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Temporal Variation of Maize Production in North Eastern Region of India: An Inter-State Comparative Study

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ABSTRACT

This paper investigates the temporal variations in area, production and yield of maize in the states of north eastern region of India during the period 1975-76 to 2014-15 which has been in turn divided into four equal decades. Among the four decades, growth rate performance of maize in the fourth decade (2005-06 to 2014-15) may be regarded well than the previous three decades which are almost similar and lower than that of the fourth decade. Among the states during the decadal study periods, Nagaland shows better performance in production growth of maize followed by Arunachal Pradesh, Meghalaya and Tripura while Assam, Manipur, Mizoram and Sikkim are running behind. The decomposition analysis has revealed that sources of output growth in the states of the region are due to either area expansion (52%) or yield improvements (44%) except in few cases where there are interaction effects (4%). Instability index in third decade (1995-96 to 2004-05) shows lowest in area, production and yield while fourth decade (2005-06 to 2014-15) is most fluctuated. Better growth rate performance but high instability in the region in fourth decade is due to the significant increase in area, production and yield of almost all the states specially Assam in the last few years of the decade. Among the states Manipur followed by Mizoram, Tripura and Nagaland depicts comparatively higher instability in area, production and yield in all the four decades while Sikkim followed by Meghalaya, Arunachal Pradesh and Assam has registered comparatively more stable. Though area, production and productivity of maize in north eastern region have shown a steady upward trend in every period of the study, due to dramatic increase of maize demand for human consumption as well as animal and poultry feed the current trend appears unable to keep pace.

1. Introduction

Maize (Zea mays L.) is an important cereal crop in the world after wheat and rice. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. It is the most versatile crop with wider adaptability in varied agro-ecologies throughout the year due to its photo-thermoinsensitive and has highest genetic yield potential among the food grain crops (source : DMR).

In India, maize is cultivated throughout the year in most of states of the country for various purposes including grain, feed, fodder, green cobs, sweet corn, baby corn, popcorn and industrial products. Yield of grain maize is very low in the north-eastern hilly states though cultivation of grain maize in hill slopes is popular among hill tribes. In the North Eastern Himalayan Region (NEHR) of India, maize is the second most important crop, next to rice and is mostly grown under rainfed hilly upland conditions. In the North Eastern Region (NER) of India, maize production plays a significant role in

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ensuring food security and is used both for direct consumption and as well as for second cycle produce in piggery and poultry farming. High yielding varieties (HYV) of maize are widely adopted in other parts of country, but in the NEHR, most of the farmers are growing low yielding local varieties, less adaptive to changing climate, particularly rainfall and temperature trend. It is anticipated that HYVs of maize with better management practices have immense potential to increase the existing production level by 2-3 times in the hilly ecosystem of NEHR (M. A. Ansari *et al.,* 2015). In NER, maize is primarily grown under jhum land and terraced area and total area under maize as per GOI, 2014-15 is 239 thousand hectare which is 2.6% of the national average. With the above background and with broad objective of analyzing the growth rates of domestic maize production, the present study was taken up with the specific objective to analyze the temporal dynamics of growth rate, decomposition of source of output growth and instability in area, production and productivity of maize in a state wise comparative mode.

2. Data and Methodology

Secondary data on area, production and productivity from department of economics and statistics, Ministry of agriculture were compiled. According to the availability of data the study was made from 1975-76 to 2014-15 and in turn the entire period was decomposed into four periods *viz.* 1975-76 to 1984-85, 1985-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 to have an understanding of decadal performance.

Growth rate Estimation

The growth rate was measured following the popular procedure adopted by various authors, Mohamed Elamin Abd Ellatif Mahir *et al.* (2010), J. S. Sonnad *et al.* (2011), Abhey Singh Godara *et al.* (2013), Edwin Kenamu *et al.* (2014), and many others and the steps followed are presented below.

By taking time as the independent variable and the area, production and productivity of the concerned oilseed crops as the dependent variable, the compound growth rates were estimated by using the formula:

$Y = A (1 + r) t$

Where,

Y = Dependent variables like area, production and productivity in the year 't' for which growth rate is estimated

A = Constant

r = Rate of annual increment

The significance of growth rate was tested by applying student 't' test statistic.

2.1 Decomposition of Growth Components

To measure the relative contribution of area and yield towards the total production change with respect of individual crop, the technique of decomposition has been adopted. The change in the production of crop between any time periods can be expressed as

Change in production = Yield effect + Area effect + Interaction effect

Thus, the total change in production is attributed due to area and yield that can be decomposed into three effects *viz.* yield, area and interaction effects.

2.2 Instability index

Instability has been estimated for area, production, and yield for maize by using the following index (Ramesh Chand *et al.,* 2008):

Instability index = Standard deviation of natural logarithm (X_{t+1} / X_t)

where, X_t refers to area (A), production (P), yield (Y), in the year "t"; and X_{t+1} denotes these for the next year. This index is unit free and robust and measures deviations from the underlying trend (log linear in this case). When there are no deviations from the trend, the ratio of X_{t+1} and X_t remains same and their standard deviation is zero. As deviation from the underlying trend increases, the standard deviation also increases.

3. Result and Discussion

Before proceeding to the analytical part lets have and overview of area, production and yield of maize in terms of Triennium Ending (TE) in five periods *viz.* TE 1975-76, TE 185-86, TE 1995-96, TE 2005-06 and TE 2014-15 (Table 1). Considering the triennium figures, on an average Sikkim registered the highest area and production under maize among the states followed by Nagaland and Arunachal Pradesh while Tripura has shown the least area and production under maize. When yield is considered, on an average Manipur ranked first followed by Mizoram then Sikkim and Meghalaya while lowest yield was observed in Assam as per the studied triennium figures. Though fluctuations were shown by few states like Manipur and Mizoram in the studied triennium endings, gradual increment in area, production and yield were observed in NER (Table 1).

Table 1. Triennium ending area, production and yield of maize in the states of NER for TE 1975-76, TE 185-86, TE 1995-96, TE 2005-06 and TE 2014-15

	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	NER	India
Area in 000' ha										
TE 1975-76	19.3	17.0	10.9	16.6	3.1	10.3			70.8	5969.7
TE 1985-86	26.4	19.1	5.3	17.5	5.3	18.0	36.3		127.8	5818.4
TE 1995-96	34.2	18.7	3.3	17.0	7.9	27.0	40.0	2.2	150.1	6036.6
TE 2005-06	39.4	19.4	2.8	16.9	9.9	47.7	37.1	2.4	175.6	7454.0
TE 2014-15	47.5	25.2	23.9	17.8	5.9	68.8	39.9	4.2	233.2	8974.8
Production in 000' tons										
TE 1975-76	22.1	9.4	24.4	11.1	5.5	6.2			71.3	6206.1
TE 1985-86	33.3	11.7	12.4	23.3	5.9	14.5	43.7		144.8	7669.2
TE 1995-96	46.3	12.4	8.4	20.8	14.7	29.0	55.5	1.7	188.8	9316.5
TE 2005-06	55.8	13.9	8.1	24.7	19.6	85.6	57.3	2.5	267.3	14622.1
TE 2014-15	70.7	45.3	54.0	35.8	8.3	135.3	68.6	5.5	423.5	23563.5
Yield in kg/ha										
TE 1975-76	1142.5	552.3	2286.6	666.7	1831.9	600.0			1017.5	1038.7
TE 1985-86	1272.3	611.7	2344.5	1328.8	1126.5	807.3	1201.5		1132.7	1318.0
TE 1995-96	1353.3	664.1	2643.6	1223.9	1861.4	1073.7	1389.5	813.3	1257.8	2058.4
TE 2005-06	1416.3	715.0	2922.1	1459.6	1988.9	1793.5	1544.2	1023.8	1522.3	1962.1
TE 2014-15	1488.5	1709.3	2263.7	2004.4	1416.5	1968.4	1717.1	1292.2	1812.8	2624.6

3.1 Growth rates of area, production and productivity

To estimate the growth performance of area, production and yield of maize in state wise comparative mode during the period1975-76 to 2014-15, time series data on area, production and productivity were analyzed. The whole period was divided into four decades to understand the decadal performance. The periods 1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 have been referred to as period 1, period 2, period 3 and period 4 respectively from here onwards.

Period 1 (1975-76 to 1984-85**)**

In this period highest growth in area was observed in Nagaland with a statistically significant growth rate of 7.48% followed by Arunachal Pradesh (4.24%), Meghalaya (1.31%), Mizoram (1.20%) and Manipur (0.77%). Highest significant production growth was also observed in Nagaland (8.98%) followed by Meghalaya (10.35%). Production growth of Arunachal Pradesh and Mizoram showed positive while that of Assam and Manipur were declining. In case of yield, all the states except Arunachal Pradesh registered positive growth while only Meghalaya (8.92%) had shown significant. When considered NER; the growth of area, production and yield were found at the increasing rate though only area was found significant (6.07%) while national figure was showing negative in area and positive in production and yield. Sikkim and Tripura were not considered during this period due to non-availability of data.

Period 2 (1985-86 to 1994-95**)**

Mizoram registered the highest positive significant growth rate in area (7.59%) and production (12.82%) followed by Nagaland (4.38%) in area and Arunachal Pradesh (3.51%) in production at a statistically significant rate. Area of Manipur and Meghalaya were declined in this period and decline in growth of production in Manipur was statistically significant. In case of yield, all the states registered positive growth while only Assam (0.82%) had shown significant. For NER, production growth was found significantly increasing (3.13%). National figure was showing positive growth in area, production and yield.

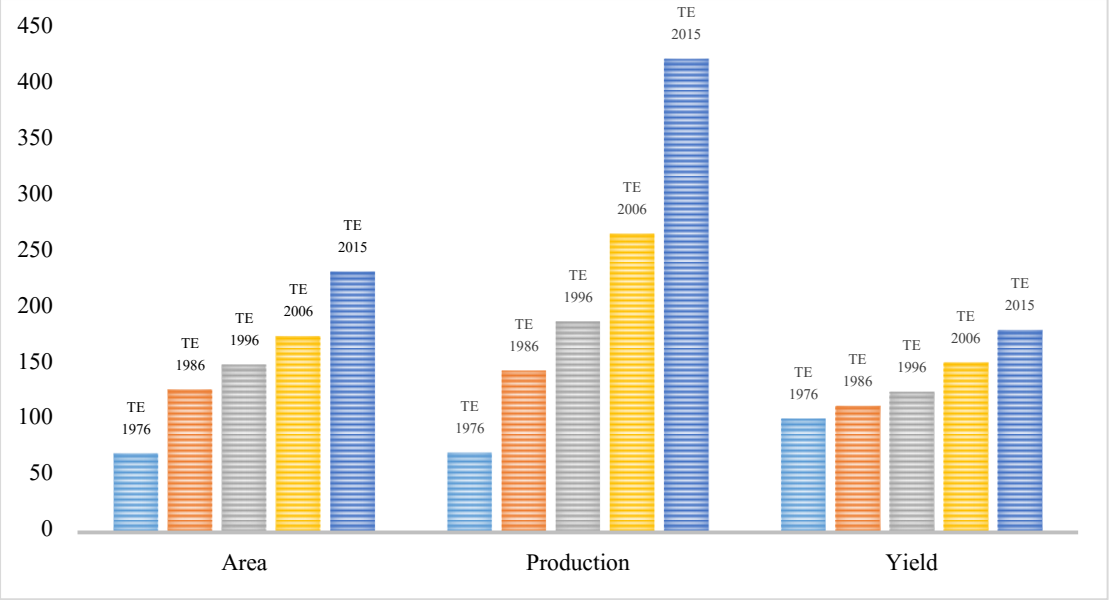
Period 3 (1994-95 to 2004-05**)**

Similar to period 1, in this period too, Nagaland topped in the growth of area, production and yield with highly significant increasing rate. Arunachal Pradesh ran second in area and production with significant positive growth rates. Rest of the states did not show any significant growth either positive of negative in all the three entities *i.e.* area, production and yield. NER and national figure showed significant positive growth in area and production.

Period 4 (2005-06 to 2014-15**)**

Highest significant growth in area and production were observed in Manipur followed by Assam in area and Arunachal Pradesh in production. Only Arunachal Pradesh and Sikkim registered significant positive growth in yield.

Figure 1. Triennium ending area, production and yield of maize in NER for TE 1975-76, TE 1985-86, TE 1995-96, TE 2005-06 and TE 2014-15



Mizoram had a significantly retarding growth rate in area. Like period 3, NER and India registered significant positive growth in area and production.

Entire period (1975-76 to 2014-14)

In the entire period, among the states Nagaland registered the highest significant growth in area (5.0%), production (8.56%) and yield (3.40%) followed by Tripura and Arunachal Pradesh. Significantly positive growth in production and yield were observed in Meghalaya and Sikkim also. Mizoram's figure was significant in area while that of Assam was in yield. In Manipur, insignificance though positive growths were observed. NER and national figure were significantly positive growth in area, production and yield. When the states with higher growths are kept first the following pattern was observed with statistically significant ones are bold, negative growths are underlined.

Area:

Period 1: **Nagaland > NER** > Arunachal Pradesh > Meghalaya > Mizoram > Manipur > India > Assam

Period 2: **Mizoram > Nagaland** > Arunachal Pradesh > NER > India > Sikkim > Assam > Meghalaya > Manipur

Period 3: **Nagaland >** Tripura **> Arunachal Pradesh > India > NER** > Assam > Mizoram > Meghalaya > Sikkim > Manipur

Period 4: **Manipur** > Tripura > **Assam** > **NER** > Nagaland > **India** > Arunachal Pradesh > Sikkim > **Meghalaya** > **Mizoram**

Entire Period: **Nagaland** >**Tripura** >**NER** >**Arunachal Pradesh** >**Mizoram >India** >Manipur >Assam >Meghalaya > Sikkim

Production:

Period 1: **Meghalaya > Nagaland** > NER > Arunachal Pradesh > Mizoram > India > Assam > Manipur

Period 2: Nagaland > **Mizoram** > India > **Arunachal Pradesh** > **NER** > Sikkim > Assam > Meghalaya> **Manipur**

Period 3: **Nagaland** > Tripura **> India > NER > Arunachal Pradesh** > Mizoram > Meghalaya > Assam > Sikkim > Manipur

Period 4: **Manipu**r > Assam > Tripura > **NER** > **India** > Meghalaya > Nagaland > **Arunachal Pradesh** > **Sikkim** > **Mizoram**

Entire Period: **Nagaland** >**Tripura** >**NER** >**India** >**Arunachal Pradesh** >Mizoram >**Meghalaya** >Assam >Manipur >**Sikkim**

Yield:

Period 1: **Meghalaya** > India > NER > Manipur > Mizoram > Nagaland > Assam > Arunachal Pradesh

Period 2: Nagaland > Mizoram > India > NER > Sikkim >**Assam** > Manipur > Meghalaya > Arunachal Pradesh

Period 3: **Nagaland** > Tripura > India > NER > Sikkim > Mizoram > Meghalaya > Assam > Arunachal Pradesh > Manipur

Period 4: Assam > Mizoram > Meghalaya > Tripura > India > NER > Nagaland **> Sikkim** > **Arunachal Pradesh** > Manipur

Entire Period: **Nagaland** > **Tripura** > **India** >**Meghalaya** >**NER** >**Assam** >**Sikkim** >**Arunachal Pradesh** >Manipur >Mizoram

The performance of period 1, 2 and 3 were more or less similar. However when period 4 came in the picture the scenario changed towards a dramatic positive direction with many statistically significant positive growth rates of area, production and yield with only three numbers of negative entries from Manipur (yield) and Mizoram (area and production). In the entire period too, the growth performance of the region was highly and significantly accelerating.

Arunachal Pradesh and Assam had consistently positive growth rates of area, production and yield in all the periods except in period 1. Manipur was having the most fluctuating growth (area, production and yield) between positive and negative in all the periods. Meghalaya presented positive growth in area, production and yield during period 1 but in period 2 negative growths in area and production were seen, again in period 3 the growth of area was declining. When Meghalaya entered period 4, it became stable showing positive growth rates in area, production and yield and similarly positive in the entire period too. Mizoram also consistently registered positive growth until the period 4 where growth of area and production were negative. Nagaland gave positive growth in all the periods for all the entities (area, production and yield) with maximum significant figures. In the study, Sikkim started from period 2 where all the growth entries were positive though insignificant while in period 3 area was declining. Sikkim also became stable in the period 4 showing all positive growths but in the entire period again area growth was negative. Tripura started from period 3 and all the entries of growth rates in all the periods were positive. When the entire NER was considered, similar to Nagaland, all the growth entries (Table 2) were positive with many significant figures and its performance in terms of growth rate of area, production and yield were even better than that of the nation.

Table 2. Compound growth rate of area, production and yield of maize in the states of NER during the decades 1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 and overall period 1975-76 to 2014-15

	Arunachal Pradesh	**Assam**	**Manipur**	**Meghalaya**	**Mizoram**	**Nagaland**	**Sikkim**	**Tripura**	**NER**	**India**
Period 1: 1975-76 to 1984-85										
AREA	4.24	-1.40	0.77	1.31	1.20	7.48**	NA	NA	6.07**	-0.21
PRDN	4.08	-0.64	-8.31	10.35**	2.74	8.98***	NA	NA	7.81	2.39
YIELD	-0.15	0.77	1.56	8.92**	1.52	1.39	NA	NA	1.65	2.60
Period 2: 1985-86 to 1994-95										
AREA	3.41	0.05	-7.65	-1.02	7.59**	4.38*	0.35	NA	1.71	0.56
PRDN	3.51**	0.87	-7.02*	-0.48	12.82*	14.77	1.49	NA	3.13*	4.28
YIELD	0.10	0.82**	0.68	0.55	4.85	9.95	11.14	NA	1.40	3.70
Period 3: 1995-96 to 2004-05										
AREA	2.34*	0.37	-1.13	-0.13	0.23	5.70***	-0.98	2.66	1.60**	2.16**
PRDN	2.36**	0.56	-4.78	0.72	1.27	13.57***	0.25	5.04	3.49**	4.11*
YIELD	0.03	0.19	-3.69	0.85	1.04	7.45**	1.24	2.32	1.86	1.91
Period 4: 2005-06 to 2014-15										
AREA	1.30	4.65**	35.95**	0.67**	-7.42**	2.04	0.68	9.94	2.88***	2.00***
PRDN	2.64*	15.20	31.42**	5.21	-1.96	4.10	2.43**	14.71	5.90*	5.70**
YIELD	1.32*	10.08	-3.33	4.51	5.90	2.01	1.74**	4.34	2.94	3.63
Entire Period: 1975-76 to 2014-15										
AREA	2.37***	0.08	0.48	0.03	1.66*	5.00***	-0.06	4.32**	2.45***	1.20***
PRDN	3.10***	1.50	1.18	2.07***	2.31	8.56***	0.89**	6.86**	4.17***	3.65***
YIELD	0.72***	1.42*	0.70	2.04***	0.64	3.40***	0.99***	2.44**	1.69***	2.42***

***Significant at 10 per cent level, **Significant at 5 per cent level, ***Significant at 1 per cent level, NA: Not applicable**

On an average, Nagaland ranked first in terms of performance of growth in area, production and yield which was followed by Arunachal Pradesh, Meghalaya and Tripura. Assam, Manipur Mizoram and Sikkim were at the lower side of growth rate performance of area, production and yield as per the study periods.

3.2 Contribution of area, productivity and their interaction

The growth analysis (area, production and yield) of maize revealed the general pattern of growth and direction of changes in yield and area. But this analysis does not evaluate the contribution of area and yield towards the production growth. So, it is necessary to examine the sources of output growth. To appraise the sources of output growth, the change in production was divided in to three effects *i.e.* area effect, yield effect and interaction effect. With the help of this additive decomposition model the relative contribution of area, productivity and their interaction on maize production in the states of NER for different periods (1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 and overall period 1975-76 to 2014-15) had been estimated and presented in table 3.

As Table 3 reveals in Arunachal Pradesh, Manipur, Nagaland and Tripura, the major contribution to the change of maize production in all the periods was consistently area effect except interaction effect in Nagaland in the overall period while in Assam and Meghalaya, the major contribution was yield effect in all the study periods. In Mizoram, except the period 3, all other periods showed area effect as the main contribution to the change in production of maize. In Sikkim, baring the period 1 as non-availability of data, the following three periods as well as entire period showed consistently yield effect as major contribution. When NER was considered, period 1 and 2 were dominated by area effect and period 3 and 4 had been dominated by yield effect while interaction effect was the major contribution in case of the entire period. Hence change in output production in Arunachal Pradesh, Manipur, Mizoram, Nagaland and Tripura was due to area expansion while those in Assam, Meghalaya and Sikkim were yield improvement.

3.3 Instability Analysis

Statewise instability was estimated to find dispersion and compare the change in instability over time among the states of NER. Variability in agricultural production consists of variability in area and yield and their interactions. Different events may affect area and yield in the same, opposite or different way. Instability in area, production and yield of maize experienced at the state level in NER during four different periods (1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15) and overall period 1975-76 to 2014-15 have been presented in Table 4.

During period 1 highest instability in area, production and yield were observed in Mizoram (38.71, 73.42, 64.42) followed by Manipur (28.30, 34.42, 17.23) and most stable was Meghalaya (3.64) in area, Nagaland (9.66) in production and Assam (2.39) in yield. Production was more instable than area and yield in case of NER (18.34) and India (14.12). In the period 2, highest instability in area was observed in Manipur (34.21) followed by Mizoram (14.53) and Nagaland (11.99). Instability in production and yield were highest in Nagaland (36.92, 40.21) followed by Mizoram and Manipur. Least instability was Sikkim in area (2.64) and production (4.71) and Assam (1.90) in yield. Yield was comparatively more instable than area and production in case of NER (4.03, 6.87,5.56) while production was more instable in India (18.77) during period 2. In period 3 highest instability in area, production and yield were observed in Manipur (47.98, 46.23, 28.25) followed by Mizoram and Tripura. Lowest instability in area was observed in Meghalaya (1.38) and Assam (1.84). Assam was found least instable too in terms of yield (5.07) while Arunachal Pradesh (4.70) registered least instability in production. In case of NER, production was more instable than area and yield while in India area was found most stable followed by yield and production in period 3. In period 4 also Manipur topped as highest instability in area (50.85) followed by Mizoram and instability in production and yield were highest in Mizoram (151.96, 135.95) followed by Assam. In this period, Assam showed highly instable in production and yield which had been comparatively consistent in all the previous periods. Least instability in area was observed in Meghalaya (1.29) while that of production and yield was observed in Arunachal Pradesh (5.92, 2.85) during period 4. Similar to period 1, production was more instable than area and yield in case of NER (12.44) and India (12.78). When we look at the entire period (1975-76 to 2014-15), instability in area remain topped by Manipur (41.48) followed by Mizoram and Tripura. Production was most instable in Mizoram (81.72) followed by Manipur and Tripura. In Yield also, Mizoram (71.57) stood highest instability followed by Nagaland and Manipur. In case of NER and India, area was found most stable in considering the entire period. On an average the period 3 was the least instable in area, production and yield followed by period 2 and 1. Period 4 was found highest instability which was even higher than that of the entire period. The high instability in period 4 was due to the significant increase in area, production and yield of almost all the states specially Assam in the last few years of the decade.

Table 3. Contribution of Area, Yield and their Interaction in the change of maize production during the decades 1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 and overall period 1975-76 to 2014-15

State	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	NER	India
Period 1: 1975-76 to 1984-85										
ΔP	10500 (100)	0	-11400 (100)	12800 (100)	100 (100)	7900 (100)	NA	NA	65400 (100)	1186000 (100)
$A_0\Delta Y$	291 (3)	NA	1026 (-9)	10883 (85)	-1868 (-1868)	2030 (26)	NA	NA	9613 (15)	1522537 (128)
$Y_0\Delta A$	10077 (96)	NA	-11908 (104)	977 (8)	2927 (2927)	4440 (56)	NA	NA	49869 (76)	-278167 (-23)
$\Delta A\Delta Y$	133 (1)	NA	-518 (5)	941 (7)	-959 (-959)	1430 (18)	NA	NA	5918 (9)	-58370 (-5)
Period 2: 1985-86 to 1994-95										
ΔP	9900 (100)	500 (100)	-4200 (100)	-2700 (100)	8300 (100)	13500 (100)	7400 (100)	NA	34500 (100)	2240700 (100)
$A_0\Delta Y$	-4097 (-41)	697 (139)	-1427 (34)	-1730 (64)	2493 (30)	3648 (27)	4788 (65)	NA	3755 (11)	4928320 (78)
$Y_0\Delta A$	15750 (159)	-186 (-37)	-3074 (73)	-1049 (39)	4180 (50)	7871 (58)	2374 (32)	NA	30019 (87)	388042 (17)
$\Delta A\Delta Y$	-1753 (-18)	-11(-2)	300 (-7)	78 (-3)	1627 (20)	1980 (15)	239 (3)	NA	726 (2)	102238 (5)
Period 3: 1995-96 to 2004-05										
ΔP	9600 (100)	900 (100)	1800 (100)	2300 (100)	500 (100)	52500 (100)	1600 (100)	1200 (100)	70400 (100)	4708000 (100)
$A_0\Delta Y$	2470 (26)	828 (92)	131 (7)	2442 (106)	1128 (226)	19388 (37)	6675 (417)	343 (29)	37798 (54)	1939554 (41)
$Y_0\Delta A$	6762 (70)	68 (8)	1638 (91)	-128 (-6)	-585 (-117)	20371 (39)	-4539 (-284)	720 (60)	27235 (39)	2287579 (49)
$\Delta A\Delta Y$	368 (4)	4 (0)	30 (2)	-14 (-1)	-43 (-9)	12741 (24)	-535 (-34)	137 (11)	5367 (8)	470866 (10)
Period 4: 2005-06 to 2014-15										
ΔP	17100	79450	50850	16660	-14080	43040	12390	3690	209100	9462755

	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
A0ΔY	7569 (44)	49622 (62)	-1395 (-3)	14084 (85)	-4975 (35)	9025 (21)	8970 (72)	667 (18)	97091 (46)	5259808 (56)
Y0ΔA	8429 (49)	6453 (8)	63445 (125)	1626 (10)	-11660 (83)	31003 (72)	2952 (24)	2320 (63)	83008 (40)	3095935 (33)
ΔAΔY	1102 (6)	23375 (29)	-11201 (-22)	950 (6)	2556 (-18)	3012 (7)	469 (4)	703 (19)	29001 (14)	1107011 (12)
Overall Period : 1975-76 to 2014-15										
ΔP	52900 (100)	81150 (100)	35150 (100)	29460 (100)	2920 (100)	129640 (100)	21290 (100)	5886 (100)	406000 (100)	16916855 (100)
A0ΔY	8056 (15)	58321 (72)	851 (2)	25303 (86)	-95 (-3)	14441 (11)	18215 (86)	-595 (-10)	85414 (21)	8614859 (51)
Y0ΔA	32864 (62)	3896 (5)	33105 (94)	1283 (4)	3066 (105)	34992 (27)	2224 (10)	4033 (69)	156041 (38)	3795534 (22)
ΔAΔY	11980 (23)	18934 (23)	1194 (3)	2874 (10)	-51 (-2)	80207 (62)	851 (4)	-749 (-13)	164545 (41)	4506462 (27)

Figures in parenthesis are in percentage

NA: Not applicable

Among the states Manipur followed by Mizoram, Tripura and Nagaland registered comparatively highly instable in area, production and yield in all the periods while Sikkim followed by Meghalaya, Arunachal Pradesh and Assam was found comparatively more stable. By inspecting table 4, the following pattern can be formed when the states are kept in the descending order of their instability in area, production and yield for different periods.

Area:

Period 1: Mizoram >Manipur >Arunachal Pradesh >Nagaland >NER >Assam >Meghalaya

Period 2: Manipur >Mizoram >Nagaland >Arunachal Pradesh >Assam >Meghalaya >NER >India >Sikkim

Period 3: Manipur >Mizoram >Tripura >Nagaland >Arunachal Pradesh >NER >India >Sikkim >Assam >Meghalaya

Period 4: Manipur >Tripura >Mizoram >Nagaland >Assam >Arunachal Pradesh >NER >Sikkim >India >Meghalaya

Entire Period: Manipur >Mizoram >Tripura >Arunachal Pradesh > Nagaland >Assam >NER >India >Meghalaya >Sikkim

Production:

Period 1: Mizoram >Manipur >Arunachal Pradesh >NER >Meghalaya >India >Assam

Period 2: Nagaland >Mizoram >Manipur >India >Meghalaya >Assam >NER >Arunachal Pradesh >Sikkim

Period 3: Manipur >Mizoram >Tripura >Nagaland >India >Sikkim >Meghalaya >NER >Assam >Arunachal Pradesh

Period 4: Mizoram >Assam >Manipur >Nagaland >Tripura >India >Meghalaya >NER >Sikkim >Arunachal Pradesh

Entire Period: Mizoram >Manipur >Tripura >Assam >Nagaland >Arunachal Pradesh >India >NER >Meghalaya >Sikkim

Yield:

Period 1: Mizoram >Manipur >India >Meghalaya >NER >Arunachal Pradesh >Nagaland >Assam

Period 2: Nagaland >Mizoram >Manipur >India >Arunachal Pradesh >Meghalaya >NER >Sikkim >Assam

Period 3: Manipur >Nagaland > Mizoram >Tripura >India >Sikkim >Meghalaya >NER >Arunachal Pradesh >Assam

Period 4: Mizoram >Assam >Nagaland >Manipur >India >Meghalaya >NER >Tripura >Sikkim >Arunachal Pradesh

Entire Period: Mizoram >Nagaland >Manipur >Assam > India >Tripura >Meghalaya >NER >Arunachal Pradesh >Sikkim

Summary and Conclusion

Temporal analysis of four decades reveals that growth rate performance of period 4 (2005-06 to 2014-15) may be regarded as the best among the four study periods while performance of period 1 (1975-76 to 1984-85), period 2 (1985-86 to 1994-95) and period 3 (1995-96 to 2004-05) are almost similar and lower than that of period 4 (2005-06 to 2014-15). In the entire period (1975-76 to 2014-15) too, the growth performance of the region is highly significantly accelerating. The statewise comparison of growth rates of area, production and yield in all the periods reveals that on an average, Nagaland may be ranked first in terms of performance of growth in area, production and yield and its overall performance is even better than that of NER and national average. Nagaland's performance is followed by Arunachal Pradesh, Meghalaya and Tripura. Assam, Manipur, Mizoram and Sikkim are at the lower side of growth rate performance of area, production and yield as per the study periods. The result of decomposition analysis shows that sources of output growth are almost same in all the periods. In all the eight states with NER, for all the periods the relative contribution to the change of output is either area effect or yield effect except in the entire period where Nagaland and NER show interaction effect as major contribution. The distribution of these three effects considering the entire table 3 are: yield effect: 44%, area effect: 52% and interaction effect: 4%. Hence production in the region has rapidly increased as a result of area expansion as well as yield improvements. In the instability analysis period 3 (1995-96 to 2004-05) was found most stable in area, production and yield followed by period 2 (1985-86 to 1994-95) and 1 period 1 (1975-76 to 1984-85) while period 4 (2005-06 to 2014-15) was found least stable. The high instability in NER during period 4 was due to the significant increase in area, production and yield of almost all the states specially Assam in the last few years of the decade. When instability analysis is concerned in statewise comparative mode it reveals that Manipur followed by Mizoram, Tripura and Nagaland depict comparatively highly instable in area, production and yield in all the periods while Sikkim followed by Meghalaya, Arunachal Pradesh and Assam has shown comparatively more stable in area, production and yield in the study periods. For NER, the instability in area, production and yield are fairly low and even lower than that of the nation. However, area remains most stable in all the periods as expected while production and yield fluctuate little from period to period. Though area, production and productivity of maize in NER have shown a steady upward trend as well as positive growth rate in every period of the study, due to dramatic increase of maize demand in the regions for

Table 4. Instability index of Area, Production and Yield of maize during the decades 1975-76 to 1984-85, 185-86 to 1994-95, 1995-96 to 2004-05 and 2005-06 to 2014-15 and overall period 1975-76 to 2014-15

	Arunachal Pradesh	**Assam**	**Manipur**	**Meghalaya**	**Mizoram**	**Nagaland**	**Sikkim**	**Tripura**	**NE**	**India**
Period 1: 1975-76 to 1984-85										
AREA	26.38	11.37	28.30	3.64	38.71	12.05			11.74	2.90
PRDN	28.50	12.84	34.42	14.90	73.42	9.66			18.34	14.12
YIELD	9.63	2.39	17.23	12.36	64.42	9.18			10.47	12.65
Period 2: 1985-86 to 1994-95										
AREA	8.88	7.95	34.21	4.41	14.53	11.99	2.64		4.03	3.23
PRDN	5.16	8.54	21.22	8.61	34.07	36.92	4.71		5.56	18.77
YIELD	9.33	1.90	26.23	9.07	29.09	40.21	4.81		6.87	16.39
Period 3: 1995-96 to 2004-05										
AREA	5.88	1.84	47.98	1.38	27.42	6.76	2.76	25.56	3.31	3.31
PRDN	4.70	4.83	46.23	6.46	30.07	15.58	6.67	29.25	6.36	11.94
YIELD	5.28	5.07	28.25	6.33	13.21	15.82	6.72	11.62	5.28	9.82
Period 4: 2005-06 to 2014-15										
AREA	4.71	7.06	50.85	1.29	18.07	7.74	2.37	18.25	4.09	1.82
PRDN	5.92	48.19	41.98	12.46	151.96	27.28	5.93	25.34	12.44	12.78
YIELD	2.85	43.58	13.88	11.22	135.95	28.16	3.76	9.91	10.37	12.11
Entire Period: 1975-76 to 2014-15										
AREA	14.02	7.80	41.48	2.97	26.03	9.64	2.56	22.08	6.63	3.03
PRDN	14.58	25.10	37.37	11.12	81.72	23.77	5.69	27.10	11.51	14.31
YIELD	7.28	21.35	21.56	9.97	71.57	25.12	5.12	10.59	8.21	12.56

human consumption as well as animal and poultry feed the current trend appears unable to keep pace. Though positive growths are observed, only around 23 % of the figures (Table 2) are statistically significant. Besides, the yield in the region (1813 kg/ha) is significantly lower than that of the national average (2625 kg/ha). This might be due to the fact that in the NEHR, most of the farmers are growing low yielding local varieties, less adaptive to changing climate, particularly rainfall and temperature trend (M. A. Ansari *et al.,* 2015). Socio economic and other constraints may be non-availability of improved seeds, inadequate input markets, ineffective technology dissemination, lack of proper management practices, and lack of collective action. Therefore, as an initial step, approaches may be made to raise upto the national average mending the gap of (812 kg/ ha) through proper control over various biotic and abiotic production constraints.

References

Abhey Singh Godara., Usha Poonia (2013). Impact of Prices on Acreage and Income From Gram In Haryana *Internatonal j innovative res dev.* 2(9).

Bal Krishan., Amar Chanchal (2014), Agricultural Growth and Instability in Western Himalayan Region: An Analysis of Himachal Pradesh, India. *J Agric Life Sci* 1(1)

Dhakre D. S., D. Bhattacharya (2013). Growth and Instability Analysis of Vegetables in West Bengal, India. *International J Bio-resource Stress Manag*, 4(3): 456-459

Priyanka Sahni, (2014). Trends in India's Exports: A Comparative Study Of Pre And Post Reform Period. *IOSR J Econ Finance (IOSR-JEF) e-ISSN: 2321-5933, p-ISSN: 2321-5925.* 3(2): 08-18 *www.iosrjournals.org* www.iosrjournals.org

Edwin Kenamu., M. Alexander. R. Phiri, (2014). Performance of Cotton Production in Malawi. *Scholarly J Agric Sci*, 4(3): 157-165 March, 2014. Available online at http:// www.scholarly-journals.com/SJAS, ISSN 2276-7118 © 2014 Scholarly-Journals

Sonnad J. S., Raveendaran N., Ajjan N. K.N Selvaraj (2011). Growth analysis of oilseed crops in India during pre and post - WTO periods. *Karnataka J. Agric. Sci,* 24(2) : 184-187

Fasih UR Rehman., Ikram Saeed, Abdul Salam (2011). Estimating growth rates and decompositionAnalysis of agriculture production in Pakistan: pre and post sap analysis. *Sarhad J. Agric.* 27(1)

Joshi P.K., N.P. Singh, N.N. Singh, R.V. Gerpacio, P.L. Pingali. 2005. Maize in India: Production Systems, Constraints, and Research Priorities. Mexico, D.F.: CIMMYT

M. A. Ansari, N. Prakash, Ashok Kumar, S. L. Jat, L. K. Baishya, S. K. Sharma, Ch. Bungbungcha, Sanatombi Kh, S. Sanjay Singh. (2015). Maize production technology highlighted in North East India. Training Manual RCM (TM) – 05. ICAR Research Complex for NEH Region, Manipur Centre, Lamphelpat, Imphal- 795004.

Marchenko Y (2009). Multiple-imputation Analysis Using Stata's mi Command. Presentation given to the 2009 UK Stata Users Group Meeting, London, UK, on September 10, 2009. Stata Corp.

Mohamed Elamin Abd Ellatif Mahir, Hag Hamad Abdelaziz, (2010). Estimation of Growth Rates and Analysis of its Components in the Gezira Scheme. *Research J Agric Biol Sci*, 6(6): 885-890 © 2010, INSInet Publication

N. Uttam Singh, Kishore K Das, A. Roy, A. K. Tripathi (2015). Estimation of Growth Rate and Decomposition of Output Componentsof Oilseed: A Comparative Study among the States of North East. *Indian J Hill Farming*. December 2015, 28(2): 96-101

N.K. Pandey, Rajesh K. Rana, Arun Pandit, K.P. Chandran, (2005). Contribution OF Uttar Pradesh towards Indian Potato. *Potato J.* 32 (3-4) : 221-222

Sadiq Mohammed Sanusi, (2014). Empirical growth rate analysis of rice production in Nigeria and its implication on food security: Comparative assessment of three economic reforms phases in Nigeria. Journal of Agricultural Economics, Extension and Rural Development: ISSN-2360-798X, 1(12): 218-223, Copyright © 2014 Spring Journals

Satinder Kumar., Surender Singh, (2014). Trends in Growth Rates in Area, Production and Productivity of Sugarcane in Haryana. *International J Adv Res in Manag Soc Sci,* 3(4) www.garph.co.uk IJARMSS | 117

Veerpaul Kaur Maan, Sandeep Kumar, (2012). State wise agricultural sector growth and performance. *International J Appl Innov Eng Manag (IJAIEM)* Web Site: www.ijaiem.org Email: editor@ijaiem.org, editor ijaiem@gmail.com, 1(2)