

**THE  
GROWTH RATES OF AGRICULTURAL OUTPUT  
IN  
THE NORTH-EASTERN REGION**

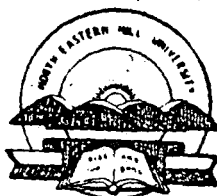
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DISSERTATION

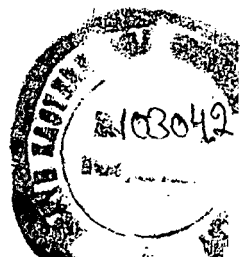
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S H I L L O N G


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READER

March 31, 1983.

TO WHOM IT MAY CONCERN

This is to certify that the dissertation entitled, "The Growth Rates of Agricultural Output in the North Eastern Region" submitted by Aranya Dutta in partial fulfilment of the requirements for the degree of Master of Philosophy is a bonafide study. To the best of my knowledge, the dissertation has not been submitted anywhere else for a degree. All the quotations, extracts and ideas of other studies have been duly referred.

This dissertation may be sent to the examiner for necessary formalities and evaluation.

  
( K. Bez )

## A C K N O W L E D G E M E N T

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*Dutta.*  
( ARANYA DUTTA )

## A B S T R A C T

The level of agricultural output in North-Eastern Region, specially the hilly areas of the Region, is significantly low as compared to the most of the other regions of the country. Moreover, the agricultural production among different states of the region also varies in a considerable degree.

As the bulk of the population in this region is rural in character, any attempt to develop the economy of this region must be directed towards agricultural development.

In the present analysis an attempt has been made to find out the growth rates of agricultural output and also to assess the level of agricultural development in the North-Eastern Region.

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**I. INTRODUCTION**

## CHAPTER I

### Introduction

For the sake of introduction it seems expedient to indicate at the first instance, among other relative points, the main object of the present study. It mainly aims at finding out the growth rates of agricultural output and also making assessment of the level of its development to this effect in the North-Eastern Region. The level of agricultural output in the North Eastern Region, specially the hilly areas of the Region, is significantly low as compared to the most of the other regions of the country. Further, the agricultural production among different states of the region also varies in a considerable degree. These variations could be due to the method and technique of farming and topographical and climatic condition.

As regards the natural and political boundaries of the Region, it is, practically speaking situated in a compact area though consisting of a number of states and union territories, viz., Assam, Meghalaya, Nagaland, Manipur, Tripura in addition to the two union territories of Arunachal Pradesh

and Mizoram. They are mostly interdependent upon one another from various points of view. In addition this region has come to be considered as an economic zone through the operation of developmental activities of a co-ordinating council set up for the region, viz., North-Eastern Council.

In this region the bulk of the population is rural in character. Therefore, the economy of the region is dependent on agriculture. Any attempt to develop the economy of this region must be directed towards agricultural development of this region. In this sense, the importance of agriculture in the North-Eastern Region is both basic and vital.

In this connection an attempt has been made to review some of the existing literature on the growth rates of agricultural output in India as a whole and different regions of the country in particular. Literature in this field of agricultural economics is too vast and subject areas are overlapping. These researches convincingly put forward new ideas to the farmers who have not yet received the message except in a few states and a few pockets here and there.

For assessing the level of agricultural development in the North-Eastern Region, attention must be focused on the existing conditions connected with agricultural growth. Hence, population, climatic conditions suitability of land for agricultural production, method of cultivation, crop intensity etc. which are directly connected with agricultural growth have been considered.

It should be mentioned here that since the bulk of the area in this region is devoted to the cultivation of mainly the food crops, this analysis is specially confined to a study of the growth rates of total foodgrains for the above mentioned period. Estimation of agricultural growth has been made by using two types statistical models :-

(i) presenting the graphical analysis of the agricultural growth using the probabilistic model, i.e., the Reaction Function, and (ii) estimating the growth rates by using Empirical Regression Models. The graphical estimates given by the probability model show that there is no significant variation in the growth rates among different states of the North-Eastern Region; whereas yearwise variations show linear trend. This means the trend is more influencing factor, which can be accounted for all the

states. Results shown by the empirical regression model on the other hand show that there is trend in growth rates, as supported by the application of probabilistic model although the fluctuations in the growth rates of outputs are varying from year to year.

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## II. REVIEW OF LITERATURE

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## CHAPTER II

### Review of Literature

271. Introduction : The aim of this study is to analyse the growth rates of agricultural output in the North-Eastern Region. Hence an attempt has been made in this chapter to review some of the existing literature on the growth rates of agricultural output in India as a whole as well as on the growth rates of agricultural output in different states. Literature in this field of agricultural economics is too vast and the subject areas are overlapping. Research into agricultural economics in the recent past is configured with techno-economic problems and more work has been done in the field effect of transition from simple means of agricultural production to more sophisticated means of production. These researches convincingly put forward new ideas to the farmers who have not yet received the message except in two states and a few pockets here and there.

The trend in growth of agricultural output cannot be attributed to a few factors. Land suitable for cultivation may not be increasing, technology is yet to reach the villages and population pressure

is increasing, so what can be said about the fluctuations or growth rate (positive) of agricultural production. It is the monsoon finally which controls agricultural growth in India and the need drives the farmers to multiple cropping to avoid total starvation.

We shall discuss a few of the recent works, although they may not be totally relevant, since this author is concerned only with the trend in growth, a time series type of analysis taking into consideration the spatial factor.

2.2. Trend or Technology : As said in the earlier section that technology has not gained importance in Indian agriculture. In the other sectors of economy, e.g., manufacturing, one can possibly single out technological progress as a factor of production through empirical analysis. But in agriculture with a few acres of irrigated land, with a few kilograms of fertilizers per acre and only one or two high yielding variety crop, no micro type analysis can be done from the time series data. A cross-sectional study in a specific area for a specific crop the effect of technology upon production can be discerned.

In a study with respect to nature and

causes of technological change in agriculture and the distribution of technological change (Rao, 1965) the author has stressed upon the following factors:

- a) Change in output with respect to technological change.
- b) factors determining the adoption of mechanised methods.
- c) application of fertilizer and
- d) issues involving distribution.

His findings can be summarised as follows :-

- (a) Despite technological change the rate of growth of foodgrains and of agricultural commodities as a whole decelerated in the decade ending 1970-71 compared to the preceding decade.
- (b) The annual fluctuation in the output of foodgrains in the country increased during 1961-71 compared to the preceding decade.
- (c) Inter-state disparities in regard to the supply of institutional credit per hectare and the percentage of net sown area irrigated has increased over the decade.
- (d) Inter-state variability in respect of the use of fertilizers in per capita terms increased.
- (e) Inter-state disparity in productivity per

hectare of major food crops experiencing technological change increased.

(f) While technological changes have led to a more even use of services of permanent farm workers during the year, the variability in the wages of casual hired labour has increased because of the rise in peak-season demand for such labour.

(g) While the absolute share of hired labour has risen, its relative share in output has declined in the areas experiencing the Green Revolution.

(h) Since the changes in Indian agriculture have been introduced on the base of 'an institutional structure featured by disparities in investible resources per acre', the growth of output has been much faster among the larger farms than among the smaller ones. As a result disparities in income have tended to widen.

(i) Under the impact of technological change the area under tenancy particularly sharecropping has declined and rents have risen - phenomena which are indicative of exclusive resumption of land on the part of landowners and also share-croppers having been forced to part with a larger share of output.

(j) Given the influence of producer interests in the fixation of higher procurement prices and in regulating inter-state movement of foodgrains, despite the technological breakthrough, farm prices in the

Punjab have increased relative to those in the deficit states.

In conclusion Rao said that the prospects of further growth in Indian agriculture hinge on technological change. It is likely to be limited in the short run in the investment in irrigation. According to him, "Where irrigation water can be made available economically, irrigated farming with H.Y.V. technology would be more profitable than the dry farming technology."

S.A. Shetty attempted to analyse the trends in agricultural production and to isolate the contribution of crop pattern from the effects of area and yield per acre (Shetty, 1970). The analysis relating to all India covered the period 1920-21 to 1964-65 and that relating to regions covered the period 1920-21 to 1954-55.

In order to ascertain the rate of growth of production, semi-log trend of  $Y = ab^t$  was fitted. In order to compare the movements in the production of foodgrains and non-food crops trends were fitted to each series separately. The main findings of his study are :-

(i) The long term trend in agricultural production has been a rising one during the period 1920-21 to 1964-65.

(ii) The trends in production of foodgrains and non food crops were also positive and significant, though the rate of growth of the latter was twice as high as that of the former.

(iii) While almost all the crops except barley have contributed in varying measures to the increase in foodgrain production, only a few crops notably groundnut and sugarcane and to some extent rapeseed and mustard contributed to the increase in the production of non-food crops.

The analysis of trends in agricultural production among the regions presents a mixed picture :-

i) In four out of the eight regions studied, agricultural production has increased while in three regions it was stagnant and in the remaining one region it declined during the period 1920-21 to 1954-55.

ii) A geographical pattern of agricultural growth is discernible in the increase in output in the northern and eastern regions with the exception of Bihar, Orissa and stagnation in output in the southern and western regions.

iii) It also found that agricultural production

tended to increase in some regions even before the advent of planning in India. The most important source of growth of production at the all India level was acreage expansion, the contributions of area and crop pattern accounting for nearly 90 percent of the increase in agricultural production. The contribution of area was also significant in almost all the regions studied with the exception of the Punjab where nearly the entire increase in production was accounted for by improvement in yield per acre. The contribution of changes in crop pattern to the growth of production was negligible in all the regions except in the Uttar Pradesh. Thus, the increase in agricultural production during the period covered seems to have been realized mainly through the expansion of area rather than through improvement in productivity of land.

In another study into the growth rates of agricultural output the authors have taken into consideration the contributions of land, irrigation and fertilizer to the growth of crop output in India during the period 1951-52 to 1962-63. (Giri et al, 1966). The authors have experimented with a number of multiple regression equations and tried to estimate 4 to 5 parameters on the basis of 12 time

series observations. These estimated coefficients of the time series production function are made use of in deriving the relevant growth equations. Besides time, they have used three independent variables:  $X_1$  - the gross area sown,  $X_2$  - the proportion of gross irrigated area to gross area sown and  $X_3$  - quantity of fertilizer (in terms of nitrozen) per unit of irrigated area, to explain the behaviour of total crop output  $Y$ . The authors have found that production of foodgrains increased during the period 1950-63 by 39 percent by extending the cropping area by 20 percent over the base year. It was also found that the growth of output was brought about more by expansion of area through the extension of cultivation than by the use of productivity raising factors. Among the foodcrops, wheat recorded highest growth of output and the major contribution to growth of production of wheat came from land. In the case of barley and gram which are substitute crops for wheat not much effort has been made to increase their production. As a result of a decline in productivity of jute, its gross yield could not improve despite an expansion in the area under it.

### 2.3. Fluctuations According to Time and Space :-

S.R. Sen in his book 'Growth and Instability in

Indian agriculture' has discussed a variety of Indian agricultural and demographic problems (Sen, 1971). On the basis of certain studies made by the Directorate of Economics and Statistics of the Ministry of food, Cooperation and agriculture, the author has shown that during the first 24 years of the period 1900-01 to 1947-48, while foodgrains production showed a rising trend, the instability was also on the increase. In the next 24 years of the same period Indian agriculture had become stagnant but unstable. In 1937-51 foodgrain production was fairly stable while the general trend was one of stagnation. On the other hand, during 1952-66 there was an unprecedented rate of growth but instability tended to increase with the rate of growth.

Marshalling statistical evidence Sen states "..... it is not enough for us merely to plan for increasing the rate of growth of food production..... It is equally important for us to plan for minimisation of the instability that often accompanies such growth."

Sen suggested that with the unprecedented facilities for analysis which modern electronic computers offer it is possible to subject all the

data regarding rainfall, run of dry days, crop conditions and crop output that are available for different regions and districts of the country, for the last 90 years or so to an imaginative programme of cooperative research by statisticians, meteorologists and agronomists which may throw light on this question and avoid or at least minimise the risk of uncertainty in agricultural production.

T. Maitra and Bina Roy studied the regional variation in yield per acre of principal crops in India during the decade 1950-51 to 1959-60. In order to get rates of increase in the productivity over the decade they fitted a linear trend to the annual data. Agricultural development in different states was compared on that basis. The fitted trend also gave trend values. These were computed for the two end years. Variation in productivity in different states was examined on that basis. (Maitra et al, 1964).

The principal results of their study are quoted below:-

1) Computed values of yield per acre of rice varied from 644 lbs in 1950-51 to 831 lbs in 1959-60, both estimates being free from annual fluctuation. In 1950-51 the yield of rice varied from 452 lbs in Bihar and 453 lbs in



Uttar Pradesh to 897 lbs in Andhra Pradesh and 910 lbs in West Bengal. Ten years later in 1959-60, the statewise yield varied from 489 lbs in Orissa and 604 lbs in Uttar Pradesh to 1375 lbs in Madras and 1204 lbs in Mysore. Thus, regional variation remained the same though the states changed places due to different increases achieved during the ten years.

ii) As for wheat the striking fact is the very small progress achieved in comparison with the progress achieved in rice. The all India average yield of wheat increased from 620 lbs in 1950-51 to 674 lbs in 1959-60. Almost all states in general retained their relative position except in case of Jammu and Kashmir, Uttar Pradesh and West Bengal recorded a decrease in yield per acre and Madhya Pradesh which showed a large increase.

iii) The authors offered similar analysis for other commodities which showed that disparities between states in yield per acre did not diminish to any appreciable extent.

In another study into the growth and imbalances in Indian agriculture the author has indicated explicitly the various constraints on agricultural growth in India and what is needed to

achieve higher rates in the future than in the past. (Dharm Narain, 1972) The possibilities for extension of net sown area have very largely exhausted themselves and therefore, the expansion of gross cropped area has to be achieved mainly through an increase in cropping intensity. Since the annual additions to the net irrigated area in recent years have averaged at nearly 2 million hectares (which is about as much as the additions realized over five year periods between 1950-51 and 1965-66) the scope for such increase in cropping intensity has of course greatly increased. Nevertheless, even at this rate of expansion of irrigation, it is unlikely that the gross cropped area will increase by more than about 12 percent over a decade. Therefore, according to the author, the growth in agricultural output will have to be achieved largely by increases in productivity per hectare. The high yielding varieties evolved so far offer hope of such increase in productivity in the case of only a few crops. The possibility of achieving much higher rates of growth in agriculture as a whole depends, therefore, to a considerable degree on whether or not technological advances of a similar nature can be secured in the case of all other crops and the increases in productivity per hectare which they make possible are in fact realized.

V.K.R.V. Rao studied the performance of the agricultural sector during the first two plan periods particularly in terms of productivity and by individual crops (Rao, 1962). Productivity was studied in terms of the relation between output and land, i.e., yield per acre. For estimating the change in agricultural productivity or yield per acre during this period, the author made use of the adjusted data as was done by the Ministry of Agriculture - "By adopting the ingenious device of linking up each year's production estimate for a crop with the preceding year's estimate through a second estimate strictly comparable with the latter and by using the chain method, constructing a time series of adjusted production estimates comparable with one another over the entire series".

The author has shown that while agricultural production as a whole increased by 36.4 percent during this period, the increase in the average yield per acre was only 18.6 percent, the rest of the increase in production being accounted for by increase in the area under cultivation. The percentage increase in the yield per acre, cropwise, ranged from + 29.5 to - 7.8, for the 25 crops considered in his analysis. The largest increases in yield per acre took place in the case of foodgrains.

Rao admitted in his analysis that the yield

per acre would be different for different crops and on the basis of physical output only inter-crop comparability could not be made. Still in India, according to him, "it is a matter of deep concern," as "its farmers have a crop pattern that favours crops with a low yield per acre without a compensating high value per unit." The author has opined that an immediate and intensive examination must be made in this regard.

In order to show inter-state variation in agricultural production the author has taken only those states which had 4 percent or more of the all India acreage under each crop. In terms of yield per acre the highest place was occupied by Madras for 5 crops out of the 7 and Punjab occupied the highest place for 4 out of the 7 crops considered in his analysis. Taking foodgrains as a whole states like Madras, Kerala, Bengal and Assam stood above the national average; U.P., Andhra, Bihar and Orissa were about the national average and Madhya Pradesh, Maharashtra, Gujrat, Mysore and Rajasthan stood below the national average. An interesting finding of his analysis is that the the states with the highest agricultural productivity (Viz., Madras, Punjab and Kerala) accounted

between them for only 11.4 percent of the total area under cultivation while states with the low agricultural productivity (viz., Maharashtra, Gujrat, Madhya Pradesh etc.) were having the largest area under cultivation.

According to Rao, "All these differences in inter-state productivity cannot be explained merely in terms of natural factors. Capital, labour, and agricultural practices must have something to do with these differences.....". Therefore, maximum attempt should be made to raise the yield per acre in all these states in order to raise their contribution to increasing the national average as well as to minimize inter-state differences in the levels of agricultural productivity.

V.G. Panse made some statistical analysis of the trend in the yield of rice and wheat. (Panse, 1959). He examined the data for yield per acre from large scale crop cutting surveys on these two most important food crops for ten years 1946-47 to 1955-56. The yield data analysed extended over 65 percent of the area under those crops in the country. The main aim of his analysis was the comparison of average yield during

the First Five Year Plan period, 1951-52 to 1955-56, with the average for the immediately preceding five years treated as a control. In order to determine how large the difference between the average yields in the two periods was in each state as compared to difference brought about by uncontrollable causes like weather, partitioning of the variation observed was done with the help of 'analysis of variance.'<sup>3</sup>

Results of his analysis showed that the average yield per acre was higher by 5.4 percent for rice and 11.8 percent for wheat in the Plan period than in the pre-Plan period. The increase in rice yield was contributed by three states, Madras, Andhra Pradesh and West Bengal, and that in wheat by all the five states, viz., Punjab, Uttar Pradesh, Bihar, Madhya Pradesh and Bombay, although the increase in Bihar was not statistically significant.

Though the author admitted that it would be an extremely difficult task to make a rigorous allowance for the multitude of weather factors on crop yields, still an attempt was made to adjust the yields of both rice and wheat for inequalities of rainfall over the series of years under study

by using regression analysis. The results of all regression analysis for wheat, however, proved negative, in the sense that the rainfall as examined did not show any considerable influence on the annual variation in wheat yields. But the results of the regression analysis on rainfall for rice were more positive. The adjusted rice yields showed an overall increase of 8.0 percent during the plan period as compared to the pre-plan period. The conclusion derived from this analysis was that irrigation should be "introduced in some rice areas as a positive measure for increasing yield by supplementing the normal rainfall of the area and not merely as a protection against the vagaries of rainfall."

So far as statewise study on growth rates of agricultural output is concerned, Raj Krishna studied the growth of aggregate agricultural output in Punjab (Raj Krishna, 1964). Using the production function of Cobb-Douglas type, an attempt was made to separate the contributions of irrigated area, unirrigated area and rainfall on the growth of crop output in Punjab during the two period, viz., 1913-14 to 1945-46 and 1939-40 to 1955-56. His study revealed that the crop output increased at

an annual rate of 1.1. percent in the first period and 4.2 percent in the second period. Whatever slow growth in crop output was achieved in the first period, was ascribed almost entirely to expansion of irrigation, but only about one-third of the faster growth in crop output in the second period was attributed to increase in irrigation and the rest to other productivity - raising factors.

C.H.H. Rao has investigated into the impact of total inputs and rainfall on crop output in Punjab during the decade 1952-62(Rao, 1965). Using the production function of Cobb-Douglas type he showed that in those districts of Punjab where agriculture was more dependent on rainfall, the coefficient of total inputs was insignificant. Whereas in other districts where agriculture was less dependent on rainfall, the crop output responded significantly to increase in the value of total inputs. Among the factors studied, land, labour input and bullock and tractor power, the coefficients of the first two factors were found to be not significant for Punjab as a whole; but in the selected 10 districts which had recorded large increases in cropped area and immigration of agricultural workers leading to intensive use of labour

and capital inputs, the coefficients for labour and capital were found significant.

In another study into the agricultural development, the author has taken into consideration regional variation in agricultural development in India and of the state of Karnataka in particular having the basic objective that regional development is a nucleus of accelerated economic growth of Indian economy (Desai, 1976).

In first part of his analysis the author has shown that various states of India show disparity in regard to their total state income, per capita income, growth rates in agriculture, growth rates of foodgrains, average yield of principal crops, population, irrigation, fertilizer use etc. This disparity among the states is of high order which stand in the way of balanced development of the country as a whole. The regional variations in agricultural development according to the author are attributable to the irrigation facilities, soil fertility, agro-climatic environment etc.

In second part of his analysis, the author has discussed the various aspects of agriculture in the state of Karnataka. Agriculture predominates

more in the state of Karnataka when compared to India both in regard to the dependence of population on agriculture and agriculture's contribution to state income. The utilisation of strategic inputs such as irrigation, fertilizer, improved seed, the role of institutional set up have been examined. The crux of discussion is that vast potentialities exist for the growth of the economy of the state in general and in agricultural sector in particular. What is required is that the farmer should be provided with incentive both in the availability of strategic inputs and organisational assistance to raise his production. It has rightly been recommended that for formulating a plan for a village or a group of villages the planning team should consist of the banker, the agricultural expert, progressive farmers and local economists and only local resources - natural as well as human - should form the basis of the plan. The long term issues which require changes for improving agriculture are the tenancy system, fragmented holdings, uneven distribution of land etc. All these come under land reform which require a change in the social structure.

Saha has shown empirically the pattern or growth rate in agriculture, particularly in food

production in the seven plain districts of Assam (Saha, 1966). The author has used simple linear trend analysis of data on area and production of rice and total foodgrains for the period 1951-52 to 1961-62. The author has found "...quite a dismal picture in the growth rates of agriculture." While population grew at a rate of more than three percent, the growth of food production was only 1 percent. Moreover, the growth rates of different districts were not uniform "even though physical conditions and development efforts are by and large similar." In concluding section, the author has opined that attempt should be made to identify the causes of such disparity in growth rates of district as this will help in taking appropriate remedial measures.

Indian Council of Agricultural Research took pain taking exercises in finding alternative to shifting cultivation which is yet to be materialized. The shifting cultivation, jhuming endangers ecological balance and effective utilization of land resources in the hill regions (Agarwal, 1932).

2.4. Summary :- In summarising the opinions held by different authors in the existing literatures on growth rates of agricultural output in India and different states, it is concluded that the present

issue reveals that agricultural development in India varies from one region to another depending upon the quality of soil, availability of water and new strategy. There exists a wide disparity in agricultural development and productivity in the country as well as in a state itself. There is a frustrating gap between the best and the average in agricultural performance in the country and sometimes even within a state.

There is no doubt about the fact that during the period of a century and a half prior to independence Indian agriculture was in a stand still position. It is only after the launching of the Five-Year Plans the stagnant waters of our agriculture began to move. But it is to be admitted that in comparison with other developing countries the income derived from agricultural products of our country still falls far behind the performance of some other developing countries, e.g., Argentina. As regards agricultural productivity there is no denying the fact that it depends on natural factors to some extent. Still by using modern technology and agricultural inputs productivity can be increased to a considerable extent inspite of natural handicaps. Different authors mentioned in this chapter have outlined the causes of low productivity in agriculture

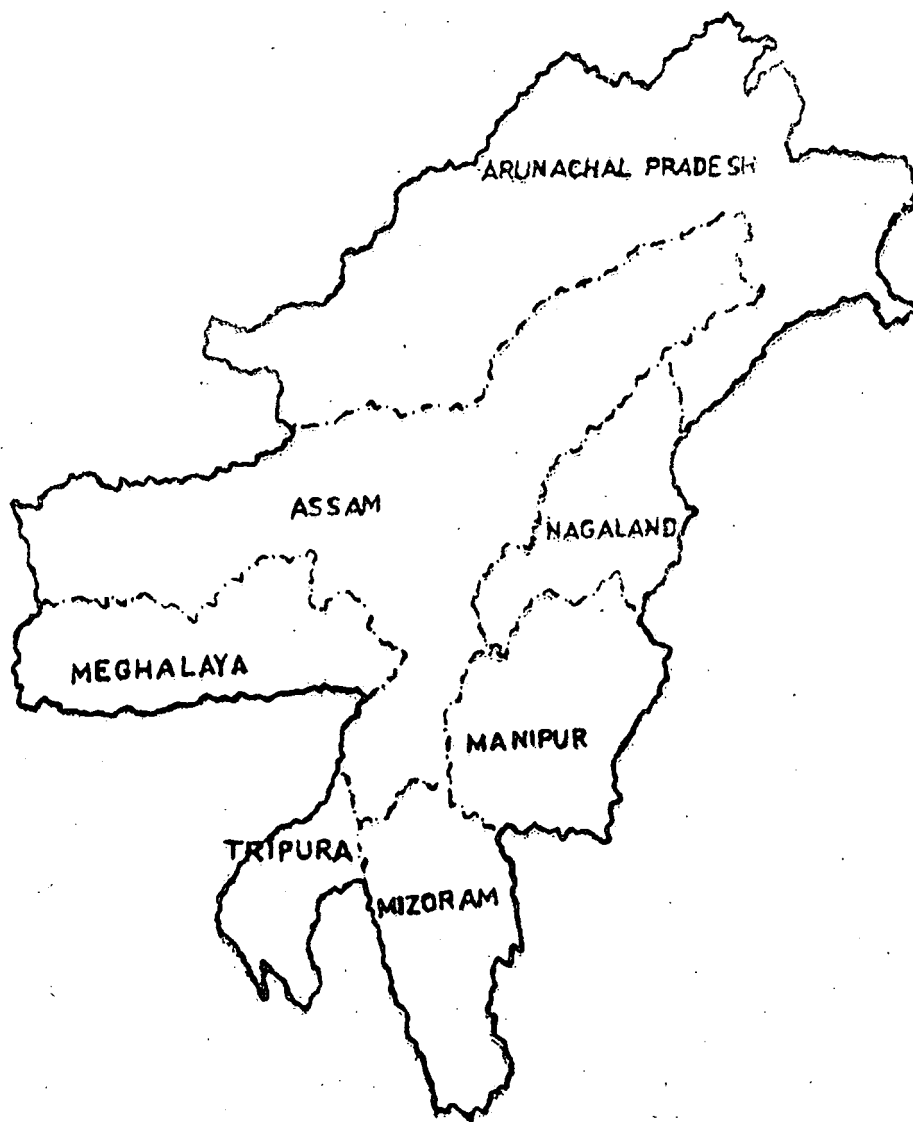
and have suggested also their own remedies in their studies. Improvement in agriculture therefore, necessitates radical change in our methods and institutions that have been built up over many generations as well as in the attitudes of millions of farmers. The sooner this is achieved the better it will be for the national economy. Swiftmess to this effect is also supported by the opinion cited here: "If you are late in doing one thing in agriculture, you are late in all things". (Cato, 2nd Century, B.C.)

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**III. EXISTING CONDITIONS CONNECTED  
WITH AGRICULTURAL GROWTH**

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# NORTH-EASTERN-REGION



## CHAPTER III

### EXISTING CONDITIONS CONNECTED WITH AGRICULTURAL GROWTH IN THE NORTH EASTERN REGION

3.1. Introduction : The North-Eastern Region covers an area of 2.6 lakh square kilometres. It represents 8% of India's geographical surface and has 3.6 per cent of the country's population.<sup>1</sup> This region incorporates Assam, Meghalaya, Nagaland, Manipur, Tripura and Union Territories of Arunachal Pradesh and Mizoram.

Assam has an area of 78,523 square kms. It is comprised of nine districts, viz., Cachar, Darrang, Kamrup, Goalpara, Lakhimpur, Mikir Hills, North Cachar Hills, Nowgong and Sibsagar.<sup>2</sup> Recently, Lakhimpur district has been divided into North Lakhimpur and Dibrugarh district. Mikir Hills district has been renamed as Karbi Anglong district.

Nagaland has an area of about 16,527 sq. kms. It is divided into three subdivisions, viz., Kohima, Mokokchung and Tuensang.

Meghalaya has an area of 22,489 sq. kms. It is comprised of five administrative districts, viz.,

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1. According to 1971 Census, Series 1 - India.
  2. Statistical Abstract of India, 1975.  
Central Statistical Organisation, Govt., of India.

1. Jaintia Hills, 2. East Khasi Hills, 3. West Khasi Hills, 4. East Garo Hills and 5. West Garo Hills.

Manipur, covering an area of 22,356 sq.Kms. is divided into six districts, viz., 1. Manipur East District, 2. Manipur West District, 3. Manipur North District, 4. Manipur South District, 5. Tengoumpal District and 6. Manipur Central District.

Tripura has an area of 10,477 sq. Kms. It is divided into three subdivisions, viz., 1. North Tripura 2. South Tripura and 3. West Tripura.

The Union Territory of Arunachal Pradesh lies in the N.E. corner of India. It has an area of 83,578 sq. Kms. and is divided into five districts, viz., 1. Kameng, 2. Lohit, 3. Siang, 4. Subansiri and 5. Tirap.

The Union Territory of Mizoram, covering an area of 21,087 sq. Kms. is divided into three districts, viz., 1. Aizawl, 2. Lunglei and 3. Chhinctuipui.

3.1. Climatic condition : The North-Eastern region is hilly. The Garo, Khasi, Mikir, Naga, Mismi, Abor, Patkai and other hills occupy a large part of the region. Heavy rainfall has led to the growth of dense forest in many areas. Thus, the region has a variety of agro climatic conditions - tropical and sub tropical in the plains and temperate in the high hills. As such any generalisation

regarding the climatic condition of the whole region will hardly be possible for its micro zones.

3.1.A. Rainfall : In the North Eastern region rainfall is high and well distributed throughout the year in the month of December and January and in some case month of November also. The normal annual rainfall in Arunachal Pradesh is 3098 m.m. in Assam and Meghalaya 2360 m.m. and in Manipur Nagaland, Mizoram and Tripura is 2022 m.m.<sup>3</sup> While Meghalaya holds the place of pride for having the world's highest rainfall receiving place, Arunachal Pradesh also has a good share. However, the seasonwise distribution of rainfall is not the ideal type in the entire region which is shown in the following table :-

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3. Statistical Abstract of India, 1975.  
Central Statistical Organisation, Govt. of India.

RAINFALL (SEASON WISE) IN THE N.E. REGION

(Actual)

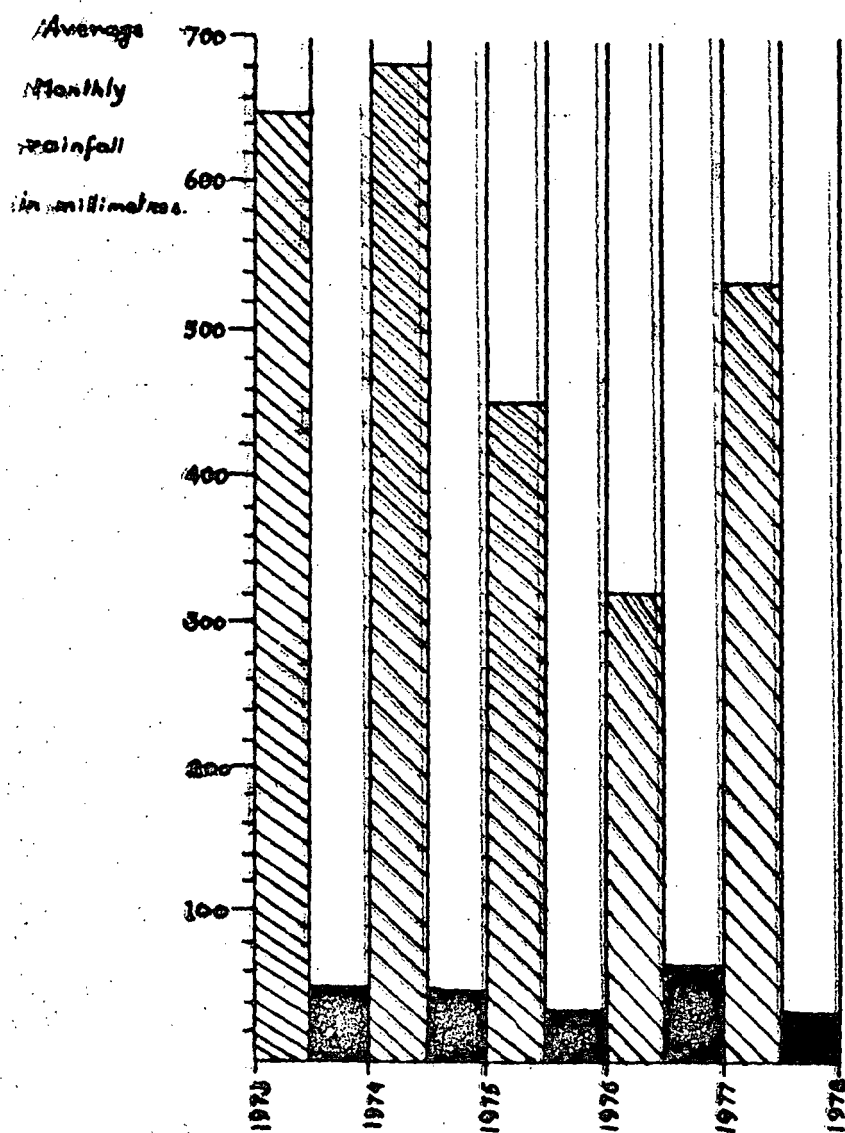
(Millimetres)

Year	Arunachal Pradesh		Assam & Meghalaya		Nagaland, Manipur, Mizoram & Tripura.	
	Rabi November to March	Kharif June to October	Rabi November to March	Kharif June to October	Rabi November to March	Kharif June to October
1973- '74	273	3243	238	1648	318	1265
1974- '75	257	3331	79	2217	100	1474
1975- '76	188	2288	144	1460	209	1368
1976- '77	331	1603	114	1571	140	1437
1977- '78	173	2663	128	1553	93	1157



Source : Basic Statistics of the North Eastern Region,  
March, 1979.

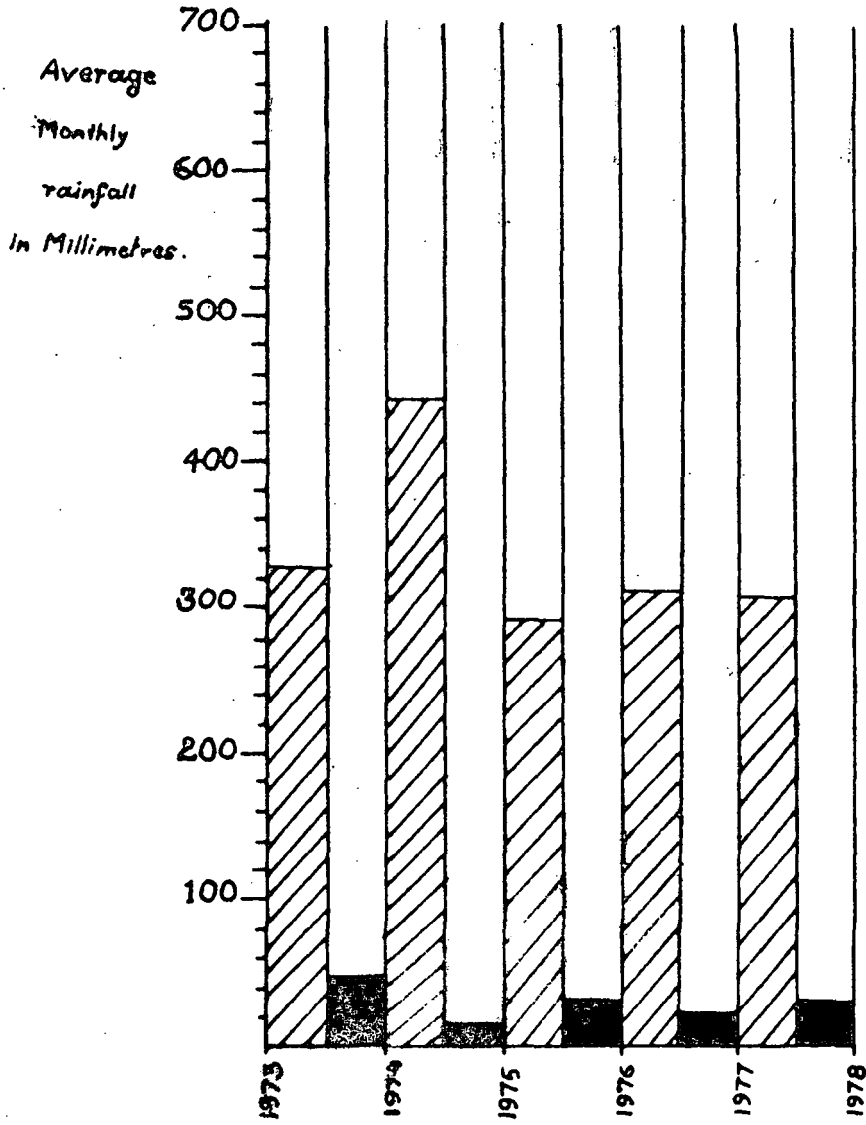
It should be mentioned here that due to heavy rainfall in the hill areas flood is very common in the plains areas mainly of Assam. The average monthly rainfall (in millimetres) seasonwise for different states of the north eastern region is shown in the following diagrams.

## DISPERSION OF RAINFALL



ARUNACHAL PRADESH

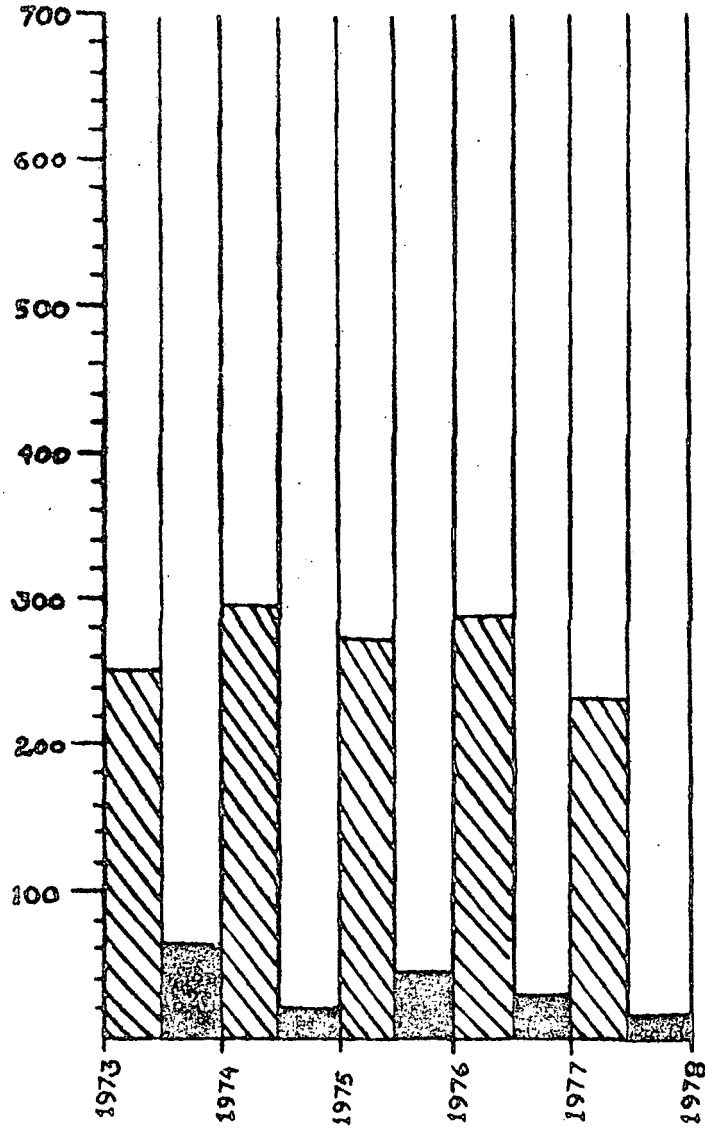
 Kharif.  
 Rabi





ASSAM & MEGHALAYA

▨ Kharif  
■ Rabi

Average  
Monthly  
rainfall  
in Millimetres.



NAGALAND, MANIPUR, MIZORAM  
& TRIPURA

 Kharif  
 Rabi

3.1.B. Humidity: As the distribution of rainfall is not the ideal type in the entire area, in the dry season a moisture deficit ranging from 9 to 60% is observed at various places. The average relative humidity in Meghalaya varies from 53% to 88% during the 12 months period. For Manipur, Tripura and Nagaland it varies from 67% to 84%, 65% to 86% and 49% to 85% respectively.<sup>4</sup> Thus, although there is a broad climatic homogeneity throughout the region yet there are considerable local variations in rainfall, range of temperature and other phenomena like mist and fog.

### 3.2. Soils in the North Eastern Region :

There are seven main types of soils in the North Eastern region : the Alluvial soil, the Laterite soil, the Ferruginous Red soil, the Laterite and Lateritic soil, Forest soil, Mountain and Hill soil and the Mountain Meadow soil.<sup>5</sup> For a better understanding of the variation of soil in different states of the North Eastern region it is necessary to discuss the properties of soil found in the North Eastern region. The old Alluvial soils, which are generally acidic in reaction, are suitable for production of wide variety of crops

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4. R.L. Singh (ed), India : A Regional Geography Varanasi National Geographical Society of India, 1971.

5. Basic Statistics of the North Eastern Region. N.E.C. Secretariat, Shillong, 1979.

including rice, wheat, sugarcane, cotton, banana and tobacco. The Laterite soils, which are deficient in potash, phosphoric acid and lime, produce good crops particularly rice. The Ferruginous Red soils which are poor in lime, potash, iron oxide and phosphoric content, are suitable for cultivation of paddy and other crops. The Laterite and Lateritic soils which are generally poor in nitrogen, phosphate and potassium and organic matter, produce good crops particularly rice. Other soils like Mountain and Hills soils produce paddy and plantation crops after terracing. Mountain Meadow soils which occur above the timber line and below the snow line are suitable for forests. At places they produce potato and sub-tropical fruit.

As regards the variation of soils in the North Eastern region we find that the soils in the Assam Valley is broadly alluvial in character. In the fringes of the valley, particularly in Kamrup, Lakhimpur, Nowgong and Sibsagar district there are limited areas with lateritic soil. The acidic character of Alluvial soils make them very suitable for tea plantation, particularly in the Upper Assam Valley. The Ferruginous Red soils occupy the major part of Nagaland and the Laterite soils occupy a very little part of the state along the border of Sibsagar district of Assam. The flat land in the plains of Tripura is all through alluvial consisting

of sand, silt and clay in different proportion. But the forest soils on tillas are generally loamy sand. In Meghalaya there are three main types of soil. The Hill soils occupy almost the entire state except a limited tract in the foot hill. The Laterite soils are confined to a small fringes and the old alluvium is found in the high land areas bordering the plains, all along the northern fringe of the state. The central plain of Manipur being the flood plain of rivers that drain it has thick deposits of sands and clays, with their usual characteristic. The soils of the Manipur hills are Ferruginous Red soils. The soils of the Mizo Hills are usually similar to that of Manipur Hills and are associated with a reddish loam. In the major parts of Arunachal Pradesh, the Ferruginous Red soils are found. The rocks are generally of the Himalayan. Soils in the valleys are clayey alluvium and rich in organic content.

Besides these main types of soils, the forest soils are found in some parts of Assam, Tripura, Meghalaya and Mizoram. The Mountain and Hill soils are found in some parts of Assam, Manipur, Meghalaya, Mizoram and Tripura. The Mountain Meadow soils are found in some parts of Assam, Arunachal Pradesh and

Nagaland.<sup>6</sup>

3.3. Population : It is an admitted fact that the process of economic development of a country is retarded by the rapidly growing population. In India, the impact of rising population as a drag on economic resources is felt in a variety of ways. The North-Eastern Region is not an exception in this regard. As against the average population of 167 per square kilometre of the country, the density of population of Assam, Meghalaya, Nagaland, Tripura, Arunachal Pradesh and Mizoram is 186, 45, 31, 48, 149, 6 and 16 respectively. The density, decennial growth and sex ratio of 1971 population of each state of North-Eastern region is clear from the following table:-

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6. R.L. Singh (ed.), India: A Regional Geography  
Varanasi National Geographical Society of India, 1971.

State/ Union Territory	Area (Sq. Kms)	Population (Persons)	Density (Persons)	Decennial Growth 1961-71 (Percent- age)	Sex ratio Females per' 000 males.
Arunachal Pradesh	83,578	467,511	6	38.91	861
Assam	78,523	14,625,152	186	34.95	896
Manipur	22,356	1,072,753	48	37.53	980
Meghalaya	22,489	1,011,699	45	31.50	942
Mizoram	21,087	332,390	16	24.92	942
Nagaland	16,527	516,449	31	39.88	871
Tripura	10,477	1,556,342	149	36.28	943
Total	255,037	19,582,296	77	35.04	906
All India	3,280,483	547,949,809	167	24.80	930

Source: Census of India, 1971, Series - 1 - India.

The bulk of the population in this region is rural in character and the economy of the rural population is dependent on agriculture. The percentage of rural population, according to 1971 census, varies from 85.47 in Meghalaya, 86.85 in Manipur and 88.55 in Mizoram to 98.59 in Tripura, 96.15 in Arunachal Pradesh and 90.11 in Nagaland - average

for the region being 91.09 percent as against the all India average of 80.09 per cent. Agriculture and allied activities constitute the main source of livelihood in this region. Of the total workers, the number dependent on agriculture is the largest in Mizoram (83.55%) followed by Arunachal Pradesh (80.00%), Nagaland (79.97%), Tripura (74.30%), Manipur (70.35%) and Assam (65.78%).<sup>7</sup>

3.4. Methods of cultivation : The age old farming system known as shifting cultivation or 'jhuming' still predominates in most of the hill areas of the North Eastern region. Shifting cultivation or jhuming can be defined as an agricultural system in which fields are cleared by firing and are cropped discontinuously. The clearings are abandoned for some reasons or the other after sometimes. Then, the cultivations shift to another clearing, leaving the old one for natural recuperation. Depending upon the agro climatic conditions and the need and food habits, a variety of crops is grown. This method of cultivation has some serious defects, viz., it depends totally on natural rainfall and top soil is removed by the steep gradient revulets for the absence of natural rainfall vegetation. Moreover, after two or three years of

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7. Census of India, 1971, Series 1, India.

cultivation the jhum field gets overgrown with weeds, becomes unsowable and, therefore, a fresh jungle is to be cleared.

The North Eastern region has a large area under shifting cultivation. Out of a total reporting area of about 227.35 lakh hectares, 26.95 lakh hectares are available for shifting cultivation. Of this, area available for shifting cultivation in Arunachal Pradesh is 2.48 lakh hectares, in Manipur 1.00 lakh hectares, in Meghalaya 4.16<sup>lakh</sup> hectares, in Mizoram 6.04 lakh hectares, in Nagaland 6.08 lakh hectares and 2.21 lakh hectares in Tripura.<sup>8</sup>

Percentage of total population (1971) dependent on shifting cultivation is 0.43 in Assam, 27.95 in Manipur (hills), 34.53 in Meghalaya, 6.42 in Tripura, 57.69 in Arunachal Pradesh and 80.74 in Mizoram.<sup>9</sup>

Thus, the pattern of agriculture of Tripura and Assam show an appreciable deviation from tradition of jhuming which is most popular in the rest of the states of the North Eastern region. The shifting

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8. Miss. F.K. Wadia : 'Control of Shifting Cultivation in the North Eastern Region'. A discussion paper presented in a seminar organised by N.E.H.U., 1977.

9. Ranjit Mukherjee : 'Problems of Shifting Cultivation in the North Eastern Region'. Journal of the North Eastern Council, Vol.1, 1975.

cultivation is confined to hills only in these two states, while most of the plain areas are under permanent cultivation.

In other hill states of the North Eastern region, most of the tribals practise jhuming resulting in soil erosion and reduction of fertility. Moreover, the cycle of jhuming also differs from area to area with the proportion of land put in for cultivation. Wadia (1977) has said that due to increasing population jhuming cycle varies between 1 to 17 years in Arunachal Pradesh, 4 to 5 years in Meghalaya, Mizoram and Tripura, 5 to 10 years in Assam Hills, 6 to 8 years in Manipur and 6 to 15 years in Nagaland. Wadia also has observed: "Where the land belongs to a community or clan, jhum appears to be little interest on the part of individual tribal family to improve the productivity of the crops or the fertility of the soil".<sup>10</sup>

In hill areas at places terraced cultivation has developed. The method of preparing land for cultivation is to dig and build the side of the hill into terraces. Each terrace cannot have its own channel and usually obtains water either from the terrace above it or from one of the terraces in the same row, the terraces being so carefully graduated that the water may flow from terrace to terrace. This method of

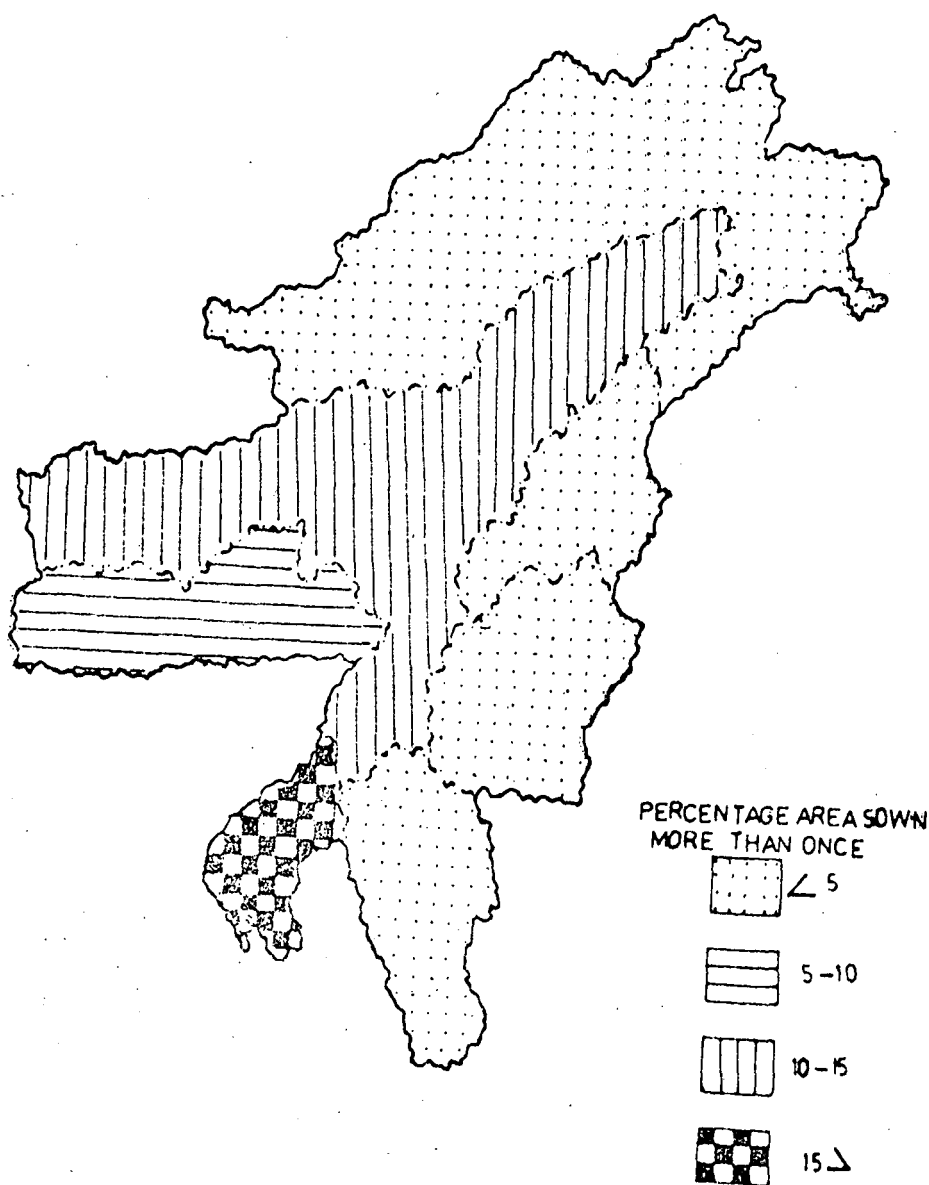
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10. Miss F.K. Wadia : 'Control of Shifting Cultivation in the North-Eastern Region', N.E.H.U., 1977.

cultivation is rather traditional.

Thus, in most of the hill areas of North-Eastern region, the shifting cultivation or jhuming is prevalent. The crop pattern varies from the higher jhum land to the lower plain strips. The crop intensity of the North Eastern region is shown on the following map:-

# INTENSITY OF AGRICULTURE NORTH-EASTERN-REGION



3. Major crops : The bulk of the cultivated area in the North Eastern<sup>Region</sup> is devoted to the production of food crops, mainly rice, as shown in the following table:-

	Year - 1977 - 78	Area-'000 hectares
State/Union Territory	Area under total foodgrains.	Area under cultivation of rice.
Arunachal Pradesh	117.9	79.0
Assam	2,458.0	2252.6
Meghalaya	128.5	106.6
Manipur	197.5	179.1
Mizoram	97.3	93.1
Nagaland	105.4	69.5
Tripura	314.3	305.2
Total	3,139.0	3,085.1
All India	127,133.0	40,001.4

Source : Basic Statistics of the North Eastern Region, 1979.

Besides rice, in Meghalaya a significant proportion of cultivable area is under production of maize, potato, vegetables, chillies, sweet potato, millets etc. These are grown particularly in the higher slopes as subsidiary food crops. A considera-

ble area is also devoted to high land paddy. In Garo hills of Meghalaya the most important crops next to rice is cotton.

In Assam, next to rice comes tea which occupies a large area. The minor crops like jutes, sugarcane, tobacco etc. occupy a small place.

So far as the Union territory of Arunachal Pradesh is concerned, the main crops are rice, maize, millets and mustard. In Mizoram maize and paddy are cultivated in hill slopes.

In Tripura next to rice jute, oil seeds and cotton give satisfactory yields. In Nagaland, besides rice, paddy and vegetables are also grown.

Among the crops grown in Manipur paddy occupies the top position both in the valley and in the hills. Among the crops of lesser importance mention may be made of wheat, mustard and pulses.

Thus, a study of the trend of production of major crops of the North Eastern region reveals that though the region takes a homogeneous character with rice occupying the bulk of the area of agricultural landscape, there is a good deal of regional variation in the cultivation of secondary crops. As a result this region is typical of an underdeveloped agricultural economy in which most of the cultivated area is devoted to almost

subsistence crops, mainly for local consumption and the immediate market.

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#### IV. METHODOLOGY

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## CHAPTER IV

### METHODOLOGY

4.1. Introduction : In this chapter we would be presenting some mathematical models that will be used for empirical analysis of trend or growth pattern of agricultural production in the north eastern region. It may be mentioned that the conventional type of time series analysis give the changes in growth over a time period. Fitting of trend line with the usual statistical method i.e., the method of O.L.S. gives the estimate of trend/time parameter for the purpose of hypothesis testing. However, if the historical data over a longer period are not available then the analysis with a trend line becomes superfluous and less objective.

The introduction of a trend variable as exogeneous variable in the absence of other probable exogeneous variables is a common practice when the information about these variables are not easily available. The output of agriculture (X) at state level (or say at global level) can be considered as a function of time (t) such as:

$$X = f(t) \dots\dots\dots (4.1.1)$$

while we assume that 't' not only does look after the influences of extraneous exogeneous variables in the agricultural production but also time variant growth. In a micro model, probably the growth of agricultural output

could have been considered as:

$$X = f(y_1) \dots\dots\dots (4.1.2)$$

where  $y_1$  = exogeneous variable or variables that affect the growth rate of agricultural output.

In a farm level the specific variables can be identified and therefore, can be introduced into the model. Taking a specific case, say a farmer with 'h' hectares of land, 'K' amount of capital and 'L' amount of labour can produce 'X' amount of output, so his production function will be:

$$X_m = f_m(h, K, L) \dots\dots\dots (4.1.3)$$

where suffix m stands for micro level. The element  $X_m$  of the universe X can have specific production function like (3) but what about the other elements of  $X_i$ , ( $i = 1, 2, \dots, m$ ) in

$$X_1 : \{X_1, \dots, X_m\} \subset \{X\} \dots\dots (4.1.4)$$

where there is every possibility of having individual production function for  $X_1$  to  $X_m$ . We do not rule out that some of X's may have similarity in terms of exogeneous variables and yet some of Xs may be functionally related to one of three variables. Therefore, unless analysis is carried out at micro level, the effect of any variable cannot be discerned satisfactorily.

In macro level, the aggregation is made possible and bias is therefore, bound to occur. Assuming that we have an aggregate production function:

$$X_1 = f_1(h_1, \dots, h_m; L_1, \dots, L_m, K_1 \dots K_m) \dots (4.1.5)$$

how do we then start with the estimation of its parameters? The best course will be either to disentangle

$$\begin{aligned} \text{e.g., } X_1 &= f_1 (h_1, K_1, L_1) \\ X_2 &= f_2 (h_2, K_2, L_2) \\ &\dots\dots\dots \\ X_m &= f_m (h_m, K_m, L_m) \end{aligned} \quad (4.1.6)$$

and estimate the parameters of land, acreage, labour and capital or to search for a global model :

$$X (f (h,L,K))\dots\dots\dots (4.1.7)$$

which is recognised as the legitimate production function.

Now the question is whether the theoretical basis for a production function can be translated into a growth function or vice versa. The growth models are known for flexibility and logistics. The growth is associated with economic dynamics and have been used to study the time differential growths. We can write the dynamic version of (4.1.7) as:

$$X_t = f_t (h_t, L_t, K_t)\dots\dots\dots(4.1.8)$$

with  $t$  as time suffix. Thus, the function of (4.1.8) is a growth function.

For our purpose of analysis of output of agriculture for the north eastern states we thought of taking the trend as well as location variable as the factors effecting the growth of agricultural production. The probabilistic model that has been applied for empirical analysis gives a thorough justification of the

incorporation of above variables into Reaction function.

We are also presenting a series of empirical regression equations to analyse the trend in growth of agricultural production.

4.2. Model for empirical analysis : In a study Dr. Bez has shown that econometric functions can be considered as reaction functions which could be interpreted in probabilistic way. We are using Dr. Bez's model for empirical analysis of our data (Dr. Bez, 1980).

The reaction function in his analysis was given as:

$$X_{1j} = f_{1j}(Y_1, Z_j) \quad (4.2.1)$$

where

$X_{1j}$  = realization or reaction of  $Y_1$  and  $Z_j$

$Y_1$  = independent random variable similar to a exogeneous variable in an econometric function.

$Z_j$  = independent random variable similar to a exogeneous variable in an econometric function.

The suffices  $i, j$  refer to state and time period respectively;  $i = 1, 2, \dots, 7$ ;  $j = 1, 2, \dots, 9$ .

It should be noted that  $X, Y$  and  $Z$  are all realizable set of sample points. Since some of the reactions may not take place at all, which implies that certain  $Y_1$  and certain  $Z_j$  may not give reactions. This is

however, not to be construed as unrealizable but we shall then have null element in the sample of X.

It is also assumed that Xs are having a conditional probability distribution such as :

$$P(X_{1j}/Y_1, Z_j) = P(X_{11}^{(1)}/Y_1, Z_j, X) + \dots + P(X_{nn}^{(P)}/Y_n, Z_j, X) \dots \dots \dots (4.2.2)$$

for all X and all Y for fixed Z<sub>j</sub>. Here the upper suffix, e.g., (1).....(P) denote the set of X that could be realized.

The above probability function is then expressed in terms of response function, e.g., for the P th set is:

$$P(X_{1j}^{(P)}/Y_1, Z_j) = f_{(P)}(X_{1j}) = f(Y_1, Z_j) \dots \dots (4.2.3)$$

Then the two sets of realizable reactions were considered for the purpose of finding relative share for any set of specific X. For this purpose the sample space of

$$X^1 \subset X: (X^{(m)}, X^{(q)}) \dots \dots \dots (4.2.4)$$

Then he found that

$$P(X^{(m)}/X^1) = \frac{P(X^{(m)}/X^1)}{P(X^{(m)}/X^1) + P(X^{(q)}/X^1)} = \frac{f^{(m)}(Y_1, Z_j)}{f^{(m+q)}(Y_1, Z_j)} \dots \dots \dots (4.2.5)$$

in terms of response functions.

The equation (5) can be interpreted also by the following probability statement

$$P(X^{(m)}/X^1) = \frac{f^{(m)}(Y_1, Z_j)}{f(Y_1, Z_j)} \dots \dots (4.2.6)$$

For estimation purpose he adopted the following frame of reference :

	$Z_j$	$Z_j$ (time period) year
$Y_1$		Yield Matrix = (( $X_{1j}$ ))
$Y_2$		
$Y_3$		
$\vdots$		
$Y_i$		
$Y_n$		
Location (State Variable)		

More specifically the frame of reference for analysing the trend or location as influencing the variables for the growth of agricultural output is presented below:-

$Y_1$	$Z_j$	$\longleftrightarrow Z_j \longrightarrow$	Average
		$X_{1j} = X_{1j}(Y_1, Z_j)$	$\sum_j X_{1j}$ = $X_{1.}$
$\updownarrow Y_1$			
Average		$X_{.j} = \sum_i X_{ij}$	$X_{..}$

The data matrix ((  $X_{1j}$  )) therefore, can be construed as the reaction of the two principal variables, i.e., one

is location and the other is trend.

For the purpose of analysis of effect of trend factor or the location factor as two of the main principal variables in the Reaction function, henceforth, the production function, the estimating equations are taken as

$$X_{1j} = f(X_{.j}) \dots \dots \dots (4.2.7.)$$

$$= \alpha_0 + \alpha_1 X_{.j} \dots \dots \dots (4.2.8.)$$

It may be interpreted that the average yield/hectare of land for any state is a function of the average yield/hectare of land of all the states together over a consecutive time period. Thereby we mean that the average yield/hectare for any state is the characteristic yield/hectare for any other state in the region. Empirically this estimating equation is arrived to highlighten the effect of trend variable over the growth of agricultural output. While assuming the effect of location factor constant, for any state, say Arunachal Pradesh, the equation (4.2.8) can be written as

$$X_{Ar.j} = \alpha_0 + \alpha_1 X_{.j} \quad (j=1, \dots, 9)$$

The other estimating equation is

$$X_{1j} = f(X_1) \dots \dots \dots (4.2.9)$$

which is assumed to be linear as will

$$X_{1j} = \alpha_0 + \alpha_1 X_1 \dots \dots \dots (4.2.10)$$

This equation implies that yield/hectare of the region

with respect to any specific time period is a function of yield/hectare averaged over the time period. In this case yield of 1970 can be taken as an effect which we might term as synergic effect of yield of all the years for this region.

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**V. EMPIRICAL ANALYSIS**

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## CHAPTER V

### Empirical Analysis

5.1. Introduction : The aim of the present study is to analyse the growth rates of total foodgrains and to show their variation among different states of the north eastern region during the period from 1969-70 to 1977-78. The north eastern region comprises five states and two union territories viz., 1. Assam, 2. Manipur, 3. Tripura, 4. Meghalaya, 5. Nagaland, 6. Mizoram and 7. Arunachal Pradesh. For this purpose data on yield of total foodgrains of each state and union territory of this region from 1969-70 to 1977-78 have been collected.<sup>1</sup>

5.2. Empirical analysis : Data on yield of total foodgrains of different states and union territories of the north-eastern region from 1969-70 have been arranged in the same order as shown in the frame of reference of the previous chapter (page 54 ).

As these data shown in Table 1 on yield (Kg.) per hectare represent non-linear trends, these data

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1. Directorate of Economics and Statistics : Ministry of Agriculture and Irrigation, Govt. of India, cited by Basic Statistics of the North Eastern Region, 1977 and 1980. North Eastern Council Secretariat, Shillong.

have been transformed into a linear function by converting all variables of table - 1 into logarithms. These data transformed to logarithms have been shown in table - 2.

The variables introduced in the above working frame are :-

$X_{ij}$  = Yield per hectare for any specific crop for the  $i$ th state for the  $t$ th period.

$Z_j$  = The trend variable for any specific time period  $j$ .

$Y_i$  = location factor or variable, i.e., any of the  $i$ th state of the region.

It could be mentioned that the reaction synonymously stands for yield per hectare for the  $i$ th region or state in the  $j$ th time period. The problem is here that unlike the conventional production function or more appropriately the growth function in the present analysis the output is not simply considered as function of time. Here resulting function is the output as a response of particular state or region for any particular time period with respect to the crop in question. The more detailed discussion about  $Y$  and  $T$  would follow later in the chapter.

TABLE-I

$Y_1 \rightarrow$	$Z_j \rightarrow$	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	Total $\sum \sum X_{1j}$	Average $(\bar{X}_{1j})$
Assam	Arumachal Pradesh	828	847	864	877	883	926	896	900	915	7936	881.78
Manipur	Assam	881	973	945	1042	971	943	996	913	987	8651	962.22
Mizoram	Manipur	1629	1154	1240	1084	1428	1533	1560	1486	1626	12750	1416.67
Nagaland	Meghalaya	1017	1023	1006	1042	1030	1010	1079	1128	1152	9487	1054.11
Tripura	Mizoram	981	969	980	963	822	743	835	650	650	7593	843.67
	Nagaland	827	893	531	581	578	612	879	905	924	6730	747.78
	Tripura	875	948	973	651	1204	1086	1216	1119	1224	9296	1032.89
	Total $\sum \sum X_{1j}$	7033	6807	6539	6240	6926	6853	7461	7101	7478		
	Average $(\bar{X}_{1j})$	1005.43	972.43	934.14	891.43	989.43	979	1065.86	1014.43	1088.29		

TABLE 42

Year and Location	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	Total $\sum \sum X_{ij}$	Average ( $\bar{X}_{.j}$ )
	$\bar{X}_i$										
Arunchal Pradesh	2.9180	2.9279	2.9359	2.9430	2.9460	2.9666	2.9523	2.9543	2.9614	26.5059	2.95
Assam	2.9450	2.9881	2.9754	3.0179	2.9872	2.9745	2.9983	2.9605	2.9943	26.8412	2.98
Manipur	3.2919	3.0622	3.0934	3.0390	3.1578	3.1856	3.1931	3.1720	3.2111	28.3221	3.14
Meghalaya	3.0073	3.0099	3.0026	3.0079	3.0128	3.0043	3.0380	3.0523	3.0614	27.2015	3.02
Mizoram	2.9917	2.9863	2.9912	2.9836	2.9149	2.8710	2.9217	2.8129	2.8129	26.2862	2.92
Nagaland	2.9175	2.9509	2.7251	2.7642	2.7657	2.7868	2.9440	2.9366	2.9657	26.7765	2.86
Tripura	2.9420	2.9768	2.9881	2.8136	3.0806	3.0358	3.0849	3.0488	3.0878	27.0584	3.00
Total $\sum \sum X_{ij}$	20.9334	20.8021	20.7123	20.5752	20.8650	20.8246	21.1273	20.9573	21.0946		
Average ( $\bar{X}_{.j}$ )	2.99	2.98	2.95	2.94	2.98	2.97	3.01	2.99	3.01		

5.3. Regression Analysis of Trend : In section (4.1) We have presented some regression functions which are usually adopted for analysis of time series data. This type of analysis is done for each state and the estimating equation are :

$$X_i = X(t) \quad (5.3.1)$$

$$X_i = a + bt \quad (5.3.2)$$

$$\log X_i = a + bt \quad (5.3.3)$$

where,  $X_i$  = yield per hectare for the  $i$  th state

$t$  = trend variable

$a, b$  = parameters of the equation.

The other estimating equations are presented in section (4.2). Now we shall be discussing about the exogeneous variables and their effects on the growth of agricultural output in the region. We must admit that the location variable, i.e., the states in the question of the N.E. region comprises most of the predominant variables that appear in a micro production function. The effects of agricultural infra-structures and infra-structures symbolizing the very appearance of economic development on agricultural growth are prima facie basic. On the other hand, the effect of other capital inputs in terms of irrigation, fertilizer, seed etc. are direct on the growth of agricultural output. In the next section we shall discuss these variables in more detail.

5.4. Explanation of the exogeneous variables : In the above model mentioned in section 5.2. and discussed in detail in section 4.2., we have taken location and the trend as exogeneous variables which influence the growth of agricultural output. Now, in this section we shall explain the reasons behind taking them as the important variables for analysing the pattern of growth.

5.4.1. Location factors :

Land : As regards the position of land for agricultural purpose in the North Eastern region it is observed that most of the areas of lands are merely useless and fallow in view of the fact that vast areas are practically unsuitable for cultivation either due to rocky and rugged terrain or inaccessibility. This observation is made clear from verification of statistics of cultivable area. Out of a total reporting area of about 23 million hectares, 2.9 million hectares in the hills and forest are under shifting cultivation.<sup>2</sup>

Again when Assam's cultivable area formed 37.2 percent of the total geographical area, it was about 8 to 9 percent in Meghalaya, Manipur and Nagaland, 20 percent in Tripura and about 3.4. percent in

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2. Miss. F.K. Wadia : 'Control of Shifting Cultivation in the North Eastern Region', Seminar paper, 1977. N.E.H.U.

Arunachal Pradesh as against 50 percent in the country as a whole.<sup>3</sup> Thus, excepting Assam and Tripura availability of land for agricultural purposes is extremely limited in all other states of the North Eastern region.

So far the food crops produced out of the total cropped area, occupy a sizeable proportion (about 78%).

Variations in soil in different states of the North Eastern region, have already been discussed in Chapter 3.

Transport : It is an admitted fact that the transport system in the North-Eastern region specially after the partition of the country has got a great set-back. Now the region is land locked and its only link with the rest of the country is a narrow strip of land through North-Bengal. So the transport link is very light and difficult. Only this strip of land is to be utilised for railway and road transport purposes outside the region. There is one important metre gauge railway system from Tezpur to Fakiragaon. Therefrom it has bifurcated towards Golakganj and Siliguri on the Northern bank of Brahmaputra. Again on the southern bank of Brahmaputra another line runs from Gauhati to

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3. Dr. S.N. Mehrotra : 'Level of Development in Agricultural Sector in N.E. Region', Journal of the North Eastern Council, Vol.1, No.3, N.E.C. 1975.

Lakhapani along with a short southward extension to Cachar district and to Tripura. From the point of transport disadvantages it needs mention that out of the collective area of 2.55 lakh sq.kms. in the North Eastern region 70% is full of hilly areas. The rest 30% is plains area but it is also crisscrossed by streams, rivers and rivulets of uncertain nature. As a result the road development of the region faces a lot of difficulties. Hence, the road links are not sufficient excepting a few National Highways.

So far as the Air links are concerned, it is apparent that Assam has the advantage of having large number of airfields. There are in all thirteen airports. These are as follows :- seven are for heavy aircrafts, four for medium aircrafts and two for light aircrafts.

Thus, inadequate transport facilities in the region itself has greatly affected the development process. Since agricultural development depends largely on free flow of fertilisers and improved technology and also on increase in income from the marketable surplus of agricultural produces, development of an efficient system of transport and communication requires priority.

Agricultural Holding : The size of operational holding is the main basis of the productivity of agriculture. Moreover, application of new or improved technique of production, irrigation etc. depend largely on the size of operational holdings. But the size of operational holdings has become very small and dispersed over a wide area in the North Eastern region owing to the fact that land for agricultural purposes is extremely limited here and there is also heavy pressure of population on land.

The size of operational holdings are shown in the following table :

Operational Holdings According to Size

Size Class (hectares)	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura
Below 0.5	2,350	651,992	9,203	21,000	-	2,487	114,486
0.5 - 1.0	3,710	468,413	23,474	34,100	-	6,311	58,944
1.0 - 2.0	9,450	466,691	34,270	51,750	-	16,397	47,049
2.0 - 3.0	12,200	189,089	9,776	27,250	-	17,070	15,976
3.0 - 4.0	8,270	86,691	2,208	8,850	-	8,853	6,242
4.0 - 5.0	9,860	43,540	658	4,150	-	11,390	3,043
5.0 -10.0	18,890	50,384	316	2,350	-	18,077	3,409
10.0-20.0	10,750	5,962	15	250	-	9,536	509
20.0-30.0	2,730	593	4	-	-	1,876	37
30.0-40.0	510	181	3	-	-	652	10
40.0-50.0	140	88	-	-	-	270	15
50.0 and above	130	752	-	-	-	334	54

Source : All India Report on Agricultural Census, 1970-71. Ministry of Agriculture and Irrigation, Government of India.

Financial Institutions : Owing to natural backwardness and difficulties existing in the North Eastern region it has not been possible for the financial institutions to make headway in the matter of giving financial loans to entrepreneurs on easy terms. This is why a very small number of bank branches has so far been established in the states and union territories of the region. Of course, in this respect the position of Assam is a bit better. As on 30.6.1978 the total number of bank branches in the entire region was 610. It was 13 in Arunachal Pradesh, 414 in Assam, 32 in Manipur, 49 in Meghalaya, 6 in Mizoram, 29 in Nagaland and 67 in Tripura. The funds advanced from these institutions have also been very low as shown in the following table :-

Particulars	Unit	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	TOTAL
1. Direct Finance (Amount Outstanding.)	Rs. in crores	0.01	0.45	0.48	0.57	0.01	0.11	1.16	6.30
2. Indirect Finance (Amount Outstanding.)	Rs. in crores	-	3.89	0.12	negl	-	0.09	0.24	4.34

Source: Basic Statistics of N.E. Region, 1979.

similarly the numbers of Primary Agricultural Credit Societies (1975-76) was very low. It was 3519 in Assam, 657 in Manipur, 548 in Meghalaya, 101 in Mizoram, 356 in Tripura and 163 in Nagaland. Total loans advanced by these institutions was Rs. 28 lakhs in Assam, Rs. 13 lakhs in Manipur, Rs. 2 lakhs in Nagaland and Rs. 47 lakhs in Tripura.<sup>4</sup>

Studies made by Dr. D.D. Mali<sup>5</sup> and others show that non-institutional sources, such as friends and relatives and money lenders are playing most important role in providing credit specially in the villages of hilly region. Hence, the role of institutional source is not very significant in these areas. Moreover, due to the operation of money lenders credit is made available only for a short period and naturally the price of rural credit is high.

Agro-based Industries : Agro-based Industries in North Eastern region have not developed for various reasons. Except for tea plantation and sugar factory in Assam there are no major industries worth mentioning. Production distribution of entrepreneurs in agro based industries in the North Eastern Region will be clear from the following table :

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4. Basic Statistics of the North Eastern Region, 1979. N.E.C. Secretariat, Shillong.
  5. Dr. D.D. Mali: 'Rural Credit in Meghalaya'. Seminar Paper, N.E.H.U., 1978.

Production Distribution of Entrepreneurs in Agro-based Industries (Number of Units)

Product	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	TOTAL
Agro - based	16	833	22	86	53	47	110	1,167

Source: [ Study of Entrepreneurial and Managerial Needs of the N.E. Region - Interim Report - Small Industries Extension Training Institute, Hyderabad, 1976.]

Number of persons employed in industries producing food products is also very insignificant : 1,288 in Assam, 85 in Manipur, 141 in Meghalaya, 24 in Nagaland and 328 in Tripura.<sup>6</sup>

It should be mentioned here that all available studies reveal the potential of such industries based on locally available resources. Many parts of the region are suitable for plantation crops such as tea, coffee, rubber, black pepper, jute and agricultural equipment.

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6. All India Report on the Census of Small Scale Industries, Vol. 1, 1976. Govt. of India.

Marketing: Inadequate transport facilities in the region has laid much hindrance in matter of marketing and storage. Practically, speaking, it has been a constant difficulty on the part of the farmers to market their surplus produce and procure fertiliser and finished goods particularly from the remote and interior areas of the hilly region. The effect of this is that while the farmers have to pay more for fertilisers and other inputs for agriculture and other consumer goods their income from the marketable surplus of agricultural produce is low. In 1977, the total number of wholesale markets in the entire north-eastern region was only 183. It was 23 in Arunachal Pradesh, 108 in Assam, 16 in Manipur, 3 in Meghalaya and 33 in Tripura.<sup>7</sup> Thus, the rich hinterland of the region with vast agricultural resources remain untapped because of transport bottlenecks and as such consequent inadequate marketing facilities.

Irrigation :- In North Eastern region natural rainfall is the main source for agricultural products as there are no sufficient irrigation facilities. Hence, agricultural is dependable to the largest extent on natural rainfall. In 1972-73, 16.47 percent of cultivated area

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7. Basic Statistics of the North Eastern Region, 1979. N.E.C. Secretariat, Shillong.

was under irrigation for the whole of North-Eastern region compared to the all India figure of 20.67 per cent. Of this 20.57 percent was in Assam, 13.41 percent in Manipur, 3.72 per cent in Meghalaya, 18.28 percent in Nagaland, 4.03 percent in Tripura, 6.23 percent in Arunachal Pradesh and 0.29 percent in Mizoram.<sup>8</sup> Cropwise the largest amount of irrigated area is under rice cultivation which covers an area of 739,000 hectares.

#### Technological Factor :

Fertiliser and H.Y.V. : Fertiliser and High-yielding varieties of seeds are the two most important inputs required for increased agricultural production. But in respect of North Eastern region as a whole it will take more time to apply to a considerable extent these two important inputs. Their application depends to a large extent on assured water supply (i.e., irrigation) but already we have shown that artificial water supply facilities have not so far been extensive in the North Eastern region. However, so far the area under H.Y.V. in different states of the North Eastern region is concerned the position of 1973-74 is shown in the following table :

Unit	Area Under Foodgrains (000 hectares)	Area Under H.Y.V. (000 hectares)
Assam	2236.9	340.0
Manipur	179.2	35.0
Nagaland	95.2	1.11
Meghalaya	119.9	7.5
Tripura	301.9	52.16
Arunachal Pradesh	62.3	5.40
Mizoram	77.6	0.60

Source : Journal of the North Eastern Council, Vol.1,  
Aug., 1975, No. 3.

Likewise if we observe data on total consumption of fertiliser per hectare of agricultural land we find that the position of this region in this respect is not at all satisfactory. In 1973-74, it was 0.35 Kgs. per hectare for Arunachal Pradesh, 2.47 Kgs. for Assam, 8.86 Kgs. for Manipur, 1.23 Kgs. for Meghalaya, 0.31 Kgs. for Mizoram, 0.97 Kgs. for Nagaland, 3.67 for Tripura as against 15.37 Kgs. per hectare in the country. Again, in 1974-75, it was 0.35 Kgs. for Arunachal Pradesh, 2.30 Kgs. for Assam, 10.90 Kgs. for Manipur, 11.40 Kgs. for Meghalaya, 0.31 Kgs. for Mizoram, 3.10 Kgs. for Tripura compared to all India

figure of 15.80 Kgs. per hectare of agricultural land.<sup>9</sup>

Moderan Agricultural Implements : The supply position of farm power and improved agricultural implements in the North Eastern region is not hopeful. Hence this region constantly suffers from adequate supply of these implements. In the face of such inadequacy most of the farmers have not shown much interest in accepting such improved practices. This may be due to the fact that most of the farmers are small farmers who are not fully acquainted with the use and utility of such agricultural implements. It has therefore, resulted in the absence of Agro Service Centre so far in this region.

#### 5.4.2. Trend Factor

Length of the season : The entire North Eastern region is blessed with a high monsoon rainfall. South west monsoon period covers the months from June to September. Pre-monsoon period covers the months from March to May. The North East monsoon period covers January and February and post monsoon period covers the months from October to December. Rice is the most important crop in the region. In Assam and Tripura winter rice is the most important crop, it is sown in the month of June - July and harvested in December - January. In Manipur autumn rice is the most important crop which is sown

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9. Indian Fertiliser Statistics, 1974-75. Govt. of India.

in early June and harvested in August-September. In hill areas the first crop is sown during March-April in upland soil depending upon the pre-monsoon rain. In Jhum land also rice is sown at the same time.

Rainfall and humidity : The monsoon winds coming from the Bay of Bengal having been obstructed by the hills in the region cause heavy rainfall. The rainfall is however greater in the hill slopes than in the valleys. In summer this region is quite hot in the plain but in the hills temperature cannot be high due to elevation. In winter it is very cold in the hill areas but in the plain the temperature is not so low. The winter is practically dry. (Distribution of rainfall and humidity in each state of the North Eastern region have been discussed in detail in Chapter III).

It needs mention here that trend factor includes factors like climatic condition viz., rainfall, humidity, length of the season etc. In fact, these factors are common to both trend and location factors.

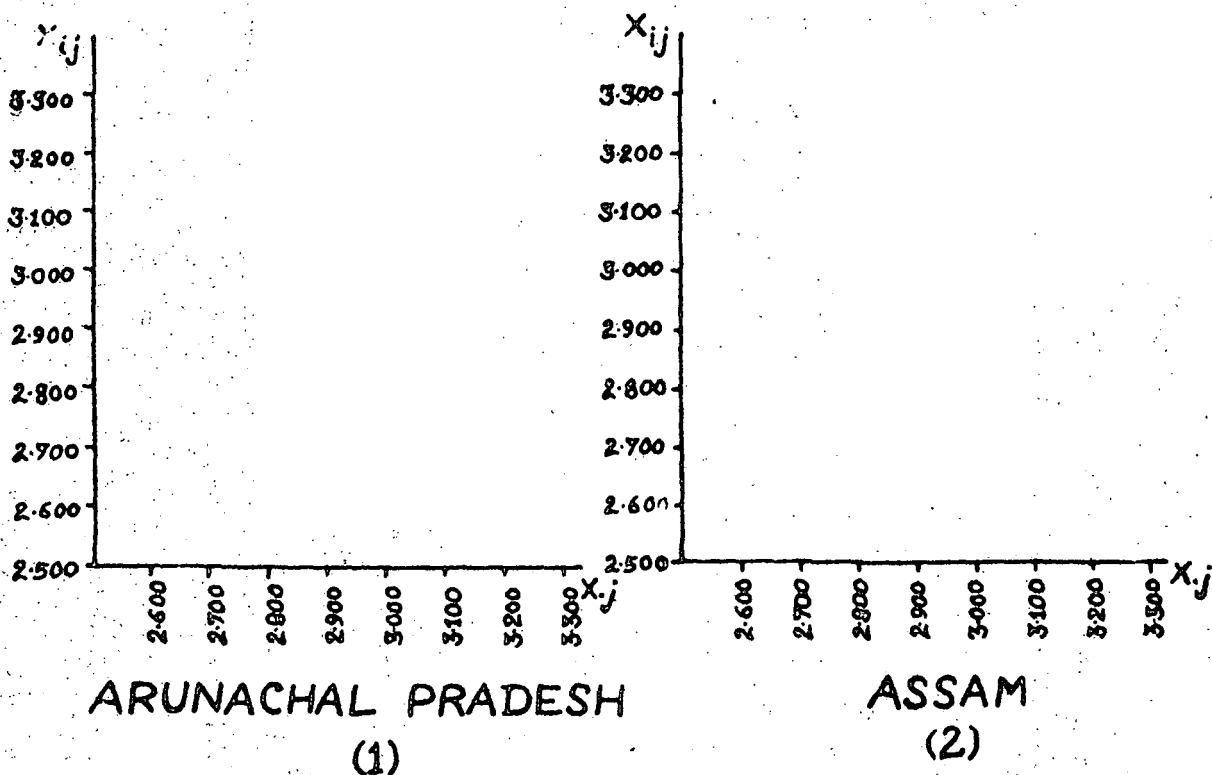
5.5. Estimation : In this section we are presenting the graphical analysis of the agricultural growth using the probabilistic model, i.e. the Reaction function. We have already presented the estimating equation in section 4.2.

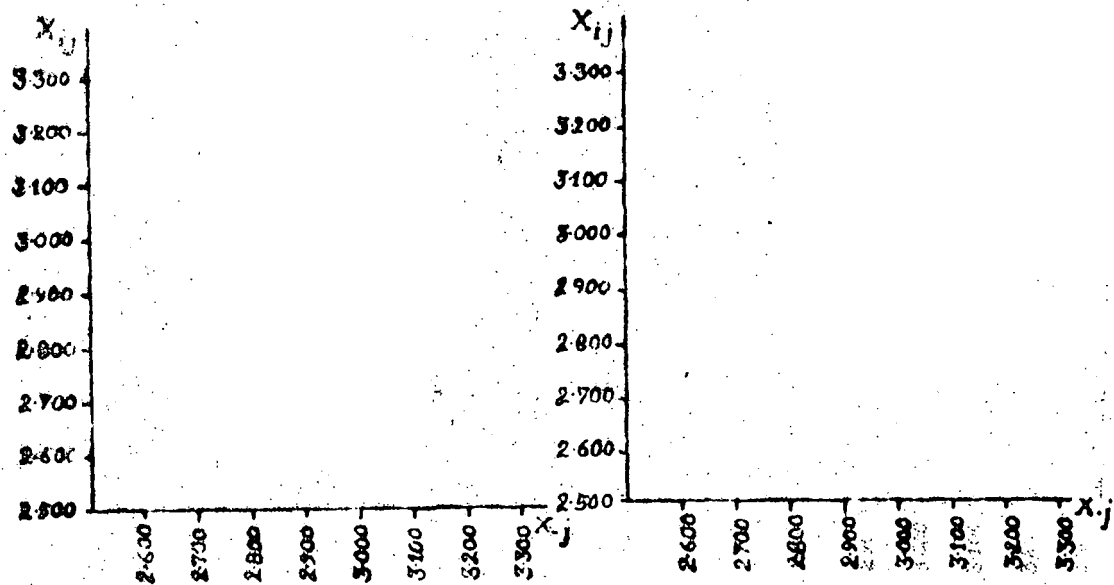
The estimation of parameters is made

graphically by the principle of marginal probability. The regression lines are expected to be proportional and linear. The intercepts could be read from the graph. The graphical estimates of the other regression coefficient, i.e.,  $\beta$  should be nearly the same to confirm proportionality. However, we shall have two types of analysis - one for the location factor and the other for the trend factor.

Yield per hectare of total foodgrains (transformed into logarithms) for the period 1969-70, 1977-78 of each state of the North Eastern Region ( $X_{ij}$ ) have been plotted in the graph papers against the average yield per hectare (of all states) of the whole North Eastern region ( $X.j$ ). These graphs as shown below reflect statewise variation in productivity in the region during the period 1969-70 - 1977-78.

STATEWISE YIELD PER HECTARE (LOG) OF EACH YEAR DURING THE PERIOD 1970-78, i.e.  $X_{ij}$  AGAINST TOTAL AVERAGE YIELD OF ALL STATES, i.e.  $X_j$ .



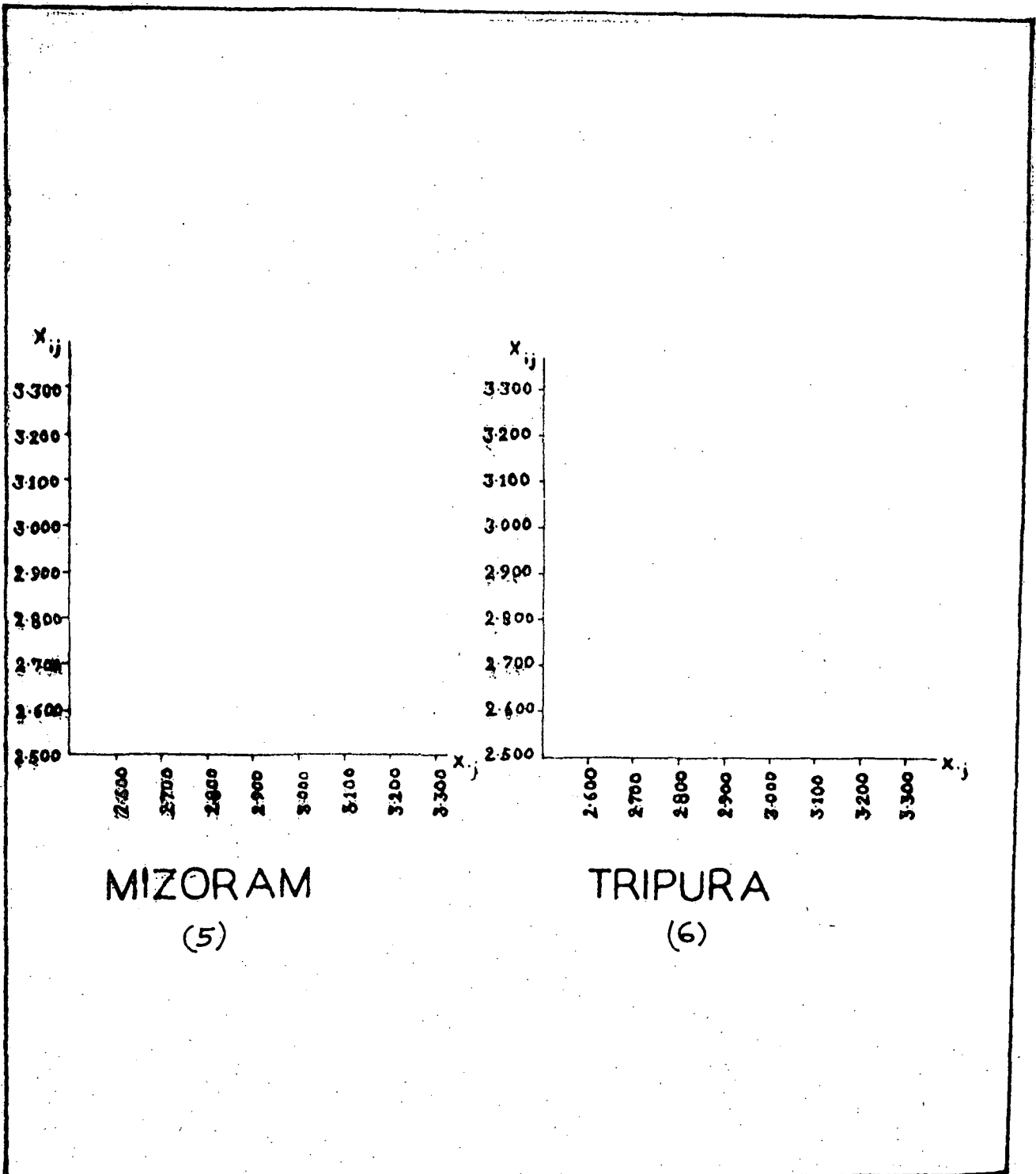


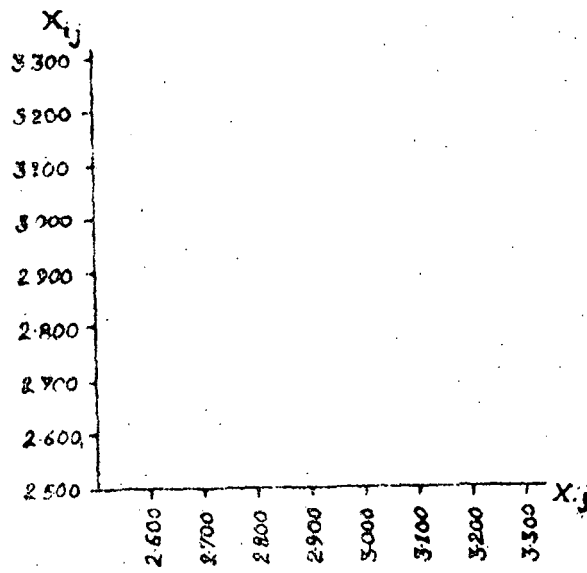
MANIPUR

(3)

MEGHALAYA

(4)



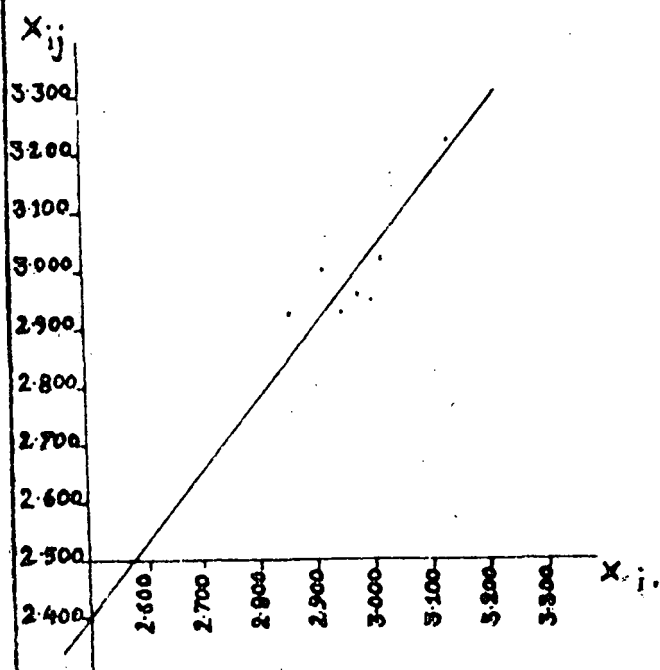


NAGALAND  
(7)

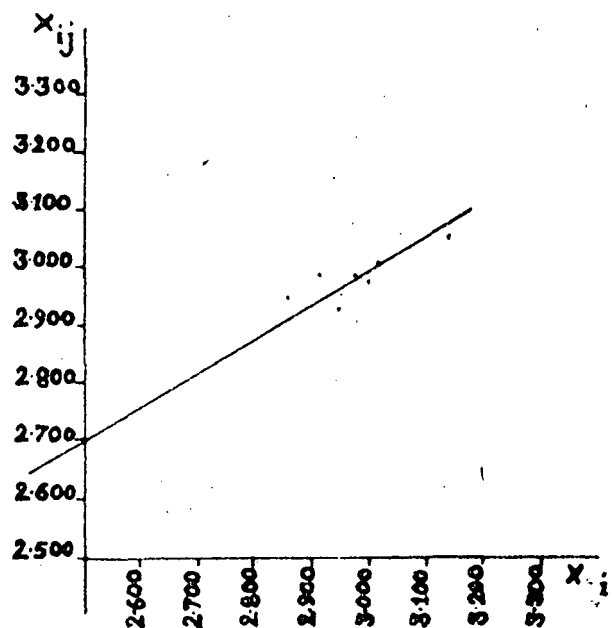
Similarly, in order to show yearwise variation in growth of agricultural output, yield per hectare of total food-grains for each year of different states ( $X_{ij}$ ) have been plotted against the average yield per hectare of the whole period from 1969-70 to 1977-78 ( $X_i$ ). These graphs are shown below :

YEARWISE YIELD PER HECTARE (100) OF ALL STATES OF NORTH EASTERN REGION  $(x_{ij})$  AGAINST

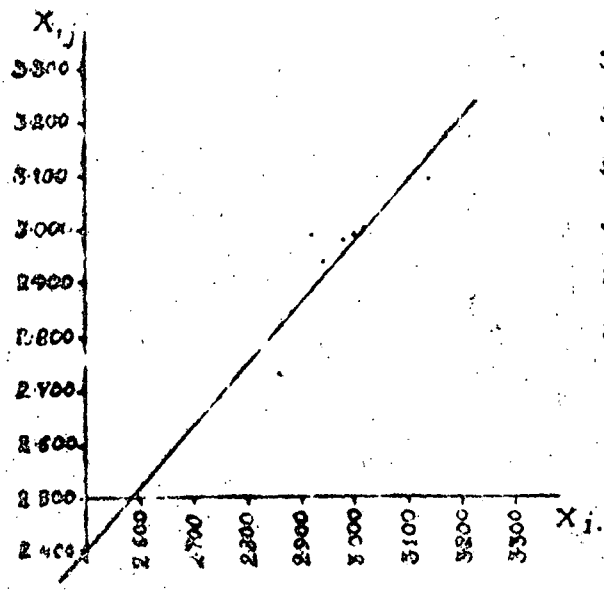
TOTAL AVERAGE YIELD  $(x_i)$  FOR THE PERIOD 1969-70-1977-78



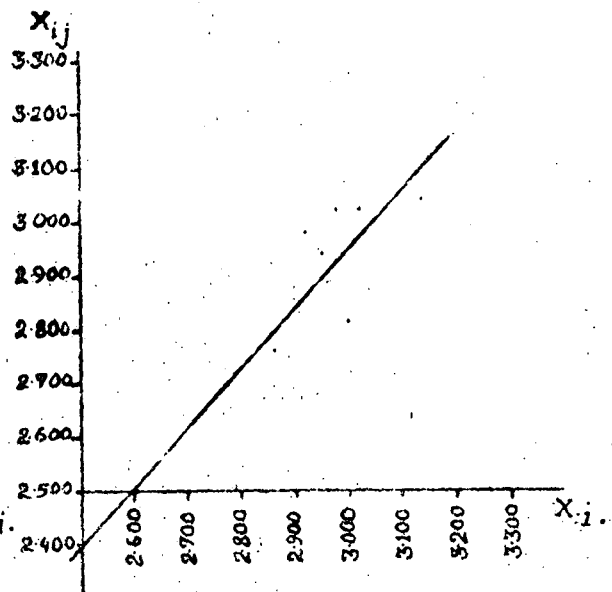
1969-1970  
(8)



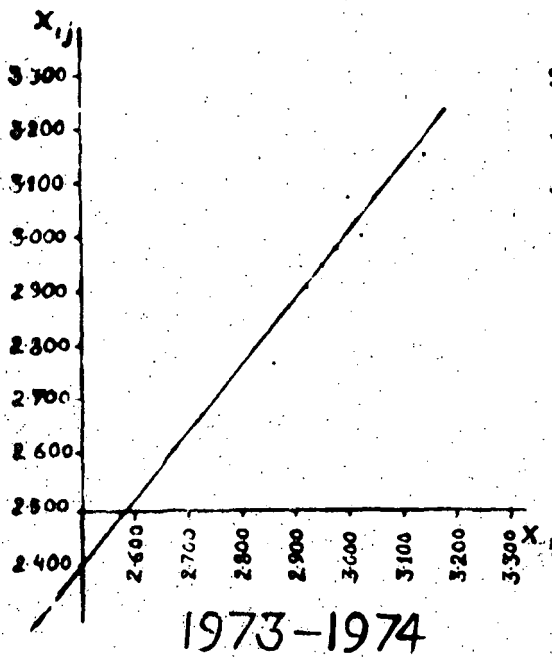
1970-1971  
(9)



1971-1972  
(I)

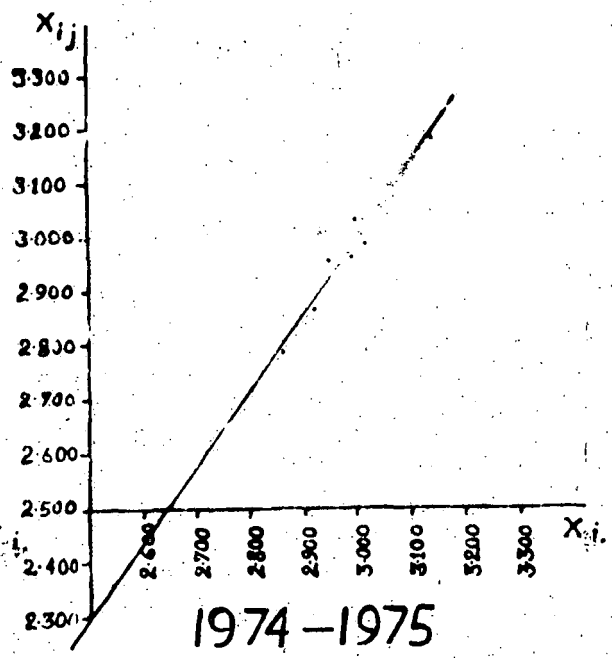


1972-1973  
(II)



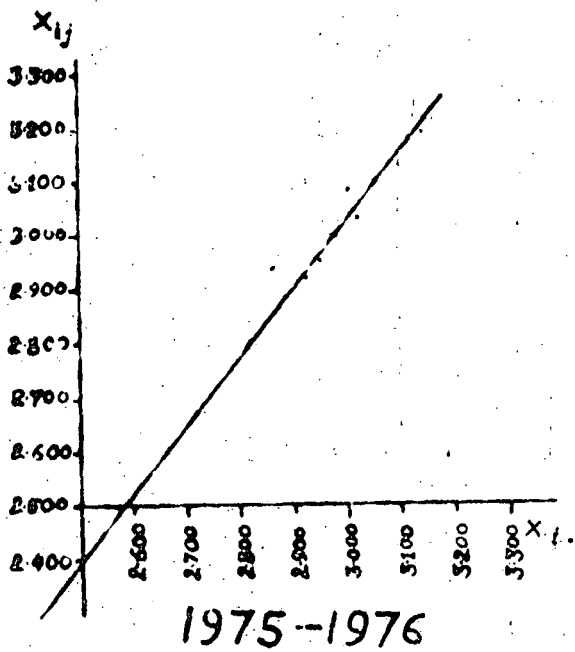
1973-1974

(12)



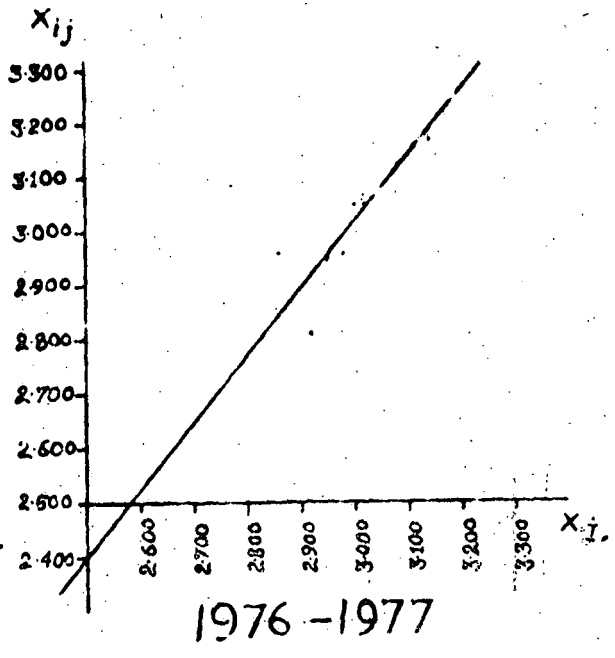
1974-1975

(13)



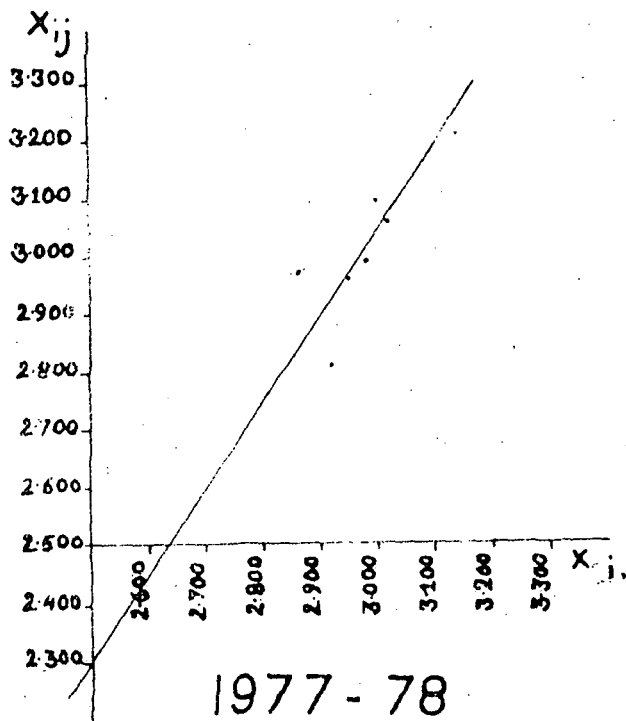
1975-1976

(14)



1976-1977

(15)



1977 - 78

(16)

From these graphs it is observed that statewise variations in yield per hectare do not show any trend. This, however, means that there is no significant variation in growth or yield per hectare among different states of the North Eastern region during the period 1969-70 - 1977-78. Whereas yearwise variations in yield per hectare show linear trend. This means that there have been significant variations in yield per hectare among different years of the period considered, i.e., over time.

In the present analysis statewise variation is considered to be due to location factor whereas yearwise variation is due to trend factor.

**5.6. Empirical Regression Models :** In this section we are estimating the parameters of the regression function in which trend (t) is the only explanatory variable. The models have been described in section 5.3. The estimating equation is

$$X_t = a + b_t$$

The same equation can be written as

$$Y = a + b X$$

where Y = yield/per hectare for any period.

X = trend variable.

a & b = parameters of the equation.

The resulting equations for each state of the North-Eastern region are as follows :-

1. Arunachal Pradesh :

$$Y = 881.87 + 10.33 X$$

2. Assam :

$$Y = 961.22 + 4.1167 X$$

3. Manipur :

$$Y = 1416.66 + 34.55 X$$

4. Meghalaya :

$$Y = 1054.11 + 1615 X$$

5. Mizoram :

$$Y = 843.67 - 46.52 X$$

6. Nagaland :

$$Y = 747.78 + 19.18 X$$

7. Tripura :

$$Y = 1032.89 + 47.17 X$$

Putting the exponential equation in logarithmic form gives :

$$\log Y_c = \log a + b \log X$$

Whereas we take the semi log model,

$$\log X_1 = a + bt \text{ (section 5.3)}$$

The trend equations in logarithmic form for each state are :

1. Arunachal Pradesh :

$$\log Y_c = 2.9451 + .005128 X$$

2. Assam :

$$\log Y_c = 2.982356 + .001946 X$$

3. Manipur :

$$\log Y_c = 3.1469 + .01127 X$$

4. Meghalaya :

$$\log Y_c = 3.022389 + .006513 X$$

5. Mizoram :

$$\log Y_c = 2.920689 - 0.024783 X$$

6. Nagaland :

$$\log Y_c = 2.864056 + .0111716 X$$

7. Tripura :

$$\log Y_c = 3.006489 + 0.02025 X$$

5.7. Conclusion : The graphical estimates given by the probability model is explicit in the sense that in the absence of rigid economic theory on growth of agricultural output, the results reveal no linearity in spatial and trend factor (figs. 1-7). This may not be taken as a final verdict, since we have only a limited data. Time series type of analysis requires data over a longer period of time. Again, with this type of model, where the exogeneous variable, i.e., the total over all the states is not free from the intrinsic effect of spatial difference, although such differences are distributed over all the years.

However, when we look at the other side of analysis that is when log value of output of each year for each state plotted against log value of average over the years we find significantly linear relationship. This could be interpreted that the trend is more influencing factor, which can be accounted for all the states. It can also be seen that as per dictum of marginal probability law, the tangent of the lines are almost the same for all the states (figs. 8-16).

Coming to empirical linear regression lines, we have a poor picture of the trend factor. The fluctuations in the growth rates of outputs are

varying from year to year. The log-linear equations, on the other hand, support the fact that there is trend in growth rates, as supported by the results given by the application of probabilistic model.

The difficulty for a complete comparability among the results given by regression model and probabilistic model is both logical and technical in nature. Probabilistic model splits the location factor and the trend factor and the regression model takes one factor at a time. The previous studies into regional variation cited in the chapter II of this dissertation have no analytical base except for the fact that two regions give two different yields per acre.

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