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TRENDS OF AREA, PRODUCTION AND PRODUCTIVITY OF FOODGRAIN IN THE NORTH EASTERN STATES OF INDIA

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ABSTRACT

The present study was undertaken to study the trends of area, production and productivity of food grain in the northeastern states. The study was based on secondary data from 1980-81 to 2011-12. The data was collected from several government publications and web site. To analyze the trend of area, production and productivity of food grains in northeastern states, the linear, quadratic and exponential functional forms were used. To fit the trend, linear 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 in the present study. The growing of food grain crops was not risky in the northeastern states as revealed by the lower coefficient of variation. The coefficients of variation (CV) of area, production and productivity of food grain crops were less than 0.551 per cent. The instability indices for area, production and productivity for food grain crops in the northeastern states were positive and thereby indicating less risk for growing food grain crops in the region. The increase in production is due to increase in area as well as interaction of area and productivity of food grain crops in the states.

Key word: Area, Food-grain, North eastern states, Production, Productivity.

INTRODUCTION

The northeastern India is a chicken-necked region, connected to the mainland with a narrow corridor and surrounded of international boundaries by Bangladesh and Bhutan. Northeastern India comprised of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura covers on area of 255.08 million hectares, which is about 8 per cent of country's land mass. More than 64 per cent (164.101 million hectares) of the total geographical area is covered by thick and deciduous forest (Barah, 2001).

The demand and supply for food out strips the production and the gap are increasing over the time. The total production increased from 27.19 lakh tonnes to 47.24 lakh tonnes while yield increased from 1,002 kg/ha during the period from 1970 to 1995 (Saikia, 2001).

The northeast India enjoys the abundance of natural resources like flora and fauna. The abundant and rich natural resources are neglected in the past but must put to efficient use now to catalyse the development process. In the absence of concerted efforts, the northeast state 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.

Therefore, appropriate strategies should be taken to boost the agricultural development. Before taking any strategies for development, one must identify the existing trends of area, production and productivity that stand in the way of development. One can know the demand supply gap by examining the trend and the required quantity to meet the future consumption / requirement with the increasing population. Hence an attempt has been made to study trends of area, production and productivity of food grain in the northeastern states.

MATERIALS AND METHODS

Data Base

The present study is based entirely on secondary sources. The secondary data regarding area, production and productivity of food grains for the period 1974-75 to 2010-11 for the northeastern states were collected from several government sources (Anonymous, 2001, 2003 and 2012). The study entails a temporal as well as spatial analysis of the growth of production, area and productivity of food grains.

Analytical Framework

To analyze the trend of area, production and productivity of food grains in northeastern states 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 food grains
X = Time variable

The functional form having the highest Co-efficient of Determination (R^2) is selected for fitting the trend. Along with this, growth rates of area, production and productivity of the crop were computed. Compound Growth Rates were also computed for area, production and productivity of food grains based on the exponential function for the periods. The compound growth rates were computed as follows:

Linear trend equation: $Y = a + bx$

Where, x is the time variable, y is the variable for which growth rate is calculated and b is the regression co-efficient of Y on x.

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

The significance 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.

$$SE(r) = 100\ b / 0.4329 \sqrt{(S \log r^2) - (\Sigma \log Y)^2 / N - (\log b)^2 \Sigma x^2] / (N-2) \Sigma x2}$$

To measure the magnitude of variability in area, production and productivity for the total period, the co-efficient of variation (%) was computed. Further the instability index was also calculated to examine the instability in area, production and productivity of food grains in the northeastern states by using the following formula:

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

The effects of area, productivity and their interaction towards increasing production were worked out by using the following formula. Similar technique was also employed by Cavery (1991), Dhakre and Sharma (2010), Padnaban (1996), Sharma and Kalita (2004) and Sharma and Kalita (2008).

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

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 1980-81 to 2011-12 was divided into two parts viz, (i). 1980-81 to 1995-96 (ii). 1996-97 to 2011-12 and contribution of area, productivity and their interaction to total production of the crop were worked out separately for each of the sub-periods and for the total period.

RESULTS AND DISCUSSION

For the different functional forms *viz*; linear, quadratic and exponential functions, the coefficients of determination (R^2) were computed and are presented in the Table 1.

Table 1 reveals that the R^2 values of linear function for all three aspects, viz., area, production and productivity for food grains in the northeastern India were higher than quadratic and exponential functions. Hence the linear functional form was selected for fitting trend of area, production and productivity of total food grains in northeastern India.

Table 2 reveals that the a and b values in the linear functional forms for area, production and productivity were positive and significant for the total food grains in the northeastern India more particularly in the state of Arunachal Pradesh, Assam, Mizoram, Nagaland and Sikkim. This implies the acceleration of growth of area, production and

TABLE 1: R^2 value of Linear, Quadratic and Exponential function for food grains in northeastern states.

States	Aspects	Linear	Quadratic	Exponential
Arunachal Pradesh	Area	77.90	93.67	61.39
	Production	84.99	86.39	81.19
	Productivity	66.27	50.82	73.91
Assam	Area	2.76	11.71	0.05
	Production	69.70	67.98	59.5
	Productivity	81.23	68.79	80.09
Manipur	Area	5.550	17.47	0.71
	Production	40.29	29.32	44.81
	Productivity	27.27	13.63	46.31
Meghalaya	Area	4.02	4.32	1.44
	Production	36.47	32.64	34.07
	Productivity	51.74	51.21	33.36
Mizoram	Area	25.99	11.85	55.35
	Production	15.50	4.63	27.94
	Productivity	8.47	1.77	8.06
Nagaland	Area	96.46	93.10	84.53
	Production	86.21	84.64	75.05
	Productivity	66.70	61.85	52.60
Sikkim	Area	61.14	67.26	33.68
	Production	70.98	77.37	47.10
	Productivity	11.41	6.67	16.93
Tripura	Area	65.39	50.84	70.72
	Production	88.18	85.11	73.47
	Productivity	94.73	89.12	83.67
North East Region	Area	58.16	41.46	69.48
	Production	85.46	73.20	80.38
	Productivity	65.12	75.64	43.83

TABLE 2: Results of the fitted trend for food grains in northeastern states (Exponential function).

States	Aspects	a	b
Arunachal Pradesh	Area	2.101	0.139
	Production	2.079	0.218
	Productivity	2.978	0.079
Assam	Area	3.407	0.017
	Production	3.347	0.165
	Productivity	2.930	0.161
Manipur	Area	2.241	-0.006
	Production	2.378	0.140
	Productivity	3.137	0.146
Meghalaya	Area	2.151	-0.013
	Production	2.059	0.197
	Productivity	2.951	0.176
Mizoram	Area	1.595	0.181
	Production	1.526	0.322
	Productivity	2.947	0.132
Nagaland	Area	1.965	0.301
	Production	1.795	0.516
	Productivity	2.829	0.215
Sikkim	Area	1.637	0.14
	Production	1.743	0.167
	Productivity	2.386	0.594
Tripura	Area	2.497	-0.064
	Production	2.502	0.179
	Productivity	3.009	0.239
North East India	Area	3.527	0.039
	Production	3.489	0.189
	Productivity	2.461	0.863

TABLE 3: C. G. R. (%) of Area, Production and Productivity of food grains in northeastern states.

States	Aspects	C.G.R. (%)
Arunachal Pradesh	Area	0.2186*
	Production	0.0371NS
	Productivity	0.119NS
Assam	Area	0.0312NS
	Production	0.2175NS
	Productivity	0.1455NS
Manipur	Area	-0.0376*
	Production	0.4047NS
	Productivity	0.2867NS
Meghalaya	Area	0.432NS
	Production	0.3014
	Productivity	2.88**
Mizoram	Area	0.3014NS
	Production	0.4696*
	Productivity	0.0889NS
Nagaland	Area	0.5609**
	Production	0.956**
	Productivity	0.307**
Sikkim	Area	0.395NS
	Production	0.413*
	Productivity	1.833**
Tripura	Area	-0.0992*
	Production	0.288NS
	Productivity	0.308NS
North East India	Area	0.0396NS
	Production	0.209NS
	Productivity	1.234*

** Significant at 5 per cent; * Significant at 10 % probability level and NS - Not significant.

TABLE 4: Co-efficient of variation (%) and Instability Index in area, production and productivity of food grains in northeastern states.

Crops	Aspects	C.V. (%)	Instability Index
Arunachal Pradesh	Area	0.0739	0.0003
	Production	0.1171	0.0019
	Productivity	0.0418	0.0009
Assam	Area	0.0089	0.0002
	Production	0.1892	0.0014
	Productivity	0.2275	0.0016
Manipur	Area	0.0390	0.0015
	Production	0.0959	0.0051
	Productivity	0.0755	0.0031
Meghalaya	Area	0.0573	0.0032
	Production	0.1724	0.0196
	Productivity	0.1124	0.0084
Mizoram	Area	0.1572	0.011
	Production	0.3764	0.102
	Productivity	0.1754	0.028
Nagaland	Area	0.165	0.004
	Production	0.292	0.021
	Productivity	0.112	0.006
Sikkim	Area	0.157	0.0163
	Production	0.149	0.012
	Productivity	0.551	0.252
Tripura	Area	0.0361	0.0004
	Production	0.0893	0.0022
	Productivity	0.0932	0.0014
North East India	Area	0.0152	0.001
	Production	0.066	0.001
	Productivity	0.443	0.114

productivity of the total food grain crops. The growth of area, production and productivity of the total food grain was found to decrease in the state of Manipur, Meghalaya and Tripura during the period.

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 the crop during 1980-81 to 2011-12. The area of food grain crops in the state of Manipur and Tripura showed a negative growth rate during the period. This might be due to the fact of shifting of area to other commercial crops and or shifting cultivation.

Variation and instability in Area, Production and Productivity

Table 4 reveals that the co-efficient of variation (%) of area, production and productivity of the food grain crops were worked out for the period 1980-81 to 2011-12. It shows that growing of food grain crops were not risky in the northeastern states as revealed by the lower coefficient of variation which were less than 0.551 per cent.

As table reveals that the instability indices depicts that the instability indices for area, production and productivity for food grain crops in the northeastern states were positive and thereby indicating less riskiness for growing of food grain crops in the region.

Measurements of effects

Table 5 reveals that to determine the relative effect of contributions of area, productivity and their interaction on increased production of the food grain crops in the northeastern states during each of the period viz; 1980-81 to 1995-96, 1996-97 to 2011-12 and 1980-81 to 2011-12 as the total period, the changes in production were partitioned separately in various effects. It also revealed the productions of the food grain crops in the northeastern states were increasing except in the states of Manipur, Mizoram and Meghalaya, where production were decreasing during the period of 1996-97 to 2011-12 and 1980-81-to 1995-96 respectively. This increase in production was due to increase in area as well as interaction of area and productivity of food grain

TABLE 5: Effect of change in area, productivity and their interaction on differential production of food grains in northeastern states.

States	Aspects (Period)	Differential production (Δ P)	Area effect (Y_0 ΔA)	Productivity effect (A_0 ΔY)	Interaction (ΔA ΔY)
Arunachal	1980-81 to 1995-96	18268.48	61378.4	7482	3504
Pradesh	1996-97 to 2011-12	64260.44	33086	51037.4	8207.6
	1980-81 to 2011-12	92628.41	84395.3	50254.1	32360.9
Assam	1980-81 to 1995-96	1152965	220286.9	587486.2	47834.9
	1996-97 to 2011-12	1033579	-4787.8	1045092.1	-1417.1
	1980-81 to 2011-12	2159257	218462.8	1522925.6	122974.4
Manipur	1980-81 to 1995-96	102527.8	64335.6	142994	-31524
	1996-97 to 2011-12	-86649.3	36693	-81765	-7678.8
	1980-81 to 2011-12	61977.62	18402.3	68878.8	-4343.4
Meghalaya	1980-81 to 1995-96	-43389.7	9832.5	41922.8	-2325.3
	1996-97 to 2011-12	59622.2	0	59622.2	0
	1980-81 to 2011-12	50545.32	11115	46650	2925
Mizoram	1980-81 to 1995-96	43585.4	47025	17840.9	24255
	1996-97 to 2011-12	-27253.7	30895.4	-33635	7768.6
	1980-81 to 2011-12	15598.35	27692.5	8175.7	6545.5
Nagaland	1980-81 to 1995-96	83534.19	58463.7	48243	26793
	1996-97 to 2011-12	104180.5	84555.9	62930.4	25053.6
	1980-81 to 2011-12	164529.7	134713.3	63581.8	81366.2
Sikkim	1980-81 to 1995-96	2380.64	12963.8	3669.6	-699.6
	1996-97 to 2011-12	17946	42636	9696	6666
	1980-81 to 2011-12	23363.24	31064.2	15067.6	6883.4
Tripura	1980-81 to 1995-96	130896	-72630	179278.3	32333.8
	1996-97 to 2011-12	127263.2	36090.3	141258.6	-9168.6
	1980-81 to 2011-12	294868.6	-58455	360048.1	52263.1
North East Region	1980-81 to 1995-96	1923592	319287.6	870458	72669.4
	1996-97 to 2011-12	41218679	23960.5	40965210	188388.35
	1980-81 to 2011-12	43377193	393055.2	38240180	3930023.7

crops in the states. These results are inconsonance with the study conducted by Padnaban (1996), Sharma and Kalita (2004) and Sharma and Kalita (2008). The interaction effect of area and productivity in the state of Assam during 1996-97 to 2011-12, Tripura during 1980-81 to 1995-96 and 1980-81 to 2011-12, Manipur and Mizoram during 1996-97 to 2011-12 were found negative and for all the periods in the case of Meghalaya and Sikkim states were decreasing as indicated by the negative values. Although the interaction of area and productivity in some periods viz, 1980-81 to 1995-96 and 1996-97 to 2011-12 for the state of Assam and Tripura were found decreasing with negative values, but for the total period it was found to be positive with increasing trend.

CONCLUSION

The above discussion highlighted the fact that the growth of area, production and productivity for food grain crops in the northeastern states were positive and statistically significant. The coefficient of variation for almost all the crops were less than 0.551 per cent thereby indicating less risky for cultivation of food grain crops in various states of Northeastern regions. This was also indicated by the lower value of instability indices. Further, the production and productivity of the crops were increasing during the study periods, which was due to the combine effect of area and productivity. Therefore, keeping the area as constant, the productivity can be further increased by taking appropriate production technologies.

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