An Analysis of Regional Disparities in Agricultural Development in Assam: An Econometric Approach

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To
My Elder Sister
Anita (Moromee)

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STATEMENT

I hereby declare that the matter embodied in this thesis is the result of investigations carried out by me in the Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, India under the guidance of Dr. S. Borbora.

In keeping with the general practice of reporting observations, due acknowledgements have been made wherever the work described is based on the findings of other investigators.

I.I.T. Guwahati
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CERTIFICATE

This is to certify that Mr. Ratul Mahanta has been working under my supervision since August 2, 1999. I am forwarding his thesis entitled “An Analysis of Regional Disparities in Agricultural Development in Assam : An Econometric Approach” being submitted for the award of Ph.D degree of this institute. I certify that he has fulfilled all the requirements according to the rules of this institute, and regarding the work embodied in his thesis has not been submitted elsewhere for a degree.

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February, 2003

Dr. S. Borbora
Supervisor

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Ratul Mahanta

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List of Abbreviation

2-SLS	Two Stage Least Square
AAIDC	Assam Agro-Industries Development Corporation
ACABL	Assam Co-operative Apex Bank Limited
AMDP	Accelerated Maize Development Programme Areas
ARIASP	Assam Rural Infrastructure and Agriculture Services Project
ASAMB	Assam State Agricultural Marketing Board
ASC	Assam Seed Corporation
BLUE	Best Linear Unbiased Estimator
CCIS	Comprehensive Crop Insurance Scheme
CES	Constant Elasticity Substitution
CID	Composite Index of Development
FMC	Field Management Committee
GDP	Gross Domestic Product
GLS	Generalised Least Square
GNP	Gross National Product
GPSS	Gaon Panchayat Samabay Samity
HYV	High Yielding Varity
ICDP	Integrated Cereals Development Programme
IPM	Integrated Post Management
IR	Increasing Rating
LAMPS	Large Size Multipurpose Societies
MIC	Middle Income Countries
MIDC	Minor Irrigation Development Corporation

ML	Maximum Likelihood
MR	Magnitude Rating
NABARD	National Bank for Agricultural Development
NAIS	National Agricultural Scheme
NIC	Newly Industrialized Countries
NPDP	National Pulse Development Programme
NPK	Nitrogen, Phosphorous and Potash
NSDP	Net State Domestic Product
NWDPRA	National Watershed Development Project for Rain Fed
OLS	Ordinary Least Square
PACS	Primary Agricultural Credit Societies
PCA	Principal Component Analysis
PCSDP	Per Capita State Domestic Product
PQLI	Physical Quality of Life Index
SC	Schedule Caste
SDP	State Domestic Product
SJDP	Special Jute Development Programme
ST	Schedule Tribe
STATFED	Assam State Co-operative Marketing and Consumer's Federation
TMOP	Technology Mission on Oil-seeds and Pulses
WACS	Weighted Average Component Score

Abstract

Regional imbalances is a ubiquitous phenomenon in both developed and developing economies. But in the latter it is more acute and glaring. It is being increasingly recognized, both on theoretical and empirical grounds, and experiences of the developing countries shows that at least in the initial stages of economic development, considerable regional imbalances in development arises. Reservation have, however, been expressed about the need to take deliberate policy measures to remove these increasing regional disparities in the levels of living.

Regional disparity exists in agricultural development in Assam. The present study intends to measure the extent of regional disparities in agricultural development in Assam and examine the factors responsible for them. This will help to find solution to the problem of regional disparities. The study assumes that there are three sources i.e. input effect, spatial effect and temporal effect that cause variation in the level of agricultural development. This study revolves around the following broad objectives:

(i) to examine the inter-regional disparity in agricultural development over a period of time and to identify the backward regions.

(ii) to study the degree and cause of regional disparity in agricultural development in Assam at a point of time.

(iii) to enquire into the spatial dynamism in the level of agricultural production in Assam over a period of time using cross-section and time series data. and

(iv) to investigate into the temporal variation in the level of agricultural production in Assam using cross-section and time-series data.

The study is envisaged to the Assam State with 23 districts. Agricultural production is taken as indicator of agricultural development in Assam. Only food grains production, which consists of rice, pulses, maize, wheat and other cereals, is considered in the present study. The district-wise related data are taken as reference period from 1990-91 to 1998-99. For Agro-Climatic zones the district-wise data have been clubbed together.

PCA (Principal Component Analysis), one of the regionalisation approach has been used to examine inter-regional disparity in agricultural development and to identify the backward regions. To study the degree and cause of regional disparity in agricultural development in Assam various tools like balance ratio, index of inter-regional imbalances, index of intra-regional imbalances and co-efficient of imbalances has been used. Error component model has been used to investigate the spatio-temporal dynamism.Applying above methodology and analysis, the results of the study are briefly summarized below.

Regionalisation in Assam

In this study PCA (Principal Component Analysis) has been used for constructing indices of agricultural development. Depending upon the level of development indices known from PCA, agricultural regions have been described as (i)Very Developed, (ii) Developed, (iii)Developing and (iv) Backward regions.

Analysis of Imbalance

The imbalances have been analysed in the following three order (i) Imbalance at Macro level (ii) Imbalance at Region level and (iii) Imbalance at District level. It is observed that the degree of inter-regional imbalances is higher at district level than at region level. Hence it goes to suggest that the problem of regional disparities in agricultural development is to be tackled district wise and region wise may not be suitable for pursuing a policy for regional balance in agricultural development.

Among the factors which effect imbalances in districts, regions and Assam as a whole, irrigation, pump sets, energized and fertilizer use are found to be dominating. The lower degree of imbalances are found as cropping intensity, length of road in a district/region and pressure of rural population on agricultural land.

Spatio-temporal Dynamism in the level of agricultural development

The estimates of spatial (regional) effect on the basis of error-component model for all six agro-climatic zones shows that due to the spatial effect the very developed regions i.e. lower Brahmaputra Valley can produce 1.13 times more than that of Hill Zones by using the same quantity of input, on the premise that there is no disturbance of weather effect.

From the results it is found that the temporal effect is very much erratic and does not follow a particular trend for any of the regions. Moreover, the temporal effect are not due to weather effects alone, but to a variety of causes which are random in nature. However, from the values of the co-efficient of variation, it can be inferred that there is low variability in the Barak Valley and Hill Zones. In the Hill Zone, the Jhum cultivation maintains almost regular impact on the level of agricultural production. Central and Upper Brahmaputra valley shows a moderate co-efficient of variation as in these two zones, floods occur annually, but with varying degrees of intensity. In case of Lower Brahmaputra Valley and North Bank Plains it shows high variability in the co-efficient of variation, as these two zones are highly sensitive to temporal effects. On the basis of the regionalisation effect, spatial (region) effect and the temporal effect, all the six agro-climatic regions can be divided according to the following manner

i) dynamic region,
ii) progressive region and
iii) sluggish region.

Under the dynamic region, comes the Lower,Upper and Central Brahmaputra Valley; under the progressive region, comes North Bank Plains ; and under the sluggish region, comes the Barak Valley and Hill zones.

From the above discussion it is known that variation in the agricultural development is due to the variations in the level of known inputs. But the study also tells that the variation may be due to the spatial and temporal effects, and as a result, it becomes very difficult to remove the inter-regional disparity merely by the re-allocation of the known inputs, and therefore, recourse has to be sought from the spatial and temporal factors. Taking into consideration these three effects this study suggest a suitable strategy which is needed for making optimal use of agricultural resources and potentialities and balancing the rate of agricultural development over regions.

Contents

Chapter 1

An Introduction

1.1 The Issues

Regional imbalances is a ubiquitous phenomenon in both developed and developing economies. But in the latter it is more acute and glaring. National economies are often composed of sets smaller and localized economies. If the national economy is to prosper, then its constituent regional economics must be brought into some sort of harmony. It is being increasingly recognized, both on theoretical and empirical grounds. Experiences of the developing countries also shows that at least in the initial stages of economic development, considerable regional imbalances in development arises. Reservation have, however, been expressed about the need to take deliberate policy measures to remove these increasing regional disparities in the levels of living. The underlying idea behind such a view is that, the lack of development of such a region may be due to its lack of potential for economic development. Hence, it is argued that efforts to lessen regional economic imbalances would be at the cost of maximization of economic growth. The problem of regional imbalances attracted much attention since 1951 when the concerted efforts for planned economic development were intensified in India. As early as 1956, when the Second Five-Year Plan was formulated the problem of regional disparity was specifically noted and it was stressed that in any comprehensive plan, the special needs of the less developed region should receive due attention and the pattern of investment must be so devised as to lead to a balanced regional development. In continuation of that in all the Five-Year Plans that followed, emphasis was laid on the systematic identification of under-developed regions and even a number of committees were appointed by the Government to identify less developed areas in the country. In view of the continuing need to help economically less developed regions, it becomes essential to evolve some indicators for the purpose of measuring economically less developed areas. Any plan or policy towards regional disparities would call for an identification of less developed regions. Such an attempt becomes imperative in a federal country not only for the purpose of transferring resources from the federal to the federating States but also to assess their competing claims for additional assistance and /or investments.

To support their claims, individual state may try to project its own standard for identifying less developed regions so as to get more assistance, hence the necessity of standard indicators to identify less developed areas.

It is argued "the progress of the nation depends in a real sense on the development of the weaker states"[1]. Large and persistent disparities in the levels of economic development and well being of different states are viewed many a times as an annoying source for political tensions and a danger to the national unity and strength. It is, therefore, natural to find reduction of regional disparities as being recognized explicitly or implicitly as a national objective along with other objectives behind national economic policy.

Some economists feel that there exists a clear conflict between the national objectives of efficiency and equity. Balogh[2] points out that the programmes designed to relieve inter-regional disparity of income levels in India may well curtail the efficiency of the national economy to the extent that no region will really become better off as a result of the equalization policy. Renaud[3] supports by arguing that "if, under free market forces, we can maximize national output, policies for greater interregional equality will tend to reduce total output". S. Gupta[4] also feels that the objectives of reducing regional disparity adds an effective constraint in maximizing national output and "hence, regional development as a separate objective, must stand more on social and political considerations than on economic efficiency; and consequently, it normally appears at a later phase of economic development when the national cake is considered to have grown sufficiently, and the fruits of planning can be more widely shared without significantly hampering the development process".

In India, Nair[5] observes that, "the first decade of Indian Planning does not seem to have witnessed any major decrease in interstate income differentials". S.K.Rao[6] concludes on the

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1. Report of the Finance Commission, 1969, p.11.
2 .T. Balogh, Equity and Efficiency: The Problem of Optimal Investment in a framework of underdevelopment, 1962, pp. 22-35.
3 . B.M. Renaud, Conflicts Between National Growth and Regional Income Equality in a Rapidly Growing Economy: The Case of Korea, 1973.
4 . S. Gupta, The Role of Public Sector in Reducing Regional Income Disparity in Indian Plans, 1973.
5 . K.R.G. Nair, A Note on Inter-State Income Differentials in India, 1950-51 to 1960-61, 1971.
6 . S.K.Rao, A Note on Measuring Economic Distances between Regions in India, 1973.

basis of a composite index of six indicators of development "regional disparities have not been reduced in the course of fifteen years of planning". V Nath[7] finds that "economic growth during the 1950s and early 1960s was probably somewhat more rapid in the developed States than in the less developed ones". Another study of the Indian Regional experience by Majumdar[8] for the period 1950-51 to 1967-68 finds intriguingly a U-shape rather than an inverted U-shape curve of regional disparity with respect to time. Majumdar and Kapoor[9] taking three yearly averages find a clear rising trend in the extent of regional disparity in India during 1962-76. An interesting study on the regional income differentials in India on the basis of district income data for the year 1955-56 reveals a positive but weak relation between the per capita income and the extent of regional income inequality (Heston)[10]. If we consider the size income distribution in India, the most systematic studies on the subject assert, "the gulf between the rich and the poor has widened". (Dandekar and Rath[11], and S.Swamy[12]. J.C.Sandesara[13] finds that "Organised industry has contributed towards narrowing the inter state imbalances………It seems fairly clear that but for the counterweight of industry, given other things, the imbalances would have probably widened". R.H Dholakia[14] find declining regional disparities in value added in the registered manufacturing sector during the sixties and early seventies. On the other hand, Majumdar[15] although finds the regional disparity in the secondary sector increasing during 1951-61 concludes that "the private sector investment exhibited a continued strong preference location in the high income regions despite the government's efforts to steer the private sector investment through licensing system and despite considerable public sector investments in the low income regions". H. Singh[16] examined the spatial and temporal variations in the level of agricultural development indicated the factors responsible for these variations and made proposals on the inter-regional and intra-regional developments in

[7] . V. Nath, Regional Development in Indian Planning, 1970.
[8] . M. Majumdar, Regional Income Disparities, Regional Income Change and Federal Policy in India, 1950-51 to 1967-68: An Empirical Evaluation, 1977.
[9] . G. Majumdar and J.L. Kapoor, Behaviour of interstate Income Inequalities in India, 1980.
[10] . A. Heston, Regional Income Differences in India and the Historical Pattern, 1967.
[11] . V.M. Dandekar and N. Rath, Poverty in India-I, Dimensions and Trends, 1971.
[12] . S. Swamy, The Distribution of Income in India: 1951-68, 1974.
[13] . J.C. Sandesara, The Indian Economy-Performance and Prospects, 1974.
[14] . R.H. Dholakia, An Inter-State Analysis of Capital and Output in the Registered Manufacturing Sector, 1979.
[15] . M. Majumdar, op. cit. n. 8.
[16] . H.Singh, Regional Disparity in Agricultural Growth, 1987

Punjab by dividing the state into three homogeneous regions. R.V. Dadibhavi[17] examines the inter-state disparities in India. The author finds that the two factors such as per worker productivity in agriculture and degree of industrialization are prominent for the inter-state disparities. Of the two factors, industrial structure and productivity, it is productivity differences which explained most of the variations in the inter-state per capita income in India. The Seventh Five Year Plan stressed that "While India's agriculture has taken massive strides in the last three and half decades planning, its growth and development has not been uniform all over the country. The differential pattern and pace of development, particularly the growth of food grains production, has lead to regional disparities"[18]. G. Jayachandra Reddy and N.B.K Reddy[19] examine the regional disparities in industrial development in Andhra Pradesh. The author finds the industrial development is very poor and unbalanced. The main cause of unbalanced is that the backward districts have very few type of industries such as food products, wood products, paper and printing, repairing and servicing which cater to the local demands. Industries like electrical, electronic, ferrous and non ferrous require heavy investment and hence absent in the backward districts. C.A Rao, J.C. Kalyal and Y.V.R.Reddy[20] observed that wide disparities in fertilizer use across different agro-climatic zones of Andhra Pradesh are the main causes for inter zonal disparity in agriculture production. Area under irrigation and commercial crops, distance of fertilizer dealers and availability of credit influenced fertilizer use significantly.

Existence of regional disparities in economic development, in vast developing countries like India, is a common phenomenon. The degree and extent of inequality may vary from period to period. Many studies in India highlighted the facts that regional disparities in India have increased over the plan period. The studies by Sampath[21], Nair[22], Singh[23] and Tiwari[24] showed that regional disparities in India are diverging despite the measures adopted by the Government of India to reduce the divergence among the states in respect of development. Various empirical studies have been conducted to estimate the extent and nature of regional

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17 . R.V.Dadibhavi, Inter-State Disparities in India, 1989.
18 . Seventh Five Year Plan Document,Govt. of India, 1985.
19 . G. J.Reddy and N.B.K.Reddy, Regional Disparities in Industrial Development in Andhra Pradesh, 1994.
20 . C.A Rao, J.C. Kalyal and Y.V.R. Reddy, Inter-Zonal Disparities in Fertiliser Use in Andhra Pradesh,1996.
21 . R.K. Sampath, Inter-State Inequalities in Income in India, 1951-71, 1977
22 . K.R. G. Nair, opcit., no.5.
23 . V.S. Singh, Giving a Fresh Look at development of backward Area, 1986.
24 . A. Tiwari, Regional Disparities and Agricultural Development: A Study of Uttar Pradesh, 1985.

disparities in economic development in India and abroad. Important and recent empirical studies have been reviewed here. The review of these studies provide broad spectrum about inter-regional and intra-regional disparities in economic development.

Rao[25] estimated the regional disparities in India, selecting six indicators of the three sectors of the economy and adopting the method used by Richard Stone in building up regional economic distances for U.K. In this method each region can be represented by point and the distance between any two points represents the distance in development. Rao classified the major states into three categories: (a) 'Most Developed' group having distances range upto 1.5 points; three states viz. West Bengal, Maharastra and Gujrat came in this category, (b) 'Not So Developed' group having distance range 1.5 to 3.0 points; Tamil Nadu, Karnataka and Punjab came in this category, (c) 'Least Developed' group having distance range of 3.0 to 4.5; the rest of the 14 states came in this category. The study proved that development during the first 15 years of planning in India did not lead to reduction in regional disparities and states experienced no significant change in their status of development as groups.

Verma[26] made an attempt to estimate the regional development levels in Bangladesh by applying Component Analysis, developed by Pearson and Hotelling, selecting 17 indicators covering all aspects of the economy. He classified all the districts of Bangladesh into four level of development viz. first, second, third and fourth level of development. He found that the districts of Bangladesh were characterized by wide disparities with the maximum value of index 15.45 and the minimum value 3.81 while the average index value was 7.03.

Pandit[27] attempted to analyse the regional differences in growth performance of industrial income by using the 'Index of Industrial Growth" (computed by multiplying growth rate and ratio of industrial income to total income of the states.) The study covered 17 majors' states during 1960-69, which was further divided into two periods –period-I (upto 1964-65) and period-II (after 1964-65). The study reported that the states like Tamil Nadu, Punjab, Haryana and Karnakata were relatively better than others in industrial growth performance. The study introduces two effects - Regional Effect (difference in sub-sector growth rate of

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[25] . S.K. Rao, A Note on Measuring Economic Distances Between Regions in India, 1973.
[26] . P.C.Varma, Measurement of Regional Development Levels in Bangladesh, 1974
[27] . M.L.Pandit, Growth of Industrial Income in the States: 1960-69, 1974.

each state and the country) and Compositional Effect (difference in industrial mix between each state and the country). The study concluded that the correlation between 'Regional Effect' and state's industrial growth rates showed a positive and strong relationship (r=0.61 and r=0.82) while no relation emerged between 'Compositional Effect' and state's growth rates as co-efficient of correlation was non-significant during the period 1960-69 and also at sub-periods 1960-65 and 1965-69. These results imply that the higher the industrial growth rates of states, more are the chances of disparities. Secondly, the study revealed that index of industrial growth and the industrial base position have no strong relationship in states of India, e.g. Tamil Nadu, Punjab and Haryana did not have much industrial base as compared to most of the states put under the category of least industrialized states.

Rao[28] prepared Composite Index of Development using Factor Analysis and Rotated Matrix Analysis and identified the backward states of India. She selected 24 variables from specific sectors like Agriculture, Industry, Education and Banking in her study, covering 15 major states of India for the period 1955-56 to 1965-66. The study showed that the co-efficient of variation of overall CID of states declined from 19.70% to 13.75% indicating general decline in absolute differentials between states. This decline in degree of disparities was not shared by all sectors, while industrial and banking sectors moved in favourable directions, agriculture and education sectors moved in opposite direction.

Sampath[29] examined the extent and pattern of the inter-state inequalities during 1951-71, with the help of weighted and unweighted coefficients of variations worked out for regional net domestic income, regional sectoral income and regional per capita income. He selected 15 major states of India and classified these into three categories on the basis of state's per capita income - Above Average States, Average States and Below Average States. Secondly, throughout the period 1951-71, non-agricultural sector did not contribute significantly to increase in inter-state inequalities particularly during 1961-71. Thirdly, there was positive correlation between regions' per capita industrial income and the degree of intra-state (inter-district) inequalities in per capita income. Fourthly, both weighted and unweighted indices showed that the overall inequality declined considerably in early fifties, more or less

[28] . Hemlata. Rao, Identification of Backward Regions and the Trend in Regional Disparities in India, 1977.
[29]. R.K.Sampath, op. cit., no. 21.

remained constant upto early sixties but during the period 1964-65 to 1970-71, the overall index of inequalities increased.

Prakesh[30] attempted to analyse the regional inequalities in terms of infrastructure facilities in India during 1951-71 with the objective to determine the extent of the exiting inequalities and identify the lagging regions. He selected important indicators like population size and density, literacy rates, urbanization, power, irrigation, banking, communication, transport, industrial and agriculture implements in the study. He concluded that there is no region/state in India, which was equally developed or underdeveloped in all the fields of infrastructure.

Kulkarni[31] attempted to examine the development level of micro-economic regions (tehsil as unit) of Rajasthan with the objectives to bring forth the intra-district disparities to limelight. On the basis of Composite Index of Development the micro-regions were classified into three broad categories. Only eleven tehsils out of 196 were marked as 'developed', 69 as 'less developed' and 116 as 'under developed'.

Tewari[32] attempted to analyse the regional disparities in overall development in Uttar Pradesh during 1971 selecting thirty-eight indicators - 14 resources based indicators, five institutional structure indicators and 19 economic development indicators. The technique of Cluster Analysis was applied to identify the planning regions. All the districts of Uttar Pradesh were classified into eight clusters on resource base and nine clusters on the basis of institutional structure as well as on the basis of level of development. For planning, all the districts were divided into 14 clusters. The study concluded that the structural approach to planning has resulted in lags between development and the utilization of resources and capacity, widening of inter-regional disparities in the level of development and heterogeneity in social structure of Uttar Pradesh during the period of planned development.

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30 . S. Prakesh, Regional Inequalities and Economic Development with Special Reference to Infrastructural facilities in India, 1977.
31 . K.M. Kulkarni, Micro-Regional variations in Economic Development of Rajasthan, 1977.
32 . A. Tiwari, op. cit., no. 24.

Chippa and Sagar[33] studied the regional differentials with respect to banking development by applying Factor Analysis, for the year 1977, selecting 11 banking development indicators. On the basis of Factor Analysis results, they classified states as Highly Developed, Moderate Developed, Low Developed and Very Low Developed. Index value of highly developed group comprising Kerala, Punjab, Maharastra and West Bengal. While the very low developed group comprising Rajasthan, Assam, Madhya Pradesh and Orissa. They observed that the literacy rate has emerged as the most dominant variable influencing the level of banking development in all states in India.

Iyenger and Sudarshan[34] examined the intra-state disparities adopting the method proposed by Morris and liser (1977) and used by Mukherjee (1980) to measure the level of development. They analysed inter-district variations in development in the districts of Andhra Pradesh for the period 1978-79 and Karnataka for the period 1980-81 on the basis of 21 important indicators of development by constructing index of level of development. By using continuous Beta Distribution they classified districts of both states into five clusters according to their level of developments-Highly Developed, Developed, Developing, Backward and Very Backward regions.

Nair[35] attempted to test the "Concentration Cycle Hypothesis" which states that inter-regional disparities increase initially but narrow down in latter stages of development. Thus inter-regional inequalities trace out an inverted U-shaped curve over the period. The states were ranked in terms of per capita net domestic product. Punjab occupied the first rank during the period while Bihar remained at the bottom. States such as Punjab, Haryana, Mahanrastra and Gujrat were at the top four positions while Bihar, Uttar Pradesh, Madhya Pradesh and Orissa occupied bottom places.

Suar[36] examined the regional disparities in economic development in Orissa for the year 1977, selecting twenty indicators of development. Principal Component Analysis, commonly called Factor Analysis, (rotated and unrotated) was used to identify factors responsible for

[33] . Chippa and Sagar, Banking Development in India: A Study into the Causes of Regional Differentials, 1981.
[34]. Iyenger and Sudarshan, A Method of Classifying Regions from Multivariate Data, 1982.
[35] . K.R.G. Nair, op. cit., no. 22.
[36] . D. Suar, Development Indicator Identification and Regional Disparity in Orissa, 1984.

inter-district variations in economic development in Orissa. The results of the study showed that 'three factors' derived from twenty variables taken together explained 78.81 percent of total variations. First factors, termed as education and infrastructure, explained 44.64 percent, while second factor (urbanization) and third factor (agriculture and rural development) explained 22.38 per cent and 11.78 percent of variations respectively. Furthermore, the districts were divided into three broad categories based on 'standardised factor scores that varied from –3 S.D. to +3 S.D. The districts having factor score between +1 S.D. and +3 S.D. were referred as developed. Those falling on the other extreme i.e. negative side of the continuum having factor score between –1 S.D and –3 S.D. were designed as under developed regions where as districts falling in-between i.e. within –1 S.D. and + 1 S.D. were considered neutral regions. The study revealed that development concentrated in certain pockets of the state. The regions (districts) having favourable agro-climatic conditions, fertile land and infrastructure were relatively developed.

Singh[37] examined the trends in inter-state disparities amongst 17 major states during 1951-81 on the basis of net state domestic product at constant prices. The study revealed that all the selected states registered steady increase in total state domestic product but the increase in per capita terms was generally low except in a few states like Punjab, Haryana and Maharastra. On the basis of annual growth rates, the 17 states have been grouped into four categories: (a) Very High Growth: Punjab, Haryana and Mahanrastra, (b) High Growth: Jammu & Kashmir, Assam, Karnataka, Gujrat and Kerala, (c) Low Growth: Orissa, Andhara Pradesh, Rajasthan, Tamil Nadu, and (d) Very Low Growth: Uttar Pradesh, Bihar, West Bengal and Madhya Pradesh. The study showed a positive association in the level of per capita income and growth rates, as a result of which inter-state income disparities have tended to widen during the period 1961-81.

Gupta[38] attempted to examine the industrial disparities amongst 17 major states in India during 1961-81 on the basis of four core indicators of industrial development relating to manufacturing sector - value of output, value-added, person employed and total productive capital employed. Hirschman Herfindalh (H.H.) Index and Theil's Index were computed to

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[37]. A.K.Singh, Trend in Regional Disparities, 1984.
[38]. D. Gupta, Inter-State Industrial Disparities in India: The Changing scene, 1985.

measure the regional concentration. Williamson's unweighted and weighted coefficients of variation were used to measure the disparities among the states. In order to examine the locational patterns of industries among the states over the period Magnitude Rating (MR) and Increasing Rating (IR) were calculated.

Desai[39] analysed the process of industrial diversification of 23 Indian states over two points of time, 1964 and 1980-81, by calculating coefficients of specialisation whose value varied between zero and one. The study revealed that the states like Andhra Pradesh, Orissa, Himachal Pradesh, Tripura, Goa and Daman & Diu reported decrease in the value of coefficient of specialization over time. This implied that these five states showed the tendency of industrial diversification. Three states, namely, Bihar, Kerala and Andaman & Nicobar reported no significant change in their respective value of coefficient of specialization over time while other 15 states out of 23 states showed the tendency toward specialization of industries, indicating lack of diversification of industries.

Kannan[40] has attempted to estimate the inter-regional disparities in banking development amongst the major 17 states in India for the period 1969-84. Index of banking development was constructed with the help of Factor Analysis technique for the selected 17 states. The study revealed that there was no significant variation in the ranking pattern of states. The coefficient of variation of banking development index reduced from 56% in 1975 to 35% in 1984. This view was further supported by 'Distance Analysis'. The states were grouped into five clusters. The credit –deposit ratio of rural branches improved by 11 per cent during the period. This could be responsible for the decline in the variations of inter-state banking development index during this period.

Singh[41] made an attempt to analyse the inter-sectoral relation, sectoral growth and structural transformation in the Indian and global perspective for the period 1949-50 to 1985-86 (which was divided into pre-Green Revolution period and post-Green Revolution period) and Two-stage Least Squares (2-SLS). The study revealed that apart from increase in agriculture – industry inter-dependence in the post-Green Revolution period, there were substantial inter-

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39. R. Desai, The Changing Pattern of Regional Industrial Diversification: A Comparison Over Time, 1986.
40. R. Kannan, Banking Development and Regional Disparities, 1987.
41. Sudama Singh, Measuring the Levels of Development-A Taxonomic Approach, 1988.

temporal and intra-sectoral growth differentials. There was significant substitution of not only primary sector by both industrial and services sector but also of industrial sector by the services sector. The rate of substitution of primary sector by the services sector was higher than that of primary sector by the industrial sector. At the global level, there were substantial inter-temporal and inter-sectoral disparities in the sectoral growth rates, structure of Gross Domestic Product (GDP) and employment.

Dadabhavi[42] conducted a study on inter-state disparities in India based on the cross-section data for 16 major states for the years 1960-61 and 1980-81, by applying simple regional quantitative measures like coefficients of variation, correlation coefficients and shift and share analysis. The study confirmed that Uttar Pradesh, Madhya Pradesh, Orissa, Bihar and Kerala were not only suffering from low per-capita income but also from unfavourable industrial structure and productivity conditions whereas these factors were favourable in Punjab, Maharastra, Gujrat and West Bengal - the high income states. The study reported that inequalities among states have been growing over the period. The study also showed that two factors viz. per worker productivity in agriculture and degree of industrialization have positive and significant association with economic development.

Rao[43] attempted to study the trends in income inequalities and poverty in four Newly Industrialized Countries (NICs) (Hong Kong, South Korea, Singapore and Taiwan) and four Middle Income Countries (MICs) (Indonesia, Malaysia, Philippines and Thailand) of middle Asia during the period 1965-84. The study shows that the average annual growth rate of GNP per capita in the four NICs was higher (6 to 8 per cent) than that of three of the four MICs – Indonesia, Malaysia and Thailand (4 to 5 per cent). Almost all the selected 8 countries experienced a significant increase in the share of industry in GNP.

Sharma[44] examined the inter-state disparities in terms of the nutritional level in all states and union territories in India with particular reference to Assam. An attempt was also made to examine the problem from both the quantitative and qualitative aspects considering seven

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[42] . R.V. Dadibhavi, op. cit., no.17.
[43]. Bhanoji Rao, Income Inequality and Poverty in East Asia Trends and Implications, 1989.
[44]. Archana Sharma, Inter-State Disparities in the Nutritional Level of Living in India with Special Reference to Assam, 1992.

core indicators related to consumer expenditure, data about which were taken from 38th Round of National Sample Survey. The Component Index of Nutrition was constructed for all states by using equal weights. The study revealed that the state like Haryana, Sikkim, Himachal Pradesh, Punjab, Assam and Andaman & Nicobar Islands were the nutritionally richest regions while Orissa, Goa, Daman & Diu, Kerala, Pondicherry among the poorest. The Component Index based on Taxonomy also placed. Haryana at the top position, followed by Himachal Pradesh, Punjab, Rajasthan and Sikkim while Orissa was placed at the bottom of the taxonomic scale. The study showed that even the states with highest nutritional level were far from the ideal value. In brief, India is still at a nutritionally poor level and wide inter-state disparities in the level of nutrition still exit.

Majumdar[45] made an attempt to analyse the inter-state disparities in Per Capita State Domestic Product (PCSDP) for the period 1960-86 to check whether regional disparities were divergent or convergent during this period. The study also introduced price differentials in the Per Capita State Domestic Product series of fourteen major states of India. With the help of coefficients of variation of per capita state domestic product of 14 selected states, the study revealed that inter state income variations were on the increase with fluctuating trend during the period.

Anuradha and Rao[46] analysed inter-state disparities in the level of industrial development over the period 1970-71 to 1985-86. They applied Williamson's unweighted and weighted coefficient of variation and Hirchman Herfindalh (H.H.) Index and Theil index to examine the disparities amongst 15 major states. Both weighted and unweighted coefficients of variation for selected indicators (except per capita productive capital in the factory sector) declined significantly indicating that inter-state disparities in industrial sector declined over time. Hirchman Herfindalh (H.H.) Index and Theil Index also supported the results. All the index values except Theil Index for productive capital declined over time. To examine the locational pattern of industries between the states two measures - Magnitude Rating (MR) and Increasing Rating (IR) were computed. The results of Increasing Rating showed that developed states like Maharastra, Gujrat had highest Increasing Rating (more than unity)

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[45] . K. Majumdar, Inter-State Disparities in Per Capita State Domestic Product in India: 1960-61 to 1985-86, 1993.

[46]. Anuradha and Rao, An Analysis of Inter-State Disparities in India: 1970-71 to 1985-86, 1995.

while the states like Andhra Pradesh, Bihar, Assam, Karnataka, Kerala, Orissa, Madhya Pradesh (except in productive capital), Uttar Pradesh and West Bengal had Increasing Rating values less than unity, indicating higher level industrial activities in the developed states like Maharastra and Gujrat during the period.

Das and Barua[47] examined the pattern of regional inequalities amongst 23 states in India during 1970-92. Net State Domestic Product (NSDP) and its various components-agriculture, primary products, manufacturing, infrastructure and services of selected states were examined by applying Theil Index of inequalities, correlation analysis, Ordinary Least Square (OLS) method. The results of inequality indexes indicated that except in primary products, regional disparities increased over the period 1970-92 in all the sectors of the Indian economy. The relationship between economic growth and inter-regional inequalities was also studied to know what happened to regional disparities in India over the period as economy moved from a very highly restrictive trade regime to gradually liberalized trade. Regression Analysis results proved that agriculture, services and unregistered manufacturing sectors were significant contributors of inter-regional income inequalities in India during 1970-92.

Rana[48] analysed the inter-state disparities on the basis of large number of social, economic and infrastructural factors during the period 1971-95. Coefficient of Variation figures worked out for selected indicators revealed that inter-state disparities widened in terms of economic indicators and the disparities reduced in social and infrastructural sectors over time. The study found that the pattern of development of Indian economy was not unison with respect to all the indicators rather it was of mixed nature. Some of the Indian states were found economically advanced and some were socially more developed. The state of Punjab had real per capita income much higher than that of Kerala but the standard of living in Kerala was far better than that of Punjab as revealed from the values of Physical Quality of Life Index (PQLI).

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[47]. S. Das and Barua, Regional Inequalities, Economic Growth and Liberalisation: A Study of the Indian Economy, 1996.
[48]. R.K. Rana, A Study of Inter-State Disparities and Pattern of Development in India, 1997.

Economic development of any country is the aggregate contribution of the different sectors. In most of the developing countries, including in India, agriculture plays a dominant role and contributes greatly to the overall economic growth. In such economy, it produces multiplier effect as well as spread effect thereby leading to a higher rate of economic growth in all the sectors of the economy. As such, the degree of agricultural development determines greatly the rate of growth of an economy.[49] On the other hand, if agriculture lags, it inhibits the pace of economic development and thereby the level of prosperity and well-being in the economy.

Agriculture contributes to economic development in a number of ways, some of which are :

(i) increased food supply[50]
(ii) marketable surplus for agricultural exports,
(iii) additional capital formation, and
(iv) additional purchasing power as a result of an increasing level of income,[51]

The role of agriculture is sometimes misunderstood. Mercantilism and physiocracy have long since ceased to enjoy respectability among social scientists but their tenants live on in the minds of millions of layman with consequent effects on public policy.[52] While Kuznets[53] claims that an agricultural revolution is a pre-condition of the industrial revolution for many sizeable regions in the world. Rostow[54], finds agricultural development as a pre-condition of economic development. To him a good part of capital should come from agriculture, if modernisation is to be achieved.

Due to diversity among nations in their physical endowments, cultural heritage and historical context, we cannot provide any universally acceptable definition of the role of agriculture, nevertheless, certain aspects of the role of agriculture appear to have a high degree of generality because of special features that characterize the agricultural sector during the course of development. There is no example of industrialization and growth in any of the

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[49] T.W. Schultz, Economic Organisation of Agriculture, p.7.
[50]. C.P. Kindleberger, Economic Development, p. 218.
[51]. B.F. Johnston and F.W.Millor, The Role of Agriculture in Economic Development, pp. 565-93.
[52] . C.J.Pierce(ed.), Economics for Agriculture: Selected writings of John D. Black, p. 470
[53] . S.Kuznets, Lectures on Economic Growth, p. 63.
[54] . W.W.Rostow, Stages of Economic Growth, p. 83.

major countries of the world, which were not preceded or accompanied by an agricultural transformation.[55] "The economics of development (itself) would be incomplete unless it could explain the emergence of new and better production possibilities in agriculture and the effects of developments from whatever source, upon agriculture."[56]

Agriculture, has played not only an economic role, but also played an important role in the development of economic theories.[57] It has provided the main examples of two important economic 'Laws': the Law of Diminishing Returns and the Engel's Law. Historically, the Law of Diminishing Returns was formulated in the first place on the basis of agricultural experience and it was a necessary part of the Malthusian theory of population. Engel's Law also owes to agriculture for its present importance. Empirical studies support that as per capita income raises, the demand for food raises relatively more in low income than in high income economies. There is another line of argument undermining the role of agriculture in economic development. Assuming that economic development occurs in specific location matrix, these location matrices are primarily industrial urban in composition and the existing economic organization works best at or near the center of a particular matrix, it is believed that industrial development is the prime mover in economic growth and that agriculture is a dependent variable in the overall pattern of industrial-urban growth.[58] The industrial development is also considered to be important for accelerating the rate of agricultural progress.

The growing importance of agriculture and the consequent concern to establish its indispensability has resulted in a vast amount of literature tracing back. Both the physiocrats and the Classicalists held that the economic surplus (net product) generated in the agricultural sector determines the rate and extent of economic development achievable by an economy. The intellectual transition from the Classicalists right down to the Modern school does not, however, endeavour to ignore the agricultural sector. In the intermediate period, however, the neo-Classicalists were almost exclusively interested in problems like the criteria of efficient allocation of resources, distribution of national income etc. The modern school,

[55] . R.M. Hartwell, In the foreward of the book, Agriculture and Industrial Revolution.
[56] . T.W.Schultz, The Economic Organisation of Agriculture, p.3
[57]. R.M.Hartwell, op.cit.
[58] . D.C.North, Agriculture in Regional Economic Growth, p 69.

represented by Fei and Ranis[59] established the role of agriculture in far broader terms than one of releasing the supply labour from the agricultural sector. This will generate an economic surplus of saving or capital, which can be re-invested for further agricultural development. The Fei-Ranis model was further developed by W.Jogerson[60] who held that Fei-Ranis model will operate only if we ensure that the process of withdrawing the excess labour from the agricultural sector. The sectoral contribution of agriculture towards the economic development of an economy was further enriched by the theoretical arguments put forward by Adelman and Morris[61] and Hayami and Ruttan[62].

The importance of agriculture in national economic development has not only been theoretically established but also empirically founded when we look into the history of development of a number of countries of the world as well as a number of states of our country. We find that it is agriculture that played the pivotal role in initiating and sustaining the process of economic growth in those economics.

1.2 The Problem

Agriculture occupies an important place in the economic life of Assam as it provides the key to economic growth. Assam has an area of 78, 520 square km, of which 63, 300 square km. are plains and 15, 220 square km. hills. The state is predominantly agricultural oriented and majority of the rural people depends on agriculture for their livelihood. The share of this sector in the State Domestic Product (SDP) of Assam at constant prices is about 35 percent in 1995-96. With about 89 percent of the state population living in rural areas and 69 percent of the total working force being engaged in agriculture and allied activities as per 1991 census, agriculture sectors contribution is immense in the states economy. Out of the total working population, 56 percent are cultivators and 13 percent are agricultural labourers in Assam as against 43 percent and 26 percent respectively in the country as a whole.[63] These facts make it clear that the economy of Assam is primarily an agriculture based rural economy and its development heavily lies on the growth of agriculture. As such, a very high priority has to be

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[59] . C.H. Fei and G. Ranis, A Theory of Economic Development, 1961.
[60]. D.W. Jorgenson, The Development of a Dual Economy, 1961.
[61]. I. Adelman and C.T. Morris, An Econometric model of Socio-Economic and Political Change in Underveloped Countries, 1968.
[62]. Y. Hayami and V.W. Ruttan, Agricultural Productivity Differences among countries, 1970.
[63] . Census of India, 1991.

accorded to the programme of agricultural development including minor irrigation and land development in the state's five year plans with a view to accelerating the tempo of economic development in the state.

Examining thus from different angles, we can safely hold the view that for the initiation as well as the sustenance of its economic growth process in the early stages of development, Assam too needs a sound agricultural sector. Although in keeping with the national trend, the sectoral share of agriculture in the SDP of the state has been declining over the years, the primacy of the agrarian sector has been more or less stable when viewed in terms of its support base for the vast rural populace. Agriculture can still provide Assam with a "bargain sector" – a sector with large unexploited potential, which can produce the requisite surplus with relatively low investment in a comparatively short time period. Truly, Agriculture is the sine-qua-non for the economic emancipation of the state of Assam.

A study of agricultural development in Assam assumes significance because of numerous reasons. Agriculture in Assam has remained stagnant even after the implementation of several plan programmes with a bias for agriculture. The programme implemented by the State, so far, has not indicated a strategy for agricultural development of Assam. As such, the programmes of agricultural development have remained as a bunch of schemes without proper co-ordination and force to trigger the process of agricultural development. In this context evolving a strategy for agricultural development incorporating guidelines for selection of schemes, technical choices, timings and sequences of investment, are worth undertaking. Frequent occurrence of floods in the state has made agricultural development of the state an urgent humanitarian problem also. The poor development of agriculture in the state and consequent lack of adequate employment opportunities in the agriculture sector have led to the exodus of agricultural labourers. This in turn has severely affected agricultural development in the state. Agriculture development being a pre-requisite for the economic development in the state, a proper strategy is called forth to boost up agricultural development in the State.

The overall agricultural development in Assam conceals considerable regional differences because of farming practices, availability of irrigational facilities, attitude of farmer etc. in different parts of the state. Regional disparities in agricultural development show that there are scopes to boost up the pace of agricultural production and thereby that of economic development in the state with area specific agricultural development programme and policies. The poor economy of Assam cannot afford to contend with low rate of agricultural yields in view of heavy pressure of population on agriculture. In Assam, only 49.38 percent of the total geographical area is under cultivation. Apart from it, about 44 percent of the total holdings in the state is of less than 2 hectares. Out of the total land holdings, 6.50 percent are of less than 0.5 hectares. Holdings of the size of 0.5 to 1 hectare constitute 12.44 percent and holdings of the size of 1 to 2 hectares constitute 24.45 percent of the total holdings. There is obviously high degree of inequality in the distribution of land in the State. Small and marginal holdings constitute most of the operated area. It is, therefore, imperative that the available land is utilized to the maximum and optimum extent so that the economy of Assam moves ahead at faster rate and there comes solution to problems of hunger, malnutrition, mass unemployment and underemployment, inequality, etc Assam is confronted with.

The low growth rate of agriculture despite high importance accorded to it shows that specific characteristics of different areas of the state have not been taken into account while formulating agricultural policies and programmes. Development of agriculture accentuates development of other sectors of the economy, resulting in overall development. Agriculture also provides highest rate of employment, which is getting serious attention in view of increasing volume of unemployment and under-employment. As most of the people thrive on agriculture and fruits of agricultural development would help ease out social tension our society is so badly faced with. This calls for maximum utilization of resources necessary for agricultural development. Different areas of the economy are not evenly endowed with such resources. There is, therefore, need to have agricultural development programmes and policies specific to resource endowments, potentials, requirements and constraints of different areas and regions. A critical analysis of variations in agricultural development pinpointing factors and constraints responsible for such variations would help policy-makers adopt area specific agricultural development strategy so as to secure regional balance in agricultural development and boost up the pace of agricultural and economic development in the state.

But apart from the task of injecting the growth stimulant into the artery of the agrarian sector of the economy of Assam, there are two major problems that confront its agricultural sector: First, the wide-spread inter-regional (spatial) disparity in agricultural production per unit of one individual input or all inputs taken together and

Secondly, an erratic temporal variation in the level of agricultural production between the regions. Such a twin phenomenon of spatio-temporal variation in the level of agricultural development unfortunately does not permit Assam, the core of North-East India to be a party to the brilliant national feat of achieving self-sufficiency in agricultural production. Such a twin phenomenon has constrained Assam to develop and gave a better experience of how poverty could co-exit with plenty. The present study is only a humble attempt to examine the nature and extent of this twin phenomenon.

Spatial (regional) disparity has been a historical fact since the dawn of planned economic development. Before making an enquiry into this phenomenon, it is essential that one draw the distinction between diversity and disparity. Differences in initial resource endownments, largely of a natural and/or physiographic character, leading to territorial specialization and division of labour through exploitation of the resource advantages - comparative as well as absolute - constitute the basis and substance of inter-regional "diversity" which is a concomitant of development. Inter-regional (spatial) disparity, on the other hand, denotes the failure of a region to exploit the development potential of its initial resource endownments, its latent comparative and absolute resource advantages, relative to another comparable region and is, therefore, comprised of the factors which are not natural or physiographic, but human, institutional, historical, socio-political and/or economic, and technological. Consequently, the former is neither the basis nor the cause of the latter. Essentially, spatial disparity is the consequence of:

(i) strong backwash effects and weak spread effects (i.e. Myrdal Effect, 1964)
(ii) relative failure of a region to convert the initial resource endownments into economic resources, i.e. capital resources, and
(iii) ill-conceived public investment programme effected under an imprudent governmental rule.

Temporal variation in the level of agricultural production, on the other hand, reflects the annual fluctuation in the level of agricultural production. The incidence of such year to year fluctuation and its extent varying from region to region is much higher in agricultural sector and such temporal variation is generally attributed to the natural factors like rainfall, flood etc.

Such a twin phenomenon of spatio-temporal variation in the level of agricultural production has been named as “spatio-temporal dynamism”. It is classified as dynamical and stochastical. It is called dynamical because it dates the variables and regards it as stochastical as it takes care of random happenings.

1.3 Scope

From the foregoing discussion, it becomes apparent that there is wide variation in the level of agricultural development both spatially as well as temporally. Now the question is what are causes of this variation. The present study assumes that there are three sources that cause variation in the level of agricultural development. These sources are:

(i) input effect;
(ii) spatial effect; and
(iii) temporal effect

The input effect can be studied either at a point of time using cross-sectional data or over a period of time using cross-sectional and time-series data. A region specific spatial differences in the level of agricultural production can be examined either at a point of time, using the Principal Component Analysis or over a period of time using cross-section and time-series data with a production function analysis. Temporal effect studies the variation of the output level varying from region to region and year to year. Such temporal variation can be studied only over a time period using cross-section and time-series data under a production function.

1.4 Objectives

On the basis of the above background, this study revolves around the following broad objectives:

(v) to examine the inter-regional disparity in agricultural development over a period of time and to identify the backward regions.

(vi) to study the degree and cause of regional disparity in agricultural development in Assam at a point of time.

(vii) to enquire into the spatial dynamism in the level of agricultural production in Assam over a period of time using cross-section and time series data. and

(viii) to investigate into the temporal variation in the level of agricultural production in Assam using cross-section and time-series data.

1.5 Hypotheses

The objectives stated above and literature available on this subject lead to the following hypothesis:

(i) there exist spatial-temporal variation in the agricultural development in Assam,

(ii) there is considerable degree of imbalance in the agricultural development in Assam and

(iii) the imbalance in the agricultural development is mainly natural factors, not man-made factors.

1.6 Geographical Coverage

The study is envisaged to the Assam State. The enquiry relates to 23 districts of Assam. Agricultural production is taken as indicator of agricultural development in Assam. Only food grains production, which consists of rice, pulses, maize, wheat and other cereals, is considered in the present study.

1.7 Reference Period

The district-wise related data are taken as reference period from 1990-91 to 1998-99. For Agro-Climatic regions, the district-wise data have been clubbed together. The required data of all 23 districts of Assam were collected from the following sources for the period from 1990-91 to1998-99.

(i) The Directorate of Economics and Statistics, Assam
(ii) The Directorate of Agriculture, Assam and
(iii) The Chief Engineer, Irrigation, Assam.

1.8 Methodology

The following methodological sequences have been followed in the present study:

(i) making an inventory into the aggregate picture of agricultural development of Assam.

(ii) an attempt has been made to delineate agricultural regions in Assam according to agricultural development taken place in different districts. Principal Component Analysis (PCA), one of the regionalisation approaches has been used. This also helps us to examine inter-regional (spatial) disparity in agricultural development of Assam over a period of time and to identify the backward regions.

(iii) to study the degree and cause of regional disparity in agricultural development in Assam at a point of time, various tools like balance ratio, index of regional imbalances, index of intra-regional imbalance and co-efficient of regional imbalance has been used and

(iv) investigating into the spatio-temporal dynamism in the level of agricultural development over a period of time with the help of cross-sectional and time-series data, using error-component model (also known as residual model).

1.9 An Outline of the Work

The present study has been organized in the following chapters.

(i) Chapter 1 provides an introduction to the study elaborating the problem, review of literature, objectives and justification of the study, its scope, geographical area, reference period and methodology.

(ii) Chapter 2 deals with the concept of "region", examine various theories and models of regional development propounded by eminent economists. Different methods made earlier measuring the regional disparities has also been discussed after making a comprehensive review of literature in this chapter. It explains also agricultural regions of Assam.

(iii) Chapter 3 examines the various econometric methods used in the analysis and determines the estimation procedure thereof.

(iv) Chapter 4 outlines the details of the trend and pattern of agricultural development in Assam vis-à-vis that in India.

(v) Chapter 5 goes in to the explanation of how an economy can be sub-divided into a system of regions based on development criteria. Disparities have been examined both at macro and micro-levels. This chapter also diagnoses the factors responsible for regional disparities in the agricultural development in Assam.

(vi) Chapter 6 deals with the regionalisation of the State and investigates into the spatial effect (spatial dynamism) on the level of agricultural production over a period of time and enquires into the temporal effect (temporal dynamism) on the level of agricultural production.

(vii) Chapter 7 discusses about the findings of the present study. This chapter also suggests a number of measures incorporating a suitable strategy for reducing regional disparities and for securing balanced regional development of agriculture in Assam. The study winds up the with an epilogue on regional development and broader conclusions of the study.

Chapter 2

The Region, Regional Development Theories and Methods of Measuring Regional Disparities

2.1 The Concept of Region

A region can be defined in various ways. The region is sometimes a group of nations, sometimes a state, sometimes a district, sometimes a block and sometimes even a village. The ambiguity surrounding the term ‘region’ is so much that there is no unique definition of ‘region’. It is difficult to define scientifically the ‘region’ so long as we consider it as something of space[64] and for most geographers region is linked with and defined in terms of space.

2.1.1 There are thus numerous definitions of a region. According to Fisher[65] and West[66] these definitions can be classified broadly in two groups viz., (i) Subjective definition and (ii) Objective definition. The subjective definition tries to identify the essence of a region in terms of subjective characteristics such as home, immediate neighbourhoods and other places within which a person operates. Here region is taken as an idea by accepting the nation as a one point economy, and arbitrarily dividing it into as many sub-divisions as the need be, independent of consideration of space[67]

An objectives definition tries to identify a region in its separate entity independent of the individuals that comprise it. An objective definition is done in terms of collectivities, viewed from various angles, e.g. political, geographical, economic, potential, developmental and so on. The subjective regions are generally subsumed within the objective region as according to Fisher each individual is constantly trying to adjust his subjective region to the objective region.

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64 . S.Groenman, Growth Poles and Regional Policies, p. 103.
65 . J.L Fisher, Regional Planning Challenge and Prospects, pp. 7-8.
66 . E.G.West, Regional Planning: Facts and Fallacy, pp. 34-35.
67 . M.Chand and V.K.Puri, Regional Planning in India, p. 1.

2.1.2 'Region', 'Area' and 'Space' these three words often create confusion while using them interchangeably. An 'Area' is always associated with at least four properties, viz. scale, location, content and boundary. It may or may not possess homogeneity or uniformity as to content and organization. 'Regions', on the other hand, are those types of areas which possess not only scale, location, content and territorial boundaries but also either homogeneity or organization or elements of both[68]. "in using the special word 'region' rather than simply 'area' even the layman implies that the area called by that word stands out in his mind as being in some way distinct"[69]. Again contrary to 'area', 'space' is unbounded. Space by definition involves a three dimensional boundless void. Space has no structure or organization. It is only a setting within which objects can be located.

2.1.3 Because of diversity in these theoretical considerations the system of regional delimitation has become very confusing. Richardson has classified the existing methods of delimiting a region, into three broad categories; homogeneity, nodality and programming[70]. According to him an homogeneous region is homogeneous in respect to certain factors, e.g. dominant industry, specialized function, per capita income level, employment level, language etc. In nodal concept each region has one or more cities or dominant nodes. Programming regions are also known as planning or political administrative region and are defined by law and state policy instruments. Distinguishing homogeneity, nodality and programming, Meyer[71] states, "The first stresses homogeneity with reference to someone or combination of physical, economic, social or other characteristics; the second emphasis the so called nodality or polarization, usually around central urban place; and the third is programming or policy-oriented concerned mainly with administrative coherence or identity between the area being studied and available political institutions for effectuating policy decisions." Meyer does not find these three policy categories mutually exclusive when he says " a so called programme or policy region is essentially homogeneous in being entirely under the jurisdiction of some one or few specific Government or administrative agencies; and a nodal region is

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68. N.S. Ginsburg, Area, Regions and Human Organisation, p. 9.
69 . R. Hortshorne, Perspective on the Nature of Geography, p. 131.
70. H.W.Richardson, Regional Growth Theory, p. 6.
71. J.R. Meyer, Regional Economics: A survey, p. 23.

homogeneous in that it combines areas dependent in some trade or functional sense or a specific center"[72].

2.1.4 The definition given by Malgavkar and Ghiara clearly emphasize on the factors of homogeneity, nodality and administrative convenience for a planning region. According to them "Geographically, it should be a contiguous unit though it could be sub-divided into plain, hilly track, coastal belt, lake area etc."

- The people of the region should have social and cultural cohesiveness.
- The region should be separate unit for data collection and analysis.
- The region should have an economic existence, which can be assessed from statistical records.
- It should be small enough to ensure local people's participation in its development.
- It should be under one administrative agency.
- It should not be too small; its geographical size should be big enough to export resources and avoid duplication (by way of partially used capacity in neighbouring region).
- It should have one or more growth points.
- There should be common appreciation of local problems and common aspiration and approaches to their solution.
- It should permit and encourage competition but not rivalry or apathy between the area and the other[73].

2.2 Inter-Regional Disparity and Development Process

Economic development has not been uniformly distributed either over space or time[74]. The fact that all the regions have not developed equally, has been partly due to the lack of resources, and partly also to the tendency to locate new investment in the 'easy' areas or in

[72]. Ibid
[73]. P.D. Malgavkar and B.M. Ghaira, Regional Development: Where and How, p. 306.
[74] . P.Baran, On the Political Economy of Backwardness: Economics of Underdevelopment, p. 75

areas which could generate some pressure on the decision-makers[75]. Certain countries and regions grow almost exponentially owing to the industrial sector working as the kingpin of the dynamic process of growth. Thus the processes of regional disparity get accentuated with the economic progress.

2.2.1 Balanced regional development does not mean equalization of the entire region. Even the rich countries like USA, UK, France etc. are not free from this problem. The important thing is not that every type of industry or agricultural operation should be developed in every region, but that the level of investment per capita, and more particularly, the level of real income per capita should be made as nearly equal as possible in all areas[76].

2.2.2 The more fundamental target is to reduce inter-personal disparities, but one can not reach that target unless inter-regional disparities are reduced[77] The regional imbalances usually results in under-utilization or even non-utilization of natural and human resources. As a result, gap between lagging region and developed region goes on widening and this may generate the tension, which may inhibit the very process of development.[78]

2.2.3 The reasons for these disparities may be stated to be three[79]:

(i) historical growth based on natural advantages,
(ii) non-uniform distribution of natural resources,
(iii) high concentration of resources.

Creation of a number of favoured pockets or enclaves of development may be attributed to the historical coincidence. The power of attraction today of a center has its own origin mainly in the historical accident that something was once started and that the start met with success. Thereafter, the ever-increasing internal and external economics interpreted in the widest

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[75] . B.Dutta, Regional Balance in Economic Development in Balanced Regional Development, in T.B.lahiri (ed.) Balanced Regional Development, p. 20.
[76] . S.K.Mandal, Regional Disparities and Imbalances in India's Planned Economic Development, p. 86.
[77]. B.Dutta, op. cit . No.12. p. 20.
[78]. I.Gandhi, in her address to the National Development Council in April, 1969.
[79]. C.S.Chandrasekhar, Balanced Regional Developments Problem and Prospects, in T.B.Lahiri (ed.) op. cit. n.12. p. 40.

sense of the word fortified and sustained their continuous growth at the expense of other localities and regions where instead relative stagnation or regression or negression became pattern[80].

2.2.4 According to Williamson[81], the inter-regional imbalances thus created and sustained, to yield a high level of equilibrium instead of a low level of stagnation without imbalances, diminishes. Williamson supported Hirschman who challenged Myrdal's hypothesis. According to Hirchman, " Myrdal's analysis strikes me as excessively dismal." In the first place, he fails to recognize that the emergence of growing points and therefore of difference in development between regions is inevitable and is a condition of further growth anywhere. Secondly, his pre-occupation with the mechanism of cumulative causation hides from him, the emergence of the strong forces making for a turning point once the movement towards North-South Polarisation within a country has proceeded for sometime[82]. So according to these economists the regional disparity may be there in the early stage of development but they will ultimately diminish and it is better to have regional balance at a high level obtained after a long period of regional imbalances than regional balance at a low level.

2.3 Theories Explaining Difference in Regional Growth

The history of regional economics has been marked by a wide variety of contributions to the analysis of inter-regional welfare discrepancies. There is a whole set of theories for the explanation of difference in regional growth, measured in income, employment or production[83]. Some of the important theories of regional growth are critically discussed briefly here.

2.3.1 Neo-Classical Models

Neo-Classical models have dominated the regional growth theory as much as they have dominated growth theory in general. The name of R.M.Solow[84], T.W.Swan[85] and J.E

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[80]. G.Myrdal, Economic Theory and Underdeveloped Regions, pp. 38-39.

[81]. C.R.Pathak, A.Aziz and R.N.Chattopadhyay, Identification of Planning Areas in the Three State Regions-Bihar, Orrisa and West Bengal. pp. 64-65.

[82]. A.O.Hirchman quoted by Williamson, ibid., p. 106.

[83]. H.Amstrong and J.Taylor, Regional Economic Policy and its Analysis.

[84]. R.M.Solow, A Contribution to the Theory of Economic Growth.

Meade[86] are associated with the neo classical growth theory. Although this theory has been advocated as a model of regional growth, it is difficult to justify its usefulness at regional level. The background assumptions of neo-classical growth theory are inapplicable to the regional economy. The full employment assumption is not usually relevant to regional economics since regional problems emerge because of substantial inter-regional differences in the degree of resources utilization, particularly labour. So if the neo-classical models were adopted in their pure unadulterated form, there would be no such field as regional economics.

A regional neo classical model might take the following form as described by Richardson[87]

$$y_i = a_i k_i + (1-a_i)l_i + t_i \quad \text{..........(2.1)}$$

$$k_i = \frac{s_i}{v_i} \mp \sum_j k_{ji} \quad \text{..................(2.2)}$$

$$l_i = n_i \mp \sum_j m_{ji} \quad \text{.................(2.3)}$$

$$k_{ji} = f(R_i - R_j) \quad \text{...............(2.4)}$$

$$m_{ji} = f(W_i - W_j) \quad \text{..............(2.5)}$$

Where y, k, l and t are the growth rates in output, capital, labour and technical progress, a= capital's share in income, s= savings/income ratio, v= capital/output ratio, K_{ji} = annual net flow of capital from region j to region i divided by the capital stock of region i, n=rate of natural increase in population, m_{ji} = annual net flow of migrants from region j to region i divided by the population of region i, R= rate of return on capital, and W=wage. Equation (2.1) is the standard growth equation, and equation (2.2) and (2.3) are definitional stating that the growth of factor inputs is composed of two elements: local inputs and net imported inputs [equation (2.3) assumes that the labour participation rate remains constant]. Equation (2.4) and (2.5) are the critical elements in the model in at least two senses; first, the ability to

85. T.W.Swan, Economic Growth and Capital Accumulation.
86. J.E.Meade, A Neo-Classical Theory of Economic Growth.
87. H.W.Richardson, op. cit. n.7. p. 33

attract inputs from other regions may be the key force that boosts a region's growth rate higher than that of its neighbours; second, these equations represent specific testable hypothesis at the heart of neo classical theory-that capital and labour move in response to differentials in factor returns.

2.3.2 Cumulative Causation Models

In the circular and cumulative causation principles, Myrdal[88] argued that 'the play of forces in the market normally tends to increase, rather than to decrease, the inequalities between regions'. Market forces lead to the clustering of increasing returns activities in certain areas of the economy. Regardless of the initial location advantage (natural resources, transport facility etc), this build-up becomes self-sustaining because of increasing internal and external economics at these centers of agglomeration[89]. There are two kinds of effects: 'spread effect' and 'backwash effect' induced by the prosperous areas, which influence the rate of growth of lagging regions. The spread effect includes market for the primary products of the lagging regions and diffusion of innovation. But these are out weighted by strong backwash effects- particularly by disequilibrating flows of labour, capital, goods and services from the poor regions to rich regions and thus inhibits development and distort the pattern of production in the poor regions. Over and above Myrdal's own arguments, Kaldor has introduced the export base concept and argued that the behaviour of a region's production and exports, depends upon (a) an exogenous factor, i.e. the rate of growth of world demand for the region's product; and (b) an endogenous or quasi-endogenous factor, the movement of 'efficiency wages' in the region relative to other producing regions.

2.3.3 The Growth Pole or Development Pole Theory

The concept of development poles is a recent one in the theories of economics of growth and regional development, and it is still far from being well established. It has nevertheless, together with similar concepts such as growth centers, growth areas, growing points, development nuclei, core area etc. attracted increasing attention in the search for tools to

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[88]. G.Myrdal, op. cit. n. 17. p. 26.
[89]. H.W.Richardson, op. cit n.7 p. 29.

solve problems of imbalance in inter-regional development in industrialized as well as in non-industrialised countries. The theory of development poles as evolved by Perroux (1955) is derived inductively from observations of the actual process of economic development. Based on the observation and subsequent recognition of the fact that 'development does not appear everywhere and all at once it appears in points or development poles with variable intensities; it spreads along diverse channels and has varying terminal effects for the whole of the economy'.

Perroux developed his theory in search of an explanation of how the modern process of economic growth deviates from Cassel's stationary conception of equilibrium growth[90]. In doing so he based his argument heavily on Schumpeter's theories of the role of innovation and large scale firms. According to Perroux, entrepreneurial innovations are the prime causal factors behind economic progress. He argues that most innovating activities take place in the large economic units, which able to dominate their environment in the sense of exercising irreversible and partially reversible influence on other economic units by reason of their dimension, negotiating strength, by the nature of their operations, etc. The close relation between scale of operations, dominance and impulse to innovate appears to be a most significant feature of Perroux's theory, which leads him to the concepts of dynamic firms and leading industries. A dynamic propulsive firm, thus, has a high ability to innovate, generate significant growth impulses to its environment, is relatively large and belongs to a fast growing sector.

Boudeville[91] translated the abstract concept of Perroux's space into a regional and geographic context. The regional growth pole consists of a set of expanding, propulsive and dominant industries and is associated with agglomeration tendencies which are caused by external economies viz., fall in firm's cost of production due to expansion of industry, development of urban labour markets, access to a larger market etc. Growth poles, however, ensure spread effects and are therefore regarded as the most promising hope for regenerating the economy of the backward regions.

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[90]. F. Perroux, Economic Space, Theory and Application.
[91] . J.R. Boudeville, Problems of Regional Economic Planning (Part I), 1966.

The development pole or the growth pole theory does not, however, solve what Hermansen calls the problem of establishing both necessary and sufficient conditions for regional economic growth[92]. It takes for granted that growth at certain poles and external economies thus created would accelerate the process of growth in whole of the region. As is feared by Myrdal that 'spread effects' may be weaker than 'backwash effects'.

2.3.4 Central Place Theories

The theories, which tried to explain the structure of spatial organization, were originally developed by Christaller[93] (1933) and Losch[94] (1940) under the name of Central Place theory. Although they have been further advanced by Beckmann[95], Von Boventer[96] and Berry[97], their basic content has not been altered. Both Christaller and Losch employed a deductive method. Based on the underlying assumption that man tries to organize his activities over geographical space in an efficient manner, they contend that the structure of spatial organization could be deductively derived and explained with reference to a number of ordering principles governing the formation of his structure.

Christaller and Losch started their analysis with very similar and extremely simplified assumptions. They assumed a homogeneous plain with even distribution and quality of agricultural conditions and natural resources. At each point, the population density is equal, and consumer preferences and production techniques for each product are also equal. They based their models on three fundamental factors, namely, the existence of space exploiting activities, transportation costs and scale economies, of which the later two generally differ from product to product. Furthermore, they assumed that each product has a corresponding demand function, which also differs from product to product. Finally, all producers and consumers were assumed to behave rationally. On the basis of their assumptions Christaller and Losch had allowed for the empirically found fact that output per plant and optimum sales areas vary among products. For each product, a hexagonal market area surrounding the

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92. T.Hermanson, Spatial Organisation and Economic Development, Development Studies, No.1. p.73.
93. W.Christaller, Central Places in Southern Germany.
94. A.Losch, The Economics of Location.
95. M.Beckmann, City Hierarchies and the Distribution of City Size.
96. V.E.Boventer, Towards a United Theory of Spatial Economic Structure.
97. B.J.L.Berry, Cities as System Within Systems of Cities.

production site is assumed, because the hexagon is the regular polygon that in a completely filled plain would come closest to a circle, which would be optimal from the point of view of the individual plant. This was first proved by Losch. The problem of spatial organization then becomes the identification of the resulting spatial distribution of plants in production having different (a) transportation costs, (b) demand functions and (c) possibilities of exploiting economics of scale[98]

2.3.5 Theories of Geographical Diffusion of Innovation

Regularities in the geographical pattern and time order of spread of innovation, particularly within rural societies, have been noted for quite a long time in many countries. It was, however, not before Hagerstrand's[99] pioneering work in the first part of 1950's that a theoretical basis was laid for an understanding of how the mechanism of the geographical diffusion of innovation work had given rise to empirical regularities of a strikingly stable nature[100]

The theory developed by T.Hagerstrand is inductive in character, based on careful empirical analysis of the spatial diffusion process with respect to particular innovations, especially agricultural innovations. In this model, the diffusion of innovation is treated as a function of communication so that delimiting the physical and social structure of the communications network provides the key to tracing the spatial spread of innovations. He also showed how the spatial diffusion process could be simulated by various types of Monte Carlo simulation models[101]

Since the diffusion of innovations is a key process of development, much attention has to be given to the formulation of propagation strategies. The most obvious cases are the various types of extension services in agriculture, small industries, health etc. Hagerstrand suggests that induced innovations should be initially concentrated utilizing the existing system of communication linkages. Instead of trying to enforce the other patterns of diffusion, efforts

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[98]. T.Hermansen, op. cit n.29. p. 31.
[99]. T. Hagerstrand, Innovation Diffusion as a Spatial Process, 1967.
[100]. T.Hermansen, op. cit n.29. p. 31.
[101]. H.W Richardson, op. cit. n. 7. p. 114.

should be made to identify the prevailing system in order to exploit its facilities and persuasion. Induced innovation is very important for the developing economics and that is why the information flows immediately become of prime importance because they are always indispensable prerequisites for flow of capital, labour and commodities. The information flow aspect is equally important in centrally planned economics as in market economics.

2.3.6 Growth Foci Model

R.P.Misra extends the concept of growth pole to the concept of growth foci because of the weaknesses in the growth pole theory in the context of underdeveloped countries. According to Misra[102], the main weaknesses of growth pole theory are:

(a) The growth pole theory owing for its origin to the western economic thought gives an undue emphasis on industrialization. It may not be the starting point for economic growth in the backward economy. There is thus functional rigidity in the theory.

(b) In a country like India need for growth demands that the growth poles should lead to the creation of conditions under which agricultural development can occur.

(c) In underdeveloped countries, the growth poles also have to function as special interaction points. They have to act as the centers of diffusion of information. Provision of extension services, educational services and meeting places are necessary to accomplish this task.

The spatial economy of India is marked with centralized concentration with a few metropolitan areas controlling the whole economy of the country. They are 'islands' devoid of functional links with the surrounding regions, exploitative in nature and thoroughly disadvantageous to the rural areas. Their spillover effects are confined to a very narrow zone. Misra finds in the concept of growth pole the existence of a functional region within which the human activities are oriented in a complementary and supplementary way to a regional center of gravity. This center forms a hierarchy of growth poles starting from the

[102]. R.P.Misra, Growth Poles and Growth Centres in Urban and Regional Planning in India.

metropolitan center to group of villages. In the context of Indian conditions, according to Misra, a four tier growth foci can be envisaged[103]

(i) Service centers at the local level.
(ii) Growth points at the sub-regional level.
(iii) Growth centers at the regional level.
(iv) Growth poles at the national level.

Later on, the concept of central village was also added making the hierarchy five tier[104]. The central village will offer marketing, recreational and social services for the community.

2.3.7 Regional Development Potential Theory

According to Nijkamp[105], the basic idea of Regional Development Potential Theory is that regional disparities are the result of long-run developments and not of short-term cyclical fluctuations. Consequently, much emphasis is placed on the supply side and hence on the capacity side. The reason is that a region is too small in comparison with the total economy for exerting a significant influence on total demand and hence total demand is considered as given. So the problem of regional disparities is essentially a comparative allocation problem, viz. which shares of total demand will be attracted by the successive regions in an open capital system. This also, according to Biehl[106], explains the degree to which regions succeed in utilizing their productive capacity, so that the question as to which factors determine the regional development potential becomes crucial.

The regional development potential depends on:

(a) Regional potentiality factors (such as availability of natural resources, locational conditions, sectoral compositions, international and national linkages and exiting capital stock)

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[103].ibid., p. 158.
[104] R.P.Misra, K.V. Sundaram and V.L.S. Prakash.Rao, Regional Development Planning in India.
[105]. P.Nijkamp, A Multidimentional Analysis of Regional Infrastructure and Economic Development.
[106]. D.Biehl, Determinants of Regional Disparities and the Role of Public Finance, n.1. pp. 44-71

(b) Mobile production factors (such as various kinds of labours and new investments)

Potentiality factors for capital can be subdivided into, (a) material and immaterial capital and (b) private and public capital. Infrastructure capital is essentially public capital which may be either material or immaterial. These potentiality factors determine the regional development potential, although the impacts of these factors may differ, depending on their mobility, individuality, non-substitutability, polyvalence and non-exclusiveness. By means of these five characteristics the regional potentiality factors may be distinguished, directly or indirectly, from other productive resources. The emphasis of the Regional Development Potential theory on public capital is extremely important for regional infrastructure policy, because, such a policy may be an effective tool in coping with the problem of spatial disparities.

2.4 Methods of Measuring Regional Disparities

Over the past decades there is a growing awareness of the existing inter-regional disparity in the level of agricultural development in the country. In the west too, such inter-regional studies were made by Richardson[107], Isard[108], Williamson[109] and others. Reviewing the existing literature, it is known that a number of studies have been carried out to identify inter-regional disparities using various criteria of development. For example, Bernet[110] constructed non-monetary index of development to focus the attention of international disparities. In India, Mitra[111] used 35 indicators and attempted to highlight regional disparities based on a simple method of assigning and adding up ranks of districts. Nath[112] also used this method to highlight disparities between different regions based on state ranks in India. The rank-

[107]. H.W.Richardson, Regional Growth Theory, 1973.
[108]. W.Isard, Method of Regional Analysis, 1956.
[109]. J.G.Williamson, Regional Inequality and the Process of National Development, 1968.
[110]. M.K.Bernet, International Disparities in Consumption Levels, 1951.
[111]. A. Mitra, Levels of Regional Development in India,1961.
[112]. V.Nath, Regional Development in Indian Planning, pp. 242-60.

ordering method of Mitra and Nath ignores the magnitude of variation between any two regions with respect to any one variable[113].

Rao[114] used the multiple factor analysis and attempted with the help of 6 variables at studying regional disparities in India. Rao found that the most important cause of inter-state disparities in growth of crop output during 1953-54 to 1963-64 was the differences in the growth of irrigation. The inter regional disparities as well as the gap between the rich and poor farmers had widened.

Pal[115] applied the method of principal component analysis to study regional disparities in India. This method was also followed by Rao. Prof. Pal found that agricultural labour productivity in rupees per person, agricultural income per acre of cropped area in rupees and percentage of irrigated area to total gross area sown are the main factors responsible for the inter districts disparities in agricultural development in India. Prof. Pal then ranked the 325 districts of the country on the basis of the aforesaid index and thereby established the existence and the extent of regional disparity in the level of agricultural development in the national context.

Iyengar, Nanjappa and Sudarshan[116] made use of component dynamic index of development and measured inter-district differentials in Karnataka's development. They assigned weights to the indicators inversely proportional to the corresponding co-efficient of variation. They used 21 indicators to find out the index of level of development and ranked them accordingly. On the basis of the level of indices, all districts of Karnataka had been divided into five categories such as, very developed, developed, developing, backward and very backward.

Dadibhavi[117] made use of the principal component analysis to find out inter-taluka disparity and backwardness in Karnataka. The inter-taluka variations in respect of agricultural development were not found to be high.

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[113]. S.K.Rao, A Note on Measuring Economic Distances Between Regions in India, p. 796.
[114]. Ibid.
[115]. M.N.Pal, Regional Disparities in the levels of Development in India, 1965.
[116].N.S.Iyengar, M.B.Nanjappa and P.Sudarshan, A Note on Inter-District Differences in the Karnataka's Development, pp.79-83.
[117]. R.V.Dadibhavi, An Analysis of Inter-Taluka Disparity and Backwardness in Karnataka State, pp.166-73.

Sundaram and Rao[118] observed that specific regional policies are needed to guide deliberate action to bring about a more even economic and social development in different parts of the economy.

Sampath[119] using a technique similar to the co-efficient of variation observed that agricultural sector significantly increases the inequality. According to author there existed wide inter-state inequality in India at the beginning of the planning era and it declined steadily until 1964-65, since then up to 1970-71, it increased steadily. Throughout the period 1951-71 non-agricultural sectors did not contribute to the increase in the inter-state inequality. In contrast to this, the growth policy of the agricultural sector during 1961-71 was such that it contributed significantly to the increase in the inter-state inequalities.

Mishra, Mahanti and Pathak[120] in their study on agricultural development and planning in the context of micro-level planning with particular reference to East Champaran district (Bihar) found agricultural development distinctly unbalanced. They further observed the growth of agriculture to be positively related with area, yield rate and interaction of the two. The component-cropping pattern was found needing planning for both increasing output and decreasing disparities.

Prakash and Rajan[121] observed that agricultural productivity per hectare and per capita were widely diffused while the agricultural inputs like iron, ploughs, tractors, fertilizers, HYV seeds, irrigation, etc. were highly concentrated. They made use of the co-efficient of concentration analysis of variance and intra-class correlations to indicate regional inequalities.

Shrivastava[122] made use of the composite index to measure regional disparities in agricultural development in Madhya Pradesh. The author found a high degree of concentration of both inputs and outputs in those districts, which are highly and fairly developed.

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[118].K.V.Sundaram and P.Rao, Regional Imbalances in India, pp. 61-80.
[119].R.K.Sampath, Inter-State Inequalities in Income in India,1977.
[120].S.K.Mishra, T.K.Mahanti and C.R.Pathak, Micro-Level Planning for Agricultural Development, pp. 24-31
[121].P.Rajan and Sri Prakash, Regional Inequalities in Rural Development in Madhya Pradesh, pp.1-14
[122].S.L.Shrivastava, Regional Disparities in Agricultural Development in Madhya Pradesh, pp.55-60.

Mandal[123] found improved farming among dominating factors that affect regional imbalances. The area under HYV and distribution of energized pump sets were found to be significantly influencing imbalances. Imbalances in respect of the agricultural productivity and area sown were not found to be significant.

Shaban and Bhole[59] attempted to measure the inter-state differentials in rural development in India by using seventeen indicators of development. They used Principal Component Analysis, Cluster Analysis and various statistical methods to measure the same. In order to find out the rural development disparities at the aggregate level for the year 1991-92, Weighted Average Component Score (WACS) were calculated. The study finds that inter-state disparities in rural development are very high. At the aggregate level of development Punjab is the most developed State followed by Haryana, Kerala and Karnataka while the least developed State is Bihar followed by Orissa, Uttar Pradesh and Assam. As the WACS method is found suitable for our study and is used here for our analysis.

So far, the studies on regional (spatial) variation in the level of agricultural development were reviewed only, a brief review of the literature on temporal variation in the level of agricultural development points out the temporal variation of weather.

In the western study, James L. Stalling's[124] studied most analytically the effect of weather on the annual yield of major crops in the U.S.A by fitting a linear regression model, where the residual was the weather-effect. Griliches[125], using the same method showed that during 1911-58, the temporal variation of weather played a very important role in the total variation of crop output in the U.S.A.

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[123].S.K.Mandal, Regional Disparities and Imbalances in India's Planned Economic Development, pp. 103-106
[59]. Shaban Abdul and Bhole L.M, Regional Disparities in Rural Development in India., pp. 103-117.
[124] . James.L. Stallings, Indexes of the Influence of Weather on Agricultural Output, 1960.
[125] . Zvi. Griliches, Estimates of the Aggregate Agricultural Production Function from Cross-Section Data, 1960.

In Indian study, for the first time Mann[126] and later on by Krishna and Rao[127] studied the influence of the monsoon and other climatic variation from year to year on the agricultural production.

R.W.Cummings and S.K.Ray[128] estimated the contribution of weather and technology to the 1967-68 and 1968-69 food grains production in India. This study was thus an attempt to identify the weather effect on agricultural production in India.

2.5 Agro-Climatic Zones of Assam

So far Assam state is concerned, very few attempts have been made to have agricultural regionalisation of the economy of Assam. Assam is divided into six agro-climatic regions based on some homogeneity factors as adopted by the Department of Agriculture, Assam, which are noted below.

2.5.1 North Bank Plains

This zone comprises the districts of Lakhimpur, Darrang, Dhemaji and Sonitpur with an area of 14319 sq. km comprising 18.37 percent of the State. This zone occupies 12.75 percent of the total cropped area of the State. It has the population of 39,26,975 (as per 1991 census) which is 17.61 percent of the state total and has density of 274 persons per sq. KM. The zone subdivided into three parallel belts: (1) foothills of the Himalayas with alluvial soil; (2) Central belt of old alluvium which are acidic and; (3) Low-lying riverine belt lying by the side of the Brahmatputra.

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[126] . H. Harold. Mann, Rainfall and Famine: A Study of rainfall in Bombay Deccan-1865-1938, 1955.
[127] . J. Krishna and M.S. Rao, Dynamics of Acreage Allocation for Wheat in U.P.-A Study in Supply Response, 1967.

[128] . R. W. Cummings and S.K. Ray, The New Agricultural Strategy-Its Contributions to 1967-68 Production, 1969.

2.5.2 Lower Brahmaputra Valley

This is the largest of all the zones and comprises the districts of Kamrup, Nalbari, Barpeta, Bongaigaon, Kokrajhar, Dhubri and Goalpara. Having the largest share of area in the State, 20,148 sq.km (25 percent of the state total), this zone also has the largest population, 79,73,791 persons as per 1991 census which is 35.77 percent of the state total. The density of population in this zone is 395 persons per sq. km. This zone occupies 35.20 percent of the gross cropped area of the state, which is the largest.

2.5.3 Central Brahmaputra Valley

This zone comprises the districts of Nagaon and Morigaon. With an area of 5535 sq. km (7.06 percent of the state aggregate), this zone has a population of 25,32,463 (11.36 percent of the state total) as per 1991 census. The density of population is the highest in this zone with 457 persons per sq. km. This zone occupies 12.20 percent of the gross cropped area of the state.

2.5.4 Upper Brahmaputra Valley

This zone comprises the districts of Jorhat, Golaghat, Sibsagar, Dibrugarh and Tinsukia. With an area of 16192 sq. km (20.64 percent of the state total), this zone has a population of 45,66,563 as per 1991 census, which is 20.48 percent of the state. The population density in this zone is 282 per sq km. This zone occupies 27.25 percent of the grossed cropped area of the state.

2.5.5 Barak Valley

This southernmost zone comprised the districts of Cachar, Karimganj and Hailakandi. With an area of 6922 sq. km (8.82 percent of the state total), this zone has a population of 29,90,009 as per 1991 census which is 11.77percent of the state total. The density of population is 360 persons per sq. km. in this zone. This zone occupies 7.8 percent of the grossed cropped area of the state.

2.5.6 Hill Zone

This zone comprises the districts of Karbi-Anglong and North Cachar Hills. These two districts are the hill districts of Assam. With an area of 15,322 sq. km.(19.53 percent of the state total), this zone has a population of 8,04,761 (3.61 percent of the state aggregate) as per the 1991 census. The density of population in this zone is the lowest in the state with only 53 persons per sq. km. This zone occupies the lowest 4.8 percent of the gross cropped area of the state.

Chapter 3

Model for Regionalisation and Spatio-Temporal Dynamism in the Level of Agricultural Development

3.1 The Method of Principal Components—A Tool of Regionalisation

In order to identify or delineate the regions (districts) according to their level of development at a particular point of time or over a period of time into some specific clusters, the method of regionalisation is resorted to. In the literature of quantitative approach to regionalisation, although many a technique are available to construct composite index by fusing the individual sectoral indices of developments levels, most of them suggest to construct a composite index either by without assigning any differential weightage to various individual indicators or by assigning weightage by subjective judgments. In this study, however, neither constant weightage nor the subjective judgements regarding the weightage were appreciated and hence, the method of Principal Component Analysis, first developed by H. Hotelling[129] in 1933, has been adopted for constructing composite indices.

In contrast to other methods, the Principal Component Analysis has got certain special advantages. These are:

(i) this method yields mathematical weightage in a purely objective manner,

(ii) this noval technique has the advantage to tackle the situation when the number of variables is larger than the number of observations, and

(iii) this approach has been suggested as a solution to the problems of multicollinearty.

The method of Principal Component is a special case of more general method of Factor Analysis. The aim of the method of Principal Components is the construction out of a set of variables X_j's (j = 1,2,…….k) of new variables (p_i) called 'Principal Component' which are linear combination of X's.

[129] . H. Hotelling, Analysis of a Complex of Statistical Variables into Principal Components, 1933.

$$\left.\begin{array}{l} P_1 = a_{11} X_1 + a_{12} X_2 + \ldots\ldots\ldots\ldots\ldots + a_{1k} X_k \\ P_2 = a_{21} X_1 + a_{22} X_2 + \ldots\ldots\ldots\ldots\ldots + a_{2k} X_k \\ \vdots \\ P_k = a_{k1} X_1 + a_{k2} X_2 + \ldots\ldots\ldots\ldots\ldots + a_{kk} X_k \end{array}\right\} \ldots\ldots\ldots\ldots(3.1.1)$$

This a_{ik}'s (i=1,2,.…..k) called loadings are so chosen that the constructed Principal Component satisfy three conditions:

(a) the Principal Component are uncorrelated (orthogonal),

(b) the first principal component P_1 absorbs and accounts for the maximum possible proportion of the total variation in the set of all X's, the second principal component absorbs the maximum of the remaining variation in the X's (after allowing for the variation accounted for by the first principal component) and so on.

(c) The loadings $a^2_{11} + a^2_{12} + \ldots\ldots\ldots\ldots + a^2_{1k} = 1$, for otherwise the variance of P_1 could be increased indefinitely simply by increasing each of the a_{ik}'s by the same factor. We thus have to maximize ΣP^2_1 subject to $\Sigma a^2_{ik} = 1$. To do this, the lagrangean equation is formed.

$$\theta = \Sigma P^2_1 - \lambda (\Sigma a^2_{ik} - 1) \ \ldots\ldots\ldots\ldots\ldots\ldots(3.1.2)$$

To illustrate, let us assume two variables X_1 and X_2 (dropping the observation subscript)

Then,

$$\theta = \Sigma (a_1 x_1 + a_2 x_2)^2 - \lambda (\Sigma a^2_i - 1) \ \ldots\ldots\ldots\ldots\ldots(3.1.3)$$

$$= a^2_1 \Sigma x^2_1 + a^2_2 \Sigma x^2_2 + 2 a_1 a_2 \Sigma x_1 x_2 - \lambda (\Sigma a^2_i - 1) \ \ldots\ldots\ldots\ldots\ldots\ldots(3.1.4)$$

Differentiating with respect to a_1 and a_2, we have

$$\frac{d\theta}{da_1} = 2\, a_1\, \Sigma\, x^2{}_1 + 2\, a_2\, \Sigma\, x_1\, x_2 - 2\, \lambda\, a_1 \quad \ldots\ldots\ldots\ldots\ldots(3.1.5)$$

$$\frac{d\theta}{da_2} = 2\, a_2\, \Sigma\, x^2{}_2 + 2\, a_1\, \Sigma\, x_1\, x_2 - 2\, \lambda\, a_2 \quad \ldots\ldots\ldots\ldots\ldots(3.1.6)$$

Setting these equal to zero and re-arranging,

$$a_1\, \Sigma\, x^2{}_1 + a_2\, \Sigma\, x_1\, x_2 = \lambda\, a_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1.7)$$

$$a_2\, \Sigma\, x^2{}_2 + a_1\, \Sigma\, x_1\, x_2 = \lambda\, a_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1.8)$$

or,

$$a_1\, (\Sigma\, x^2{}_1 - \lambda)^2 + a_2\, \Sigma\, x_1\, x_2 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1.9)$$

$$a_2\, (\Sigma\, x^2{}_2 - \lambda)^2 + a_1\, \Sigma\, x_1\, x_2 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1.10)$$

from which,

$$\lambda^2 - (\Sigma\, x^2{}_1 + \Sigma\, x^2{}_2)\, \lambda + \Sigma\, x^2{}_1\, \Sigma\, x^2{}_2 - (\Sigma\, x_1\, x_2)^2 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots(3.1.11)$$

This is a quadratic in λ which, when solved in terms of the known sums of square and cross-products of the x's, will give two roots.

In order to maximize the variance to be accounted for by P_1, the larger of the roots is chosen, equations (3.1.9) and (3.1.10) together with the constraint $a^2{}_1 + a^2{}_2 = 1$ which allows us to solve for a_1 and a_2 and thus enable us to form the first principal component $P_1 = a_{11}\, x_1 + \ldots\ldots\ldots\ldots + a_{1k}\, x_k$.

Principal Component –Method of Estimation

Although the aforesaid explanation clearly spells out the meaning of the principal component analysis, the estimation of the principal components P_i's by obtaining the estimates of a $_{ik}$'s becomes very complex with the aforesaid approach through calculus. Therefore, this study resorts to the method devised by C.Burt, which employs mainly the correlation co-efficient between the k explanatory variables.

What is needed to have a correlation matrix having the correlation coefficient between k explanatory variables in a systematic manner.

The steps of estimation may be outlined as follows:

(i) The explanatory variables x_j's have standardized the simple formula, $x_j^* = x_j/Sx_j$ where x_j^* is the standardized variable; $x_j = x_{ij} - \bar{x}_j$ and Sx_j is the standard deviation of x_j. This standardization has been done in order to make the variables unit free.

(ii) All the values of the indicators have been scaled by converting them into logarithm of 10 base. Threshold log values need not have to be introduced as there was no zero valued indicator.

(iii) Simple correlation co-efficient between k explanatory variables have been estimated and these correlation co-efficient were then arranged in a matrix form, called correlation matrix. The total independent elements in the matrix will be ½ n (n-1) where n is the number of explanatory variables. The main diagonal elements in this matrix are unity since elements of these diagonals are self-correlation ($r_{xi\ xj}$ = 1 for all I's). The matrix is symmetrical, that is, the element of each row are identical to the elements of the corresponding column since, $r_{xi\ xj} = r_{xjxi}$. The format of the correlation matrix will assume the following form (by dropping the identical elements to the left of the diagonal entries) as given in Table no. 3.1.

Table No. 3.1 Correlation matrix

	X_1	X_2	X_3	X_4	…………X_k
X_1	$r_{x1\,x1}$				
X_2	$r_{x1\,x2}$	$r_{x2\,x2}$			
X_3	$r_{x1\,x3}$	$r_{x2\,x3}$	$r_{x3\,x3}$		
X_4	$r_{x1\,x4}$	$r_{x2\,x4}$	$r_{x3\,x4}$	$r_{x4\,x4}$	
.					
.					
.					
X_k	r_{x1xk}	$r_{x2\,xk}$	$r_{x3\,xk}$	$r_{x4\,xk}$	$r_{xk\,xk}$

(iv) Next step is to sum up the elements of each column (or row) of the correlation matrix and obtain k sums of simple correlation coefficient.

$$\sum_{j=1}^{k} r_{xixj} = \sum_{i=1}^{k} r_{xixj}$$

and subsequently, the square root of the sum total of the column (or row) sums have been found out, which is-

$$\sqrt{\sum_{i=1}^{k}\sum_{j=1}^{k} r_{xixj}}$$

next, the loading (a_{ik}'s) for the first principal component P_1, has been found out by dividing each column (or row) sum by the square root of the grand total.

$$a_{ik} = \left(\sum_{j=1}^{k} r_{xixj}\right) \Big/ \sum_{i=1}^{k}\sum_{j=1}^{k} r_{xixj}$$

Where 'i' refers to the ith variable x.

(v) finally, the latent root of the first principal component has been found out in order to estimate the variation accounted for by the first principal component (P_1). In doing so, the sum of the squares of the loadings of the first principal component is estimated.

L_1 = (Latent root of P_1) = $\sum_{i=1}^{k} a_{1i}^2 = a^2_{11} + \ldots\ldots\ldots\ldots + a^2_{1k}$

In general,

$L_m = \sum_{i=1}^{k} a_{mi}^2$ (Latent root of the m th principal component)

The sum of the latent roots of all the principal components is equal to the number of x's.

$\sum_{i=1}^{k} Li = k$ (Where x ranges from 1 to k).

For example, if we have $\Sigma L_i = 5$, it is intuitively clear that the latent root of any P_i provides an indication of the importance of P_i of the amount of the total variation that the particular P_i has extracted from the set of x's. In effect the latent root is the actual variation extracted by the P_i th principal component. A convenient way of presenting the latent roots is to express them as a percentage of the total variation in the set of x's. When the correlation table is used, the percentage contribution of P_i in the total variation in the standardized x's is defined by the expression.

Percentage variation accounted by per P_m $= \frac{Lm}{k} 100 = \frac{\sum_{i=1}^{k} a_{mi}^2}{k} 100$

To measure the agricultural development disparities at the aggregate level, the Weighted Average Component Score (WACS) is calculated from Principal Component Score (PCS) of the retained PCs. For example, the WACS for the state is arrived at as

$$WACS_j = \left[\frac{PCS-1_j \, PS_1^2 \Big/ \sum_{i=1}^{m} PS_1^2}{N} \right] + \ldots\ldots\ldots + \left[\frac{PCS-m_j \, PS_m^2 \Big/ \sum_{i=1}^{m} PS_1^2}{N} \right] \quad \ldots.(3.1.12)$$

Where, PS^2 = percentage of the total variance explained by PC 1,2………k;

$\sum PS^2$ = percentage of the total variance collectively explained by PC 1,2…k;

N = number of $\lambda>1$; m = N<k:

The higher positive WACS show the higher levels of agricultural development.

The composite index is nothing but the first principal component of the variables, where WACS are taken as variables.

The measure adopted is :

$$Z_{ij} = \sum_{j=1}^{k} aij \frac{Xij - \bar{X}j}{\partial Xj}$$

Where,

Z_{ij} = the composite index of development of 'i' th state.

aij = factor loadings on the first principal component vector.

Xij = value of the Xi variable on 'j'th observation..

∂Xj = standard deviation on the Xj variable.

3.2 Method for Regional Disparities in Agricultural Development: A Regional Profile

There are various theories, which explain the causes and courses of regional disparities. There is a need for intensive look into the regional disparities in agricultural development in order to secure balanced regional agricultural development and to raise the level of agricultural development with an aim of bringing about economic prosperity in Assam. Attempts are made to analyse the degree and course of the variation within the perspective of tolerable inequality. It will examine factors responsible for the variation so that measures be suggested for balanced agricultural development. There are various methods of measuring the degree of regional imbalances and these measures range from the conventional ones like mean, range, standard deviation, co-efficient of variation, index of regional imbalances index of inter-regional variation etc.

In the present study, use of the tools like balance ratio, index of regional imbalance, index of intra-regional imbalance and co-efficient of regional imbalance has been made to measure the extent of regional disparities in agricultural development in Assam. These techniques are simple and lucid and provide sufficient clue to the extent of regional imbalances. They give sufficient information for formulating region-specific strategies. The co-efficient of imbalance has an added advantage as it is sensitive to the real units into consideration and this aspect is of vital importance.

Values of all these tools are non-negatives. The ideal value of balance ratio is unity and its opposite extreme value is zero. The technique of the balance ratio is supposed to be indicative of the relative development-status following the system given below:

Value of Balance Ratio (y)	Status of Relative Development
$0.0 < y \leq 0.6$	Backward
$0.6 < y \leq 0.9$	Developing
$0.9 < y \leq 1.5$	Developed
1.5 and above	Very Developed

The cut-off points are arbitrary and based on value judgements.

The ideal value of the co-efficient of imbalance is zero. Both index of inter-regional imbalance and index of intra-regional imbalances have been used for broad comments only as they do not have operational utility. In the present study, co-efficient of imbalances has been used as an important tool of analysis as it has operational significance in deciding priorities among different relative indicators. The objective of balanced development requires higher priorities to the relative indicators having higher co-efficient.

Computational Procedure:

Let the symbols:

S	denote the norm-region
r	denote the region
k	denote the sub-region
N	denote non-negative numerator indicator
D	denote non-negative denominator indicator
x	denote relative indicator
y	denote balance ratio
C	denote co-efficient of imbalance
R	denote the index of regional imbalance
I	denote the index of intra-regional imbalance

Then, N_{sj} is the Jth numerator indicator of the norm region.

N_{rj} is the Jth numerator indicator of the region.

N_{kj} is the Jth numerator indicator of the sub-region.

D_{sj} is the Jth denominator indicator of the norm region.

D_{rj} is the Jth denominator indicator of the region.

D_{kj} is the Jth denominator indicator of the sub-region.

The non-identical indicator 'i' is:

(a) for the norm region

$$X_{si} = \frac{N_{sj}}{D_{sj}}$$

(b) for the region

$$X_{ri} = \frac{N_{rj}}{D_{rj}}$$

(c) for the sub-region

$$X_{ki} = \frac{N_{kj}}{D_{kj}}$$

Balance ratio with respect to relative indicator 'i' is

(a) Norm region

$$Y_{si} = \frac{X_{si}}{X_{si}} = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.2.1)$$

(b) Region

$$Y_{ri} = \frac{X_{ri}}{X_{si}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.2.2)$$

(c) Sub-region

$$Y_{ki} = \frac{X_{ki}}{X_{si}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.2.3)$$

The Co-efficient of imbalance in 'i' th relative indicator is

(a) Norm region

$$C_{si} = \left[\sum_{k=1}^{m} (Y_{ki} - 1)^2 \Big/ m \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots(3.2.4)$$

Disaggregated at district level.

$$C_{si} = \left[\sum_{r=1}^{l} (Y_{ri} - 1)^2 \Big/ m \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots(3.2.5)$$

Disaggregated at region level.

m= number of sub-regions within the norm region.

l= number of regions in the norm-region.

(b) Region

$$C_{ri} = \left[\sum_{k=1}^{m} (Y_{ki} - 1)^2 \Big/ m \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots\ldots\ldots(3.2.6)$$

m = number of sub-regions within the region.

The index of regional imbalance is

(a) Region

$$R_r = \left[\sum_{l=1}^{n} (Y_{ri} - 1)^2 \Big/ n \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots\ldots\ldots(3.2.7)$$

(b)Sub-region

$$R_k = \left[\sum_{l=1}^{n} (X_{ri} - 1)^2 \Big/ n \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots\ldots(3.2.8)$$

n = number of indicators

The index of intra-regional imbalance is

(a) Norm-region

$$I_s = \left[\sum_{i=1}^{n} \sum_{r=1}^{l} (Y_{ri} - 1)^2 \Big/ n \times l \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots(3.2.9)$$

Disaggregated at region level.

$$I_s = \left[\sum_{i=1}^{n} \sum_{k=1}^{m} (Y_{ki} - 1)^2 \Big/ n \times m \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots(3.2.10)$$

Disaggregated at sub-region level.

(b) Region

$$I_r = \left[\sum_{i=1}^{n} \sum_{k=1}^{m} (Y_{ki} - 1)^2 \Big/ n \times m \right]^{\frac{1}{2}} \times 100 \quad \ldots\ldots(3.2.11)$$

In the present exercise, Assam as a whole has been taken as norm-region and the administrative districts sub-regions. The agricultural regions identified by using Principal Component Analysis have been taken as regions. However, analysis has also been carried to natural regions of Assam, i.e all six Agro-Climatic zones.

3.3 A Model for Reflecting Spatio-Temporal Dynamism in the Agricultural Development of Assam

The pooling of time-series and cross-section data has been one of the most important areas where numerous studies have been made over the years. But before an attempt is made to work out the effect of time-series and cross-section data on a particular production path, one has to, first of all, design a particular production function model fitted to a time-series of cross-section data.

There are basically two approaches to study the production relationship in a production function (relationship between input and output). First, single factor productivity approach, and the second, multiple factor productivity approach. Though the single factor productivity is simple, yet it suffers from many methodological flaws and practical inadequacy.

In recent years, a number of studies have been attempted to calculate the multiple factor productivity with the help of production function analysis. One of the most important and frequently used production function is the Cobb-Douglas production function, also known as the linear in logarithm type. The Cobb-Douglas (1928) production function generally takes the following form:

$$Y_{rt} = K\prod_{j=1} X_{jrt}^{\alpha j} e^{U_{rt}} \quad \text{……… ……………….(3.3.1)}$$

or

$$LogY_{rt} = LogK + \sum_{j=1} \alpha_j LogX_{jrt} + U_{rt} \quad \text{…………….(3.3.2)}$$

Where,

Y = Output ;

K = Constant ;

X_j = input j ;

α_j = elasticity of output with respect to input j;

U= random disturbance;

r,t = region and year respectively.

The Cobb-Douglas production function is popular as evident from its frequency of occurrence in production economics literature due to its relative simplicity of use. Being a homogeneous function, it provides a scale factor that enables one to measure the returns to scale and to interpret the elasticity co-efficient with relative ease. It is also thought to be a good fit to the agricultural data in Indian context. But inspite of all the aforesaid qualities of Cobb-Douglas production function, there are several limitations.

In order to do away with the inherent limitations of the Cobb-Douglas production function, several alternative production functions have been proposed recently. Important among these alternative production functions are: the C.E.S. (Constant Elasticity of Substitution) production function (Arrow and others, 1961) and the quadratic production function. Under the C.E.S. production function, elasticity of substitution can take values ranging from zero to infinity and suit all lines of production. But there is sufficient empirical evidence that confirms that the C.E.S function fitted to agricultural production data at different levels of aggregation gives elasticity of factor substitution not significantly different from unity.

The quadratic production function of the general type assumes the following form:

$$Y_{rt} = M + \sum_{j=1} \left(b_j X_{jrt} + C_j X_{jrt}^2 \right) + U_{rt} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3.3.3)$$

where,

Y = Output;
M = Constant;
X_j = input j;
b,c = co-efficient of the variables;
U = Random disturbance;
r,t = region and year respectively;

Unlike the Cobb-Douglas type, output elasticity is not a constant, but varies with input quantity, it declaims with increasing level of input if the estimated signs of the co-efficient are as expected.

In the present study, the C.E.S. production function could not be followed since the C.E.S. cannot incorporate more than two independent variables in the model. Also, the Quadratic production function could not be fitted because of the complexities inherent in it when viewed in terms of an error-component model. In view of the aforesaid limitations, this study had to rely on the Cobb-Douglas production function. Because the incorporation of the error-component model (or residual model), Cobb-Douglas production function becomes much easier and simpler.

The Pooling of Cross-Section and Time-Series Data

The easiest way to combine the effect of spatial (regional) and temporal effect on the level of agricultural production is to use the residual model. A residual model can be formulated as given in equation no. 3.3.4

$$Y_{rt} = \alpha X_{rt} + U_{rt} \qquad \text{……………………..(3.3.4)}$$

Where U_{rt} are random disturbances for region r and year t. In a pure cross-section analysis, it is usually assumed that a host of factors which affect the regions in the sample and the value of the dependent variable for each of them, but which could not be explicitely included as independent variables, may be summarized as a random disturbance. In a pure time series analysis, a similar assumption is made about stochastic disturbances. Although, econometric analysis under an OLS method takes as its basis, the assumption of the stochastic mechanism that generates the disturbance, e.g. U_{rt} as given in equation (3.3.4), complication arises when the cross-section and time-series data are combined together. It is, however, possible that the other exogenous factors (variables) may vary between regions but is constant for a particular region for the given time period. It is further possible that these exogenous variables vary both over time and region. Such a dual phenomenon, can be taken care of by breaking up the disturbance (U_{rt}) in to two components.

$$U_{rt} = \mu_r + y_{rt} \qquad \text{……….…………………(3.3.5)}$$

Where μ_r represents regional effect, the effect which remains constant for a particular region over a given time-period but varies between the regions; and y_{rt} represents the temporal effect that varies with both region and time. Equation (3.3.5) is known as the 'error component' or 'random effects' model. One of the important assumptions of the 'error component' model in a production analysis is that the explanatory variables (Xs') are independent of the disturbance U_{rt} in equation (3.3.4). Another important assumption of the error component model is the homogeneous but disturbed relationship between inputs and output.

The main reason in choosing an error-component model lies in the fact that in most production function analysis in agriculture, the range of the explanatory variables is very wide. Many of these variables are not measurable while for many others, data are not available, as a result of which such variables are not included in the model. The exclusion of such variables have some important effects on the estimates of the function. When the excluded variables are related to the included variables in a production function, the co-efficients estimated by OLS will be biased upward or downward depending on the relationship between the independent and the omitted variable on the one hand, and the omitted variable and the included variable (to which, the omitted variable is related) on the other. If the omitted variable varies less than proportionately with the included variable, the method of OLS shall lead to an under-estimate of the returns to scale. When cross-section and time-series data are pooled, the problem becomes compounded as a result of the introduction of these aforesaid additional effects which can be either region specific or time specific. Under such a circumstance, the OLS method is all likely to be biased and the best alternative under such a situation is the error-component model.

The Estimation of the Model

The model has been prepared in the light of the dynamic model developed by Balestra and Nerlove[130].

It is assumed that there are 'r' regions indexed by r = 1……….R and 't' successive time periods indexed by t =1……….T, giving a total of Q = R×T sample points. The explanatory variable can be indexed as X = 1……….N. The variables are denoted by,

Y_{rt} = Value of the dependent variable for region r in period t.

X_{jrt} = Value of jth explanatory variable for region r in period t.

The linear hypothesis would then be (for a Cobb-Douglas form)

130 . P. Balestra and M. Nerlove, Pooling of cross-section and time-series data in the estimation of a dynamic model: The demand for Natural Gas, 1966.

$$LnY_{rt} = Ln\alpha + \beta_1 LnX_{1rt} + ... + \beta_n LnX_{nrt} + U_{rt} \ldots\ldots(3.3.6)$$

The best way of organizing the data in equation (3.3.6) is in the following manner:

(a) Dependent Variable = Y $_{rt}$

$$\begin{bmatrix} Y_{11} \\ Y_{12} \\ . \\ . \\ . \\ Y_{1T} \\ . \\ . \\ . \\ Y_{RT} \end{bmatrix}_{RT\times 1}$$

(b) Independent (Explanatory) variables = X $_{jrt}$

$$\begin{bmatrix} X_{11}^{(1)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_{11}^{(N)} \\ . \\ . \\ . \\ X_{1T}^{(1)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_{1T}^{(N)} \\ . \\ . \\ . \\ X_{RT}^{(1)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_{RT}^{(N)} \end{bmatrix}_{RT\times N}$$

(c) Residual = U_{rt}

$$\begin{bmatrix} U_{11} \\ U_{12} \\ . \\ . \\ . \\ U_{1T} \\ . \\ . \\ . \\ U_{RT} \end{bmatrix}_{RT \times 1}$$

(d) and co-efficient of explanatory variables =β_n

$$\begin{bmatrix} \beta_1 \\ \beta_2 \\ . \\ . \\ . \\ . \\ . \\ . \\ \beta_N \end{bmatrix}_{N \times 1}$$

Now from the time-series of cross-sections, the following relation is estimated.

Y = Xβ+U, where U is an RT ×1 vector of residuals. Since the aim is to capture the spatial and temporal (other than the input) effects on the production process, it is required to decompose the disturbance term (U_{rt}) into two statistically independent parts, a spatial effect (or a regional effect) and a random temporal effect. The spatial (regional) effects are assumed to be constant for a particular region for a specific time-period, but between two regions they vary. On the other hand, the temporal effects are purely random effects that vary from time(year) to time and region to region. Thus the model takes the following form:

$$LnY_{rt} = Ln\alpha + \beta_1 LnX_{1rt} + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_n LnX_{nrt} + \mu_r + y_{rt} \quad \ldots\ldots\ldots(3.3.7)$$

which is the same as

$$Y_{rt} = \alpha \prod_{n=1}^{N} X_{nrt}^{\beta_n} e^{\mu_r + y_{rt}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.3.8)$$

Where μ_r is another parameter of the model and y_{rt} is the random disturbance term.

In equation (3.3.7) the residual have been decomposed.

$$U_{rt} = \mu_r + y_{rt} \quad \ldots\ldots\ldots\ \ldots\ldots\ldots\ldots\ldots(3.3.5 \text{ or } 3.3.9)$$

where μ_r and y_{rt} are statistically independent.

i.e. $E\mu_r y_{rt} = 0, \forall r, \forall t.$

It is assumed that there is no serial correlation among y_{rt} and that these are independent of each other, thus,

$$Ey_{rt} y_{r^{/} t^{/}} = \left[\sigma_y^2, r = r^{/} \text{ and } \ t = t^{/}\right.$$

= 0, otherwise

similarly,

$$E\mu_r \mu_{r^{/}} = \left[\sigma_\mu^2, r = r^{/}\right.$$

= 0, otherwise.

This assumption implies heteroskedasticity and cross-sectional independence.

Define $\sigma^2 = \sigma_\mu^2 + \sigma_y^2$

and $\rho = \sigma_\mu^2 \big/ \left(\sigma_\mu^2 + \sigma_y^2\right) = \sigma_\mu^2 \big/ \sigma^2$

Then from the relation $E\mu_r y_{rt} = 0,$ we have the variance-co-variance matrix of the residuals U as follows:

$$EUU^{/} = \Omega = \sigma^2 \begin{bmatrix} M\,0.........................0 \\ 0M.........................0 \\ .... \\ .... \\ 00...........................M \end{bmatrix}$$

Where Ω is an RT× RT matrix. The Ω matrix, when elaborated takes the following form

$$\Omega = \begin{bmatrix} E(u_{11}^2)E(u_{11}u_{12})..............................E(u_{11}u_{RT}) \\ E(u_{12}u_{11})E(u_{12}^2)..............................E(u_{12}u_{RT}) \\ .... \\ E(u_{21}u_{11})...........E(u_{21}^2)..................E(u_{21}u_{RT}) \\ .... \\ E(u_{RT}u_{11})..........E(u_{RT}u_{22}).............E(u_{RT}^2) \end{bmatrix}$$

Elucidating the variance-covariance matrix further, it can be presented it in the following form:

$$E(uu^{/}) = \begin{bmatrix} \sigma^2 M\,00..............0 \\ 0\sigma^2 M\,0..............0 \\ .... \\ 00.................\sigma^2 M \end{bmatrix}$$

Where

$$\sigma^2 M = \begin{bmatrix} \sigma^2 \sigma_p^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \sigma_p^2 \\ \sigma_p^2 \sigma^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \sigma_p^2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \sigma_p^2 \sigma_p^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \sigma^2 \end{bmatrix}$$

Where $\sigma^2 M$ is an T×T matrix .

or,

$$\sigma^2 M = \sigma^2 \begin{bmatrix} 1\rho\rho \ldots\ldots\ldots\ldots \rho \\ \rho 1 \ldots\ldots\ldots\ldots\ldots \rho \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \rho\rho \ldots\ldots \rho \ldots\ldots\ldots 1 \end{bmatrix}$$

In pure cross-section study, there is only one time period for each region and, therefore, it is only the upper left hand corner entry. That is, for T=1,

$$U_{rt} = \begin{bmatrix} u_{11} \\ u_{21} \\ . \\ . \\ . \\ u_{r1} \end{bmatrix}$$

and

$$uu' = \begin{bmatrix} u_{11}^2 u_{11} u_{21} \ldots\ldots\ldots\ldots\ldots u_{11} u_{R1} \\ u_{21} u_{11} u_{21}^2 \ldots\ldots\ldots\ldots u_{21} u_{R1} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ u_{R1} u_{11} \ldots\ldots u_{R1} u_{31} \ldots\ldots\ldots u_{R1}^2 \end{bmatrix}$$

and

$$E(uu') = \begin{bmatrix} \sigma^2 0 \ldots\ldots\ldots\ldots\ldots\ldots.0 \\ 0\sigma^2 \ldots\ldots\ldots\ldots\ldots\ldots.0 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ 00\ldots\ldots\ldots\ldots\ldots\ldots.\sigma^2 \end{bmatrix}$$

or,

$$E(uu') = \sigma^2 \begin{bmatrix} 10\ldots\ldots\ldots\ldots\ldots.0 \\ 01\ldots\ldots\ldots\ldots\ldots.0 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ 00\ldots\ldots\ldots\ldots\ldots.1 \end{bmatrix} = \sigma^2 I_R$$

Where I is an R×R identity matrix.

In the case of a pure time-series analysis, since there is only one region, the residual can not be decomposed into regional and random effects. So it can be assumed $\mu_r = 0$ and $\sigma^2_\mu = 0$, That is, for R = 1,

$$u_{rt} = \begin{bmatrix} u_{11} \\ u_{12} \\ . \\ . \\ .u_{1T} \end{bmatrix}$$

and

$$uu' = \begin{bmatrix} u_{11}^2 u_{11} u_{12} \ldots\ldots\ldots\ldots\ldots u_{11} u_{1T} \\ u_{12} u_{11} u_{12}^2 \ldots\ldots\ldots\ldots\ldots u_{12} u_{1T} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ u_{1T} u_{11} u_{1T} u_{12} \ldots\ldots\ldots\ldots u_{1T}^2 \end{bmatrix}$$

and

$$E(uu') = \begin{bmatrix} \sigma^2 0 \ldots\ldots\ldots\ldots\ldots\ldots 0 \\ 0\sigma^2 \ldots\ldots\ldots\ldots\ldots\ldots 0 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ 00 \ldots\ldots\ldots\ldots\ldots\ldots \sigma^2 \end{bmatrix} = \sigma^2 \begin{bmatrix} 10 \ldots\ldots\ldots\ldots\ldots\ldots 0 \\ 01 \ldots\ldots\ldots\ldots\ldots\ldots 0 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ 00 \ldots\ldots\ldots\ldots\ldots\ldots 1 \end{bmatrix} = \sigma^2 I_T$$

Where I is an T×T identity matrix.

Since the model assumes the form of Generalised Least Square model because of the assumption of heteroskedasticity and cross-sectional independence, it is not be possible to run the OLS method directly. For such model, in order to get BLUE, one has to go in for transformation of the data to remove heteroskedasticity and then use the OLS method on the transformed data.

The method of transformation, as suggested by Balestra and Nerlove (1966) may be summarized as follows:

We have $U_{rt} = \mu_r + y_{rt}$

And we have defined earlier,

$$\sigma^2 = \sigma_\mu^2 + \sigma_y^2$$

and $$\rho = \sigma_\mu^2 / (\sigma_\mu^2 + \sigma_y^2) = \sigma_\mu^2 / \sigma^2$$

The maximum Likelihood estimate of σ^2 and p as derived by Balestra and Nerlove takes the following form:

$$\sigma^2 = \frac{\sum_{r=1}^{R} \sum_{t=1}^{T} u_{rt}^2}{RT}$$

and $\rho = \frac{\sum_{r=1}^{R}\left[\left(\sum_{t=1}^{T} u_{rt}\right)^2 - \sum_{t=1}^{T} u_{rt}^2\right]}{(T-1)\sum_{r=1}^{R}\sum_{t=1}^{T} u_{rt}^2}$ ………………………(3.3.10)

or,

$$\rho = \frac{\sum_{r=1}^{R}\sum_{t=1}^{T}\sum_{t'=1}^{T} u_{rt}u_{rt'} - \frac{1}{N}\left(\sum_{r=1}^{R}\sum_{t=1}^{T} u_{rt}\right)^2}{NT^2\sigma^2} \quad \text{……………………. (3.3.11)}$$

The value of p will be between 0 and 1 and the U_{rt}'s can be calculated by the OLS method on the original data from the equation

Y = Xα+U

Now let,

$$\theta = \sigma^2[(1-p)+Tp] \quad \text{………………………..(3.3.12)}$$

and

$$\eta = \sigma^2(1-p) \quad \text{..………………………(3.3.13)}$$

Where θ and η are the two distinct characteristics roots of the matrix $E(UU')/\sigma^2$. The aforesaid values of σ^2 and p derived through a maximum likelihood estimates have the desirable properties of consistency, asymptotic normality and asymptotic efficiency.

Now coming to transformation of the original data, the following procedure is followed: Taking the original variable Y, we have an RT×1 vector of Y. For a given region over time, it can be calculated as

$$Y_r = \frac{\sum_{t=1}^{T} Y_{rt}}{T} \qquad \text{.........................(3.3.14)}$$

Now, transform the original variable in the following way:

$$Y_{rt}^{*} = \left[\frac{Y_{rt} - Y_r}{\sqrt{\eta}} + \frac{Y_r}{\sqrt{\theta}} \right] \qquad \text{..........................(3.3.15)}$$

Where Y^{*}_{rt} is the transformed variable. This method of transformation is to be repeated on all the independent variables. After this exercise, the OLS is run on the transformed data fitting it in equation. While running the OLS on the transformed data, it is to run first with the assumption of a composite disturbance term U_{rt} and from the set of estimates, to deduct the Y_{rt} from the constant term α and then run the same set of transformed data for the second time by dropping the constant term α and by decomposing U_{rt} between μ_r and Y_{rt}. Such a manipulation has to be done in order to make the inversion of $(X^{/}X)$ possible, in order to satisfy the relationship.

$$B = (X^{/}X)^{-1} X^{/}Y$$

Where B is a column vector of unknown parameters. Y is a column vector of observations on the dependent variables Y and X is a matrix of observation on the dependent variables.

Chapter 4

Trends in Agricultural Development in Assam

4.1 Agricultural Development in India

Agriculture is the backbone of Indian economy as about more than fifty percent of the population of the country depends on this sector for their livelihood and it contributes about 27 percent of the national income. As such, agricultural development is the sine qua non of economic development in India. In any regional scheme of economic development in India, agricultural development should get due priority on the basis of available factor endownments. The superstructure of industrial development can be built only on the solid foundation of a dynamic and viable agriculture. Till the end of the Third Five Year Plan, Indian Planners and politicians who were greatly enamoured with the Soviet model of rapid industrialization through growth of heavy industry, neglected the development of agriculture, as a result of which economic development with stability continued to be a mirage. During the interregnum between the Third Plan and the Fourth Plan, the agricultural economy, witnessed what is now popularly known as 'Green Revolution'. The emphasis on new agricultural technology, involving the use of High Yielding Varity (HYV) seeds, fertilizers and irrigation facilities was sought to be continued during the Fourth plan. In the Seventh Plan, it was rightly pointed out that "Adequate and timely availability of inputs of assured quality at stable prices should be ensured. These would cover fertilizers, pesticides, HYV seeds and pest control services. Special attention should be devoted to economically vulnerable groups like small farmers, marginal farmers and Scheduled Caste (SC's) / Scheduled Tribes (ST's) engaged in agricultural production. When input use is lagging, it should be intensified." The achievement of agricultural growth in the Eight Plan includes the development of high-yielding varieties, maximization of yield of rainfed crops, extending hybrid technology to new crops and improvement of export oriented crops. Special emphasis lays on agriculture in both Ninth and Tenth Plan period since growth in this sector is likely to lead to the widest dissemination of benefits, especially to the rural poor including agricultural labour

4.1.1 Agricultural Production

Due to efforts all round for agricultural development over the plan periods, there has been a remarkable increase in agricultural production in India. The increase in agricultural production is particularly impressive after the Green Revolution. Particularly gratifying has been the growth in the production of food grains enabling the nation to put an end to the frequent occurrence of famines. The food grains production has been increased from 50.8 million tonnes in 1950-51 to 108.4 million tonnes in 1970-71 to176.4 million tonnes in 1990-91 to 208.9 million tonnes in 1999-2000, showing four times increase over the years. The following table 4.1 gives the detail picture of this.

Table 4.1 Food grains Production in India. (Million Tonnes)

Group/ Commodity	1960-61	19970-71	1980-81	1990-91	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Food grains	82.0	108.4	129.6	176.4	184.3	191.5	180.4	199.4	192.3	203.5	208.9
Kharif	NA	68.9	77.7	99.4	100.4	101.1	95.1	103.9	101.6	102.8	104.9
Rabi	NA	39.5	51.9	77.0	83.9	90.4	85.3	95.5	90.7	100.7	104.0
Cereals	69.3	96.6	119.0	162.1	170.9	177.5	168.1	185.2	179.3	188.6	195.5
Kharif	NA	65.0	73.9	94.0	95.0	96.4	90.5	98.4	97.3	97.7	99.9
Rabi	NA	31.6	45.1	68.1	75.9	81.1	77.6	86.8	82.0	90.9	95.6
Pulses	12.7	11.8	10.6	14.3	13.3	14.1	12.3	14.2	13.0	14.9	13.4
Kharif	NA	3.9	3.8	5.4	5.4	4.7	4.6	5.5	4.3	5.1	4.9
Rabi	NA	7.9	6.8	8.9	7.9	9.4	7.7	8.7	8.7	9.8	8.5
Rice	34.6	42.2	53.6	74.3	80.3	81.8	77.0	81.7	82.5	86.0	89.5
Kharif	NA	39.5	50.1	66.3	70.7	72.6	67.9	71.3	72.5	72.7	76.7
Rabi	NA	2.7	3.5	8.0	9.6	9.2	9.1	10.4	10.0	13.3	12.8
Wheat	11.0	23.8	36.3	55.1	59.8	65.8	62.1	69.4	66.3	71.3	75.6

Note: Kharif-Winter and Autumn season, Rabi-Summer season

NA: Not available

Source: 1) Directorate of Economics & Statistics, Department of Agriculture & Cooperation, Govt. of India, Year 2001, Economic Survey 2000-2001.

2) Ministry of Commerce & Industry, Govt. of India, Year 2001.

It may be observed from the table that the increase in production of food grains has mainly been contributed by the impressive increase in cereals whereas production of pulses has been almost stagnant. It is a matter of assurance that Indian agriculture has almost been able to shed out in fluctuating fortune so far as production of cereal is concerned. In fact, food economy has moved from deficit to a position of surplus. The growth of agricultural sector may be described in terms of the rise in the index number of agricultural production. The index number of agricultural production is given in Table 4.2. It may be observed from the table that agricultural production has shown an increasing trend in cases of food grains, non food grains and all commodities year to year fluctuations notwithstanding. The average annual rate of increase in the index of agricultural production over the period from 1970-71 to 1999-2000 works out to 1.92 percent in case of food grains production.

Table 4.2 All India Index Numbers of Agricultural Production (Base: Triennium ending 1981-82=100)

Commodity	Weight	1970-71	1980-81	1990-91	1994-95	1995-96	1996-97	1997-98*	1998-99*	1999-2000*
1. Food grains	62.92	87.9	104.9	143.7	155.7	146.1	160.9	155.7	165.2	169.0
(a) Cereals	54.98	84.1	105.0	144.2	158.3	149.8	163.9	159.9	168.0	174.4
Rice	29.74	84.4	107.8	149.4	164.5	154.8	164.4	166.0	173.0	179.9
Wheat	14.45	67.7	103.2	156.6	186.8	176.4	197.0	188.5	202.5	214.7
Coarse cereals	10.79	105.4	99.8	113.1	103.2	100.2	118.2	104.9	108.1	105.3
(b) Pulses	7.94	113.6	104.1	140.5	137.4	121.0	140.1	126.9	145.8	131.4
Gram	3.07	126.3	105.4	130.2	156.5	121.1	135.3	149.1	165.3	123.5
2. Non Food grains	37.08	82.6	97.1	156.3	180.9	185.4	200.9	181.6	199.8	190.0
3.All commodities	100.0	85.9	102.1	148.4	165.0	160.7	175.7	165.3	178.1	176.6

*. Provisional for Non food grains and all commodities.
Source: Directorate of Economics & Statistics, Department of Agriculture & Cooperation, Govt. of India, Year 2001, Economic Survey 2000-2001.

Table 4.3 Index Numbers of Area Under Principal Crops (Base: Triennium ending 1981-82=100)

Commodity	1970-71	1980-81	1990-91	1994-95	1995-96	1996-97	1997-98*	1998-99*	1999-2000*
1. Food grains	97.9	99.8	100.7	97.6	95.3	97.4	97.6	102.0	97.0
(a) Cereals	97.9	100.1	99.1	96.8	94.8	97.1	97.0	101.9	97.8
Rice	93.6	100.2	106.5	106.8	106.9	108.4	108.4	122.8	112.2
Wheat	82.2	100.4	108.9	115.8	112.7	116.7	120.3	124.0	123.6
Coarse cereals	110.1	99.9	86.7	77.1	73.7	75.9	73.6	70.0	70.3
(b) Pulses	98.0	98.6	108.4	101.2	97.9	98.6	100.5	102.9	93.1
Gram	109.5	92.1	105.3	105.6	99.7	95.9	105.9	117.8	88.3
2. Non Food grains	91.1	99.4	120.0	126.2	131.7	134.6	133.6	134.9	134.1
3.All commodities	96.3	99.7	105.2	104.2	103.8	106.0	105.9	109.6	105.3

*. Provisional for Non food grains and All commodities.
Source: Directorate of Economics & Statistics, Department of Agriculture & Cooperation, Govt. of India, Year 2001, Economic Survey 2000-2001.

The Table 4.3 shows the Index number of area under principal crops. It is seen from the table that area under rice remained constant while area under wheat and coarse cereals increased during this period in case of foodgarins. In case of Non-food grains area under these increased in a remarkable sense.

The improvement in the growth rates is especially impressive after the Green Revolution as a result of technological developments, such as irrigation, improved crop varieties, fertilizers, mechanization and increased use of inputs. Changes in the index number of some of the principal crops can be seen from table 4.4. It is seen form the table that the increase of food grains from 1970-71 to 1999-2000 is about 1.70 times, while for non-food grains it is 1.48 times. The improvement in the yield rates may be attributed to the extension of irrigation, increased use of fertilizers, use of high yielding varieties, plant protection measures, soil improvement and adoption of superior agronomic practices.

Table 4.4 Index Numbers of Yield of Principal Crops (Base: Triennium ending 1981-82=100)

Commodity	1970-71	1980-81	1990-91	1994-95	1995-96	1996-97	1997-98*	1998-99*	1999-2000*
1. Food grains	93.2	105.1	137.8	150.2	143.1	154.5	148.4	146.8	159.2
(a) Cereals	89.9	104.9	139.3	152.7	146.3	156.7	152.0	148.3	162.0
Rice	90.2	107.7	140.2	154.0	144.8	151.7	153.1	140.8	160.3
Wheat	82.4	102.8	143.8	161.3	156.5	168.9	156.7	163.3	173.7
Coarse cereals	97.0	100.2	128.8	130.9	131.9	151.3	137.8	148.9	142.9
(b) Pulses	114.4	106.6	128.1	132.9	120.3	139.1	123.1	136.2	137.7
Gram	115.3	114.3	123.6	148.1	121.5	141.1	140.7	140.4	139.9
2. Non Food grains	91.4	99.2	128.0	138.9	135.7	143.8	132.3	141.7	135.7
3.All commodities	92.6	102.9	133.8	145.5	139.8	149.8	141.4	144.7	149.0

*. Provisional for Non food grains and All commodities.

Source: Directorate of Economics & Statistics, Department of Agriculture & Cooperation

Table 4.5 Progress of Selected Agricultural Development Programmes

Programme	Unit	1970-71	1980-81	1990-91	1993-94	1994-95	1995-96	1996-97	1997-98*	1998-99*	1999-2000*
HYV	Ml.hec										
Paddy	,,	5.6	18.2	27.4	28.9	31.0	31.4	33.4	32.2	NA	NA
Wheat	,,	6.5	16.1	21.0	22.0	23.2	23.1	23.7	23.0	NA	NA
Other	,,	3.3	8.8	16.6	15.8	17.1	17.8	19.3	20.8	NA	NA
Total HYV	,,	15.4	34.1	65.0	66.7	71.3	72.3	76.4	76.0	NA	NA
Irrigated Area	,,	38.0	54.1	70.8	75.7	77.5	79.3	80.7	81.8	83.6	84.7
Major & Medium	,,	17.3	22.7	26.0	27.1	27.5	27.9	28.4	28.9	30.1	30.5
Minor@	,,	20.7	31.4	44.8	48.6	50.0	51.4	52.3	52.9	53.5	54.2
Soil conservation+	,,	13.4	24.4	34.9	37.3	38.2	39.3	NA	NA	NA	NA
Fertiliser consumption	Ml.ton	2.2	5.5	12.5	12.4	13.6	13.9	14.3	16.2	16.8	18.1
Nitrogenous	,,	1.5	3.7	8.0	8.8	9.5	9.8	10.3	10.9	11.4	11.6
Phosphatic	,,	0.5	1.2	3.2	2.7	2.9	2.9	3.0	3.9	4.1	4.8
Potassic	,,	0.2	0.6	1.3	0.9	1.2	1.2	1.0	1.4	1.3	1.7

*. Provisional
NA: Not available
@. The figures for minor irrigation indicate the net benefit after allowing for seepage.
+. Commulative level at the end of the year.
Ml.hec: Million hectares
Ml. ton: Million tones.
Sources: 1) Directorate of Economics & Statistics, Department of Agriculture & Cooperation.
2) Ministry of Water Resources, Govt. of India, Year 2001.

4.2 Agricultural Development In Assam

Agriculture occupies a very important place in the economy of the State and forms the major occupation of the people of Assam. But, compared with other states in the country, the pace of development of this sector has not been up to the expectations. The backwardness of Assam agriculture is, however, somewhat deep-rooted and it may be attributed to the continuing exploitative agrarian structure in the face of very poor implementation of land reforms and tenancy reforms, fragmented and tiny holdings, backward technology and agricultural finance. The land reforms have made very negligible impact on the agricultural economy and the economic condition of the small peasants and landless labourers. The main reason for the failure of land reform in Assam is the lack of political will and determination to carry out this revolutionary programme[131]. Small size and fragmented holdings due to population explosion is also one of the reasons for the unpopularity of the use of modern technique for increasing agricultural production[132]. The backwardness of Assam's agriculture may be attributed to a number of factors some of which are mentioned above. Besides these, marketing is also an important factor for better performance in agriculture through which producers will be encouraged to produce surplus for sale. Not only that the marketing agencies created by the government are functioning unsatisfactorily, they are also very limited in their operation area. Owing to very poor communication facilities farmers of remote and far, flunged areas are not able to get benefit of these institutions. They are forced to sell their produce to the petty traders in village itself and are thereby forced to corner a handsome part of their hard-earned income to the traders. This problem is particularly severe

[131]. K.Alam: Land Reform, Assam Institute of Development Studies, March 1989.
[132]. A.R.Baruah & H. Bhattacharya: Constraints of Crop Production in Assam, Assam Institute of Development Studies, March, 1989.

in hilly terrain areas of Assam. There is also acute lack of storage facilities. Agricultural production is growing at about 2 percent in Assam. While the growth rate is impressive, but this is lower than the all India average (2.6 percent per annum).The agricultural production is increasing in Assam because of the more use of composite fertiliser (viz. NPK) and HYV seeds, irrigation system and mechanization. The annual occurance of flood always affects the agriculture crops in the state, still its productions are going up slowly and steadily. However due to the strategies adopted by the State Government lately for attaining self-sufficiency in food-grains, a positive indication can be seen in the form of a growing awareness on the part of the State's cultivators for use of improved seeds, manure etc.

4.2.1 Climate

The soil, topography, rainfall and climate in Assam is suitable for cultivation of rice crop which occupies about 70 percent of the gross cropped area and more than 90 percent of the total area under food-grains. Agriculture in Assam is mainly dependent on rainfall. On an average the State receives rainfall in different seasons as follows:

Winter (December to February)	90 mm.
Summer (March to May)	640 mm.
Monsoon (June to September)	1460 mm.
Post Monsoon (October to November)	140 mm.

4.2.2 Agricultural Production

The production of food-grains has increased from 1438 thousand tones in 1950-51 to 3434 thousand tones in 1998-99 showing 2.4 times increase during these period. Out of total food grains rice is the main crop. Total rice production increased from 1398 thousands in 1950-51

Table 4.6 Food-grains Production in Assam (in '000 tonnes)

Commodity	1950-51	1960-61	1970-71	1980-81	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Rice	1398	1633	1986	2459	3270	3197	3299	3361	3309	3390	3328	3382	3255
Autumn Rice	211	277	378	466	522	494	613	586	619	516	520	597	521
Winter Rice	1184	1341	1575	1949	2565	2486	2442	2556	2477	2622	2516	2471	2288
Summer Rice	2.7	14	32	44	182	216	243	218	212	251	293	314	446

Maize	1.1	3.4	6.2	8.9	13	12	13	12	13	13	13	15	14
Wheat	16	30	117	106	140	111	78	100	103	95	117	110	91
Cereals	1482	1641	2007	2589	3393	3326	3395	3478	3430	3504	3464	3513	3365
Pulses	23	26	32	46	48	53	51	57	59	57	58	64	69
Food grains	1438	1668	2040	2635	3442	3379	3447	3535	3489	3561	3532	3578	3434

Source: 1) Directorate of Economics & Statistics, Govt. of Assam.
2) Directorate of Agriculture, Govt. of Assam.

to 3255 thousand tones in 1998-99. However the contribution of rice to total food grains production decreased from 97 percent in 1950-51 to 94 percent in 1998-99. Out of total rice, winter rice is the main component. It contributes nearly 80 percent during the whole period. Next to rice cereals is the second most important in food grains. It increased from 1482 thousand tonnes in 1950-51 to 3365 thousand tones in 1998-99. The increase is near about 2.3 times during these period.

4.2.3 Index of Agricultural Production

The index of agricultural production (base triennium ending 1981-82=100) for the State has been showing a steady upward trend over the last couple of years. The general index for all crops stands at the point of 151 in 1998-99 as against 138 in 1990-91. The following Table 4.7 shows the trend in agricultural production in the state as well as in the country as reflected through the movement of index of agricultural production for the last few years.

Table 4.7 Index of Agricultural Production in Assam and India (Base: Triennium ending 1981-82=100)

Year	Assam			India			P.C. change over the previous year for all crops	
	Food	Nonfood	AllCrops	Food	Nonfood	AllCrops	Assam	India
1990-91	144	131	138	144	156	148	7.0	3.5
1991-92	142	143	142	138	159	146	2.9	(-)1.4
1992-93	144	142	143	144	164	152	0.7	4.1
1993-94	148	149	148	150	170	157	3.5	3.1
1994-95	146	154	150	156	181	165	1.4	5.1
1995-96	150	157	153	146	185	161	2.0	(-)2.4
1996-97	148	157	153	161	201	176	0.0	9.3
1997-98	149	161	155	156	183	165	3.3	8.7
1998-99	143	158	151	165	199	178	NA	NA

NA : Not available

Source: 1) Directorate of Economics & Statistics, Govt. of Assam.
2) Directorate of Agriculture, Govt. of Assam.

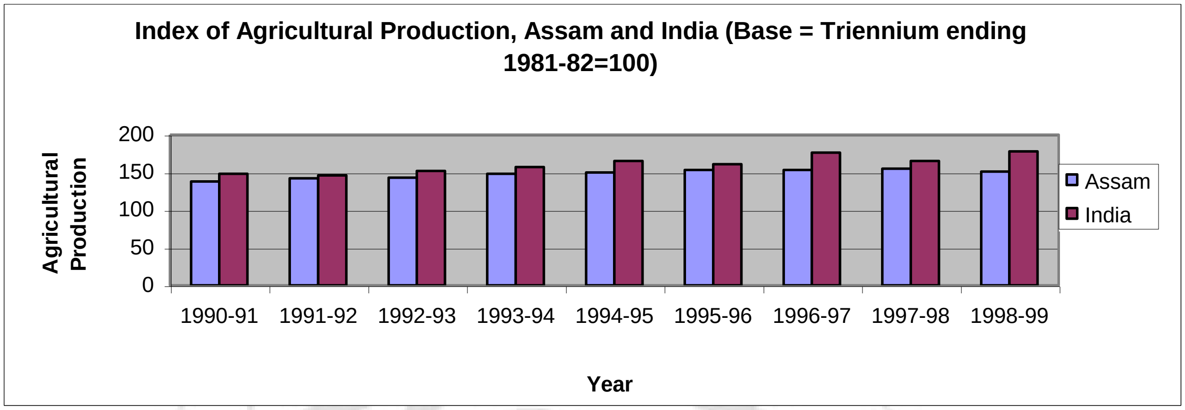

Fig.1

4.2.4 Area Under Crops

The latest provisional estimates of land utilization statistics for the State are available for the year 1990-91. These statistics reveal that Assam had an estimated 39.26 lakh hectares of gross cropped area, of which, the net area sown was about 27.77 lakh hectares which is about 35 percent of the total geographical area of the State. The area shown more than once stood at 11.49 lakh hectares during the year. Thus the ratio of area sown more than once to the net area sown was 41 percent in 1992-93 as against 28 percent in 1981-82 and 22 percent 1975-76. The following Table 4.8 shows the clear picture about the area under crops.

Table 4.8 Area Under Some Important Crops in Assam (Area in thousand hectares)

Commodity	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Rice	2527	2572	2560	2563	2486	2540	2528	2527	2454
Autumn Rice	608	639	635	637	647	625	620	607	595
Winter Rice	1801	1704	1776	1797	1708	1760	1736	1743	2635
Summer Rice	117	128	148	128	132	155	172	175	224
Maize	20	19	19	18	19	19	19	19	20
Wheat	83	76	74	79	81	86	88	85	90
Cereals	2641	2677	2661	2668	2596	2656	2645	2640	2574
Pulses	113	117	109	109	109	107	120	118	127
Food grains	2755	2794	2770	2777	2704	2763	2765	2758	2701

Source: 1) Directorate of Economics & Statistics, Govt. of Assam.
2) Directorate of Agriculture, Govt. of Assam.

Amongst the important crops in the State, the area under rice dominated the position, sharing near about 65 percent of the total cropped area in 1998-99. During the year 1998-99, the area under autumn and winter paddy stood at 5.95 lakh hectares and 26.35 lakh hectares respectively as against 6.08 lakh hectares and 18.01 lakh hectares in 1990-91. On the other hand area under wheat rose by 1.12 times from 1990-91 to 1998-99. The area under maize seems to be remain constant during these whole period. One important thing is that the table shows the area under total rice decreased from 25.27 lakh hectares in 1990-91 to 24.54 lakh hectares in 1998-99. The area under cereals also decreased from 26.41 lakh hectares in 1990-91 to 25.74 lakh hectares in 1998-99. In the same way the area under total food grains decreased from 27.55 lakh hectares in 1990-91 to 27.01 lakh hectares which shows negative trend of area under food grains.

4.2.5 Yield Rate

The following table shows the productivity of some important crops in the State. From the table, it can be seen that the productivity of almost all crops within food grains increased from 1990-91 to 1998-99. In case of rice, the increase of productivity of autumn rice is prominent. It increases from 873 kg. per hectare from 1990-91 to 1000 kg. per hectare in 1997-98. The productivity of maize increases from 629 kg. per hectare in 1990-91 to 851 kg.

Table 4.9 Yield Rate of Some Important Crops in Assam (in Kg. per hectare)

Commodity	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Rice	1313	1261	1308	1331	1350	1421	1334	1356	1344
Autumn Rice	873	785	982	937	973	839	853	1000	889
Winter Rice	1446	1399	1396	1443	1472	1513	1471	1439	1474
Summer Rice	1556	1684	1645	1708	1615	1619	1701	1797	1749
Maize	629	634	663	658	658	681	679	766	851
Wheat	1248	1455	1066	1277	1290	1107	1332	1299	1346
Cereals	1301	1259	1293	1322	1340	1380	1326	1347	1356
Pulses	428	473	469	522	552	533	572	546	589
Food grains	1265	1226	1261	1263	1308	1395	1308	1313	1326

Source: 1) Directorate of Economics & Statistics, Govt. of Assam.
2) Directorate of Agriculture, Govt. of Assam.

per hectare in 1998-99 which shows 1.22 times increase during these period. The productivity of cereals increased to 1356 kg. per hectare in 1998-99 as against 1301 kg. per hectare. In terms of total food grains the productivity increased from 1265 kg. per hectare to 1326 per hectare.

4.2.6 Agricultural Holding

As per Agricultural Census 1990-91, there were 25.2 lakh operational holdings in the State covering an area of about 32.0 lakh hectares of land. Compared with the figures of the earlier Census 1985-86, the number of operational holdings and operated area during 1990-91 were higher by 4.13 percent and 1.26 percent respectively. The marginal holdings with less than 1 (one) hectare of land accounted for 60.3 percent of total holdings and 19.0 percent of the total operated area of the State in 1990-91. In case of small holdings with size class between 1-2 hectare, the share turned out to be 22.2 percent of total holdings and 24.5 percent of the total operated area. On the other hand, the large holdings (20 hectares and above) constituted only 0.09 percent of the total number of operational holdings, with 11.37 percent of the total operated area in the State. An important feature revealed by the Agricultural Census is that the average size of operational holdings in the state recorded a declining trend over the successive censuses. The average size of operational holdings which was 1.37 hectares in 1976-77 recorded marginal decline to 1.36 hectares in 1980-81. In 1985-86, the same

Table 4.10 Number of Agricultural Holding & Operated Area as per Agricultural Census in Assam

Item	1970-71	1976-77	1980-81	1985-86	1990-91
1. Number of holdings	19,64,376	22,53,654	22,97,588	24,19,156	25,23,379
2.Total operated area (in,000 hectares)	2,882	3,079	3,121	3,161	3,205
3.Average size of holdings (in hectares)	1.47	1.37	1.36	1.31	1.27

Source: Directorate of Agriculture, Govt. of Assam.

registered further decline to 1.31 hectares and in 1990-91 it again came down to 1.27 hectares. At all –India level too, the average size of holding was found to have gradually declining from 2.0 hectares to 1.69 hectares over the period 1976-77 to 1985-86. The above table shows the position of agricultural holding and operated area from 1970-71 to 1990-91.

4.2.7 Fertilizer

The distribution system of fertilizer in Assam is channelised through AAIDC, STATFED, ASAMB, GPSS, ASC and other private agents/dealers under the control of State Department of Agriculture. These organizations play a very vital role in fertilizer distribution system. The distributors are to procure the fertilizer (controlled fertilizer) from the manufactures as per allotment made by the State Agricultural Department and sell directly or through their respective branches located at various corners of the State. Although an increasing trend is observed as regards consumption of fertilizers in Assam, its consumption in terms of NPK is far below the level achieved by other states as well as national level. The following table gives the actual consumption of fertilizers in the State.

Table 4.11 Actual Consumption of Plant Nutrients in Kharif and Rabi Seasons in Assam (in tonnes)

Crops		1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Kharif	N	11724	11696	9875	19096	15012	11522	15505	19195	22486
	P	4116	4095	3461	3125	2925	2966	3062	6589	9448
	K	5481	4927	3443	2787	2721	6064	4896	11975	3115
	Total	21321	20718	16779	25008	20658	20552	23463	37759	35049
Rabi	N	8172	7599	6060	10775	9287	12143	16652	18951	25204
	P	3824	3748	1387	2132	2035	2487	2777	8479	11108
	K	3514	3456	1683	5257	5030	13959	12919	5786	6741
	Total	15510	14803	9130	18164	16352	28589	32343	33216	43053
Kharif & Rabi	N	19896	19295	15935	29871	24299	23665	32157	38146	47690
	P	7940	7843	4848	5257	4960	5453	5839	15068	20556
	K	8495	8383	5126	8044	7751	20023	17815	17761	9856
	Total	36831	35521	25909	43172	37010	49141	55806	70957	78102

Source: Directorate of Agriculture, Govt. of Assam.

4.2.8 Irrigation

The irrigation facilities in Assam is extremely limited. Although the State has abundant surface and ground water, it is not being effectively used for irrigation purposes. The facilities of assured and controlled water supply should have been the main element of strategy for development of agriculture in the State. This is also necessary to induce the farmers to change their existing cropping pattern and to go for a second crop in the dry winter season. Although, in the recent years, Assam has made some progress in the sphere of creation of additional irrigation potential, much more still remains to be done to bring the situation to a satisfactory level.

Out of the total estimated gross cropped area of about 40 lakh hectares, the irrigation potential of Assam utilized during the year 1997-98 was 1.14 lakh hectares, which was same as in the previous year. The creation of gross irrigation potential in the State up to 1998-99 was 4.83 lakh hectares under Government scheme. The private irrigation schemes are promoted through the Assam State Minor Irrigation Development Corporation by channelising institutional finance.

Additional irrigation potential created during 1998-99 in the State was 1452 hectares as against 334 hectares in 1997-98 and 512 hectares in 1996-97. The following table shows the target and achievement of additional potential created under different irrigation schemes in the State.

Table 4.12 Additional Irrigation Potential Created in Assam (Government Scheme)

(Potential area in hectare)

Sector	1995-96		1996-97		1997-98		1998-99	
	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
Minor	10300	2227	5300	512	5300	334	1750	776
Major/ Medium	9500	840	7000	-	200	-	200	676
Total	19800	3067	12300	512	5500	334	1950	1452

Source: Chief Engineer, Irrigation Department, Govt. of Assam.

4.2.9 Area Under High Yielding Variety (HYV)

The area under HYV rice have been showing a gradual increase over the years. The total area under HYV rice (Autumn, Winter and Summer) which stood at 11.64 lakh hectares decreases to 11.17 lakh hectares in 1994-95 , but again it increases to 12.74 lakh hectares during 1998-99. These fluctuation in area under HYV is mainly responsible for the fluctuation of irrigation facilities in Assam. The newly introduced high yielding varieties of rice are

Masuri, Ranjit, bahadur, Pankaj, Irri etc. In percentage terms 78 percent of the area were under HYV in 1998-99 against 75 percent during 1997-98. The following table shows the areas under different HYV rice from 1990-91 to 1998-99.

Table 4.13 Area Under High yielding Variety Rice In Assam (In hectares)

Period	Autumn	Winter	Summer	Total
1990-91	289965	796533	78355	1164853
1991-92	271266	750065	63518	1084849
1992-93	289884	780275	66831	1136990
1993-94	258973	797458	87697	1144128
1994-95	239109	778055	99507	1116671
1995-96	239744	797163	116143	1153050
1996-97	252761	821473	127071	1201305
1997-98	234995	875705	136752	1247452
1998-99	218404	880718	174825	1273941

Source: Directorate of Agriculture, Govt. of Assam.

4.2.10 Agricultural Credit

The Assam Co-operative Apex Bank Limited (ACABL) and other nationalized banks including the State Bank of India provide agricultural credit to the farmers who are members of GPSS/LAMPS of the State. The annual target of coverage under Kharif and Rabi crop were fixed at Rs. 200 lakhs and Rs. 500 Lakhs for the year 1998-99.

The disbursement of loan for Kharif and Rabi for the year 1998-99 was very low. During 1998-99 only a sum of Rs. 32.38 lakhs was advanced as agricultural short-term loan by the ACABL and the same had decided to finance Rs. 36.00 lakhs agricultural loan to the non-defaulting members of the PACS directly.

The annual targets for the year 1999-2000 under the Ninth Five Year Plan towards short-term, medium-term and long-term loans have been fixed at Rs. 8.00 lakhs. Rs. 500 lakhs and Rs. 700 lakhs respectively.

The State Government signed MOU with the NABARD jointly with the ACABL for revamping of co-operative credit structure in the State and it has also been proposed to strengthen the financing base of co-operative credit institutions by clearing their balance sheet. The State Government has taken an experimental programme with the NABARD to route crop loan through Field Management Committees (FMC), a farmers organization from

1996-97. In the year 1998-99 the crop loan has been extended to more FMCs coverning both the Kharif and Rabi season. The amount of loan disbursed was Rs. 62.66 lakhs and Rs. 25.51 lakhs in the Kharif and Rabi season respectively. The present scheme of extending credit through FMCs will continue during the year 1999-2000 also.

4.2.11 Crop Insurance

At the instance of Government of India, the National Agricultural Insurance Scheme has been adopted by the Government of Assam and is proposed to be implemented from Rabi Season, 1999-2000. The crops proposed to be covered are: (i) Summer paddy, (ii) Autumn paddy, (iii) Winter paddy, (iv) Wheat, (v) Mustard, (vi) Sugarcane and (vii) Potato.

In addition to the objects of the existing CCIS, other salient features are as follows:

1. The more crops like sugarcane and potato are included.
2. Non-loanee farmers are covered in addition with the loanee farmers.
3. A farmer may insure his crop beyond value of threshold yield level up to 150 percent of average yield of notified area on payment of extra premium.
4. To meet catastrophic losses, a corpus fund shall be created with contributions from the Government of India and State on 50:50 basis.
5. Claims beyond 100 percent of premium will be borne by the Government of India and State on 50:50 basis. Thereafter all claims up to 150 percent premium will be met by implementing agency and claims beyond 150 percent shall be paid out from corpus fund for a period of three years. After this period of three years claims up to 200 percent will be met by implementing agency and above this ceiling out of the corpus fund.

4.2.12 Special Production Programme

To enhance the awareness for cultivation of certain crops with the sole aim of increasing crop production in Department of Agriculture has been implementing various schemes in the State. Amongst the different schemes mention may be made of:

1. A special World Bank Oriented Programme viz. Assam Rural Infrastructure and Agriculture Services Project (ARIASP) being implemented since 1995 for all round development of agriculture and allied sector
2. Integrated Cereals Development Programme (ICDP-Rice) introduced in the State since 1995-96.
3. Accelerated Maize Development Programme (AMDP), a Centrally Sponsored Scheme under TMOP&M under implementation from 1998-99.
4. Sugarcane Development Programme undertaken from 1979.
5. Centrally sponsored Special Jute Development Programme (SJDP) being implemented in the ten major jute-growing districts.
6. Centrally sponsored National Pulse Development Programme (NPDP) being implemented in the State since 1986-87.
7. Technology Mission on Oil-seeds and Pulses (TMOP) and Centrally sponsored scheme of OPP introduced since 1986-87.
8. National Watershed Development Project for Rain Fed Areas (NWDPRA), a centrally sponsored scheme started in Assam since 1991-92.
9. Centrally sponsored scheme for Balanced and Integrated use of Fertiliser.
10. Centrally sponsored scheme on National Project on Development of Fertiliser use in Low Consumption Rain Fed Areas.
11. State Plan scheme for Cotton Development is in operation in the two hill districts.
12. Centrally sponsored scheme on Integrated Post Management (IPM) for judicious use of pesticides in crops implemented since 1994-95 in the State.

Chapter 5

Agricultural Regions in Assam and Analysis of Imbalance

5.1 Agricultural Regions in Assam

This section relates to the attempts made to demarcate the economy of Assam into agricultural regions. It is observed from review of literature that most of the studies have made analysis on the basis of natural regions and further, attempts made earlier for agricultural regionalisation have not taken agricultural development fully into account. Therefore, this study makes a fresh attempt to delineate agricultural regions in Assam according to agricultural development. In this study Principal Component Analysis has been used for constructing indices of agricultural development.

In the present analysis, 23 districts have been taken into account. For the analysis, 13 relative indicators have been considered. These indicators are sufficient to indicate advancement of the districts in the field of agriculture. The data relates to the reference years, 1990-91 to 1998-99. These indicators are as follows:

(X1) Gross irrigated area/Gross area sown, (X2) Area under HYV seeds/Gross area sown, (X3) Consumption of fertilizer/Gross area sown, (X4) Net area sown/Gross area sown, (X5) Number of tractor use/Gross area sown, (X6) Total amount of bank credit/Gross area sown, (X7) Number of pump sets energized/Gross area sown, (X8) Gross value of agricultural production/Gross area sown, (X9) Number of village electrified/Total no. of village, (X10) Road length/Geographical area, (X11) Total no. of literate people/Total population, (X12) Rural population/Gross area sown and (X13) Annual rainfall/State average annual rainfall.

The correlation matrix of indicators of agricultural development is given in Table 5.1. This is a pooled correlation matrix.

Table 5.1 Correlation Matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X2	0.252											
X3	-0.040	0.510										
X4	-0.218	0.140	0.449									
X5	0.634	0.485	-0.045	0.087								
X6	0.537	0.615	0.568	-0.085	0.631							
X7	0.192	0.576	0.682	0.012	0.436	0.927						
X8	0.602	0.315	0.531	0.864	-0.101	-0.156	-0.130					
X9	-0.091	0.581	0.542	0.418	-0.052	-0.059	-0.003	0.471				
X10	-0.207	0.084	0.164	0.468	-0.015	-0.026	0.709	0.418	0.842			
X11	-0.192	0.575	0.794	0.547	0.722	-0.021	0.101	0.452	0.858	0.976		
X12	-0.109	0.545	0.039	0.389	0.211	0.607	0.647	0.417	0.324	0.675	0.689	
X13	0.769	0.526	-0.064	0.095	0.607	0.350	0.375	0.722	0.051	0.069	0.047	0.508

The variables are seen to be mutually co-associated (either positively or negatively).With the help of Principal Component Analysis we are able to reduce 13 indicators into five PCs for the year 1990-91. These PCs (λ>1) are able to explain 72.9 percent of the total variation. On the basis of the PCs, the Principal Component scores are developed and with the help of the formula given above we can get the weighted average component scores(WACS) for the year 1990-91. Nagaon district has the highest level of agricultural development in the state as evident from WACS given in Table 5.2 in 1990-91. This is followed by Kamrup, Sibsagar and Dibrugarh district. The district having the lowest level of agricultural development is N.C.Hills district followed by K.Anglong, Karimganj and Hailakandi district. The district having higher WACS have fertile soils, a good deal of medernisation, more bank credit facilities to the farmers to purchase modern inputs and high cropping intensity. On the other hand the districts having lower WACS is characterized by little irrigation, high rainfall, large proportion of fellow lands and little employment of modern agricultural inputs. In between these two range other districts is characterized by low rainfall, heavily congested area with small size of agricultural holdings, low cropping intensity, poor use of modern inputs and little irrigation. The above mentioned procedure is applied for other years and calculated WACS for these all years also. These can be seen from the Table 5. 2. On the basis of the WACS all districts of Assam are ranked for the whole period from 1990-91 to 1998-99.

Table 5. 2 WACS and Development Ranks of the Districts

Districts	1990-91		1991-92		1992-93		1993-94		1994-95		1995-96		1996-97		1997-98		1998-99
	WACS	R	WACS	R	WACS	R	WACS	R	WACS	R	WACS	R	WACS	R	WACS	R	WACS
Goalpara	-0.02053	12	-0.02806	14	-0.03315	13	0.05223	10	-0.00822	10	-0.07564	16	0.046711	11	0.006021	15	0.00512
Dhubri	-0.06001	16	-0.11509	21	0.11460	9	-0.1104	18	-0.10473	18	-0.02007	21	-0.19594	21	-0.0442	18	-0.17254
Kokrajhar	-0.01246	11	-0.00904	12	-0.4781	15	-0.10434	19	-0.06164	15	-0.1235	20	-0.04062	18	0.004075	16	-0.13823
Bongaigaon	0.022468	10	-0 .1143	20	0.16611	5	-0.05148	16	-0.05682	14	-0.05812	15	0.023655	14	-0.03757	17	-0.11300
Barpeta	-0.02256	13	-0.12931	23	0.00231	13	-0.02113	14	-0.12879	20	-0.08828	17	0.01766	15	0.007165	14	-0.02218
Nalbari	0.124465	6	0.047375	9	0.13949	7	0.119603	4	0.138701	4	0.15121	4	0.102562	5	0.139881	4	0.09235
Kamrup	0.301158	2	0.128432	5	0.22730	2	0.105107	5	0.154705	3	0.12903	6	0.153577	3	0.134556	5	0.15724
Nagaon	0.350390	1	0.173431	2	0.18259	3	0.139522	3	0.096429	6	0.255938	1	0.126088	4	0.158045	3	0.12621
Morigaon	0.026545	9	-0.061	16	-0.05764	17	-0.01343	13	0.010670	9	0.118634	7	0.055629	10	0.03695	11	0.02958
Darrang	-0.09779	17	-0.1215	22	0.15407	6	0.030079	12	-0.09143	17	0.080453	11	0.011276	16	0.057877	9	-0.03595
Lakhimpur	-0.14867	18	-0.10826	19	-0.04808	16	0.042688	11	-0.03609	12	-0.01393	13	0.030416	13	0.008916	13	-0.11129
Dhemaji	-0.22269	19	-0.10415	17	-0.11398	19	-0.09023	17	-0.11609	19	0.08924	10	-0.05611	19	-0.09596	20	-0.0460
Jorhat	0.191966	4	0.183723	1	0.17251	4	0.186362	2	0.24468	1	0.193659	2	0.172628	1	0.272322	1	0.19029
Sonitpur	-0.05435	15	0.048682	8	0.03862	11	-0.03007	15	-0.04577	13	-0.04817	14	0.033674	12	0.039886	10	0.04168
Sibsagar	0.222817	3	0.128699	4	0.24224	1	0.315113	1	0.16772	2	0.186907	3	0.163759	2	0.208267	2	0.22121
Dibrugarh	0.186496	5	0.010588	11	0.13279	8	0.093363	6	0.07853	7	0.134612	5	0.094864	6	0.119367	6	0.03629
Tinsukia	0.086110	8	-0.02996	15	0.09158	10	0.058466	9	-0.03244	11	0.05293	12	0.059661	9	0.03395	12	0.03324
Golaghat	0.100299	7	0.110401	7	0.01121	12	0.08454	7	0.015375	8	0.109458	8	0.081665	7	0.083611	7	0.10651
Cachar	-0.04264	14	0.15813	3	-0.13371	20	0.071543	8	0.118449	5	0.094381	9	0.06005	8	0.073206	8	0.06248
Karimganj	-0.24106	21	0.031446	10	-0.26507	21	-0.18239	21	-0.08972	16	-0.10241	18	-0.03476	17	-0.06375	19	0.01247
Hailakandi	-0.22998	20	0.122907	6	-0.05894	18	-0.10436	20	-0.13145	21	-0.12168	19	-0.05669	20	0.21478	22	0.01526
K.Anglong	-0.29874	22	-0.22164	13	-0.31815	22	-0.2696	22	-0.30887	23	-0.33621	22	-0.29553	23	-0.11584	21	-0.16532
N.C.Hills	-0.30264	23	-0.1055	18	-0.34094	23	-0.33117	23	-0.22457	22	-0.38364	23	-0.24671	22	-0.30795	23	-0.28019

Now taking the weighted average component scores of the whole period i.e from 1990-91 to 1998-99 as variables the first principal component can be measured. The correlation matrix of these 9 variables are given in Table 5. 3.

Table 5. 3 Correlation Matrix

	X1	X2	X3	X4	X5	X6	X7	X8
X2	0.647							
X3	0.838	0.475						
X4	0.830	0.701	0.807					
X5	0.716	0.888	0.651	0.816				
X6	0.773	0.708	0.702	0.882	0.778			
X7	0.819	0.744	0.726	0.908	0.836	0.903		
X8	0.857	0.633	0.750	0.901	0.706	0.841	0.843	
X9	0.635	0.806	0.467	0.735	0.740	0.746	0.691	0.734

The three variables show positively high correlation with each other. The first principal component accounts 78.6 percent of the total variation. The largest eigen value is 7.0750. The composite index of agricultural development given in the follwing equation is the first principal component of the 9 variables.

$$CI = 0.336\frac{X_{11}-\overline{X_1}}{\partial X_1} + 0.310\frac{X_{12}-\overline{X_2}}{\partial X_2} + 0.303\frac{X_{13}-\overline{X_3}}{\partial X_3} + 0.358\frac{X_{14}-\overline{X_4}}{\partial X_4} + 0.336\frac{X_{15}-\overline{X_5}}{\partial X_5}$$
$$+ 0.347\frac{X_{16}-\overline{X_6}}{\partial X_6} + 0.354\frac{X_{17}-\overline{X_7}}{\partial X_7} + 0.344\frac{X_{18}-\overline{X_8}}{\partial X_8} + 0.308\frac{X_{19}-\overline{X_9}}{\partial X_9}$$

After putting the values of the respective variables in the above equation, the value of the composite index of agricultural development has been found out and tabulated (Table 5. 5.) with their respective classes of occurrence. The classification of index has been done in the way as given in Table 5. 4.

Table 5. 4 Classification of Indices

Class interval	Status	Symbols
above 1	Very Developed	VD
0 to 1	Developed	DD
-1 to 0	Developing	DE
above –1	Backward	BD

Table 5. 5 Value of index and Classes of their Occurrence

Sl. No.	Districts	Value of index	Rank	Classes
1.	Goalpara	-0.12993	12	DE
2.	Dhubri	-2.30278	21	BD
3.	Kokrajhar	-0.98895	17	DE
4.	Bongaigaon	-0.71925	14	DE
5.	Barpeta	-0.63403	15	DE
6.	Nalbari	2.370073	5	VD
7.	Kamrup	3.302609	4	VD
8.	Nagaon	3.530144	3	VD
9.	Morigaon	0.278874	10	DD
10.	Darrang	-0.166390	13	DE
11.	Lakhimpur	-0.881950	16	DE
12.	Dhemaji	-1.802220	19	BD
13.	Jorhat	4.202619	2	VD
14.	Sonitpur	0.020951	11	DD
15.	Sibsagar	4.240671	1	VD
16.	Dibrugarh	1.914589	6	VD
17.	Tinsukia	0.687602	9	DD
18.	Golaghat	1.588743	7	DD
19.	Cachar	1.180608	8	DD
20.	Karimganj	-2.045940	20	BD
21.	Hailakandi	-1.174610	18	BD
22.	K.Anglong	-4.989170	22	BD
23.	N.C.Hills	-6.192630	23	BD

The “Very Developed” region consists of 6 districts, namely, Nalbari, Kamrup, Nagaon, Jorhat, Sibsagar and Dibrugarh. The “Developed” region is composed of 5 districts, namely Morigaon, Sonitpur, Tinsukia, Golaghat and Cachar. The “Developing” region encompasses 6 districts like, Goalpara, Kokrajhar, Bongaigaon, Barpeta, Darrang, Lakhimpur. The “Backward” region consists of 6 districts, as Dhubri, Dhemaji, Karimganj, Hailakandi, K.Anglong and N.C.Hills.

Table 5. 6 Agricultural Regions in Assam

Sl. No.	Agricultural Region	Districts Included
1.	Very Developed (6)	Nalbari, Kamrup, Nagaon, Jorhat, Sibsagar and Dibrugarh
2.	Developed (5)	Morigaon,Sonitpur,Tinsukia, Golaghat and Cachar
3.	Developing (6)	Goalpara,Kokrajhar,Bongaigaon, Barpeta,Darrang, and Lakhimpur .
4.	Backward (6)	Dhubri,Dhemaji, Karimganj, Hailakandi, K.Anglong and N.C.Hills

Note: Figures in parentheses indicate number of districts included.

Table 5.7 Classifications of Districts by Natural Division and Level of Agricultural Development

Sl. No.	Region/ Zone	Districts				Total
		Very Developed	Developed	Developing	Backward	
1	North Bank Plains	-	1	2	1	4
2.	Lower Brahmaputra Valley	2	-	4	1	7
3.	Central Brahmaputra Valley	1	1	-	-	2
4.	Upper Brahmaputra Valley	3	2	-	-	5
5.	Barak Valley	-	1	-	2	3
6.	Hill-Zone	-	-	-	2	2
Total		6	5	6	6	23

The findings do not appear contrary to what one may expect. Rather they are reflective of the general notion about the agricultural development of different districts. It is seen from the above table that a few very developed and developed districts are remain some what stable in their position in the entire period by gaining or loosing their position within themselves. Obviously so far agricultural development is concerned, Jorhat, Sibsagar, Kamrup and Nagaon district are the most developed districts among all districts of Assam. On the other hand, N.C.Hills and K.Anglong districts are the two hilly districts where the growth of agricultural development is not satisfactory.

The system of regions presented here is based on the varying degrees of development indicators. The overall state position shows considerable regional or districts wise differences in terms of irrigation facilities, consumption of fertilizer, bank credit facilities and other infrastructural facilities. The area having a good deal of modernization, more bank credit facilities to purchase modern inputs, other infrastructural facilities to the farmers and high cropping intensity have indicated steady progress, whereas the areas without having above mentioned facilities exhibit low and unsteady progress. The present exercise thus established the existence of regional disparities in the level of agricultural development of Assam. Although the present analysis could not cover all the variables associated with the agricultural development, it can safely demand that a reasonably wider domain of agricultural development index has been taken care of. If the agricultural plans are formulated and implemented in accordance with the diversities of different regions, the distance between districts and regions would be narrowed down and the cherished goal of regional balance can be achieved. It would help utilize the resources in an efficient manner and thereby achieve the objectives of regional balance without affecting economic efficiency. The agricultural development potentials of districts would also help formulate and execute district plans. In the following section, regional imbalance in Assam agricultural development will be analysed both at region and district levels.

5.2 **Analysis of Imbalances**

This section discusses the analysis of imbalances in the following three levels:

(i) Imbalance at Macro-level
(ii) Imbalance at Region level, and
(iii) Imbalance at District level

The whole analysis is based on secondary data collected from The Directorate of Economics and Statistics, Assam, The Directorate of Agriculture, Assam and The Chief Engineer, Irrigation, Assam. The data relates to the reference year 1998-99. Altogether 13 non-negative indicators (relative) have been used in the present study which are listed above.. These indicators pertain to different aspects of agricultural development and are positively associated with agricultural development.

(i) Imbalance at Macro Level

The macro level disparities have been analysed with the help of the index of intra-regional imbalance and the co-efficient of imbalances with respect to different relative indicators. The following table shows the level of imbalance in agricultural development in Assam as a whole.

Table 5.8 Imbalance of Agricultural Development in Assam as a whole.

Sl. No	Disaggregation level	Index of Intra-regional Imbalance
1	Agricultural region	34.16
2.	Natural(Agro-climatic zones) region	67.13
3.	District	57.56

It is observed that the degree of intra-regional imbalances is higher in district level than in the agricultural region. Further, the degree of intra-regional imbalance in natural region is higher than the district level. It is observed from the table that intra-regional imbalance is less in agricultural region, which is delineated according to agricultural development than the natural region. Therefore, if it compares the intra-regional imbalance between agricultural region and district level it goes to suggest that the problem of regional disparities in agricultural development is to be tackled at district level where regions was delineated by taking some agricultural development indicators and regional-division may be not suitable for pursuing a policy for regional balance in agricultural development.

Table 5.9 and Table 5.10 show the co-efficient of imbalances of different relative indicators in Assam disaggregated at regional level and at district level. The co-efficient of imbalance when indicators are taken at regional level i.e. in terms of both agricultural region and agro-climatic region can be seen from Table 5.9. The maximum amount of imbalance is found in the case of gross irrigated area in terms of agricultural region. This is because the difference between the use of irrigation in cultivated land in the very developed and backward region is very high. The backward region which consists of two hill-districts, namely N.C.Hills and K.Anglong is relatively very poor in case of using irrigation facilities. This is mainly because of their geographical structure. Moreover, due to recurrent flood also, the irrigation facility is not so easily be used in a satisfactory manner in all the districts of Assam. This reasons also explain the high degree of imbalances in case of HYV seeds use and consumption of fertilizer. The disparity in terms of total number of pumpsets energized and number of tractor use are also significant. In terms of agricultural region net area shown, gross value of agricultural production and literacy rate do not indicate significant degree of imbalances. Regions are almost balanced in respect of the above relative indicators.

In terms of both agricultural and natural regions the gross irrigated area had shown highest degree of imbalances in comparison to other relative indicators. In terms of natural region except gross irrigated area other relative indicator shows some what same degree of regional imbalances. But it can be observed from the Table 5.9 that all the relative indicators in terms of natural region had shown higher degree of imbalances than in case of agricultural region. Obviously, irrigation facilities contribute much to the imbalances in agricultural development.

The extent of the variability in the co-efficient of imbalances of different indicators in Assam disaggregated at district level (Table 5.10) is found to be lower than that at regional level, in terms of agricultural region, but it is higher than that of natural region. It is 0.831 in the district level, where as it is 0.844 in the agricultural region and 0.315 in the natural region.

Table 5.9 Co-efficient of Imbalances in Assam Disaggregated at Regional Level

Relative Indicator	Co-efficient of Imbalance	
	Agricultural region	Natural region
1.Gross irrigated area/ Gross area sown	81.32	132.73
2. Area under HYV seeds/ Gross area sown	29.18	71.05
3. Total consumption of fertiliser/Gross area sown	39.25	79.15
4. Net area sown / Gross	6.86	72.06

area sown		
5.Number of tractor use/ Gross area sown	43.45	78.00
6. Total bank credit / Gross area sown	31.79	75.30
7. Total no. of pump sets energized / Gross area sown	46.15	69.60
8. Gross value of agricultural production/ Gross area sown	10.91	74.43
9. No. of village electrified/Total no. of village	14.79	72.94
10.Total road length/ Geographical area	20.87	71.85
11.Total literate person/ Total population	8.78	71.84
12. Rural population/Gross area sown	15.78	74.84
13.Annual rainfall/ Average rainfall	21.76	76.59
Co-efficient of range	0.844	0.315

If the degree of imbalances in all 13 relative indicators are compared, it can be seen that in terms of district level they are more pronounced than in case of agricultural region. The pattern of dispersal of different indicators does not differ in a marked way at natural region and district level. In the case of district level also there is highest degree of imbalances in respect of gross irrigated area in comparison to all other relative indicators. The total fertilizer consumption, number of tractor, bank credit and pump sets energized indicates higher level of imbalance in both agricultural region and in the district level. Imbalances in the net area shown are found to be lower in both agricultural region and in the district level. In respect of only number of tractor use the degree of imbalances is shown higher in the district level than in the natural region. The degree of imbalances are found to be lower in respect of literacy rate in agricultural region than in the district level. The cropping pattern shows considerable degree of imbalance at district level than at natural region. This can be seen from the co-efficient of range. It may be due to the fact that soil in a district may be more suitable to food crops or non-food crops while aggregation at regional level makes balanced distribution of areas under food crops and non-food crops possible.

Table 5.10 Co-efficient of Imbalance in Assam Disaggregated at District Level

Relative Indicator	Co-efficient of Imbalance
1.Gross irrigated area/ Gross area sown	129.77
2. Area under HYV seeds/ Gross area sown	32.07
3. Total consumption of fertiliser/ Gross area sown	74.88
4. Net area sown / Gross area sown	11.94
5.Number of tractor use/ Gross area sown	88.98
6. Total bank credit / Gross area sown	61.46
7. Total no. of pump sets energized / Gross area sown	64.50
8. Gross value of agricultural production/ Gross area sown	49.49
9. No. of village electrified/Total no. of village	23.51
10. Total road length/Geographical area	28.80
11.Total literate person/Total population	14.24
12. Rural population/Gross area sown	21.94
13.Annual rainfall/ Average rainfall	37.65
Co-efficient of range	0.831

The low extent of imbalance at agricultural regional level in comparison to that at the district level may be attributed besides other factors to the macro-sectoral approach to agricultural planning which is still vague. Such an approach takes into consideration the totality of a region and does not take care of the diversity existing in the constituent areal units of a region. Therefore, from these three conclusions may be derived. In order to tackle the problem of disparities in agricultural development, the problem must be viewed at lower areal levels. Approach to agricultural planning should be area-specific and in conformity with the problems, potentialities priorities of the area. The problem or imbalance is not natural alone, it is rather more a men created phenomenon.

(ii) Imbalance at Region Level

Imbalances at region level have been analysed with the help of balance ratio, co-efficient of imbalances, index of regional imbalance and index of intra-regional imbalance.

a. Balance Ratio

The balance ratio of relative indicators are given in Table 5.11 for agricultural regions and in

Table 5.12 for natural regions. It can be observed from these two tables that "Very Developed" region are favourable in the balance ratio in all most all for all relative indicators

Table 5.11 Balance Ratio of Relative Indicators in Agricultural Regions in Assam

Relative Indicator	Regions			
	Very Developed	Developed	Developing	Backward
1.Gross irrigated area/ Gross area sown	1.068	0.932	0.870	2.551
2. Area under HYV seeds/ Gross area sown	1.183	1.130	0.724	0.856
3. Total consumption of fertiliser/ Gross area sown	1.177	1.192	0.744	0.341
4. Net area sown / Gross area sown	1.075	1.036	0.893	0.979
5.Number of tractor use/ Gross area sown	1.127	1.403	0.617	0.345
6. Total bank credit / Gross area sown	1.515	0.963	0.773	0.707
7. Total No. of pump sets energized / Gross area sown	1.702	0.991	0.682	0.492
8. Gross value of agricultural production/ Gross area sown	1.188	0.953	0.959	0.909
9. No. of village electrified/Total no. of village	1.059	1.055	1.010	0.716
10. Total road length/Geographical area	1.319	0.990	0.867	0.766
11.Total literate person/Total population	1.129	1.012	0.917	0.915
12. Rural population/Gross area sown	1.037	1.130	0.909	0.730
13.Annual rainfall/ Average rainfall	0.775	1.049	1.125	0.728

except rainfall while in "Developed" region the balance ratio is balanced. The balance ratio of relative indicators is deficient in both for "Developing" and "Backward" region. In the "Backward" region, the balance ratio is very favourable in the case of irrigation facilities. Similarly from Table 5.12 it can be seen that the balance ratio of relative indicators are almost favourable for both Upper Brahmaputra Valley and Barak Valley. The balance ratio of relative indicators in Lower Brahmaputra Valley, Central Brahmaputra Valley and North Bank Plains are some how balanced. The balance ratio of relative indicators in Hill zones are deficient.

Table 5.12 Balance Ratio of Relative Indicators in Natural Regions in Assam

Relative Indicator	Regions					
	N.B.P.	L.B.V.	C.B.V.	U.B.V.	B.V.	H.Z
1.Gross irrigated area/ Gross area sown	1.360	0.823	1.823	0.113	0.042	3.735
2. Area under HYV seeds/ Gross area sown	0.804	0.907	1.470	1.009	1.219	0.989
3. Total consumption of fertiliser/	0.483	1.192	2.612	0.912	0.947	0.048

Gross area sown						
4. Net area sown / Gross area sown	0.935	0.948	0.893	1.108	1.080	1.029
5.Number of tractor use/ Gross area sown	0.992	0.448	0.677	1.869	1.525	0.311
6. Total bank credit / Gross area sown	0.978	1.122	0.624	1.342	0.507	0.878
7. Total no. of pump sets energized / Gross area sown	0.734	0.916	1.170	1.270	1.000	0.450
8. Gross value of agricultural production/ Gross area sown	0.934	0.822	1.064	1.088	1.444	0.803
9. No. of village electrified/Total no. of village	0.897	1.161	1.058	1.000	1.015	0.563
10. Total road length/Geographical area	0.915	1.070	1.269	1.125	0.759	0.705
11.Total literate person/Total population	0.970	0.923	0.954	1.116	1.053	1.009
12. Rural population/Gross area sown	0.933	0.963	0.947	1.021	1.420	0.633
13.Annual rainfall/ Average rainfall	1.023	1.213	0.974	0.687	1.387	0.438

Note: N.B.P.: North Bank Plains, L.B.V.; Lower Brahmaputra Valley, C.B.V: Central Brahmaputra Valley, U.B.V.:Upper Brahmaputra Valley, B.V.: Barak Valley and H.Z.: Hill Zones.

b. Co-efficient of Imbalance

The co-efficient of imbalances of different relative indicators can be seen from Table 5.13 for agricultural regions and from Table 5.14 for natural regions. Co-efficient of imbalances shows once again similar pattern in both agricultural regions and natural regions. So far indicators are concern irrigation, use of HYV seeds, fertilizer, no. of tractor use, bank credit facilities, pump sets energized, gross value of agricultural production, village electrification, total road length and rainfall are associated with high magnitude of the co-efficient of imbalances. The co-efficient of imbalances are widely varied both between regions and for different indicators within a region except in cases of cropping intensity, literacy rate and pressure of rural population.

Table 5.13 Co-efficient of Imbalance in Assam Disaggregated at District Level

Relative Indicator	Regions			
	Very Developed	Developed	Developing	Backward
1.Gross irrigated area/ Gross area sown	118.66	102.81	87.40	228.63
2. Area under HYV seeds/ Gross area sown	46.71	41.06	40.68	50.79
3. Total consumption of fertiliser/ Gross area sown	52.96	96.35	77.43	95.46
4. Net area sown / Gross area sown	13.58	33.05	55.87	55.61
5.Number of tractor use/ Gross area sown	46.06	128.49	69.61	80.01
6. Total bank credit / Gross area sown	105.57	52.17	62.50	61.26
7. Total no. of pump sets energized / Gross area sown	107.56	53.49	68.94	72.67
8. Gross value of agricultural production/ Gross area sown	39.81	60.17	56.18	58.73
9. No. of village electrified/Total no. of village	36.93	35.07	61.52	65.76
10. Total road length/Geographical area	37.67	41.81	57.28	60.67
11.Total literate person/Total population	18.48	32.78	35.63	56.63
12. Rural population/Gross area sown	11.01	41.64	35.47	53.01
13.Annual rainfall/ Average rainfall	31.33	42.70	62.27	71.20

5.14 Co-efficient of Imbalance in Natural Regions of Assam

Relative Indicator	Regions						
	N.B.P.	L.B.V.	C.B.V.	U.B.V.	B.V.	H.Z	Assam
1.Gross irrigated area/ Gross area sown	129.18	64.26	140.47	91.38	95.85	273.98	129.77
2.Area under HYVseeds/ Gross area sown	31.74	26.77	47.30	49.22	59.63	53.35	32.07
3. Total consumption of fertiliser/ Gross area sown	67.65	40.20	174.34	57.15	70.66	95.21	74.88
4. Net area sown / Gross area sown	12.27	12.06	10.89	16.49	13.32	3.68	11.94
5.Number of tractor use/ Gross area sown	31.06	58.07	50.32	59.83	105.71	69.14	88.98
6. Total bank credit / Gross area sown	31.86	92.11	37.95	62.59	77.01	28.04	61.46
7. Total no. of pump sets energized / Gross area sown	42.31	43.58	162.69	64.34	60.44	56.28	64.50
8. Gross value of agricultural production/ Gross area sown	14.51	32.19	8.15	60.07	90.68	25.47	49.49

9. No. of village electrified/Total no. of village	32.98	17.69	31.56	46.63	57.18	43.83	23.51
10. Total road length/Geographical area	18.02	30.65	29.74	54.17	58.17	30.01	28.80
11.Total literate person/Total population	12.25	18.42	8.29	16.97	14.97	11.01	14.24
12. Rural population/Gross area sown	9.65	11.10	15.32	14.99	13.53	16.74	13.94
13.Annual rainfall/ Average rainfall	26.32	40.92	16.04	54.49	66.46	56.17	37.65

Note: N.B.P.: North Bank Plains, L.B.V.; Lower Brahmaputra Valley, C.B.V: Central Brahmaputra Valley, U.B.V.:Upper Brahmaputra Valley, B.V.: Barak Valley and H.Z.: Hill Zones.

c. Inter-Regional Imbalance

The inter-regional imbalance has been measured by taking values of different indicators at region-levels. It may be observed from Table 5.15 that among agricultural regions, “Backward” region has shown the maximum degree of diversity and it is followed by “Very Developed”, “Developing” and “Developed” region respectively. Among natural regions, Hill zone is most diversed followed by Central Brahmaputra Valley, Barak Valley and Upper Brahmaputra Valley. In North Bank Plains and Lower Brahmaputra Valley similar agricultural conditions and agricultural practices put them in the similar category.

Table 5.15 Index of Inter-Regional Imbalance in Assam

Region	Index of Regional Imbalance
A. Agricultural Region	
1. Very Developed	28.53
2. Developed	19.84
3. Developing	20.88
4. Backward	54.99
B. Natural Region	
1. North Bank Plains	20.35
2. Lower Brahmaputra Valley	20.03
3. Central Brahmaputra Valley	57.71
4. Upper Brahmaputra Valley	38.10
5. Barak Valley	39.99
6. Hill Zone	87.51

d. Intra-Regional Imbalance

The intra-regional imbalances in different regions can be seen from the Table 5.16. These imbalances have been explained by taking data at district-level. As compared to regions,

Table 5.16 Index of Intra-Regional Imbalance in Assam

Region	Index of Regional Imbalance
A. Agricultural Region	
1. Very Developed	14.27
2. Developed	9.92
3. Developing	10.44
4. Backward	27.50
B. Natural Region	
1. North Bank Plains	8.31
2. Lower Brahmaputra Valley	8.18
3. Central Brahmaputra Valley	23.56
4. Upper Brahmaputra Valley	15.56
5. Barak Valley	35.27
6. Hill Zone	48.27

imbalances at district levels are not such significant. The “Backward” region once again is most heterogeneous followed by “Very Developed”,”Developing” and “Developed’ region. Among natural regions again Hill zone shows the maximum degree of diversity followed by Barak Valley and Central Brahmaputra Valley. Lower Brahmaputra Valley, North Bank Plains and Upper Brahmaputra Valley shows low degree of diversity in terms of intra-regional imbalances.

The index of intra-regional imbalance can also be seen at the district level. From Table 5.17, it is seen that the intra-regional imbalance are highest in the backward districts and very developed districts followed by developed and developing districts. This reveals the same whatever has been observed in the previous section.

Table 5.17 Index of Intra-Regional Imbalance Disaggregated at District Level.

District	Index of Intra-Regional Imbalances
1.Goalpara	0.56
2.Dhubri	0.63
3.Kokrajhar	0.58
4.Bongaigaon	0.69
5.Barpeta	0.45
6.Nalbari	0.59
7.Kamrup	2.31
8.Nagaon	3.37
9.Morigaon	2.31
10.Darrang	0.53
11.Lakhimpur	0.66
12.Dhemaji	1.08
13.Jorhat	1.06
14.Sonitpur	1.57
15.Sibsagar	0.82
16.Dibrugarh	0.78
17.Tinsukia	3.91
18.Golaghat	0.35
19.Cachar	1.02
20.Karimganj	1.57
21.Hailakandi	1.34
22.K.Anglong	3.80
23.N.C.Hills	3.14

(iii) Imbalance at District Level

The imbalance at district level has been made here to highlight the broad disparity of different districts in respect of agricultural development. The imbalance at district level can be seen from Table 5.18. Different districts are quite heterogeneous in respect of different indicators both within the region and between the regions. However, cropping intensity

Table 5.18 Balance Ratio of Relative Indicators in Districts

Relative Indicator	Balance Ratio					
	Very Developed Region					
	Sibsagar	Jorhat	Kamrup	Nagaon	Nalbari	Dibrugarh
1.Gross irrigated area/ Gross area sown	0.076	0.140	1.972	2.961	0.945	0.931
2. Area under HYV seeds/ Gross area sown	1.403	0.939	1.030	1.418	1.274	0.799
3. Total consumption of	0.720	0.900	1.585	1.948	1.344	0.305

fertiliser/ Gross area sown						
4. Net area sown / Gross area sown	1.266	1.072	1.032	0.916	1.051	1.085
5.Number of tractor use/ Gross area sown	1.452	1.754	0.478	1.063	0.738	1.127
6. Total bank credit / Gross area sown	1.670	1.076	3.222	0.573	0.993	1.717
7. Total no. of pump sets energized / Gross area sown	1.259	2.003	1.085	3.169	1.670	1.084
8. Gross value of agricultural production/ Gross area sown	1.331	1.572	0.550	1.114	0.794	0.511
9. No. of village electrified/Total no. of village	1.212	0.950	1.176	1.158	1.276	1.103
10. Total road length/Geographical area	1.576	1.369	1.289	1.396	1.596	0.905
11.Total literate person/Total population	1.187	1.241	1.235	0.885	1.077	1.108
12. Rural population/Gross area sown	1.116	0.916	1.004	1.195	0.940	0.980
13.Annual rainfall/ Average rainfall	0.787	0.459	0.808	1.133	0.933	0.757

shows almost similar pattern over the districts. Divergence is quite marked in respect of irrigated area, tractorisation, use of fertilizer and bank credit facilities. The balance ratio of length of surfaced road in a district, literacy rate, pressure of rural population and annual rainfall are remain somewhat same in all most all districts and do not have a definite relation to the level of agricultural development.

Table 5.18 (Continued)

Relative Indicator	Balance Ratio				
	Developed Region				
	Golaghat	Cachar	Tinsukia	Morigaon	Sonitpur
1.Gross irrigated area/ Gross area sown	0.192	0.042	0.124	0.685	3.041
2. Area under HYV seeds/ Gross area sown	1.123	1.113	0.781	1.523	1.031
3. Total consumption of fertiliser/ Gross area sown	0.731	0.984	1.905	3.276	0.453
4. Net area sown / Gross area sown	1.091	1.174	1.024	0.871	0.946
5.Number of tractor use/ Gross area sown	0.888	1.966	4.123	0.291	1.331
6. Total bank credit / Gross area sown	1.035	0.817	1.211	0.675	1.146
7. Total no. of pump sets energized / Gross area sown	0.994	1.538	1.012	0.232	1.265
8. Gross value of agricultural production/ Gross area sown	1.374	1.535	0.652	1.013	0.947
9. No. of village electrified/Total no. of village	0.800	1.157	0.933	0.958	1.069
10. Total road length/Geographical area	0.964	0.570	0.809	1.141	0.887
11.Total literate person/Total population	1.094	1.114	0.947	1.023	0.914
12. Rural population/Gross area sown	0.957	1.458	1.138	0.700	1.012
13.Annual rainfall/ Average rainfall	0.687	1.366	0.743	0.816	0.991

Table 5.18 (Continued)

Relative Indicator	Balance Ratio					
	Developing Region					
	Goalpara	Darrang	Bongaigaon	Lakhimpur	Barpeta	Kokrajhar
1.Gross irrigated area/ Gross area sown	0.536	2.054	0.478	0.288	1.455	0.888
2. Area under HYV seeds/ Gross area sown	1.110	1.065	0.927	0.632	0.440	0.795
3. Total consumption of fertiliser/ Gross area sown	1.503	1.201	1.514	0.209	0.805	0.668
4. Net area sown / Gross area sown	1.111	1.094	0.881	0.807	0.784	0.897
5.Number of tractor use/ Gross area sown	0.445	1.246	0.089	0.572	0.414	0.560
6. Total bank credit / Gross	1.405	0.786	0.604	1.402	0.703	0.564

area sown						
7. Total no. of pump sets energized / Gross area sown	0.661	0.528	0.364	0.741	0.734	1.321
8. Gross value of agricultural production/ Gross area sown	0.328	0.913	0.896	0.756	1.014	1.055
9. No. of village electrified/Total no. of village	1.113	1.191	1.196	0.954	1.159	1.187
10. Total road length/Geographical area	1.289	1.082	0.778	1.021	0.903	0.784
11.Total literate person/Total population	0.884	0.812	0.948	1.129	0.817	0.770
12. Rural population/Gross area sown	1.140	0.874	0.915	0.855	0.779	1.036
13.Annual rainfall/ Average rainfall	1.042	1.047	1.110	1.397	1.334	1.954

The districts of Upper and Lower Brahmaputra Valley, which cover most of the "Very Developed" region, are most favourably placed in terms of agricultural development. On the other hand the districts of Barak Valley and Hill Zone, which cover most of the "Backward" region are deficient in terms of agricultural development. The districts of North Bank Plans and Central Brahmaputra Valley are more or less evenly placed in terms of agricultural development.

Table 5.18 (continued)

Relative Indicator	Balance Ratio					
	Backward Region					
	Hailakandi	Dhemaji	Karimganj	Dhubri	K.Anglong	N.C.Hills
1.Gross irrigated area/ Gross area sown	0.051	0.056	0.031	0.183	1.903	1.566
2. Area under HYV seeds/ Gross area sown	0.190	0.488	0.354	0.771	1.421	0.374
3. Total consumption of fertiliser/ Gross area sown	0.463	0.069	0.394	0.927	0.064	0.032
4. Net area sown / Gross area sown	1.120	0.895	0.945	0.879	1.001	1.052
5.Number of tractor use/ Gross area sown	0.384	0.820	0.225	0.412	0.254	0.368
6. Total bank credit / Gross area sown	0.412	0.579	0.290	0.364	1.130	0.625
7. Total no. of pump sets energized / Gross area sown	0.531	0.404	0.930	0.576	0.330	0.570
8. Gross value of agricultural production/ Gross area sown	0.599	1.120	1.198	1.120	0.641	0.965

9. No. of village electrified/Total no. of village	1.134	0.374	0.754	1.022	0.533	0.593
10. Total road length/Geographical area	0.750	0.669	0.957	0.889	0.759	0.650
11.Total literate person/Total population	0.130	1.024	1.031	0.728	0.899	1.118
12. Rural population/Gross area sown	0.326	0.993	1.477	0.925	0.637	0.628
13.Annual rainfall/ Average rainfall	0.162	0.658	1.643	1.309	0.437	0.439

The degree of imbalances of different districts are given in Table 5.19. In terms of disparity, K.Anglong ranks first followed by Hailakandi, N.C.Hills and Morigaon. These districts except Morigaon are placed in "Backward" region and they are not agriculturally better placed. The high degree of diversity in these districts may be attributed to irrigation, fertilizer use, tractorisation and bank credit facilities. Among the least diversed districts, Kamrup ranks first followed by Nagaon, Jorhat and Golaghat. These districts are placed in a better position in respect of different relative indicators and agriculturally developed.

Table 5.19 Index of Regional Imbalance of Districts and Region in Assam

District/Region	Index of Regional Imbalance
1. Sibsagar	43.55
2.Jorhat	24.02
3. Kamrup	22.94
4.Nagaon	23.56
5. Nalbari	36.92
6. Dibrugarh	32.93
Very developed Region	28.53
7. Golaghat	28.45
8. Cachar	48.52
9. Tinsukia	44.79
10. Morigaon	72.93
11. Sonitpur	60.12
Developed Region	19.84
12. Goalpara	35.76
13. Darrang	35.06
14. Bongaigaon	39.87
15. lakhimpur	38.98
16. Barpeta	42.06
17. Kokrajhar	36.46
Developing Ragion	20.88

18. Hailakandi	90.79
19. Dhemaji	59.83
20. Karimganj	60.02
21. Dhubri	67.94
22. K.Anglong	93.52
23. N.C.Hills	89.01
Backward Region	54.99

It may, then, be observed that the intensity of imbalance is more pronounced at lower level of agricultural development as compared to that at higher level of agricultural development. In order to examine the relation between the stage of development of a region and imbalance within the region Table 5.20. is prepared. It may be observed that the extent of intra-regional imbalance has got inverse relation with agricultural development of regions. The index of intra-regional imbalance has been found 27.50 in “Backward” region as against 14.27 in “Very Developed” region, 9.92 in “Developed” region and 10.44 in “Developing” region. The degree of imbalance is high in “Backward” region compared to other regions.

Table 5.20 Index of Intra-Regional Imbalance in Agricultural Region of Assam

Agricultural Region	Index of Regional Imbalance
1. Very Developed	14.27
2. Developed	9.92
3. Developing	10.44
4. Backward	27.50

The degree of imbalance is low at macro-level, i.e in the economy of Assam as a whole and high at lower areal levels. The index of Intra-regional imbalance in Assam disaggregated at agricultural region was found to be 34.16 whereas it worked out 57.56 when the economy of Assam was disaggregated at district level. This goes to suggest that the problem of imbalance should be viewed and tackled at area-levels. Instead of macro-planning there should be area-based planning which would take proper care of the disparity of different areas in the farme of their potentialities, needs and priorities in order to ensure regional balance. Thus the hypothesis that there is considerable degree of imbalance in agricultural development in Assam necessitating area-based planning gets substantiated.

5.3 Factors Responsible for Disparities

Among the factors, which affect imbalances in district, region and Assam as a whole irrigation and modern agricultural inputs were found dominating. Among individual indicators mention may be made of use of HYV seeds, use of fertilizer, tractorisation, pump sets and bank credit facilities. The cropping intensity does not show the imbalance in a significant way. The degree of gross value of agricultural production, literacy rate and pressure of rural population do not explain imbalances in agricultural development. The factors considered in the analysis are not exhaustive. However, a clue to factors, which affect imbalance, may be obtained from the examination of the effects of these indicators. The present study has its limitations, as it could not take into account some of the other factors, which may be responsible for imbalances in agricultural development in Assam. However, it may be inferred that man-made factors such as irrigation facilities, use of HYV seeds, use of fertiliser, tractorisation, pumpsets and bank credit have greater impact on occurance of imbalances in agricultural development. It goes to support the hypothesis that imbalance is largely man-made.

The lower degree of imbalance at region than at district level may be attributed to the success of schematic planning in the state. It also suggests lack of efforts towards striking balance between areal units. No attempt has been made in Assam to take spatial diversification of different areas into account either in formulation, execution or in monitoring of agricultural development plans. The District Planning has been started only recently and it has still to take a concrete shape. These observations underline the role of human effort in achieving regional balance and balanced agricultural development.

Chapter 6

Regionalisation of the State and Results of Spatio-Temporal Dynamism in the Level of Agricultural Development

6.1 Regionalisation –Concept and Approaches

The concept of regionalisation originated as early as 5th century B.C. when Herediotus made an attempt to divide the then known world into regions. The modern regional consciousness and thinking in terms of areas and regions instead of places and points began only in the beginning of the present century. Credit goes to the monumental work in 1903 on the 'Geography of France' by Vidal de la Blache. Regionalisation is of recent origin in the field of Economics. India recognized regionalisation much after the Second World War and not before the Third Five Year Plan.

Regionalisation has got two approaches- the first being that of delineating a system of regions considering the static elements of space, the approach, the geographers are most familiar with and is based on maximum internal homogeneity principle. The second involves the dynamic aspects of spatial processes such that it takes in to account the inter-regional disparity, diversity, inter-linked spatially differentiated resources, their levels of utilization and changing settlement structure[133]. However, in the present study of regionalisation of Assam, the second approach has been considered. Following the second approach, the regionalisation tries to identify disparities in the levels of development of the constituent regions. Regions do change over time; they change in response to changing inter-relationship of the spatial elements. Change if evolutionary is a slow process but could be very rapid through planned intervention in the socio-economic sphere. It is an empirically tested and scientifically established fact that unless a deliberate and very careful control over the spatial dynamic of development is not exercised with the development of the state, the advanced regions will go on developing leaving the backward regions languishing in the dark. It is

[133] C.R.Pathak and A.Kundu, Regionalisation and Regional Planning-An Axiomatic Approach, 1973.

often found that while some regions maintain a high rate of growth, others experience just the reverse, and only a few could achieve proportionality.

Hence, regionalisation technique emerges not as a “cutting up” of the country into territorial parts for the convenience of research, but systematic uncovering of actually existing integrated territorial unit.

6.2 Regionalisation-Methodology

Coming to the methodology of regionalisation, it is felt necessary to determine and select the indicators of agricultural development in order to identify the level of development. In the present analysis, the same relative indicators are taken whatever are taken in chapter 5. The required data relates to the reference year 1990-91 to 1998-99 for the six agro-climatic zones i.e North Bank Plains, Upper Brahmaputra Valley, Central Brahmaputra Valley, Lower Brahmaputra Valley, Barak Valley and Hill Zones. In this study, the Principal Component Analysis (PCA), first developed by H.Hotelling in 1933, has been adopted for constructing composite indices. The technique of Principal Component Analysis and the method of estimation thereof have been discussed in detail in chapter 4.

6.3 Identification of the Level of Agricultural Development of the Agro-Climatic Zones

After applying the Principal Component Analysis (PCA), the values of the indices of agricultural development have been found out and tabulated in the Table 6.2 with their

Table 6.1 Classification of Indices

Class Symbols	Class interval of indices
Above 2	Very Developed
1 to 2	Developed
0 to 1	Developing
Below 0	Backward

respective classes of occurrence. The classification of indices has been done in the way as given in Table 6.1.

Table 6.2 Values of Indices and Classes of its Occurrence

Agro-climatic zones	Values of index	Class symbol of index
North Bank Plains	0.36588	Developing
Lower Brahmaputra Valley	4.62587	Very Developed
Central Brahmaputra valley	1.33176	Developed
Upper Brahmaputra Valley	2.12345	Very Developed
Barak Valley	-0.49106	Backward
Hill Zones	-3.56267	Backward

Following Table 6.2 the development levels in the agricultural sector of the agro-climatic zones of Assam could be identified by arranging the agro-climatic zones in the following order:

(a) Very Developed agro-climatic zones--Lower Brahmaputra Valley and Upper Brahmaputra Valley
(b) Developed agro-climatic zones—Central Brahmaputra Valley
(c) Developing agro-climatic zones— North Bank Plains
(d) Backward agro-climatic zones— Barak Valley and Hill zones.

It is found that the districts under the "Very Developed" zones are in a better placed in terms of input use while the districts under the "Backward" zones are poor in terms of input use. The districts under "Developed" and "Developing" zones are somewhat more or less placed in a position where uses of inputs are moderate.

6.4 Spatial Disparity in the level of Agricultural Development in Assam

This section examines the existence of spatial disparity in the level of agricultural development in Assam, which requires a rigorous production function technique to make the analysis. With this aim, the section deals with the estimates of the aggregative agricultural production function for the selected agro-climatic regions of the state of Assam. As discussed earlier in chapter 4, a production function tries to capture the relationship between output and input, and the inputs in the case of agricultural range from the physical and measurable inputs to the immeasurable social, institutional and climatic factors.

The production function has been fitted to the aggregated annual output of food grains, agro-climatic zone-wise, for the period from 1990-91 to 1998-99. As discussed in chapter 4, Cobb-Douglas production function has been used which is also known as the linear in logarithm.

The equation for the Cobb-Douglas production function is

$$Y_{rt} = \alpha \prod_{j=1}^{N} X_{jrt}^{\beta_j} e^{u_{rt}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(6.4.1)$$

as considered 13 inputs, so the equation will be as follows

$$Y_{rt} = \alpha X_{1rt}^{\beta_1} X_{2rt}^{\beta_2} X_{3rt}^{\beta_3} X_{4rt}^{\beta_4} X_{5rt}^{\beta_5} X_{6rt}^{\beta_6} X_{7rt}^{\beta_7} X_{8rt}^{\beta_8} X_{9rt}^{\beta_9} X_{10rt}^{\beta_{10}} X_{11rt}^{\beta_{11}} X_{12rt}^{\beta_{12}} X_{13rt}^{\beta_{13}} e^{u_{rt}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(6.4.2)$$

Taking natural log on both sides we have,

$$LnY_{rt} = Ln\alpha + \beta_1 LnX_{1rt} + \beta_2 LnX_{2rt} + \beta_3 LnX_{3rt} + \beta_4 LnX_{4rt} + \beta_5 LnX_{5rt} + \beta_6 LnX_{6rt} + \beta_7 LnX_{7rt} + \beta_8 LnX_{8rt} + \beta_9 LnX_{9rt} + \beta_{10} LnX_{10rt} + \beta_{11} LnX_{11rt} + \beta_{12} LnX_{12rt} + \beta_{13} LnX_{13rt} + U_{rt}$$

Where, Y_{rt} = Volume of aggregate food grains production (agro-climatic zone wise)

X_{1rt} = Gross irrigated area/Gross area sown (agro-climatic zone wise)

X_{2rt} = Area under HYV seeds/Gross area sown (agro-climatic zone wise)

X_{3rt} = Consumption of fertilizer/Gross area sown (agro-climatic zone wise)

X_{4rt} = Net area sown/Gross cropped area (agro-climatic zone wise)

X_{5rt} = Number of tractor use/Gross area sown (agro-climatic zone wise)

X_{6rt} = Total amount of bank credit/Gross area sown (agro-climatic zone wise)

X_{7rt} = Number of pump sets energized/Gross area sown (agro-climatic zone wise)

X_{8rt} = Gross value of agricultural production/Gross area sown (agro-climatic zone wise)

X_{9rt}= Number of village electrified/Total no. of village (agro-climatic zone wise)

X_{10rt} = Road length/Geographical area (agro-climatic zone wise)

X_{11rt}= Total no. of literate people/Total population (agro-climatic zone wise)

X_{12rt}= Rural population/Gross area sown (agro-climatic zone wise) and

X_{13rt}= Annual rainfall/State average annual rainfall (agro-climatic zone wise)

U_{rt} = Residual

r = Region (r = 1,2,3…..6)

t = time period (t = 1,2,…….9); 1990-91 to 1998-99

α = constant

β_i's = Output elasticity with respect to input i.

Table 6.3 Estimates of the Cobb-Douglas Production Function

Variables	Original Variables			Transformed Variables		
	Co-efficient	STD error	t- value	Co-efficient	STD error	t-value
X_1	0.81	0.07	11.57*	0.75	0.06	12.50*
X_2	0.45	0.19	2.37*	0.38	0.17	2.24*
X_3	0.72	0.07	10.29*	0.49	0.03	16.33*
X_4	-0.24	0.47	0.51	-0.43	0.37	1.16
X_5	0.56	0.10	5.60*	0.47	0.13	3.62*
X_6	0.23	0.16	1.44	0.15	0.13	1.15
X_7	0.60	0.11	5.45*	0.54	0.14	3.86*
X_8	0.16	0.19	0.84	0.04	0.17	0.24
X_9	0.01	0.03	0.33	0.01	0.02	0.50
X_{10}	0.26	0.28	0.92	0.21	0.20	1.05
X_{11}	0.16	0.89	0.18	0.12	0.70	0.17
X_{12}	-0.06	0.40	0.15	-0.02	0.33	0.06
X_{13}	-0.03	0.13	0.23	-0.08	0.11	0.73
Constant	15.15	4.54	3.34*	57.85	13.54	4.27*
R^2	0.84			0.86		

*. Significant at 5% level of significance.

It is assumed that all the six agro-climatic zones lie on the same production function. After that Ordinary Least Square method (OLS) has been run on the pooled data and the estimated results of Cobb-Douglas production function for the pooled analysis are tabulated in Table 6.3. Two sets of estimates have been calculated, using (i) OLS on the original variables and (ii) OLS on the transformed variables. The OLS estimates from the original variables are likely to be affected due to the omission of relevant regional time-invariant factors and also because of the special problems of pooling cross-section and time-series data.

Before an analysis is made to interpret the results of the OLS before and after transformation, first it is better to find out the individual contribution of each of the inputs. From Table 6.3, it is observed that irrigation plays the most important role followed by use of fertilizer, pump sets energized , tractorisation and use of HYV seeds. It is known that without irrigation, use of fertilizer, use of HYV seeds and mechanization is meaningless as irrigation is the root ingredient for the use of modern inputs. The same thing can be seen from here also is that whenever irrigation plays important role in increasing food grains production, other modern inputs also playing important role in increasing food grains production. It shows that keeping other variables constant, if there is an increase in the irrigation facilities by 1 percent then it can be anticipate that there will be an increase in the food grains production by 0.81 percent. Similarly due to increase in use of fertiliser, use of HYV seeds, pumpsets energized and tractorisation by 1 percent respectively, food grains production will increase by 0.72, 0.45, 0.60 and 0.56 percent respectively. The contribution of length of road surfaced and bank credit facilities are remarkable in increasing food grains production in the State. Keeping other variables constant, 1 percent increase in road length and bank credit facilities respectively brings positive change of 0.26 and 0.23 percent in food grains production respectively. The contribution of gross value of agricultural production, village electrification and literacy rate are negligible in increasing food grains production. This shows that keeping other variables constant; if these variables are increase by 1 percent respectively then there will be 0.16, 0.01 and 0.16 percent increase in the agricultural production respectively. It can also be noted from Table 6.3 that the sum of the production elasticity's is greater than unity, which means that the agricultural production throughout the state is on increasing returns to scale. It means that if all inputs are increased by 100 percent, the output of food grains will rise by 304 percent. The value of R^2 is 0.84, which indicates that the thirteen variables included in the study explain 84 percent variation in the gross output level. From the t-value it can be seen that those variables who's co-efficient are remarkable are also significant at 5% level of significance.

So long, it has been discussed about the production elasticities of each of the inputs based on their original values. Next discussion will deal with the OLS estimates after the transformation of the original variables. The co-efficient obtained from the transformed variables are presented in the same Table 6.3. The transformation here has been performed by decomposing the residuals into two components-regional (and time-invariant) and random (varying both over region and time). A comparison of the result before and after transformation shows that all the thirteen co-efficient (related to thirteen variables) values has been reduced. Similar changes took place in the study made by Balestra and Nerlove (1966). One possible reason for the reduction of the co-efficient is that variables that are excluded from the study, e.g. the quality variables, the management variables, the efficiency variables are region-specific and time variant, and have all positive association with and less variation than the included variables.The transformation of data, by removing this effect, produces reduced but efficient estimates. The difference in the co-efficient yielded by the OLS on original level of variable and the transformed variables may be interpreted as reflecting the effects of region-specific factors such as, quality, efficiency and management. If allowances are made for these factors, there should be larger application of those variables whose co-efficient have decreased by transformation. Thus, for Assam agriculture, the results suggest that for increased production, the inputs whatever are included in the study should be increased. The R^2 being 0.86 indicates that the thirteen transformed variables together explain 86 percent variation in the output level. Here also from t-value it can be seen that those variables that's co-efficient are remarkable are significant at 5% level of significance.

Before concluding the discussion on the results of the production function, some points require special mention. First, it is quite probable that if production function is fitted for different agro-climatic zones then, different results would have been there for different agro-climatic zones. But since more or less, all the agro-climatic zones run on an almost similar production function, the combined estimate reflect the broad pattern of agricultural production. Secondly, the input data used in the study are highly aggregative, and, if these could be broken down into different types and qualities, it is quite likely that a much larger proportion of the output variation could be explained. Thirdly, since it has been observed in the present study that increases in known input can lead only to limited increases in agricultural output, the explanation for the growth of it should be sought beyond known and traditional inputs.

6.5 Spatial-Dynamism in the Level of Agricultural Development

This section deals with the examination of regional effect. It is often observed that even though the same level of the known inputs is used in two regions, there is still difference in output levels. This may be due to differences other than input use in the vary nature of the regions that are stable over time. Such time invariant regional nature may be reflected in the qualitative, climatic and institutional factors. For example, two regions may differ as far as the quality of land or inputs is concerned. It may also be that one region is using more of same input not explicitly included in the calculation, than another region. The region may be on different technological levels, or even the history and tradition of one region may be more conducive to greater efficiency in the use of identical inputs. Assuming that none of these factors (qualitative, climatic and institutional) change systematically over time in such a way as to alter the rankings of the regions with respect to the use of input concerned, the combined effects of these omitted factors is known as the spatial or regional effect. Such an effect brings spatial dynamism in the level of agricultural production.

The estimate of the spatial (or regional) effect has been derived by the econometric technique discussed in chapter 4. The estimate of spatial effect is the value of component e^{μ_r} of the residual of the Cobb-Douglas production function (equation 4.3.7). The econometric method, as developed in chapter 4 employed to construct the production function in an error component model enables the derivation of the regional effects from the residual of the function.

The estimates of the spatial effect on the basis of the error-component model constructed for the six agro-climatic zones of the State for the period 1990-91 to 1998-99 have been tabulated in Table 6.4. It may be pointed out that in view of the limitations in the data used, the estimates presented here should be interpreted for policy purposes as broad indicators rather than precise magnitudes of regional differences.

Table 6.4 Spatial Effects based on an Error-Component Model

Rank	Agro-climatic Zones	Spatial (Regional) effect
1.	Lower Brahmaputra Valley	13.85
2.	Upper Brahmaputra Valley	13.52
3.	North Bank Plains	13.39
4.	Central Brahmaputra Valley	13.18
5.	Barak Valley	12.82
6.	Hill Zones	12.25

The estimates ranging from 13.85 in Lower Brahmaputra Valley to 12.25 in Hill Zones indicates a wide disparity between the agro-climatic zones of the state in agricultural development. The implication of the spatial (regional) effect is that if for example, the lower Brahmaputra Valley uses the same quantity of all inputs, the output in the Lower Brahmaputra Valley is likely to be about 1.13 times than that of Hill Zones provided, of course, that there is no disturbance due to weather effect. It should be noted, however, that in reality the qualities of inputs are almost in all cases different between regions, either adding to or dampening the purely regional effects. The effect of the weather and their temporal factor are similar; one region with a high region effect may suffer an unusual drought or flood in a given year, thus wiping out its favoured technical advantage.

It is important to note that the results of the spatial effect do conform to the result of the regionalisation effect (Table 6.2). It can be seen that the ranking of the agro-climatic zones is almost identical with spatial (regional) effects and regionalisation indices. Such an identical result indicates that over a period of time, the agro-climatic regions behave in a particular fashion towards agricultural development.

The argument put forward regarding the rankings of the agro-climatic zones based on regionalisation index can not, however, be used in the case of orderings of the agro-climatic zones on the basis of spatial effect. The regionalisation index, as represented by the principal component method, does not carry any economic meaning as such. The principal components are linear combination of the explanatory variables. They are artificial orthogonal variables not directly identifiable with a particular economic magnitude. The spatial effect, however, tells the values of the regional strength of the agro-climatic zones. It reveals the strength of each agro-climatic zone numerically, which is attributable to the region-specific time-invariant factors like quality factors, climatic factors, institutional factor and also those other inputs whose explicit inclusion in the model was not possible. For example, the low value of spatial effect in the Hill zones in comparison with Lower or Upper Brahmaputra Valley speaks for the very primitive method of cultivation being practiced in the Hills which is region specific and time-invariant. Therefore, extensive research needs to be carried out to explore the nature and magnitude of the regional (spatial) effects. To do justice to such question, it is necessary to have more information not only about the zone-wise differences in the type and quality of each input used and omitted, but also on the geo-climatic, physical, socio-political, institutional and numerous other factor that might influence difference in the efficiency of production.

6.6 Temporal Dynamism in the level of Agricultural Development

The temporal effect is one of the sources of variation in the output level. The factors behind such temporal effect vary from year to year in a random manner. Some of the temporal factors are fairly wide-spread in their incidence while some are highly localized. For example, a good rainfall or a severe drought in a given year may affect large regions more or less. Similarly, a flood may affect parts of a region, while a cyclone or a locust or past attack may affect only one small pocket of a region. Variation in seasonal conditions between regions and crops in a given year may affect the crop production differently in different parts of the state. The effects of temporal factors, therefore, vary from year to year and from region to region, and thus cannot be captured in a production function model that assumes that these effects are invariant over the region and specific to years. It is also inappropriate to use the amount of rainfall in the production function and call its effect temporal effect or weather effect, because rainfall is only one of the many elements that constitute the temporal factors.

This section will discuss the estimates of the temporal effects on agricultural production based on the error-component model applied to the six agro-climatic zones of the State. The temporal effect stands for the Y_{rt} component of the error-component model (4.3.7). The estimates are, however, not the direct measure of the weather factors, but are derived from the Cobb-Douglas production function constructed for the agro-climatic zones. These are the random components of the residuals between the actual and the predicted output of each region and year. Since the effects of the known input and the region-specific and time-invariant factors (the spatial effect) have already been isolated, the present estimate may be assumed to reflect the effects of factors, which are random in nature and thus these, are by and large, effects of the weather variables on regional agricultural output.

The model is based on the assumption that the effects of the temporal factors are independent of the efficiency level of a region (regional effect) and the level of inputs used (input-effect). In the short run, such an assumptions holds good, because farmers choose the level of input maximize expected earnings and have little control over the impact of the temporal factors. In the long run, however, temporal factors are controllable. For example, adequate flood control measure may reduce the ravages of flood in a given year and help increase the regional effect of the region while reducing the temporal effect.

The estimates of the temporal effect (Table 6.5) indicate how at the regional level, the impact of the temporal factors caused crop output to fluctuate from year to year. The extent of this impact varies widely among the region suggesting their varying degrees of susceptibility to the temporal factors. It also appears that even in a given year, all the regions do not move in the same direction in their temporal effects.

Table 6.5 Temporal Effects for each Agro-Climatic Zone

Agro-climatic zones	Temporal variation									Co-efficient of variation of Temporal effects (%)
	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	
North Bank Plains	0.60	0.04	0.30	0.21	0.07	0.26	0.12	0.30	0.13	71.12
Lower Brahmaputra Valley	0.67	0.33	0.53	0.51	0.49	0.56	2.23	0.46	0.48	78.94
Central Brahmaputra Valley	0.56	0.11	0.53	0.45	0.56	0.34	1.34	0.62	0.60	54.98
Upper Brahmaputra Valley	0.16	0.28	0.41	0.10	0.08	0.29	0.39	0.13	0.11	55.73
Barak Valley	0.08	0.10	0.06	0.07	0.06	0.09	0.12	0.14	0.08	28.78
Hill Zones	0.03	0.07	0.05	0.09	0.07	0.03	0.07	0.05	0.06	32.41

In spite of the diversity in the temporal characteristics of the region, it may be enquired whether there can be discerned any climatic cycles for the agro-climatic zones that conform to their varying temporal effects. For this purpose, the agro-climatic zones can be classified into three groups on the basis of the co-efficient of variation of their temporal effects.

(1) low variability zone with temporal variation less than or equal to 33 percent
(2) medium variability zones with temporal variation less than equal to 66 percent but greater than 33 percent
(3) high variability zones with temporal variation less than or equal to 78.94 percent, but above 66 percent

It is noticeable that unlike in the case of regional effects, the temporal effects do not display any clear geographic pattern of the variability levels. This implies varying degrees of sensitivity to temporal factors among neighbouring regions. Moreover, the temporal effects are not due to weather factors alone, but to a variety of causes, which are random in nature. Nonetheless, the major explanation for the variation in the temporal profiles of the region may be sought in the climatic patterns of individual regions and the extent of their built-in-resistance to weather fluctuation and pest problems. From Table 6.5, it can be seen that the temporal effect are vary much erratic and does not follow a particular trend for any of the six agro-climatic zones. However, from the values of the co-efficient of variation, it can infer that the reasons behind the low variability of Barak Valley and Hills Zones is that the intensity of ravages of floods (which is natural calamities in Assam annually) do not have greater impacts in Barak Valley and in the Hill Zones, the jhum cultivation maintain almost regular impact on the level of agricultural production. In case of Upper and Central Brahmaputra Valley, co-efficient of variation shows medium variation. The reason for such a phenomenon in case of Upper and Central Brahmaputra Valley is that, these two zones experience flood almost annually but with varying degrees of intensity. One year of heavy flood may be followed by a year of moderate flood in these zones and the in-built-resistance of these zones being relatively poor. In case of Lower Brahmaputra Valley and North Bank Plains, it shows high variability in the co-efficient of variation. It is because the recurrence of floods in these two zones is most random and these two zones are highly sensitive to temporal effects. Besides flood effects, other reasons may be relative lack of experience on the farmers in the use of the modern inputs and the non-availability of the appropriate quantities and qualities of inputs to individual farmers. Yet another reason may be the most irregular variation in the level of inputs used. Not a single agro-climatic zone had a secular upward trend in the level of inputs used, might have caused the irregular fluctuation in the output level temporally.

On the basis of the regionalisation effect, spatial (region) effect and the temporal effect, all the six agro-climatic regions can be divided according to the following manner as the discussion on spatio-temporal dynamism in the level of agricultural production in Assam remain inclusive if the regions are not divided in order of spatio-temporal dynamism.

i) dynamic region,
ii) progressive region and
iii) sluggish region.

Under the dynamic region, come the Upper Brahmaputra Valley, Lower Brahmaputra Valley and Central Brahmaputra Valley; under the progressive region, comes North Bank Plains and under the sluggish region, comes the Barak Valley and Hill Zones. Such an efficiency ranking of the regions is not arbitrary and it does conform to the usually broad pattern of clustering.

It can thus be concluded that the answer to the variation in agricultural production should be sought from the spatio-temporal dynamism of agricultural production across the agro-climatic zones in the state. It is the spatial (regional) factors like the quality of different inputs, geo-climatic conditions, socio-political factors, managerial inputs, technological advancement etc. and the susceptibility of the agro-climatic zones to the erratic fluctuations of temporal factors, like food, pest attack etc. which account for the variation in agricultural production. Such a combination of socio-temporal factors speak for the difference in agricultural production between the agro-climatic regions using the same level of physical inputs. And such an analysis helps us to determine the quantum of investment in different inputs for different zones rationally and also to minimize the spatio-temporal effects to the extent possible.

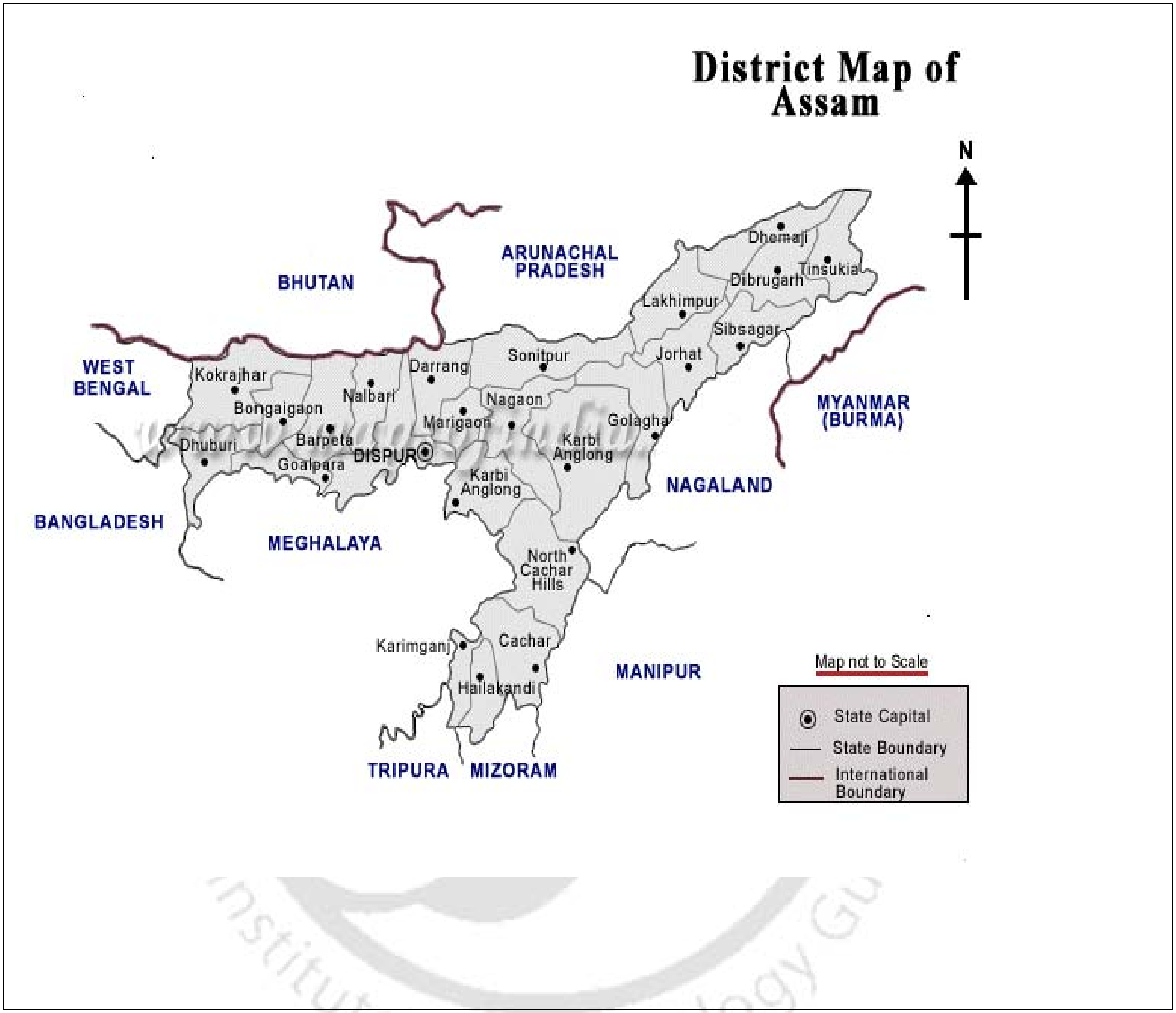
District Map of Assam
N
BHUTAN
ARUNACHAL PRADESH
WEST BENGAL
BANGLADESH
MEGHALAYA
NAGALAND
MYANMAR (BURMA)
MANIPUR
TRIPURA
MIZORAM
Dhemaji
Dibrugarh
Tinsukia
Lakhimpur
Sibsagar
Jorhat
Sonitpur
Darrang
Kokrajhar
Nalbari
Bongaigaon
Nagaon
Marigaon
Golaghat
Barpeta
Dhuburi
DISPUR
Goalpara
Karbi Anglong
Karbi Anglong
North Cachar Hills
Cachar
Karimganj
Hailakandi
Map not to Scale
State Capital
State Boundary
International Boundary

Fig. 2

Identification of Agro-Climatic Zones of Assam

- Lower Brahmaputra Valley (Kamrup, Nalbari, Barpeta, Bongaigaon, Kokrajhar, Dhubri and Goalpara)
- North Bank Plains(Lakhimpur, Darrang, Dhemaji and Sonitpur)
- Central Brahmaputra Valley(Nagaon and Morigaon)
- Upper Brahmaputra Valley(Jorhat, Golaghat, Sibsagar, Dibrugarh and Tinsukia)
- Barak Valley(Cachar, Karimganj and Hailakandi)
- Hill Zones(Karbi Anglong and N.C. Hills)

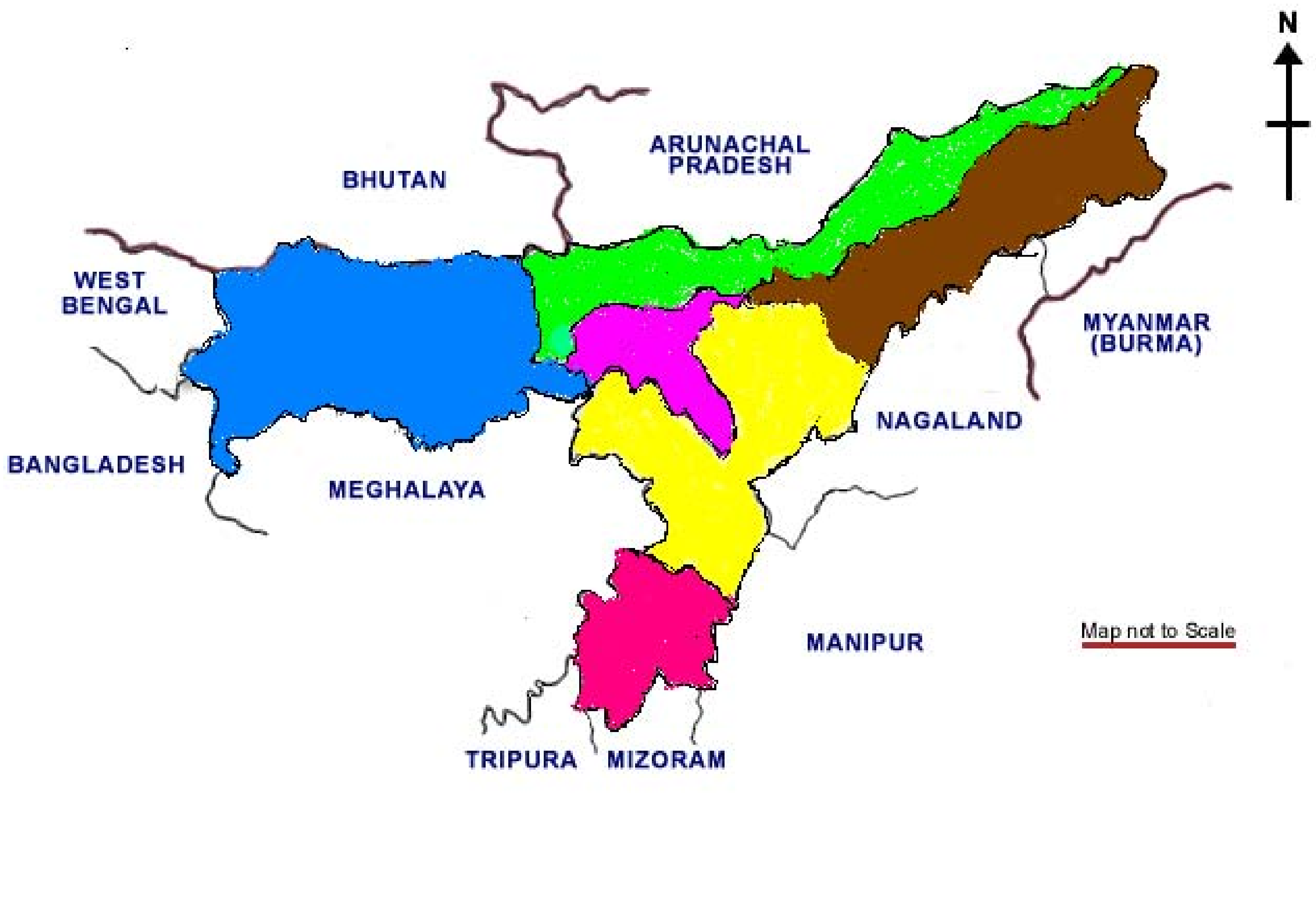

Fig. 3

Indentification of Agricultural Regions of Assam on the basis of Principal Component Analysis

Very Developed Region (Lower Brahmaputra Valley and Upper Brahmaputra Valley)

Developed Region (Central Brahmaputra Valley)

Developing Region (North Bank Plains)

Backward Region (Barak Valley and Hill Zones)

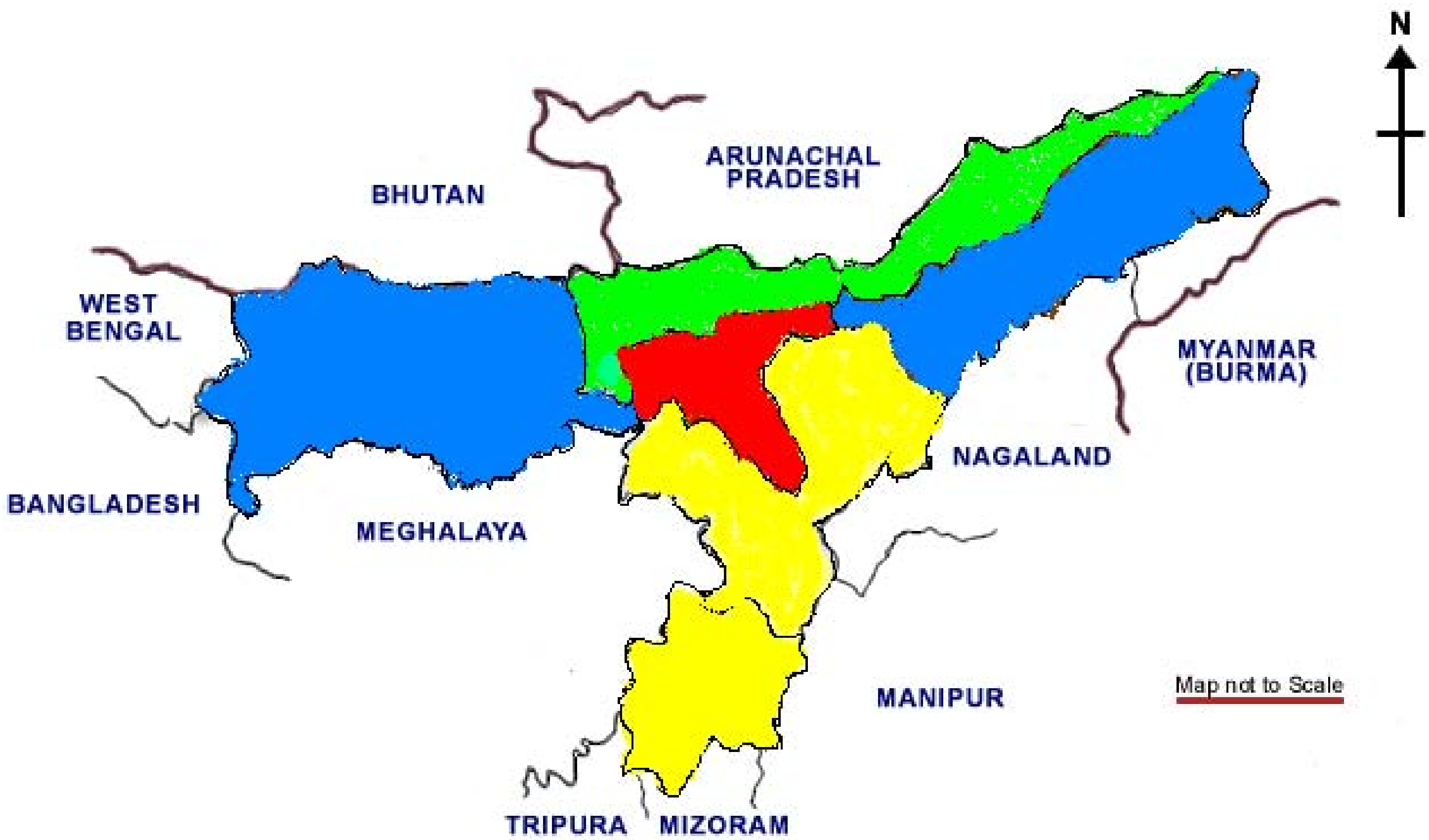

Fig. 4

Identification of Agro-climatic zones of Assam on the basis of Spatio-Temporal Dynamism

Dynamic Region (Upper Brahmaputra Valley and Lower Brahmaputra Valley and Central Brahmaputra Valley)

Progressive Region (North Bank Plains)

Sluggish Region (Barak valley and Hill Zones)

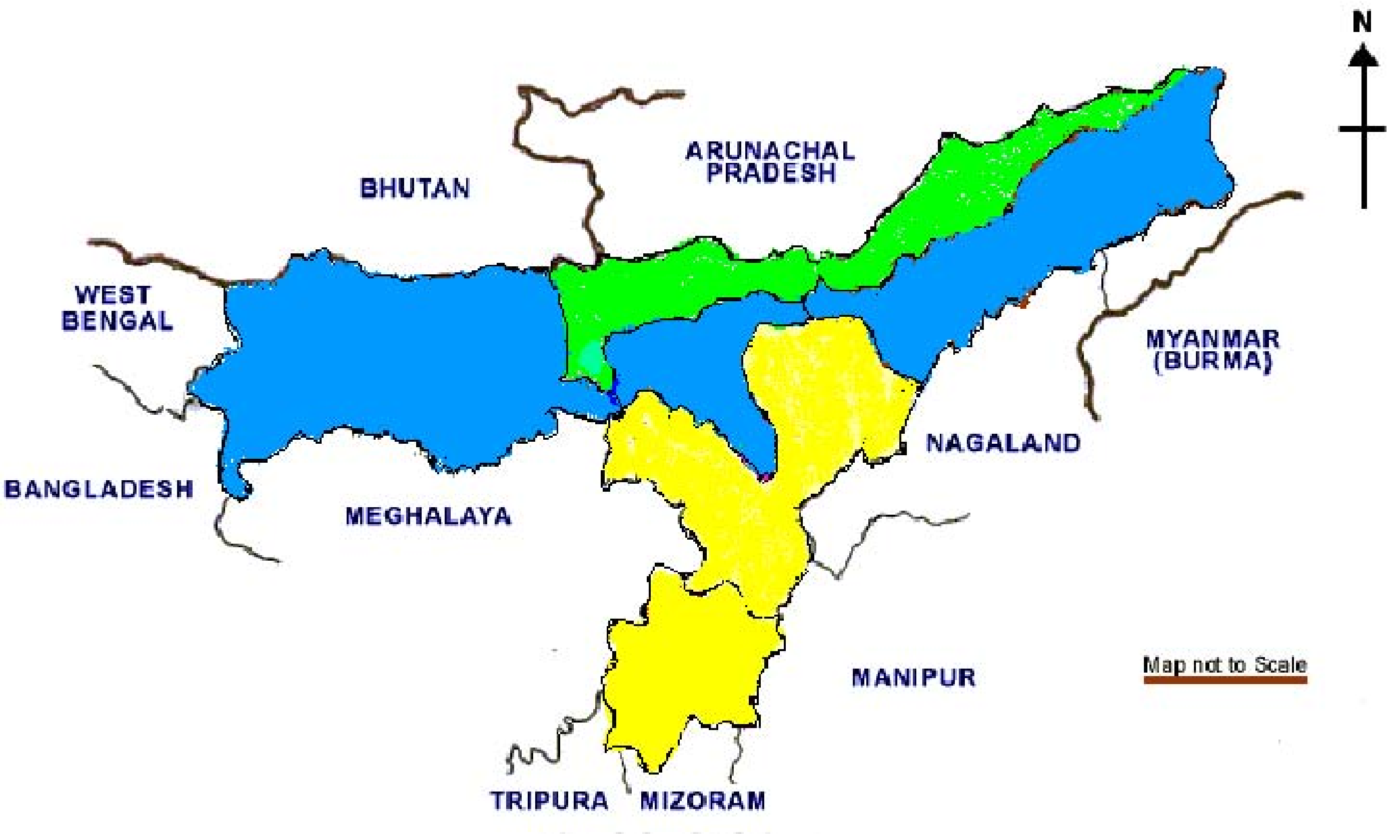

Fig.5

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Chapter 7

Summary of Findings and Strategy for Balanced Regional Development of Agriculture in Assam

7.1 Summary of Findings

This chapter summarises the findings of the study and bring out the factors responsible for the disparities in agricultural development in Assam, which are already discussed elaborately in previous chapters. It also makes an attempt to identify suitable measures, which may put Assam on a path of balanced agricultural development over regions.

Agriculture in Assam has not been accorded priority as it should have been till mid nineties. What is needed for the development of an agriculturally dominated economy like that of Assam is more emphasis for it's all round development. Such a policy will favourably affect agricultural production and productivity. However, owing to ad-hocism in the agricultural strategy, failure in implementing agricultural policies and programmes in a determined, co-ordinated and integrated way, failure of the Government in making institutional reforms, lack of responsiveness on the part of the administration towards challenges of agricultural development, absence of area-specific strategy for agricultural development, etc. Assam continues to be in backwardness trap. The performance of Assam's agriculture has in fact gone down and the State stands in the lower position in respects of all indicators of agricultural development compared to other states of the country. It is a matter of serious concern for academics, administrators and policy-makers to find a State with tremendous natural and human resources languishing in a state of stagnation.

In terms of agricultural development Assam, in the early years of independence placed well with other states. But a very slow growth has resulted in the declining position of Assam with the slower shift in the sectoral distribution of state domestic product with the share of tertiary sector remaining almost static.

Irrigation is the most important ingredient of the new technology and there is lack of irrigation facilities in Assam. A large part of the State is heavily affected by the recurring flood and is thereby deprived of any systematic mode of irrigation. Assam is one of the States of India, which has not been able to make much headway in irrigation development. Up to the country's independence, Assam had plenty of cultivable land area in comparison to her population. There was self-sufficiency of food grains in those days. But over the years, situation began to change faster. Agricultural production in Assam is one of the lowest in the country accounting for only 5.6 percent of India's production. Slow adoption of improved agricultural technology has been identified as the prime factor of this low production and productivity. That there is a relationship between high productivity and improved farm technology is still unknown to most of the farmers of the State. Most of them still pursue cultivation of Sali paddy under traditional practices depending entirely upon the rainfall of South-West Monsoon during the summer season. Though some fund was earmarked for irrigation in the Five-Year plans and in the State budget, the progress has not been encouraging. It seems that the planners and administrators were content with the idea that artificial irrigation is not necessary in Assam which receives annual rainfall from the South-West monsoon and the State has vast surface water resources from her two mighty rivers viz. the Brahmaputra and the Barak with her numerous tributaries. Moreover, there are some problems of irrigation development in Assam. Assam has two distinct physiographical divisions. One is the hill region with two districts and the other is the plain region of the valleys viz. the Brahmaputra Valley and Barak Valley. There are various difficulties in irrigation development in the hill region due to its hilly nature and paucity of flat land. On the other hand, the two valleys are annually hit by devastating flood of the two big rivers and their tributaries. It causes deep injury to irrigation by washing away and damaging the channels, dams, pump sets, etc. Though Assam receives heavy rainfall annually it spreads over a period of seven months from April to October. The winter season from December to March is practically dry. Occasionally there are evidences of prolonged breaks in the South-West monsoon which affects the Sali paddy of the State. Irrigation development is, therefore, absolutely necessary and is being carried out under these circumstances and uncertainty[134]. Due to lack of required irrigation facilities in Assam there is less use of fertiliser and HYV seeds, which affect agricultural production in the State.

Adoption of new technology by small and medium size farmers in any significant scale can not be expected without active support of institutional credit. Improving the quality and quantity of institutional rural credit is thus an imperative for bringing about a 'Green Revolution' in the state, where large majority of the farmers are with small internal resource base. In fact, in a backward state like Assam rural credit institutions are required to play a more active role, as credit here is required not only for adopting improved farming practices, but also for developing agricultural infrastructures. Besides increasing the volume of credit to the rural sector, it is also necessary to simplify and streamline the procedure of dealing with the farmers. The problem of default, which is often cited by bankers as the main hurdle in enhancing the role of financial institutions in the rural economy, also deserves a closer examination. On the other hand, it is hard from the farmer's side that countless formalities and corrupt practices among bank employees deter them from approaching credit institution for
loans, even when they can not use modern inputs due to lack of finance[135].

The under-development of the agricultural sector in Assam may thus be attributed to the numerous factors. On the one hand, it may be the failure of the Government to implement proper strategy for agricultural development and on the other, it may be the unawareness and other reasons on the part of the farmers to use modern method of cultivation which keep agriculture backward. Government failure manifests in many different ways. Owing to Government's apathy, indifference and unresponsiveness, the process of agricultural development in the State has not reached the desired growth rate. As such, different regions have not only been unable to make full use of their resources and put the rate of agricultural development to the maximum possible level, but they also reflects a high degree of disparities in agricultural development.

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[134] K.Gogoi: Irrigation in Assam, Assam Institute of Development Studies, March 1989.
[135]. M.P.Bezbaruah: Financing Agricultural Development, Assam Institute of Development Studies, March 1989.

Besides the factors cited above which are responsible for the regional disparities in agricultural development in Assam, the present analysis systematically identifies the various regions with different levels of development based on their regionalisation effect, spatial effect and temporal effect. The sources of variation identified in this study are:

(i) variation due to the known measured inputs;

(ii) variation due to spatial factors which are region (space)-specific and time-invariant

(iii) variation due to the temporal factors which vary both over space and time.

Among the 13 indicators taken in the study irrigation, use of HYV seeds, use of fertiliser, tractorisation, pumpsets and bank credit facilities made greater impact on the occurance of imbalances in the agricultural development in Assam. The cropping intensity, gross value of agricultural production, literacy rate and pressure of rural population on land do not show much impact in explaining imbalances in agricultutal development. The degree of imbalance is high in the district level than at macro level i.e. in the economy of Assam disaggregated at agricultural region was found to be 34.16 where as it worked out 57.56 when the economy of Assam was disaggregated to district level. This goes to suggest that the problem of imbalance should be viewed and tackled at area-levels.

Besides inputs effect, the study also tells us that the variation in the agricultural development may be due to the spatial and temporal effects and as a result, it becomes very difficult to remove the inter-regional disparity merely by the re-allocation of the known inputs, and therefore, recourse has to be sought from the spatial and temporal factors. Due to spatial effect there occurs differences in the output level in the different regions, though they uses the same quantity of all inputs, provided that there is no disturbance of weather effect. Because of spatial effect the output in the Lower Brahmaputra Valley is likely to be about 1.13 times more than that of Hill Zones. Unlike in the case of regional effects, the temporal effects does not display any clear geographic pattern of the variability levels and they are very much erratic and does not follow a particular trend for any six agroclimatic zones. Among the spatio-temporal factors, some are amenable to human influences in the long run, while others are difficult to control. For example, in case of region-specific factors, it may be possible to convince the tribal folk to switch over to the scientific method of terrace cultivation from the age old tribal practice of jhum or shifting cultivation. But it will be difficult to influence factors like the basic type and the humus content of the soil or the height or geographical location that influence the productivity of a region. In case of temporal factors it can, to an extent minimize the ravages of floods, pest attack etc. by undertaking extensive flood and pest control measures.

This study indicates that the simultaneous attainment of the goals of maximizing output and reducing disparity is far from a simple task. Much depends on the nature of the spatio-temporal effects, to what extent they are amenable to changes by present and past investments and as well as the nature of such investments. If it is assumed that spatio-temporal effects are not at all amenable to change by known policy instruments, in such a situation, if two regions are using the same levels of measured inputs but have different spatio-temporal effects, the allocation of additional inputs to the region with higher regional and lower temporal effect will not only help maximize output, but also will increase the disparity between the two regions. Here, there is a trade off between the two goals. The actual situation, however, is much more complicated, and the trade off is not necessarily present in all cases. Decision on the allocation of development resources in such cases will have to be based on relative difference in regional and temporal effects and the marginal productivities of inputs in different regions. What is needed, therefore, for a realistic policy formulation, is to examine intensively the nature of the regional and temporal effects and the existing levels of inputs used for each regional unit.

Apart from the problem of spatial imbalances, there is another area of concern, which is the temporal variation in the level of agricultural production. The steadiness and the sustenance of the growth in agricultural production over the years in the state is often questionable. The biggest threat to a steady growth of output in Assam has been the periodic fluctuations in its agricultural output, subject to the impact of natural calamities like variations in rainfall, flood damages, insect and locust problems, etc. The present study provides a measure of the extent to which agricultural output in the regions varies from year to year due to these problems and such a measure might be used for a short run policy of building stocks to meet natural calamities. Moreover, further research may be undertaken to identify the nature of causes governing the temporal variability of output in individual regions. For instance, policies to reduce such fluctuations will depend on whether these are due to floods recurring every year or whether it is caused by pest damage.

7.2 A Strategy for Balanced Agricultural Development

Agricultural development combines a number of factors and the people, the climate conditions and the water resources plays a vital role. The economy of Assam has different areas with different agricultural terrains. Whereas the Assam plains are one of the most fertile lands in India, the hill zones is having hilly tract of low fertility. As such balanced agricultural development does not imply an equality in the agricultural income in different regions of the state. By balanced regional development of agriculture it simply means raising the rate of agricultural growth to the maximum possible extent by making optimum use of the resources and potentialities of a region.

A suitable agricultural strategy is needed for making optimal use of agricultural resources and potentialities and balancing the rate of agricultural growth within regions. The strategy for agricultural development combines policies and programmes that influence the pattern of agricultural development as well as the rate of increase in farm output. It is one of the components of agricultural planning. Evolving a strategy for agricultural development in harmony with the objectives of overall economic development is of primary importance in the developing economies. In order to achieve maximum efficiency in agricultural development, agricultural strategy should ensure an efficient sequence of different investments and a co-ordination between timings of different policies and programmes.

There are vast opportunities for improving the efficiency and production through a complex of technical innovations and institutional change. However, Government cannot force the farmers to use scientific inputs to modernize agriculture as such action has to be in compatible with democracy. The government can only induce the farmers to change the pattern and content of input use by providing a good network of different kinds of infrastructural facilities. The scope for action by government with regard to input use in farms can be widened by increasing the number of co-operative, State controlled or local-body administered firms. It depends upon the development of organizational infrastructure suitable to the community. The Government has to perform the role of the promoter of infrastructural facilities in order to stimulate the process of agricultural development. In view of the limited capital resources Government may take up the task of developing critical infrastructural facilities, viz. transport facilities, irrigation, etc. on a priority basis instead of investing in all sorts of infrastructural facilities. The agricultural facilities must pay due attention due to timings and sequences of investment in agricultural sector in order to make investment efficient and farm sector develop faster. Irrigation, marketing credit extension and tenurial improvement measures when go together in proper sequence have greater impact on agricultural efficiency.

The strategies for development of Agriculture in Assam should be formulated on the basis of existing situation. In this context the concept of agro-climatic regional planning can be extended to the district level provided basic data on soils, land situations, water resources, climatic information etc. are available. Long term and short-term programme are to be formulated for implementation. Some work has already been done by the Zonal Planning Team for the Eastern Himalayan Region.

In Assam, the strategies for chronically flood affected area and flood free area should be different. The basic strategy for chronically flood affected areas should be to advance the season of the rice crop to February –May by introducing in a large scale HYV early Ahu with irrigation. The flood escaping rice crop should be the lead crop for the area. Crops may be grown again from September onwards in the same land with irrigation. A possibility of growing Winter rice crop may be taken. Rabi crops are best suited to flood affected areas. In the flood free areas, the attempt should be to raise at least two rice crops, Winter rice and Early Ahu with irrigation in the heavy textured soils. Rabi crops may be encouraged as a second crop in the light textured soils.

In the hills, integrated development strategy should be undertaken to the basic purpose of soil and water conservation, providing maximum possible cover by afforestation, social forestry for fuel and timber needs of the people, fodder and horticultural plants and plantation crops.

Zonal planning team has suggested a production complex approach for the hill areas of North East which envisage selecting compact areas embracing 5000 hectares of land and 150 to 200 families, basic resource survey of the area and preparation of plans for development embracing all aspect of tribal life. The integrated approach is the key point of the production complex approach. Ultimate goal is to reduce the incidence of shifting cultivation and bring about all round development of the tribal population under a separate agency.

The strategies outlined above are interlinked with (1) evolution of suitable varieties of crops to change the crop season (2) technological supports from experts to suggest alternatives (3) development of irrigation facilities particularly for rabi season irrigation for pre-kharif rice and other rabi crops (4) production and distribution of quality seeds of recommended varieties and making them available in time within reasonable distance of the farmer with retail outlets. (5) distribution of fertilizers and other inputs in time (6) efficient and committed development personnels to educate and organize the people (7) effective organization of the people to undertake the activities (8) development of marketing and storage facilities and (9) development of transport and communication.

It can thus be concluded that the variation in the agricultural production can be minimised by adopting appropriate strategy which combines both inputs and spatial-temoral factors. Such a strategy will help to make a balanced regional agricultural development in the state of Assam.

This study makes an attempt to examine the inter-regional disparity in agricultural production in Assam. The study also tries to know the degree and causes of regional disparity in agricultural development in Assam. Moreover it also tries to examine the spatio-temporal dynamism in the level of agricultural development of the state. But the study suffers from a number of limitations.

(i) first, the present study could not take into account several other variables such as quality of soil, impact of family size of the agricultural labour, impact of hired labour, cropping pattern of different districts, impact of holding size of the farmers etc., thus leaving the scope for further widening the purview of the study.

(ii) the present study is based on the secondary data collected from published sources. The validity of the results of this study is therefore based on the degree of reliability of the secondary data.

(iii) the present study suffers from the inherent limitations of the econometric methods themselves, used in the analysis.

(iv) the proposed study also suffers from the limitations inherent in the assumptions underlying the estimation of the variables-dependent as well as independent.

Thus in view of the aforesaid limitations, whatever conclusion has been drawn in every stages of the present study, are subject to criticism and therefore be seldom all inclusive or final. It may be referred only as an exercise to tackle the problem in hand.

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