LEVELS OF AGRICULTURAL DEVELOPMENT IN ASSAM

A REGIONAL ANALYSIS

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Dissertation

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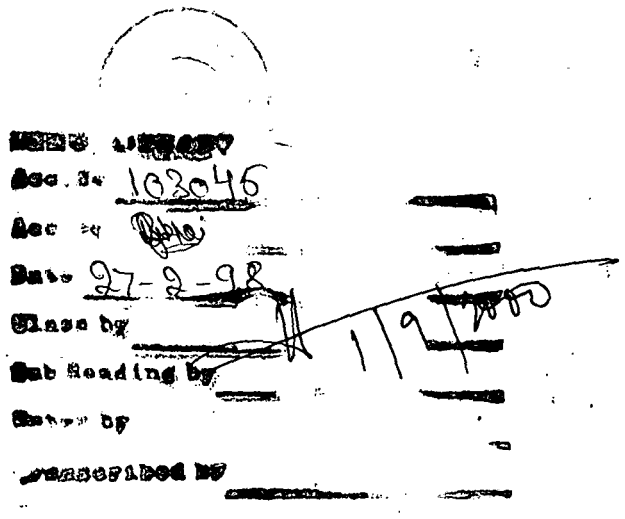

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C E R T I F I C A T E

This is to certify that the dissertation submitted by Md. Riajur Rahman for the degree of Master of Philosophy (M.Phil) at the Department of Geography, NEHU, Shillong, Meghalaya, entitled, " Levels of Agricultural Development in Assam : A Regional Analysis " is a bonafied study of the author to the best of my knowledge and belief.

This may now be placed before the examiners for due evaluation.

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Place : Shillong
Date : 13.7.94.

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Supervisor

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Riajur Rahman

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Date : 13-7-94

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CHAPTER - I

INTRODUCTION

Agriculture is the principal occupation and main source of livelihood for the majority of the people in the largely rural areas of the state of Assam. It shares nearly half of the total state's income. The economic conditions, standard of living and socio-cultural setup of rural people are solely based on agriculture and its allied activities. The rapid increase of population, limited cultivated land by peculiar physiographic conditions of the state, low yield of crops, regular natural havocs etc. all these are the major problems and hindrences of the agricultural growth and development. As a result, state of Assam has low level of agricultural productivity(land productivity is Rs.1868/ha.in 1990-91) and very low annual growth rate of agricultural output (3.35 percent)during the 1980s.On the otherhand, the ever increasing population from 18.1 million(1981) to 22.2 million (1991) which is increasing at the rate of 2.3 percent annually while the national average is also recorded 2.3 percent from 685.2 million(1981) to 843.9 million(1991),requires more food. Infact, increase in total agricultural production has been recorded from 11.8 million tonnes(1980-1)to 14.3 million tonnes (1989-90) i.e. 2.1 percent annual increase during the last decade which was lesser than the increase in population.Therefore,per capita availability of food is diminishing gradually from 17,221gm/person (1981) to 16,945 gm/person (1991). Consequently,the state is much dependent on the import of food supply, though the overall performance of the agricultural conditions is better during the same

Table 1.1: Agriculture's Contribution to Rate of Economic Growth in Assam

Year	TPa	TPn	NDP	Pa	Pn	ra	rn	Para
1980 - 81	1183.7	1172.4	2356.1	0.5023	0.4976	-	-	-
1981 - 82	1163.8	1476.5	2640.3	0.4407	0.5592	-0.0168	0.2593	-0.0074
1982 - 83*	1205.0	1545.0	2750.0	0.4381	0.5618	0.0354	0.0463	0.0155
1983 - 84	1263.6	1650.0	2913.6	0.4336	0.5663	0.0486	0.0679	0.0210
1984 - 85	1308.0	1523.4	2831.4	0.4619	0.5380	0.0351	-0.0767	0.0162
1985 - 86	1302.1	1853.3	3155.4	0.4126	0.5873	-0.0045	0.2165	-0.0018
1986 - 87	1338.2	1997.6	3335.8	0.4011	0.5988	0.0277	0.0778	0.0111
1987 - 88	1427.8	2091.5	3519.3	0.4057	0.5942	0.0669	0.0470	0.0271
1988 - 89	1318.3	2271.9	3590.2	0.3671	0.6328	-0.0766	0.0862	0.0281
1989 - 90	1438.9	2557.5	3996.4	0.3600	0.6399	0.0914	0.1257	0.0329

N.B.= * Projected Figure
Data at 1980 - 81 Prices.

Abbrevation: TPa = Agricultural Net Product, TPn = Non- Agricultural Net Product, NDP = Total Net Domestic Product, Pa = Agricultural Sector Share of NDP, Pn = Non-Agricultural Sector Share of NDP, ra = Annual Growth Rate of Agricultural Sector Product, rn = Annual Growth Rate of Non-Agricultural Sector Product.

period. The performance of agriculture into state's economy can better be understood by looking into the following parameters.

Role of Agriculture in Overall Economic Development

Since agriculture is the main activity and the major part of working force of rural areas is based on agricultural sector of the state, the agricultural sector is playing the dominent role in the overall economic development in various waus. Agricultural sector is producing surplus production of many crops like tea, oilseed, jute etc. which is used as raw material of many industries. Even there are many and varied types of industries which are consuming locally available surplus agricultural products. Secondly, the surplus agricultural products are moving towards market. Thus, it is also contributing to the market development which is related to non-agricultural activities. Thirdly, the factors contribution also important aspect because production operations are based on labour and capital factors. Assamese farmers are poor and, therefore, surplus labour is absorbed by agricultural sector.

The contribution of agricultural sector to overall economy of the state can further be studied by taking into account of two main attributes of agriculture : its share and growth rate. These attributes explain the relative performance of agricultural sector to the overall economy of the state. It is obvious from Table-1.1 that the share of agricultural sector to the

total Net Domestic Product (NDP) of the state tends to decline from 50.23 percent (1980-1) to 36.00 percent (1989-90). This decline is recorded fast in the early 1980s, especially during 1981-82 and slow in the mid and late eighties, while the average annual decrease was observed nearly 1.5 percent which is significant for accelerating the pace of economic development of the state. On account of decline in the share of agricultural sector's production or simultaneously increase in the share of non-agricultural sectors of the economy of the state, there must be recorded a shift in the occupational structure also. But comparing the decline in the share of agricultural force, it is found that there is a slow decline in the share of agricultural force rather than the decline of agricultural sector's production (1.5 percent).

On the otherhand, growth of agricultural production, which is second attribute and refers to the proportional increase of total magnitude of production is very much fluctuating in the last 10 years. However, there is a smooth increase in the total magnitude of agricultural products from Rs. 1183.7 crores(1980-1) to Rs. 1438.9 crores (1989-90), while its annual growth is recorded highest as 9.14 percent in 1989-90. Sometimes in 1981-s and in 1988-9. it was recorded negative as 1.68 and 7.66 percent respectively. An insignificant negative growth of 0.45 percent was also recorded in 1985-6. The main causes of the negative growth

in these years are the regular flood in the state, less use of techno-economic factors to the agricultural production processes, lack of knowledge among the farmers, difficult physiographic conditions, some political and social problems during eithties like Assam agitation etc.

Since the comparision between the growth rate of agricultural and non-agricultural sectors of the Assam's economy is made, it can be concluded that the growth of non-agricultural sector is recorded faster and less fluctuating than the growth of the agricultural sector. Very fast growth of non-agricultural sector was recorded in 1982-2 and in 1985-6 as 25.93 and 21.65 percent respectively while in the same years the growth of agricultural sector was recorded negative. It means there seems an imbalance in the growth process of overall economic development in Assam. But the year 1989-90 was the best time for balanced growth of both the sectors of economy when 9.14 percent growth rate was recorded in agricultural sector and 12.75 percent in non-agricultural sector (Table-1.1).

Further more, the degree of temporal fluctuation can be seen in the proportionate sectoral growth of agriculture which is the multiplier of both the attributes of agricultural sector, share and growth. The annual performance of proportionate growth of agricultural sector which is given in the last column of the Table-1.1, confirms the fact that there is a smooth increase in

Table 1.2: Sectorwise State Income According to Major Heads of Economy (1980 - 81 to 1990 - 91)
At 1980 - 81 Prices.

(Rs. in Crores)

Heads	1980 - 81		1990 - 91	
	Total	%	Total	%
1. Agriculture	1183.7	50.2	1549.6	37.8
2. Mining & Quarring	48.0	2.0	99.2	2.4
3. Manufacturing	163.4	6.9	530.9	12.9
4. Electricity, Gas & Water Supply	10.8	0.5	58.4	1.4
5. Construction	102.8	4.4	234.2	5.7
6. Trade,Hotel & Restaurant	259.7	11.0	462.1	11.3
7. Transport, Storage & Communication	56.3	2.4	137.4	3.4
8. Financing, Insurance, Banking,Real Estate & Business Services	31.7	1.3	111.9	2.7
9. Community, Social & Personel Services	229.1	9.7	469.4	11.4
10. Per Capita Net Domestic Product	1200	-	1656	-

Source: Statistical Hand Book, Assam.

the proportionate growth, while in 1981-2 and 1985.6 it was a negative growth of 0.74 and 0.18 percent respectively. The highest annual proportionate growth recorded in 1989-90 as 3.29 percent and the lowest recorded as 1.11 percent in 1986-7.

So far as per capita NDP and its change over time is concerned, it can also reveal a true picture of economic development. In fact, perscapita NDP was recorded Rs. 1200 in 1980-1 in Assam which rose nearly 38.00 percent during the 1980s. It means that there is a sharp increase in domestic product in the non-agricultural sectors. Table-1.2 reveals that the manufacturing sector of economy grew fast during the 1980s. It was accounting for 6.9 percent income to the total economy in 1980-1 which was rose upto 12.9 percent during 1980s. Now, it got first place in the non-agricultural sector of the state's economy. Trade, Hotel, Restaurant and personal services are also major sources of the income which are containing significantly in non-agricultural sectors (Table-1.2). Thus, there are various problems of agricultural sector which should be dealt with the next section of this chapter in detail.

Statement of the Problem

Above discussion reveals that majority of the Assam's people depend on agriculture and this sector is so important that it alone contributes 56.0 percent to the state's total income which is higher than that of the national income (45.0 percent).

It plays the most important role as the main absorber of working population by engaging as high as 80.0 percent of the total workers of the state's work force.

There are various attributes of the agricultural development which should be highlighted here. For example, in Assam, the agricultural output per capita is Rs. 148.6 per person while the national figure is Rs. 280.601 per person (1991) which is almost double from that of Assam state. The average annual growth rate of agricultural cutput of Assam is 3.35 percent (1980-1 to 1990-1) when the national percentage for the same period is 4.439 percent. Again the land productivity of Assam is Rs. 1868.8 per hectare which is almost same with the national figure of Rs. 1576.620 per hectare (1988-90). According to the 1991 Survey Report, the labour productivity of the state is Rs. 575.1 per worker which is lesser than the national level for the same year i.e. 1189.411 per worker. Accordingly, if we compare the crop intensity figure of Assam with the national average then it is found that crop intensity in Assam is lower (122.27 percent) than the national average (134.219 percent) in 1988-90.

While the agricultural activities of the state are solely depend on monsoons and the agricultural production processes are operated accordingly, the crop intensity, cropping patterns and even general land use patterns are season based. For example,

namely, Kharif, Rabi and Zaid exist according to the climatic seasons. The monsoon rain in the state is generally heavy to moderate in almost all areas and 90 percent of it's rainfall occurs during rainy season from May to October months of the year. However, there is areal variation in rainfall distribution in some of the stations of the state. Some stations receive meagre rainfall, e.g., Lumding receives only 4 mm. rainfall during January month while there is a gradual increase in rainfall month wise and, during the month of July, it receives about 45 mm. rainfall. While some other stations, namely, Chaparmukh, receives 20.4 mm. rainfall during January month while in July it receives 350.2 mm (approx) rainfall within 10 days of rainy days. Therefore, some areas of Assam receiving heavy rainfall causes flood and hence the crop failure in the season is a regular affair which influences entire agro-economic conditions of the state. Likewise, some areas due to lack of water also the crop failure is common phenomena. Thus, the soil conditions of the state not equally favourable for agricultural growth. The poor economic conditions of the peasants put them away from the use of fertilizer, application of new technology in agriculture, use of irrigation facility, use of anti-desease medicines etc. and sometimes some socio-economic factors also play an important role in the agricultural growth and development in the state of Assam.

All these factors are also responsible for the regional variation in the agricultural production and productivity. The regional imbalances in the production patterns are related to the

aspects of agricultural resource utilization and above mentioned geographical conditions. Though after the adoption of Green Revolution Technology, there seems to be tremendous changes in the land use pattern, agricultural production processes by adopting multiple cropping pattern, HYV and also it changes the productivity and efficiency of production. After the enhancement of modern technology during The Green Revolution period, it directly or indirectly influenced the production patterns, but there appears the regional imbalances in the aggricultural phenomena specially in productivity and growth patterns in the state. It may be the consequences or either of the different agro-ecological conditions prevailing in the state or because of impact of modern technology.

Thus, these problems of the agricultural development of Assam state can be tackled by analysing the regional patterns of these attributes of agricultural development.

Objectives :

On the basis of the above discussion of the agricultural problems prevailing in the state of Assam, attention is focussed on the following objectives of the present study.

They are :

(1) to interpret the distributional pattern of agricultural development in the Assam state, especially of agricultural growth and productivity,

(2) to delineate the agricultural regions on the basis of homogenity within and heterogenity between these regions so that the causes of the regional variations can be identified, and

(3) to prepare and suggest the regional investment strategy for the intensification and expansion of the effects of modern technology for the self sustained growth and, balanced development.

Research Questions :

The objectives of the present proposed study are related to some important research questions and hypotheses which are given as :

(1) What are the main causes of low levels of agricultural productivity and growth in Assam ?

(2) Why are the regional processes of agricultural development are weak and unarticulated ?

(3) What is the degree of spatial variance of the agricultural developmental attributes and how it forms the regional structure of agriculture in Assam ?

The answers to these research questions can logically be given by testing the validity of some concerned hypotheses.

Hypotheses :

In fact, the patterns of agricultural growth and productivity have a specific relationship everywhere. If it is positive, then the developmental structure has a concentrated pattern which creates primacy in the structural forms and, consequently, agricultural developmental processes would be accelerated by the metropolitan forces of the area/region. On the other hand, if the regional patterns of agricultural growth and productivity is negatively related, then the developmental structure is diversified and the impact of physical and socio-cultural factors is obvious on agricultural activities. Because of initial stage of agricultural development in the Assam state and dominance of agro-ecological factors on the attributes of agricultural structure, it is hypothesized here that :

(1) Agricultural growth and productivity patterns must be negatively related for the balanced development of the state;

(2) the level of land and labour productivities are determined by agro-ecological conditions rather than techno-economic factors, and consequently,

(3) the magnitute and intensity of agricultural growth potentials are prevelent in the low productivity areas and faster agricultural growth can be predicted in backward areas of the state.

Methodology :

(a) Methods :

For giving the answers to the research questions which have been put forward in the preceeding section, some methodological aspects are important to deal with here. So far as methods and research design of the present study are concerned, the main methodological aspects are related to two important aspects : (i) the measurement of agricultural productivity and (ii) the measurement of agricultural growth. These aspects are closely related to the assessment of level of agricultural development. They can be interpreted in detail by puting them in the separate heads.

(1) Measurement of Agricultural Productivity : In fact, agricultural productivity has two important components ; (i) land productivity and (ii) labour productivity. Many agricultural scientist interpreted land productivity and, named it as agricultural productivity, because land is a geographical phenomena and therefore land productivity is directly related to geographical factors (Shafi 1960, Singh 1985).

So far as the measurement of agricultural productivity is concerned, it is related to the aggregated production of all the crops of a particular area per unit of cultivated land. Therefore, for assessing the land as well as labour productivity of a particular area, aggregated index of the total production of the

crops is essential to calculate. Thus, land productivity is refers to total production per areal unit of land, and labour productivity refers to the total production per worker engage in agricultural activities.

Now question arises how to measure the aggregated picture of all the crop production because crops have different significant level in terms of their prices, caloric level, market importance and so on. Therefore, there are various methods of aggregating the production of various crops. The pioneer work of Bhatia (1967) on the measurement of agricultural productivity is remarkable. He aggregated the production of various crops on the basis of converting the yield of the crops into their ratios and multiplying them with their crop areal share. He formulated agricultural productivity in the following manner

$$lya = \frac{Ya}{Yr} \times 100$$

$$Ei = \frac{lya.Ca + lyb.Cb + \ldots lyn.Cn}{Ca + Cb + \ldots Cn}$$

Where Ei = Agricultural efficiency index;

lya, lyb etc. = Yield index of crop a,b, etc.

Yc = The hectare yield of a crop in an enumeration unit ;

Yr = The average yield of a crop in the entire region ; and

Ca,Cb etc. = The percentage of crop land under different crops.

The above measurement is solely based on two attributes of agricultural production, that are crop-yield and crop-area. Since Indian agriculture has become now commercial oriented rather than subsistence based, the price mechanism and the cost of the agricultural inputs are equally important. Therefore, the significance of the crops can also be assessed not only on the basis of yield and area attributes of the agricultural crops, but, the crop production prices are also equally important. Singh and Chauhan (1977) also tried to incorporate these factors for measuring agricultural productivity in Rohilkhand, and they prepared standardised yield index on the basis of caloric significance, market price and, local requirement of agricultural crops. But they did not include crop price as a main component of productivity.

Considering crop-yield, crop-area and crop-price of the principal crops of a particular area, the total agricultural output has been assessed here for calculating land as well as labour productivity. This aggregation technique is although simple in calculating the agricultural output in terms of money value, yet, it is very much useful for the comparison of aggregated index over time (Dayal 1985). The total agricultural output is formulated in the following manner :

$$O = \sum_{i=1}^{n} Ai.\ Yi.\ Pi, \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

Where i1 = 1,2,3, ... n as number of crops ; Ai, Yi, Pi are the area, yield and prices of a particular crop of a district ; and O is total agricultural output.

(i) Land Productivity : Since land productivity is the relative measure of agricultural output for areal unit of land, it is measured by dividing total agricultural output by the total Gross Cropped Area (GCA) of a particular district as ;

$$Y = O/A \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where O is total agricultural output as defined in equation (3) and A is total GCA of a particular district.

(ii) Labour Productivity : It is the relative index of total agricultural output per person of agricultural labour force. Therefore, it is calculated by dividing the total output by the total agricultural work force of a particular area, give as ;

$$Yl = O/L, \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Where L is total agricultural workforce.

It can be noted here that land productivity and labour productivity are closely related to each other because, when dividing the denumeration and numeration of the above fraction (eqn.5), it is found that labour productivity is the product of land productivity (o/A) and cultivated area per agricultural worker (A/L). Thus, eqn.5 can be written as ;

$$O/L = (O/A)\ (A/L) \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Therefore, labour productivity is comparable to land productivity. More details and the practical aspects of these measurements would be discussed in the concerned chapters. Now we can proceed our discussion towards the measurement of agricultural growth.

(2) Measurement of Agricultural Growth : Growth of a particular phenomena refers to the proportionate change in its total volume over time. Therefore, agricultural growth can be measured to observe the change in the total agricultural output over time. Since output is the product of three important components namely : yield, area and price, the change in these components, would be the determinent of agricultural growth. There are various methods for calculating the agricultural growth like compound growth, linear growth and logerethemic growth of the changing agricultural production. Minhas and Vaidyanathan (1965) calculated growth on the basis of decomposing the growth elements and therefore, they found that there is an interaction factor which affects the growth of agricultural patterns. Likewise, Bhalla and Tyagi (1989) interpreted the composit index of growth components.

In present reference, agricultural growth for each districts of Assam has been calculated by taking the difference of total agricultural output for two points of time in its proportionate manner formulated as :

$$r = \frac{(\phi,91-0,81)}{0,81.\ t} \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Where r = Average annual growth of a particular district, 0 = total output for base year (1980-1) and, current year (1990-1) and t = time (no of years, and in this year t=10).

In fact, growth is closely related to the proportionate change of crop-yield and crop-area while crop-price can be considered as constant. Therefore, agricultural growth can be compared with calculating the growth ratios of yield and area components of all the crops separately for a particular district. The growth ratios of crop-area and crop-yield are also calculated for findingout the causes of areal variations of agricultural growth patterns evolving in the state of Assam. The detail discussion regarding the methodological part of growth ratios of crop-yield and crop-area are given in the concerned chapter.

Further the last research question is related to the delineation of agricultural regions for which district is considered as an areal unit. Taking the value of various attributes of agricultural development, the spatial variance for each of the districts and the formation of homogeneous agricultural regions are delineated by applying statistical techniques. The concerned literature and the methods of delineating the agricultural regions are given in the concerned chapter.

(b) Data Collection and Tabulation :

So far as data collection and mapping are concerned, the present research has utilised varied sources of informations at secondary levels. The district-wise crop-statistics, area, yield and production of the principal crops for early 1980s and 1990s have been collected from 'basic agricultural statistics', published by statistical wing, Directorate of Agriculture, Assam, Gauhati.

The necessary maps are collected from different sources like Toposheet and, the Geological Survey of India, Shillong. Rainfall, temperature data collected from The Mateorological Centre, Gauhati.

Fertilizer, landuse statistics, aree under irrigation, agricultural workers etc. from the statistical Hand Book, Assam, for the year of 1980-81, 1990-91, published by the Directorate of Economics and Statistics, Govt. of Assam, Gauhati. The farm harvesting prices of principal crops have been collected from the Hand Book on Marketing Intelligence published by Department of Agriculture, Marketing Section, Assam, Gauhati.

Data tabulation and, generation of variables for agricultural productivity, growth and its regionalisation are done manually with the help of calculators. The district-wise authentic map of Assam is used as base map for showing the regional

patterns of agricultural attributes. The relevent data were shown by preparing diagram and graphs.

Design of the Present Study :

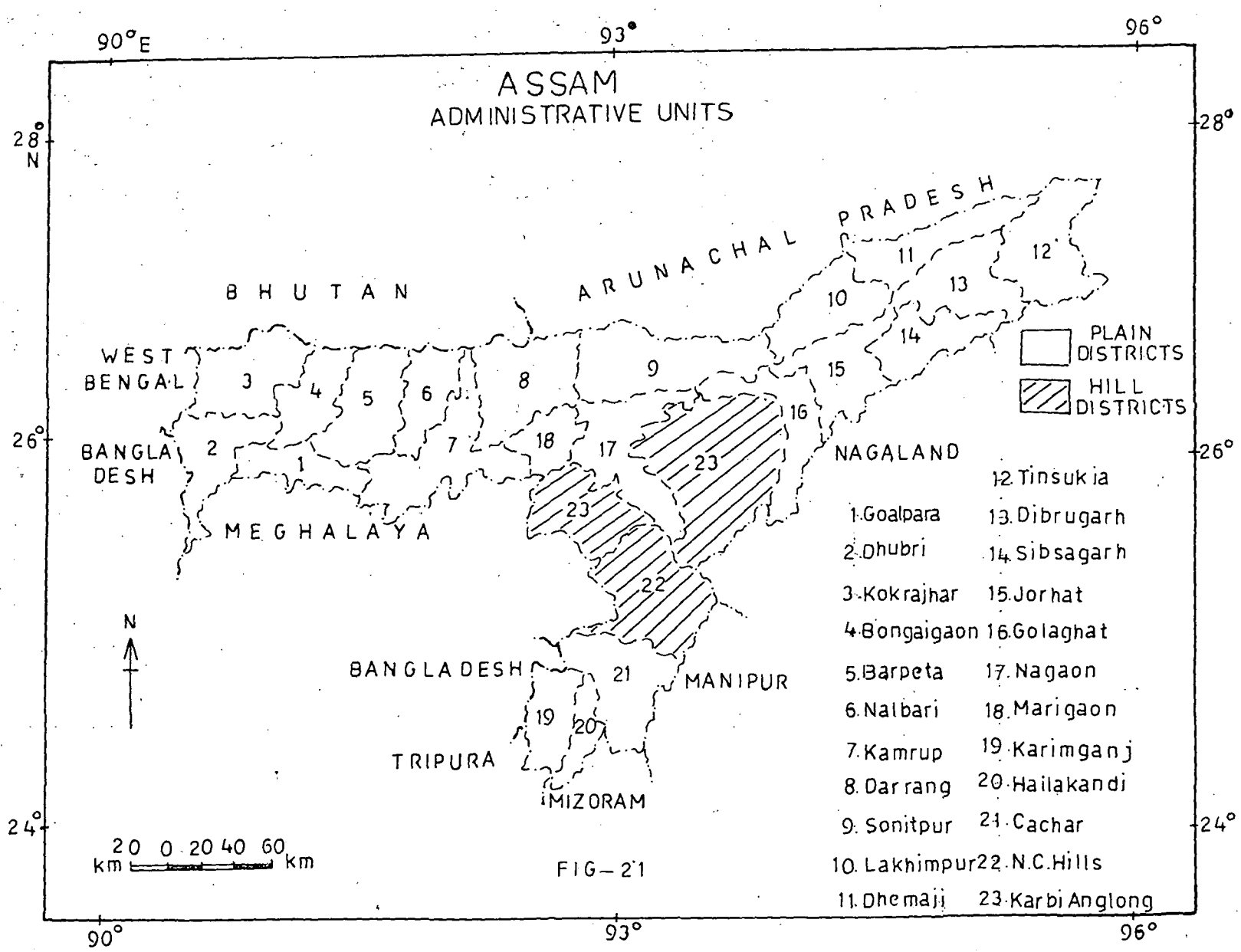
According to the objectives and research questions mentioned above, the whole material is arranged by putting into six chapters. Chapter I highlights the statements of the problem, objectives, research questions, hypotheses, methods and database, while the Chapter II deals with geographical personality of the study area. Chapter III covers the agricultural productivity i.e. the land and labour productivity of the state which are main attributes of agricultural development. Chapter IV includes the agricultural growth. Chapter V has the detailed study of agricultural regions and their characteristics while the last Chapter VI includes conclusion and main finding and some relevant suggestions for the balanced agricultural development in its regional frame. Though the main title of the present piece of research is " Levels of Agricultural Development in Assam : A Regional Analysis ", however, here main emphasis is given to delineate the agricultural regions for the interpretation of agricultural characteristics of the state. Thus, in identifying the levels of agricultural development, the regional approach is adopted.

CHAPTER - II

GEOGRAPHICAL PERSONALITY OF THE AREA

The Study Area :

The study area covers the Assam state as a whole which is situated in the extreme north-eastern part of the country, extending from 24° 8' N to 27° 56' N. latitudes and 89°42'E. to 96°0'E. longitudes. The Assam state is surrounded by Bhutan Arunachal Pradesh in the north ; Arunachal Pradesh and Nagaland in the east ; Manipur and Mizoram in the south-east and Meghalaya in the south. The state is bordered by Bangladesh in the west and south-west ; and by West Bengal in the west. The Assam along with other states of North-East India, Viz., Meghalaya, Nagaland, Manipur, Mizoram, Tripura and Arunachal Pradesh, is linked with the rest of India by a narrow strip of submontane region in North Bengal. The total geographical area of the state is recorded 78,438 Sq.Km. of which 17,580 Sq.Km area is under reserved forest, 15, 89 Sq.Km. area under barren and uncultivated land and about 2,485 Sq.Km. area under net sown area. The state has total population of 22,294,562 (1991) of which male population is 11,579,693 and female 10,714,869. The population growth rate is +52.44 percent (1971-91) and density of population is 284 per Sq.Km. Sex ratio in the state is 925 females per 1,000 males. Literacy rate 53.42 percent where male literacy is 62.34 percent and female 43.70 oercent (Both excluding the children in the age group 0-6). In July 1983 with the creation of


ASSAM
ADMINISTRATIVE UNITS
90°E
93°
96°
28° N
26°
24°
BHUTAN
ARUNACHAL PRADESH
WEST BENGAL
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1.Goalpara
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6.Nalbari
7.Kamrup
8.Darrang
9.Sonitpur
10.Lakhimpur
11.Dhemaji
12.Tinsukia
13.Dibrugarh
14.Sibsagarh
15.Jorhat
16.Golaghat
17.Nagaon
18.Marigaon
19.Karimganj
20.Hailakandi
21.Cachar
22.N.C.Hills
23.Karbi Anglong

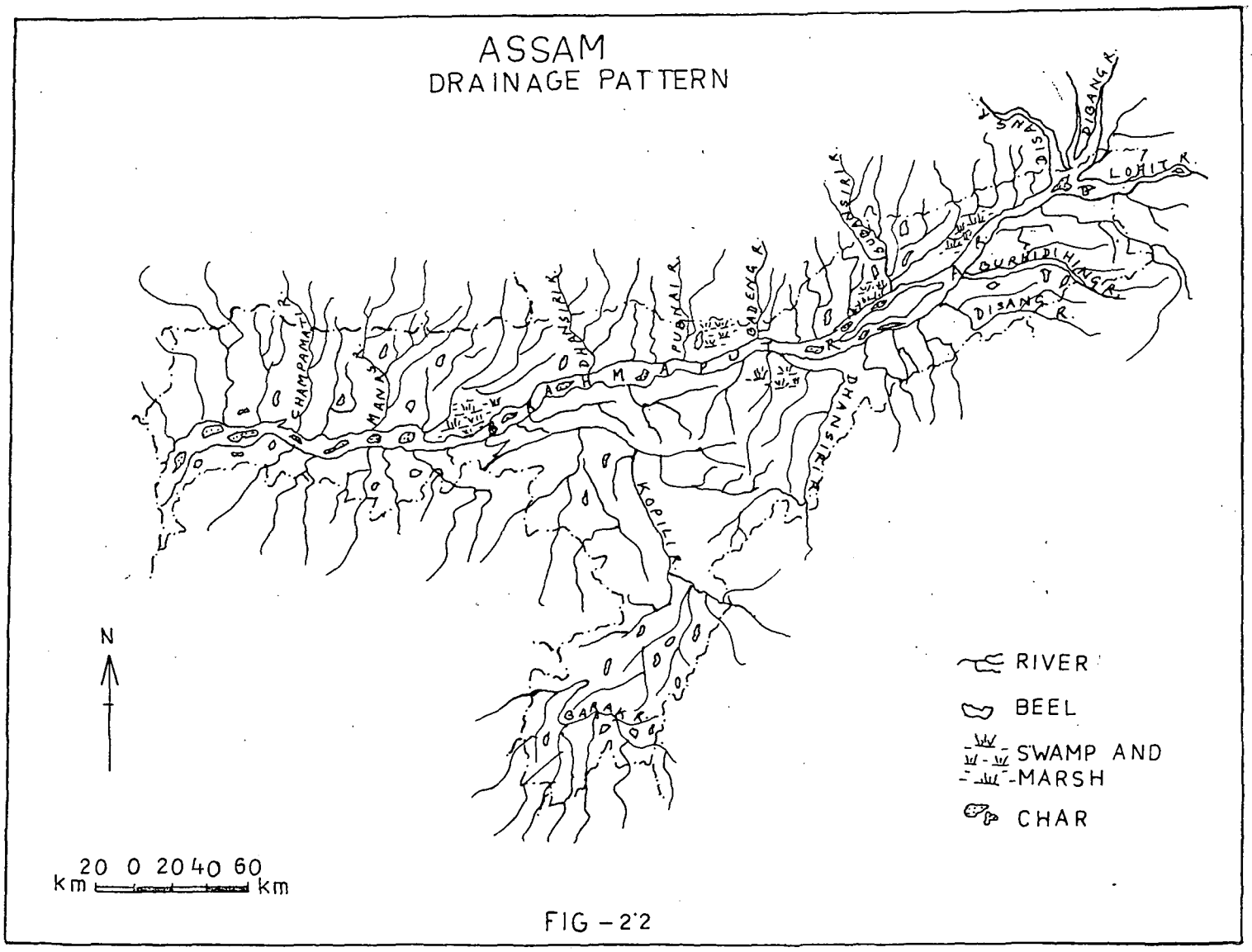
FIG–2.1

six new districts and again in 1991 adding more five districts from the earlier sub-divisions, the present state of Assam comprising total 23 administrative districts of which two in the hills Viz., Karbi Anglong and N.C. Hills and the rest 21 districts in the plains (Fig-2.1).

Drainage Pattern :

The state Assam is drained by a number of rivers, water channels and water bodies or 'beels' and low-lying swamps out of which the river Brahmaputra and the Barak are the main rivers. The mighty Brahmaputra controls the drainage system in the Brahmaputra Valley while the Barak river controls that of the Barak Valley (Fig-2.2).

The central Assam hill range in the state forms approximately the watershed for Brahmaputra and Meghna Basins. The present master slope of this basin finds a gap between the Shillong plateau and the Eastern Himalayas to open in Bangladesh. The Brahmaputra river discharges about 30 percent of the total water resources of the country. River Brahmaputra is joined by some forty tributaries like Subanziri, Jiabharali, Manas, Dhansiri on the north bank and Dholai, Burhi-Dihing, Disang, Kapili-Kalang, Kulsi-Jinjiram on south bank. Most of the rivers during the summer season (monsoon period) causes devastating floods and it damage a large number of crop fields and it directly effects on the yield and pattern of crops in the state. The Barak river and its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20 0 20 40 60
km
km
RIVER
BEEL
SWAMP AND MARSH
CHAR

FIG – 2·2

tributaries originate in heavy rainfall areas of the Meghalaya and Nagaland hills. So, they also couses flood in the southern plains in the state. The mighty Brahmaputra and the Barak river systems have large annual flow. In terms of depth flow in metres per hectare of the cultivable area, it is nearly 7 metres for the Brahmaputra and 3.18 metres for the Barak. In spite of annual flood created by all these main river and its tributaries in Assam, they form one of the most important physical basis of agriculture of the state. All these streams supply water to the agricultural fields, they built up the fertile alluvial soils and the poor country people take the advantage of fishing from these rivers and from the more than 1,200 beels and swamps scattered over both the river valleys. The areas which covered by the beels and swamps are not used for agricultural production. Some of these are fairly large and deep containing water throughout the year, while others are shallow and turn into muddy puddle during the dry season.

(Taher 1978).

Geological Structure :

In the broad sense of view the geological structure in the state of Assam treasures a wide age range, right from the Archean to Recent age, obviously has undergone diversified nature depending on parent materials, physiographical conditions and climatic conditions to which it was subjected. The geological formations in the state forms the following groups :

(1). The Archaean group comprising on metamorphic complex of gneisses and schists with younger acid/basic intrusives. This group of geological structure founds in the north and south banks of the Brahmaputra river.

2. The precambrian group consisting of quertzites and phyllites restricted to the northern part of the North Cachar Hills.

3. The lower Tertiary shelf sediments of the Jaintia group extending along the geosynclinal Disang Group over the parts of the North Cachar hills.

4. The Upper Tertiary (oligo-Mio-Pliocene) shelf and geosynclinal sediments covering the North Cachar hills, the hills of Cachar district in the Surma Valley and the margins of the Sibsagar and Dibrugarh districts.

5. Unclassified older and Newer alluvium (Quarternary deposits) comprising high level of terraces, the red bank soil and the Recent alluvial deposits of the Brahmaputra and Surma Valleys.

The Archaean and Precambrian are confined to the Karbi-Anglong, northern parts of North Cachar Hills, eastern part of Nagaon district, the southern border of Goalpara and Kamrup districts and over the isolated inselbergs in the Brahmaputra valley. The tertiary sediments resting over the weathered platforms

of the Archaean group. The geosynclinal facies (Disang group) are restricted to the south of Halflong-Disang Thrust in the central part of North Cachar Hills upto the head waters of Dhansiri. The Tipam group of rocks exposed in many areas in the Cachar district and in Digboi region. The sand stones of this group associated with fragments of semi-silicified and simi-carbonised fossil wood and minor seams of lignite are exposed in the Subansiri river section in Lakhimpur district and the Bharali river in Darrang district.

The Brahmaputra Valley, developed during the Quarternary period of alluviation of the foreland depression in between the Himalayan orogenic belt and the messif of the Shillong plateau. In the northern bank the alluvial terrain presents a stepped sequence of three to four geomorphic surfaces, each surface having steep slope near the mountain front and a very gentle gradient near the Brahmaputra corresponding respectively to the piedmont and the flood plain.

Climate :

The climate factors are very much responsible for the agricultural growth and its development. In general, the main character of climate of the state is reletively cool, extreme humid, heavy rainfall in summer season and winter is dry. The mean annual temperature varies from maximum 30.21° C. to minimum 18.74°C. The mean annual rainfall is recorded more than

Table 2.1 : Temperature, Rainfall And Humidity for Some Selected Centres (1986 - 91)

Name of the Station	Annual Mean Temp. (in °C)			Annual Total Rainfall (in mm)	Average Humidity (in %)
	Average	Max.	Min.		
1. Chaparmukh (Nagaon)	24.83	28.66	21.0	2790	84
2. Dhubri (Rupsi)	23.79	32.08	15.5	3197	83
3. Dibrugarh	24.10	30.80	17.4	2832	82
4. Gauhati	24.65	29.30	20.0	1763	83
5. Lumding (Nagaon)	28.65	31.50	15.8	1248	81
6. Majbat	24.65	31.30	18.0	2053	82
7. N.Lakhimpur	24.89	29.88	19.9	3228	82
8. Silchar	24.00	27.90	20.1	3083	81
9. Tezpur	25.75	30.50	21.0	2083	83

Source: Statistical Hand Book, Assam.

2475 mm during the period of 1986-91, and the mean relative humidity 82 percent. Due to the longitudinal shape of the state, it has regional variations in the climatic conditions. The upper part of the Brahmaputra Valley like in Dibrugarh, Lakhimpur and Sibsagar and in the lower part like Goalpara, Cachar (in Bark valley) receive very heavy rainfall. Kamrup, Darrang, Nagaon and K.Anglong receive comperatively less amount of rainfall. More than 70 percent of the total annual rainfall are confined to the months of June, July and August, whereas the month of December, January and February are almost dry. As a result there are two crop seasons : (1) Kharif (The summer season) and (2) Rabi (The winter season). Moreover, according to the meteorological department of Assam, the annual variation have been shown by dividing it into four seasons which has a great influence on the agricultural cycle in the state. They are (1) Pre-Monsoon (March-April), (2) Monsoon (June-September), (3) Retreating Monsoon (September-November), and (4) Dry winter (November-February), No doubt, there is a close relation between climatic conditions and agricultural growth and development in the state of Assam.

Climatic Conditions and Soils :

The climatic conditions of the state are also mostly responsible for the soil forming processes. It is important in respect of its colour, texture, composition, consistency and

Table 2.2 : Monthly Mean Temperature and Rainfall for some selected centres (1986-91)

(Temp.in °C and Rainfall in mm)

Name of the stations		J	F	M	A	M	J	J	A	S	O	N	D
Chepar-mukh	Temp	17.8	18.3	20.7	22,0	26.0	29.0	30.5	30.5	280	250	22.5	18.5
	Rainfall	7.0	20.0	16.00	390.0	150	511	385	500	640	300	20	21.0
Rupsi	Temp	16.5	18.0	22.0	24.0	25.5	27.5	29.5	28.5	28.5	24.0	21.5	18.0
	Rainfall	16	15	25	250	230	800	625	425	490	235	35	15
Dibru-garh	Temp	16.5	19.0	21.5	24.0	25.5	28.5	29.0	27.7	28.0	23.5	20.5	17.0
	Rainfall	12	65	75	200	300	650	615	415	550	100	5	40
Gauhati	Temp	17.5	19.5	22.5	24.5	26.5	29.5	30.0	29.5	28.0	24.5	22.5	19.0
	Rainfall	9	14	55	2240	275	200	395	175	150	210	5	4
Lumding	Temp	13.5	17.5	19.0	21.5	24.5	27.5	30.0	29.0	27.5	23.0	19.0	15.5
	Rainfall	4	20	50	200	210	305	400	230	205	190	3	10
Majbat	Temp	19.0	21.0	22.0	24.5	27.0	30.0	30.5	29.0	28.5	25.0	20.0	19.5
	Rainfall	12	35	40	190	245	205	450	415	395	95	20	25
N.Lakhim-pur	Temp	17.0	18.5	21.5	23.5	26.0	28.0	29.5	29.0	27.0	23.5	20.0	18.5
	Rainfall	40	70	75	200	305	680	590	315	400	75	80	30
Silchar	Temp	18.0	19.0	22.5	24.0	26.5	29.5	30.0	29.5	27.5	24.0	21.5	18.5
	Rainfall	15	50	140	300	350	650	690	450	400	200	40	50
Tezpur	Temp	17.5	19.0	20.0	23.5	25.5	28.5	28.5	29.5	26.5	22.0	20.5	18.0
	Rainfall	10	30	50	150	250	275	300	200	250	210	150	15

humus content in the soil. The average amount of rainfall is about 2527 mm (1991) and the rainy days is about 140 days in the state. The average maximum and minimum temperature in the state is 35.7°C. and 17.8°C. respectively and in June and July months, temperature reached the highest while January is the coldest month of the year.

The alluvial soils mainly in the flood-plain areas of the state is less acidic and clayey to sandy loam in texture. In the north bank middle plain areas of the state viz., Dhubri, Kamrup, Darrang and Lakhimpur and in the narrow patches along the southern margin of the south bank middle plain from Goalpara to Dibrugarh the alluvial soils are found and it is due to the excessive rainfall in these regions. A wide variety of crops such as rice, wheat, sugarcane, bannana, jute, oilseeds, pulses, tobacco and vegetables grow well in alluvial soils.

Soils :

The soil has a great significance in its geological structure and landscape ecology and it forms on the basis of which all the planning of agriculture and forestry could be prepared in a systematic manner. Depending on the soil resources and its character the types of crops, the system of farming and the nature of practices all to be considered. The

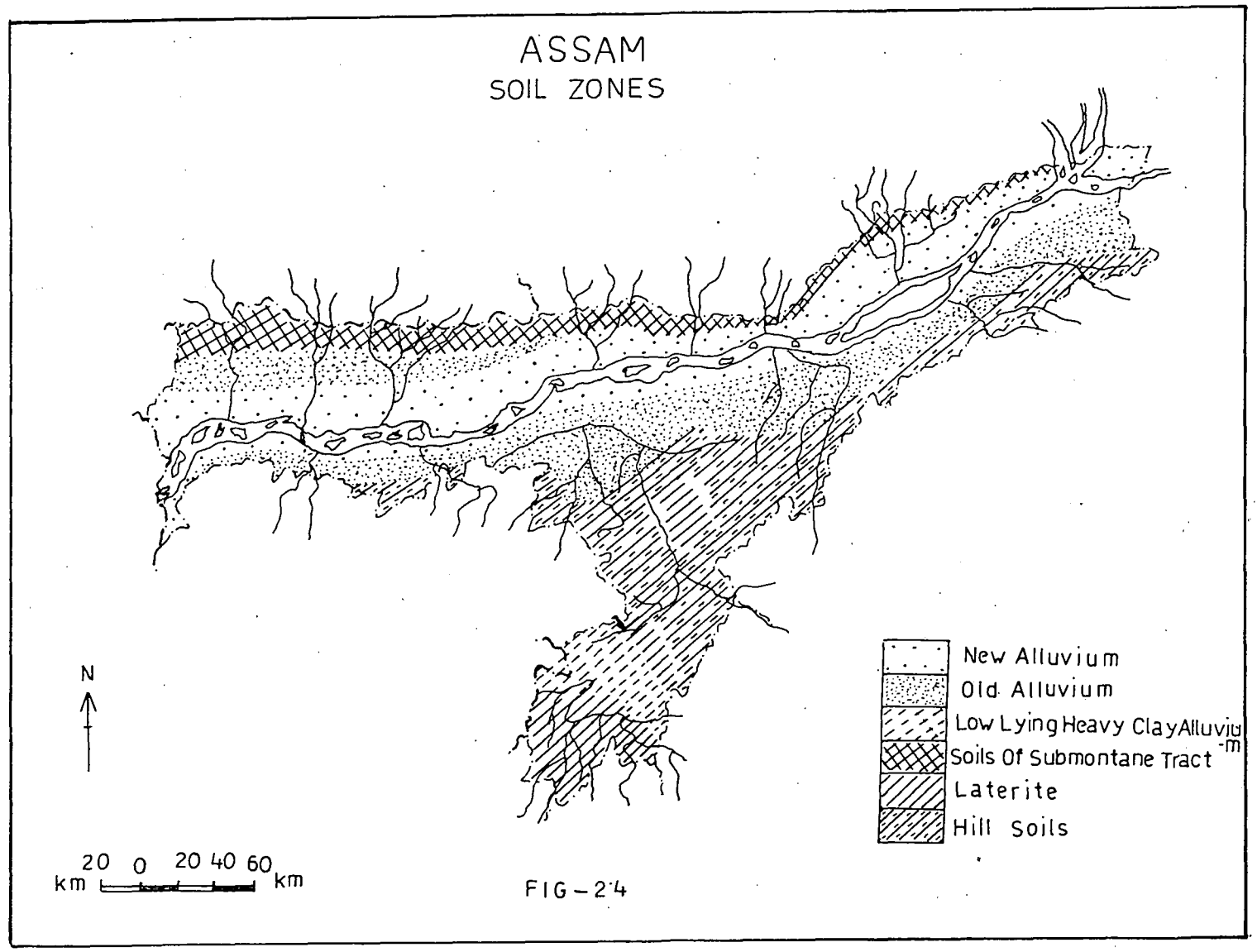
ASSAM
SOIL ZONES
N
20 0 20 40 60
km
km
New Alluvium
Old Alluvium
Low Lying Heavy Clay Alluvium
Soils Of Submontane Tract
Laterite
Hill Soils

FIG – 2·4

climatic conditions and the geological structure of an area are the important factors of the soil forming processes. And the vegetation also provides the humus content and the soil fertility status. The soil groups which have got strategic significance in the present day land utilization, the soils of Assam may be classified into Zonal and Azonal (Based on the Russain system) depending upon soil genesis.

Soil types :

1. Older Alluvial Soil : These are developed almost entirely in Cachar district and is light grey to dark grey in colour. These soils are practically unaltered alluvium representing sand, salt and humus rich clay depending on land form components.

2. Red Loamy Soil : These red loamy soils are developed in the entire Karbi-Anglong district, parts of North Cachar Hills and a little fringe in the northern border of North Lakhimpur district. These are deep red loamy soils with clay rich latasol profile.

3. Red and Yellow Soil : In the low level terrace, red yellow to brick red soil, restricted mainly in the northern border of the N.C. Hills. They are clayey plastic latasol with sedimentary structures and the textures totally obliterated in the solum.

4. Lateritic Soil : The forested and lateritic soils are brick red to brownish red in colour. These are developed in the vicinity of Halblong in N.C. Hills district, southern parts of Kamrup and Nagaon districts.

5. New Alluvial Soil : These soils are developed along the vast places of Brahmaputra basin. They are yellow to yellowish grey in colour and are unaltered alluvium which represents sand, silt and humus rich. The soil PH is generally feebly alkaline excepting bog soils.

6. Tarai Soil : The soil group representing Bhabar and Tarai fall in this sub-division. These are brownish grey soil and are mainly constituted of sand with very little clay. These soil groups are generally slightly alkaline to acidic.

Of all the soils mentioned above, the alluvial soils found throughout the Brahmaputra Valley is the most fertile and useful for agricultural purposes. Again, the lateritessoils are deficient in nitrogen, potash, phosphoric acid and lime but very responsive to nitrogen and phosphate and so this soil is favourable for good crops.

Vegetation and Soils :

The state Assam having fertile soil, humid climatic conditions and its favourable topography support the growth of abundent vegetion. The state has a total area of 21522.60 Sq.Km

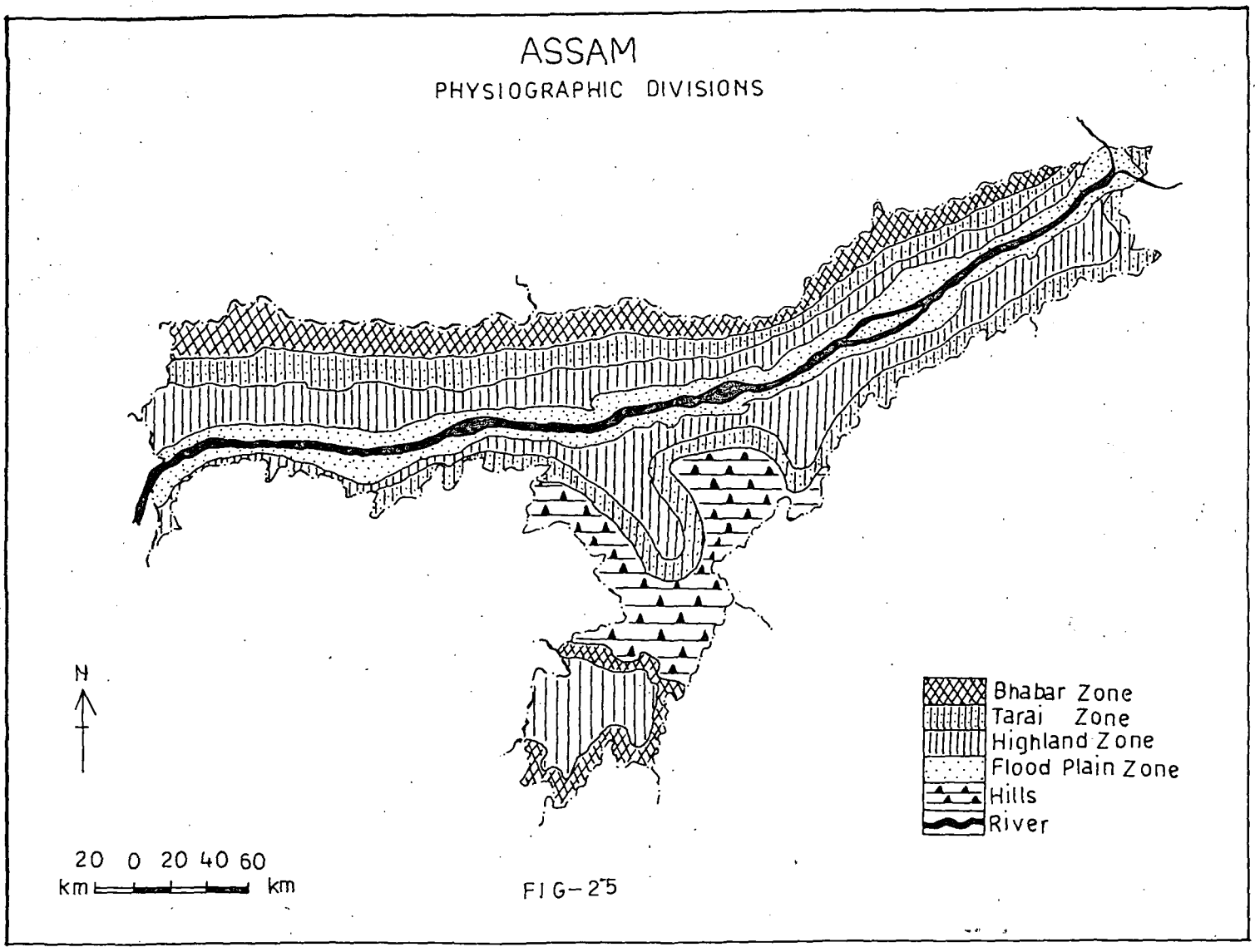
ASSAM
PHYSIOGRAPHIC DIVISIONS
N
20 0 20 40 60
km km
Bhabar Zone
Tarai Zone
Highland Zone
Flood Plain Zone
Hills
River

FIG-2.5

of land under forest in 1989-90 which is increased a little upto 21684.52 Sq.Km. of land in 1991-92. The total increase of forest land during this people is about 162.Sq.Km. area. The areas like Silchar (1680 Km^2), K.Anglong (1118 Km^2) and and West K. Anglong (1026 Km^2) of the state occupy the highest area under forest. The soil in those areas are rich in mineral contents. And the areas like Hamren (105 Km^2), Goalpara (385 Km^2) and Domdoma (434 Km^2) cover the lowest area under forest. Botanically vegetations in the state are as tropical evergreen forest, Savannah type and miscellaneous forest etc.

Physiographic Divisions :

Assam may be divided into three physiographic divisions (1) The Brahmaputra Valley, (ii) The Barak Valley (or Cachar) Valley and (iii) The Hills Region (Fig-2.3).

The Brahmaputra Valley which is an alluvial plain covers 725 Km. long and 80 Km. broad on the average and consists of an area of 56,339 Sq.Km. The Brahmaputra Valley represents about 72 percent of the total area of the state. The river Brahmaputra has innumerable tributaries by whibh it deposited new and old alluvium in the plains. The general gradient of the valley is from north-east to south-west i.e. from Sadiya to Dhubri. The river Brahmaputra to its long gradient areas formed a number of river islands called 'Chaparis' or 'chars'.

Physiographically, the land surface of the Brahmaputra valley may be sub-divided into five distinct sub-divisions which run almost parallee to the main river. They are - (1) the northern foot hill zone, (2) the middle plain of the north bank, (3) the active flood plain and 'Charlands', (4) the middle plain of the south bank and (5)the southern foot hill zone (Taher 1975).

The Barak (i.e. called Cachar) valley which is about 100 Km. long from the east to the west and 70 Km. wide from morth to south covers an area of 6,962 Sq.Km. This Barak Valley or Cachar plain lies to the south of the Meghalaya plateau and is created by both erosional and depositional activities by the river Barak and its different tributaries. The important character of this plain is that it is closed by hills on it's three sides while only towards the west is open to the Sylhet district of Bangladesh. The gradient of the Cachar plain is very low and consequently, it is covered with a network of sluggish streams and Saucer - like depressions and Silchar is only 26.5 metres high above mean sea level (Administrative Report). A number of isolated hillocks are found in this physiographic divisions knowns as 'tilas' in local term. Due to the alluvial deposits in the central part around Silchar town and to the western part, this part is rich in rice-belt.

The hill division of Assam state comprised Karbi and N.C. Hills covering an area of 15,322 Sq.Km. It is further divided into three sub-divisions, viz., the Karbi Hills,

Table 2.3:Population of Assam (1901 - 1991)

Year	Population	Decade Variation of population	Percentage of Decade Variation
1901	3,289	--	--
1911	3,848	+558	+16.99
1921	4,636	+788	+16.99
1931	5,560	+923	+20.48
1941	6,694	+ 1,134	+20.40
1951	8,028	+ 1,334	+19.93
1961	10,837	+ 2,808	+34.98
1971	14,625	+3,787	+34.95
1981	--	--	--
1991	22,294 *	+7,669	+52.44

* Two decades figure

the Hamren hills and the N.C. hills. In all these hill divisions 'jhum' cultivation practiced by the hill tribes.

Population Structure (As a Resource) :

Indian agriculture is labour dominent and hence the role of man in agricultural production is directly related and has a great importance because he himself is engaged in agriculture in different forms. The Assam stands a total population of 22,294,562 persons (1991 census).* The growth rate of population is 52.44 percent (1971-91).

In Assam, the 1981 census could not be conducted due to the unfavourable situation prevailing at that time. Consequently the growth of population has been shown for the period of 20 years ie. from 1971 to 1991. During these two decades Assam wintnessed an increase of 52.44 percent over the total population in 1971.

It appears from the Table-2.4 that the decadal growth rate of Assam has shown an abrupt increase during 1951-61 and 1961-71. But the growth was not so high during the people of 20 years from 1971 to 1991 compared to the earlier two decades. The Dhemaji district has recorded the highest annual growth rate(+5.22 percent) followed by North Cachar Hills (+3.64 percent) districts. Jorhat district registered the lowest growth rate in 1991 followed by Sibsagar and Dibrugarh districts.

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* Population Atlas for 1991 are provisional

Only three towns in Assam have crossed the 1,00,000 population mark. Dibrugarh and Silchar Municipality has crossed this figure for the first time in 1991 census.

The desnity of population in the state is 284 persons per Sq.Km (1991) while the corresponding figures of density was 186 persons per Sq.Km (1991). Dhubri district is recorded the highest density (467) followed by Kamrup (457) and Karimganj (456). North Cachar Hills district has the lowest density of population (31) followed by Karbi-Anglong (63) and Dhemaji (146) districts. The sex ratio is 925 females per thousand males (1991) whereas in 1971 this ratio was 896. Highest sex ratio recorded in Goalpara district (956) followed by Dhubri district (951). On the otherhand, the lowest sex ratio recorded in North Cachar Hills district (878) followed by Kamrup district (881). The literacy rate in the state according to 1991 census is recorded at 53.42 percentwwhich is slightly higher than the national average (52.11 percent). In this composition, male are more literate (62.34 percent to total literate) than female literates (43.7 percent).

Occupational Structure :

The total population of the state is divided into working population and non-working population while the workers are classified into nine categories. In the state, the working force is 31.69 percent (1991) to the total population.

Table 2.4 : Occupational Structure in Assam

(Persons in ' 000)

Occupational Categories	No.of workers 1971	%	No.of workers 1991	%	% change ('71-'91)
PRIMARY SECTOR					
1. Cultivators	2,283	55.90	3,538	50.07	-5.83
2. Agricultural Labourers	4,05	9.91	9,30	13.16	+3.25
3. Livestock,Forestry,	4,46	10.92	7,65	10.82	-0.10
4. Fishing,Hunting,plantation etc.					
4. Mining and Quarrying	14	0.34	42	0.59	+0.25
SECONDARY SECTOR					
5.a. Manufacturing,processing, Servicing and reparing in household industry	56	1.37	65	0.92	-0.45
5.b. Manufacturing, processing, Servicing and reparing in other than household industry	112	2.74	2,15	3.04	+0.30
TERTIARY SECTOR					
6. Construction	39	0.95	1,09	1.54	+0.59
7. Transport,Communication and Storage	102	2.49	1,73	2.44	-0.05
8. Trade and Commerce	231	5.65	4,68	6.62	+0.97
9. Other Services	396	9.69	7,60	10.73	+1.06
	4,084		7,065		

Therefore, the non-working population in the state is more than two-third share of the total population (Table-2.4). As a result, it is clear that the dependency ratio in the state is high. It indicates that the dependent population (i.e. children and old aged persons) which is higher in state has a potential manpower which can be utilised in near future.

General Landuse Patterns:

Landuse is the reflection of the use of land resources for human needs. Therefore, the study of landuse is the integral part of acceleration of production processes in any areal respect. But land utilization refers to a proper use of land. It reflects the planning of land categories in relation to physical, socio-cultural, historical and techno-economic factors of land.

There is a general categorisation of landuse which has been adopted by the Govt. of India for the scientific study of land resources. It is adopted on the recommendation of the Standing Advisory Committee on statistics, F.A.O. (Mamoria 1972). According to the classification, total land is classified into nine broad categories, viz., forest, Barren and uncultivable lands, Lands put to non-agricultural uses, cultivable waste land, permanent pasture and grazing lands, Land under miscellaneous tree crops and groves, current follows and Net Area Sown.

Collecting data of general landuse categories for early 70s, 80s and 90s, the changing landuse patterns in Assam are

Table 2.5 : Changing General Landuse Patterns (1970-1 to 1990-1)

Area in ' 000 hectares)

Categories	1970-1		1980-1		1990-1	
	Area	%	Area	%	Area	%
Total Geographical Area	7852		7852		7852	
1. Forest	2080	26.49	1984	25.26	1904	24.24
2. Land put to Non-agricultural use	768	9.18	914	11.64	1015	12.92
3. Barren and Cultivable land	1802	22.94	1541	19.62	1220	15.53
Total (2 + 3)	2570	32.73	2455	31.26	2235	28.46
4. Permanent Pasture and grazing land	234	2.94	184	2.34	136	1.73
5. Miscellaneous tree crops & groves not included in net sown area	226	2.87	247	3.14	234	2.98
6. Cultivable waste	184	2.34	104	1.32	98	1.24
Total (4+5+6)	644	8.20	535	6.81	468	5.96
7. Fallows other than current fallows	166	2.11	84	1.06	76	0.96
8. Current fallows	122	1.55	88	1.12	80	1.01
Total (7+8)	288	3.6	172	2.19	156	1.98
9. Net Sown Area	2226	28.34	2706	34.46	3070	39.09
Area Sown More than Once	548	6.97	754	9.60	952	12.12
Gross cropped Area (GCA)	2774	35.32	3460	44.06	4022	51.22

Source : Data Collected from The Directorate of Economics and Statistics, Govt. of Assam and Statistical Hand Book, 1992.

interpreted here (Table-2.5). It could be helpful for understanding the processes of agricultural landuse. From the table it has been clear that the net area sown has increased from 2226 thousand hectares (28.34 percent) in 1970-71 to 3070 thousand hectares (39.09 percent) in 1990-1 in the state. This increase in NSA (10.75 percent during 20 years) has supported by decreasing in forest and waste land areas. During this two decades the forest land decreased by 176 thousand hectare (2.25 percent) and the waste land area decreased by 86 thousand hectares (1.10 percent). But this increase in NSA still have to compete the rate of population increase in the state which was 17.49 percent during last two decades.

During last two decades it has been observed that the land put in non-agricultural use increased about 3.14 percent to the total geographical area of the state while the barren and cultivable land has decreased to 7.41 percent. Therefore, total decrease shown by those two categories of landuse is 4.27 percent. The land put into the 4,5 and 6 number categories decreased by 2.24 percent while category 5 has increased a little bit (0.11 percent) during 1970-1 to 1990-1. The lands, under fallow category : other than current fallows and current fallows both, has decreased by 1.62 percent. It is interesting to note here that if the cultivable waste lands and total fallow lands are added to the present net sown area, then the total area available to cultivation would be 3324 thousand hectares(42.33 percent). Cultivation, therefore, can be extended to about 254 thousand hectares of lands adding to that of NSA and if adequate

facilities are provided to such lands that constitutes 3.22 percent of the total land area of the state.

Due to the pressure of agricultural population on cultivable land, it is observed an increase in the area sown more than once. The areas sown more than once was only 548 thousand hectares in 1970-1 which has increased to 952 thousand hectares in 1990-1 (5.15 percent), thus, cropping intensity is increasing gradually. Assam as the agricultural dominent state, the cultivable area has particular importance. In the world as a whole, the total agricultural land is 32 percent of the total geographical area and the corresponding figure for India is 50 percent (Agriculture in Brief, 1970).

In case of forest area it can be mentioned that the " National Forest Policy of India " laid down that at least third (33.3 percent) of the total geographical area of a region should be under forest. On account of this, Assam covers only 24.24 percent area (1991) under forest which is still less of about 9.06 percent to touch of that particular limit so that it can maintain the ecological balance of the state.

Transport and Communication :

Though the transport and communication are not the resource directly related to agricultural practices, yet, they are indispensable infrastructure for the development of agriculture. Assam's main produces- tea, jute, petroleum, timber etc. are

dependent on market situated outside Assam. On the other hand, other produces like cloth, wheat, salt, sugar, pulses, edible oil, footwear, drugs and medicines, iron, cement, C.I. sheet, stationeries etc. Assam has to import. The bottle-neck facility of transport and communication there is a great scarcity of essential commodities and hence the cost of living is much higher in Assam then the other state of the country. The transport and communication indirectly related to the cropping patterns, crop-yield and mobility of surplus production and labour also.

The road system in Assam is very important as it has strategic and economic significance and also the main link to the neighbouring states. Extension of road transport yet to be done to the rural areas which is essential for agricultural development. The total lenght of road (P.W.D.) in Assam was 29,035 Km in the year 1988-89 and it increased to 30,086 Km in 1989-90. According to 1991 census the surfaced road lenghts is 6,839 Km., gravelled 22,223 Km and 1,024 Km is earthen road. Considering the surfaced road density in Assam it has been found that in the lower part of Assam (including Dhubri, Kokrajhar, Goalpara and Bongaigaon districts).The surfaced road density is 0.09 Km/Sq Km of area while in middle part this density is a little bit more (0.10 Km/Sq.Km). In Upper Assam region the surfaced road density is 0.10 Km/Sq.Km and in Barak Valley it is only 0.06 Km/Sq.Km of area. Air transport also plays an important role in the transport system of the state. Six aerodroms in Assam connect the state with Calcutta regularly by the Indian Airlines Corporation.*

* Economic Survey, Assam, 1975-76, op.cit. P.37.

As the air transport is too costly, it is not directly influence on agriculture in Assam. Moreover, the river Brahmaputra with its innumerable tributeries has a great scop for the development inland water transport system. However, the implementation of the programme suggested by the Bhagavati Commission set up by the Govt. of India is essential for full utilisation of the river route potentials of Assam.**

In the end, it can be concluded that the physical conditions of the state are favourable for the growth and development of agricultural activities. However, the attributes of agricultural development are observed weak. Before finding out the causes of these unartienlated processes of development, we should turn to the interpretation of areal patterns of these components of agricultural systems.

** Das, M.M. 'Peasant Agriculture in Assam', 1980, p.83.

CHAPTER - III

AGRICULTURAL PRODUCTIVITY AND PRODUCTION FACTORS

Introduction :

In the previous chapter, the geographical personality of the Assam state has been discussed in relation to the agricultural attributes. Agricultural productivity is one of the main component of agricultural development. Infact, agricultural productivity is a relative term which refers to the agricultural production in relation to the production factors basically associated with land and labour. In physical term, agricultural productivity is assessed by taking into account the total agricultural production (or output as in money term) per unit of arable land because land is a piece of resources and the intensity of these resources are influenced by the physical as well as techno-economic factors of land. Therefore, the agricultural geographers, namely, Bhatia (1969), Stamp(1950), Safi (1960) and others conceived and defined land productivity as agricultural productivity. Indeed, productivity can also be measured with respect to agricultural labour force because it is also an important factor of agricultural production. Generally, economists defined it as labour productivity (Bhalla and Tyagi 1989, Thakur 1987). The study of labour productivity is also equally important especially in the Indian conditions. In the agricultural conditions of the Assam state where the entire operational systems of agricultural production are labour-based, The, enhancement of labour productivity has become an important aspect of agricultural development and planning. Thus, labour

productivity determines the standard of living, economic standard and rate of earning of the rural masses of the state. In the present chapter, land and labour productivities which are the main aspects of agricultural productivity and refers to the working processes in the agricultural systems would be studied with respect to their regional dimensions, so that the causes of their areal variations and temporal changes may be interpreted for the balanced agricultural development.

So far as the assessment of land and labour productivity is concerned, the literature review and productivity measurements have already been included in detail in the methodological section of the Chapter-I. However, a brief background of the measurements is required for the logical discussions. According to equation (4), since land productivity is the ratio between two attributes of agricultural production system : agricultural putput and cultivated land as O/A, the level of land productivity is positively related to the total output because it is the numerator of productivity fraction and is negatively related to the size of cultivated land. The same fact can be stated in the way that the areas of higher level of agricultural output may have very high levels of land productivity and the areas of higher magnitude of cultivated land may have lower level of land productivity. But, it may not be true to all the cases because land productivity is the ratio.

Further more, labour productivity is the ratio of agricultural output with the total labour force employed in agricultural production processes (equation.5). While spliting the

labour productivity equation into components, it is found that it is the product of two major attributes of agricultural systems, namely, the land productivity and cultivated land per unit of labour force employed in the production activities (O/A), (A/L). Thus cultivated land per person of agricultural labour force is less than 1.0 hectare, then the labour productivity per person must be lesser than the land productivity in a particular area and vice-versa. Therefore, it may be predicted that the areas of high labour intensity would have low levels of labour productivity. These facts are tested here empirically for finding the causes of their areal variations.

A. Land Productivity:

For the assessment of land productivity levels, the output of 19 principal crops has been calculated and aggregated with the help of equation (3). On the other hand, total GCA, though it includes farming intensity which is very low in the study area has been taken into account for each and every district of the state. After measuring the land productivity levels of each unit (i.e. district) for two points of time, 1980-81 and 1990-91, the total areal units of the state have been distinguished into four categories of same class interval. They are as :

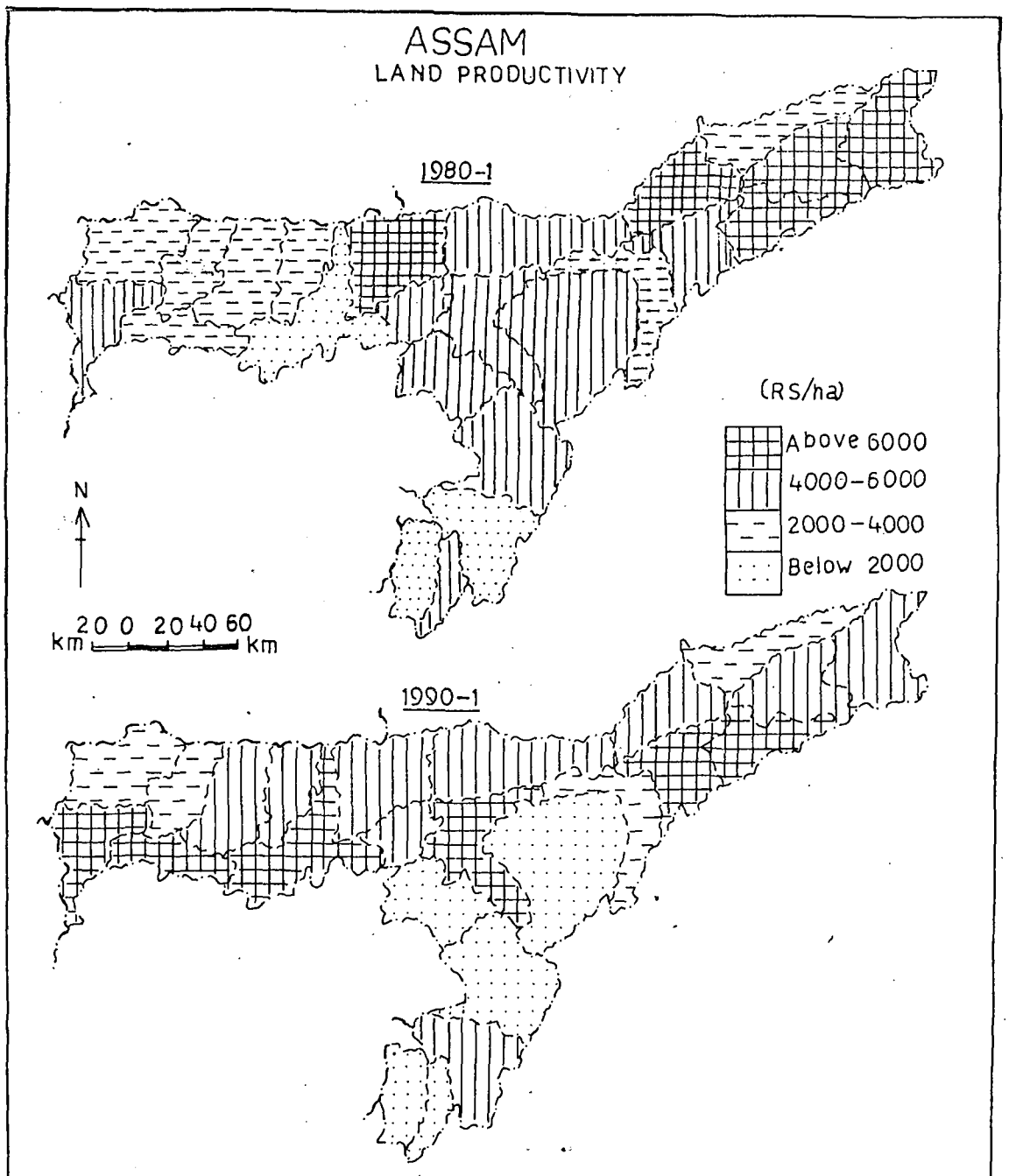

ASSAM
LAND PRODUCTIVITY
1980-1
(RS/ha)
Above 6000
4000-6000
2000-4000
Below 2000
N
200 0 20 40 60
km
km
1990-1

FIG-3.1

(1) High land productivity (Above Rs. 6000), (2) Medium productivity (Rs. 4000-6000), (3) Low productivity (Rs. 2000-4000), (4) Very low productivity levels (Below Rs.2000).

The areal extent of these categories would be able to explain the land productivity patterns which are interpreted in the following manner.

(a) Land Productivity Patterns (1980-1):

Comparing the distributional patterns of land productivity i.e. agricultural output per hectare of cultivated land for 1980-81 (Table-3.1) it seems that there are only seven districts of high land productivity class which covers 34.74 percent (1030540 ha) of the total cultivated area in the state. These high land productivity areas are situated in the Upper Assam except Karbi Anglong district. Here, in these most of the areas with fertile alluvial soils, the agricultural output per hectare of land is recorded high. The medium productivity class (Rs. 4000 to 6000) includes 6 districts incorporating 21.38 percent (634335 ha) of total cultivated land in the state. These districts of medium land productivity scattered in entire state having low to medium fertility conditions of the soil. The low land productivity class (Rs. 3000 to 4000) incorporates 31.73 percent (941378 ha) of total cultivated land during 1980s. It includes total 7 districts. These districts mostly situated in the western part, north and south-east parts, of the state. In the very low productivity class (Rs. below 2000) which incorporates only

Table 3.1 : Levels, No.of districts and Area under various categories of Land Productivity

(1980-81)

(Area in hectare)

Productivity Categories (Rs/ha)	Total No.of Districts	Area	
		Total	%
1. High (above Rs. 6000)	7	1030540	34.74
2. Medium (4000-6000)	6	634335	21.38
3. Low (2000-4000)	7	941378	31.73
4. Very Low (below 2000)	3	360145	12.14
		2966398	

Table 3.2 : Levels, No.of districts and Area under various Categories of Land Productivity (1990-1)

(Area in ha)

Productivity Categories (Rs/ha)	Total No.of districts	Area	
		Total	%
1. High (above Rs.6000)	6	1077429	32.35
2. Medium (4000-6000)	9	1413098	42.43
3. Low (2000-4000)	4	522045	15.67
4. Very Low (below 2000)	4	317487	9.53
		3330059	

3 districts covering only 12.14 percent (360145 ha) of cultivated land. One district is situated in Brahmaputra valley while other two districts namely Cachar and Karimganj situated in the Barak valley region.

(b) Land Productivity Patterns (1990-1):

The distributional patterns of land productivity during 1990-1 which are shown in Table-3.2 depict that there were 6 districts in the high land productivity class incorporating 32.35 percent (1077429 ha) of total cultivated land in the state. These districts are situated in the Brahmaputra Valley where the soil fertility for agricultural production is favourable and climatic conditions are also condusive to accelerate agricultural production processes. The medium land productivity class includes the maximum number of districts that are nine in number which incorporate 42.43 percent (1413098 ha) of total cultivated land. They are dispersed in upper and lower parts of Brahmaputra valley excluding Cachar district which is located in Barak Valley area. The low and very low land productivity classes include very low percentage of total cultivated area, i.e., 15.67 and 9.53 percents respectively. Both the low and very low productivity classes together include 8 districts which are located in Brahmaputra as well as Barak valley region of the state.

(c) Changes in Land Productivity Patterns (1980-1 to 1990-1)

Changing patterns of land productivity are shown by calculating the difference of percentage share of the area from

Table 3.3 : Annual Average Change of Area in various Land Productivity Categories (1980-1 to 1990-1)

Productivity Categories (Rs/Ha)	Percentage share in Total Area		Changes in % of areal share
	1980-1	1990-1	
1. High (above 6000)	34.74	32.35	-2.39
2. Medium (4000-6000)	21.38	42.43	21.08
3. Low (200-4000)	31.73	15.67	-16.06
4. Very Low (below 2000)	12.14	9.53	-2.61

Table 3.4 : Levels, No. of district and Area under various categories of Labour Productivity (1980-81)

(Area in Hectare)

Productivity Categories (Rs/worker)	Total No.of districts	Area	
		Total	%
1. High (above 6000)	7	954465	32.18
2. Medium (4000-6000)	4	694680	23.42
3. Low (2000-4000)	8	811993	27.37
4. Very Low (below 2000)	4	505260	17.03
		2966398	

1980-1 to 1990-1. Table-3.3, shows that there is an increase of about 21.0 percent of proportionate areal share in the medium land productivity category while the change in low, very low and even high productivity categories are recorded negative. It means there is a transformation from low productivity to medium productivity. As a result the areal patterns of land productivity in 1990-1 are uniform rather than the production patterns of 1980-1. For example, the areas of lower Brahmaputra valley which were following low productivity are now increased their levels of land productivity and come under the medium category (Fig-3.1).

(B) Labour Productivity :

Similarly, the labour productivity levels for each areal unit of the Assam state are assessed by dividing the figures of total agricultural output by total agricultural labour force (cultivators and agricultural labourers) for 1980-0 and 1990-1. Here, also the 23 districts are classified into 4 categories for showing the areal variations in the level of labour productivity. Since labour productivity reflects the standard of living of agricultural workers, the effect of absolute rise of agricultural force and the degree of labour absorption capacity of agricultural sector (Bhalla and Alagh 1983, Thakur 1987), there is therefore a need of understanding the regional patterns of labour productivity and changes therein. They are

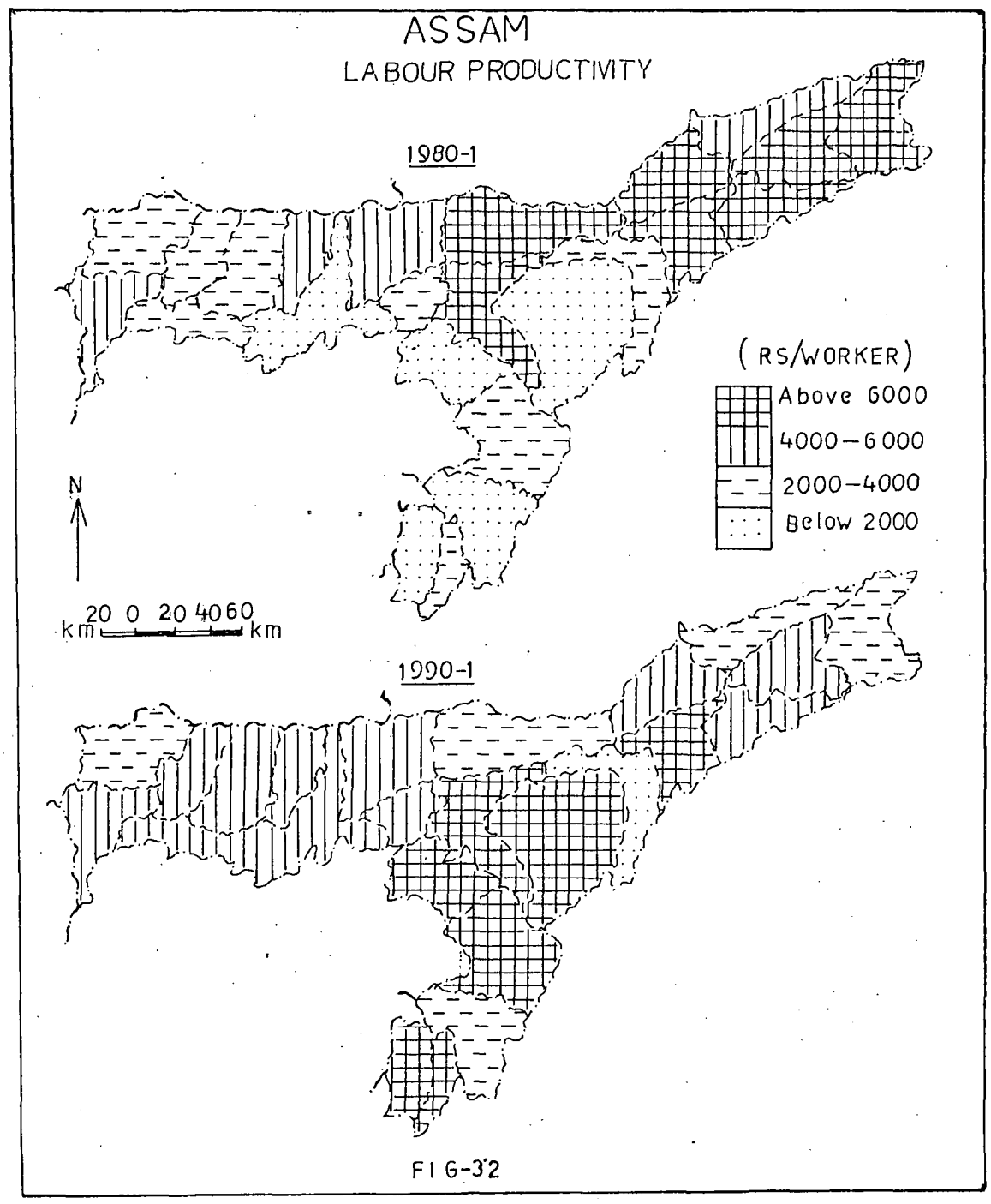

ASSAM
LABOUR PRODUCTIVITY
1980-1
(RS/WORKER)
Above 6000
4000-6000
2000-4000
Below 2000
N
20 0 20 40 60
km
km
1990-1

FIG-3.2

Table 3.5 : Levels, No of districts and Area under various categories of Labour Productivity (1990-1)

(Area in hectare)

Productivity Categories (Rs/Worker)	Total No. of districts	Area	
		Total	%
1. High(above 6000)	7	988823	29.69
2. Medium(4000-6000)	10	1590246	47.75
3. Low (2000-4000)	5	627105	18.83
4. Very Low(below 2000)	1	123885	3.72
		3330059	

Table 3.6 : Average Annual Change of Area in Various Labour Productivity Categories (1980-1 to 1990-1)

(Area in ha)

Productivity Categories (Rs/Worker)	Percentage share in Total Area		Average Annual Change of area in Percentage
	1980-1	1990-1	1980-1 to 1990-1
1. High(above 6000)	32.18	29.69	-2.49
2. Medium(4000-6000)	23.42	47.75	24.33
3. Low (2000-4000)	27.37	18.83	-8.54
4. Very(below 2000)	17.03	3.72	-13. 31

interpreted in the following way.

(a) Labour Productivity Patterns (1980-1) :

Labour productivity pattern for 1980-1 reveals that the high productivity class consists of 7 districts of Assam state located in Upper Brahmaputra valley region. These high labour productivity districts in the state incorporate about 32.20 percent (954465 ha) of total cultivated lands. The medium labour productivity class, comprising 4 districts which incorporated 23.42 percent (694680 ha) of total cultivated land of the state, includes in extreme west, north-eastern and northern parts of the Brahmaputra valley. The low labour productivity class, which accounts for only 8 districts of the state, incorporates 27.37 percent (81199 ha) of total cultivated land mainly situated in the north-western part of Brahmaputra valley and some districts are located in the Barak valley region.Very low labour productivity class incorporates only 4 districts which occupies only 17.03 percent (505260 ha) of total cultivated lands. They are dispersed both in Brahmaputra as well as Barak valley region.

(b) Labour Productivity Patterns (1990-1):

The distributional patterns of labour productivity during the year of 1990-1, which are depicted by Table-3.5. show that the high labour productivity (Rs. above 6000) includes near about 29.7 percent (988803 ha) share of the total cultivated

land of the state, which is situated in the lower parts of Brahmaputra valley. It may be because of high land productivity and high share of cultivated land per worker (A/L). On account of labour dominated intensive cultivation and lower intenstity of agricultural labour force, the labour productivity is high. Average size of cultivated land per worker is recorded higher here in these areas. It is observed from Fig-3.2 that the medium productivity (Rs. 4000/ person to Rs.6000/ person) category includes nearly half of the area of the state (47.75 percent) which is dispersed mostly in the upper and middle Brahmaputra valley. While low productivity is recorded in the areas of extreme south-western part of the rate. It may be because of higher pressure of agriculture workforce which increase its intensity and affects negatively the level of labour productivity.

(c) Changes in Labour Productivity Patterns (1980-1 to 1990-1):

Concerning the labour productivity and the changes occuring therein during 1980-1 to 1990-1, it is obvious from the Table-3.6. that there is maximum areal expansion of the medium labour productivity class (Rs.4000 to 6000 per worker) from 23.42 percent (1980-1) to 47.75 percent (1990-1) that is 24.33 percent increase. There were only four districts in this medium category in 1980-1, which were increased upto ten districts during the decade. From the distributional map (Fig-3.2) of labour productivity, it is clear that some districts which were having low productivity of agricultural labour, now have come to medium

category. On the otherhand, the high, low and very low labour productivity classes, have reduced their areal extent by 2.49, 8.54 and 13.31 percents respectively. From the Fig-3.2, it is clear that there is a transformation taking place in low high and labour productivity areas by reducing their areal extents in the rate which were mainly situated in the upper Assam region.

Thus, total magnitude and intensity of agricultural work force is the main cause of areal variation. We should discuss the patterns of agriculture work force in detail.

C. Agricultural Work Force :

According to census figures, the agricultural work force which includes two categories i.e. cultivators and agricultural labourers, has important impact on agricultural production patterns, its growth and development. Infact, Assam's agricultural sector is man-power dominent. The cultivators have their own agricultural fields while the agricultural labourers physically operate the agricultural production processes by exchanging their labour in cash or kind, that is called wage rate. The changing patterns of agricultural work force and its intensity has direct influence on the agricultural labour productivity patterns and their changes.

So far as increase in the intensity of agricultural labour force is concerned, it is obvious from the table-3.7, that the intensity was recorded very high in the lower Brahmaputra

Table 3.7 : Districtwise Labour Intensity and Alricultural Labour-Cultivator Ratio (1980-1 to 1990-1)

Districts	Labour Intensity (Persons/Km^2)		Agricultural Labour-Cultivator Ratio	
	1980-1	1990-1	1980-1	1990-1
1. Kokrajhar	61.93	88.93	0.22	0.24
2. Goalpara	53.64	57.70	0.15	0.34
3. Bongaigaon	59.24	71.89	0.16	0.30
4. Dhubari	63.43	93.35	0.20	0.43
5. Barpeta	63.93	84.66	0.11	0.28
6. Nalbari	59.10	82.34	0.19	0.36
7. Kamrup	40.58	57.17	0.09	0.23
8. Nagaon	31.86	69.63	0.20	0.26
9. Morigaon	31.86	69.63	0.20	0.26
10. Darrang	93.79	86.17	0.15	0.23
11. Sonitpur	27.93	55.87	0.17	0.24
12. Lakhimpur	35.70	13.77	0.10	0.10
13. Dhemgaji	21.57	42.06	0.04	0.04
14. Jorhat	29.92	52.07	0.08	0.12
15. Golaghat	26.18	53.01	0.15	0.15
16. Sibsagar	33.85	63.13	0.13	0.14
17. Dibrugarh	22.68	40.48	0.14	0.14
18. Tinsukia	20.23	38.20	0.14	0.46
19. Cachar	39.56	52.48	0.46	2.46
20. Hailakandi	49.32	25.13	0.38	0.13
21. Karimganji	62.64	73.56	0.42	0.38
22. K. Anglong	9.50	19.84	0.08	0.08
23. N.C. Hills	4.65	7.07	0.03	0.03
Assam	38.05	55.50	0.18	0.24

areas of the state during the last decade. It was 59.56 persons per Sq.Km. in 1981 which raised by 30.9 percent and reached upto 78 person per Sq.Km. in 1991. But the highest increase (88.54 percent) was recorded in the upper Brahmaputra areas (Lakhimpur, Dibrugarh, Tinsukia, Jorhat and Dhemaji) from 24 persons per Sq.Km. in 1981 (i.e. lowest in Assam) to 45 persons per Sq.Km. in 1991. The fast increase in the agricultural workforce intensity in this area may be because of fast migration from the other parts of the state and even from outside also. While the intensity in Barak valley was recorded medicin at both the points of time i.e. 14.85 percent, the lowest in the state.

Agricultural labourer - cultivator ratio in the total magnitude of agricultural workforce is the indicator of the availability of landless labourer per cultivator. In spite of a significant increase in labour intensity in Barak valley, the agricultural labour - cultivator ratio has increased 134.6 percent during the decade. It was 0.26 in 1981 which was raised upto 0.61 in 1991. It means there is a fast increase in landless agricultural labourers. It may be because of the cultivators who have very small piece of land are selling their land properties and become landless labourer. It is interesting to note here that the conversion from cultivators to landless labourers indicates that the small size of land holdings are not profitable in the area. In the other areas namely, the areas of upper Brahmaputra this conversion tendency recorded low. Therefore,

there is only 9.0 percent increase in this ratio during the last decade (Table-3.7).

Agricultiral Production Factors

The agriculture in the state of Assam is subsistence in nature because of more population density and availablity of agricultural labour. Near about 80 percent of the total workers are engage in this primary sector in the state. There are various factors which directly or indirectly influence in agricultural production. The factors like Physical, social, economic and biological all are equally significant in agricultural economy. No doubt that the modern agricultural technology is great important in the agricultural production and it is good substitute for human-labour as well as animal labour which is very slow in operating in comparison to machine technology. Here it should be mention that the technical force has limited power. The size of holdings and the size of fields also have a great influence upon the efficiency and the productivity of farming. Here, in Assam, the size holdings are very small and fragmented for which the use of machine technology is difficult. It causes considerable waste of labour of the cultivators, and his plough cattle and time consuming also. The factors influencing agricultural activities in Assam can be interpreted in detail.

Physical Factors:

There are many and varied physical factors which influence the agricultural practices and land productivity. The terrai

conditions are more or less similar in the rate of Assam. However, there is a significant areal variations in soil and climatic conditions. These two factors of land directly influence the plant-growth and crop-yield. Therefore, these factors should be interpreted here for areal variations of agricultural productivity.

A. Climate :

Climate with its different valuable elements like temperature, sunlight, rainy days, frost, fog, moisture percentage, wind, length of growing season all these directly or indirectly influence on the cropping pattern of a region. Infact, all these climatic elements are inter-related to each other.

Temperature : Temperature is one of the significant element of climate which directly and indirectly affects on agricultural growth through its media of heat, light and sunshine. Temperature mostly influences germination of seeds, its growth and development and the ripening of seeds. The increasing temperature declines the length of crop-growth at a constant rate of five days per degree celsius of temperature (Singh 1994). Therefore it is known that the crop growth duration is shorter in dry and hot conditions than the humid climatic conditions. It is important to note that if the moisture condition is not adequate then due to high temperature the crop become dry up and there is a maximum temperature limit for plant growth.

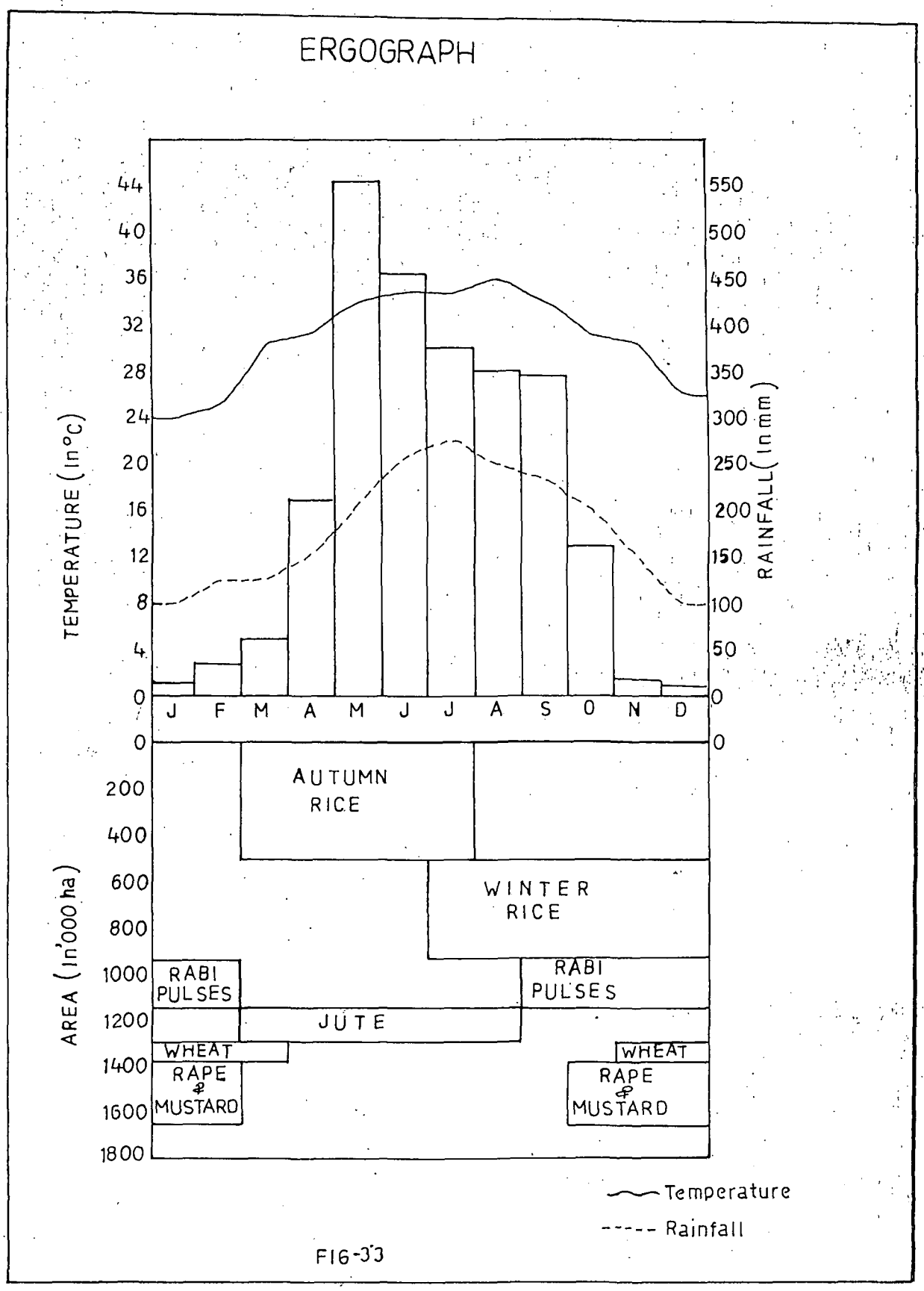

ERGOGRAPH
TEMPERATURE (In°C)
RAINFALL (In mm)
AREA (In'000 ha)
44
40
36
32
28
24
20
16
12
8
4
0
550
500
450
400
350
300
250
200
150
100
50
0
J F M A M J J A S O N D
AUTUMN RICE
WINTER RICE
RABI PULSES
RABI PULSES
JUTE
WHEAT
RAPE & MUSTARD
WHEAT
RAPE & MUSTARD
0
200
400
600
800
1000
1200
1400
1600
1800
Temperature
Rainfall

FIG-33

In the state Assam, the main food grain is rice which need minimum average temperature of 20°C. Rice is largely the alluvial areas of Brahmaputra river and Barak river valleys. Here the areas included Cachar in the Barak valley region where the average minimum temperature remains more than 19.5°C. during the winter rice season and maximum upto 36°C. during that period. Again, in the upper Brahmaputra valley, specially in Sibsagar areas, temperature ranges from 19°C to 35°C in winter seasons. It is most suitable for rice cultivation and therefore good quality rice with higher yield is growth in these areas. On the other hand, wheat and maize are mainly grown in areas like Dhubri, Nagaon, Morigaon etc. where average temperature ranges from 7°C to 10°C. which is favourable for wheat crops. The lower limit of temperature variation influence the growth of cotten crop. Cotton requires warm temperature during night time for its maximum growth and development, and so, in Assam, the cotton production is very less because of lack of favourable temperature at night time.

The general relationship between the climatic conditions and the crop seasons has been depicted by Ergograph (Fig-3.3). Erogograph explains the fact that the rice is extensively cultivated during the summer season when both the temperature and rainfall are very high. On the other hand, the rabi crops are grown during the winter season which requires less rainfall and temperature. For instance, the wheat season is during November to April and this crop grows in the areas where minimum temperature remains 7°C to 10°C (Fig.3.3).

Rainfall : Moisture condition is related to magnitude and intensity of rainfall, surface conditions and underground water table. Therefore, it indicates the soil-water relationship which has a great importance in agriculture. Soil-water conditions vary because the plants collect water from the soil through their root systems. The lack of water in the soil may be the cause of crop damage and similarly the excessive amount of water or rainfall, changes various chemical quantities contained in the soil which also affect the plant growth. Assam's agriculture depends on monsoonal rainfall which is uncertain and unevenly distributed over the state. Failure of rainfall or excessive of rainfall in a short period of time have brought repeated crop failures and famines in many parts of the state.

Fig-3.4 reveals a general relationship between rainfall and land productivity in the state. It is seen that as the rainfall increases, the land productivity also increases gradually. Most of the districts in the state fall in the medium to high land productivity class as the rainfall increased. Even, some of the areas of the state indicate a good land productivity condition in a rainfall increasing situations. Thus rainfall-productivity is weak though positive.

B. Soils : Soil is a natural organism which influence agriculture. The fertility of soil determines the level of agricultural productivity. Soil is a mixture of different chemicals, living organisms of plants, animals, insects, bacteria, fungi etc.

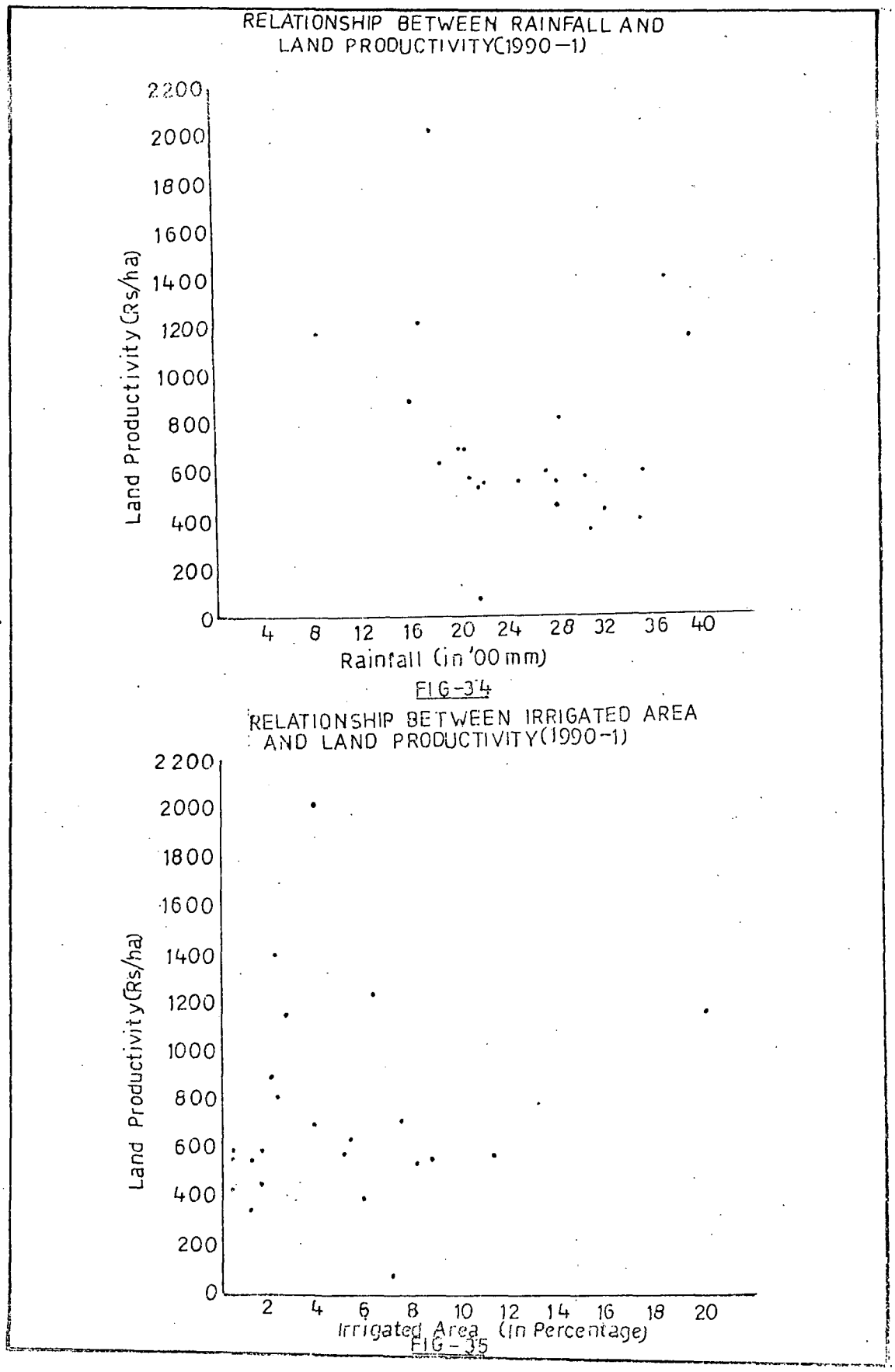
which provide fertility to the soil. Soil is always related to its climatic conditions, parent materials, living origanismsp topography, land utilization and time to its maturity.

As soil is weathered complex material of the igneous, sedimentary and metamorphic rocks, it support life of plants, insects, becteria and worms. The physical and chemical properties of soils determine the soil characteristics. The temperature and rainfall are the factors which affect in the weathering of rocks and the decomposition of minerals. The amount of humus content also depend on the climatic conditions. The moderately warm climate generate more humus contents than the soils of a cold or arid-dry climate. The soils that correspond to the great climatic belts are called Zonal soils. In the state of Assam, there are two major groups of soils, namely alluvial soil and Lateritic soil. Among all these, the alluvial soils are most fertile and available along the flood-plain areas of both the Brahmaputra and Barak valleys. Alluvial soils in the state support a good production of rice crops. It has already been indicated that the Cachar district occupies the highest percentage of area under rice cultivation (94.82 percent) in the state. It is because of availablity of fertile alluvial soils. In the Brahmaputra valley areas, some of the districts like Dibrugarh, Sibsagar also rich in fertile alluvial soils which support a good production of rice crops. The laterite soils are very responsive to nitrogen and phosphate

and also favourable for agricultural production. Thus soils having different fertility conditions which differentiate the level of agricultural productivity and growth. Therefore, areal variations are observed in productivity. There are other factors also which influence the productivity patterns as given in the next section of the present chapter.

Techno-Economic Factors :

The technological changes including the use of modern hand tools, animal drawn implements, tractors, thrashers, etc. play a vital role in the selection of crops grown and decision-making at the farm level. The agricultural mechanisation makes it possible to carry out farming operations more quickly and at the precise time calculated to maximise the outputs. In fact, the major factors of modern technology are irrigation, use of chemical fertilizers and HYVs. The economic conditions of the farmers as well as their knowledge for application of all these components to agricultural production-processes also poor which keep them behind from the use of all these factors and agricultural development in the state. In general, it is fact that the areas of humid climatic conditions do not require more irrigation for farm operations. However, irrigation is important factor for plant growth. In Assam, irrigation facilities are required for winter season crops. But some other moder technological factors are important to boost up the agricultural productions here.


RELATIONSHIP BETWEEN RAINFALL AND
LAND PRODUCTIVITY(1990-1)
Land Productivity (Rs/ha)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
4 8 12 16 20 24 28 32 36 40
Rainfall (in '00 mm)
FIG-34
RELATIONSHIP BETWEEN IRRIGATED AREA
AND LAND PRODUCTIVITY(1990-1)
Land Productivity(Rs/ha)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2 4 6 8 10 12 14 16 18 20
Irrigated Area (In Percentage)
FIG-35

A. Irrigation : Irrigation enhance the productivity of both land and labour and encourages the farmers to use more fertilizers (Sawant 1983). World Development Report (1982) also describes that irrigation has made the largest contribution to increase the agricultural production in much of Asia, North-Africa and Middle East.

But North-Eastern part of the country falls under the humid zones, therefore, there is not much need of big schemes of irrigation. However, minor irrigation schemes like tubewell and pump-set are needed because of seasonal variations in the rainfall. Winter season is dry in Assam and hence seasonal irrigation is required for intensification farming practices. Incidently, the Central and Lower Brahmaputra valley has the highest proportion of surface flow irrigation project mainly because of two Medium Flow Irrigation Project i.e. Jamuna in Nagaon and Sukla in Kamrup district having 27034 hectares and 14961 hectares of Kharif rainfall respectively. These projects were taken up during the Third Plan Period but have not been helpful to the cultivators much.

Surface Lift Irrigation (SLI) is mainly applicable to the plain areas, SLI project i.e. the Rajabari in Kokrajher and the Koliabor in Nagaon district completed in 1984. Other SLI projects are under Minor Irrigation Schemes. These irrigation projects have shown successful cultivation of two paddy crops. The Ground Water Life (GWL) has currently gained grounds

Table 3.8 : Distriwise Irrigation Potential Utilisation and Irrigation Potential Created in Assam (1990 - 91)

Districts	Potential utilisation under Rabi and Pre-Kharif Crops under Govt. Minor Irrigation.	Potential Created upto (1991 - 92)
1.Kokrajhar	497	4960
2.Goalpara	1159	--
3.Bongaigong	209	--
4.Dhubri	2302	--
5.Barpeta	1593	35093
6.Nalbari	1683	--
7.Kamrup	2378	15635
8.Nagaon	1979	69329
9.Morigaon	3073	--
10.Darrang	1807	3000
11.Sonitpur	328	25362
12.Lakhimpur	142	--
13.Dhemaji	181	--
14.Jorhat	3848	--
15.Golaghat	778	--
16.Sibsagar	86	--
17.Dibrugarh	442	400
18.Tinsukia	199	--
19.Cachar	395	--
20.Hailakandi	696	--
21.Karimganj	1042	--
22.K.Anglong	2272	6983
23.N.C.hills	--	--
Assam	27089	160762

Source: Statistical Hand Book, Assam, 1992.

under Minor Irrigation through shallow tubewells under subsidised scheme. In Assam it is in operation through Minor Irrigation Development Corporation (MIDC).

No major irrigation projects have been completed in the state, but two projects are reported to be under progress one is 'Pagladia'which has catchment in Bhutan also and the other is 'Dhansiri' irrigation project in Darrang district.

The Table-3.8 depicts that the potential utilization of irrigation is recorded high in district Jorhat followed by Kamrup, Dhubri and K. Anglong. Their potential utilization is 3848, 2378, 2302 and 2272 hectares respectively. The low potential utilization of irrigation is recorded in Lakhimpur (142 hectares) followed by Dhemaji (181 hectares) and Tinsukia (199 hectares) districts. On the otherhand, the potential created for irrigation in Kamrup district is 15635 hectares, in K.Anglong is 32.54 percent which was more than that of state's percentage (16.86 percent). In Dibrugarh district, the potential created is 400 hectares while the potential utilization is 442 hectares i.e. The potential utilization was about 10 percent more than that of its created amount.

Fig-3.5 shows a general relationship between irrigated area (in percentage) and land productivity (Rs/ha) for the year 1990-1. From the figure it is clear that majority of the districts of the state have low land productivity with less percentage of irrigated area and, some districts of high land

productivity have less percentage of area under irrigation. All the districts of both the Brahmaputra and Barak valley regions where the area under irrigation is less in percentage, the land productivity also low to medium. Some particular districts like, N.C. Hills, Jorhat, Darrang, Marigaon and Sonitpur having high percentage of area under irrigation with low land productivity. All these irrigularities between irrigated area and land productivity may be due to irregular supply of irrigation water and other natural hovocs like flood etc.

B. <u>High Yielding Variety of Seeds</u> : The increase of HYV seeds is one of the main factor for the development of agriculture of any region. As more HYV seeds are introduced in agricultural practices, there are more chances to increase farm productivity. For the first time in Assam during the adhoc annual plan (1966-67 to 1968-69), a few HYV of seeds were introduced. The seeds were like I-R-8, Tinchung, Monohar Sali and wheat of Mexican variety etc. The introduction of such HYV seeds it makes possible to grow rice crops thrice in a year and also makes possible to use more areas under HYV seeds where the proper irrigation facilities are available.

Assam Agricultural University (AAU), Jorhat has been producing HYV seeds since 1980. The crops include both agricultural and horticultural crops (vegetables). In case of gegetable the AAU produces only certified seeds. Infact, rice is the main crop in Assam and AAU is trying /to produce HYV seeds

Table 3.9 : Districtwise Area of HYV Paddy (Hectares)

(1990-91)

District	Area under HYV Paddy (in ha)	Area Under HYV paddy (in presentage to the total HYV Paddy area)	Area Under HYV Paddy (in percentage to the total Paddy area in the district)
1. Kokrajhar	44000*	3.74	35.43
2. Goalpara	17357	1.47	20.76
3. Bongaigaon	44000*	3.74	41.14
4. Dhubri	61000	5.19	46.54
5. Barpeta	131000*	11.15	30.01
6. Nalbari	58000*	4.93	40.08
7. Kamrup	92928	7.90	63.36
8. Nagaon	111500	9.49	45.09
9. Morigaon	519333	4.42	59.63
10. Darrang	63499	5.40	38.76
11. Sonitpur	82931	7.05	59.36
12. Lakhimpur	36181	3.07	29.30
13. Dhemaji	21697	1.84	25.99
14. Jorhat	49056*	4.17	45.38
15. Golaghat	67987	5.78	74.40
16. Sibsagar	29107	2.47	27.09
17. Dibrugarh	45626	3.88	53.04
18. Tinsukia	23800*	2.02	18.30
19. Cachar	53378	4.54	51.12
20. Hailakandi	20750	1.76	48.41
21. Karimganj	38034	3.23	46.59
22. K. Anglong	26600*	2.26	22.11
23. N.C. Hills	2962	0.25	21.62
Assam	1174849	100.00	21.69

* Provisional

Source : Basic Agricultural Statistics, 1990-91, Statistical Wing, Directorate of Agriculture, Assam.

Paddy includes the Autumn, Summer and Winter Paddy onl

for rice. It has some research centres for the agro-ecological conditions of rice seed geermination. But the main problem in Assam is how to diffuse these HYV seeds to the farmers. Therefore, Assam has far away from the use of HYV. Likewise there are several technical as well as administrative constraints i.e. specific agro-climatic situations like soil types, temperature, photo-periods, thermal periods, elevation and soil water regime etc. The administrative problems relate to the multiplication of the breeder seed and ultimate distribution to the farmers.

Table-3.9 reveals the spatial variation of area under HYV paddy with respect to total HYV paddy area of the state and the total paddy area of the district (1990-1). District Barpeta covers the largest area (131000 ha). followed by Nagaon (111500 ha). and Kamrup (92928 ha). districts. It can be mention here that in all these districts the farmers mostly the immigrant Muslims adopt the HYV paddy seeds. So, in case of state's total HYV paddy area the districts Barpeta, Nagaon and Kamrup cover the very high percentage i.e. 11.15, 9.49 and 7.90 percent respectively. But the state Assam covers total 1174849 hectares area under HYV paddy (21.69 percent). But the percentage figures of paddy HYV seeds area with respect to total paddy area (Autumn, summer and winter paddy) are slightly different. District Golaghat has the highest percentage area under HYV paddy(74.40 percent) followed by Kamrup (63.36 percent) and Morigaon(59.63 percent) districts. The fact of minimum area covered under HYV

Table 3.10 : Use of Fertilizers in Agricultural Practices (1990-1)

Category in NPK Use (Kg/ha)	No.of Dists	Total NPK Used (in 000 Kg)	Percentage Use
1. Very Low (0-5)	2	1310	3.50
2. Low (5-10)	13	18982	50.82
3. High (10-15)	2	2247	6.01
4. Very High (More than 15)	6	14810	39.65
State Average (11.10Kg/ha)		37349	100.00

paddy in Assam (21.69 percent) because of inadequate supply of good seeds, lack of input facility, high percentage if illiteracy among the farmers, paucity of irrigated water, lack of power supply to the village areas etc. and all these keep the state away from the agricultural development.

C. Fertilizer Use ? The use of chemical fertilized is one of the important components of modern technology. Adding the manures and chemical fertilizers to the soils in a calculated quantity, the capacity of yield of the crops can be increased.

In the state of Assam, the total NPK used in 1990-1 was recorded 37349 thousand Kg. But the total amount of used fertilizer is not comparable, therefore, the consumption of fertilizer per hectare of cultivated land is calculated and the districts of the state have been classified accordingly (Table-3.10). It is found from the table that very high and high consumption of chemical fertilizers (more than 10 Kg per hectare) is marked in eight districts which are using near about 45 percent share of the total quantity used for the entire state. These districts are situated in the lower and middle Brahmaputra valley of the state. On the other hand, low intensity of the use of fertilizers (5 to 10 Kg/ha) is recorded in 13 districts areas mostly situated in upper Brahmaputra and Barak valley.

Comparing the figures of fertilizer used in the various districts with land productivity figures of the corresponding districts, it is found that there is a positive relationship between

RELATIONSHIP BETWEEN FERTILIZER USE AND LAND PRODUCTIVITY(1990-1)

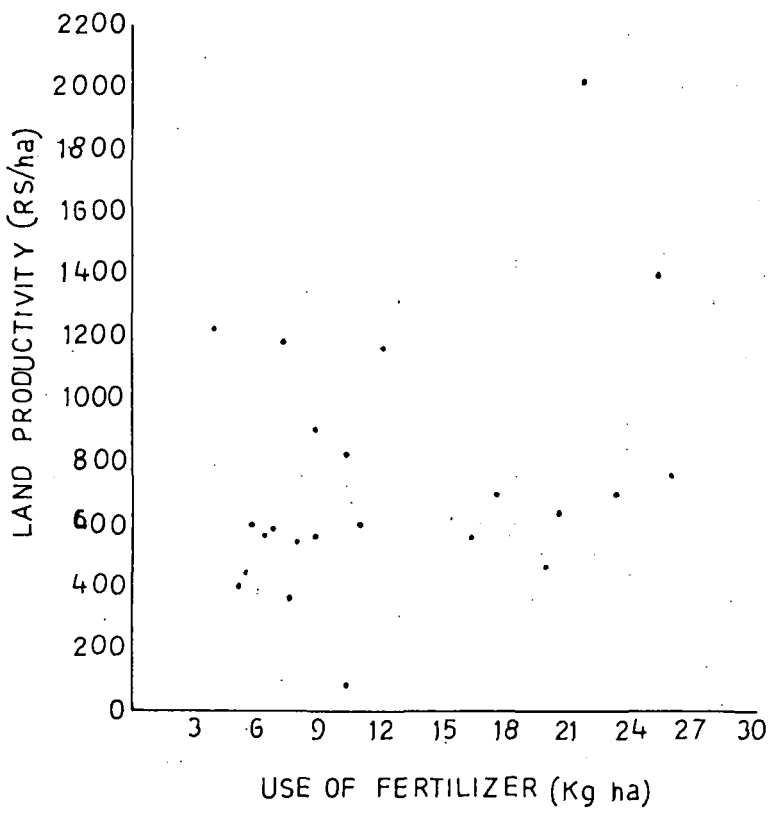


FIG – 3.6

land productivity and fertilizer consumption (r = 0.153) though it is insignificant. It means some areas which are consuming more fertilizer per ha. are not having higher level of land productivity (Fig-3.6). These areas are situated specially along with the Brahmaputra river in the central part of the state (Jorhat,Golaghat and Kamrup). Because of fertile new alluvial soils and well connectivity of the roads of these areas with the Gauhati central city, the farmers are using chemical fertilizers intensively. However, the land productivity is low in these areas because of floods and therefore, the crop intensity is low and the farmers grow only two crops in a year instead of multiple cropping patterns With this result, the degree of scatteredness of the districts is high (Fig-3.6).

CONCLUDING REMARKS

After comparing the land and labour productivities with their production factors, it can safely be concluded that land and labour productivities which are the main attributes of agricultural development are positively and highly related (r=0.845). It means that the patterns of labour productivity are solely development on land productivity patterns. Land productivity is the result of physical factors specially in Assam where technology is being used at very low level in the agricultural operations. On the other hand, the emerging patterns of labour productivity are also dependent on the physical attributes of the land including labour factor because labour intensity is the main determining factor of labour productivity.

RELATIONSHIP BETWEEN LAND AND
LABOUR PRODUCTIVITY(1990-1)

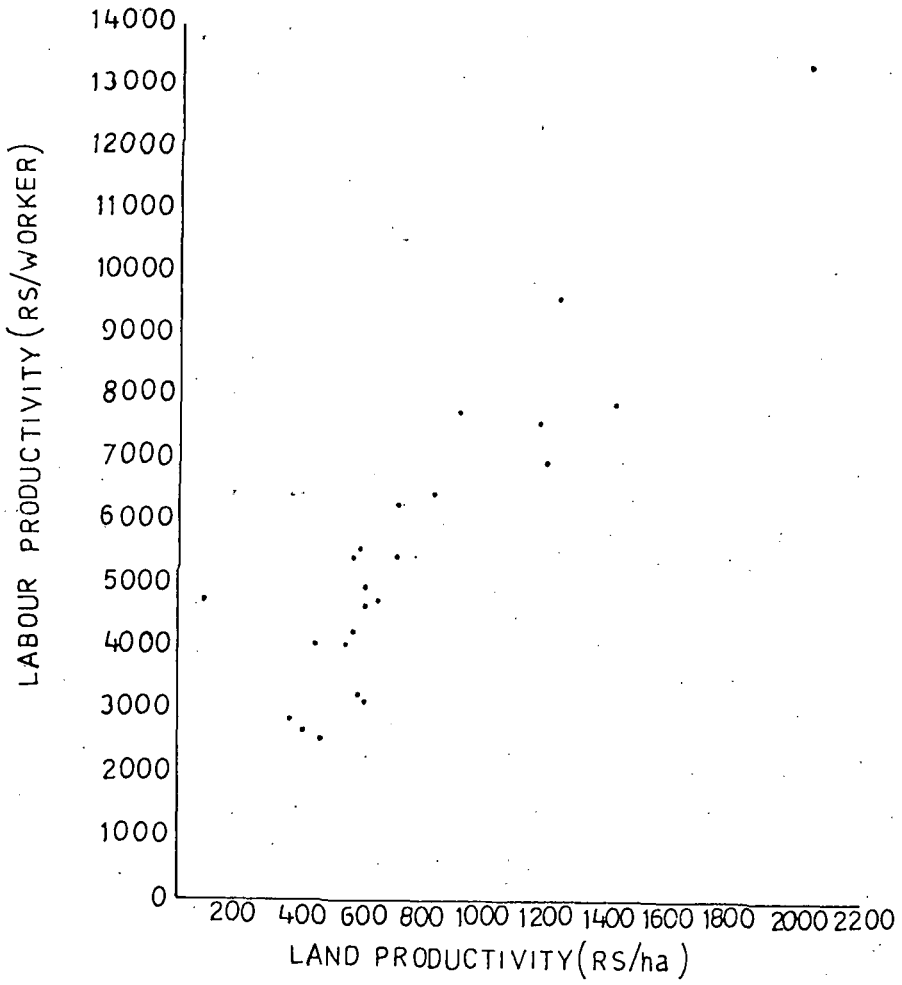


FIG-3'7

RELATIONSHIP BETWEEN CHANGING PATTERN OF LAND AND LABOUR PRODUCTIVITY(1980-1 to 1990-1)

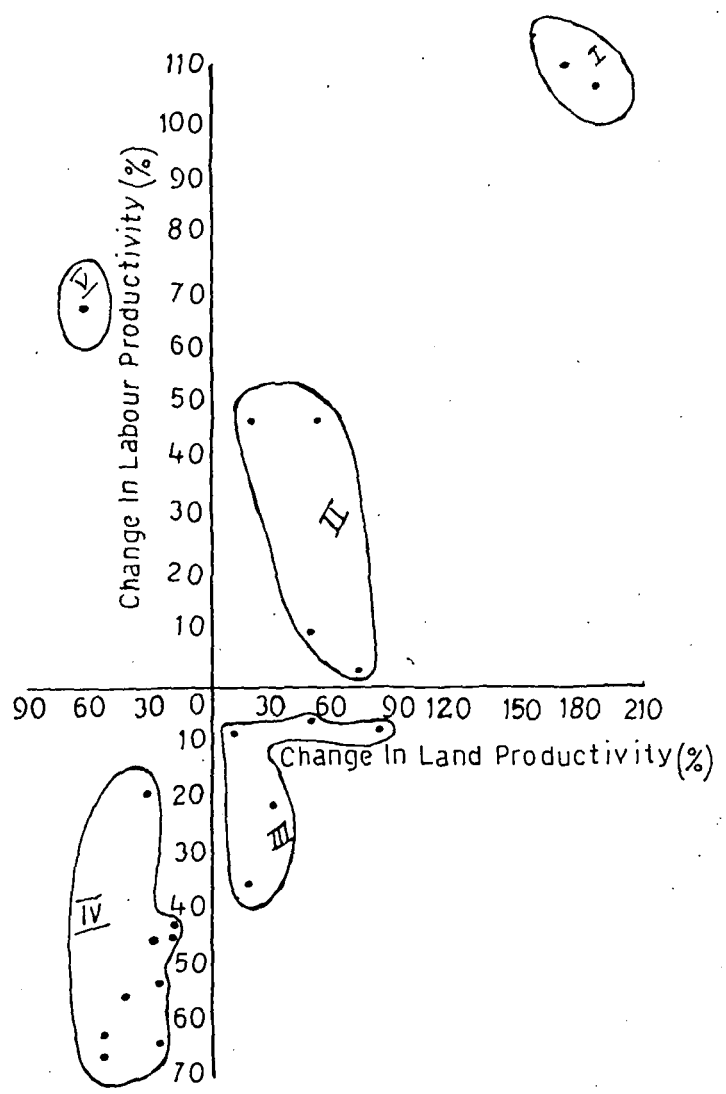


FIG-3.8

Table 3.11 : Relationship between proportionate Change in Land and Labour Productivity (1980-1 to 1990-1)

Categories	Change		No.of districts	Area	
	Land Prodt.	Labour Prodt.		Total	%
I. Highy Prosperous conditions	+	+	2	67334	2.11
II Prosperous Conditions	+	+	4	770751	24.18
III Increasing Land productivity with decreasing Conditions	+	-	5	868601	27.25
IV Deteriorating Conditions	-	-	10	1382776	43.38
V Diversified Conditions	-	+	1	103700	3.25

N.B. + Indicates Positive Change

\- Indicates Negative Change

The relationship between the proportionate change of labour productivity over time with respect to land productivity shows that there are some diversified patterns emerging in the state (Fig-3.8). This relationship is studied by categorising the distributive nature of the related attributes into four classes. The areas of (i) highly prosperous conditions where the change in land and labour productivity is recorded positive. Two districts which incorporate only 2.11 percent of the total area (Hailakandi and N.C. Hills) are situated in the South of Brahmaputra river (ii) The areas of prosperous conditions where the change in land and labour productivity is positive, but, their changing magnitudes are very low have near about 1/4 In share of the total area of the state. It incorporates four districts mostly situated in lower Assam region. (iii) The areas of inverse conditions of relationship - the five districts which incorporates 27.25 percent of the areal extent have positive increase in land productivity with a significant level of decrease in labour productivity. (iv) The areas of deteriorating conditions where the change in land and labour productivity is recorded negative. They incorporates near about 43 percent of the total land of the state and are situated in Central and upper Assam region. In the last only one district has a diversified conditions where land productivity is decreasing with the significant increase in labour productivity (Fig-3.8).

The changing patterns of land and labour productivities influence directly to the agricultural growth patterns. This relationship would be analysed after studying the growth patterns of the state which is also an important attribute of agricultural development.

CHAPTER - IV

AGRICUDTURAL GROWTH

Introduction :

Agricultural growth is one of the main components of agricultural development. It is influenced by the changes occuring in agricultural productivity. Therefore, the spatial patterns of growth and productivity changes should be positively related in the study area. But it is hypothesised that agricultural growth patterns should be negatively related to the productivity patterns for balanced development of agricultural activities. It means that the areas of low productivity should have fast growth of agriculture for balanced development. Therefore, the attention is focussed in the present chapter to find-out the causes of low level of agricultural growth in Assam by examining the growth patterns in relation to agricultural productivity patterns. It would provide some clues for balanced development and self sustained agricultural growth in the state.

Agricultural growth basically depends upon the changing tendency of total volume of agricultural output over time because the absolute change in total output is the main attribute of agricultural growth. Infact, incremental output is the absolute measurement of change while agricultural growth refers to the proportionate change in output over time. The same facts have already been discussed conceptually in detail in the last section of the Chapter-I. Furthermore, since agricultural output is the product of three major production elements, namely; area,

yield and production prices of the various crops, the changes of these elements would be the main determinents of change in agricultural output. It means agricultural growth is the result of changes in these three elements. Infact, crop production-prices are assumed.constant in growth equation (3) and hance, agricultural growth is the product of only the changes of two agricultural elements that are crop yield and area. If area under cultivation and crop-yield are increased in a particular area, there would be a chance to increase in agricultural output. Therefore, agricultural growth is dependent on the proportionate change in the area and yield of various crops. The same facts has been formulated by Singh (1994) in the following manner :

$$r = \frac{ail.yil.\ pio - aio.Yio.Pio}{aio.yio.\ pio}$$

$$= (ail/aio).\ (Yil/Yio) - (1.0)$$

Where, ail and aio are areas under ith crop for the current and base years, Yil and Yio refer to the crop-yield for the current and the base year respectively, and Pio denotes prices per unit of production of ith crop.

There are various methods of calculating agricultural growth like compound growth, linear growth and logearithemic growth of agricultural output over time : Minhas and Vaidyanathan (1965) calculated growth on the basis of decomposing the growth components or elements and therefore, they found that

there is an interaction factor which affects the growth of agricultural patterns. Likewise Bhalla and Tyagi (1989) interpreted the index of growth components. Again, Bhalla and Alagh (1979) interpreted the multiplicative decomposition scheme of growth component elements which predicts annual exponential rate of agricultural output growth. The compound rate of aggregated agricultural output used by many scientists (Mahapatra 1982) and Department of Agriculture and Cooperation, Govt. of India for estimating the growth rates, production and yield of principal crops in India (Ministry of Agriculture 1991). The linear growth rate which is based on linear-trend equation (equ.7) is used here. In present context, agricultural growth for each district of the state has been calculated by taking the difference of total agricultural output for two points of time, 1980-1 as base year and 1990-1 as current year.

In fact, previously mentioned that growth is closely related to the proportionate change of crop-yield and area.Therefore, agricultural growth patterns evolving in the state of Assam can be described in relation to the changing patterns of the crop-area and crop-yield and calculating the growth ratios of yield and area components of all the crop (19 crops are considered here) separately for a particular areal unit (district), because growth ratios of the crop-yield and area are the main components which would give us some important clues and causes of evolving patterns of agricultural growth in the state of Assam. Before interpreting growth ratios, changing patterns of crop-area and yield must be studied.

Cropping Patterns and its changes (AN Area Component):

Crops are the main component of Indian agriculture because Indian agriculture is characterised by crop-dominated and more than 80 percent cultivated area is under various crops. As a result, many scientists studied crop-regions of India and inferred results for agricultural development (Bhat and Learmonth 1968). It is, however, a dynamic concept as no cropping pattern can be good and ideal for all times to come (Hussain 1979). In the state of Assam, the cropping pattern is mainly traditional because of subsistence nature of farming with the underdeveloped agricultural conditions in which every farmer attempts to produce the grains mainly for family consumption and sometimes a little part of food grains, i.e. agricultural surplus traded to the local market only. The significance of cropping patterns of the Assam state for the agricultural development can be proved by studying its two main aspects, namely (1) Cropping pattern as the result of agro-ecological conditions and (2) Cropping pattern as components of agricultural production (share of land occupancy).

The cropping patterns in relation to the agro-ecological conditions of different districts of the state (Physical attributes) have been studied by grouping the crops as food grains, pulses, oil seeds, industrial crops and vegetable acrops. But, according to the Agricultural Census of India, the various crops have generally categorised into two crop-seasons, i.e.

Kharif crops in summer season and Rabi crops in the winter season. On the otherhand, the industrial crop tea is the all season crop.*

Assam's agriculture is foodgrain dominated where in 1990-1, more than three-fourth share of total GCA (79.05 percent) was under foodgrain crops which include rice, Maize, Wheat and cereals and Small Millets). The detail district wise figure of cropping pattern as given in Appendix-1 reveals that rice is the principal crop in the state, and this is due to almost all the communities of people living in the state consuming rice as main food. Due to the lack of irrigation facilities in the state, the rice crop depends on monsoonal rains which mainly occurs during June-July months. Winter rice (July to December) is grown in a vast area of the state and therefore, it is observed that most of the areas, the agricultural field is occupied only for six months. Winter rice accounts for 55.10 percent of GCA during 1980-1 which tends to decrease by 1.51 percent during the 1990s (Appendix-1). Autumn rice covers the next position to that of winter rice and accounts for 20.43 percent in 1980-1 and 18.53 percent in 1990-2 which decreased about 1.90 percent during the decade. But summer rice shows a little increase (2.89 percent) during the decade. Decrease in the areas of rice except summer crop, is recorded in winter rice (1.51 percent), autumn rice (1.90 percent) during the 1980s. It decreases due to the changes in the climatic conditions and slow move of the farmers

* Tea crop is excluded from the study of cropping pattern.

from rice cultivation to commercial crops. But area under summer rice crop is increased gradually. Thus, an overall picture of land-occupancy under rice cultivation has been increased by 12.06 percent during 1980-1 to 1990-2. There appears to be crop concentration towards rice crop. It may be because of increasing demand of stapple food (i.e. rice in Assam) of ever increasing population. In fact, population of Assam rose near about 5.5 percent annually from 1971 to 1991 while an annual increase of 6.0 percent was recorded in the land occupancy share of rice crops during the last decade. It is little bit higher than that of population increase. It means to fulfil the needs of the people of Assam, there might be an increase in crop-yield of rice which would be discussed in the next section of the present chapter.

So far as changing cropping pattern of the Assam state is concerned, district-wise percentage share of land occupancy data for the principal crops are used for 1980-1 and 1990-2. It is found that 19.43 percent area from 1980-1 to 1990-1 is increased under rice cultivation in the Tinsukia district which followed by Dhemaji, Barpeta and Morigaon districts where the increase of rice crop areas are recorded 8.58 percent, 6.64 percent and 5.04 percent respectively. It shows that ecological conditions are more favourable specially in the upper part of the Brahmaputra valley because of fertile new alluvial soils and favourable climatic conditions for rice cultivation.

The other crops like maize, wheat and other cereals and small millets including commercial crop jute are recorded a significant decrease in their land occupancy during the decade. It shows an interesting feature of change in cropping pattern of the Assam state which are concentrating toward rice crop, a locally consumed stapple foodgrain, rather than the other commercial crops. Therefore, the agriculture developmental aspects are based on rice cultivation in the state.

Crop-Yield and Changes Therein :

Crop-yield itself has an important position in a agricultural production components. Yield denotes the production of crops in per unit of cultivated land and, accordingly, it has direct influence on the patterns of output growth. The main features of crop-yield have been depicted in Appendix-II, reveals an overall increase in all crops-yields in the state during 1980-1 to 1990-2, where the maximum increase is shown in grams from 9505 Kg/Ha in 1980-1 to 28397 Kg/ha in 1990-2. (Gram including Black and Green grams). The yield pattern of rice crops has been increased during the decade. The yield level of summer rice was 27439 Kg/ha in 1980-1 which increased to 32611 Kg/ha in 1990-2. Increase of winter rice crop was 27503 Kg/ha to 31812 Kg/ha. and total increase of autumn rice was 1113 kg/ha during the last decade. The other food grains (Maize, Wheat), the increase of yield level was 306 Kg/ha for maize and 4751 Kg/ha for wheat from 1980-1 to 1990-2. The commercial crops including cotton, jute, sugarcane all have increased their yields of 56 Kg/ha, 1627 Kg/ha and 88001 kg/ha respectively. It

can be noted that the gram cultivation requires minimum application of fertilizer and other modern facilities and with a least-taking care it gives a good yield. For good production of gram, clayey loam soil is very favourable. Therefore, its yield recorded fast increase in Cachar, Lakhimpur, Hailakand, K. Anglong and in some parts of Dibrugarh, Sibsagar and Nagaon districts.

The district-wise data of crop yield increase in the state reveals that the northern part of the Brahmaputra valley recorded the highest increase in winter rice crop where the increase percentage recorded from 40 percent to more than 60 percent during the last decade. In this region of the state the summer rice increase has been recorded from 30 percent to more than 90 percent in some districts. This increase of crop-yield (rice crop) in this part of the state may be due to the favourable agro-ecological conditions with fertile alluvial soils. Thus, the emerging features of crop-yield pattern is generally related to the cropping patterns of the state. For example, the record increase in area (19.43%) under rice cultivation is marked in Tinsukia district, the maximum increase in autumn rice yield was also recorded in Tinsukia district (74.41%) during 1980-1 to 1990-2. It is noticed that the change in wheat yield was recorded 63.75 percent in Dhubri district followed by Goalpara district (60.43 percent). But in some districts of the state like Nagaon, Darrang, Lakhimpur etc., there is recorded a noticable increase in wheat-yield. In case of Jute,

Kokrajhar district has record increase (41.53%), followed by Lakhimpur (31.24%), Nagaon (28.11%). In these areas, the jute yield is marked the highest increase from the rest of the state, because, mainly the Muslim immigrants from Bangladesh practicing the jute cultivation and jute is a commercial crop.

It can be concluded that the areas of upper Brahmaputra valley are marked significant to concentrate the increasing trends of land occupancy of the dominating crops of cropping patterns and even the yields of these crops (mostly rice and jute) have been increased in these areas of favourable agro-ecological conditions. Consequently, the agricultural growth should be higher than the national average specially in these areas of the state. These facts can also be justified by interpreting the patterns of growth ratios of area and yield of various crops because they are the direct influents of agricultural growth.

AGRICUETURAL GROWTH RATIOS (Area and Yield Components)

The changes in the crop-area and crop-yield discussed above give an absolute picture of changes in production conditions of various crops, while the growth ratios of the crops based on last 10 years from 1980-1 to 1990-1 are also important to find out the clear picture of proportionate change of area and yield of various crops and the causes of slow rate of agricultural growth. The study of district wise growth ratios of different crops in their area and yield (Appendix-III)

shows different patterns rather than the crop-area and yield patterns in the state. According to Appendix-III, the main features of growth ratios of the area and yield of various crops reveal that Dhubri emerges as the most dynamic district in the state where the values of the growth ratios for crop-area have been recorded extremely high for all crops except autuman rice, tur and gram. In this district, the area under linseed and caster has increased 5.67 times, maize 5.03 times, seaamum 3.40 times, millets and summer rice 2.85 and 2.41 times respectively during the last decade. For the particular district, the yield-ratio also increased except some crops like autumn rice, rapseed and mustard, tur and potatoes. N.C. Hills and Karimganj district respectively occupied the next position to Dhubri district in growth ratios of crop area. Extremely high growth-ratio for crop-yield has been recorded in Goalpara district of the state. Here in thirteen crops out of sixteen, the higher crop-yield ratios has been recorded. Tur has increased 1.80 times while wheat increased 1.60 times during the last decade. On the other hand, extremely low growth ratio for crop-area has been recorded in Dhemaji district which emerged as a new district in 1991 from the original Lakhimpur district. District Darrang and Lakhimpur in upper Brahmaputra valley and Karimganj and Barak Valley emerged as the lowest growth-ratio districts for crop-yield during the last decade. Assam as the food grain dominated state only the summer rice (Ahu) has been recorded highly increased crop in some districts

RELATIONSHIP BETWEEN AGRICULTURAL
GROWTH RATIOS OF AREA AND YIELD
(1980-1 to 1990-1)

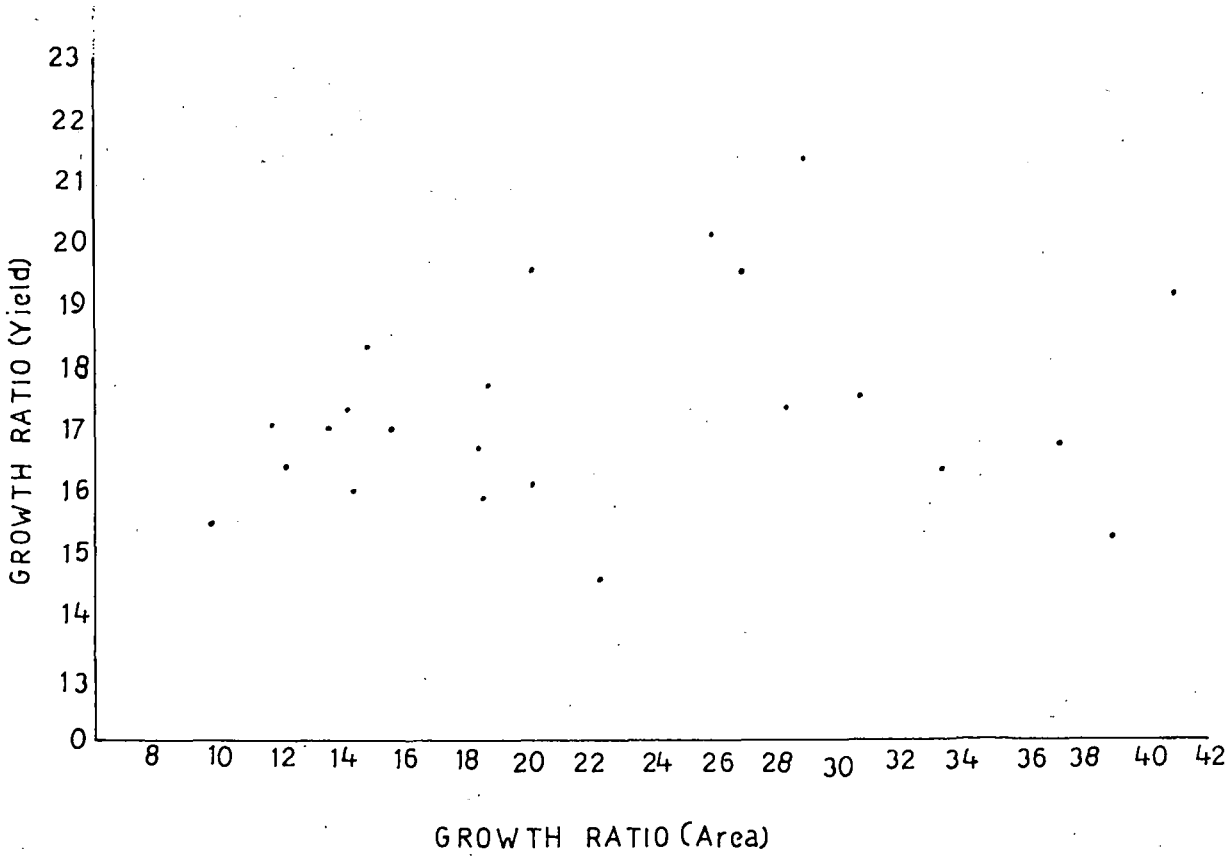


FIG-41

among all rice crops. In the Brahmaputra valley region the districts like Dibrugarh, Barpeta, Golaghat, Jorhat and Nagaon have been recorded as extremely high growth-ratio for crop-area as 13.40, 11.97, 11.10, 9.60 and 9.40 respectively. High growth ratios for crop-yield of food grains (mainly autumn rice, winter rice and summer rice) have been recorded in Barpeta district (1.94). In case of commercial crop-jute, the high growth-ratio for area and yield is recorded in Kokrajhar district (1.36 and 1.42 times respectively). On the other hand, considering the state as a whole, for all crops, the maximum growth ratio can be observed for summer rice (3.58) for its crop-area and for crop-yield the cereals and millets (1.42) during the decade.

An overall performance of the areal (district) variations of growth-ratio generalises the fact that there is a negative areal relationship between the growth ratios of crop-area and crop-yield. It means that the districts with expansion of crop-area do not have the higher ratio of crop-yield. There is very low growth of crop-yield vis-a-vis to crop-area. For instance, district Dhubri which has the maximum increase in growth ratio of its crop-area (5.67) for linseed and caster, has no increase in crop-yield ratio (0.98) during 1980-1 to 1990-1. It reflects a diverse nature of agricultural growth processes in its regional frame which results a diversified and week areal patterns of agricultural growth in the state(Fig-4.1).

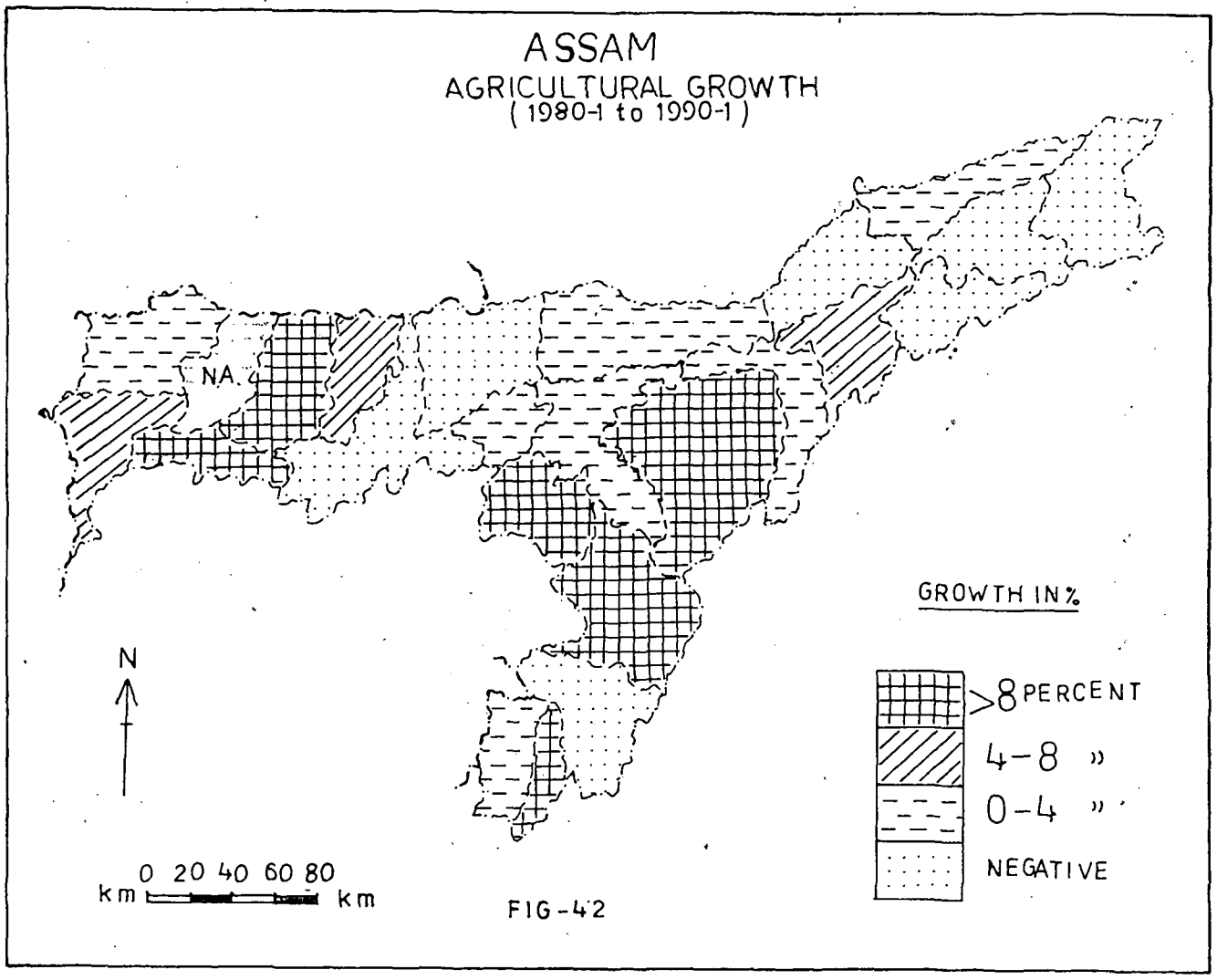

ASSAM
AGRICULTURAL GROWTH
(1980-1 to 1990-1)
N.A.
N
0 20 40 60 80
km km
GROWTH IN %
>8 PERCENT
4-8 »
0-4 »
NEGATIVE

FIG-42

Patterns of Agricultural Growth :

On account of diversified patterns of various conponents of agricultural growth as described in the previous sections of the present chapter, the agricultural growth of Assam in recorded very low. The total volume of agricultural output (19 crops included here) and its incremental nature has been calculated by applying equation (7) for the year 1980-1 as base year and 1990-1 as current year. And then the areal patterns of agricultural growth have been interpreted in its regional frame.

For interpreting the average annual rate of agricultural growth, total areal units (districts) have been classfied into four categories (including the negative growth rate) for a detailed study of the regional agricultural growth processes. It has been observed that there are high degree of inter-district variations in the range of growth rate. The annual average growth rate varies from the highest growth rate of 22.0 percent to the lowest i.e. negative growth rate of -5.31 percent during the decade (1980-1 to 1990-1) in the state, while the state average of the annual growth of output has been recorded only 3.35 percent which is far low than that of national average. For the study, all the areal units of Assam (i.e. districts) have been distinguished into four categories of equal interval which form the areas of (i) high growth rate (more than 8.0 percent of annual growth rate), (ii) medium growth rate (between 4.0 and 8.0 percent), (iii) low growth rate (0.0 to 4.0 percent and (iv) negative growth rate i.e. declining growth

Table 4.1 : Categorywise growth, No.of district, total output and percentage shows and changes therein (1980-1 to 1990-1)

(output figs in Rs)

Category	No.of Dist.	1980-1		1990-1		Changes	
		Total output	%	Total output	%	Total output	%
1. High Growth (8%)	5	3160443	14.66	5111205	21.74	1950762	7.08
2. Medium Growth (4-8%)	3	2339792	10.85	3686541	15.68	1346749	4.83
3 Low Growth (0-4%	8	7670910	35.60	9184750	39.07	1513840	3.47
4 Negative	7	8374629	38.86	5520108	23.48	-2854521	-15.38

(Table-4.1, Fig-4.2).

The regional patterns of agricultural growth categories and the causes of variations in growth are interpreted in detail in the following manner :

(i) <u>The Areas of High Agricultural Growth</u> : The high agricultural growth areas (exceeding 8.0 percent) account for five districts of the state namely : Goalpara, Barpeta, Hailakand, Karbi-Anglong and N.C. Hills. It appears that the processes of growth are accelerated fast in two types of agro-ecological conditions : (a) the fertile areas of humid lands of lower Brahmaputra valley and (b) the areas of upper Barak valley where terai and Cachari conditions of fertile lands are prevelent. In these areas of high growth, the total agricultural output was increased from Rs. 3160443 in 1980-1 to Rs.5111205 in 1990-1, estimating 7.08 percent increase during the decade. All these high growth rate areal units of the state have improved infrastructural facilities, available water supply for crops growth. All necessary requirements are comparatively better here than the other parts of the state and consequently the growth have been recorded high in these areas.

(ii) <u>The Areas of Medium Agricultural Growth</u> : The districts fall under medium agricultural growth category are Dhubri, Nalbari and Jorhat which are located in Brahmaputra valley region. The total agricultural output is recorded increasing from Rs. 2339792 (1980-1) to Rs.3686541 (1990-1). It means there is record

increase of 4.83 percent in output during the last decade. All these areal units which included in medium growth rate have favourable infrastructural facilities, better supply of water, intensive use of fertilizer to the agricultural production processes. But, sometimes agricultural growth is affected by natural hindrances like flood occurences, variations in climatic conditions and so on.

(iii) The Areas of Low Agricultural Growth : In this low agricultural growth category (between 0.0 to 4.0 percent), there is an increase of 3.47 percent in output from Rs.7670910 to Rs.9184750 during the decade. This category includes eight districts, out of them four districts (Kokrajhar, Bongaigaon, Sonitpur and Dhemaji are located in upper Brahmaputra valley, three districts (Nagaon, Morigaon and Golaghat) are located in lower Brahmaputra valley and only one district (Karimganj) is located in Barak valley region of the state (Fig-4.2). All these areas are characterised by low agricultural growth because of recurring floods by mighty Brahmaputra as well as Barak and their many tributary rivers for which the seasonal crop failure is a common phenomena. Besides, lack of infrastructural facilities including road and transport facility, lack of power supply all these are highly responsible for low agricultural growth rate of these districts.

(iv) The Areas of Negative Agricultural Growth : The areas where negative growth rate is recorded during the decade have been estimated a decrease of 15.38 percent in total output from

Rs. 8374629 (1980-1) to Rs.5520108 (1990-1). There are seven districts of the state which have negative growth. They are namely, Kamrup, Darrang, Lakhimpur, Sibsagar, Dibrugarh and Tinsukia in upper Assam region and the Cachar district in Barak Valley region. In these areas, unfavourable growth conditions prevail as excessive rain in some areas and paucity of water in other areas, unfavourable topographic donditions due to existence of hills, lack of proper irrigation facility to the crop fields and lack of other agro.economic and technological factors to the agricultural production processes - all these are highy responsible for negative agricultural growth. It can be mention here that though some of the negative growth districts of the state produces large quantity of food grains (mainly paddy crops), yet, they show a negative growth during the last decade because of above mentioned causes. Thus, it can be summerised that due to all these natural as well as other techno-economic facilities to the agricultural production processes, some districts of the state recorded high growth rate though they produce less amount of agricultural products and vice-versa. Lastly, it must be noted that if the values of growth-ratios are higher than 1.00, then there is an increase in the elements of agricultural growth and vice-versa. These ratios indicate proportionate changes in crop-area and/or crop-yield accordingly. Now, the agricultural growth must be studied in relation to agricultural productivity because productivity levels and changes therein might be able to explain other causes

of agricultural growth.

Agricultural Growth in Relation to Agricultural Productivity:

There is a research question which is posed in the Chapter-I that agricultural growth and productivity should have a negative relationship for the balanced development. To give the answer to this question and to test, the validity of the growth-productivity relationship hypothesis, the patterns of agricultural growth have been studied in relation to land as well as labour productivities. This relationship is established by preparing bi-variate frequency table and showing distribution by dispersion diagrams.

(A) Agricultural Growth in Relation to Land Productivity:

The sub-classification of agricultural growth categories by land productivity categories, the total areal units are arranged according to this cross-classification. Thus, there must be sixteen cells (4x4) in the classification. The percentage share of area and number of districts have been calculated for each and every cell which shows the areal extent and frequency of the areal units. Infact, if the area is equally distributed in each cell, it must be equal to 6.25 percent to the total area (i.e. 100 16=6.25). But, if the area is more than that figure, it means these categories are dominating in the distribution. By choosing the cells of the bivariate frequency distribution which have areal percentages

AGRICULTURAL GROWTH (1980s)
In Relation To
LAND PRODUCTIVITY(1990–1)

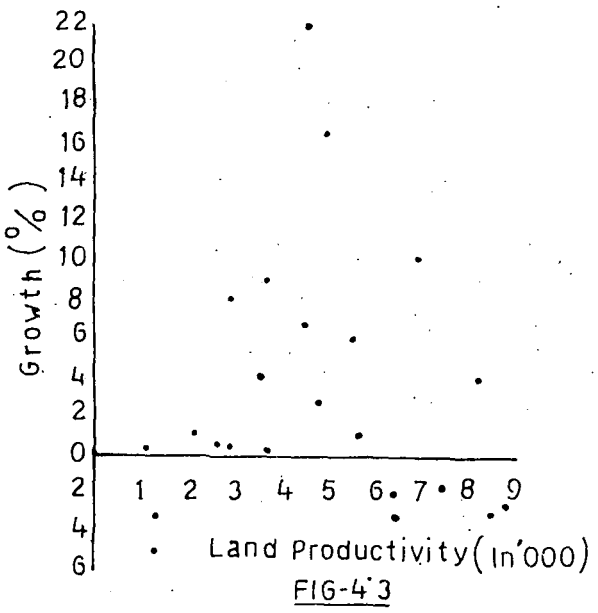


FIG-4.3

AGRICULTURAL GROWTH (1980s)
In Relation To
LABOUR PRODUCTIVITY(1990–1)

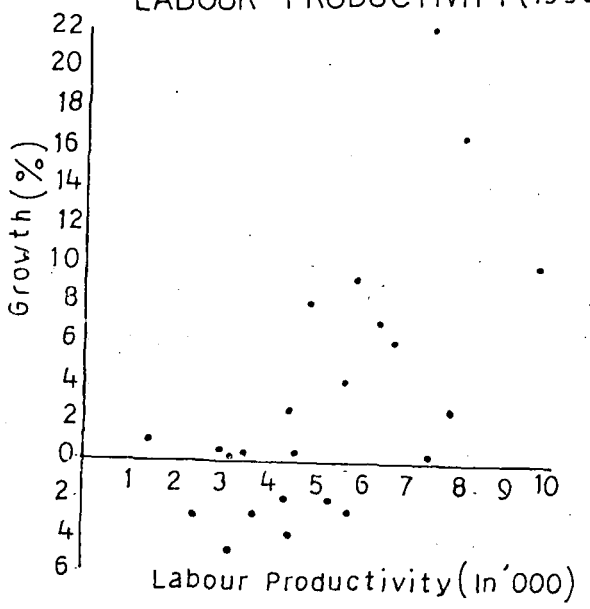


FIG-4.4

Table 4.2 : Bi-Variate Frequency Distribution of Agricultural Growth (1980-1 to 1990-1) and relation to Land Productivity (1990-1)

Agricultural Growth (1980-1 to (1990-1)	Land Productivity (Rs/Ha)				Total
	High (6000)	Medium (4000-6000)	Low (2000-4000)	Very Low (2000)	
1. High (8%)	-	-	7.24 (3)	11.75 (2)	18.99 (5)
2. Medium (4%-8%)	-	6.15 (1)	3.88 (1)	7.16 (1)	17.19 (3)
3. Low (0%-4%)	3.30 (2)	11.80 (2)	8.98 (2)	9.47 (2)	33.55 (8)
4. Negative	9.38 (2)	10.96 (2)	9.84 (3)	-	30.18 (7)
Total	12.68 (4)	28.91 (5)	29.94 (9)	28.38 (5)	99.99 (23)

N.B. Figures within Bracket indicates No. of districts and the other figures indicate areal extent in % of each category of the Bi-variate frequency distribution.

more than this average value 6.25 (Table-4.4), the agricultural growth and preductivity relationship is studied and its areal extent is explained. The following are the salient features of bi-variate distribution :

(1) <u>The Areas of High Growth with Low Land Productivity</u> : It can be interpreted from the Table 4.2 that the areas where growth is high (above 8%) with low and very low levels of land productivity occupy nearly one-fifth part (19 percent) of the state. It is situated in the Barak valley and the eastern parts of upper Brahmaputra valley. Here, though the output per cultivated land is very low, inspite of favourable climatic conditions. However, agricultural growth has been recorded very high in these areas. It may be because of initial growth of stage where less intensity of technology may enhance faster growth in the agriculture practices.

(2) <u>The Areas of Medium Growth with Low Land Productivity</u>:This category of agricultural growth productivity relationship shows that near about 11.00 percent of the total area falls under this category. It includes the areas of three districts, namely; Dhubri, Nalbari and Jorhat. There is also negative relationship but weak.

(3) <u>The Areas of Low growth with Medium to Low Land Productivity</u>: This category includes nearly 20.25 percent area of the total state. The districts are scattered in the Brahmaputra and Barak valleys.

(4) <u>The Areas of Negative Growth with High and Medium Land Productivity</u> : Some of the districts in the state located in Brahmaputra and Barak valley regions where the soil fertility is good and land productivity is high to medium, a negative growth rate of agricultural productions have been recorded during the last decade. In this category total seven districts included and incorporated about 30.20 percent of total cultivated land in the state. The causes of high level of land productivity in these areas are related to availability of new alluvial fertile soils but agricultural growth is low due to the natural havocs like recurring floods, lack of irrigated water to some regions, lack of use of modern techno-economic factors to the agricultural production processes.

Now from the above discussion, it is clear that the agricultural growth-productivity (land productivity) relation is negative but weak. The validity of this fact can also be tested by preparing scattered diagram of agricultural growth versus land productivity. The diagram shows a higher degree of scatterness of distribution (fig-4.3). It means relationship is weak. The areal patterns are diversified because of variations of agro-ecological and socio-cultural factors. Thus, agricultural growth must be interpreted in relation to labour productivity.

<u>Agricultural Growth in Relation to Labour Productivity:</u> Preparing bi-variate frequency table of agricultural growth with labour productivity category (Table-4.3), it can be concluded

Table 4.3 : Bi-variate Frequency of Agricultural Growth (1980) in relation to Labour Productivity (1990-1)

Growth 1980-1 to 1990-1)	Land Productivity (Rs/person)				Total
	High (9000)	Medium (6000-9000)	Low (3000-6000)	Very Low (3000)	
1. High (80%)	4.89 (1)	-	9.52 (3)	4.95 (1)	19.36 (5)
2. Medium (4%-8%)	-	3.87 (1)	13.32 (2)	-	17.19 (3)
3. Low (0%-4%)	12.37 (2)	8.05 (2)	9.47 (2)	3.68 (1)	33.57 (7)
4. Negative	16.83 (4)	6.50 (2)	6.84 (2)	-	30.17 (8)
Total	34.09 (7)	18.42 (5)	39.15 (9)	8.63 (2)	100.00 (23)

N.B. - Figures within Bracket indicates No. of districts and the other digures indicate areal extent in % of each category of the Bi-variate frequency distribution.

that growth and labour productivity are negatively related (Fig-4.4). The details of the facts can be interpreted in the following manner :

(1) <u>The Areas of High Growth with Low Labour Productivity</u>: This category of agricultural growth with low labour productivity incorporates about 14.50 percent of total cultivated land. These areas include total four districts in the state located both in upper and lower parts of Brahmaputra valley region. These areas having low labour productivity with high growth rate because of intensive use of water facility, fertilizer to the soils and favourable climatic conditions. On the otherhand, the labour productivity recorded low to very low because of less application of seed-fertilizer package and high intensity of agricultural labour force employed in the agricultural production processes.

(2) <u>The Areas of Medium Growth with Medium Labour Productivity</u>: In this category of agricultural growth which occupies about 18.0 percent of total cultivated land, the labour productivity has recorded medium. It incorporates only three districts located in the north of Brahmaputra valley region. There is a probability to increase the agricultural output by using modern agricultural facilities to its production processes where from high agricultural growth with high labour productivity can be expected in future.

(3) <u>The Areas of Low Growth with Medium Labour Productivity</u>: There are stagnent conditions of growth and productivity in the areas which are covering a more than one-third parts of the state.

In the low growth areas, the labour productivity must be higher for balanced development. But, it does not happen in these areas. Therefore, they have been recorded as stagnent conditions of growth. But, because of strong techo-economic factors to the agricultural production processes in these areas, a high growth rate could be expected in near future.

(4) The Areas of Negative Growth with High to Medium Labour Productivity : Some of the districts located in the most flood-prone areas like Lakhimpur, Dibrugarh and Cachar, where crop failure during the monsoon season is a common phenomena, having negative growth with high to medium labour productivity levels. These negative growth areas covered about 24.00 percent of the total cultivated land. These areas are having good fertility of the soils, but, it is affected by flood and other natural havocs. Therefore, a negative growth in agricultural output is recorded. And if some protective measures can be taken to tackle the flood situation, then a good amount of food-grain (mainly paddy) production from all these regions can be expected.

CONCLUDING REMARKS :

By describing agricultural output growth trends and patterns in detail, an attempt was made to highlight the inherent characteristics of growth structure in the state in its regional frame. The salient features of growth processes which have been described here bring out an important generalisation.

It is logically proved that the linear trend of agricultural output growth is more significant for predicting proper growth results of various crops in the state. It can be concluded that high productivity can be observed in the areas where soil is fertile with sufffeient water availablity and climatic conditions are favourable, The agricultural growth processes are not accelerated only on the basis of local demand but market forces are also influency them. Technological inputs are intensifying the growth processes. Therefore, the fertile zones of Brahmaputra and Barak valley regions have higher agricultural growth (about 7.08 persent) during the decade. Thus, there are expectations to intensify technology for accelerating growth processes.

Testing the validity of facts of growth-productivity hypothesis, it is found that agricultural growth is negatively related with land productivity in the state with diversified its areal patterns while growth is also negatively related with labour productivity levels but at insignificant level which is healthy symbol of balanced development and self-sustained growth. In the end, it can be said that our discussion must proceed towards an integrated approach of agricultural development for preparing the 'region-specific'strategy. Thus, these all components and characteristics of agricultural development which have been studied in the preceding chapters must be interpreted together by delineating the agricultural regions of the state of Assam.

CHAPTER - V

AGRICULTURAL REGIONS AND THEIR CHARACTERISTICS

In the previous chapters, the agricultural personality of the study area, agricultural productivity and production factors and agricultural growth characteristics have been discussed in detail. The previous discussion on different aspects of agricultural characteristics depicts a clear picture about the areal patterns of the agricultural development of the Assam state and it gives the answer to the question how and why agricultural activities differ on space in different physical as well as socio-economic conditions. Infact, these agricultural characteristics are interrelated and inter-dependent in its regional frame. Therefore, in the present chapter, it is tried to prepare an optimal regional frame of agricultural characteristics for the balanced development and self-sustained growth of agriculture.

Before discussing the regional characteristics of agricultural phenomena of the Assam state, it is important to interpret and analyse the theoretical and methodological aspects of region-formation so that a sutiable regional scheme of agricultural phenomena may be prepared. Thus, the concerned literature and the procedure of region-formation are to be discussed.

So far as concerned literature on agricultural regionalisation is concerned, there have been numerous studies in region-formation processes specially in India and abroad. The

work of Whittlesey (1936) is noticeable and a starting point of the studied on agricultural regionalisation. His classical concept on the agricultural regions of the world is the base for neo-classical theories. He incorporated five characteristics aspects in his classification, namely; (a) Crop and livestock combination, (b) intensity of landuse, (c) degree of technological development, (d) processing and trading of agricultural output and (e) types and association of buildings and other structures related to farming. But as his criteria for regionalisation considere as subjective, which was based on traditional indicators for regionalisation, it could not therefore prolong for longer period. The idea of agricultural regions sometimes involved with the idea of natural regions and it has been mentioned by T.W. Freeman (1971). But many agricultural geographers rejected this notion because agricultural regions should be defined in agricultural terms instead of natural regions (Morgan and Munton 1971, Kostrowicki 1968). On the otherhand, some other classifications with special reference to agricultural problems were made by Padadakis (1938,1966). His new system of classification introduces a specific kind of climodiagrm by which crop-ecological extremes are identified for ecological requirements of agriculture (Papadakia 1966). A comprehensive review and comparison of various criteria used for the examination of system of the agricultural regions of the world were produced by Grigg (1969) and he pointed out that ther are a number of predictable changes going on in agriculture in different parts of the world which will minimize many of the

present regional differences. But the principal difference between the systems of world agricultre which not used as criteria in most systems, is productivity which must be included in the criteria of agricultural regions for accelerating the production processes in future (Grigg 1969, p.118-120). As a sample of early ideas on the agricultural region, the agricultural regions delineated by H.Wood (1931) for Scotland which have favoured by stamp and Beaver (1971). They commented that the work of Wood was based on environmental factors and it is suitable for agricultural landscape. Baker (1926-1932), specified the agricultural regions in purely agricultural terms and his work was for North-America. He considered a number of basis for agricultural regionalisation, viz., predominent crop/ livestock, association of crops and/or stock animals, type of farming etc. In the neo-classical work on agricultural regions of the work, Kostrwicki (1968) who identified the 33 model types of world agriculture on the basis of considering 20 agricultural attributes and putting them into 'typograms. The agricultural attributes which he choosen are related to the characteristics of agriculture.

So far as agricultural regionalisation in India is concerned, the agro-ecological attributes, viz., topography, climate and soil have been considered for macro-agricultural zonation, and cropping patterns for meso and micro-agricultural regions (Sen Gupta 1968, Bhat and Learmonth 1968). The concept

of'natural regions' has been applied to delineate the agricultural regions especially during the mid of this century because Indian agricultural systems might have been controlled by the natural factors particularly by physical features and climatic conditions before the green revolution period (Randhawa 1958, ICAR 1964, Planning Commission 1964, e.f.Mamoria 1975). But after the green revolution, it appears to be the significant changes in the crop-combinations, productivity patterns and in regional structure of agricultural growth which has been interpreted by Singh (1994) . These areal features are breaking the limits of physical attributes of agricultural systems with a significant transformation of agricultural characteristics from traditional less- productive system to modern systems of more productive ones with rapid growth (Singh 1994). Singh considered total twenty variables for agricultural regionalisation in India and these twenty variables were classified into four categories of agricultural characteristics, viz., Agro-ecological characteristics, Production characteristics, Agricultural growth potential characteristics and Organisational and Technological characteristics.

But so far as agricultural development of the Assam state is concerned, it is important to mention here that the Assam state is an areal unit of meso-level but it has a significant variation in the physical, socio-cultural and economic factors, though the agricultural production processes in Assam is still operative in its traditional way. As a result, the

criteria for analysing the present day system of state's agriculture are still under the influence of agro-ecological and physiographic conditions of land rather than techno-economic factors.

Now, question arises how to delineate the agricultural regions of the Assam state so that the regional processes of agriculture may be studied and the factorial impact on the processes of region-formation can be interpreted. For giving the answer to this question, three aspects of agricultural region-formation are to be interpreted to understand the complete procedure of agricultural regionalisation. They are : (a) the choice of the agricultural attributes for region-formation, (b) the procedure for identifying the system of region-formation, and (c) the spatial contiguity criteria and optimal classification of areal units. These aspects have been discussed here in detail in relation to agricultural phenomena of the Assam state in the following way.

A. <u>The Choice of Agricultural Attributes</u> :

There are numerous variables related to agricultural phenomena which can be included in the present study of regionalisation. But the important variables which are closely related to the agro-ecological, production and infra-structural and institutional characteristics of the agriculture of Assam, are generaged and included in the present scheme of agricultural regionalisation. They are 15 in number as given in Table-5.1.

Table5.1: Districtwise Selected Attributes for Agricultural Regionalisation

Districts	RF (mm)	SF	PE (mm)	PCAO (Rs/p)	AGRAO (%)	LP (Rs/ha) 1990-1	DCLP 1980-1 1990-1	LP1 (Rs/p) 1990-1	DCLP1 1980-1 1990-1	CI 1980-1 (%)	NSA-GA	LI (p/ha)	AI 1990-1	CF (kg/ha) 1990-1	LH 1980-1
1.Kokrajhar	2727	65.8	1250	771	1.24	3984	34.50	2776	-21.55	134.75	29.87	1.81	6.37	5.29	1.12
2.Goalpara	2482	67.8	1248	1047	8.16	6720	139.82	4840	68.93	128.92	42.60	1.77	6.90	10.33	1.04
3.Bongaigong	2630	66.5	1150	1037	1.24	3984	34.50	4695	32.66	120.50	36.50	1.52	5.25	5.95	1.12
4.Dhubri	2655	67.5	1140	1294	6.22	8320	43.30	6492	10.57	130.76	52.00	1.38	3.24	10.95	0.95
5.Barpeta	2412	65.0	1230	1095	9.49	5605	52.97	5523	47.16	135.02	53.47	1.28	1.84	6.26	0.95
6.Nalbari	2475	66.5	1280	1024	4.19	5820	68.84	5661	3.03	155.10	72.77	1.24	6.14	6.78	1.31
7.Kamrup	1682	46.4	1066	600	-4.66	6372	380.54	4804	-61.64	126.01	37.36	1.31	5.76	20.33	1.05
8.Nagaon	1750	61.2	1166	1603	3.93	9108	12.13	7878	-36.30	131.77	56.31	1.33	2.13	8.94	2.91
9.Morigaon	1680	60.5	1120	1019	2.51	5670	18.42	4376	47.58	125.60	45.00	1.03	2.00	25.82	2.19
10.Darrang	2214	67.8	1280	965	-2.74	5490	-34.80	4150	-20.84	118.00	57.63	1.01	8.18	7.99	0.70
11.Sonitpur	2093	67.5	1130	700	0.97	5742	- 0.45	3340	-45.35	129.74	30.03	1.32	12.09	8.69	1.25
12.Lakhimpur	3251	74.4	1379	909	-1.01	4363	-42.95	4151	-55.59	130.90	29.15	1.71	0.42	5.28	2.23
13.Dhemaji	3325	73.5	1390	807	0.49	3559	- 5.67	2975	-43.33	124.50	27.50	1.16	0.30	7.69	1.90
14.Jorhat	2081	70.0	1140	1079	6.95	7149	48.90	6328	- 2.58	127.41	43.35	1.29	4.75	23.07	1.57
15.Golaghat	1804	71.5	1100	3114	1.19	2015	-10.20	3484	-44.91	109.91	34.18	1.13	3.23	21.66	1.52
16.Sibsagar	2295	71.0	1347	908	-2.25	7060	-18.44	5529	-52.55	121.58	53.46	1.50	3.10	17.53	1.74
17.Dibrugarh	2800	74.4	1076	549	-1.29	5694	- 7.74	4995	-41.97	125.35	30.34	1.46	4.10	16.24	3.18
18.Tinsukia	2750	73.6	1010	389	-3.50	4567	-31.81	2600	-65.69	130.20	32.20	1.15	3.25	19.78	2.20
19.Cachar	3377	67.6	1427	535	-5.51	5963	364.77	3282	-64.73	120.52	27.60	1.27	0.89	10.79	1.47
20.Hailakandi	3050	66.0	1350	1474	16.40	1402	-70.86	7156	106.64	116.80	25.30	1.36	1.00	25.12	1.30
21.Karimganj	3992	65.5	1450	1233	0.91	1164	1.30	7646	-7.21	135.93	34.78	1.75	1.91	12.17	0.80
22.K.Anglong	1784	61.2	1445	3061	10.00	1231	-82.16	9685	-4.21	114.28	36.00	1.27	6.11	3.99	1.38
23.N.C.hills	1183	56.6	1761	1611.	22.00	1188	-73.11	7061	106.82	104.76	14.00	1.71	19.27	7.17	0.95
Assam	2456	67.20	1249	1468	3.35	4877	35.71	5589	-6.30	126.01	39.27	1.39	4.60	11.33	1.06

Abbrevations: RF = Rain Fall; SF = Soil Fertility; PE = Evapo-transpiration; PCAO = Per capita agricultural output; AGRAO = Annual growth rate of agricultural output; LP = Land productivity; DCLP = Decadal change in land productivity; LP1 = Labour producitivty; DCLP1 = Decadal change in labour productivity; CI = Crop intensity; NSA-GA = % of NSA to total geographical area; LI = Labour input; AI = % of area under irrigation; CF = use of chemical fertilizer; LH = average size of operational land holding.

and their salient features are given below.

(i) Agro-ecological Characteristics : Out of the total 15 variables, three belong to the group of agro-ecological dondeitions. Rainfall, soil fertility and Potential-Evapotranspiration (PE) all are directly related to plant growth and agricultural productivity of a region. Infact, soil fertility is the outcome of various physical and climatic factors, viz., geological formations (mentioned in Chapter-II), slope, drainage density, temperature and rainfall etc. and agricultural productivity is positively related to soil fertility. Therefore, the agricultural characteristics of Assam are controlled by physiographic features mainly. Soil fertility is a strong crop-ecological factor which even after the adoption of green revolution technology to Indian agricultural field, would play a significant role for the agricultural development (Bhat 1988).

(ii) Production Characteristics : This group incorporates five variables. Out of them, three variable, e.g.,labour productivity (agricultural output per person of agricultural work force), land productivity (agricultural out put per unit of cultivated land) and crop intensity are directly related to existing production structure of agriculture.Agricultural growth which is an important variable of agricultural development of a region has been included in this category of variables. Moreover, the percentage of Net Sawn Area (NSA) also included under this category because it is a good indicator of areal extent of agricultural activities.

Table 5.2 : Selected Attributes for Agricultural Regionalisation and their Mean, Standard Deviation and Coefficient of Variations.

Name of the Variables	Mean	Standard Deviation (S.D.)	C.V.(%)
A. Agro-Ecological Characteristics:			
1. Rainfall (mm)	2456.17	654.50	26.65
2. Soil Fertility	67.21	4.55	6.77
3. Potential-Evapotranspiration (PE) (mm)	1186.93	295.04	24.86
B. Production Characteristics :			
4. Per Capita Agricultural output (Rs/person)	1468.00	1488.17	101.37
5. Annual Growth Rate of Agricultural output(%)	3.27	6.51	199.08
6. Land Productivity (Rs/ha)	4877.22	2236.14	45.85
7. Decadal Change in Land Productivity(%)	35.71	115.06	322.21
8. Labour Productivity (Rs/person)	5662.04	2463.65	43.51
9. Decadal Change in Labour Productivity(%)	-6.31	51.27	812.52
10. Crop Intensity(%)	126.01	10.00	7.94
11. Percentage of NSA to Total Geographical Area	39.28	13.05	33.22
C. Organisational and Technological Characteristics:			
12. Labour Input(Person/ha)	1.39	0.23	16.55
13. Percentage of Area Under Irrigation Potential Utilised	4.67	4.14	88.65
14. Use of Chemical Fertilizer (Kg/ha)	12.48	6.88	55.13
15. Average Size of operational Land Holding	1.48	0.59	39.86

(iii) Organisational and Technological Characteristics : There are various attributes related to the intensification of agricultural production and development of an area. But under this category four important variables have been chosen for agricultural regionalisation. They are : labour input (agricultural labour per hectare), area under irrigation, use of chemical fertilizer (kg/ha) and average size of operational land holding. The last variable i.e. average size of land holding reflects the ownership characteristics of land, which is indirectly related to the agricultural developmental processes of a region also chosen as an important variable of the present study.

B. The Procedure of Identifying the Regions :

After discussing the choice of the variables, it is important to interpret the procedure of identifying the regional systems so that the agricultural regions of the Assam state can be delineated and the regional processes of agricultural characteristics may be analysed. So far as identifying the regional systems for agricultural characteristics is concerned, there are numerous studied made in India and abroad (Barker 1926-1932, Bhat and Learmonth 1968). But for identifying the regions on the basis of homogenity within and hatero-genity between the regions, three important methodological tasks to be discussed here. The first task is related to how to put all the variables, which are taking into for regionalisation, on to their uniform scale, because, the variables have

ORDERING OF SPATIAL VARIANCE
(COMPUTER ALGORITHM)

STEPS:

I RAW DATA MATRIX
(R-MAT)

$i = 1,2,3,\cdots,n$
$j = 1,2,3,\cdots,m$

II STANDARD DATA MATRIX
(Z SCORE-MAT)

$Z = [(X_i - X_i)/\sigma_i]$

III DISTANCE MATRIX
(D-MAT)

$(D_{ij} = [\sum_{j=1}^{m}(X_{ij} - X_{Kj})^2]^{1/2}$

IV REDUCTION OF n
(REDUCED D-MAT)

V STOP

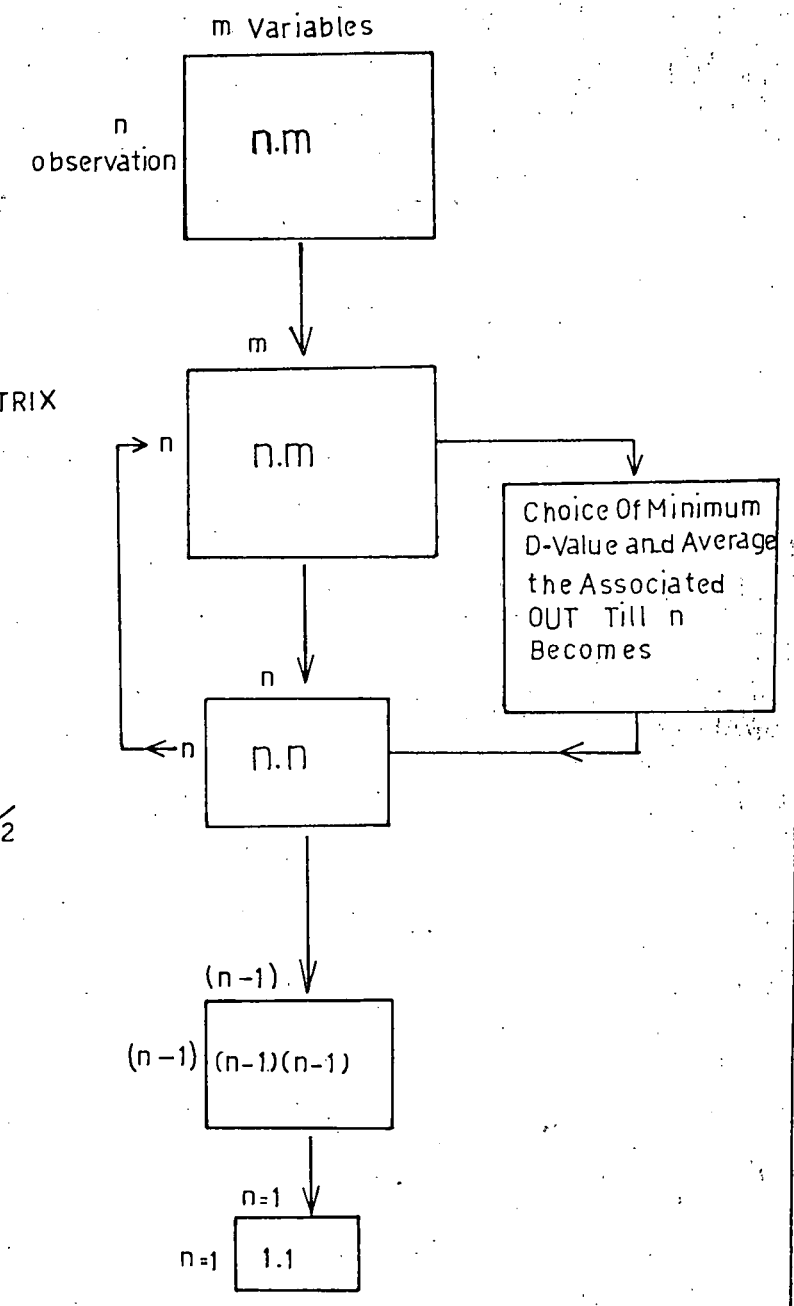


FIG 5.1

their different characteristics. The second task is to put the aggregated force of the variables into its areal hierarchy which is directly concerned with the ordering of spatial variance. And third task is associated with the findingout the assimilation processes of region formation which would highlight the areal processes and similarity of the areal units its regional frame.

There are various techniques to assimilate the areal units for forming the regional boundaries. For example, with the help of cartographic techniques like preparing distributional maps of the agricultural attributes, the composit picture of emerging regions can be highlighted. But, there are numerous statistical techniques which are useful for classifying/ grouping the areal units (Grigg 1967). In the present study the ordering of spatial variance of agricultural attributes have been interpreted by following the algorithm of "functional distance minimisation" which follows four important steps as : (i) transformation of raw data matrix, (ii) the calculation of functional distances and creation of distance matrix, (iii) the choice of the minimum value of the distance matrix and clubbing the most similar areal units into an areal group and (iv) arrangement of all these areal units into the various groups of these areal units on the basis of the most similar functional characteristics. The important steps of this algorithm are given in figure-5.1.

(c) <u>Spatial Contiguity and Optimal Classification</u>:

This is the important aspect of procedure of region formation because, since the procedure of ordering of spatial

Table 5.3 : Similarity within and between the Groups in Region Formation.

Areal Groups	Within the Group - D Values			
	Absolute	%	Cumulative	% to
Prior to grouping	0	0	0	-
After I grouping	1.941	23.12	1.941	23.12
2nd grouping	0.652	7.77	2.593	30.89
3rd "	0.013	0.15	2.606	31.04
4th "	0.005	0.06	2.611	31.10
5th "	0.003	0.04	2.614	31.14
6th "	0.077	0.92	2.691	32.05
7th "	0.024	0.29	2.715	32.34
8th "	0.154	1.83	2.869	34.17
9th "	0.201	2.39	3.070	36.57
10th "	0.394	4.69	3.464	41.26
11th "	0.230	2.74	3.694	44.00
12nd "	0.148	1.76	3.842	45.77
13rd "	0.011	0.13	3.853	45.90
14th "	0.169	2.01	4.022	47.71
15th "	0.109	1.30	4.131	49.21
16th "	0.139	1.66	4.270	50.86
17th "	0.024	0.29	4.294	51.15
18th "	0.416	4.96	4.710	56.11
19th "	0.380	4.53	5.090	60.63
20th "	0.491	5.85	5.581	66.48
21st "	0.147	1.75	5.728	68.23
Last "	2.666	31.76	8.394	100.00
	8.394			

11

variance is operated by computer, the grouping of the areal units may not be in its contiguous nature. Therefore, for practical purpose one has to modify the areal grouping schemes according to the spatial contiguity. Thus, spatial contiguity criteria also considered here for delineating the agricultural regions of the Assam state.

Agricultural Region Formation :

Generating the data of 15 agricultural variables as given in Table-5.1, the ordering of spatial variance programme of which algorithm is given in Fig-5.1 was operated with the help of computer. The spatial features of assimilation processes of areal units are as follows:

(1) Table-5.2. which shows mean, standard deviation and co-efficient of variation of all the agricultural attributes of the state of Assam, reveals that the decadal change in labour productivity has the highest co-efficient of variation (812.52 percent). It follows decadal change in land productivities (322.21 percent). It means the change in the labour as well as land productivities have diversified pattern in the study area while soil fertility index and crop intensity have the lowest areal variations in Assam that are 6.77 and 7.94 percent respectively. It can be visualised from the table that all the organisational and technological characteristics of agricultural phenomena have the variations but significant.

(2) The trend and tendencies of grouping the areal units show that the first group is assimilated at the similarity level of

GROUPING TENDENCIES

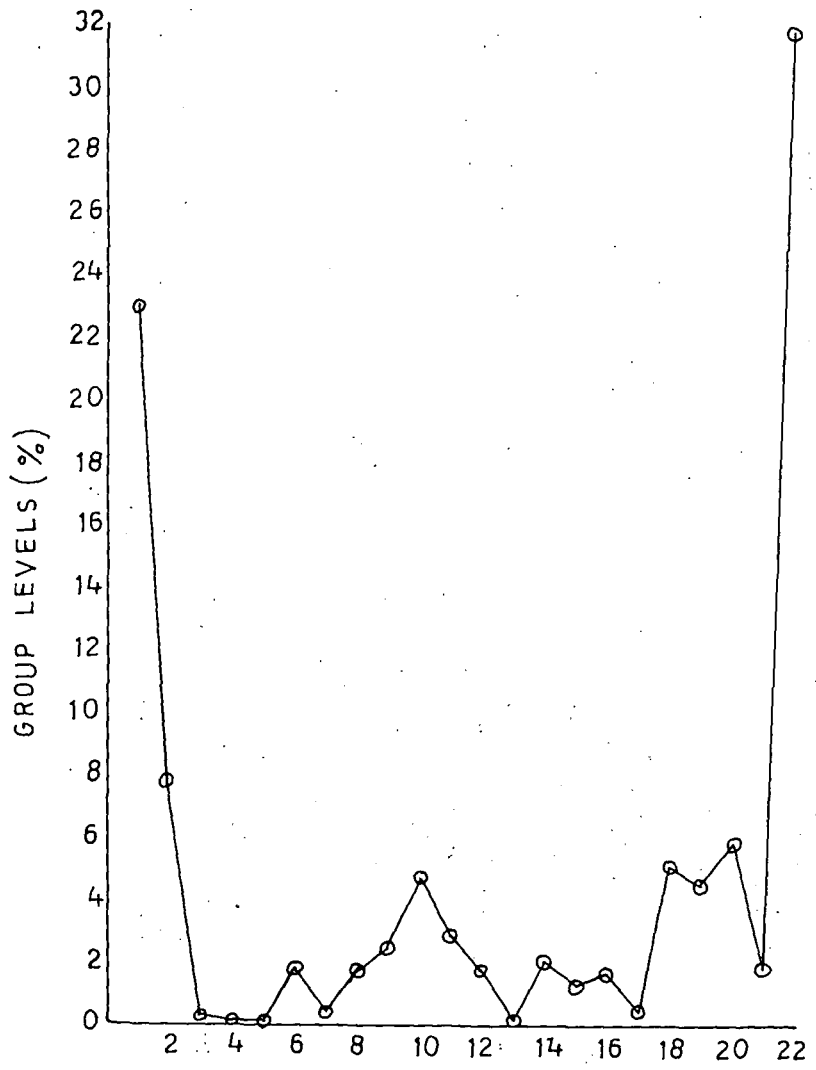


FIG-5'2

1.94 which includes 23.12 percent of the total variation while there seems a fluctuating nature of general trend of assimilation of areal units. But, at 2nd group of assimilarity procedures the similarity level was recorded 0.652 which is 7.77 percent of the total variation. The trend fluctuates at 10th grouping where the absolute similarity level is recorded 0.394 which is 4.69 percent. In the last stage of assimilation level the variation within the group is recorded higher as 0.491 at 20th group, 2.666 at the last group of assimilation (Table-5.3). As a result the nature of grouping tendency graph beccmes 'U' shaped (Fig-5.2).

(3) Arranging all the areal units according to their order of areal variation, a dendrogram (i.e. called linkage tree) is prepared carefully which shows the areal variations within the groups (Fig-5.3). Fig-5.3, reveals that there are two clear-out broad groupings of the areal units at 4.8 similarity level with the exception that a few areal units have very high level of similarity level in the assimilation process of regionalisation. But, at lower similarity level of 3.75, there are emergence of 5 clear groups of the areal units within those broad regions of macro level. These 2nd order groupings are called meso agricultural regions. If we go in more detailed at lower level then there are again sub-division of these meso agricultural regions. They are called micro region. Some areal units which falls under these agricultural regions of various levels are called unique regions of different characteristics because they have different agricultural characteristics. However, these units had to incorporate under these regions on the basis of spatial contiguity

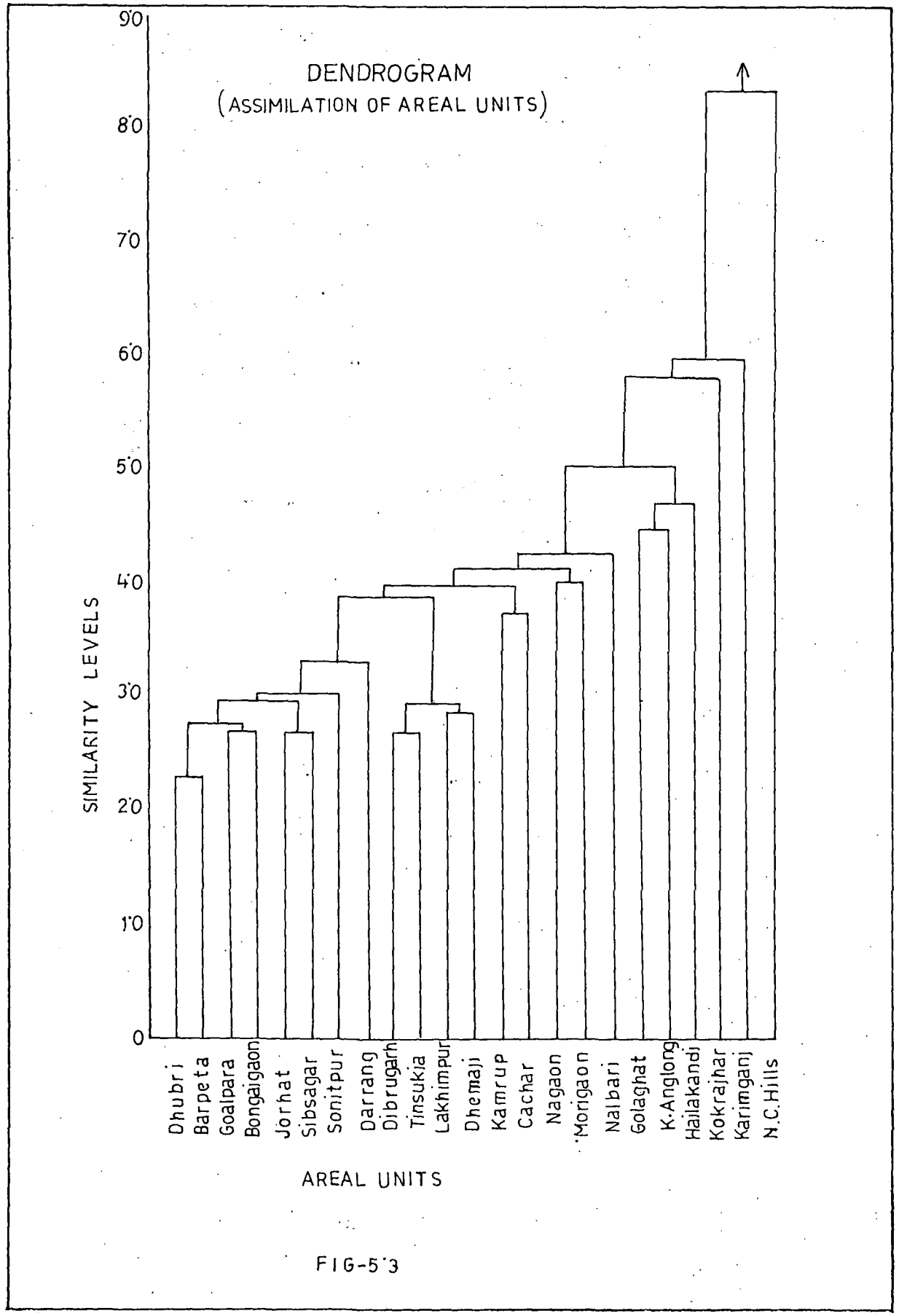

DENDROGRAM
(ASSIMILATION OF AREAL UNITS)
SIMILARITY LEVELS
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
0
Dhubri
Barpeta
Goalpara
Bongaigaon
Jorhat
Sibsagar
Sonitpur
Darrang
Dibrugarh
Tinsukia
Lakhimpur
Dhemaji
Kamrup
Cachar
Nagaon
Morigaon
Nalbari
Golaghat
K.Anglong
Hailakandi
Kokrajhar
Karimganj
N.C.Hills
AREAL UNITS

FIG-5·3

oriteria.

(4) The regional hierarchy of agricultural elements and assimilation tendencies have some important dharacteristics in its regional frame. For example, the region which includes 5 districts of lower Brahmaputra valley (IA) has two micro regions (IAI and IA2). These regions are similar in their physiographic characteristics. However, they are different in their agricultural attributes. Therefore, they have put separately into two micro level regions. Likewise, the macro region of Barak valley (II) is having two meso level regions while IIB forms separate meso level region in the assimilation process. Inspite of homogeneous physiographic characteristics of these two regions, they assimilate at very high level of similarity. Therefore, the variation between those region is recorded very high. These regions of meso level are different in their labour productivity.

(5) On the other hand, IBi which forms the central part of Middle Brahmaputra meso region assimilating two areal units (Kamrup and Nalbari districts of the state) form a homogeneous group (Fig-5.4), but there seems a deviation of the boundaries of agricultural regions from the physographic regions of the state. Say for example, Karbi-Anglong district is similar to the other contiguous districts in its agricultural characteristics of productivity and growth, but it is totally different in its physiographic as well as socio-cultural conditions, though this deviation can be seen at micro level of the spatial ordering.

ASSAM

AGRICULTURAL REGIONS

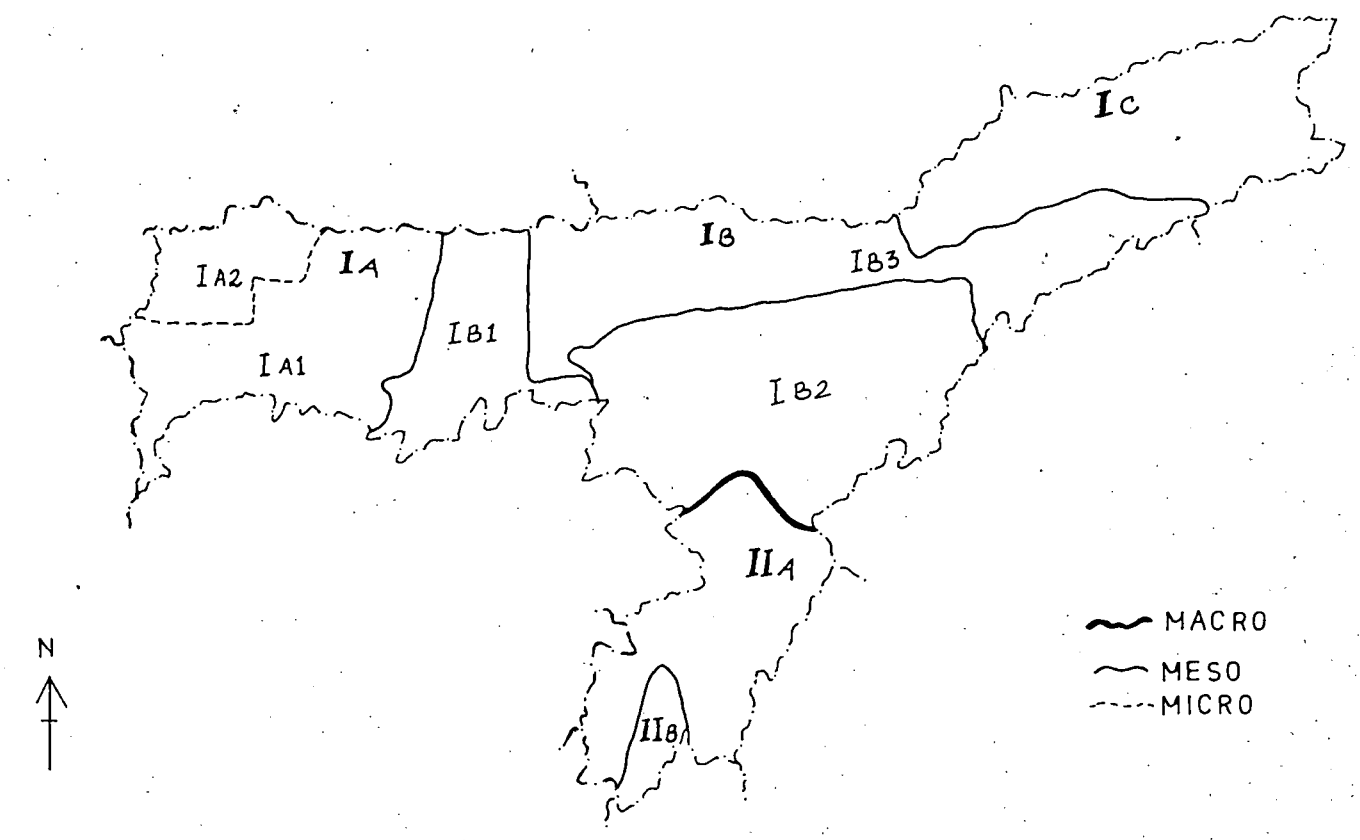


FIG – 5·4

CHARACTERISTICS OF AGRICULTURAL REGIONS

After assimilating all areal units at three various levels of macro, meso and micro regions, the agricultural regions of the Assam state have been delineated. The nomenclature of these agricultural regions is given on the basis of general characteristics of physical and agricultural phenomena which is given in Table-5.4. The general agricultural characteristics and the processes of agricultural development within the delineated regions have been interpreted in the following manner :

1. Brahmaputra Valley Region :

It is macro-agricultural region of I order which includes total 19 districts of the state. The areas under this region is dispersed from Dhemaji (upper Brahmaputra) to Dhubri (Lower Brahmaputra valley). This region includes more than 75 percent of total geographical area of the state. There are three meso-level agricultural regions with in it. They would highlight the agricultural characteristics in their most homogeneous manner.
They are :

IA. Lower Brahmaputra Valley Region :

This region of meso-level includes 5 districts of the lower Brahmaputra valley region of the state and has two micro level regional units namely: low land of lower Brahmaputra valley (IAI) and Kokrajhar region (IA2). All these regions are

Table 5.4: Assimilation Process and Groupings of Agricultural Regions

A.G.	No. of Dist.	RF (mm)	SF	PE (mm) 1990-1	PCAO (Rs/p) 1990-1	AGRAO (%) 1990-1	LP (Rs/ha) 1990-1	DCLP 1980-1 (%)	LP1 (Rs/p) 1990-1	DCLP1 1980-1	CI 1980-1	NSA-GA	LI (P/ha)	AI 1990-1	CF (kg/ha)	LH
I.Brahmputra Valley Region	19	2362.68	67.90	1197	1521.63	6.36	5392	31.54	5488.53	6.66	127.38	42.09	1.36	3.49	12.20	1.56
IA1.Low land of Lower Brahmaputra Valley Region	4	2545.00	66.70	1192	1118.25	6.28	6157	67.65	5387.85	39.83	128.80	46.14	1.49	4.11	8.17	1.02
IA2.Kokrajhar Region	1	2727.00	65.80	1250	7711.00	1.24	3984	34.50	2776.00	-21.55	134.75	29.87	1.81	6.37	5.29	1.12
IA. Lower Brahmaputra Vally Region	5	2581.40	66.52	1204	2436.80	5.27	5722	61.02	4865.20	27.55	129.99	42.89	1.55	4.56	7.59	1.04
IB1.Gauhati Surrounding Region	2	2078.50	65.45	1173	812.00	-.25	6096	224.69	5232.50	-29.31	140.55	55.07	1.38	5.95	13.56	1.18
IB2.Nagaon-Golaghat Region	4	1754.50	63.60	1158	2199.25	29.61	4506	-15.55	8855.75	- 9.46	120.40	42.88	1.19	3.37	15.11	1.82
IB3.Longitudinal Humid Region	4	2170.75	69.08	1224	913.00	0.73	6362	- 1.20	4836.75	-30.33	124.19	46.12	1.28	7.03	14.22	1.32
IB.Middle Brahmaputra Valley Region	10	1985.80	66.16	1187	1407.30	12.08	5566	38.24	6523.50	-21.78	125.94	46.61	1.26	5.35	14.48	1.49
IC.Upper Brahmaputra Valley Region	4	3031.50	73.98	1214	663.50	-1.33	4545	-22.04	3680.25	51.66	127.74	29.80	1.37	2.02	12.25	2.38
II.Barak Valley Region	4	2900.50	130.48	1497	1213.25	8.50	2429	55.52	6486.25	35.38	119.50	25.92	1.53	5.77	13.81	1.10
IIA.Cachari Region	3	2850.67	151.97	1546	1126.33	5.87	2772	97.65	5996.33	11.63	120.40	26.13	1.58	7.36	10.04	1.07
IIB.Hailakandi Region	1	3050.00	66.00	1350	1474.00	16.40	1402	-70.86	7956.00	106.64	116.80	25.30	1.36	1.00	25.12	1.20

Abbreviations: RF= Rainfall, SF = Soil fertility, PE = Evapo-transpiration, PCAO = Percapita Agricultural output, AGRAo = Annual Growth rate of Agrl. output, LP = Land productivity, DCLP = Decadal change in land productivity, LP1 = Labour productivity, DCLP1 = Decadal change in labour productivity, CI = Crop intensity, NSA-GA = % of NSA to total geographical area, LI = Labour input, AI = % of area under irrigation, CF = Use of chamical fertilizer, LH = Averagr size of operational land holding.

agriculturally homogeneous though the Kokrajhar region is indifferent in agricultural characteristics from the other region because it assimilates at 5.5 level in the region formation processes. The general characteristics of these regions of micro-levels are as follows :

IAI. <u>The Low Land of Lower Brahmaputra Valley Region</u>: This micro-level region includes 4 districts of lower Brahmaputra valley namely : Dhubri, Goalpara, Bongaigaon and Barpeta where annual rainfall recorded 2545 mm which is sufficient for agricultural production. The soil fertility index (66.7) and potential erapo-transpiration (1192 mm) are favourable for crop growth. In this micro-level region, the annual agricultural growth thus recorded more than 6.0 percent which is more than that of state's average (3.35 percent). On the other hand, the land and labour productivities have been recorded Rs.6157/ha and Rs.5387/person respectively. It is also noticed that the land productivity is more than the state's average (Rs.4877/ha) where the labour productivity is a slightly lesser than that of state's level. It is interesting to note that this region recorded medium use of chemical fertilizer (8.17 kg/ha), medium use of agricultural labour input (1.49 persons/ha)where crop intensity is recorded 128.08 percent and NSA to toal geographical area is 46.14 percent (Table-5.4). Comparing all these attributes to the state's average figures, it has been clear that this region has medium intensification of the use of all these agricultural inputs.

IA2. Kokrajhar Region : This micro-level region includes only Kokrajhar district which have heterogenity in agricultural attributes with other regions of the state and therefore, it is identified as unique region of single district. Inspite of favourable agro-ecological conditions of this region like annual rainfall recorded 2727 mm. soil fertility (65.8) and PE recorded 1250 mm. The annual agricultural growth recorded low (1.24 percent) with low land productivity (Rs.39-84ø ha) and low level of labour productivity (Rs.2776/person). The decadal changes in land and labour productivities are very low even land productivity decreases by 21.55 percent during 1980-1 to 1990-1. Thus, percapital agricultural output was recprded lowest (Rs. 7711/person). Inspite of weak productivity conditions, the crop intensity is recorded very high (134.75 percent). The cause of low levels of agricultural productivity may be very high intensity and employment of labour input(1.87 person per hectare) and very low level of the use of chemical fertilizer (5.29 kg/ha) which is less than half of the state's level (11.33 kg/ha). However, the percentage share of irrigated area is recorded 6.37 percent, i.e. higher than that of state's average (4.60 percent).

IB. Middle Brahmaputra Valley Region :

This meso-region includes 10 districts of middle Brahmaputra valley region (Fig-5.4) of the state of Assam and has three micro-level regional units, namely : Gauhati surrounding

region (IBI), Nagaon-Golaghat region (IB2) and longitudinal humid region (IB3). The salient features of these micro-level agricultural regions are described as follows :

IB1. Gauhati Surrounding region : It includes only 2 districts of middle Brahmaputra valley region. Climatically, this region is favourable for agricultural development and receives 2078 mm average annual rainfall with high evapo-transpiration (1173 mm) where the value of soil fertility index is recorded 65.45. Because of favourable agro-ecological conditions especially of soil conditions and availability of water, the land productivity level is recorded high (Rs.6096/ha), which is more than that of the state's average while the agricultural output per worker also recorded high (Rs.5232/person). It is important to mention that though this region produces large amount of agricultural products yet, due to some natural havoes like flood the annual agricultural growth rate has been recorded decreased (0.25 percent) during the last decade. More than half (55.07 percent)area recorded under NSA to total geographical area and about 6.0 percent cropped area under irrigation where use of chemical fertilizer is more than 13 kg per hectare. Intensification in agricultural practices is being done by growth of central place of this region, i.e. the Gauhati city,which plays an important role as innovation centre of all these agricultural inputs and diffusing these innovations to it's suffounding area. As a result, a satisfactory intensification of all these agricultural inputs have been recorded in this region. Therefore, it can be suggested that protecting

the annual flood measure, a record growth in agricultural production can be achieved in near future.

IB2. Nagaon- Golaghat Region : This micro-regional unit incorporates 4 districts of central part of middle Brahmaputra valley region where a different physiographic conditions are found due to the existence of hills in surrounding of Nagaon district and mainly in Karbi-Anglong district. Though, Karbi-Anglong district is totally different in its physiographic nature from the other parts of the region, However, it is similar in agricultural characteristics at its ~~st~~ significant level. It can be separated in the lowest order of similarity on the basis of its physiographic condition. In this region, where the conditions are favourable for future agricultural growth, rainfall of 1754 mm is recorded during 1990s when the PE is 1157 mm and soil fertility is recorded as moderate (63.6). In case of production characteristics, this micro region has a prosperous tendencies of future development. In spite of decrease in land land labour productivities during the decade (1980s), from Rs.6096/ha to Rs.5250/ha land productivity and from Rs.8855/person to Rs.7109/person in labour productivity with a very low percentage share of irrigated area (3.37percent only), the significant agricultural growth of about 3.00 percent annually has been recorded during the decade. It may be because of intensive use of chemical fertilizers (15 kg/ha). This region may be identified as 'developing agricultural region' of the state.

IB3. Longitudinal Humid Region : This micro-level region situated in the middle Brahmaputra valley region includes 4 districts, namely, Darang, Sonitpur, Jorhat and Sibsagar where 3 to 4 times repeated flood havoc has been recorded ruing every monsoon season. The fertility of the soil of this region is rich with alluvium. The annual average rainfall is recorded higher (2170 mm) with 1224 mm potential evapo-transpiration when the soil fertility index is also high (69.08). This region is famous for mono-culture cropping pattern where rice is the dominating crop. Due to recurring flood, a negligible percentage of annual growth rate of agricultural output (.73 percent) has been recorded. The seasonal crop failure is a common phenomena here. The land and labour productivities have been recorded Rs. 6361/ha and Rs.4836/person respectively with a decreasing change during the decade. The crop intensity is also low (124.18 percent). However, about 46 percent land is under Net Sown Area to total geographical area. The percentage share of irrigated area is very low (7.03 percent). But the farmers are using chemical fertilizer intensively (14.32 kg per hectare). This longitudinal humid region has a good chance to boost up the agricultural productions after controlling the flood conditions and developing the production and technological characteristics which can be identified as 'agriculturally prosperous region'.

IC. Upper Brahmaputra Valley Region :

This meso-agricultural region includes 4 districts of upper Brahmaputra valley. They are Lakhimpur, Dhemaji in

north of Brahmaputra river and Tinsukia and Dibrugarh districts situated in the south bank of Brahmaputra river. A high average annual rainfall of 3031 mm and high potential evapo-transpiration (1213 mm) with fertile soils of humid conditions (soil fertility index 73.98) have been recorded. This region is agro-ecologically rich for agricultural production where woil is more fertile as tarai soils. In spite of favourable soil and climatic conditions for agricultural development, the land productivity recorded low (Rs.4545/ha) which is lesser than the state average with its decrease at an annual rate of 2.2 percent during 1980-1 to 1990-1. The labour productivity level also low (Rs.3680/person), though it has been increasing at an annual rate of 5.17 percent. In spite of favourable agro-ecological conditions with high intensity of agricultural growth potentials, the level of crop intensity is very low (127.7 percent) with a very less share of NSA to total geographical area (29.8 percent). Because of these weak conditions of agricultural practices the agricultural growth is recorded negative (-1.33 percent) in the last decade. On the other hand, the area under irrigation for this meso-region recorded very low (only 2.02 percent) while the use of chemical fertilizer is recorded 12.25 kg per hectare. On account of relatively bigger average size of operational land holding (2.38) comparing to all other agricultural regions of the state, there are better chances for adoption of seed-fertilizer technology in the agricultural practices. It

is obvious that this agro-ecologically rich meso-level agricultural region where agricultural growth potential is enough to use may accelerated production processes fast through utilising technological packages in the future.

II. Barak Valley Region :

It is the macro-agricultural region of a small areal unit which includes only 4 districts of the Barak Valley, namely, N.C. Hills, Cachar, Hailakandi and Karimganj districts which covers less than 25 percent of the total geographical area of the state. This region has a separate physiographic identity. It is formed by the sedimentation of Barak river, that is called Cachar plain. It is a transitional region surrounded by ranges of hills on three sides and open only towards the west (Bangladesh side) with its socio-cultural diversities. There are two meso-level regions within it. They are :

IIA. Cachari Region : This Cachari region (cachar plain) is most fertile region with alluvial deposits and rich in rice-belt in which 3 districts are included in the similarity basis (N.C.Hills, Cachar and Karimganji districts). A high average annual rainfall of 2850 mm and high potential evapotranspiration of 1546 mm with very high soil fertility index (151.97) indicate a good amount of agricultural growth potential. The favourable agro-ecological conditions are available for proper plant growth. Land and labour productivity recorded

Rs. 2771/ha and Rs.5996/person respectively. Though the land productivity recorded less than that of state's average, yet its decadal change recorded about 98.0 percent which is a positive indicator in agricultural input attributes for the region. Agricultural growth recorded about double (6.0 percent) than state's average (3.35 percent). The area under irrigation recorded 7.36 percent and use of chemical fertilizer to agricultural production is 10.04 kg per hectare. All these favourable climatic as well as production characteristics supports to identify this region as agriculturally ('developed region' of the state.

IIB. Hailakandi Region : It includes only Hailakandi district having more variation in agricultural attributes with developed conditions and stands as unique region of single district. Here the agro-ecological conditions like annual rainfall (3050 mm), potential evapo-transpiration (1350 mm) has been recorded high and soil fertility recorded 66.0. The annual agricultural growth in output recorded 16.40 percent, land and labour productivity has been recorded Rs. 1402/ha and Rs.7956/person respectively during the last decade. Crop intensity is also moderate (116.80 percent) and the use of chemical fertilizer recorded higher (25.12 kg/ha). All these agricultural characteristics indicate that this region as moderately developed region.

In the end, it can be concluded that the regional processes of agricultural development and assimilating tendencies of the districts of Assam are still governed by the physical factors of land. As a result, the boundaries of agricultural regions are confsiding perfectly with the physiographic regions of the state, except Karbi-Anglong district which is the outer part of Meghalaya plateau rather than Assam plains. The influence of physical factors can also be seen on meso-level regional boundaries of agricultural regions. But the socio-cultural and economic factors like the influence of labour migration, food demand of local people, the impact of townships on their surrounding areas can be seen at micro and lowest level of agricultural regions. Thus, these factors are influencing the regional processes of agricultural development at local levels rather than state level.

CHAPTER - VI

CONCLUSION AND SUGGESTIONS

In the present study, the main aspects of agricultural development in Assam is analysed in relation to its regional frame. It is viewed that the regional interpretation of agricultural phenomena for balanced agricultural development and self-sustained growth is required. In the present piece of research, an integrated approach have been adopted for understanding the regional processes of agricultural development. The salient features of agricultural development and its related findings have been concluded here in the following way :

(1) The study area (Assam state) has favourable agro-ecological conditions with high agricultural growth potential for agricultural development on one hand, and it has some physiographic constraints due to to frequent occurence of floods, unhealthy and uncultivable hilly regions on the other hand. On account of these different physiographic conditions, the areal variations in the level of land productivity can be seen. For instance, the upper Assam region is characterised by higher level of land productivity (Above Rs.6000 per hectare) where the index of soil ferility is higher because of availability of alluvial soils. Again low and very low land productivity have been observed in both Brahmaputra as well as Barak valley regions (e.g., Lakhimpur, Dhemaji, Dibrugarh Cachar districts) where recurring floods and other natural

havocs destroy the existing crops repeatedly in a single crop season. Due to these unhealthy and uncertain climatic conditions in the state, the agricultural development processes and their regional forces are weak and areally diversified. Even then these processes are being controlled by the physiographic factors.

(2) As the state's economy is agriculturally dominated ; agriculture alone contributes 56 percent of the state's total income and near about 80 percent work force is engaged in the primary sector, the farming intensity is very low with monocropping patterns. Therefore, there is no diversification in crop-combinations. Entire operations are based on rice-cultivation which is for local consumption. As a result, the secondary and fertiary sectors of economy of the state are weak with concentrated occupational structure. The large amount of workers are engaged in agricultural sector only. Inspite of unlimited supply of labour to the agricultural practices, the agricultural developmental processes are unarticulated in the state because of stagnent conditions of agricultural activities. The agricultural labour productivity (i.e. agricultural output per worker) is recorded very low. While the non-agricultural sectors absorb only 25.5 percent of the total workforce in 1990-1, as 4.0 percent in secondary and 21.5 percent in tertiary sectors.

(3) The agricultural labour productivity is found low because of lack of modern technology and in migration mainly in the

rural areas. The intensity of agricultural workforce was recorded higher than the decadal growth of total population during 1980-1 to 1990-1. Thus the agricultural production processes have been accelerated by the labour intensification rather than the inducement of modern technology.

(4) Inspite of favourable agro-ecological conditions, large size of land holdings and very low ratio of agricultural labourers to cultivator (0.18) in the upper Brahmaputra valley which includes the districtsp namely, Lakhimpur, Dhemeji, Tinsukia, Dibrugarh, the per capita agricultural income is recorded low (Rs.663/person) with very low level of land (Rs.4545/ha) as well as labour productivity (Rs.3680/worker). There is a record decrease in land productivity (22 percent) during 1980-1 to 1990-1 and consequently, agricultural growth is recorded negative (-1.33percent). Therefore, there are the stagnent conditions of agricultural development. The factors of stagnent conditions may be many, but, it may be mainly because of natural floods and havocs.

(5) In Barak valley region per capita income (Rs.1213/person) is medium with high agricultural growth (8.5 percent). In spite of low level of agricultural productivities, the growth is recorded high and it is mainly because of high increase in land as well as labour productivities. Therefore, there is a negative relationship between growth and productivity, but growth is positively related with the changes in land and labour productivity. In this prosperous region of the state,

labour intensity is high (1.53 persons per hectare) with smaller size of land holdings (1.10 hectare per cultivator). Therefore, agricultural labourer-cultivator ratio is recorded very high (1.36). In spite of dominence of labour input in the production processes, this region may produce more agricultural products and may accomodate more labour force in future because of very high intensity of agricultural growth potentials.

(6) It may safely be concluded by establishing the relationship between land productivity and it technological production factors that the use of fertilizer, irrigation and HYV seeds are positively related but insifnificant. It means the high productivity areas are not influenced by irrigation because of humid conditions of the state. Therefore, rainfall is more prominent than irrigation conditions.

(7) The relationship between land and labour productivity is highly and significantly positive. It means that the areas of higher level of land productivity have the higher levels of labour productivity and vice-versa. It indicates that the factors of land productivity are dominent for labour productivity also.

(8) The growth-productivity relationship is weak which reflects the diversified patterns of agricultural growth. It is hypothesized in the present research that this relationship must be negative for balanced agricultural development in its regional

frame. But the hypothesis is rejected, because there is positive relationship between these attributes of agricultural development. In the areas of high productivity, growth proceeds faster on account of higher levels of agricultural production potential which is third important attribute of agricultural development. For the justification of this statement, productivity patterns in relation to agricultural production potentials would be interpreted separately in next section of this chapter.

(9) In the processes of region-formation of agricultural characteristics, it is clear that the physical conditions are influencing directly to the areal homogenity of agricultural activities. As a result, the regional boundaries of agricultural regions are coinciding the physiographic divisions of the state at their meso-level of regional demercations. But this fact is not true for middle Brahmaputra region where the boundaries of physiographic regions are not coinciding at meso-level.

SUGGESTIONS :

In the concluding part of the present chapter, it is found that the agricultural developmental processes are evolving diversified patterns which are very weak in nature and therefore, there is a diversified nature of developmental

attributes. For strengthening the entire system of agricultural production and its micro regional systems, few suggestions which are very much important and would help to integrate the structural components of agricultural systems have been give.

They are as follows :

(1) Indeed, the agricultural production processes accelerated in Assam state are too weak so that they are not able to produce surplus production in the area. Since there is no surplus production, the agro-industrial base of the state would be weak and consequently, the secondary and tertiary sectors are not having the proportionate share of occupational structure. On the other hand, the entire agricultural production processes are stagnent. Undoubtedly, these production processes are labour dominated accelerating through the peasantry system of the farming for the local consumption (Das 1980). However, strong agro-industrial base is required for getting the maximum remuneration to the farmers. Agro-industrial set up would help to shift in the occupational structure also. Thus, at the district head quarters the number of rice mills, flour mills and oil spellers would be established in futre. On the other hand, to strengthen the industrial facilities for agricultural development like fertilizer depots, seed stores, storage facilities should also be established at the rural towns of the state. As a result, there

Table 6.1 : Region-Wise Production Potential Attributes (1990-91)

Agricultural Regions	Average Land Productivity (Y)Rs/ha	Maximum Expected Yield Level (A)Rs/ha	Production Efficiency (Y/A)	Production Potential	
				Magnitude (Rs/ha)	Intensity (in unity (A/Y)
IAI. The Low Land of Lower Brahmaputra valley Region	6157	8842	0.70	2685	1.44
IA2. Kokrajhar Region	3984	4500	0.88	516	1.13
IBI. Gauhati-Surrounding Region	6096	8685	0.70	2589	1.42
IB2. Nagaon-Golaghat Region	4506	5073	0.88	567	1.13
IIB3. Longitudinal Humid Region	6361	7785	0.82	1424	1.22
IC. Upper Brahmaputra Valley Region	4545	8296	0.55	3751	1.83
IIA. Cachar Region	2771	5584	0.50	2813	2.01
IIB. Hailakandi Region	1402	3592	0.40	2190	2.56

Source : Cropwise Max. Expected yield figures are collected from the I.C.A.R., Shillong.

would be a functional change according to agro-industrial set up of the area and it would help to shift the occupational structure from agricultural sector to non-agricultural sector.

(2) So far as the acceleration of decision making processes is concerned, there is a triangular relationship among agricultural attributes, They are :

(i) existing production structure of which land productivity is the main atrribute,

(ii) the agricultural production potential which is related to the level of the maximum expected yield (A), and

(iii) the inpute intensities (X). The relationship among these attributes can be established and the optimisation of the agricultural systems can be suggested.

Table-6.1, reveals that the magnitude of production putential which is difference between existing productivity and potential productivity (A-Y) is recorded highest in upper Brahmaputra valley region while its intensity is highest in Hailakandi region. It means that these two extreme resource intensities of stagnent agricultural regions can be utilised to intensify the technological inputs (Fig-6.1). Thus, use of fertilizer, HYV and pesticides should be made more in these regions.

REGIONWISE LAND PRODUCTIVITY AND
MAXIMUM EXPECTED YIELD LEVELS

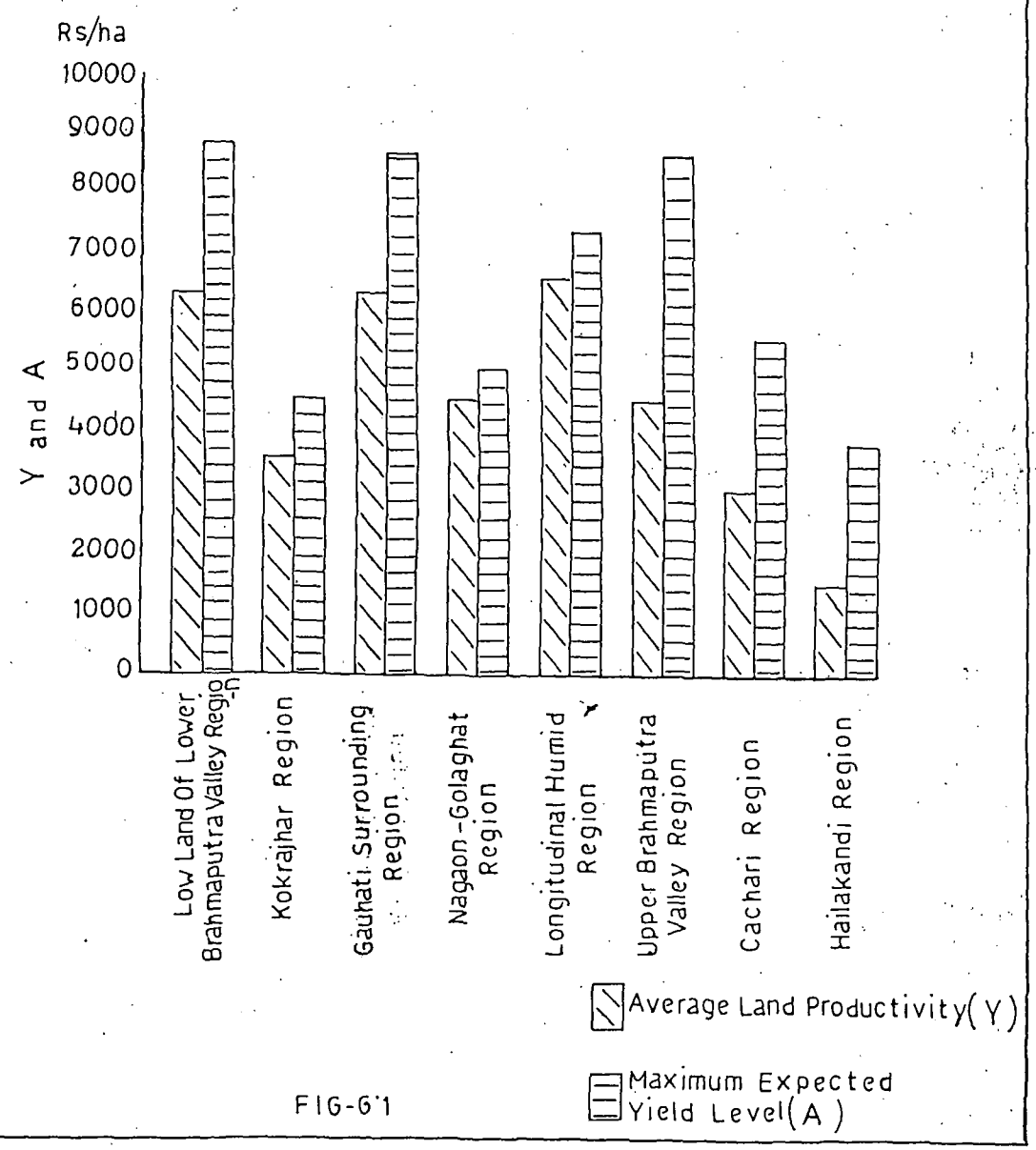


FIG-6.1

(3) The relationship between land productivity and technological input is weak in the agricultural practices in the state. The above suggestion would also help to strengthen this relationship and would increase the rate of agricultural productivity with respect to technological inputs. However, for preparing the proper regional investment strategy for longer period, the agro-ecological conditions should also kept in mind because agricultural regions are properly coinciding the agro-ecological conditions of the state.

(4) The flood control programme must be implemented specially in the flood-prone areas specially in the upper parts of Brahmaputra Region so that the farming intensity and productivity levels can be raised.

(5) There has been a record decrease in productivity and negative growth in agricultural production in the upper Brahmaputra and Barak Valley regions during the last decade (1980-1 to 1990-1). The growth can be increased by changing the cropping patterns of these regions. The cropping patterns are paddy-dominated rather than commercial crops. These areas have favourable agro-ecological conditions for the growth of oil seeds and jute cultivation. Thus, it is suggested that jute and oil seeds should be cultivated in these areas in future so that the agricultural productivity and growth can be increased fast with the optimal patterns of development.

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APPENDIX - I

Districtwise changing crop-patterns in Assam (1980-1 to 1990-1)

Districts		R_A	R_W	R_S	M	W	OCM	T	G	L	P	R_P	LC	S	MR	J	C	S_U	D	P & S_P
1. Kokrajhar	80-1	30.01	52.02	0.18	0.54	1.89	0.32	0.18	0.08	-	-	2.97	0.13	0.56	6.43	3.29	0.01	0.15	-	1.16
	90-1	26.10	53.64	0.31	0.55	1.20	0.04	0.26	0.02	0.73	0.20	0.09	0.39	9.15	5.36	0.01	0.02	0.21	0.76	
	C	-3.91	1.62	0.13	0.01	-0.69	-0.28	0.08	-0.06	-	-	-2.88	0.05	-0.17	2.72	2.07	-	-0.13	-	-0.40
2. Goalpara	80-1	27.28	49.93	1.51	0.15	5.87	0.53	0.20	0.05	-	-	2.97	0.13	0.73	4.80	4.62	0.03	0.16	-	1.03
	90-2	26.86	48.14	5.51	0.18	4.08	0.79	0.32	0.20	0.92	0.58	0.67	0.33	0.55	4.15	4.88	0.01	0.17	0.16	1.07
	C	-0.42	-1.79	4.00	0.03	-1.79	0.26	0.12	0.15	-	-	-2.30	0.20	-0.18	-0.65	0.24	0.007	0.01	-	0.04
3. Bongaigaon	80-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	90-1	28.80	45.67	2.22	0.35	2.47	0.42	0.10	1.83	0.72	0.46	0.36	0.24	0.59	9.67	4.00	0.01	0.17	0.15	1.68
	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
4. Dhubri	80-1	34.50	32.84	2.27	0.03	5.92	0.68	0.29	0.27	-	-	3.54	0.03	0.25	5.46	11.50	0.002	0.06	-	2.24
	90-1	28.60	29.90	4.70	0.14	7.07	1.67	0.10	0.06	0.67	0.42	0.61	0.38	0.75	7.45	12.18	0.003	0.06	0.34	3.75
	C	-5.90	-2.94	2.43	0.11	1.15	0.99	-0.19	-0.21	-	-	-2.93	0.35	0.50	1.99	0.68	0.001	-	-	1.51
5. Barpeta	80-1	31.04	35.75	0.33	0.17	5.17	1.50	0.11	0.37	-	-	6.16	0.97	0.23	9.40	6.20	0.01	0.22	-	2.27
	90-1	30.57	40.69	3.08	0.01	4.13	1.08	0.07	0.12	1.38	1.32	1.08	0.92	0.51	9.29	3.32	0.001	0.10	0.43	3.56
	C	0.47	4.94	2.75	-0.16	-1.05	-0.42	-0.04	-0.25	-	-	-5.08	-0.05	0.28	-0.11	-2.88	-0.009	-0.12	-	1.29
6. Nalbari	80-1	32.91	48.43	0.51	0.18	3.19	0.07	0.33	0.02	-	-	2.56	0.86	0.44	5.87	2.11	0.01	0.77	-	1.64
	90-1	21.61	58.20	0.75	0.05	1.45	0.09	0.33	0.09	1.21	1.25	0.50	0.84	0.50	7.66	1.91	0.02	0.38	0.02	2.21
	C	-11.30	9.77	0.24	-0.13	-1.74	0.02	-	0.07	-	-	-2.06	-0.02	0.06	1.79	-0.20	0.01	-0.39	-	0.57
7. Kamrup	80-1	27.67	47.32	3.02	0.15	5.67	0.32	0.21	0.24	-	-	3.95	0.67	0.54	4.19	4.12	0.05	0.78	-	1.04
	90-1	16.26	55.83	6.17	0.20	3.02	0.08	0.18	0.15	1.07	1.33	0.29	0.48	0.83	6.53	3.02	0.05	0.40	0.21	3.34
	C	-11.41	8.51	3.15	0.05	-2.65	-0.24	-0.03	-0.09	-	-	-3.66	-0.19	0.29	2.34	-1.10	-	-0.38	-	2.30
8. Nagaon	80-1	13.08	55.41	1.72	0.26	3.39	0.04	0.31	0.07	-	-	4.17	0.08	0.49	9.84	6.67	0.08	3.09	-	1.21
	90-1	17.88	42.77	12.82	0.18	3.62	0.03	0.76	0.04	0.75	1.77	0.19	0.18	0.32	7.90	4.38	0.03	2.87	0.21	2.16
	C	4.80	-12.64	11.10	-0.08	0.23	-0.01	0.45	-0.03	-	-	-3.98	0.10	-0.17	-1.94	-2.29	-0.05	-0.22	-	0.95
9. Morigaon	80-1	17.82	45.77	6.40	0.11	5.50	0.36	0.27	0.21	-	-	6.15	0.16	0.59	7.32	7.77	0.01	0.77	-	0.71
	90-1	18.58	39.85	16.60	0.02	6.21	0.19	0.04	0.11	0.66	1.84	0.25	0.29	0.34	8.23	5.13	0.01	0.35	0.20	0.44
	C	0.76	-5.92	10.20	-0.09	0.71	-0.17	-0.23	-0.10	-	-	-5.90	0.13	-0.25	0.91	-2.64	-	-0.42	-	-0.27
10. Darrang	80-1	24.60	45.76	0.14	0.25	3.93	0.17	0.34	0.17	-	-	4.23	0.27	0.42	9.84	6.39	0.12	0.73	-	2.55
	90-1	27.04	44.19	0.60	0.26	1.99	0.23	0.20	0.17	0.61	0.97	0.57	0.30	0.31	14.63	4.18	0.04	0.45	0.18	2.17
	C	2.44	-1.57	0.46	0.01	-1.94	0.06	-0.14	0.00	-	-	-3.66	0.03	-0.09	4.79	-2.21	-0.08	-0.28	-	-0.38

11. Sonitpur	80-1	12.09	63.51	0.27	0.47	5.40	0.03	0.33	0.21	-	-	4.00	0.04	0.25	5.44	3.60	0.02	1.98	-	2.29
	90-1	14.48	64.73	1.32	0.42	1.89	0.005	0.09	0.13	0.29	1.32	0.12	0.15	0.46	8.62	1.53	0.01	0.69	0.16	2.59
	C	2.39	1.22	1.05	-0.05	-3.51	-0.025	-0.24	-0.08	-	-	-3.88	0.11	0.21	3.18	-2.07	-0.01	-1.29	-	0.30
12. Lakhimpur	80-1	15.84	62.55	0.15	0.25	3.53	0.17	0.07	0.01	-	-	4.22	0.23	0.30	7.56	1.96	0.08	0.80	-	2.22
	90-1	16.01	62.75	0.32	0.19	0.69	0.01	0.03	0.84	0.05	1.01	0.05	0.15	0.22	14.79	0.47	0.02	0.29	0.08	1.93
	C	0.17	0.30	0.17	-0.06	-2.84	-0.16	-0.04	0.83	-	-	-4.17	-0.08	-0.08	7.23	-1.49	-0.06	-0.51	-	-0.29
13. Dhemaji	80-1	10.60	58.03	0.25	0.52	1.24	0.51	0.13	0.03	-	-	4.69	0.42	0.49	19.44	0.25	0.14	0.97	-	2.20
	90-1	16.62	60.76	0.08	0.64	0.61	0.04	0.05	0.01	0.04	1.04	0.01	0.14	0.11	17.13	0.22	0.02	0.06	0.15	1.73
	C	6.02	2.73	-0.17	0.12	-0.63	-0.47	-0.08	-0.02	-	-	4.68	-0.28	-0.38	-2.31	-0.03	-0.12	-0.19	-	-0.47
14. Jorhat	80-1	13.68	67.40	0.008	0.09	2.85	-	0.06	-	-	-	5.42	0.07	0.05	7.38	0.32	0.03	1.48	-	0.99
	90-1	13.61	68.31	0.07	0.02	1.49	0.009	0.01	0.34	0.08	2.92	0.03	0.02	0.08	10.04	0.12	0.003	0.50	0.16	2.11
	C	-0.07	0.91	-0.062	-0.07	-1.36	-	-0.05	-	-	-	-5.39	-0.05	0.03	2.66	-0.20	-0.027	-0.98	-	1.12
15. Golaghat	80-1	7.88	65.81	0.01	0.12	2.12	-	0.08	0.04	-	-	1.63	0.02	0.16	9.33	2.28	0.08	9.28	-	1.11
	90-1	15.22	58.13	0.08	0.36	1.08	0.03	0.05	0.02	0.09	1.24	0.22	0.04	0.22	10.99	0.99	0.01	9.28	0.07	1.44
	C	7.34	-7.68	0.07	0.24	-1.04	-	-0.03	-0.02	-	-	-1.41	0.02	0.06	1.66	-1.29	-0.07	0.00	-	0.33
16. Sibsagar	80-1	3.52	90.16	0.12	0.05	1.04	-	0.01	0.004	-	-	1.04	0.02	0.05	2.33	0.18	0.02	0.76	-	0.62
	90-1	5.69	87.00	0.13	0.06	0.29	-	0.01	0.008	0.01	0.42	-	0.04	0.05	4.26	10.06	0.008	0.22	0.05	1.29
	C	2.17	-3.16	0.01	0.01	-0.75	-	0.00	0.004	-	-	-	0.02	0.00	0.93	9.88	-0.012	-0.54	-	0.67
17. Dibrugarh	80-1	11.03	70.75	0.009	0.75	4.37	-	0.10	0.004	-	-	4.74	0.009	0.09	6.15	0.08	0.009	0.64	-	1.23
	90-1	11.46	72.84	0.13	0.46	0.84	0.25	0.04	0.01	0.03	1.14	0.08	0.03	0.20	8.92	0.04	0.04	0.63	0.08	1.51
	C	0.43	2.09	0.121	-0.49	-3.53	-	-0.06	0.006	-	-	-4.66	-0.021	0.11	2.77	-0.04	0.031	-0.01	-	0.28
18. Tinsukia	80-1	6.36	57.16	0.01	4.56	3.18	0.02	0.15	0.02	-	-	3.17	0.02	0.28	14.70	0.05	0.01	4.86	-	5.37
	90-1	9.14	73.73	0.09	1.44	0.25	0.20	0.02	0.57	0.01	0.67	0.05	0.01	0.12	10.82	0.04	0.002	0.76	0.12	1.78
	C	2.78	16.57	0.08	-3.12	-2.93	0.18	-0.13	0.55	-	-	-3.12	-0.01	-0.16	-3.88	-0.01	-0.008	-4.10	-	-3.59
19. Cachar	80-1	17.50	72.79	3.70	0.09	0.09	0.03	0.04	0.01	-	-	0.83	0.14	0.06	0.82	0.36	0.10	1.29	-	1.24
	90-1	13.63	75.63	5.88	0.04	0.09	0.01	0.02	0.02	0.001	0.26	0.29	0.02	0.10	2.12	0.05	0.02	0.33	0.06	1.30
	C	-3.87	2.94	2.18	-0.05	0.00	-0.02	-0.02	0.01	-	-	-0.54	-0.12	0.04	1.30	-0.31	-0.08	-0.96	-	0.06
20. Hailakandi	80-1	22.19	70.17	1.51	0.002	0.20	0.05	0.09	0.04	-	-	0.62	0.06	0.15	0.96	0.28	0.08	1.82	-	1.65
	90-1	14.32	74.90	1.71	0.04	0.07	0.008	0.08	0.008	0.008	0.98	1.02	0.03	0.09	2.75	0.20	0.12	0.43	0.22	2.88
	C	-7.87	4.74	0.20	0.039	-0.13	-0.042	-0.01	0.032	-	-	0.40	-0.03	-0.06	1.79	-0.08	0.04	-1.39	-	1.23

21. Karimganj	80-1	25.51	63.43	3.51	0.03	0.17	0.006	0.02	0.01	-	-	0.35	0.008	0.03	0.47	0.13	0.04	5.21	-	1.00
	90-1	16.56	68.64	8.18	0.11	0.05	0.02	0.02	0.003	0.008	0.36	0.44	0.09	0.05	1.04	0.10	0.04	2.77	0.04	1.30
	C	-8.95	5.21	4.67	0.08	-0.12	0.014	0.00	-0.007	-	-	0.09	0.082	0.02	0.57	-0.03	0.00	-2.44	-	0.30
22. K.Anglong	80-1	10.37	61.79	0.08	8.05	0.11	0.76	0.68	0.34	-	-	0.76	0.26	1.36	8.83	2.09	1.18	3.41	-	0.60
	90-1	6.83	66.34	0.14	6.60	1.22	0.13	0.52	0.33	0.12	0.22	0.20	0.35	1.34	10.00	1.25	0.42	2.38	0.10	0.69
	C	-3.54	4.55	0.06	-1.45	1.11	-0.63	-0.16	-0.01	-	-	-0.56	0.09	-0.02	1.17	-0.84	-0.76	-1.03	-	0.09
23. N.C.Hills	80-1	36.50	38.35	0.05	3.47	0.06	0.28	0.37	0.12	-	-	1.50	0.63	1.85	7.68	0.57	6.92	1.09	-	0.51
	90-1	30.51	37.04	0.21	6.24	0.27	0.25	1.00	0.12	0.06	0.46	0.14	0.47	2.11	10.30	0.56	3.29	4.19	0.03	1.58
	C	-5.99	-1.31	0.16	2.77	0.21	-0.03	0.63	0.00	-	-	-1.38	-0.16	0.36	2.70	-0.01	-3.63	3.10	-	1.07
Assam	80-1	20.43	55.10	1.16	0.76	3.39	0.32	0.22	0.12	-	-	3.46	0.27	0.40	7.18	3.78	-	1.62	-	1.61
	90-1	18.53	54.24	3.65	0.58	2.38	0.31	0.20	0.08	-	-	1.98	0.30	0.43	8.89	2.92	-	1.09	-	1.96
	C	-1.90	-0.86	2.49	-0.18	-1.01	-0.01	-0.02	-0.04	-	-	-1.48	0.03	0.03	1.71	-0.86	-	-0.53	-	0.35

Abbreviation: C = Changes in Percentage, RA = Autumn Rice, RW = Winter Rice, RS = Summer Rice, M = Maize,W = Wheat,OCM = Other Cereals and Millets, T = Tur, G = Gra
L = Lentil, P = Pea, RP = Rabi Pulses, LC = Linseed and Custers, S = Seasum, MR = Rapseed and Mustard, J = Jute, C = Cotton, SU = Sugarcane, O = Onio
P&SP = Potato & Sweet Potato,

APPENDIX - II

Districtwise changes in crop-yields in Assam (1980-1 to 1990-1) (yield in Kg/ha)

Districts		R_A	R_W	R_S	M	W	OCM	T	G	L	P	R_P	LC	S	MR	J	C	S_U	O	P & S_P
1. Kokrajhar	80-1	716	1013	1091	510	1132	450	680	500	-	-	370	980	675	380	1240	70	52600	-	14483
	90-1	617	1039	911	507	1695	600	627	1315	502	377	479	1062	605	421	1755	72	51180	2425	13232
	d	-13.82	2.57	-16.50	-0.59	49.73	33.33	-7.79	163.0	-	-	2.43	8.37	-10.37	10.79	41.53	2.86	-2.70	-	-8.64
2. Goalpara	80-1	811	990	1264	510	1203	350	720	425	-	-	336	775	450	434	1366	80	34650	-	9216
	90-1	834	1422	1825	574	1930	450	855	1199	411	360	360	560	440	583	1383	80	54850	1975	10486
	d	2.84	43.64	44.38	12.55	60.43	28.57	18.75	182.12	-	-	7.14	0.65	-2.22	34.33	1.44	0.0	58.30	-	13.78
3. Bongaigaon	80-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	90-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Dhubri	80-1	569	885	914	600	949	500	750	600	-	-	463	955	485	459	1589	70	2860	-	11665
	90-1	448	1270	1197	647	1554	550	709	1369	459	389	404	938	485	425	1633	70	45193	2353	10509
	d	-21.26	43.50	30.96	7.83	63.75	10.00	-5.46	128.16	-	-	-12.74	-1.78	0.0	-7.40	2.76	0.0	57.57	-	-9.90
5. Barpeta	80-1	718	706	950	600	984	540	750	450	-	-	394	800	550	327	1487	80	29450	-	9000
	90-1	538	1130	1845	600	1186	575	807	1304	525	625	474	1027	600	476	1339	75	40485	1350	13762
	d	-25.06	60.05	94.21	0.0	20.52	6.48	7.60	189.77	-	-	20.30	28.37	9.09	45.56	-9.95	-6.25	37.47	-	52.91
6. Nalbari	80-1	728	961	1230	650	1191	550	760	400	-	-	314	720	510	319	2172	80	30543	-	7745
	90-1	889	1216	1038	652	1355	322	525	1409	475	650	414	1075	536	624	1528	70	40485	680	11768
	d	22.11	26.53	-15.60	0.30	13.76	-41.45	-30.92	252.25	-	-	31.84	49.31	5.09	95.61	-29.65	-12.50	32.5	-	51.94
7. Kamrup	80-1	842	987	1298	610	1270	500	800	500	-	-	448	850	400	290	1146	80	28138	-	8923
	90-1	757	1113	1694	612	1577	325	800	1261	407	482	400	770	407	548	1556	80	39843	1011	9449
	d	-10.09	12.77	107.55	0.33	24.17	-37.0	0.0	152.2	-	-	-10.71	-9.41	1.75	88.97	35.78	0.0	41.60	-	5.89
8. Nagaon	80-1	672	1217	1473	510	1363	450	700	400	-	-	294	850	500	141	1366	70	27838	-	6581
	90-1	1109	1454	1694	483	1235	430	667	1337	340	313	346	850	450	602	1750	70	36870	1333	9550
	d	65.03	19.47	33.07	-5.29	-9.39	-4.44	-4.71	234.25	-	-	17.69	0.0	-10.0	326.95	28.11	0.0	32.44	-	45.11
9. Morigaon	80-1	641	994	1382	540	1055	450	750	410	-	-	414	800	450	395	1426	75	28431	-	6444
	90-1	374	1326	1981	537	1055	445	684	1195	403	330	403	806	467	444	1615	75	39061	2270	8836
	d	-41.65	33.40	43.34	-0.55	0.0	-1.11	-8.80	191.46	-	-	-2.65	0.75	3.77	12.40	13.25	0.0	37.38	-	37.11
10. Darrang	80-1	760	1098	1319	630	1259	400	760	540	-	-	453	1000	400	539	1282	70	35179	-	8501
	90-1	834	1226	893	622	1040	534	628	1461	560	450	479	896	614	530	1282	73	29886	2436	5853
	d	9.74	11.66	-32.3	-1.27	-17.39	33.5	-17.37	170.55	-	-	5.74	-10.4	53.5	-1.67	0.0	4.29	15.05	-	-31.15

11. Sonitpur	80-1	727	944	1283	560	1152	450	690	500	-	-	388	910	450	803	1670	75	45288	-	10160
	90-1	922	1384	1201	556	1268	400	740	1440	394	423	436	1042	523	440	1674	75	33864	3150	10461
	d	26.82	46.61	-6.39	-0.71	10.06	-11.11	7.24	188.0	-	-	12.27	14.5	16.22	-45.2	0.23	0.0	-25.22	-	2.96
12. Lakhimpur	80-1	831	1436	1269	600	1193	560	720	400	-	-	392	440	480	867	1463	75	29247	-	8999
	90-1	786	1392	1684	580	851	560	709	1211	453	410	441	798	375	444	1920	73	41157	2580	7813
	d	-5.42	-3.06	32.7	-3.33	-28.66	0.0	-1.83	202.75	-	-	12.5	81.36	-21.88	-48.79	-31.24	-2.67	40.72	-	13.18
13. Dhemaji	80-1	719	1381	1269	560	1158	510	700	480	-	-	479	850	350	660	1463	70	29840	-	10971
	90-1	617	1126	1620	556	1197	502	722	1159	561	404	408	855	262	534	1584	72	35166	2636	11154
	d	-14.18	-18.46	27.65	-0.71	3.37	-1.56	3.14	141.45	-	-	-14.82	0.58	-25.14	-19.09	8.27	2.87	17.84	-	1.66
14. Jorhat	80-1	1106	1664	1269	500	1387	-	650	-	-	-	446	380	450	879	1463	65	46560	-	9901
	90-1	1227	1973	1620	501	1637	526	650	1427	475	346	408	380	446	978	1584	67	35667	2139	12229
	d	10.94	18.56	27.65	0.20	18.02	-	0.0	-	-	-	-8.52	0.0	-0.88	11.26	8.27	3.07	-23.39	-	23.51
15. Golaghat	80-1	823	1446	1269	530	899	-	670	400	-	-	396	700	480	557	1463	70	35905	-	7512
	90-1	832	1747	1620	539	1312	472	680	1472	547	378	419	400	485	726	1192	72	35409	3167	10818
	d	1.09	20.81	27.65	1.69	45.93	-	1.49	268.0	-	-	5.80	-42.85	1.04	30.34	-18.52	2.85	-1.38	-	44.0
16. Sibsagar	80-1	1156	1335	1269	500	1152	-	650	380	-	-	378	680	380	640	1468	70	33908	-	7880
	90-1	1555	1959	1620	510	962	-	621	1380	350	372	-	810	408	794	1584	70	40747	1978	11032
	d	34.42	46.74	27.65	2.00	-16.49	-	-4.46	263.16	-	-	-	19.12	7.37	24.06	7.90	0.0	20.17	-	40.0
17. Dibrugarh	80-1	1144	1412	1269	510	1158	-	700	480	-	-	367	400	410	560	1463	80	30297	-	8794
	90-1	1316	1627	1620	536	1102	500	704	1299	446	324	400	764	514	493	1584	73	24692	1733	10273
	d	15.03	15.23	27.66	5.09	-4.84	-	0.57	170.63	-	-	8.99	91.0	25.37	-11.96	8.27	-8.75	-18.5	-	16.82
18. Tinsukia	80-1	809	1379	1269	510	1261	500	710	470	-	-	426	500	475	632	1463	70	35483	-	7110
	90-1	1411	1446	1620	685	1248	500	742	820	360	358	364	835	468	525	1584	70	41896	1950	9934
	d	74.41	4.85	27.65	34.31	-1.03	0.0	4.50	74.46	-	-	-14.55	67.0	-1.47	-16.93	8.27	0.0	18.07	-	39.71
19. Cachar	80-1	1420	1379	1495	500	1158	560	710	460	-	-	366	450	360	386	1463	70	28770	-	9495
	90-1	1605	1743	1359	490	1351	466	704	1641	459	459	450	467	442	622	1084	63	28514	2254	9527
	d	13.03	26.4	-9.09	-2.0	16.67	-16.79	-0.85	256.74	-	-	22.95	3.78	22.78	0.02	-25.91	-10.0	-0.89	-	0.34
20. Hailakandi	80-1	1707	1443	1281	400	1158	500	700	460	-	-	345	425	400	509	1463	65	42000	-	9829
	90-1	1682	1588	1247	395	1351	497	700	1487	449	279	344	830	400	365	1584	65	51059	1213	6041
	d	-1.46	9.89	-2.65	-1.25	16.66	-0.06	0.0	223.26	-	-	-0.29	95.29	0.0	-28.29	8.27	0.0	21.56	-	-38.53

21. Karimganj	80-1	1839	1590	1238	550	1158	500	700	450	-	-	366	420	350	996	1463	72	47211	-	11573
	90-1	1622	1658	1082	559	1351	542	695	962	355	324	380	404	465	386	1584	71	29449	3083	8978
	d	-11.79	4.27	-12.6	1.63	16.66	8.40	-0.71	113.77	-	-	3.82	-3.81	32.85	-61.24	8.27	-1.38	-37.62	-	-22.42
22. K.Anglong	80-1	1273	1832	1269	640	361	385	629	400	-	-	385	778	487	520	1780	80	39267	-	8853
	90-1	1028	1370	1620	682	1384	321	645	1129	337	377	450	850	485	846	1861	79	51271	1770	11225
	d	-19.24	-25.21	27.65	6.56	283.38	-16.62	2.54	182.25	-	-	16.88	9.25	-0.41	62.69	4.55	-1.25	30.57	-	26.79
23. N.C.Hills	80-1	1064	1664	1269	650	640	406	800	400	-	-	406	980	500	481	1463	85	35833	-	10653
	90-1	1185	1603	1620	653	1351	459	800	1120	395	530	477	965	507	281	1584	85	36375	1450	12437
	d	11.37	-3.66	27.65	0.46	111.09	13.05	0.0	180.0	-	-	17.48	-1.53	1.40	-41.58	8.27	0.0	1.51	-	16.41
Assam	80-1	21075	27503	27439	12170	24241	8561	15699	9505	-	-	8626	15643	9992	11774	32617	1622	775118	-	204288
	90-1	22188	31812	32611	124676	28992	9976	16274	28397	-	-	8736	17404	10384	12087	34244	1678	863119	-	225066
	d	5.28	15.66	18.84	2.51	19.59	16.52	3.66	198.75	-	-	1.27	11.25	13.93	2.65	4.98	3.45	11.35	-	10.17

Source: Basic Agricultural statistics..1980-1 & 1990-1, statistical wing, Directorate of Agriculture, Assam.

Abbreviation: d = Changes in Percentage, RA = Autumn Rice, RW = Winter Rice, RS = Summer Rice, M = Maize,W = Wheat,OCM = Other Cereals and Millets, T = Tur, G = Gram, L = Lentil, P = Pea, RP = Rabi Pulses, LC = Linseed and Custers, S = Seasum, MR = Rapseed and Mustard, J = Jute, C = Cotton, SU = Sugarcane, O = Onion, P&SP = Potato & Sweet Potato,

APPENDIX - III

Districtwise Growth ratio of Crop-Areas and Crop-yields in Assam (1980-1 to 1990-1)

Districts		R_A	R_W	R_S	M	W	OCM	T	G	L	P	R_P	LC	S	MR	J	C	S_U	O	P & S_P
1. Kokrajhar	A	0.73	0.86	1.44	0.86	0.53	0.11	1.18	0.25	-	-	0.03	1.16	0.59	1.19	1.36	0.85	0.14	-	0.55
	Y	0.86	1.03	0.84	0.99	1.50	1.33	0.92	0.93	-	-	1.29	1.08	0.90	1.11	1.42	1.03	0.97	-	0.91
2. Goalpara	A	27.28	49.93	1.51	0.15	5.87	0.53	0.20	0.05	-	-	2.97	0.13	0.73	4.80	4.62	0.03	0.16	-	1.03
	Y	26.86	48.14	5.51	0.18	4.08	0.79	0.32	0.20	0.92	0.58	0.67	0.33	0.55	4.15	4.88	0.01	0.17	0.16	1.07
3. Bongaigaon	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
4. Dhubri	A	0.94	1.03	2.41	5.03	1.39	2.85	0.42	0.23	-	-	0.20	5.67	3.40	1.59	1.24	1.40	1.16	-	1.89
	Y	0.79	1.44	1.31	1.08	1.64	1.10	0.95	1.00	-	-	0.87	0.98	1.00	0.93	1.03	1.00	1.56	-	0.90
5. Barpeta	A	1.25	1.47	11.97	0.13	1.04	0.94	0.76	0.40	-	-	0.23	1.23	2.86	1.28	0.69	0.17	0.62	-	2.03
	Y	0.75	1.60	1.94	1.00	1.21	1.06	1.08	1.04	-	-	1.20	1.28	1.09	1.46	0.90	0.94	1.37	-	1.53
6. Nalbari	A	0.55	1.01	1.23	0.26	0.38	1.19	0.83	2.95	-	-	0.17	0.82	0.97	1.10	0.76	1.00	0.42	-	1.14
	Y	1.22	1.27	0.84	1.00	1.34	0.59	0.69	1.07	-	-	1.32	1.49	1.05	1.96	0.70	0.88	1.33	-	1.52
7. Kamrup	A	0.65	1.30	2.30	1.52	0.59	0.31	0.96	0.68	-	-	0.08	0.81	1.74	1.75	0.82	1.15	0.58	-	3.61
	Y	0.90	1.13	1.31	1.00	1.24	0.65	1.00	1.00	-	-	0.89	0.91	1.01	1.89	1.36	1.00	1.42	-	1.06
8. Nagaon	A	1.71	0.97	9.40	0.87	1.34	0.99	3.00	1.54	-	-	0.06	2.62	0.81	1.00	0.82	0.53	1.16	-	2.24
	Y	1.65	1.19	1.33	0.95	0.91	0.96	0.95	1.05	-	-	1.18	1.00	0.90	4.27	1.28	1.00	1.32	-	1.45
9. Morigaon	A	1.11	0.92	2.75	0.22	1.20	0.56	0.19	0.54	-	-	0.04	1.89	0.62	1.19	0.70	1.20	0.48	-	0.66
	Y	0.58	1.33	1.43	0.99	1.00	0.99	0.91	1.09	-	-	0.97	1.00	1.04	1.12	1.13	1.00	1.37	-	1.37
10. Darrang	A	1.25	1.08	4.66	1.16	0.57	1.49	1.67	1.04	-	-	0.15	1.28	0.84	1.66	0.74	0.46	0.70	-	0.96
	Y	1.10	1.12	0.66	0.99	0.83	1.34	0.83	0.98	-	-	1.06	0.90	1.54	0.98	1.00	1.04	0.85	-	0.69
11. Sonitpur	A	1.32	1.12	5.35	0.97	0.54	0.20	0.30	0.70	-	-	0.04	4.02	2.03	1.75	0.47	0.63	0.39	-	1.42
	Y	1.27	1.47	0.94	0.99	1.10	0.89	1.07	1.20	-	-	1.12	1.15	1.16	0.55	1.00	1.00	0.75	-	1.03
12. Lakhimpur	A	1.59	1.58	3.35	1.20	0.31	0.18	0.78	1.40	-	-	0.02	1.00	1.19	3.08	0.38	0.43	0.57	-	1.38
	Y	0.95	0.97	1.33	0.97	0.71	1.00	0.98	1.02	-	-	1.13	1.81	0.78	0.51	1.31	0.97	1.41	-	0.87

13. Dhemaji	A	1.76	1.17	0.36	1.40	0.55	0.09	0.42	0.40	-	-	0.03	0.40	0.26	0.99	0.98	0.16	0.07	-	0.88
	Y	0.86	0.82	1.28	0.99	1.03	0.98	1.03	0.86	-	-	0.85	1.00	0.75	0.81	1.08	1.03	1.18	-	1.02
14. Jorhat	A	1.14	1.16	9.60	0.37	0.60	0.03	0.34	-	-	-	0.01	0.42	1.77	1.56	0.33	0.13	0.39	-	2.42
	Y	1.11	1.19	1.28	1.00	1.18	1.17	1.00	-	-	-	0.91	1.00	0.99	1.11	1.08	1.03	0.77	-	1.24
15. Golaghat	A	2.43	1.11	11.10	3.74	0.65	-	0.84	0.67	-	-	0.17	1.89	1.74	1.48	0.50	0.23	1.26	-	1.63
	Y	1.01	1.21	1.28	1.02	1.46	-	1.01	1.06	-	-	1.06	0.57	1.01	1.30	0.81	1.03	0.99	-	1.44
16. Sibsagar	A	1.53	0.92	1.07	1.14	0.27	-	0.71	2.00	-	-	-	1.37	0.83	1.73	0.36	0.33	0.28	-	1.98
	Y	1.35	1.47	1.28	1.02	0.84	-	0.96	0.08	-	-	-	1.19	1.07	1.24	1.08	1.00	1.20	-	1.40
17. Dibrugarh	A	0.99	0.98	13.40	0.59	1.18	-	0.41	0.60	-	-	0.01	3.10	2.04	1.39	0.53	4.10	0.94	-	1.18
	Y	1.15	1.15	0.99	1.05	0.95	-	1.00	0.98	-	-	1.09	1.91	1.25	1.88	1.08	0.91	0.81	-	1.17
18. Tinsukia	A	1.38	1.24	8.10	0.30	0.08	6.88	0.58	19.28	-	-	0.01	0.65	0.42	0.71	0.80	0.13	0.15	-	0.32
	Y	1.74	1.05	1.28	1.34	0.99	1.00	1.05	1.74	-	-	0.85	1.67	0.98	0.83	1.08	1.00	1.18	-	1.40
19. Cachar	A	0.79	1.05	1.60	0.51	1.00	0.34	0.54	1.45	-	-	0.36	0.19	1.60	2.58	0.15	0.27	0.26	-	1.06
	Y	1.13	1.26	0.91	0.98	1.17	0.83	0.99	0.94	-	-	1.36	1.04	1.23	1.61	0.74	0.90	0.99	-	1.00
20. Hailakandi	A	0.58	0.95	1.01	0.21	0.37	0.11	0.80	0.16	-	-	1.48	0.51	0.59	2.56	0.63	0.55	0.21	-	1.57
	Y	0.99	1.10	0.97	0.78	1.17	0.89	0.99	0.94	-	-	1.00	1.95	1.00	0.72	1.08	1.00	1.22	-	0.61
21. Karimganj	A	0.69	1.16	2.48	4.08	0.31	3.80	1.25	0.20	-	-	1.33	16.00	1.60	2.33	0.86	0.88	0.57	-	1.40
	Y	0.88	1.04	0.87	1.01	1.17	1.08	0.99	0.95	-	-	1.03	0.96	1.33	0.39	1.08	0.99	0.62	-	0.78
22. K.Anglong	A	0.74	1.21	1.80	0.93	11.85	0.19	0.86	1.09	-	-	0.30	1.53	1.11	1.28	0.68	0.40	0.79	-	1.29
	Y	0.81	0.75	1.28	1.06	3.83	0.83	1.03	0.02	-	-	1.17	1.09	1.00	1.63	1.05	0.99	1.31	-	1.27
23. N.C.Hills	A	0.98	1.13	4.40	2.18	1.14	0.20	3.23	1.10	-	-	0.10	0.91	1.38	1.63	1.17	0.57	4.61	-	3.67
	Y	1.11	0.96	1.28	1.00	2.11	1.13	1.00	0.78	-	-	1.17	0.98	1.01	0.58	1.08	1.00	1.01	-	1.17
Assam	A	1.01	1.10	3.58	0.86	0.79	1.09	1.04	0.76	-	-	0.64	1.23	1.23	1.40	0.57	0.50	0.76	-	1.20
	Y	0.91	1.17	1.35	1.19	1.23	1.42	0.99	1.00	-	-	1.13	1.27	1.13	1.09	1.14	1.12	0.92	-	1.09

Abbreviation: C = Changes in Percentage, RA = Autumn Rice, RW = Winter Rice, RS = Summer Rice, M = Maize, W = Wheat, OCM = Other Cereals and Millets, T = Tur, G = Gram, L = Lentil, P = Pea, RP = Rabi Pulses, LC = Linseed and Castors, S = Seasum, MR = Rapseed and Mustard, Je = Jute, C = Cotton, SU = Sugarcane, O = Onion, P&SP = Potato & Sweet Potato,

A = Crop - Area, Y = Crop - Yield.