeper chilli. Among these, ginger and turmeric are prominent and their cultivation is mostly done in the jhum areas and grown in almost all the states of the NER but the leading states are Assam, Meghalaya, Mizoram, Arunachal Pradesh and Sikkim (Hnamte *et al*., 2012) [10]. Ginger is already a well established cash crop in Assam, Meghalaya and Mizoram with highest yield in the country. Apart from improved varieties like Nadia, China and Varada a number of local varieties are grown in the region. In turmeric, the major varieties that are widely grown in the region are Megha-turmeric and Lakadong for their high yield and quality. During 2019-20, the area under ginger in NER accounts for 57.18 thousand hectares with a production of 504.7 thousand tons which is much lower as compared to national level with an area of 175.26 thousand hectares and production of 1875.94 thousand tons. Among the states in NER, Assam has the highest area and production under ginger producing about 183.16 thousand tons during the fiscal year 2020 contributing about 9.76 percent to the total ginger production in the country. Similarly, the area under turmeric in the NER stood at 38.6 thousand hectare with a production of 93.16 thousand tons which was also quite lower as compared to national level. Among the states of NER, Assam has the highest area under turmeric with 17.63 thousand ha followed by Mizoram and Sikkim. In case of production, Mizoram stood at the top with 29.51 thousand tons followed by Assam and Sikkim.

Methodology

The present study is based on the secondary data for 20 years period from 2001 to 2020 collected from Spices Board and Directorate of Arecanut and Spices Development, Govt. of India. The period was further sub-divided into period-I from 2001-2010 and period-II from 2011-2020 and for overall period i.e. 2001-2020. The methods used in the study included estimation of growth rate with its test of significance, coefficient of variation and decomposition of growth components.

To analyze the trends in growth of area, production and productivity ginger and turmeric, exponential function was used which is given as under:

$$Y_t = ab^t$$

Where,

Y_t = Dependent variable on area, production and productivity in the year't'

a = constant (intercept)

b = regression coefficient

t = time element which takes value 1, 2, 3,……., n

Taking the logarithm on both sides to convert the equation into linear form, we get:

$$\text{Log } Y_t = \log a + t \log b$$

By taking log Y = y, log a = A and log b = B; the model becomes linear between y and t, as $y^t = A + Bt$ fit the model of Ordinary Least Square (OLS) technique.

The compound annual growth rate (CAGR) was further obtained by the formula:

$$\%AGR = \{EXP\ (b)-1\} \times 100$$

The significance of growth rate was tested by using the Student't' test as under

$$t = \frac{CGR}{SE(CGR)} \text{ with degree of freedom } (n-2)$$

Where,

t = Student 't' test

CGR = Compound growth rate

SE = Standard error

Instability Index

To measure the instability in area, production and productivity of ginger and turmeric Cuddy Della Valle index (1978) was used. The instability index (IX), is given as under:

$$IX = CV\ (1-R^2)^{1/2}$$

Where,

CV = Coefficient of variation (in percent)

R^2 = Coefficient of determination from a time-trend regression adjusted by the degree of freedom.

Decomposition of output growth

In order to have a broad spectrum of the relative contribution of area and yield to output growth of production of ginger and turmeric in the study, decomposition technique was used. Any change in the output of a crop in physical term depends fundamentally on the change in the area under the crop and its average yield. To measure the relative contribution of area and yield towards the total production the component analysis model was used as given under:

$$\Delta P = A \times \Delta Y + Y \times \Delta A + \Delta A \times \Delta Y$$

Where,

ΔP = Change in production

$A \times \Delta Y$ = Yield effect

$Y \times \Delta A$ = Area effect

$\Delta A \times \Delta Y$ = Interaction effect

Results and Discussion

Growth rate analysis of ginger and turmeric in NER

The account of compound annual growth rates of area, production and yield/productivity of ginger during period-I from 2001-2010, period-II from 2011-2020 and for the overall period during 2001-2020 has been presented in the table 1.

The analysis revealed that during the period-I, all the states in the region have shown a positive growth rate in area except Tripura (-2.49%). The highest non-significant growth rate in area under ginger was observed in the state of Assam with 15.31% followed by Manipur with a significant growth of 6.33% and Nagaland at 7.25%. The same trend follows in case of production where all the states of the region experienced a positive and significant growth rate except Mizoram (-0.36%) and the highest growth rate was witnessed in the state of Assam which accounted for 22.67% followed by Sikkim and Manipur with significant growth of 22.23% and 16.61%. With regards to yield, majority of the state showed a positive growth except Arunachal Pradesh and Mizoram and the highest growth was registered in Tripura

with significant growth of 17.42% followed by Sikkim at 16.13% and Nagaland with 6.54% respectively. For NER, the yield was recorded with a small significant growth of 2.78% per annum with a production significant growth at the rate of 9.07% which may be largely attributable by the corresponding significant growth in area by 6.11% per annum during the period-I.

Table 1: Compound growth rate (%) in area, production and yield of ginger in NER

States	Period-I (2001-10)			Period-II (2011-2020)			Overall period (2001-2020)		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Arunachal Pradesh	4.58**	3.75*	-0.78	-4.66	-7.45*	-2.92*	1.22	0.7	-0.51
Assam	15.31	22.67***	6.38**	1.58*	5.05***	3.46***	6.99	11.86	4.55
Manipur	12.25***	16.61***	3.88*	-1.07	21.87**	23.21**	2.84*	9.33***	6.31**
Meghalaya	1.44*	2.04*	0.59	0.72***	2.09***	1.35**	0.8	2.16	1.34
Mizoram	1.77	-0.36	-2.09	3.71***	9.56***	5.63*	3.35***	3.13**	-0.21
Nagaland	7.25	11.69*	6.54	2.63	1.86	-0.74	5.58*	5.34**	1.00
Sikkim	5.25**	22.23*	16.13*	-5.55	6.40**	-2.38*	1.32	10.83***	4.82*
Tripura	-2.49*	14.49**	17.42***	2.75*	9.73**	6.82*	1.69**	10.45	8.62
NER	6.11***	9.07***	2.78**	0.17	4.16	1.85**	3.09	5.91	2.10

A – Area (in 000' ha), P- Production (000' tons) and Y-Yield (tons/ha)
*Significant at 10% level of significance;
**Significant at 5% level of significance
***Significant at 1% level of significance

For period-II, it was evident that more than half of the states of the region witnessed a positive but sluggish growth in area under ginger and the highest significant growth was registered in the state of Mizoram (3.71%) followed by Tripura (2.75%) and Nagaland (2.63%) while negative growth was observed in Arunachal Pradesh (-4.66%), Manipur (-1.07%) and Sikkim (-5.55%). The production growth rate revealed that almost all the state showed a positive growth except Arunachal Pradesh (-7.45%) and the highest significant growth was recorded in Manipur (21.87%) followed by Tripura with a significant growth of 9.37% and Mizoram which was accounted for 9.56% respectively. For NER, the production of ginger was recorded with a non-significant growth of 4.16% per annum. It was attributed by both i.e. non-significant but slow growth in area by 0.15% and significant growth in yield by 1.85%.

During the overall period, the highest non-significant growth rate in area and production was observed in Assam at 6.99% followed by Nagaland (5.58%) and Mizoram (3.13%). In case of production too, Assam achieved the upmost growth at 11.86% followed by Sikkim and Manipur with a significant growth at 10.83% and 9.33%. With regards to yield, the highest non-significant growth was witnessed in Tripura at 8.62% followed by Assam and Sikkim at 6.31% and 4.82%. For NER, the production growth rate was found increasing at 5.91% but non-significant which was mainly on account of the corresponding increase in the area and yield by non-significant growth of 3.09% and 2.10%. Therefore, it can be summed up that the growth rate in area, production and yield of ginger in the region was found to be decreasing during the period-II. The promising reason for this might be due to the shifting in the area in ginger cultivation to some other valuable crops. Moreover, ginger is mostly cultivated in the tribal dominated areas of the region by small and marginal farmers adopting indigenous methods of production leading to low yield. Also, it may be cited that increase in the area also influenced by the prices and demand as well as the prevailing prices in the domestic and international market. Under several circumstances, high prices induces the farmers to increases the area under ginger which leads to excess production and fall in price.

And this fall in prices may leads to fall in area in the subsequent season which are responsible for price fluctuation. Further, if any increase in the production is not accompanied by the increase in demand, it may cause the prices to be collapsed leading to decline in the area of ginger.

Table 2: Compound growth rate (%) in area, production and yield of turmeric in NER

States	Period-I (2001-10)			Period-II (2011-2020)			Overall period (2001-2020)		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Arunachal Pradesh	-0.91	0.45	1.38*	0.89	3.75*	2.82**	2.04**	4.21	2.12
Assam	2.04**	2.82***	0.75	1.21*	7.07***	5.78***	2.52	6.20	3.57
Manipur	-1.04	-3.16	-2.13	16.51**	11.57	-4.24	13.47	32.96***	17.17***
Meghalaya	4.25***	2.93	-1.29	4.58***	-12.65*	-16.47*	3.32	-2.53	-5.54**
Mizoram	46.84**	26.03*	-15.27*	6.26***	3.67***	-2.43*	23.53	17.47***	-3.97*
Nagaland	-21.25**	-23.34**	-2.57*	29.42**	26.69*	-2.1	0.06	-1.26	-1.2
Sikkim	6.53**	10.64***	3.78**	23.25***	19.41***	-3.11*	13.62	13.16	-0.32
Tripura	-7.34**	-2.48	5.23	3.24**	-3.26	-6.3	0.87	1.3	0.43
NER	4.28*	6.23*	1.87	4.95	3.46*	-1.25	5.07	7.46	11.94***

A – Area (in 000' ha), P- Production (000' tons) and Y-Yield (tons/ha)
*Significant at 10% level of significance;
**Significant at 5% level of significance
***Significant at 1% level of significance

Table 2 showed the compound growth rate in area, production and yield of turmeric during the period-I, period-II and for overall period. The analysis result revealed that during the period-I half of the states in the region i.e. Assam, Meghalaya,

Mizoram and Tripura witnessed positive growth in area while the other half of the states observed a negative growth. The reason for this negative growth in area might be due to the declined in the area under shifting cultivation practices that have occurred during the last decade and increased in the settled cultivation. The highest significant growth rate in area and production was registered in the state of Mizoram (46.84% & 26.03%) followed by Sikkim (6.53% & 10.64%) and Meghalaya (4.25%% 2.93%) per annum. In case of yield, 50% of the states in the region witnessed positive growth while remaining states experienced a negative growth which attribute mainly due to the increase in the incidence of pest and diseases, unavailability of quality panting materials, lack of irrigation and price fluctuation. For NER, the growth rate in area, production was found to be positive and significant at 4.28 and 6.23% per annum while yield with positive and non-significant at 1.87%.

In period-II, all the states achieved a positive growth rate in area and the highest significant growth was observed in Nagaland (29.42%) followed by Sikkim (23.25%) and Manipur (16.51%) per annum. For production, all the state showed positive growth rate except Meghalaya and Tripura. The highest significant growth rate in production was also observed in Nagaland (26.69%) followed by Sikkim (19.41%) and Manipur with positive and non-significant growth of 11.57%. With regards to yield, most of the states indicated negative growth except Arunachal Pradesh and Assam. For the region as a whole, though the area and production witnessed a positive growth of 4.95% and 3.46%, yield was found to be negated by a growth of -1.25% as referred in table 2. The possible reason for the negative growth in yield might be reason for fluctuation in prices, incidence of pest and diseases due to the used of previous season harvested seeds, low adoption of scientific package of practices and dependent on rainfed farming system. For overall period, the same result follows as in period-II where all the states achieved positive growth in area and the highest was shown in the state of Mizoram with 23.53%. Again, the production growth rate revealed that most of the states achieved a positive growth except Meghalaya and Nagaland. Considering for yield, half of the states showed a positive growth rate and the highest significant growth was observed in Manipur at 17.17% per annum. For NER, the output growth increased at 7.46% per annum which resulted from the significant growth in area by 5.07% and yield by a non-significant growth of 11.94% per annum.

Instability index analysis of ginger and turmeric in NER

In order to assess the consistency of growth performance, it becomes imperative to study the instability index for ginger and turmeric during the study period. The instability in area, production and yield of ginger and turmeric for all the three periods was worked out and presented in table 3. The value of instability presents in three categories viz., low (0 to 15), moderate (15.1 to 30) and high instability (above 30). It is revealed from the result of variability that during period-I the lowest variability in area, production and yield was experienced in the state of Meghalaya which accounted for 3.93%, 5.38% and 5.02% while the highest was observed in Nagaland with 97.27%, 54.99% and 41.59 percent respectively. High instability in yield indicated that the production of ginger was increase mainly due to the increase in productivity of the crop. The remaining state observed a low and moderate instability whereas for state Sikkim production and yield witnessed a high instability at 37.22% and 37.41%. Considering for the region, the area, production and yield showed low instability during the same period.

Table 3: Cuddy Della Valle Instability Index in area, production and yield of ginger

States	Period-I (2001-10)			Period-II (2011-2020)			Overall period (2001-2020)		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Arunachal	8.09	10.97	6.24	17.78	21.9	7.58	20.17	25.75	8.6
Assam	8.17	16.89	12.14	4.44	6.44	3.06	15.89	19.52	8.95
Manipur	18.49	14.99	12.7	6.72	51.29	48.51	21.91	59.02	67.29
Meghalaya	3.93	5.38	5.02	0.69	2.92	2.39	3.05	4.2	4.29
Mizoram	28.86	17.93	16.28	3.26	20.9	21.91	17	26.33	22.09
Nagaland	97.27	54.99	41.59	21.71	17.88	38.55	56.27	34.76	40.78
Sikkim	10.84	37.22	37.41	28.15	12.3	9.09	28.61	31.34	27.63
Tripura	7.08	29.62	30.43	8.97	23.58	27.91	12.43	23.71	28.78
NER	7.64	7.98	6.3	6.89	3.05	3.42	10.16	8.44	5.06

Note: All figures are in percentages

During the period-II, it was observed that almost all the states in the region witnessed a low and moderate instability in area, production and yield of ginger. Similar pattern was observed as in period-I where the lowest variability was shown in the state of Meghalaya accounting for 0.69%, 2.92% and 2.39% in area, production and yield. However, the instability in yield was found to observed high in Manipur and Nagaland with 48.51% and 38.55%. The area, production and yield instability in the region revealed low instability with 6.89%, 3.05% and 3.42%. Similar result was observed during the overall period where Meghalaya achieved the lowest variability while Nagaland showed the upmost variability in area, production and yield. For other states, a low and moderate instability was shown in area production and yield. However, in Manipur yield showed high variability at 67.29% which may be the resulting increase in the variability in production by 59.02% during the same period under study. Impressive result was also shown in the region as low instability was observed in area, production and yield during the overall period as referred in table 3. It can be summed up that the instability index in area, production and yield of ginger during the period-II was lower than in the first period as well as from the overall period.

Table 4 explained the result of instability analysis in area, production and yield of turmeric during period-I and period-II as well as for overall period. A perusal of the table revealed that though the area and production in the period-II was comparatively lower than the period-I in the region. However, the yield was comparatively higher in period-II as compared to period-I and the decrease in area instability much more compensated for the increase in yield instability resulting in reduction of production instability. The state wise analysis

revealed that in period-I, Assam registered the highest stability in area, production and yield accounted for 5.19%, 4.3% and 3.57% whereas the highest variation was witnessed in the state of Mizoram in area, production and yield at 77.59%, 107.09% and 40.01%. For period-II also, Assam also recorded the lowest variation in area and yield while Mizoram showed the lowest instability indices in production at 3.96%. For overall period, the yield variability performed badly by registering a high instability of 95.44% as compared to area with low instability at 7.86% and production at a moderate instability with 17.74% in the region.

Table 4: Cuddy Della Valle Instability Index in area, production and yield of turmeric

States	Period-I (2001-10)			Period-II (2011-2020)			Overall period (2001-2020)		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Arunachal	11.39	10.63	4.18	16.14	13.62	6.67	16.03	15.45	5.95
Assam	5.19	4.3	3.57	3.15	7.06	6.14	5.10	9.61	9.37
Manipur	37.33	46.84	18.73	26.2	52.29	64.1	42.67	74.45	87.09
Meghalaya	4.39	14.34	12.58	4.44	40.22	33.66	5.66	35.15	27.47
Mizoram	77.59	107.09	40.01	6.38	3.96	8.72	36.05	41.00	43.93
Nagaland	35.63	35.68	7.71	37.92	103.84	72.35	66.89	108.39	52.17
Sikkim	12.56	10.13	7.43	23.44	30.12	9.03	35.36	28.63	13.51
Tripura	15.21	21.14	30.36	7.5	32.79	27.96	20.31	33.25	32.01
NER	12.39	24.71	16.09	2.54	12.42	63.16	7.86	17.74	95.44

Note: All figures are in percentages

Statewise analysis indicated that Assam showed lowest instability in area and production recoded at 5.10% and 9.61%. For yield, Arunachal Pradesh achieved the lowest instability registering at 5.95%. Whereas, Nagaland experienced a high instability in area and production of 66.89% and 108.39% while high instability in yield was observed in the state of Manipur by 87.09%.

Decomposition of output growth of ginger and turmeric in NER

In order to provide an empirical support for designing policies to improve the pace of agriculture growth a better understanding of different sources of growth and their magnitude is of prime importance (Sagolsem *et al*., 2017). The decomposition analysis also shows whether the different components influencing the growth in output has changed over the period or not and variability which indicates the input and output relation. This method analyzed the importance of changes in area-yield correlations accounted for the increased in production instability. It also explains why fluctuations in area and yield have become more coordinated.

Perusal of the table 5 reveals that during the period-I, the highest contribution to the change in ginger output was of area effect (71.82%) followed by yield effect (37.03%) in the region. Further, analysis showed that half of the states in the region viz., Mizoram, Nagaland, Sikkim and Tripura observed to be the major contributors towards the change in production from yield effect whereas the remaining half of the states contributed from area expansion. Again during the period-II, all the states in the region showed that yield factor is as high as sufficient enough to nullify the area and interaction effect including the region as a whole wherein, the dominant factor to the output was of area effect (59.40%) followed by yield effect (43.07%). For overall period, the area effect (59.64%) emerged out to be the dominant factor for increase in the production of ginger than yield and interaction effect in the region. Again, it was also observed that 50% of the states in the region showed area effect to be the major factor that contributes towards change in production. For Manipur and Tripura, it was the yield effect that significantly contributes to the output growth of ginger whereas for Nagaland and Sikkim, the contribution was from interaction effect.

Table 5: Contribution of area and yield on change in production of ginger in NER (all figures in percentage)

Variables	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	NER
Period I (2001-10)									
A○Δ Y	0.34(21.72)	2.80(28.46)	0.14(34.39)	0.11(13.57)	-0.82(32.97)	3.19(289.37)	1.41(82.48)	0.71(151.48)	5.21(37.03)
Y○ΔA	1.16(74.09)	6.36(64.67)	0.36(85.16)	0.77(93.81)	-0.14(5.77)	-1.61(-146.03)	0.40(23.35)	-0.20(-42.34)	10.11(71.82)
ΔA ΔY	0.06(4.17)	0.67(6.85)	-0.08(-19.55)	-0.06(-7.38)	-1.52(61.24)	-0.43(-43.34)	-0.10(-5.83)	-0.04(-9.14)	-1.24(-8.85)
Δ P	1.57(100)	9.83(100)	0.43(100)	0.82(100)	-2.48(100)	1.10(100)	1.71(100)	0.47(100)	14.08(100)
Period II (2011-20)									
A○Δ Y	-0.42(411.16)	4.57(59.79)	1.47(107.19)	0.62(63.38)	1.62(60.96)	-5.29(58.58)	-1.91(65.78)	0.42(65.10)	4.34(59.40)
Y○ΔA	-0.32(315.26)	2.78(36.37)	-0.08(-5.83)	0.34(35.32)	1.13(42.49)	0.81(-8.97)	-0.53(18.51)	0.32(49.18)	3.14(43.07)
ΔA ΔY	0.64(-626.42)	0.29(3.83)	-0.01(-1.36)	0.01(1.29)	-0.09(-3.45)	-4.55(50.38)	-0.45(15.70)	-0.09(-14.29)	-0.18(-2.48)
Δ P	-0.10(100)	7.65(100)	1.37(100)	0.98(100)	2.66(100)	-9.03(100)	-2.90(100)	0.65(100)	7.30(100)
Overall period (2001-20)									
A○Δ Y	0.04(5.21)	4.02(42.53)	0.69(88.62)	0.49(45.00)	0.50(294.11)	-1.21(29.42)	-0.11(24.42)	0.58(101.48)	5.54(46.65)
Y○ΔA	0.52(55.34)	4.92(52.05)	0.11(14.95)	0.62(57.20)	0.52(305.88)	-0.24(6.02)	-0.07(14.87)	0.06(10.97)	7.09(59.64)
ΔA ΔY	0.37(39.43)	0.51(5.41)	-0.02(-3.58)	-0.02(-2.20)	-0.85(-500)	-2.65(64.54)	-0.29(60.69)	-0.07(-12.45)	-0.74(-6.30)
Δ P	0.95(100)	9.45(100)	0.78(100)	1.09(100)	0.17(100)	-4.12(100)	-0.48(100)	0.57(100)	11.88(100)

Figure in parentheses are in percentage.

Note: The values within the parentheses are percentage share of column total (P= Production in '000 tonnes, A= Area in '000 ha, Y= Yield in tons/ha, ΔP, ΔA and ΔY are change in production, area and yield, respectively)

Change in the output growth of turmeric during period-I, period-II and overall period is shown in table 6. It was revealed that during period-I, all the states in the region showed area expansion to be the dominant factor for output growth except Mizoram and Sikkim wherein yield effect emerged as the major for output growth and for Manipur it was interaction effect that contributes to change in production of turmeric. For NER, the yield effect (41.23%) was the major driving factor for output growth as compared to area and interaction effect with 39.48% and 19.27%. Perusal of the table further revealed that during period-II, most of the states in the region showed area effect as the major contributor to the output growth except Assam and Meghalaya wherein yield effect accounts for the major change in production. Similar results was observed in period-II as in period-I for NER where yield effect (80.51) was found to be the dominant factor for change in output followed by area effect (15.90%) and interaction effect (3.58%).

Table 6: Contribution of area and yield on change in production of turmeric in NER (all figures in percentage)

Variables	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	NER
Period I (2001-10)									
A○Δ Y	0.01(-94.53)	0.004(20.91)	0.004(21.05)	-0.15(-131.23)	1.92(53.80)	-0.01(5.28)	0.06(65.16)	0.12(-32.64)	1.31(41.23)
Y○ΔA	-0.01(99.31)	0.16(97.87)	0.005(26.31)	0.28(240.37)	0.84(23.64)	-0.25(88.16)	0.05(56.12)	-0.32(85.22)	1.25(39.48)
ΔA ΔY	-0.01(95.22)	-0.001(-0.79)	0.01(52.63)	-0.01(-9.09)	0.80(22.54)	-0.01(6.54)	-0.02(-21.29)	-0.18(47.41)	0.61(19.27)
ΔP	-0.01(100)	0.16(100)	0.02(100)	0.11(100)	3.56(100)	-0.28(100)	0.10(100)	-0.38(100)	3.18(100)
Period II (2011-20)									
A○Δ Y	0.05(52.33)	0.97(76.41)	-0.82(-101.76)	-1.10(165.65)	-0.69(-180.35)	-0.11(-9.89)	-0.06(-5.03)	-0.11(-66.43)	81.79(80.51)
Y○ΔA	0.06(64.48)	0.27(21.72)	1.51(188.04)	0.43(-64.72)	1.24(320.59)	0.74(65.58)	1.39(104.39)	0.23(138.32)	16.15(15.90)
ΔA ΔY	-0.01(-16.81)	0.02(1.86)	0.11(13.71)	0.006(-0.93)	-0.15(-40.23)	0.50(44.31)	0.008(0.64)	0.04(28.11)	3.64(3.58)
Δ P	0.10(100)	1.27(100)	0.80(100)	-0.66(100)	0.38(100)	1.14(100)	1.33(100)	0.16(100)	101.59(100)
Overall period (2001-20)									
A○Δ Y	0.03(71.44)	0.52(64.64)	-0.42(-98.12)	-0.63(220.36)	0.64(30.86)	-0.06(-15.09)	-0.004(-0.53)	-0.005(-8.79)	43.79(79.04)
Y○ΔA	0.02(58.71)	0.27(33.83)	0.80(183.46)	0.34(-121.78)	1.09(52.73)	0.26(58.25)	0.77(101.52)	0.14(240.09)	9.36(16.90)
ΔA ΔY	-0.01(-30.16)	0.01(1.52)	0.06(14.66)	-0.004(1.41)	0.34(16.39)	0.25(56.84)	-0.007(-0.98)	-0.07(-131.30)	2.24(4.05)
Δ P	0.04(100)	0.80(100)	0.43(100)	-0.28(100)	2.08(100)	0.45(100)	0.76(100)	0.05(100)	55.39(100)

Figure in parentheses are in percentage.

Note: The values within the parentheses are percentage share of column total (P= Production in '000 tonnes, A= Area in '000 ha, Y= Yield in tonnes/ha, ΔP, ΔA and ΔY are change in production, area and yield, respectively)

Also for overall period, the area effect accounts for larger share of the change in the production in most of the states including NER except for some of the states like Arunachal Pradesh, Assam and Meghalaya where yield effect has major impact to the output growth.

Conclusions

The region indicated a sluggish growth rate in area, production and yield of ginger. However, minimum fluctuations were observed as the instability indices were found to confine within the range of low instability during the three sub-periods accompanied by largely dependent on area expansion for its output growth during period-I and period-III. Similar outcome was observed in case of turmeric too where low growth rate was observed in all the study sub-periods. Also, the region witnessed a negative growth rate in yield during the period-II which might be possibly due to used of previous year harvested seedlings, incidence of pest and diseases and improper packages of practices. Instability analysis indicated that during period-I moderate variation was observed in production and yield instability was comparatively high as compared to area and production during period-II and period-III. The growth output during the three sub-period showed that yield effect was found sufficient enough to nullify the area and interaction effect in the region.

Further, it is inferred that in view of the existing low growth and wide fluctuation in area, production and yield of ginger and turmeric, future developmental programmes should be envisaged on stabilization in the production of these spice crops through adoption of improved packages of practices. Lack of diseases free quality planting materials, lack of improved management practices standardization of production techniques, paralyzed infrastructure and poor geographical links, the states in the region are experiencing a dawdling pace in catching up the spices development. Under this circumstance, the horticulture sectors needs prioritization of development perspectives for increasing the adoption of recommended production technologies through capacity building programmes, supply of inputs, support of financial institutions and marketing infrastructure. More importantly, developmental research programme must address the need-based location specific technologies for the specific agro-ecological situations.

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