

ECOLOGICAL FACTORS AND PRODUCTIVITY OF TEA : A CASE STUDY OF SONITPUR DISTRICT, ASSAM

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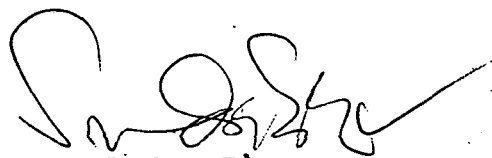
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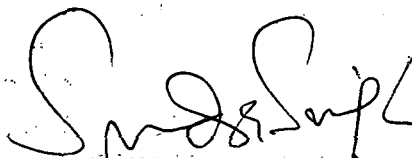
C E R T I F I C A T E

This is to certify that the Dissertation entitled, "ECOLOGICAL FACTORS AND PRODUCTIVITY OF TEA : A CASE STUDY OF SONITPUR DISTRICT, ASSAM" submitted by Bimal Barah for the degree of Master of Philosophy at the Department of Geography, School of Environmental Sciences, North-Eastern Hill University, Shillong is a bonafied study of the author to the best of my knowledge and belief.

The study may now be placed before the examiner for evaluation.

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B. Barah

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CHAPTER I

INTRODUCTION

CHAPTER I**INTRODUCTION:**

In the world of ever increasing population along with the increasing demands on various goods, productivity is the only alternative solution to mitigate the increasing demands. This is a high time for all in different spheres, either in agriculture or in industry to produce more and more output from less and less inputs. Tea is also not an exception in this regard for the demands on tea in the world have been increasing at a rate of 4-5 percent every year. Such an accelerating demand on tea is basically due to the locational specific nature of the tea crop which consequently leads to its confinement in some tropical countries like India, Srilanka, Kenya, etc. The rest of the world is highly dependent on the cultivation and production of these tea producing countries. The challenges for these countries are more, because they have to meet both internal and international demands. It is, therefore, urgent for all tea producing countries including India to enhance the current productivity level so that a balance can be maintained between the demands and supply of tea.

STATEMENT OF THE PROBLEM:

Tea is one of the labour intensive plantation crops and most well-organised in the field of agriculture. It is a great source of employment as well as a convenient base for earning foreign exchange. Its reputation being the 'biggest employer of women workers in India', with equal pay for equal works is another

significant aspect of tea (Bhuyan 1989, pp.25-31). In the international perspective, India continues to be the World's largest producer and exporter of tea. During the year 1990, tea production in India reached a record level of 715 million Kgs (28.6 percent of the world's total production) and earned an estimated Rs.1028 crores (37th Annual Report, 1990-91, pp.12-13). North-East India produces about 75 per cent tea of India's production, and out of this, the state of Assam is the biggest producer of quality tea having a significant share of more than 53 percent. Interestingly enough, over 50 percent of the nation's exportable tea is Assam's contribution and what is most striking is that, Assam as a single unit still produces more than 1/6th of the world's tea. At present, the state has nearly 1.9 lakh hectares of land under tea cultivation representing 2.5 percent of the total geographical area of the state. There has been a steady expansion of land under tea and the annual rate of expansion was 0.8 percent during 1981-1990. Similarly, the production of tea in the state had been increasing at an annual rate of 4.8 percent during the said period. The productivity also increased from 1415 Kg in 1980-81 to 1674 Kg in 1989-90. In the sphere of labour input, it employs directly over 4.5 lakh workers all over Assam of which the female workers are nearly half. It also employs the highest number of mandays per hectare of land per year against any other agricultural produce, specially against paddy, the main foodcrop of Assam. According to an estimate, tea employs approximately 900 mandays per year per hectare against 330 mandays in paddy cultivation. The approximate cost of paddy produced from one hectare of land is about Rs.8000/- whereas the value of tea from one

hectare of land on average production is over Rs.50,000/- (Ehuyan, 1989, p.29). Besides this, tea is a kind of 'environment friendly' industry and apart from arresting the deforestation and denudation, it has a significant impact on the economy of the state (Deogun, 1989, p.3).

Inspite of its notable contribution in different physico-socio-economic spheres, production of tea in India is yet to achieve the expected target. The continuous increase in demand for domestic consumption at the rate of 4-5 percent every year has affected the country's export profile. Some of the tea producing countries like Kenya, Srilanka, China, Indonesia have seriously challenged Indian tea in the world export market (Borbora, 1993, Assam Tribune April 1). Therefore, the nation now requires to be substantially stepped up to meet the increasing domestic demand and at the same time, suitable strategies have to be adopted if the country is to continue as the world's leading producer and exporter of tea by reversing the current shrinking share in international market at 18 percent from 31 percent in 1971. The domestic consumption of tea by 2000 AD is estimated to be about 750 million Kg and the target for export is 250 million Kg. Therefore, the production target for tea industry is 1000 million Kg. by the turn of the century and the share of North East India is expected to be 750 million Kg.(Borbora,1993). Since Assam in the north eastern states alone supplies half of the nation's exportable tea, it would be urgent for the state to increase the current productivity level to maintain its glorious

historical trend. Because, the production of tea by bringing more area under tea cultivation at the cost of either cultivated land or forest land is not advisable and it is no longer remain as a permanent solution to fulfil the increasing demand. Therefore, the study of productivity against the backdrop of ecology seems to be meaningful. Moreover, tea being a dominant cash crop in the state, needs empirical investigation in micro-areal unit to highlight the complex relationship exist between the ecological conditions and the productivity of tea. Since the district Sonitpur of Assam is an important tea growing area, the selection of this district for empirical study is relevant for the purpose and is expected to be a good representative unit of the state for understanding the levels of productivity in relation to land, labour and capital inputs.

The second aspect of the selection of this district for intensive study is that it has the favourable ecological conditions required for tea cultivation. Generally, tea in natural conditions grows upto a height of 9 metres but by pruning it is allowed to grow upto 1-2 metres. Stagnant water on soil is injurious to tea crop and so the sloppy lands are preferred. Tea thrives well if the area is characterised by heavy rainfall (50 to 250 cm) and high temperature (13° to 30° c) during the growing period. High organic content of the soil and the pH. value of 4.5 to 5.5 are other required ecological conditions of tea. However, all these factors are prevailing in the district for which it is coming up as an important area for tea cultivation. It is also seen that out of the total geographical area of 5255 Sq.Km., 4.7 percent

is under tea cultivation in the district, i.e., higher than the state's average of 2.8 percent. Similarly, out of the total workers of 2.7 lakhs, 19 per cent is associated with the tea cultivation in the district against the state's average of 12 percent. The production of tea in the district in 1989-90 was 49.6 mt million Kg. against the state's total of 363.7 million Kg, thus representing nearly 13 percent share to the total output of the state. The average yield (Kg/h) of tea in the district in the said period was 2007 Kg which is higher than the state's average of 1674 Kg which indicates the suitability of tea cultivation in the area. The district has, however, more potentialities to enhance the productivity by creating an effective relationship among the production factors and hence, an integrated approach is needed to examine the existing levels of productivity as well as to increase the productivity. The significance of the study therefore, lies in the fact that it will throw light on some of the hitherto unexplored problems associated with tea cultivation and productivity which will provide a meaningful basis for future planning and development.

OBJECTIVES OF THE STUDY:

Based on the above background, the following aspects in regard to the productivity of tea in the district are proposed to be dealt with:

- a) To study the ecological and other related factors prevailing in the tea growing areas of the district.

- b) To examine the distributional pattern of land, labour and capital productivities in different ecological conditions of the district.
- c) To interpret the functional effects of production factors on the productivity of tea, and
- d) To suggest the feasible solutions for optional utilization of factors of production within the specific set of ecological conditions.

RESEARCH QUESTIONS:

The following questions are proposed to be answered in the present analysis.

- 1) What is the pattern of existing level of production and productivity under the specific set of ecological and non-ecological conditions ?
- 2) What are the effects of different explanatory variables on the land, labour and capital productivities ?
- 3) How does the production level of tea be optimised by reducing the yield gap for various ecological conditions?

DATA BASE AND METHODOLOGY:

Relevant informations for this study are collected from both secondary and primary sources. The secondary sources constitute the various books, journals, tea directory etc. published by the concerned Government and private departments. The geog-

raphical background of the study area is described with the help of maps and published informations. The informations relating to the climatic conditions, i.e., rainfall, temperature, humidity, sunshine, evaporation that are included in this study are collected from Tea Research Association, North Bank Branch, Thakurbari (Tezpur). Data for the description of Physical characteristics of soil of the tea growing areas of the district are collected from the soil survey reports (1967-68), published by Tocklai Experimental Station, Jorhat. The informations and statistics related to chemical characteristics of the soils, labour conditions and other capital inputs (like machine maintenance cost, transport cost, factory electrification cost, etc.) for various tea estates have been collected from their offices by the author. Some relevant informations which are not available in the records are collected by preparing questionnaires/schedule (Appendix I) for the physical aspects and households of the tea estates. The primary informations are gathered by taking some sample tea gardens based on stratified random sampling in which the size of the garden has given prime importance. Altogether nine samples have been taken which represented 15 percent of the total gardens of the district.

The collected data have been tabulated and presented by using various statistical techniques like regression analysis, correlation coefficient method etc. Production-function approach has been applied to measure the distributional pattern of productivities of land, labour and capital. A correlation matrix has been used to observe the degree of relationship among the twelve explanatory variables (Independent variables) and considering

the non-colinearity of these variables, three of them have been dropped from the analysis because of co-linearity problem. Then, to understand the effects of nine explanatory variables on productivities of land, labour and capital, a step-wise linear regression model has been used. The mathematical form of the equation is

$$Y = a + b_1x_1 + b_2x_2 \dots b_nx_n$$

Where Y = Productivity (Dependent variable)

x_n = Input variables (Independent variable)

a = Constant

$b_1, b_2 \dots b_n$ are coefficients.

The degree of effects of these variables are measured with the help of degree of determinants (R^2) which has provided the coefficient of the contribution of spatial variances. The existing and optimum yield patterns are obtained by estimating the values of tea productivity. Since cartography is the tool for geographical studies, the facts and findings are also shown by maps and diagrams.

REVIEW OF LITERATURE:

According to the objectives of the present study, an attempt has been made to highlight the research works already done in this field. The main aspects of tea cultivation found in these works can be studied by putting the material into a number of specific heads. The first group of study relates to

the impact of ecological conditions, basically climate (Rain-fall & Temperature) soil and drainage on the production of tea. Choudhury (1978), Biswas (1978) and Eden (1976) have attempted to elucidate these factors on the experimental basis and confined the study in the Terai Region and some parts of Assam. Grice (1971) made an experiment between the shade and the cultivation of tea, and showed how per hectare yield under different degree of shade is effected by nitrogen, soil type and age of the tea. This studies, however, are unable to recognise the composite effects of several production factors and the relative contribution of each explanatory variable to the production and productivities of tea is also not attempted.

The second group of study relates to the various socio-economic factors and its impact on production of tea. It is obvious that economic factors can contribute only where the ecological conditions are favourable. Misra (1991) analysed the relationship between the change in price and production of tea by taking some examples from Dooars and Darjeeling. Roy (1988) and Sarkar (1972) went a step further and described the situation in relation to consumption, production, price and trade of in world perspective. These studies are highly descriptive in nature and fail to highlight how the current rate of productivity of tea is encouraged by the factors of production.

The third group of study relates to the labour-management relation and productivity of tea. Venkatakrishnan(1981) and Baruah (1981) studies these things in North East India and only has shown

the importance of it in the cultivation of tea, but unable to make any generalisation on regional basis. Production of any agricultural produce varies according to the size of the farm and in this regard, tea is not an exception. Mitra(1987)described that the productivity of tea varies from large to small farms. But he did not give any generalised idea regarding the degree of variations from large to small farms.

From the above discussion it is seen that these studies are of fragmentary in nature and unable to provide a reasonable base for understanding the productivity level of tea. Therefore, an integrated approach comprising ecological and other non-ecological factors needed for tea cultivation has been sought to explore the levels of land, labour and capital productivities of tea in Assam, with special reference to the productivities of tea in Sonitpur district.

CHAPTER SCHEME:

The entire material of this study is arranged into a coherent manner by putting the material into five chapters. The first chapter deals with the conceptual background, statement of the problem, objectives, research questions, data base and methodology and the review of literature, while in the second chapter, geographical background of the study area is analysed. Third chapter deals with the agro-ecological conditions and input structure of the tea growing areas. Chapter four incorporates the production and productivity of tea. Functional analysis of explanatory variables are also included in this chapter. Research findings, suggestions and conclusion are presented in the fifth chapter.

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CHAPTER II

**SONITPUR DISTRICT : AGAINST THE BACKDROP OF
GEOGRAPHY**

CHAPTER IISONITPUR DISTRICT : AGAINST THE BACKDROP OF GEOGRAPHY

INTRODUCTION:

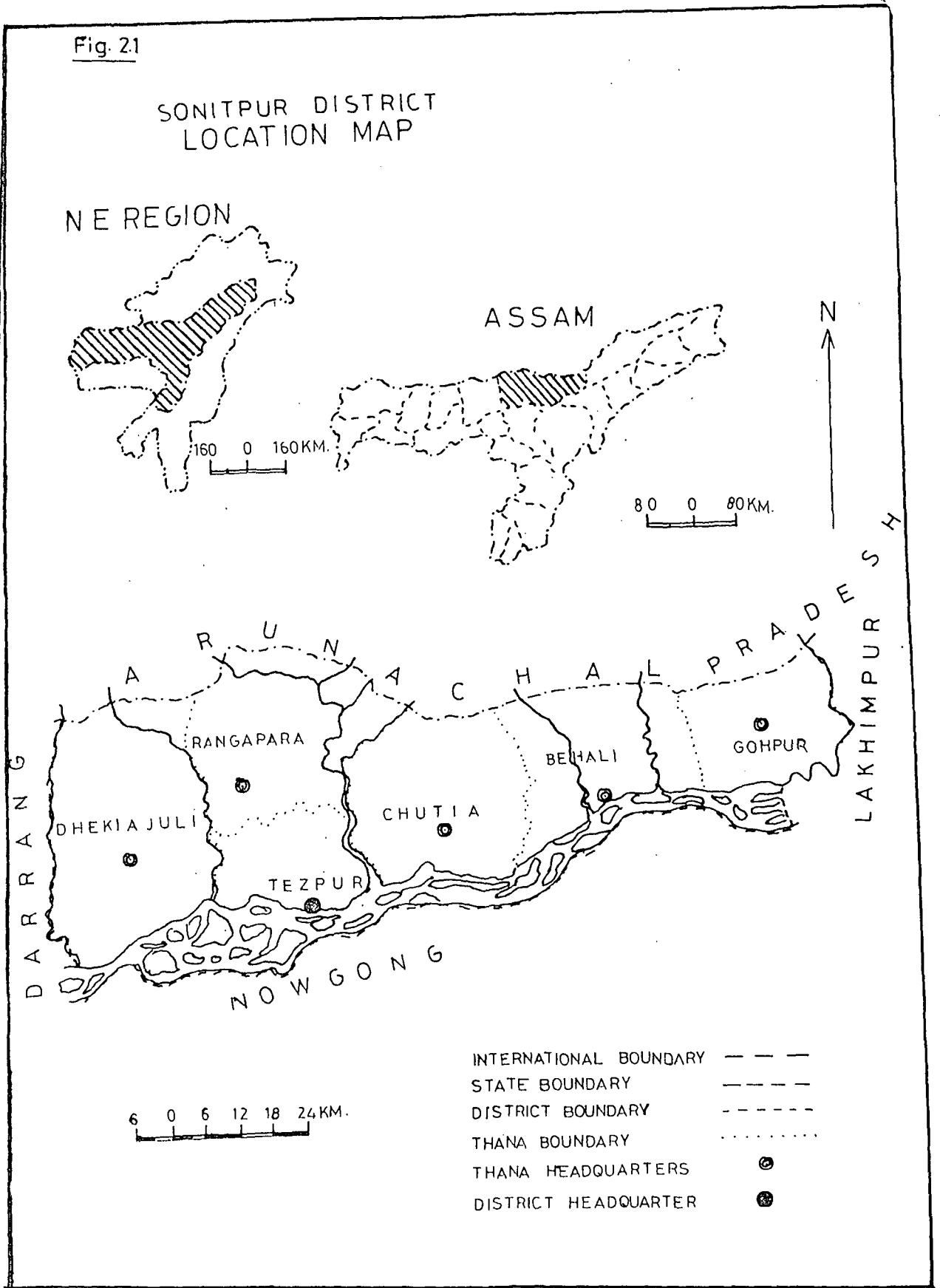
Sonitpur, "the city of blood" ('Sonit' means blood and 'pur' means city) is the reflection of some beautiful legends, narrated elaborately in "Kumar Haran", and a brief account is obtainable from Gazetteer (1978, p.2) in the following form:

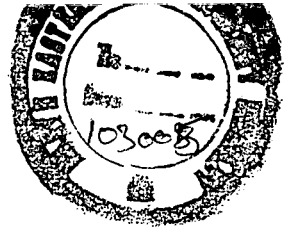
'In the Kumar Haran, an Assamese book written in verse, it has been described how Aniruddha, grandson of Krishna secretly entered the castle where Bana's beautiful daughter was kept under surveillance. Usha had earlier dreamt of Aniruddha and was charmed with his beauty. Aniruddha married her according to Gandharva ceremony. When Bana came to know about this marriage, he immediately threw Aniruddha into prison. This led to a grim battle between Bana and Lord Krishna who came to rescue his grandson. The profusion of blood that spilled in this war was the reason for calling this place 'Sonitpur'.

The present district Sonitpur, however, was a sub-division of erstwhile Darrang district of Assam. In 1985, it became a separate district with two sub-divisions, viz. Tezpur and Biswanath Charali. There are six Police Stations namely, Gohpur, Behali, Chutia, Rangapara, Dhekiajuli and Tezpur.

GEOGRAPHICAL LOCATIONS:

The district lies between $26^{\circ}30'N$ and $27^{\circ}08' N$ latitudes and $92^{\circ}17'E$ and $93^{\circ}47'E$ longitudes. It covers an extensive but





elongated alluvial tract between the river Brahmaputra in the south and the foothills of the eastern Himalayas in the north. The district Lakhimpur and Darrang exist in the east and west respectively. It has greater east-west extension (nearly 155 Kms) than North-South (35 Kms approximately). Altogether, the geographical area of the district is 5255 sq.Kms which is nearly 6.67 percent of the state. The total area under tea in the district is 247.2 sq.Kms against the state's total of 2268.3 sq. kms. It represents 4.7 percent of the area under tea cultivation in the district and 10.9 percent against the state. The estimated population of the district was about 14 lakhs(6.1 percent) in 1991 against the state's total population of 222 lakhs.

PHYSICAL SETTING:

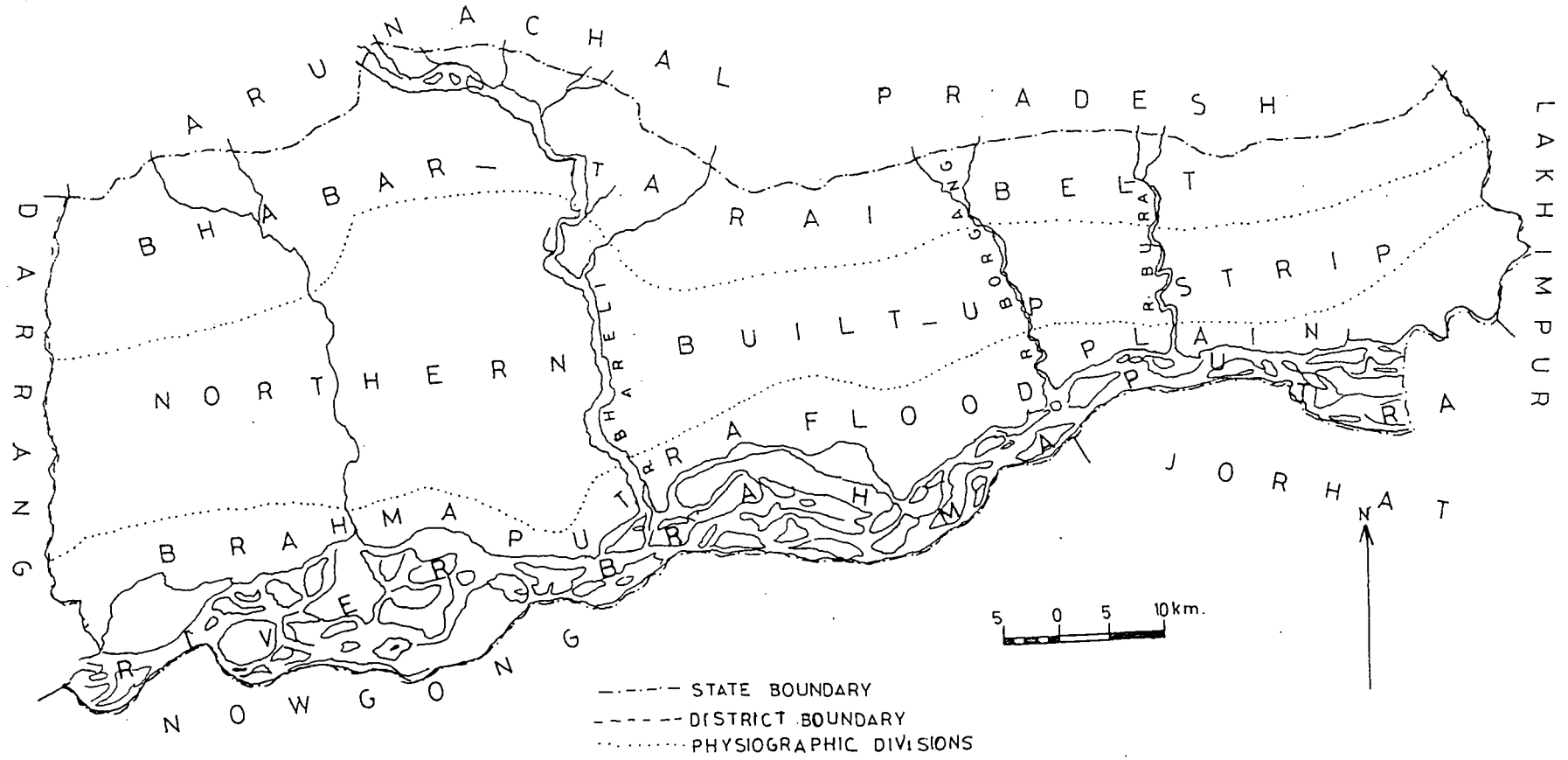
GEOLOGY:

From the geological point of view, the entire district is covered by quaternary alluvial deposits. There are, of course, some isolated hillocks of pre-cambrian gneisses exposed in the southern part with occasional outcrops of the tertiary sandstones. The contrast in terms of geology is very less in district. However, certain minor variations can be referred to by dividing the district into three parallel zones, viz. northern foothill, central plain and the Brahmaputra flood plain(Regional Division of India, 1991, pp.165-187).

Geologically, the northern foot-hills are characterised by the Upper Tertiary Sand Stones consist of fine to medium grained,

Fig.2.2.

DISTRICT SONITPUR PHYSIOGRAPHIC DIVISIONS



bluish to greenish grey ferruginous sandstones with partings of dark grey splintery shales and occasional lumps and fragments of lignite and carbonised wood, resembling the Tippam Sandstone of Upper Assam. On the other hand, the central plain is covered by alluvial deposits of recent and sub-recent origin. There are, however, a few outlying patches of elevated grounds composed of Sand, Clay, Loam and rounded Pebbles apparently resembling the older alluvium. These high grounds are suitable for tea cultivation and mostly seen north of Tezpur (Rangapara and Balipara) and in Biswanath area. The Brahmaputra flood plain belongs entirely to alluvial rocks of recent origin. These are composed of loosely consolidated sands, clays and single beds with occasional accumulation of vegetation.

TOPOGRAPHY:

The topographical features of the district are well reflected against its geological structure. It is seen that the district is a flat alluvial plain gradually slopping down from the foothills towards the Brahmaputra plain. A few scattered inselbergs of gneissic rock are lying along the northern bank of the Brahmaputra river with a height of 90 to 140 m. above mean sea level. There are also some low lying mounds in the district made up of unassorted river terraces (GSI, 1851-1976). Physiographically, the district can be divided into three units corresponding to the three parallel geological zones as cited above. These units are identified as Bhabar-Terai Belt of northern foothills, northern-built up strip or central plain and the flood plain of the river Brahmaputra (Taher, 1986, pp. 1-9).

All along the foothill of the eastern Himalaya there is a narrow high zone made of coalescence of alluvial fans. This is the Bhabar zone characterised by the unstratified and unconsolidated thick accumulation of alluvium. The numerous streams from the Himalayas, on encountering the plain leave boulders, pebbles, cobbles, sands and silt at the juncture which, in course of time have joined with one another to form the Bhabar belt. The most interesting feature is that the larger rivers here braid, while the smaller ones disappear from the surface due to percolation in this zone. Along the south of this belt, there lies the flat Terai Belt, where the disappeared water reappears, keeps the ground saturated. It creates a series of swamps that support tall grasses in this belt. The belt is also the source region for a number of seasonal tributaries.

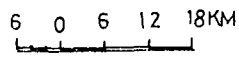
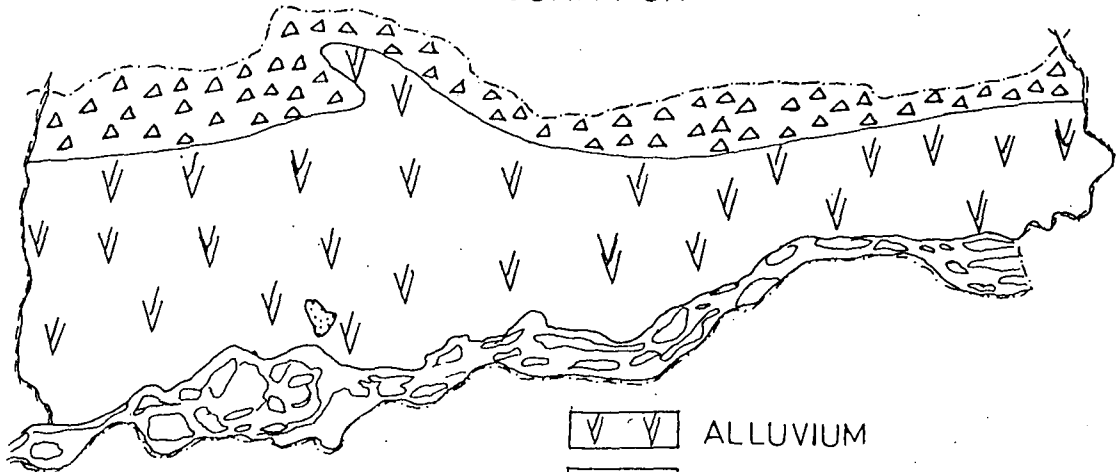
Next to the Bhabar-Terai Belt, i.e., to the south of this belt, there lies a strip of relatively high land with a dense population. This belt is called 'built-up-zone' and most of the tea gardens are located here. Again to the south of this belt lies the flood plain of the river Brahmaputra, supporting a series of 'swamps' and 'beels', in which most of the north-bank tributaries lose their tract (Taher, 1986).

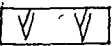
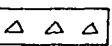
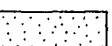
SOIL:

The soils of the district are basically alluvium of both recent and sub-recent origin. These soils are generally suitable for the cultivation of tea. Although alluvium, there are slight variations of soil characteristics in different physiographic

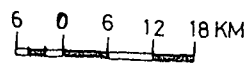
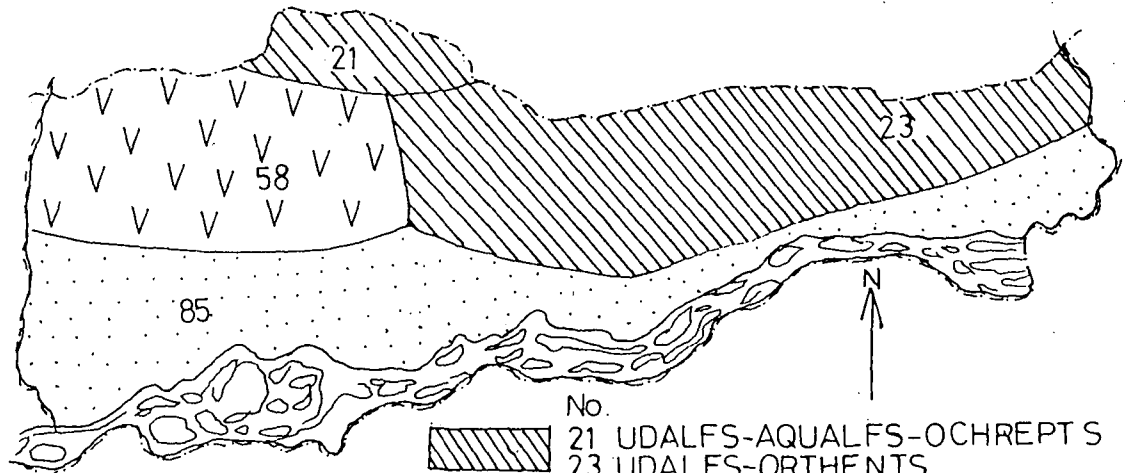
Fig. 2.3.


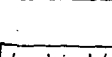
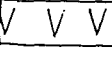
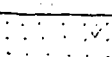
GEOLOGY
DISTRICT SONITPUR



-  ALLUVIUM
-  TIPAM AND SURMA GROUP
-  KHASI GREEN STONE

SOILS
DISTRICT SONITPUR



- No.  21 UDALFS-AQUALFS-ORCHREPTS
-  23 UDALFS-ORTHENTS
-  58 ORTHENTS-ORCHREPTS
-  85 ORCHREPTS-AQUEPTS-FLUVENTS

NOMENCLATURE

- AQUALFS — High base status soils (Hydromorphic)
- AQUEPTS — Brown soils (Hydromorphic)
- ORCHREPTS — Shallow black, brown & alluvial soils of northern region
- ORTHENTS — Recently formed soils
- UDALFS — High base status soils of humid regions
- FLUVENTS — Alluvial soils (recent alluvium)

units. The soils of the northern foot-hill are composed of loose sandy texture with occasional sands and gravel. Three types of soil are identified in this unit, These are:-

- a) Orthents-Ochrepts (58) - Western (North & South) part of the belt.
- b) Udalfs-Orthents (23) - Eastern part (both North and South), and
- c) Udalfs-Aqualfs-Ochrepts (21) - in the Northern corner of the belt.

Both older and new alluvium soils are found in the central plain or built-up zone. It also reflects three types of soil, namely -

- a) Orthents-Ochrepts (58) - covers the northern part.
- b) Ochrepts-Aquepts-Fluents (85) - spread over southern and eastern part; and,
- c) Udalfs-Orthents (23) - covers eastern part of the region.

The soils in the third physiographic unit, i.e., in the flood plain, are characterised by alluvial soils of recent origin. These can be classified into two groups:

- a) Ochrepts-Aquepts-Fluents (85) - covers the larger part of the region,
- b) Udalfs-Orthents (23) - found in certain places (Fig. 2.3).
(Regional Divisions of India, 1991, pp.175-187).

Considering the variety of soils found in the district, it is, however, seen that acidity is the general characteristics of the soil and is more so in case of older alluvium. New alluvial soils representing the lands of the river banks are less acidic. Acidic alluvial soils are suitable for tea cultivation, while heavy clays with high percentage of nitrogen in low land areas give a good return of rice. Generally, the soil in the district is characterised by sandy to clayey loams texture with high nitrogen content, low to moderate potash content and medium in phosphoric acid content (detail discussion is given in the Chapter III).

An examination of geology, topography and soil conditions of the district shows that there are three ecological zones with their own physiographic conditions. These ecological zones are :-

- i) Northern Foot-hills,
- ii) Central plain, and
- iii) The Flood Plain of the river Brahmaputra.

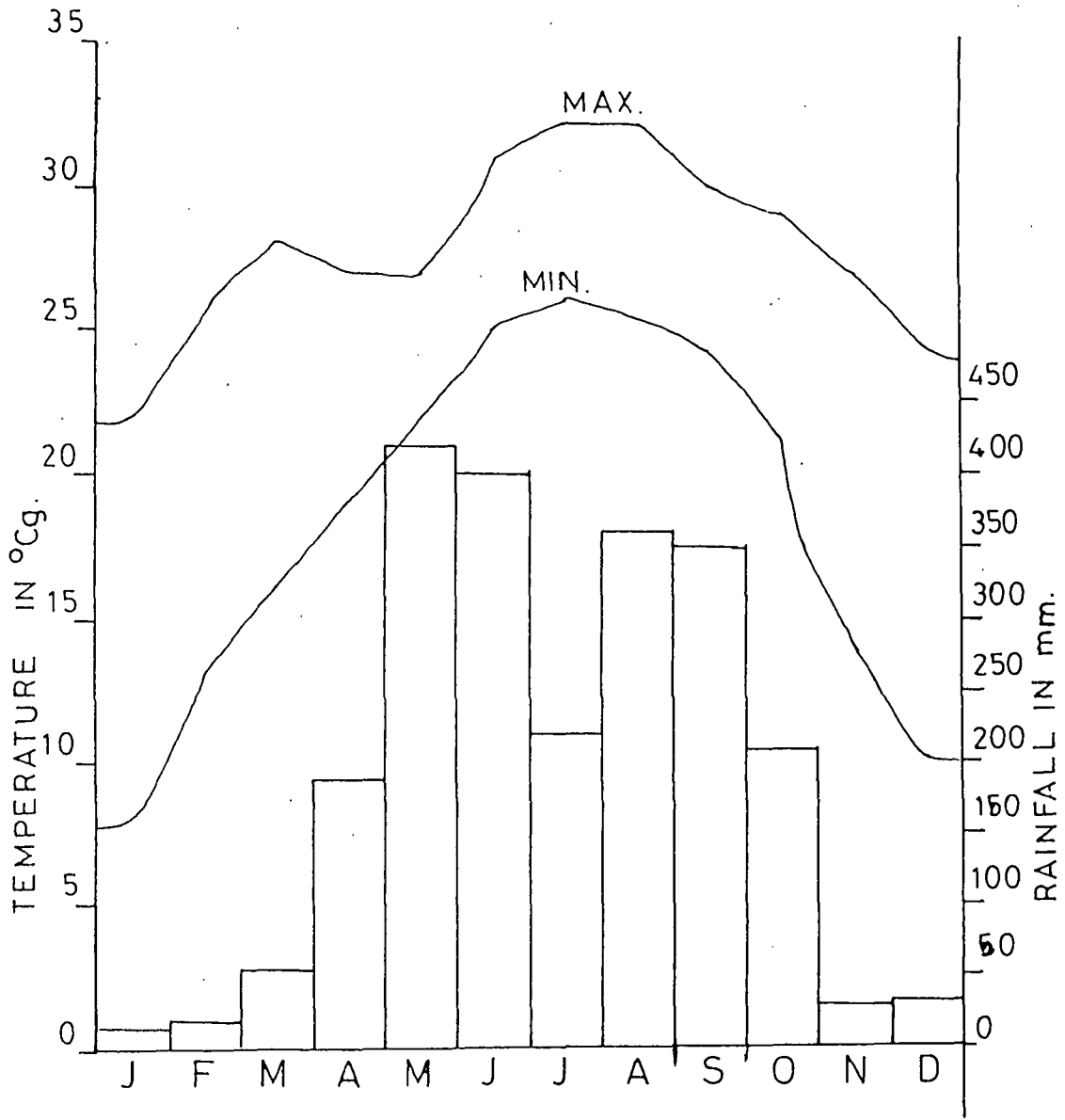
The relationship of each ecological zone with tea cultivation would be discussed in the following chapters.

CLIMATE:

The climatic characteristics of the district show similarity with the state. Both the state and the district is devoid of hot dry summer season. The maximum temperature is experienced during the south-west monsoon season accompanied by abundant rainfall. Significantly, the district experiences high humid atmospheric conditions throughout the year. On the other

Fig. 2.4.

RAINFALL AND TEMPERATURE
DISTRICT SONITPUR



DATA COLLECTED FROM MONABARIE TEA GARDEN , 1991.

hand, the cold season of the district starts from December which continues till the end of February. Generally this season is followed by a period of thunder-storms from March to May. The important season in respect to the economy of the district is the rainfed south-west monsoon that starts from June, continues upto the month of October. October and November is the post-monsoon period.

RAINFALL:

The average annual rainfall in the district is 2187mm. against the state average of 2455mm (1990). Interestingly enough, rainfall increases from the Brahmaputra river in the south to the foot-hills of the eastern Himalayas in the north of the district (Gazetteer, 1970, pp.39-40). Rainfall mostly as thunder-shower amounting to about 1/5th of the annual is received in the pre-monsoon period of April and May. The south-west monsoon arrives over the district by about the beginning of June. Nearly 2/3rd of the annual rainfall occurs between June and to September. June and July are the rainiest months. The annual variation of rainfall is very less. Altogether, there were about 169 rainy days in the district during 1991 (Details of climatic conditions are given in Chapter III).

TEMPERATURE:

There are two meteorological observations, one at Tezpur and the other at Gohpur. The recorded data from these two stations show that January is the coldest month of the year with the mean daily maximum temperature at 24°C and the mean daily minimum at

6.6°C to 10°C (Statistical Hand Book, 1980, pp.86-90). During the winter season, in association with low pressure waves passing eastwards, the district experiences cold spells a day or two when the minimum temperature may fall below 5°C. Temperature, however, begins to increase from the month of March and the highest is experienced in July and August. During this period, the mean daily minimum remains around 25°C. This phenomenon along with high humidity makes the south-west monsoon rather unpleasant, but becomes congenial for tea crops. With the termination of monsoon, however, the weather tends to become cooler and leads towards the winter season.

HUMIDITY:

Most interestingly, the air in the district remains highly humid throughout the year, except during the period February to April when the relative humidity is relatively less, particularly in the afternoon.

SKY CONDITIONS:

Entire state is characterised by heavy cloud to overcast in the south-west monsoon season. The district in this regard is no exception. There is, however, no cloudiness after the withdrawal of the monsoon and in the winter season specially the period from November to April sky is generally clear or lightly clouded. Winds are also light throughout the year except for short spells of strong winds thunderstorms from March to May. North-easterly or easterly winds are most common throughout the

year. Cyclonic storms and depressions from the Bay of Bengal which move into Assam do not reach near enough to affect the weather of the district. Fog occurs on some days at post-monsoon winter season.

DRAINAGE:

The tea shrubs grow on well drained lands as stagnant water is harmful. Because of this factor, hill slopes are practically preferred for tea, but if the drainage is good, it grows equally well in valleys. The district consists of a large number of tributaries coming down from the Himalayas and finds its way into the river Brahmaputra. Foothill regions are well drained but most parts of it is covered by forest. Therefore, area under tea in this zone is lesser than central plain. The Flood plain region of the district is not good for tea cultivation because of inundation during the summer season. The high lands of central part of the district are suitable for tea crops. The drainage system of the district shows some notable characters. The main rivers are Burai, Bargang, Burhigang, Ghiladhari, Dikorai, Jia-Bharali, Gabharu and Pachnai (Fig. 2.5). Of those tributaries only Jia-Bharali is of the Great Himalayan zone and are essentially rainfed. There is also another category of tributaries which have their origin in the Terai Belt. These collect water, recharged after seepage and underground flow below the foot-hill Bhabar trait (Taher, 1986). Such tributaries are ephemeral with water flowing only in the summer season. However, the Bharali is the largest river in the district and flows about 193 kms. in the hills and nearly 56 kms. in the plains. This is led by the

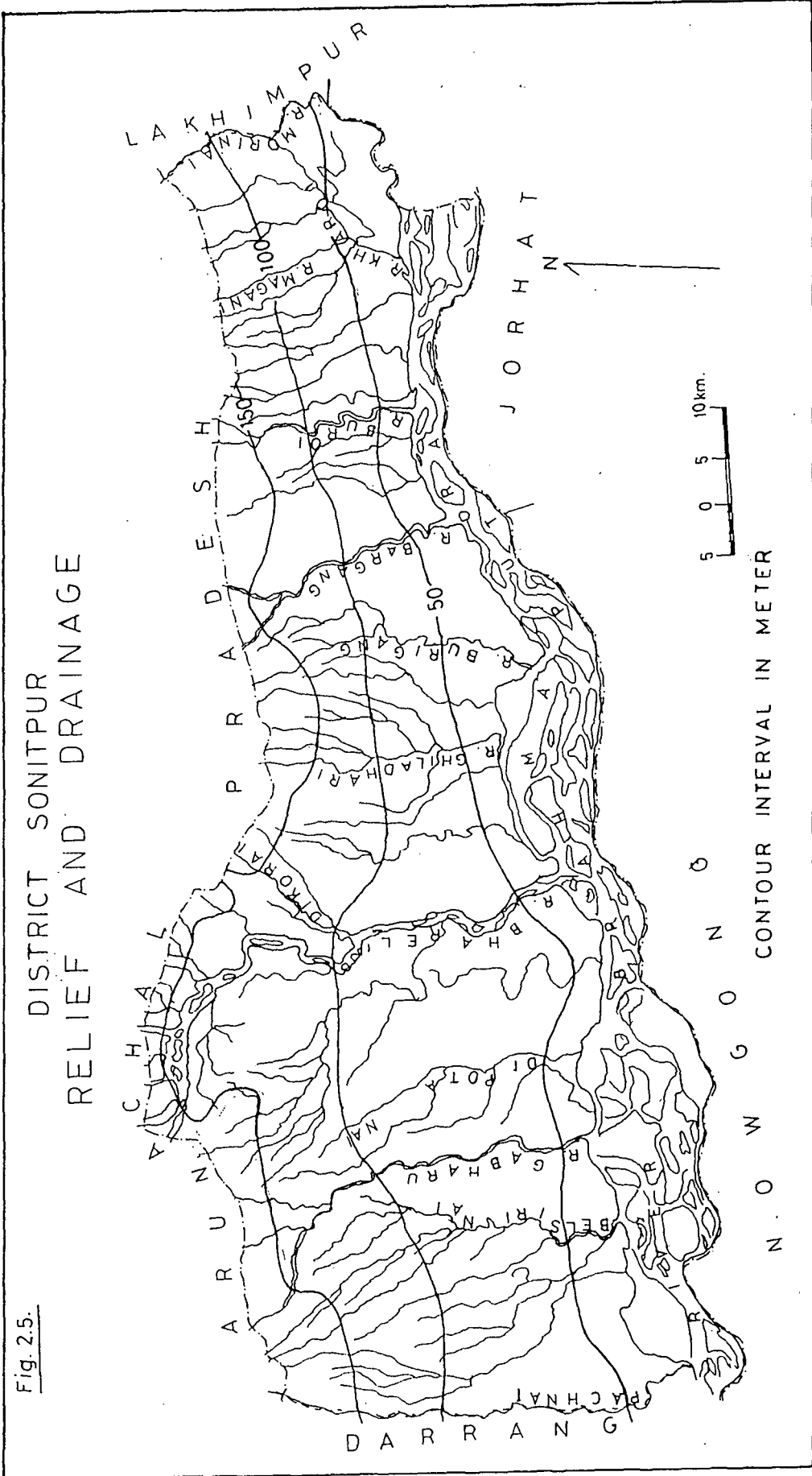


Fig. 2.5.

DISTRICT SONITPUR
RELIEF AND DRAINAGE

CONTOUR INTERVAL IN METER

discharge from a large catchment area through its large number of tributaries. The principal left bank tributaries are Bordikorai and Upor Khari while the Upor Sonai, Nam Sonai and Mansiri are right bank tributaries. The Burai is an important eastern most river of the district and its approximate length is about 32 kms. in the plains. Borgang river is located in the west of Burai, the length being 29 kms. The main features of this river are that it flows between very wide banks and that it has very steep bed slope due to which the canal flow of the river goes on changing in every flood season. The Ghiladhari and Gabharu are also two important rivers in the district, the lengths being 33 kms. and 64 kms. respectively. However, almost all the north bank rivers including the rivers of the district take a course sub-parallel to the Brahmaputra before opening into it. This is mainly because of the presence of an incipient level along most part of the north bank of Brahmaputra (Taher, 1986).

HUMAN - ACTIVITIES:

LANDUSE PATTERN:

The pattern of land use in the district is highly dependent on various physical factors mentioned above. An analysis of the land use reveals (Table -2.I) that about 36 percent of cadastral area is not available for cultivation. Such land is used for homesteads, roads, factories, rivers, ponds, towns, villages and so on. Other uncultivated land like permanent pastures, grazing, miscellaneous tree crops etc. has covered nearly 5 percent of the total geographical area. Although the waste land area was very high till the later part of the 19th century, it has now been taken

Table -2.1 : Pattern of Landuse in Sonitpur District.

Sl.No.	Classification of Land	Area in 000 hect.	P.C. to Total Area
1.	Forest	142	27.00
2.	Not Available for Cultivation		
a)	Land put to non-agricultural uses	181	34.41
b)	Barren and uncultivated land	12	2.28
3.	Other uncultivated land excluding fallow land		
a)	Permanent pastures and other grazing land	14	2.66
b)	Land under miscellaneous tree crops & groves not included in net area	12	2.28
c)	Cultivable waste	0.3	0.06
4.	Fallow land		
a)	Fallow land other than current fallow	3	0.57
b)	current fallow	4	0.76
5.	Net area sown	158	30.03
Total Reporting Area		526	100.00

Source: Statistical Hand Book, Assam, Directorate of Economics and Statistics, Govt. of Assam, 1990, pp.68-71.

Table -2.2 : Percentage of Area Under Major Crops in Sonitpur District

Sl.No.	Major Crops	P.C.of Area to Total Geographical Area
1.	Rice	
a)	Autumn Rice	2.98
b)	Winter Rice	18.18
c)	Summer Rice	0.08
	Total Area Under Rice	21.23
2.	Wheat	1.99
3.	Rabi pulses	1.57
4.	Sugar cane	0.61
5.	Rape & Mustard	2.17
6.	Jute	0.96
7.	Tea	4.70*

* Tea Directory, 1989-90.

Source: Agricultural Statistics, Assam, 1981-82.

up for various uses and only a fraction, i.e., 0.06 percent now remains as wasteland in the district. At present, the large tracts of wasteland have been taken up for tea cultivation. Similarly, the proportion of fallow land in the district is very less (1.3 percent). This includes practically all unsettled area, the vast area of which are known to be either hillock or lowlying areas. Unfortunately, the area under forest in the district is only 27 percent which is far lower than the proportion (33 percent) assumed to be adequate for maintaining the ecological balance of a region. Net Area Sown in the district constitutes nearly 30 percent of the total geographical area. Paddy, Jute, Tea, Sugarcane, Mustard, Pulses are major crops while fruits like Mangoes, Coconut, Banana, Pine-apples, etc. are subsidiary crops. However, rice occupies the major part of the district and nearly 80 percent of the population depends on the production of rice. The proportion of area under different crops in the district is given in the table-2.2. The data shows that rice covers nearly 21 percent of the total geographical area followed by tea whose share is nearly 4.7 percent among the cash crops tea ranks first in the district and its share is higher than the state's average of 2.89 percent to the total geographical area.

POPULATION AND LABOUR FORCE:

According to the 1991 census, Sonitput district accounts for about 7 percent of the total population of Assam. The number of population in the district is nearly 14 lakhs(1991) of which

male constitutes about 53 percent. The density of population in the district stands in 1991 at 266 persons per sq.km. which shows an increase by 95 persons per sq. km. over that of 1971. The density of population is, however, higher in the central part of the district (more than 300/Km²) where the concentration of tea gardens is also higher. Therefore, there is no shortage of labour force for the tea cultivation in the district. The share of working population in the district is only 30.13 percent of the total population and a majority of them remains as non-workers. This figure for the state as a whole is 36.37 percent (1991) and in this respect, the incidence of non-working population in the district is higher than the state.

TRANSPORT NETWORK:

After independence in 1948-49, there was only about 100.7 Kms of metalled roads, about 675 kms of gravelled roads and about 77 kms of natural soil motorable roads under the Central Assam Division of the Public Works Department (Gazetteer, 1978, p.269). At present, the picture has changed to a great extent and the district is connected with the rest part of the state either by road or rail transports. The National Highway No.52 runs through the district and almost parallel to it, North East Frontier Railway also passes and both of these lines are well connected with the tea gardens of the district. It is seen that during 1986-87, the total length of the roads in the district was 1832 Kms thus representing 6.6 percent of the total road length of the state.

Out of this, the length of the National Highway is 206 kms against the state's total of 2020 Kms. The length of the State Highway is 68 kms and the other roads under Public Works Department is 1558 kms. The road length per lakh of population in the district is 131 kms (1986-'87) which is higher than the state's average of 122 kms. On the other hand, the density of roads per hundred sq.km of area in the district is 35 kms and it is just equal to the state's average of 35 Kms. The transport net-work in the district is favourable for the development of tea industry.

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CHAPTER III

AGRO-ECOLOGICAL CONDITIONS AND INPUT STRUCTURES OF

TEA CULTIVATION

CHAPTER IIIAGRO-ECOLOGICAL CONDITIONS AND INPUT STRUCTURE OF TEA CULTIVATION

INTRODUCTION:

The culture of the tea plant is of such a special character that it is surrounded by difficulties the meaning and force of which can hardly be judged by the standards of ordinary agriculture in India or elsewhere. First, the tea plant itself is a perennial tree brought by cultivation to a shrub form, and then grown for leaf, while nearly all cultures of similar plants are made for the production of fruit or seed. Again, while this bush will grow on the greatest variety of soil, and with considerable variation of climate, yet such growth can only profitably take place under very strictly defined conditions, and variations which would often be ignored in ordinary agriculture would be fatal to the commercial production of tea in any district or country (Watt and Mann, 1987, pp.1-2). The tea plant, bush or tree, is an ever-green of "Camellia" family, generally flourished in the warm, rainy regions of the tropics and sub-tropics. The climate considered most favourable to tea culture should be characterised by a small daily rise in temperature, generous rain throughout the year and the absence of strong dry winds and freezing temperature. It is established that tea thrives well where the annual rainfall ranges between 150 to 200 cm. But experts consider 127 cm. as marginal, unless, however, humidity, temperature and such other factors mitigate. But the crop production suffers considerably if the monthly average rainfall is below 5 cm over a period of

several months. The mean minimum and maximum temperature should be between 13° to 30°C. At the same time, the soil on which tea is grown has a strong influence on the quality of tea. Clay soils tend to give a strong scent but poor in flavour to tea. Black organic soils tend to produce a leaf giving a sweet taste but a poor aroma. Loose sandy loams usually give a favourable balance of taste and aroma. Practically all tea soils must be fertilised if the tea plant is to thrive. The luxurious growth of a tea plant depends upon general care in cultivation, pruning, plucking and control of pests and diseases (Gazetteer, 1978, pp.170-176). All these together contribute for increasing the total output as well as yield per hectare of tea.

In the present analysis an attempt has been made to examine the levels of land, labour and non-land capital productivities of tea in the district against the background of existing ecological and non-ecological conditions. To achieve the objectives, relevant data have been collected from nine sample tea gardens of the district and the relative importance at each of these productions factors (land, labour and capital) has been analysed systematically.

1. LAND AS AN INPUT:

Land is a basic and most influential input in the cultivation of tea. Capacity of land which is determined by the physiographic factors like climate, soil, reliefs, etc., directly influence to the tea plant growth, its yield and quality. Being the

study area as a micro-areal unit of 5255 sq.km., relief and drainage conditions are less influential, while climate and soils of which the elements vary at micro-areal unit have direct and implicit effects on the variations of tea yield. Therefore, the micro-elements study of the climatic conditions and micro-nutrient analysis of soil properties and their areal variations are interpreted in the following paragraphs.

1.a. CLIMATE:

The influence of climate on the production of tea is considerable. The chief climatic elements incorporated in this study are rainfall, temperature, humidity, evaporation and sunshine. The entire informations relating these climatic elements are collected from Meteorological observations at Tea Research Association, North Bank for 1989, 1990 and 1991 (North Bank, 1991), and then three years average are calculated to show the daily variations of climatic conditions. The data which are taken into account here for three years do not have much variations over time and represent to the normal climatic conditions of the district. These data reflect the following conditions of climate for the years 1989-1991.

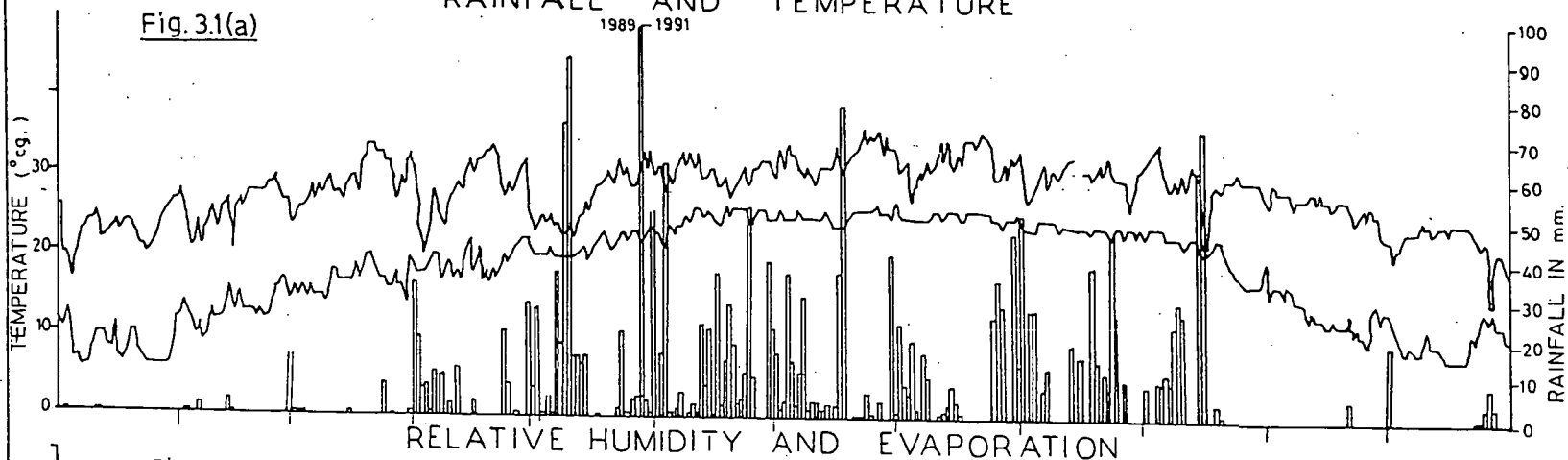
1.a.(1) RAINFALL:

During 1989-91, the total annual rainfall (3 year average) in the tea growing areas of the district was 1775mm. with a total of about 107 rainy days. The intensity of rainfall for the period was 16.5mm per day. Rainfall amounting to about

DISTRICT SONITPUR
RAINFALL AND TEMPERATURE

Fig.3.1(a)

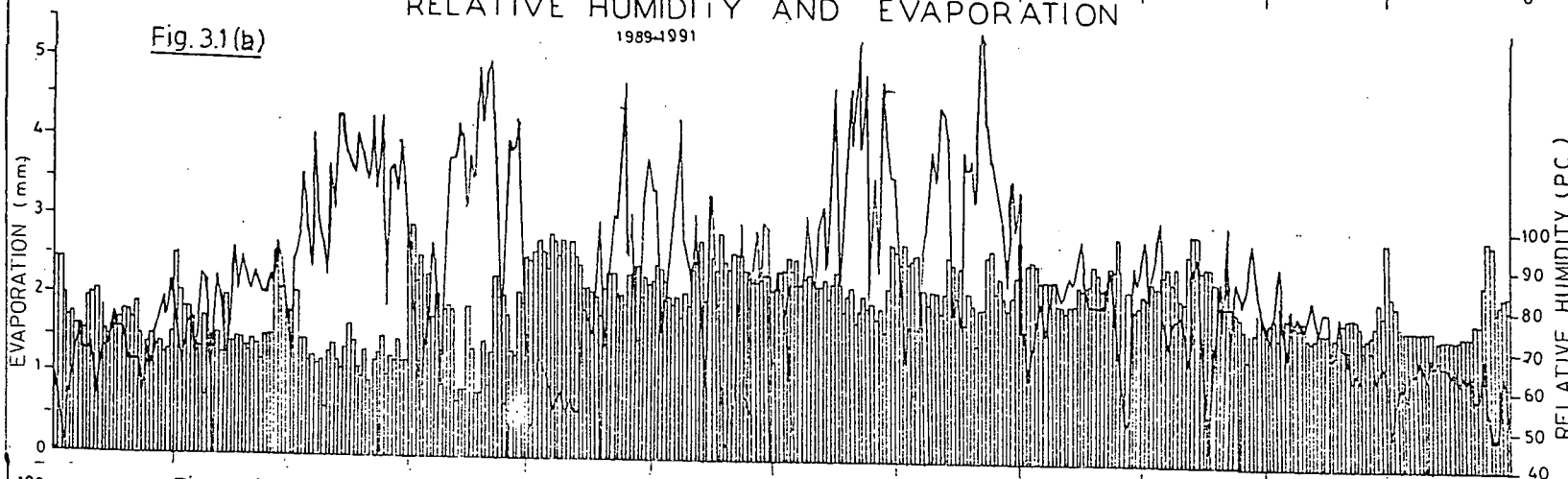
1989-1991



RELATIVE HUMIDITY AND EVAPORATION

Fig.3.1(b)

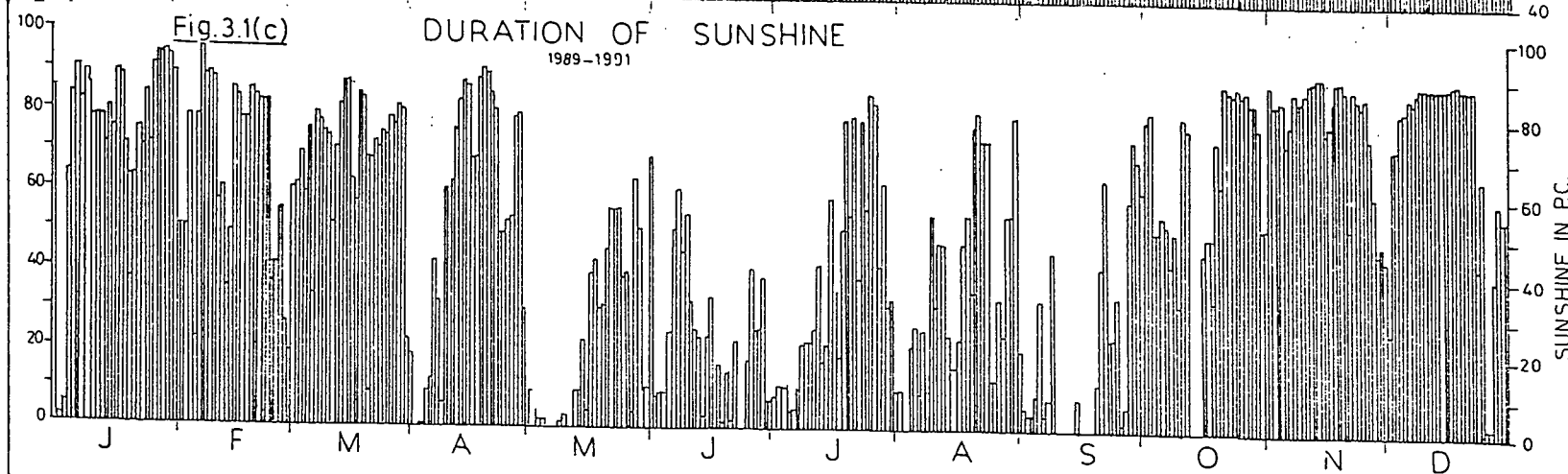
1989-1991



DURATION OF SUNSHINE

Fig.3.1(c)

1989-1991



22 percent of the annual total was received in the month of April/May, i.e., the pre-monsoon months and this amount is most significant for tea because this is the growing period of tea leaves. The highest rainfall was recorded on 28th May with 97mm. However, altogether there were 39 rainy days in the months of April and May, 11 days with rainfall more than 20 mm, and 17 days with less than 5mm. The rainfall in the period June to September accounts for about two-third of the total annual rainfall. In the cited year, June was the rainiest month with a total fall of about 385 mm. in 26 rainy days. In July, the total amount of rainfall was 225 mm. and the number of rainy days was 23. On the other hand, there were 19 and 17 rainy days during the months of August and September respectively with a total amount of 400mm. However, September recorded larger amount than that of the August. It is seen that (Fig. 3.1.a) during 1991, rainfall continued upto 15th of October and occasionally, there was heavy rainfall in the midst of October (72 mm. on 15th October). Right from October 16th, the rainfall was very less and sometimes no rainfall at all and the trend persisted upto March. Now the point is that the growth of tea plant, like other plants is not maintained at a continuous rate, but periods of rapid growth alternate with periods of dormancy. This rapid growth period for the district starts in April and continues upto November and is associated with the high rainfall.

1.a.(ii) TEMPERATURE:

The conditions of temperature in the district's tea growing areas are quite congenial for the growth of the tea plant.

Generally, January is the coldest month of the year and in 1991, the average monthly maximum and minimum were recorded to be 22°C and 11°C respectively. Of course, there were daily variations of both maximum and minimum temperatures (Fig. 3.1. a). Although January is the coldest, however the mean daily maximum reached the level of 27.2°C on 29th, while the daily minimum was lowest on January 25th, coming down to the level of 6°C only. The highest temperatures were experienced in the months of July and August, the mercury reached the level of 36.2°C on 23rd July. Similar value was also recorded on August 25th. Against these highest values, the mean daily minimum temperatures were recorded on July 17th and August 27th, the amount being 24°C and 24.5°C . respectively. However, the monthly average maximum temperature was more than 32°C for the months of July and August. After this, both maximum and minimum values of the temperature came down and both remained less than 30°C and 20°C respectively for the months of September, October, November and December. It is interesting to note that the mean maximum temperature above 30°C is believed to be harmful, but in the district it is not like that because of abundant rainfall and high humidity during the growing period of tea crop.

1.a.(iii) HUMIDITY:

The data shows that the air is humid throughout the year (Fig. 3.1.b.) except the months of February and March (Relative Humidity is less than 70%). The relative humidity in the tea growing areas of the district remained well above 80 percent

during the period from April to October and from November to January, the proportion remained between 70 to 80 percent. However, relative humidity is higher in the morning than afternoon. The collected data showed that during 1991, daily average relative humidity in the morning (8 A.M.) was around 90 percent while in the afternoon (5.30P.M.), it came around 60 percent or less.

1.a.(iv) EVAPORATION:

The pattern of evaporation in the tea growing areas showed a fluctuating trend (Fig.3.1.b) throughout the year, 1991. It is seen that the lowest rate of evaporation took place on 24th June, the rate being 0.5mm and the rate of evaporation was highest on 23rd August, the rate being 5.5 mm. In November and January, the rate was found between 1mm to 2mm, and from February to October, it was more than 2 mm/day. Sometimes, however, it was more than 4 mm (as evident from the Fig.3.1.b). It is seen that the rate was not continuous throughout the year. Significantly day to day variations were more pronounced. However, it can be generalised that during the growing period of the crop, the rate of evaporation was higher than other period. From March to August, it took place at an average rate of 4 mm or more per day.

1.a.(v) SUNSHINE:

Generally skies are heavily clouded to overcast in the south-west monsoon season and decrease in cloudiness found after the withdrawal of the monsoon. For instance during 1991, the duration of sunshine was recorded to be around 80 per cent (Sunshine duration normally expressed in hours, but here it has been con-

verted into percentage) during the period November to April and 40 percent or less from May to October. However, the growing period has less duration of sunshine than the other periods, thus making the condition suitable for tea cultivation.

RELATION TO TEA PRODUCTION:

The harvesting of tea leaves from the bushes in the plantation determines the total output of tea. If the harvesting of green leaf is more, the production would be higher (the ratio between green leaf and made tea is 4.5:1). The harvesting or plucking depends to a great extent on climatic conditions. Under favourable hot and wet weather the new shoots develop very quickly, and the bushes need to be plucked at short intervals of 6 to 10 days. The variation in the interval of plucking is effected by the variation of the rainy season, e.g., it is 6 to 7 days from April to July, $6\frac{1}{2}$ to $7\frac{1}{2}$ days from August to October and 8 to 10 days from October to December (Awasthi, 1975, pp.75-78). This plucking variation is due to the varying rates of the growth of the tea leaf. The growth of tea leaf takes place at a rate of .25 sq.cm per day in the month of April, more than .29 sq.cm per day during the months of May, June, July and August and nearly .20 sq.cm per day during the months of September and October*. The growth rate

* The growth rate of tea leaf has been calculated by using the equation:

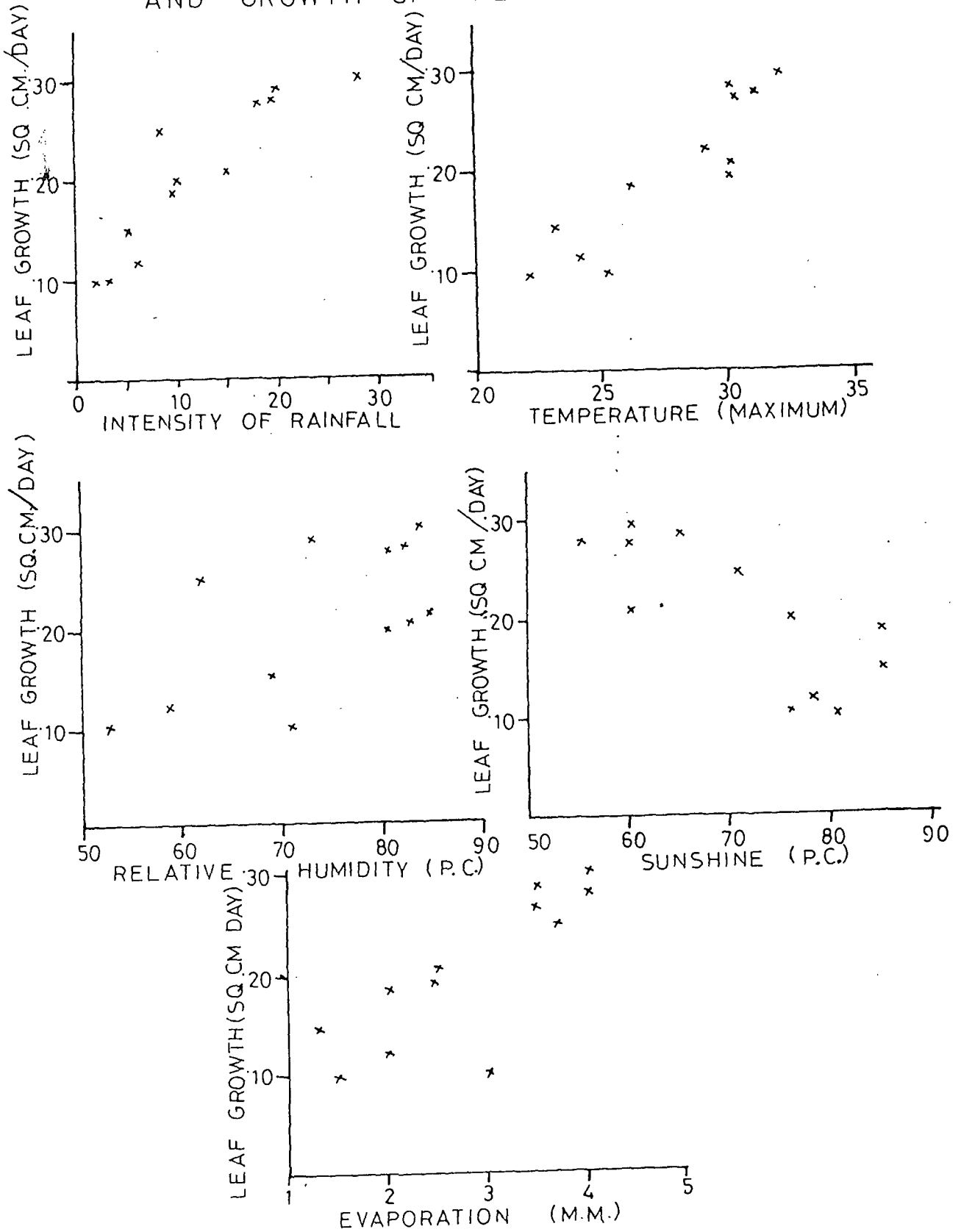
$$\text{rate of leaf growth per day} = \frac{(A_1 - A_0)}{Aot}$$

where A is the area of the leaf,
 $A = \frac{\text{length in cm of leaf} \times \text{width(cm)} \times 3.14}{4}$

A_0 is the initial reading, A_1 is the final reading
 t is the time, 3.14 and 4 are constants.

Fig. 32.

RELATIONSHIP BETWEEN CLIMATIC FACTORS AND GROWTH OF TEA LEAF.



of tea leaf is less than .20 sq.cm per day for the remaining months. The inference is that there is a positive relationship between the growth of tea leaf and the intensity of rainfall, temperature, humidity and evaporation (Fig. 3.2). On the other hand, there is a negative relationship between the duration of sunshine and the growth of tea leaf. The district seems to be characterised by heavy rainfall during the growing period accompanied by high temperature and humidity and less sunshine. All these together encourage for the production of tea in the district.

2. SOIL:

A point in the history of tea cultivation has now been reached at which it is possible to lay down with some approach to confidence the soil conditions which are necessary for the production of the most vigorous tea bushes and the maximum production of leaf. The first of these is undoubtedly the friability, or at any rate the easy penetrability of the land to a considerable depth to the plant roots and also to water (Watt and Mann, pp.35-36). All these depend to a great extent on the physical and chemical properties of the soil. But no systematic attempt has been made so far to establish the various physical and criteria of the soil on a regional basis to determine the production capacity of the soil with respect to tea. However, Tea Research Association (T.R.A) has conducted a special survey covering the thirteen tea districts of North East India and collected two or three samples from each district to examine the changes in the physical and chemical properties of soils with different periods of cropping from virgin jungle to old tea (Soil Survey, 1967-68, pp.2-8). From this survey,

some references regarding soil properties of two tea estates of Sonitpur district have been obtained to examine the textural characteristics and these two are assumed to reflect the general soil conditions of different tea estates located in various parts of the district.

2.a. PHYSICAL OR TEXTURAL CHARACTERISTICS:

To study the various textural conditions of the soils, two estates, one from the foothill region and the other from the central plain, have been selected by TRA and the characteristics are presented in the table-3.1. The data shows that depending upon locations soils vary in texture within the tea district. For example, Dufflaghur neighbouring foothills has heavier soils belonging to the silty clay loam and silty loam classes, whereas Gingia, away from the foothills has lighter soils belonging to the textural classes of coarse sandy loam and sandy loam. The inference is that, "Red Bank" soils, i.e., those situated near the foothills, are likely to be difficult ones from the point of view of permeability and root development. From textural consideration alone river bank soils (represented by Gingia) are likely to be more conducive for rapid percolation and consequently good root growth (Soil Survey, pp.6). From the average data of all the profile sites, it is observed that no change takes place in the various mechanical fractions like sand, silt and clay with varying periods of cropping.

The percentage distribution of various sizes of particles in sub soils (30 to 60 cm) layers is almost similar to the

Table -3.1 : Textural Analysis of Soil (P.C. on dry wt. basis)

Name of the T.E.	Location	Age*	Mechanical Fractions					
			coarse (2.0mm)	fine sand (0.2mm)	silt (0.02mm)	clay (0.002mm)		
Dufflaghur	Foothill Older Alluvium	Vergin	a.	2.29	39.34	53.22	5.15	
			b.	2.61	58.88	33.97	4.54	
			c.	2.34	38.60	53.68	4.38	
			Young	a.	23.68	64.03	98.39	13.90
				b.	12.80	85.51	92.60	9.05
			medium	c.	17.90	37.26	39.07	4.37
				Old	a.	22.99	39.59	31.83
			b.		36.11	48.60	11.81	3.48
			c.	19.30	37.26	39.07	4.37	
	Gingia	Central Plain, Older Alluvium	Vergin	a.	23.99	49.19	22.57	4.25
				b.	42.44	37.92	17.41	2.23
				c.	79.32	13.06	5.45	2.17
			Young	a.	11.10	73.81	103.71	11.38
				b.	3.70	81.35	104.78	10.17
			Medium	c.	4.97	66.03	120.59	8.41
				Old	a.	3.36	40.87	49.77
			b.		1.39	56.55	35.73	6.33
			c.	0.64	59.89	34.84	4.63	

* Vergin jungle or as near
 Young tea -Less than 10 years.
 Medium tea -About 20 years.
 Old tea-More than 40 years

Abbreviations: a= Top soil (0-30cm) layer
 b= Sub soil (30-60cm) layer
 c= Sub soil (60-90cm) layer.

Source : Soil Survey, 1967-68, Results for the North Lakhimpur and Biswanath Districts, T.R.A, T.E.A., Jorhat, Assam, 1970, pp.5-8.

top soils (0 to 30 cm) with certain exception of Dufflaghur Tea estate. The percentage of sand fraction increases in the 30-60 cm sub-soil layers at Dufflaghur, which is a typical example of variable nature of profile texture in the case of alluvial soils. From the average data, it is observed that slight changes take place in the mechanical fractions with varying periods of cropping, which may be attributed to site variabilities rather than due to the effect of age of cropping. At the same time, the percentage distribution of mechanical fractions in sub-soils layers of 60-90 cm is same with that of 30-60cm layer, as is evident from the table- 3.1. (Soil Survey, pp.7-8).

2.b. CHEMICAL CHARACTERISTICS:

Under plantation condition soil fertility is an intimate interplay of soil physics and soil chemistry. The chemical status of the soil affects the soil nutrients. Although soil data on regional basis is not available, most of the tea gardens have their own soil reports relating chemical characteristics, which they send for test at TRA, North Bank Advisory Department, Thakurbari, Assam. In the following table - 3.2 , the chemical status of the soils for different tea gardens (Nine Samples) are presented.

The table shows the variations of chemical characteristics of the soils according to location. However, various proportions of chemical contents and its relationship with the tea crops can be correlated with the help of certain norms given by the TRA (Planters Hand Book, 1991, pp.8-9). It is stated that tea grows

Table -3.2 : Chemical Characteristics of soils.

Name of T.E.	Location of T.E. in the Dist.	Date of Soil Test	Depth	No. of samples	pH of water extract	C% on drywt. basis	N% on drywt. basis	ppm available K ₂ O	ppm available P ₂ O ₅
1. Pan. Foothill Old Allu.		14.2.87	Top.	25	5.25	1.057	0.119	80.00	23.00
			Sub.	20	5.30				
2. Kac. F.H. & O.L		7.10.91	Top.	45	4.75	1.010	0.154	81.00	24.00
			Sub.	30	4.60				
3. Nya. F.H. & O.L		6.5.88	Top.	54	5.00	0.967	0.096	82.00	29.00
			Sub.	40	5.50				
4. Mon. C.P., O & N. Al.		23.8.89	Top.	42	4.80	1.224	0.105	123.80	31.00
			Sub.	40	4.50				
5. Per. C.P., O. & N. Al.		5.10.89	Top.	60	5.00	1.064	0.092	137.40	38.00
			Sub.	30	4.30				
6. Dec. C.P., N. Al.		12.4.89	Top.	35	5.00	0.859	0.089	85.00	30.00
			Sub.	25	5.15				
7. Bho. C.P., O & N. Al.		10.10.89	Top.	20	4.85	0.800	0.084	80.00	25.00
			Sub.	N.A.					
8. Hal. C.P., O. Al.		10.6.89	Top.	30	4.90	0.870	0.094	89.00	30.00
			Sub.	25	4.00				
9. N. Pu. F.P., N. Al.		5.5.89	Top.	35	5.00	0.995	0.095	75.00	24.00
			Sub.	30	4.85				

C.P- Central Plain, F.H- Foot Hill, N.Al-New Alluvium, F.P-Flood Plain.

Source : Soil Reports are Collected from Tea Gardens.

well at 4.5 to 5.5 of pH values, above and below this range, the value should be adjusted. The collected samples require no adjustment in this respect. But there are areas within the gardens where the pH sometimes goes up and for that matter, adjustment over certain locations becoming important (It is known during the period of field study). Besides pH value, other plant nutrients play an important role in the production and productivity of tea. For instance, nitrogen promotes quantity and speed of leaf growth, phosphate promotes root growth and potash encourages vigour and help in metabolism. Regarding potash (K_2O), it is stated that on a scale of 10-100 ppm, 80 plus is adequate, below this, remedial doses of potash fertilizers should be applied. In the foothill soils represented by Panbarie, Kacharigaon and Nya Gogra Tea Estates, the status of potash seems to be adequate (as seen from the table- 3.2). Potash is more than sufficient in Monabarie and Feratabghur Tea Estates which are represented by both old and new alluvium soils of the central plain of the district. In Dhekiajali, Bholaguri and Halem, the status of potash is seen adequate. The potash status is low in New Purupbari tea garden which is located over flood plain region characterised by alluvial soils of recent origin. On the other hand, the proportion of nitrogen (N%) in the soil is less than 1 for all tea gardens. Foot hill soils, however, show greater proportion than the soils of central plain and flood plain zone of the district. Assessing the carbon content in the soils of nine sample gardens, it is found that in the foothill soils it is lesser than that of the soils of central plain. Generally, a rich soil has 2 percent organic carbon. Soils below 1 percent are poor and need attention. In between 1 and 2

percent, soil can be said moderate for tea cultivation. It is, therefore, seen that only Panbarie, Kacharigaon, Monabari and Pertabghur have moderate soils so far as carbon content is concerned. Another important element of the soil is the phosphoric acid which shows great variations from garden to garden. Even in the gardens located over the older alluvial soils have shown different proportions of phosphate content. The high or low proportion of this element is the outcome of the age of cropping, rather than the site variabilities. Collected data, however, shows that the foothill regions have less phosphate content than the soils of the central plain. It is stated that (Planters Hand Book, p.8) on a scale of 5-50 ppm, 35 plus is adequate, below this remedial measures should be taken. Monabarie, Pertabghur, Dhekiajuli and Halem have adequate phosphate in this regard and others have less than the cited norms.

Analysing the various climatic and soil elements, it has observed that the variations of these cited elements have some kinds of relationship with the physiographic divisions of the district that discussed in the Chapter II. Each physiographic division has its own ecological setting and is different from one another, although the variation is not sharp. Taking the physiographic units as base and considering the ecological conditions prevailing in various tea gardens (Nine samples), the district can be divided into three distinct zones namely -

- 1) Zone I - Most favourable ecology for tea cultivation represented by the Northern Foot Hill Region.

Table -3.3 : Number of Tea Estates and Areas under Tea, and Sample Gardens in Diifferent Ecological Zones of the District.

ZONE I : Most Favourable Ecology (Northern Foothill)

No. of T.E.	Total Area Under T.E. (h)	No. & Name of Samples	Area Under T.E. (h)
20	7262 (30 %)	1.Panbarie 2.Kacharigaon 3.NyaGogra	395.00 412.89 656.83
Total Area Under Study			1463.00 (20%)

ZONE II: Favourable Ecology (Central Plain)

34	16494 (66%)	4.Halem 5.Monabarie 6.Pertabghur 7.Bholaguri 8.Deckiajuli	577.29 1141.41 938.52 125.22 640.71
Total Area Under Study			3421.00 (20%)

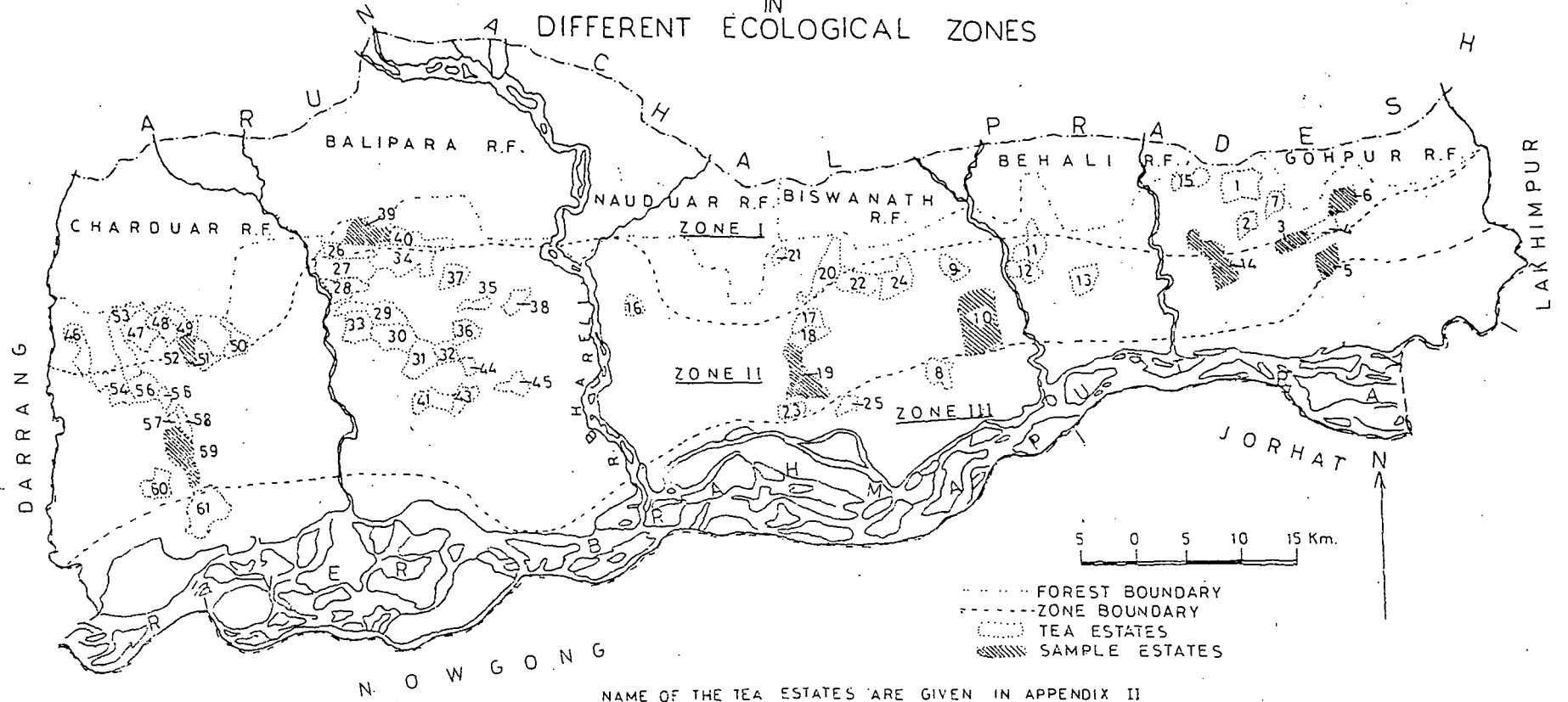
ZONE III: Moderate Ecology (Flood Plain)

4	965 (4%)	9.NewFurupbari	224.84
Total Area Under Stydy			224.84 (4%)

Source : The Assam Directory & Tea Areas Hand Book, 1989-90.

Fig.3.3

DISTRICT SONITPUR
DISTRIBUTION OF TEA ESTATES
IN
DIFFERENT ECOLOGICAL ZONES



- ii) Zone II - Favourable Ecology for tea cultivation represented by the Central Plain Region , and
- iii) Zone III - Moderate ecology for tea cultivation represented by the Flood Plain Region (Map 33.).

The total number of tea gardens in various zones, the number of samples selected for study and its area have been given in the table- 33. . From the table, it is clear that most of the tea gardens are located in the central plain and both the number and area under tea are lesser in the foothill region inspite of its most favourable ecological conditions. In the flood plain region it is still less due to unfavourable ecological condition. In the foot hill regions, the large number of area is under forest cover for which the area under the tea is becoming less. Transport facilities and high density of population lead to the cultivation of tea easier in the zone II.

3. LABOUR INPUT:

Tea is one of the most labour-intensive industries in the world and the production of tea is strongly determined by the quantity and quality of labour. It is stated that labour cost in the tea industry is nearly 37 percent of the total costs involved in the process of production. Out of this, about 20 percent is paid in the form of cash wages, 2 percent as incentive plucking and the remaining 15 percent in the form of fringe benefits (Awasthi, 1989-90, pp.40-41). Therefore, labour force structure be described in detail.

Table -3.4 : Total population, workers and non-workers in various sample tea estates (Zone-wise) of the District.

ZONE I				
Name of the	T.P.	T.W.	T.N.W.	D.R. (%)
1. Panbarie	1395	612 (43%)	783 (67%)	127
2. Kacharigaon	2632	825 (31%)	1807 (69%)	219
3. NyaGogra	5402	1771 (32%)	3631 (68%)	205
Zonal Total	9429	3208 (34%)	6221 (66%)	193
ZONE II				
4. Halem	3927	1317 (33%)	2610 (67%)	198
5. Monabarie	7094	3040 (42%)	4054 (58%)	133
6. Pertabghur	3282	955 (30%)	2324 (70%)	243
7. Bholaguri	619	272 (43%)	347 (67%)	127
8. Deckiajuli	1770	700 (37%)	1070 (61%)	152
Zonal Total	16692	6284 (37%)	10405 (53%)	165
ZONE III				
9. NewPurupbarie	1525	507 (33%)	1018 (67%)	200

T.P. - Total Population, T.W - Total Workers,
T.N.W - Total Non-Workers, D.R. - Dependency Ratio.

Source : Census 1971, Darrang District.

3.a. WORK FORCE:

Initially, the labour was supplied to tea plantations by contractors from various regions of India. With the passage of time, the number of labour population in each and every tea garden has increased considerably, and at present, the tea estates have their own labour stock, sometimes more than sufficient in some gardens. Although 1991 data is not available. Yet a generalised picture of the workforce can be obtained from the table-34 .

It is seen that in the Zone I, i.e., the northern part of the district with most favourable ecological conditions for tea, the share of total workers to the total population was 34 percent during 1971. It is high (37 percent) in zone II, i.e., in the central part of the district with favourable ecological conditions and low in zone III (33 percent), i.e., the flood plain region with poor ecological conditions for tea cultivation. The dependency ratio for Zone I, II and III were 193, 165 and 200 per hundred of workers respectively.

3.b STRUCTURE OF WORKING FORCE IN THE TEA EXTATES:

The proportion of workers employed in tea estates in the district is nearly 8 percent of the total population and about 26 percent of the total workers which is higher than the state's average of 2.8 percent and nearly 10 percent respectively. However, the district represents nearly 18 percent of the total workers employed in various tea gardens of the state.

Table -3.5 : Incidence of Permanent, Casual and Children Workers
(Zonewise)

Zone I					
Name of the Tea Estates	Permanent Farm	Permanent Factory	Casual	Children	Total Permanent
1. Panbarie	676	28	500	31	704
2. Kacharigaon	698	24	480	40	722
3. NyaGogra	1310	41	776	75	1351
Zonal Total	2684	93	1756	146	2777
Zone II					
4. Halem	1257	63	534	55	1320
5. Monabarie	2557	72	1176	78	2629
6. Pertabghur	2022	28	985	70	2050
7. Bholaguri	200	11	75	15	211
8. Deckiajuli	1117	23	1100	60	1140
Zonal Total	7153	197	3870	278	7340
Zone III					
9. NewPurupbari	408	23	100	25	431
Zonal Total	408	23	100	25	431

Source : Collected from Tea Estates, 1991.

3.b.(1) TYPES OF LABOUR:

There are three categories of workers in the gardens, viz. permanent, casual and children. Again there are two in permanent category, i.e., labour in the field and factory and it constitutes the total work force. Accordingly, a permanent worker is one who resides inside the tea-estate and whose name is entered in the estate roll of workers. A worker who is engaged for work mainly for a temporary period is known as casual worker. Workers below 18 year of age are considered as child worker. This group also performs work during a specific period, i.e., in the growing period and engaged for plucking tea leaves or for spraying. The data for various ecological zones of the district (Table- 3.5) denote the following features of the work force.

3.b.(11) DEMOGRAPHY OF LABOUR FORCE:

An important feature of this industry is that it employs more women than any other organised industry. The reasons behind it are, "In the first place that plantation work is only a special kind of agricultural work and is therefore, familiar to Indian women, the vast majority of whom live in rural districts; Secondly, that facilities have been given to male workers to settle on or in the vicinity of plantations, and to take their wives and family with them and finally, that under the old system the labour contracts based on the principle of utilizing every able-bodied persons in the family for labour and of fixing the wage rates accordingly, many women had to seek employment in order to balance

Table -3.6 : Demographic Structure of Working Force (Zonewise)

Zone I				
Name of the Tea Estates	Total Workers	Male	Female	Male-Female Ratio(%)*
1. Panbarie	704	400 (56)	304 (44)	131
2. Kacharigaon	722	346 (47)	376 (53)	92
3. NyaGogra	1351	749 (55)	602 (45)	124
Zonal Total	2777	1495 (53)	1282 (47)	116
Zone II				
4. Halem	1320	800 (60)	520 (40)	153
5. Monabarie	2629	1397 (53)	1260 (47)	110
6. Pertabghur	2050	1575 (76)	475 (24)	331
7. Bholaguri	211	165 (78)	46 (22)	358
8. Deckiajuli	1140	644 (56)	496 (44)	129
Zonal Total	7340	4581 (62)	2797 (42)	163
Zone III				
9. NewPurupbari	431	250 (58)	181 (42)	138
Zonal Total	431	250 (58)	181 (42)	138

* Expressed as the number of male per hundred of female workers.

** Bracketed figures indicate percentage.

Source : Collected from Tea Estates, 1991.

the family budget and although the contract system has been abolished, the wage system and the need for supplementary earnings still remain" (International Labour Organization, pp. 35-36, cf. Awasthi, 1975, p.164). However, the demographic structure of the work force has been presented in the table-3.6 .

In all zones, the share of male worker is higher than that of the female. But in Zone II, male constitutes nearly 62 percent of the work force while in Zone I and III, it is 53 percent and 58 percent respectively. The male-female ratio is highest in Zone II followed by Zone III and Zone I.

3.b.(iii) INTENSITY OF WORKING FORCE:

Although the work in tea plantation and industry seems to be an agricultural in nature, yet it has many features in common with an organised industry. Say for example, there should be intensive drive for producing more tea both in field and factory with the help of labour. The labour turnover in the district is almost similar to that of the state, it being 2.31 labour per hectare in district against the state's average of 2.34 per hectare. The table- 3.7 is an important indicator to evaluate the intensity of working force in different zones. The data shows that the labour input intensity per hectare is very high(2.05/h) in the centrally situated zone which is followed by Zone I i.e., the northern foot hill (1.86/h) and zone III (1.92/h) or the flood plain region. It may be because of cheap available labour force from the surrounding areas of the zone and more labour immigration in this area. The proper transport facility and the means

Table -3.7 : Intensity of Working Force.

Zone I		
Name of the Tea Estates	Workers/h	Mandays/h
1. Panbarie	1.78	911
2. Kacharigaon	1.75	863
3. NyaGogra	2.05	915
Zonal Average	1.86	897
Zone II		
4. Halem	2.28	900
5. Monabarie	2.30	988
6. Pertabghur	2.18	968
7. Bholaguri	1.69	664
8. Deckiajuli	1.78	1021
Zonal Average	2.05	908
Zone III		
9. NewPurupbari	1.92	684
Zonal Average	1.92	684

Source : Collected from Tea Estates, 1991.

of transportation are also the causes for the persuasion of labour force from the other parts of the state. More details and correct picture of labour force intensity can be shown by changing the data of total labour force into mandays. It denotes the actual working days in a year. Thus, the figures of labour force intensity i.e., mandays per hectare for various ecological zones show that the centrally situated zone (Zone II) has the higher intensity (908 mandays/h) because of large number of working population while the zones situated in the northern part (Zone I) and the southern part of the district (Zone III) have low level of intensity (897 manday/h and 684 mandays/h respectively) of labour input, even lower than the state's average of 900 mandays/h.

3.b.(iv) WAGE CONDITIONS:

Majority of the labour force in the tea gardens are employed on piece rates in the plucking season and on time rates for the rest of the year (Choudhury, 1978, pp.24-25). Under the time rate system the labourers are required to complete the task allotted to them within a fixed period. The task is only considered for payment irrespective of the time devoted by the labourers. The operations which are carried on a task basis include pruning, skiffing, cultivation, manuring, planting tree and miscellaneous works like uprooting tea bushes and cutting new drains etc. The work rates differ from garden to garden, from work to work. The task is generally so calculated as to engaged an average labourer for about 7 to 8 hours in the garden. The labourer generally completes the work within a day, if he has

Table -3.8 : Wage Conditions of Workers.

Zone I			
Name of the Tea Estates	Total Wage Rate(Rs.)	Annual Wage Rate/worker(Rs.)	Labour Wage/h (Rs.)
1. Panbarie	5343042	7589	13526
2. Kacharigaon	6239365	8641	15144
3. NyaGogra	8210298	6077	12499
Zonal Total	19792705	7127	13528
Zone II			
4. Halem	9129000	6951	15821
5. Monabarie	17462747	6642	15304
6. Pertabghur	13123594	6401	13991
7. Bholaguri	2034000	9639	16272
8. Deckiajuli	9012198	7905	14081
Zonal Total	50751529	6914	14835
Zone III			
9. NewPurupbari	2358235	5471	10488
Zonal Average	2358235	5471	10488

Source : Collected from Tea Estates, 1991.

not completed then either he receives proportionate payment or is allowed to complete the work the very next day. In a factory, however, a worker is paid a fair wage on completion of 8 hours duty. If the worker is required to work for extra hours the over-time allowance at the specified rate is paid which is double than the ordinary rate of wages. In case of agricultural operations, it is only one and half time of the ordinary rate of wages (Awasthi, 1975, pp.170-180). But, there are variations of wage rates according to age. Generally, the adults receive the wages @ Rs. 18.53 while for children, it is half, i.e., Rs.8.77. The piece rate system is applicable in case of plucking green leaf. The pluckers normally get money according to the weight of the leaf plucked. Within the district plucking rate is uniform @Rs.0.69 per Kg. of green leaf. In the table- 3.8 , total wage rate, annual wage rate per worker and labour wage per hectare is given. It is apparent from the data that the total wage rate has a kind of relationship with size of the gardens. But in the matter of annual wage rate per worker, it is found that in the northern zone (Zone I) of the district, the value is Rs.7127/- which is higher than the central zone (Zone II), Rs.6914/-. In the southern zone (Zone III), of the district, the average annual wage rate is only Rs.5471/-. Labour wage per hectare is most important in increasing the level of productivity. It is low in Zone I which is ecologically most favourable for tea, but high in Zone II with favourable ecology. Although the labour wage/h is very low in Zone III, it is not because of the good ecological condition, but due to the fact that there is only one sample from this zone and is, therefore, not sufficient to reflect the pattern. On the other hand, it can

be said that in Zone I, the labour/h is only 1.86 but in Zone II, it is 2.05/h. Low labour/h means the higher work load and consequently higher wage rate and vice-versa. Since the mandays/h is low in zone I and III, therefore, labour wage/h is also low in this two zones, while opposite is the case seen in Zone II.

NON-LAND CAPITAL INPUT:

Besides land and labour inputs, non-land capital input plays a significant role in the cultivation of tea. It includes the machine maintenance cost and factory electrification, costs of chemical fertilizer and pesticides used for plant growth and the transport cost also. It obvious that tea leaf has to undergo several physical and chemical changes before it is placed for consumption, These changes require the provision of specially constructed buildings and machineries. Moreover, it also includes five different processes which require close and skilled supervision. These processes are withering, rolling, fermentation, drying, shifting and grading. The machines involved in these processes need large amount of capital. At the same time, for better production tea needs large amount of chemical inputs like fertilizer, insecticide, pesticide, weedicide, etc. A considerable proportion of money is invested in this sector. For carrying green leaf and other materials, transport becomes an indispensable part of this industry. In table- 3.9 , the non-land capital inputs for different sample gardens are presented.

Table -3.9 : Non-Land Capital Inputs in Different Tea Estates
(zone wise).

Zone I						
Name of the Tea Estates	(a)	(b)	(c)	(d)	(e)	(f)
1. Panbarie	1401815	3548	962850	2437	378000	956
2. Kacharigaon	818792	1987	812645	1968	294193	714
3. NyaGogra	1058000	1610	1092088	1659	1058000	1612
Zonal Total	3278607	2241	2867582	1960	1730192	1182
Zone II						
4. Halem	1200000	2078	1014317	1757	800000	1386
5. Monabarie	2456376	2152	1882695	1650	1215000	1064
6. Pertabghur	2000000	2131	1825885	1945	1049449	1118
7. Bholaguri	00	00	154370	1235	48843	390
8. Deckiajuli	889000	1387	1713000	2676	996608	1557
Zonal Total	6545375	1970	6590627	1926	4109900	1201
Zone III						
9. NewPurupbari	9012752	1791	309459	1381	91897	410
Zonal Total	9012752	1791	309459	1381	91897	410

Abbreviations:

- (a) Machine Maintenance Costs and Factory Electrification Costs (Rs.).
- (b) Cost in rupees Per Hectare.
- (c) Chemical Inputs Including Fertilizer, Insecticide and Pesticide (Rs.).
- (d) Chemical Inputs Per Hectare (Rs.).
- (e) Garden Transport Costs (Rs.)
- (f) Transport Cost Per Hectare (Rs.).

Source : Collected from Tea Estates, 1991.

So far as machine maintenance cost and factory electrification is concerned, it is found from the table that non-land capital cost is very high (Rs.2241/h) in the northern zone followed by the central zone (Rs.1970/h) of the district. It cannot be generalised from the data that the cost is related to the ecological conditions. Infact, the cost may become more if there is any kind of replacement of machines. Otherwise, it will remain almost proportional to the number of machines that exist in the gardens. However, the matter is different in case of the use of chemical inputs per hectare. The data shows that (Table 10) the chemical input per hectare is higher in zone I than the zone II and III. But the use of fertilizer (N, P & K) is lower in zone I (469 Kg/h) than zone II (556 Kg/h). In Zone III, the proportion is only 360 Kg/h. On the other hand, other chemical inputs like insecticide, pesticide, weedicide, etc. used in zone I remain higher than zone II and III. It is found that Zone I is surrounded by forest and hence the incidence of pests and diseases is higher. Therefore, the total costs involved in total chemical inputs is highest in this zone. This situation is not prevailing in zone II and zone III. They are making less investment on insecticide and pesticide. Transport cost is another important factor in tea cultivation. For carrying materials to and from the gardens, it becomes essential. This cost is determined by two factors, viz., distance and the size of the gardens. The zone II has recorded larger transport cost than zone I and III. Large size gardens are located over the zone II and they need large amount of material to continue the factory activities.

At the same time, large size gardens have produced more green leaf and the carrying of green leaf from the field to the factory is higher in this zone. Zone II and III has small size gardens and require less investment in this sector.

In the end, it can be concluded that the variations in the ecological conditions and input costs in tea cultivation have direct impact on the quality and production of tea in the district. So, the study of tea production and productivity is required separately in detail. It is done in the next chapter separately.

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CHAPTER IV

PRODUCTION AND PRODUCTIVITY OF TEA

CHAPTER IV

INTRODUCTION:

In the previous chapter, the input component and the production factors of tea cultivation in Sonitpur district have been interpreted. It is obvious from the facts already cited that tea is a labour intensive and technology oriented commercial crop. Thus, the operations of tea production processes are to be studied by establishing relationship between the output and input components of system. In this chapter, an attempt has been made to examine the tea production and productivity under various ecological conditions. At the same time, functional analysis of tea productivity would be attempted to understand the priorities of the production factors for preparing the strategy of yield-optimisation.

TEA PRODUCTION AND PRODUCTIVITY:

The plantation and manufacturing of tea is the major industry in the state. In the national scenario, the state's share in terms of production is more than 50 percent. Similarly, out of the total land of 4.14 lakh hectares under tea in the country, the state alone covers 2.2 lakh hectares, representing more than 54 percent of the country's total area. Since the inception of this very industry in 1837, both the production and acreage of tea has been increasing in the state. It is found that in 1971, the total area and production of tea in the state was 1.8 lakh hectares and 223.6 million Kg respectively.

This scenario, however changed to a considerable extent by the following decades. For instance, the area was increased to 2.27 lakh hectares in 1989-90. Similarly the level of production rose to 299 million Kg in 1982-83 and 379 million Kg. in 1989-90. These changes which took place during the last decades reflect some interesting features in respect of both the area and production levels. The horizontal expansion of tea area which proceeded at an annual rate of 1.44 percent during 1971-1982 has come down to a rate of only 0.94 percent during 1982-1990. This trend indicates that in the coming years, the possibility of increasing the area under tea would be becoming more less, which finally will prove that the scope of increment of tea production by bringing more area under tea is being limited. And as such, an alternative approach to reach the expected goal has to be adopted. Here in lies the significance of vertical expansion, or in other words, the strategy of a raising the productivity of tea per hectare of land. So far as the level of production is concerned, the state reflect an optimistic trend. It is found that the annual growth rate of tea production during 1971-1982 was 3.09 percent which has increased to 3.44 percent during 1982-1990. Significantly enough, the yield per hectare has been increasing at an annual rate of 1.4 percent between 1971-1981 and 2.3 percent between 1982-1990. The yield per hectare in 1971 was 1227 Kg which had reached the level of 1415 Kg in 1981 and 1674 Kg in 1990. The scope to increase the yield is still large while comparing it with other tea producing regions (e.g., 2020 Kg/h in Karnataka, 2290 kg/h in Tamil Nadu etc.).

Since the district occupies an important position in terms of area and production of tea in the state, it reflects some notable features that deserve elaboration. The total land under tea in the district was 23630 hectares in 1980 (4.4 per cent) and it has increased to 2472 hectares in 1989-90 (4.7 percent). It presents the picture that during the decade the expansion of the area under tea was only 91 hectares and the annual rate of expansion was very less, only 0.47 percent, lower than the state's average. That means in the district the area to bring under tea is very low. On the other hand, the total output of tea in the district was 40.5 million Kg. in 1980 and 49.6 million Kg in 1989-90. It shows that the annual rate of growth is only 2.25 percent, lower than the state's average. The yield per hectare was 1717 Kg in 1980 which had increased to 2007 Kg by 1989-90. The yield, however, is higher than the other tea producing districts in the state except Dibrugarh (1931 Kg/h). The yield rate has been increasing at a rate of 1.68 percent annually, but the rate is lower than that of the state. The importance of the district, however, lies in the fact that it represents more than 10 percent of the total tea cultivated land of the state and contributes more than 13 percent to the total production. At the same time, the district has 58 tea estates against the State's total number of 845, thus represents nearly 7 percent of the total tea estates of the state (Tea Areas Hand Book, 1989-90).

PRODUCTION AND YIELD IN VARIOUS ECOLOGICAL ZONES:

The tea industry in the district is little more than a century old and inspite of all the stresses and strains that it came across, the industry continues to make rapid strides both in production and acreage as well as yield. The credit for pioneering tea industry in the district goes to Mr. Martin who, in 1854, opened a plantation at Balipara and in 1857 started a garden at Holeswar (Gazetteer, 1978, pp.222-225). Gradually, the plantation work started spreading in different ecological zones with various levels of production and yield. In table- 4I, the pattern of production and level of yield for different sample gardens from various ecological zones have been presented.

The collected data from different ecological zones reflect on opposite picture. The zone which is believed to be characterised by most favourable ecology (i.e., zone I) has shown lower yield/h than the zone II. The lowest yield in Zone III is the outcome of poor ecological conditions. But the yield is not a simple function of the climatic and soil factors alone, in fact it is determined by some other non-physical factors like labour, capital, etc. The zone II, however, has achieved the ultimate target in terms of production and yield which is higher than both the state and district averages. This zone is successful in making an effective relationship among the production factors. In this sense, the zone I and III has much larger scope to enhance the production and yield by putting

Table -4.1 : Tea Production and Yield in Different Tea Estates
(zone wise).

ZONE I		
Name of the Tea Estates	Production ('000kg.)	Yield(kg/h)
1. Panbarie	900	2278
2. Kacharigaon	700	1696
3. NyaGogra	1344	2047
Zonal Total	2944	2007
ZONE II		
4. Halem	1125	1948
5. Monabarie	2721	2384
6. Pertabghur	2022	2154
7. Bholaguri	145	1160
8. Deckiajuli	1708	2666
Zonal total	7721	2062
ZONE III		
9. NewPurupbari	260	1156
Zonal Total	260	1156

Source : Data Collected From Tea Gardens, 1991.

the production factors into a systematic manner. However, zone I and II is influenced by favourable ecology for which the levels of yield show higher ratio than the district and state.

PRODUCTIVITY: THE CONCEPT AND METHOD:

Productivity is a relative term. It reflects the relationship between the amount that is produced and the work, money etc. that is needed to produce it (Longman dictionary, 1992 p.826). The level of productivity is determined in relation to land, labour and capital, the factors of production, while measurements are made for each factor separately, it will indicate the relative importance of one factor over the other. To examine the productivity of tea in the district against the factors of production, viz., land, labour and non-land capital, the following methods have been used:

(a) Land Productivity - Infact, land productivity is simply the average yield of a crop or crops. In the present context, the productivity of tea crop is the ratio of total tea production of a particular tea estate with its total area under tea cultivation. In physical term, it is therefore the average yield of tea crop is written as:

$$Y_1 = P/A, \quad \dots(4.1)$$

Where P is the total production of tea(Kg),

A is the area under tea cultivation.

Further, it can be said that the prices of the tea product is also important attribute which directly or indirectly influences the tea productivity because it is a commercial crop. To incorporate the price attribute of the tea production, tea productivity has also been calculated in its value-added term as:

$$Y_1 = [(P.p) / A] \dots(4.2)$$

Where p is market price of tea and the other notations are given above.

(b) Labour Productivity - The calculation of labour productivity is a difficult task because the data of the effects of labour on production processes are not available separately. Infact, total production is the result not only of the labour but of the other production factors also. Total production of tea data is available. Therefore, total production per person or per labour force in mandays is defined as labour productivity. It is obvious that tea is labour intensive activity and employment statistics of labour force in persons and in terms of man days are available. Thus, two indices of labour productivity are prepared. They are as:

$$Y_1 = [(P.p) / L], \dots(4.3)$$

$$\text{and } Y_{1m} = [(P.p) / L_m] \dots(5.4)$$

Where Y_1 is tea output per person, L is total labour labour force employed in the production activities, Y_{1m} is output per unit of labour in terms of mandays,

Lm is labour force in mandays.

(c) Non-Land Capital Productivity - Non-Land capital includes the capital invested on technological factors like machine maintenance cost, factory electrification, chemical cost, garden transport cost etc. It does not include the land costs for calculating productivity productivity. Thus, non-land capital productivity is simply the output per unit of technology employed in tea production. The equation is

$$Y_c = |(P.p)/NLC|$$

Where Y_c is the non-land capital productivity

NLC is the total non-land capital cost(in Rs)

This will show the capital productivity and is expressed as the Rupees per hundred rupees of capital.

PRODUCTIVITY IN VARIOUS ECOLOGICAL ZONES:

To measure the productivity of land, labour and capital, relevant informations are collected from the tea gardens and presented in the table. Moreover, the pattern of land, labour and non-land capital productivity for different ecological zones of the district is shown in fig.4.1 . The data shows that in all zones the productivity of land is higher than that of the labour and capital. It is so because the land is a base upon which labour and capital interacts with each other. The land productivity, while compared among the zones is found highest in zone II. The yield per hectare in this zone is 2062

Table -4.2 : Land, Labour and Non-Land Capital Productivities of Tea in Different Ecological Zones.

ZONE I							
Name of the Tea Estates	Y1	(a)	Y2(i)	(b)	Y2(ii)	(c)	Y3
1. Panbarie	98181	178	551.57	911	107	4941	1987
2. Kacharigaon	73097	175	417.69	863	84	4669	1566
3. NyaGogra	88225	205	430.36	915	96	4881	1807
Zonal Average	86501	186	466.54	896	96	4805	1786
ZONE II							
4. Halem	83958	228	368.23	900	93	5221	1608
5. Monabarie	102750	230	446.73	988	103	4866	2112
6. Pertabghur	92837	218	425.85	968	95	5194	1787
7. Bholaguri	49996	169	295.83	664	75	2785	1795
8. Deckiajuli	114904	178	645.52	1021	112	4120	2788
Zonal Average	88889	204	436.42	908	95	4437	2018
ZONE III							
9. NewPurupbari	49823	192	259.49	684	72	3582	1390
Zonal average	49823	192	259.49	684	72	3582	1390

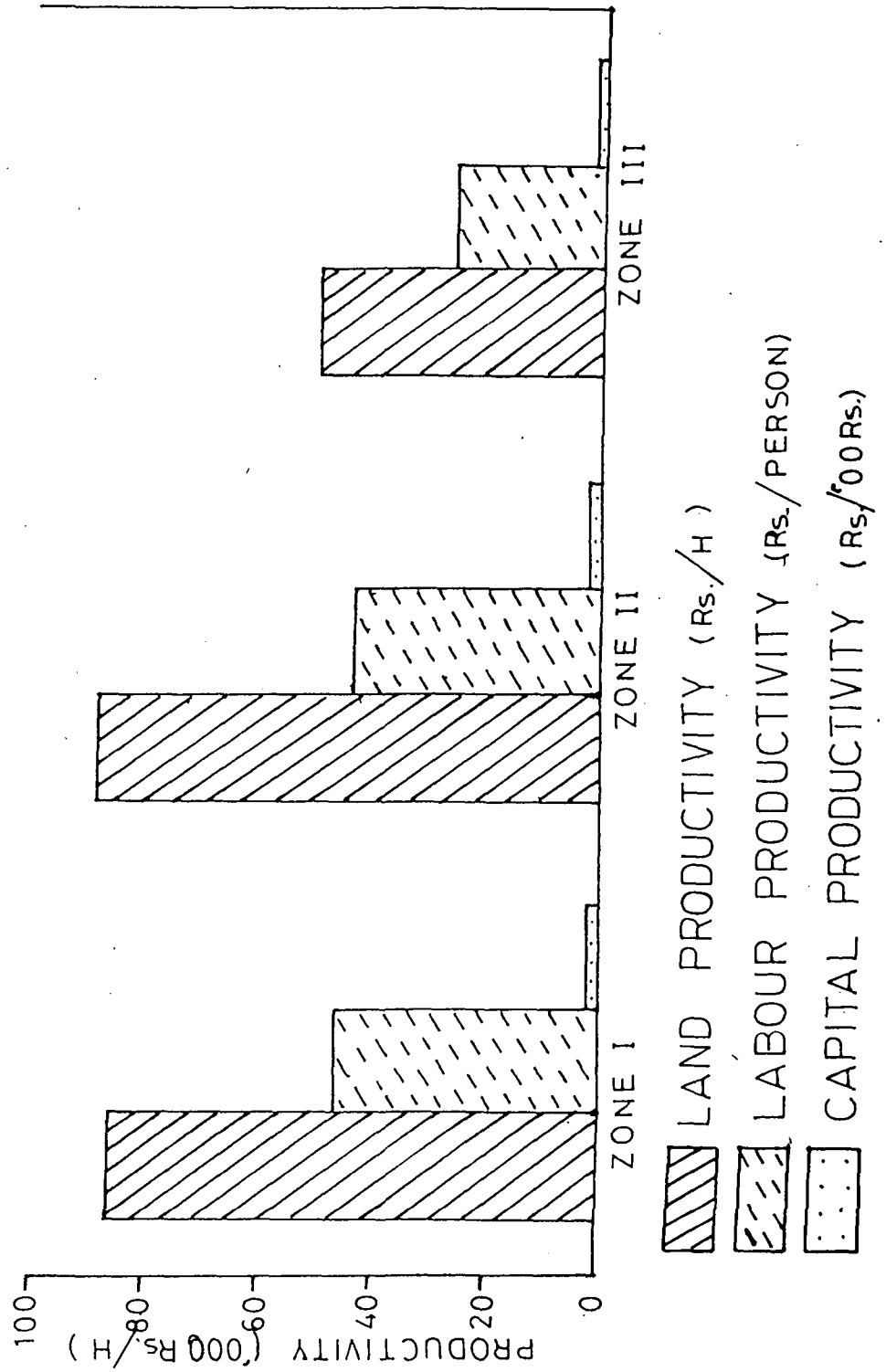
Abbreviations:

- Y1 - Land Productivity (Rs./h)
- Y2(i) - Labour Productivity (Rs./'00 persons).
- Y2(ii) - Labour Productivity (Rs./Person/Day)
- Y3 - Non-Land Capital Productivity (Rs./'00 Rs.)
- (a) - Workers/'00 hect. of Land
- (b) - Mandays/hect.
- (c) - Non-Land Capital Input (Rs./hect.)

Source : Data Collected from Tea Estates, 1991.

DISTRICT SONITPUR
 LAND LABOUR AND CAPITAL
 PRODUCTIVITY OF TEA

Fig 4.1



Kg per hectare. In terms of money, it is Rs.88,889/- (converted it into Rs. by taking the market price of tea, which Rs.43.10/- in 1990-1991, Tea Board, p.13). In this respect, zone II is followed by zone I and III respectively. Productivity in terms of labour is higher in zone I followed by zone II and III, but the capital productivity is higher in zone II and lower in zone I and III. It is seen that there are zonal variations of productivity level and at the same time intra-zonal variations are also no less significant. The probable causes behind this variations of land productivity can be explained in terms of the following statement. The gardens in the hills, more so in North-East India, have bushes which are highly Chinese hybrid. The characteristic of these bushes is, their leaves are smaller than the Assam jats. As the hill gardens place more stress on quality, the general practice is fine-plucking: i.e., two leaves and a bud. This is done by plucking on 'five or six day round'. However, in the plains where more of C.T.C. (crushing, tearing and curling) manufacture is resorted to, the style of plucking is coarser, i.e., three leaves and a bud. Therefore, the plucking is on 'seven to nine day round'. Moreover, leaves on tea bushes in the plains are broader and larger. This gives greater quantity of leaf per hectare (Manoharan, 1974, p.72). During the period of field study, it has been confirmed that the ratio between green leaf and made tea which is 4.5:1, is almost same every where in the district. It is therefore apparent that higher productivity of land in zone II located over the plains is the outcome of greater quantity of green leaf per hectare of land.

The second important factor operating behind the higher productivity of land is the use of labour input per hectare. It is seen from the data (table-42) that labour per hundred hectare in zone II is 204 while in zone I and III, the proportions are 186 and 192 respectively. The inference is that if the labour input is high, productivity per hectare is also high. Zone III is an exception in this regard. It shows very lower rate of productivity not only because of less labour input but also because of some natural hazards like flood which caused low production during 1991. While land productivity is incorporated with the mandays per hectare, the picture becomes more clear. The mandays per hectare in zone II is 908, but in zone I and III, it is only 896 and 648 respectively. The higher is the number of mandays per hectare, the greater is the level of land productivity. The fact is established by the situation prevailing in different ecological zones of the district. The similar scenario has been reflected by capital input per hectare, more specifically by the use of chemical fertilizer and insecticide. The larger investment of capital in this sector has secured better outcome.

The intra-zonal variation of land productivity is also seen to be an outcome of the interplay of labour and capital input per hectare. For example, Deckiajuli tea estate in zone II has the highest number of mandays (1021/h) and largest amount of chemical input (Rs.2676/h). Consequently, it shows a better out turn of the tea. But opposite is the case prevailing in

New Purupbari tea estate where both the mandays and chemical input per hectare are exceptionally low.

There are the variations of labour productivity in the district from zone to zone. It is seen from the data that the labour productivity i.e., Rupees per hundred person are found higher in zone I followed by zone II and III. In zone I and III, both the labour and mandays per hectare are lower than that of the zone II. But the labour productivity per hundred person in zone I is Rs.466.54/- while in zone II the amount is Rs.436.43. At the same time productivity per person per day in zone I is Rs.96.00 against Rs.95.00 in zone II. In this respect, i.e., productivity per person per day from one hectare of land, the variation is less. Greater intensification of labour input can cause more productivity in case of tea production system. In the northern foothill, labour productivity is higher perhaps because of its favourable geographical location. In zone III, the situation is not comparable with other zones as it is surrounded by many more difficulties because of its unfavourable ecological conditions. Here the labour productivity per person per day is Rs.72.00. The inference is that large number of labour input under favourable ecology gives greater output to the land as well as higher labour productivity ratio.

Non-land capital productivity in different zones of the district shows some more significant features. It is highest in zone II followed by zone I and III. Like the labour input

per hectare, non-land capital input per hectare is higher in zone I and lower in zone II and III respectively. It is found that in zone I the non-land capital productivity is Rs.1876 per hundred rupees while in zone II and III, the amount is Rs.2018 and Rs.1390 per hundred rupees respectively. Zone I invests much more capital over land for which the productivity per rupee becomes less. On the other hand, zone II has less share in this sector which consequently leads the greater capital productivity per rupee. Since the land productivity in zone III is low, non-land capital productivity is also low. But the significant aspect in the tea industry is that here the investment of one hundred rupee can make more than Rs.1700 per year from each hectare of land. Perhaps no other agro-based industry in India or elsewhere can convert its original investment more than seventeen times greater as the tea industry does. Although the industry requires large amount of capital, it is not difficult for it to get back the already invested money within a short span of time.

FUNCTIONAL ANALYSIS OF TEA PRODUCTIVITY:

In this section, an attempt is made to critically review the production function. The production function is a function of certain number of input variables that indicates the 'maximum' possible output that can be obtained from the transformation of a certain combinations of inputs (Ashok Rudra, 1982, p.254). The analysis of production function tells what kind of output

changes are observed to accompany changes in input combinations as one passes from farm to farm (Raju, 1987, p.21). The second aspect of this section is to examine the functional relationship between the production (i.e., yield) and the various production factors. This would be done so that the impact of various inputs and/or the combination of production factors on production increase can be found out to identify their importance. For this reason, three important aspects of production function for tea cultivation in Sonitpur district are studied here. The first aspect of production function is to generation of explanatory variables on the basis of some valid norms and hypotheses and their testing in the real world situation. Some variables which have co-linearity in spatial variance can be dropped out because they may create problem to infer the results. The second aspect of the production function is to choose the best fitted curve or line for the distribution and its co-efficients with the degree of areal variance. It is evident from the facts inferred in the previous sections of the present chapter that the distributional patterns of tea production against input variables follow more or less linear tendencies. Therefore, step wise linear regression analysis must be the suitable tool for inferring areal variance results. The mathematical form of regression analysis has already been described in chapter I. The third aspect of production function function is associated with the interpretation of the results which are produced by the regression analysis. Step-wise regression analysis would yield the functional priorities and the importance of production factors. Thus, the detail

discussion regarding these aspects of the functional analysis of tea production are given in the following manner.

GENERATION OF VARIABLES:

Since tea is a kind of specialised agriculture, both ecological and non-ecological factors play significant role in determining the volume of its production and levels of its productivity. The 'optima-limit theory of agricultural growth' propounded by Mccaraty and Lindburg (1956) generalises the facts that the agricultural production is controlled by the ecological conditions. Therefore, the variables related to agro-ecological conditions namely, rainfall, temperature, humidity, evaporation, sunshine, relief, soil conditions etc. are to be incorporated in understanding the areal variations of tea production in the study area. In fact the study area is a micro-areal unit (every small in its extent) and hence the climatic conditions are homogeneous throughout. Climatic conditions vary over time which have already been studied in detail in chapter III. They are not included here for the functional analysis of tea production. But soil elements vary even at micro-areal unit which have been included in the present analysis. They are four in number, namely carbon(X2), nitrogen (X3), potash(X4) and phosphate(X5). Further, tea estate size is an important organisational component of tea production because the effects of technological factors and socio-cultural variables may vary according to the size of the estate. Therefore, size of the tea estates as variable number X1 is included

The third group of explanatory variables related to the intensity of workforce in the tea estates. They are workers per unit of land(X6) and mandays per year per unit of land(X7). In fact, work days may vary according to the season and hence the average for whole year is used for the purpose.

The fourth group of explanatory variables is related to technological and transport costs (i.e., called non-land capital inputs). It incorporates five variables, namely fertilizer(X8), insecticide and pesticide(X9), machine maintenance and factory electrification costs(X10), garden transport cost (X11) and irrigation(X12). These variables are interdependent and inter-related in their uses and hence they form a complex nature of their effects on tea productivity. The clear cut grouping of these variables and their definitions are given in table 4.3.

Table - 4.3 Name of the Explanatory variables and their unit.

Explanatory variables	Units
A. Organizational	
1) Size of the tea Estate	(X1)
B. 1) Ecological (especially soil)	
2) Carbon percent in soil	(X2)
3) Nitrogen percent in soil	(X3)
4) Potash content in soil	(X4)
5) Phosphate content in soil	(X5)

C. Non-Ecological (especially labour)

- | | | |
|----|---------------------|------|
| 6) | Workers per hectare | (X6) |
| 7) | Mandays per hectare | (X7) |

D. Technological

- | | | |
|-----|-------------------------------------------------------------------|--------|
| 8) | Fertilizer (in Kg/h) | (X8) |
| 9) | Insecticide and pesticide(in Rs/h) | (X9) |
| 10) | Machine maintenance and Factory
electrification cost(in Rs./h) | (X10) |
| 11) | Garden transport cost (Rs./h) | (X11) |
| 12) | P.C. of irrigated area | (X12). |
-

In generating these variables for the explanation of tea productivity, it is assumed that there are the most significant variables for functional analysis. But their validity can be tested to prepare a symmetric correlation matrix of 12 X 12 dimensions which must explain co-linearity problem in order to drop out some variables for further operations (Table 4.4).

DROPPING OUT OF THE VARIABLES:

A careful examination of the correlation matrix (Table 4.4) has indicated some non-colinearity within the independent variables which is reduced by dropping of them. For example, potash (X4) and phosphate (X5) of the soil are highly correlated with each other ($r = .8566$). Therefore, phosphate (X5) as a variable is dropped because its contribution to the explanation of productivity is already incorporated in the potash (X4) varia-

Table -4.4 : Correlation matrix of Explanatory Variables (12 x 12)

Sl. No.	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂
X ₁	1.00	.64	-.07	.84	.79	.76	.82	.70	.31	.31	.59	.43
X ₂		1.00	.37	.59	.21	.46	.39	.20	.59	.62	-.02	.36
X ₃			1.00	-.16	-.43	-.26	.10	-.12	.37	.50	-.20	.59
X ₄				1.00	.86	.67	.53	.40	.22	.17	.21	.08
X ₅					1.00	.69	.60	.45	-.04	-.01	.44	-.01
X ₆						1.00	.43	.26	.01	.26	.44	-.01
X ₇							1.00	.79	.53	.48	.82	.79
X ₈								1.00	.27	.02	.63	.54
X ₉									1.00	.83	.17	.68
X ₁₀										1.00	.23	.61
X ₁₁											1.00	.58
X ₁₂												1.00

ble. Similarly, mandays/h (X7) and transport cost(X11) are highly correlated ($r=.8204$) and as such the transport cost (X11) is dropped from the analysis. Mandays/h(X7) is more meaningful than the workers/h(X6) and therefore, the latter is dropped from the analysis. Although, the size of the estate (X1) and potash (X4) are highly correlated ($r=.8422$), none of them is dropped because the productivity in relation to the size of the estate is more useful. Finally, nine explanatory variables are included for step-wide linear regression analysis. On the other hand, three variables of tea productivity, namely land(Y1), labour(Y2) and non-land capital productivities(Y3) as dependent variables are taken into account for observing the effects of explanatory variables on these productivity variables. The name of these variables are given in table - 4.5.

Table - 4.5 : Finally selected explanatory variables for Step-Wise multiple-Regression Analysis.

Name of the Variables	
A.	Productivities as Dependent variables.
	1. Land Productivity(Y1)
	2. Labour Productivity(Y2)
	3. Non-Land Capital Productivity(Y3)
B.	Explanatory (Independent) Variables.
	1. Size of the tea Estate (X1)
	2. Carbon Percent in Soil (X2)

3. Nitrogen Percent in Soil(X3)
 4. Potash content in Soil (X4)
 5. Mandays/h (X7)
 6. Fertilizer(in Kg/h) (X8)
 7. Insecticide & Pesticide (Rs./h) (X9)
 8. Machine Maintenance, etc. (Rs./h) (X10)
 9. Irrigation (X12)
-

ANALYSIS:

The analysis of the results is arranged into three heads by following the interpretation of tea productivity patterns, patterns of explanatory variables and their effects on productivity. The salient features of the analysis of tea productivity are described in detail in the following way.

a. Distributional Pattern of Productivity Variables:

The distributional pattern of land, labour and non-land capital productivity variables show different pictures, as evident from the following analysis.

a.(1) The distributional pattern of land productivities is given in Table-4.6. It is seen that with the increase in size of the land i.e., tea estate, productivity is also increasing but the rate of change in productivity is decreasing. Tea estates belong to the size class of 900-1000ha. has the maximum productivity level beyond which the change in productivity becomes zero (Fig.4.2a). There is a positive rela-

Table -4.6 : Distributional pattern of Land Productivity.

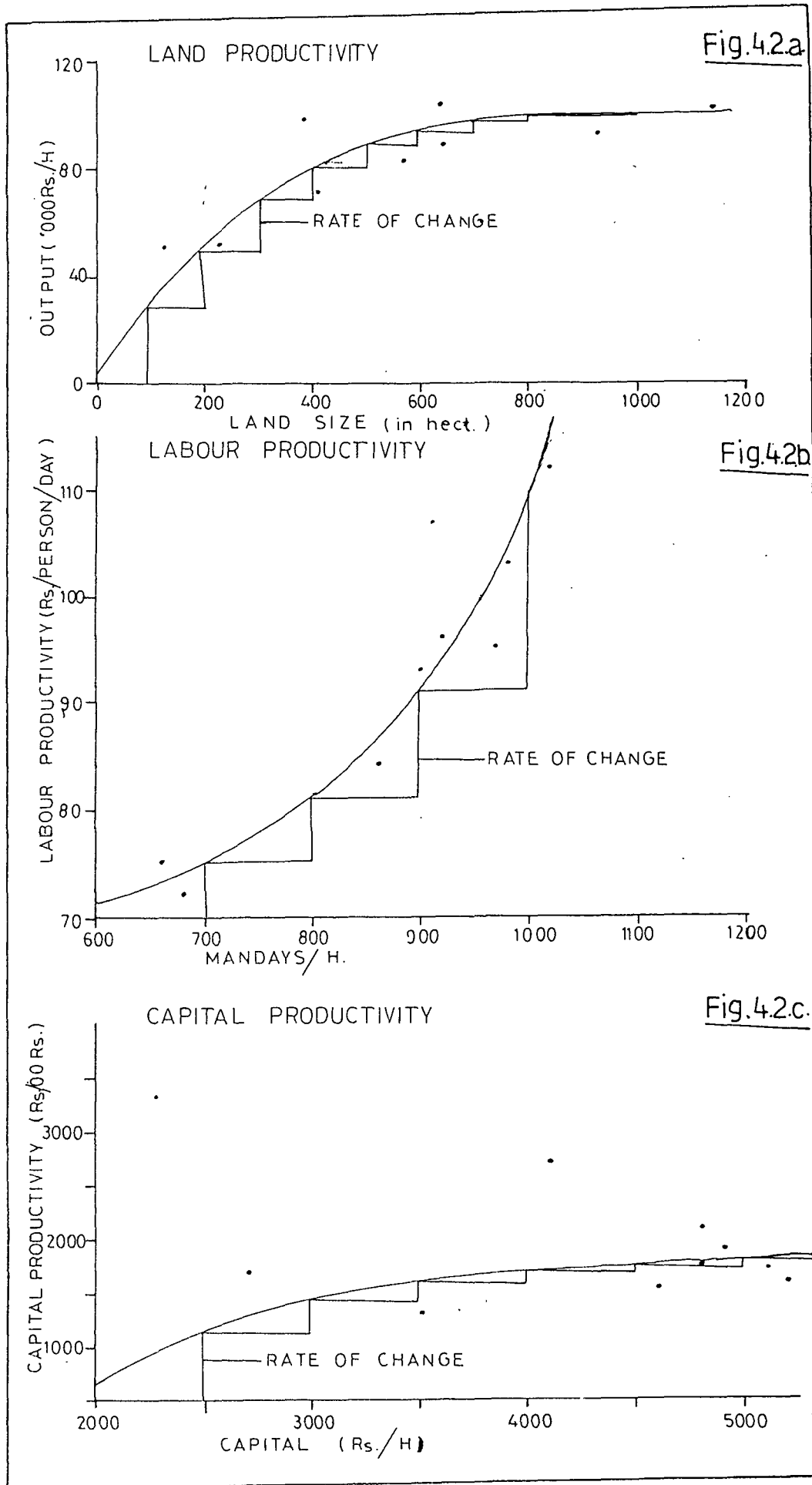
Land Size classes(h)	Productivity Level (Rs./h)	Change in Productivity(in Rs.)
0-100	27000	21000
100-200	48000	19000
200-300	67000	13000
400-500	88000	8000
500-600	92000	4000
600-700	96000	4000
700-800	98000	2000
800-900	99000	1000
900-1000	100000	1000
1000-1100	100000	0000
1100-1200	100000	0000

Table -4.7: Distributional Pattern of Labour Productivity.

Labour Size classes(Mandays/h)	Labour Prod. Level (Rs/person per day)	Change in Productivity (in Rs.)
600-700	75	6
700-800	31	10
800-900	91	19
1000-1100	132	22

Table -4.8 : Distributional Pattern of Non-land capital Productivity.

Capital Input classes(Rs./h)	Productivity level(Rs./unit of Rs).	Change in Productivity(in Rs.)
1500-2000	6	5
2000-2500	11	3
2500-3000	14	2
3000-3500	16	2
3500-4000	17	1
4000-4500	18	1
4500-5000	18	0
5000-5500	18	0



relationship between the size of the tea estates and the level of land productivity but the rate diminishes. It means that larger size of tea estates have more facilities of adopting new technology of tea processings. Therefore, the size of the estate and technological factors must be positively related.

a.(ii) The distributional pattern of labour productivity shows an opposite stance (Table - 4.7) and it is found that as the labour input increases the level of productivity with its rate of change also increases. It means labour productivity curve is convex in nature (Fig.4.2b). But it does not mean that it has no maximum limit. It is not predictable from the figure only because of the less number of observations. However, the curve shows the possibility of further engagement of workers in the process of tea cultivation.

a.(iii) The distributional pattern of non-land capital productivities is shown in table - 4.8. It reflects that non-land capital productivity increases with its decreasing rate of change when this input is intensified in the tea production process (Fig.4.2c). The maximum limit of non-land capital size belongs to the class of Rs.4500-5000 and beyond it the rate of change is equal to 3000. It means that the investment of capital in tea production process is influenced by the law of diminishing return.

Table -4.9 : Areal Variations of Explanatory Variables and Dependent Variables (Y1,Y2,Y3)

ZONE I								
Sl. No.	Y1	Y2	Y3	X1	X2	X3	X4	X5
1.	98181	107	1987	395	1.057	0.119	80.00	23.00
2.	73097	84	1566	412	1.010	0.154	81.00	24.00
3.	88225	96	1807	656	0.967	0.096	82.00	29.00
Zone II								
4.	83958	93	1608	577	0.870	0.094	89.00	30.00
5.	102750	103	2112	1141	1.224	0.105	123.80	31.00
6.	92837	95	1787	938	1.064	0.092	137.40	38.00
7.	49996	75	1795	125	0.809	0.084	80.00	25.00
8.	114904	112	2788	640	0.859	0.089	85.00	30.00
Zone III								
9.	49823	72	1390	224	0.995	0.95	75.00	24.00
X	83752	93	187.1	567.5	0.983	.1031	92.57	28.22
SD	21215	12.9	383.3	306.7	.120	.036	20.88	4.51
CV	.253	.138	.204	.540	.122	.349	.225	.159

ZONE I

Sl. No.	X6	X7	X8	X9	X10	X11	X12
1.	1.78	911	459	830	3548	956	80
2.	1.75	863	453	382	1987	714	78
3.	2.05	915	480	319	1610	1612	60

Zone II

4.	2.28	900	480	300	2078	1386	40
5.	2.30	988	632	530	2152	1064	60
6.	2.18	968	480	450	2131	1118	40
7.	1.69	664	430	200	NA	390	NA
8.	1.78	1021	658	400	1387	1557	70

Zone III

9.	1.92	684	360	250	1791	410	NA
X	1.97	879.33	492.44	406.77	1853.7	1023	47.5
SD	.225	118.89	89.10	177.41	870.6	428.33	28.73
CV	.114	.135	.181	.436	.469	.418	.604

\bar{X} =Mean, SD=Standard Deviation, CV=Coefficient of Variations

Y_1 =Land Productivity (Rs./h)

Y_2 =Labour productivity in
Rs./person/day

Y_3 =Non-Land Capital
Productivity(Rs./ '00Rs.)

X_1 = Land size (h)

X_2 =C% on dry wt. basis.

X_3 =N% on dry wt. basis

X_4 =ppm available K_2O

X_5 =ppm available P_2O_5

X_6 =Workers/h

X_7 =Mandays/h.

X_8 =Fertilizer (N,P,K), Kg/h

X_9 =Insecticide, Pesticide,
Weedicide, etc.(Rs./h.)

X_{10} =Machine maintenance cost
and factory electrification
cost(Rs./h)

X_{11} =Garden transport cost(Rs./h)

X_{12} =P.C.of irrigated area.

b. Areal variations of Explanatory variables:

Before making an elaborate explanation regarding the effect of explanatory variables on productivity level, it is essential to describe their areal variations to determine the degree of reliability of average values of each variable. In table 4.9, the average values (\bar{X}), the standard deviations (SD) and the coefficient of variations (CV) have been presented. Considering the calculated CV values the reliability of variables is attempted to find out. The degree of reliability of organizational variable, i.e., the size of the estate is found to be very less (CV=54.0%). It means that the size as a variable is less consistent, less uniform and less stable. On the other hand, the stability, uniformity and consistency is high in case of ecological variables mainly soil characteristics. Here the CV for nitrogen (34.9%), Carbon (12.2%), P Potash (22.3%) and phosphate (15.9%) are less than 50 percent. The reliability and uniformity is very high in respect of labour input (CV for workers/h=11.4% and mandays/h=13.5%). Except irrigation (CV=60.4%), other technological factors are more uniform in which the calculated CV is found below 50 percent. However, this degree of variability of explanatory variables is related to the level of productivity.

c. Effects of Explanatory variables on Productivity level:

Analysing the step-wise multiple regression model, the relative effects of each explanatory variables for land, labour

and non-land capital productivities are obtained in the following way.

a) Land Productivity: Using land productivity (Y_1) as dependent variable and nine explanatory variables as independent variables for regression model, it is found that the impact of explanatory variables on land productivity increases as the number of variables increases (Table- 4.10). For instance, the size of the estate (X_1) has 53.27 percent contribution on the productivity of land and when there is the addition of one more variable, say, carbon percent of soil (X_2), the degree of contribution goes up to 56.27 percent, and so on. But the real picture does not come unless an analysis in relation to the effects of each explanatory variable on productivity is sought for. Table- 4.10 shows that the effect of size (X_1) on land productivity is very high (53.27%) followed by mandays per hectare (X_7) and potash content of the soil (X_4). The contribution of mandays is 29.86 percent and potash is 8.08 percent. The composite effect of these three variables is more than 90 percent while the remaining variables can make only 10 percent contribution on land productivity. Therefore, in determining land productivity, three variables namely size, mandays and potash emerge as most significant variables.

b) Labour Productivity: Similarly, in the multiple regression model using labour productivity (Y_2) as dependent variable, three explanatory variables viz. size of the estate (X_1), mandays (X_9) and potash (X_4) again emerge as most significant. But the point

Table -4.10 : The effects of explanatory variables on Land Productivity

Input Variables	B - values	R ² (%)	Effect (%)
X ₁	50.38 (2.817) **	53.14	53.14
X ₁	60.61 (2.498) **		
X ₂	-40870.50 (0.656)	56.27	3.13
X ₁	69.65 (2.46) **		
X ₂	-717530.00 (.92)		
X ₃	254670.10 (.72)	60.41	4.14
X ₁	98.12 (2.52) **		
X ₂	-48044.50 (.60)		
X ₃	134859.00 (.36)		
X ₄	0575.76 (1.02)	68.69	8.08
X ₁	-33.29 (1.59)		
X ₂	46980.00 (1.83)		
X ₃	-27700.40 (2.34) **		
X ₄	-70.80 (.42)		
X ₇	235.58 (7.13) +	98.25	29.56
X ₁	-44.98 (3.50) +		
X ₂	55058.00 (3.67) +		
X ₃	-24850.80 (3.73) +		
X ₄	13.84 (0.14)		
X ₇	217.88 (10.87) +		
X ₈	52.08 (2.77) **	99.62	1.37
X ₁	-13.51 (1.59)		
X ₂	11824.00 (1.05)		
X ₃	-176.99 (6.42) +		
X ₄	81.25 (2.03) **		
X ₇	161.53 (10.91) +		
X ₈	46.05 (7.31) +		
X ₉	2.35 (4.25) +	99.97	0.35

N.B. : The nomenclatures (X₁, X₂, ... X₁₂) are as in Table 4.9. The figures in parentheses indicate the 't' values. **, *, + indicates that values are Significant at 5%, 1% & 10% level respectively. The effects of X₁₀ and X₁₂ are not shown in the table.

Table -4.11: The effects of explanatory variables on labour Productivity.

Input Variables	B - values	R ² (%)	Effect (%)
X ₁	.0263 (2.10) **	38.66	38.66
X ₁	.0327 (1.86) **		
X ₂	-22.97 (0.52)	41.23	2.57
X ₁	0.0632 (1.87)		
X ₂	-37.53 (0.66)		
X ₃	119.66 (0.47)	43.76	2.53
X ₁	0.561 (2.03) **		
X ₂	-19.71 (0.34)		
X ₃	29.90 (0.11)		
X ₄	0.4313 (1.06)	56.15	12.39
X ₁	0.0348 (1.64)		
X ₂	7.06 (1.80)		
X ₃	254.88 (2.17) **		
X ₄	-0.076 (0.45)		
X ₇	0.166 (0.93) *	95.18	39.03
X ₁	-0.0435 (2.05) **		
X ₂	53.021 (2.12) **		
X ₃	-238.99 (2.15) **		
X ₄	-0.0164 (0.08)		
X ₇	0.15268(4.57) +		
X ₈	0.0684 (1.18)	97.17	1.99
X ₁	0.0094 (0.72)		
X ₂	-19.547 (1.23)		
X ₃	-118.87 (3.05) *		
X ₄	-0.173 (3.06) **		
X ₇	0.058 (2.76) **	99.89	2.72
X ₈	0.0299 (3.28) *		
X ₉	0.0376 (5.01) +		

N.B. : Same parentheses as given in the Footnote of Table -4.10.

Table -4.12 : The effects of explanatory variables on non-Land Capital Productivity.

Input Variables	B - values	R ² (%)	Effect (%)
X ₁	0.4623 (1.05)	13.69	13.69
X ₁	0.8646 (1.53)		
X ₂	6028.10 (1.11)	28.48	14.70
X ₁	0.8615 (1.25)		
X ₂	-1591.65 (0.84)		
X ₃	-87.44 (1.02)	28.49	0.01
X ₁	1.346 (1.38)		
X ₂	-1157.31 (0.56)		
X ₃	-2282.64 (0.24)		
X ₄	-10.54 (0.73)	36.90	8.41
X ₁	-0.8354 (0.48)		
X ₂	444.90 (0.21)		
X ₃	-0.9719 (0.94)		
X ₄	-2.035 (0.14)		
X ₇	3.975 (1.44)	62.69	25.79
X ₁	-1.8969 (2.97) *		
X ₂	1177.59 (1.57) *		
X ₃	-715155.7 (2.14) **		
X ₄	5.656 (1.11)		
X ₇	2.3666 (2.36) **		
X ₈	4.725 (4.85) +	97.06	34.37
X ₁	-2.519 (1.47)		
X ₂	2032.5 (0.89)		
X ₃	-6568.5 (1.55)		
X ₄	7.526 (0.94)		
X ₇	3.480 (1.17)		
X ₈	4.820 (3.72) +		
X ₉	-0.440 (0.42)	97.50	0.44

is that the relative importance and contribution of these variables is not same as happened in case of land productivity. Here, the effect of mandays is highest on labour productivity (39.03%) followed by the size of the estate(38.66%) and the potash content of the soil(12.39%). These three variables together contribute 90.08 percent to the productivity of labour. Other explanatory variables have made less than 10 percent contribution (Table -4.11). It means that the productivity per labour is high if the intensity of labour input in tea cultivation and production processes is higher. It also indicates the labour intensive nature of tea culture.

c) Non-Land Capital Productivity: In this respect, five out of nine explanatory variables emerge as having significant effect on non-land capital productivity (Table 4.12). The effect of fertilizer is highest (34.37%) on non-land capital productivity followed by mandays(25.79%), carbon percent(14.79%), size of the estate(13.69%) and potash content of the soil(8.41%). The composite effect of these five variables is 99.05 percent and less than 3 percent contribution is made by other variables on non-land capital productivity. It means that among different non-land capital, the impact of fertilizers on productivity is highest. Because it can promote quantity and speed of leaf growth. Root growth and metabolism of tea plant is also associated with chemical input like phosphate and potash.

Out of the nine explanatory variables, five namely the size of the tea estate, mandays, fertilizer and soil conditions like potash and carbon are emerging out as most dominant in

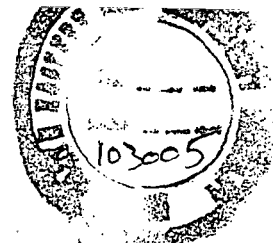
tea cultivation and production in the district. Of course, other factors are also no less significant in this respect. But in the present situation they are remaining as less influential considering the relative performance of these explanatory variables, it can be concluded that tea productivity in the district against the existing ecological and other non-ecological conditions is the function of four important variables, i.e., size of the tea estate, intensity of labour input, use of chemical fertilizer and the nature of soil.

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CHAPTER V

CONCLUSIONS AND SUGGESTIONS



CHAPTER V

CONCLUSION AND SUGGESTIONS:

After interpreting the various agro-ecological conditions and input structure in the district's tea growing areas and their effects on the cultivation and production of tea, certain number of important features have been obtained. These are given systematically in the following way and some important suggestions are also forwarded for reducing the yield gap of tea production. The main findings of this analysis are given below:

1. The climatic conditions (Rainfall, temperature, humidity, sunshine, evaporation) of the district are most congenial for the production of tea and have direct bearing on the levels of productivity.
2. There are variations of soil conditions in the district and depending on the characteristics of soil and relief, the district is divided into three zones, viz., northern foot hill (most favourable for tea cultivation), central plain (favourable for tea cultivation) and the flood plain of Brahmaputra (poor ecology for the cultivation). The level of productivity is higher in the central plain, i.e., in zone II than that of the foot hill and flood plain regions. It is mainly because of the large number of labour input/h and the large size of the gardens in this zone.
3. The distributional pattern of land productivity shows that the land productivity levels are positively related to the

size of the tea gardens. It means that the land productivity increases when the size of the tea estates are larger. But it is observed that the rate of change in land productivity is decreasing with respect to increasing size.

4. Level of labour productivity is increasing with the increasing rate in respect to the intensification of labour in the tea production system. It reflects that more labour can be employed in future.
5. Levels of non-land capital productivity increases with decreasing rate of productivity. It means that there might be managerial or other technological insufficiencies at the higher level of intensification of non-land capital, i.e., technology.
6. Among the ecological conditions, soil characteristics, viz. carbon and potash are found to be most important in determining productivity levels. On the other hand, labour input and fertilizer are most significant non-ecological factors while the size of the gardens remains as basic factor for increasing productivity level. Because, by analysing the effects of nine explanatory variables, following pictures are found in relation to land, labour and non-land capital productivities.
 - a) The effects of land size ($R^2 = 53.14\%$), labour ($R^2 = 29.86\%$) and the potash ($R^2 = 8.03\%$) are higher on land productivity and their composite effect is more than 90 percent while the effects of remaining variables are less than 10 percent.

- b) The same variables are important for labour productivity but the effect of labour input/h, i.e., mandays/h ($R^2 = 39.03\%$) is highest followed by the size of the gardens ($R^2 = 38.66\%$) and the potash content ($R^2 = 12.39\%$) of the soil. The composite effects of these three variables are nearly 90 percent and other factors have made only 10 percent contribution.
- c) The effect of fertilizer input is highest on capital productivity ($R^2 = 34.37\%$) which is followed by labour input ($R^2 = 25.79\%$), carbon content of the soil ($R^2 = 14.79\%$) and the size of the garden ($R^2 = 13.69\%$). The potash content of the soil is also significant ($R^2 = 8.41\%$) in this respect. The composite effect of these five variables is more than 97 percent.

SUGGESTIONS:

Meeting the growing internal demand of tea and achieving the export target is a dual challenge that can only be met if the production of tea in India reaches the level of 1000 million Kg. by 2000AD. The major share of this increase has to come from North-East India, specially from Assam. But the state cannot supply adequate amount tea unless the tea producing districts including Sonitpur increases the current rate of productivity level. There is wide scope to increase the present yield in the district. In a report submitted to Tandon Committee I, "Development requirements of Tea Industry in North East India", it has been mentioned that improved cultural practices and

Table -5.1: Existing and Maximum Expected Yield of Tea in various Ecological Zones of the District

Ecological Zones	(A)		(Y)		(A-Y)*		(A/Y)**
	(a)	(b)	(a)	(b)	(a)	(b)	(in p.c)
Northern Foothill (zone i)	2750	118525	2007	86501	743	32024	37.02
Central Plain (zone ii)	2750	118525	2062	88889	688	29631	33.34
Flood Plain (zone iii)	2750	118525	1156	49823	1594	68702	137.89

* Yield gap shows the hidden capacity of the production which refers to the magnitude of yield potentials.

** Yield efficiency is simply the ratio of maximum expected yield with existing yield.

Abbreviations: (A)-Maximum Expected Yield
(Y)-Existing Yield
(a)-Yield Quantity in Physical Term(kg/h)
(b)-Yield Quantity in Monetary Term(Rs./h)

efficient management can improve the average yield upto 2750 Kg/h (Jain, 1983, p.5). It is apparent that in the study area, the existing yield rate is far below than maximum expected yield resulting a wide gap between the two. It is worth while to note here that yield gap refers to intensity of yield potential of the area. In table -5.1, the existing and expected yield rate of tea for the district has been presented. The data indicates that the yield gaps to tea are widened in the southern zone or flood plains (zone III). The gap in absolute quantity is 1594Kg/h (Rs.68,702) and 137.89 percent in relative terms. The yield gap is low in the northern foothill zone (Zone I) and very low in the centrally situated zone (Zone II), it being 743Kg/h (Rs.32,024) and 688Kg/h (Rs.29,636) respectively. In terms of percentage, the yield in these two zones is 37.02 and 33.34 respectively. Considering this gap between the existing and maximum expected yield of tea in the district, following suggestions are forwarded to minimise the gap.

1. In all these zone, viz., the northern foothill, central plain and the flood plain zones of the district, the intensity of labour input seems to be low in comparison to the state. Analysing the distributional pattern of labour productivity (Chapter IV) it was found that the level of productivity as well as the rate of change in productivity increases with the increase of labour input per hectare. It indicates that the existing level of productivity can be increased to a significant level by the intensification of more labour input per hectare. The existing level of labour input in different zones

show the positive relationship between the productivity and the labour input. Therefore, the intensification of labour input, i.e., mandays/h can be increased to minimise the yield gap of tea in the district.

2. Drainage in the flat or gently sloping land specially in the flood plain zone (zone III) is becoming difficult due to heavy siltation which causes the problem of water logging. During the monsoon months or during the high flood periods, the tea estates arterial drainage system rises almost to the water table of the flat lands with low gradients, restricting the outfall for effective drainage of tea estates. This has greatly affected the yield of tea in the district. Therefore, the water logging areas of the tea estates need good drainage system because the improved drainage system can increase tea yields to the extent of 30-35 percent over a period of time (Jain, 1983, p.18). In the areas where free flow conditions do not exist due to outfall restrictions can be supplemented by the introduction of pumping system to take out the water. In a study conducted by S.K.Dey (Dey, 1983, pp.19-20) in the Brahmaputra and Cachar valleys, suggested that pumping is economic and efficient for providing positive control of channel water level and stabilizing ground water table in the tea growing areas. It is, therefore, a suitable method to solve the problem of water logging in the district's tea growing areas.

3. Most of the tea gardens of the district were planted in and around 1930s and they have now almost completed their most productive period of 70 years. During the period of field study

(1991) it was found that in each and every sample garden the area under old tea bushes were nearly half. It was also found that the uprooting and replanting of tea bushes had been taking place at a rate of 1-2 percent every year. Since the old tea plants were less productive, the process of uprooting of old tea and the replanting of young tea is most urgent for the district, so that by the turn of the century none of the tea bushes should be older than the economically productive life. It seems to be a best alternative solution to increase the productivity level and to reduce the existing and expected yields.

4. Clones and seed varieties possessing high yield and quality have been developed and are being used in the field of tea cultivation. This development and the level of use in the field has to be intensified replacing the old traditional variety. The existing hybrid tea populations should be thoroughly screened with the dual objects of isolating elite vegetative clones and bushes with special features to add to the germplasm collection of tea.

5. Tea crop requires large amount of water during the growing period. The district dependent for water on the gamble of monsoon rain. Since there is an irregularity regarding the occurrence of monsoon rain, most of the tea plants sometimes suffer from drought condition. As a result, there is the loss of crops as the photosynthetic machinery of the tea leaf does not function properly under water stress. The obvious solution to this problem is irrigation. The proportion of area under irrigation in the district is about 50 percent (Average of three


zones). The irrigation facility needs extension to cover the entire tea garden so that during the periods of drought production does not hamper. On the other hand, the use of chemical inputs like fertilizer would be meaningless without constant supply of water to the tea plant.

6. The tea plant is susceptible to a wide range of pests and diseases caused by fungi, algae and bacteria. Some of these pests and diseases, if unchecked, can cause serious loss of crops and death of plants also. The tea planters are not unaware of this problem and effective measures are already taken in this direction. But the point is that the pesticide, fungicides, weedyicide in use are now mostly imported. Efforts are needed to produce these chemicals within the country so that planters can get it with easy reach and cheap cost. This will encourage the level of productivity indirectly.

7. Manufacturing of tea is a continuous process. At every stage of tea manufacture, the leaf is handled manually and tea maker relies on his senses to decide the completion or otherwise of a process. The tea maker is often required to work against his better judgement because of unkind weather, poor quality of the plucked leaf brought into the factory, lack of withering space, breakdown of machinery etc. As a result, a tea factory is incapable of turning out a standard product. Although the existing tea factories cannot be altered or replaced overnight, yet there is scope for improving the working condition of these factories both mechanically and hygienically. In many factories,

machines are installed haphazardly requiring a host of unskilled labourers to carry leaf from one machines to another. In such cases re-alignment of the machines, for which motorised drives will be necessary, will save cost, improve sanitation and release a large number of labourers for gainful employment in other estate activities.

8. Since the size of the garden and the productivity of tea has shown a positive relationship, it is imperative for the small size gardens in all zones to extend the area under tea, if possible. Large size gardens have the advantage of making much more use of different inputs in higher proportion. Greater amount of input per unit of land can lead to the higher productivity of tea.

Since tea has the dual nature of agriculture and industry, labour-management relation is most important in increasing the level of productivity. Finally, it can be concluded that a proper integration of several production factors can only minimise the existing and maximum expected yield  in the district.

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APPENDIX - I

2. Climatic Conditions

(a) Temperature and Rainfall (1989 to 1991)

Year:	Months :	Temp(Cg)	Rainfall	Humidity in	Evaporation
		Max. Min.	(cm/inch)	%(Relative)	

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(B) Relief Features (Map)

- (a) Altitude (Above MSL)
- (b) Drainage Pattern :
(Natural or Artificial)
- (c) Contour Map :
- (d) Soil Erosion Condition:

3. Landuse Pattern in the Tea Garden:

- (a) Land under settlement (in hectares or Acres)✓
- (b) Land under routes & streams:
- (c) Waste Land (cultivable but not cultivated):
- (d) Land Under tea cultivation:
- (e) Others (Recreational, Graveyard etc.)

4. Tea Cultivation:

Variety : Area under : Yield/H: Total prodn. : Latest Price/Kg
of Tea each variety

5. Labour Input in the cultivation:

Categories : Total Nos : Sex : Wages(Total)
of Labour M F

- 1. Permanent
farm Labour
- 2. Casual
Labour(Time)

3. Technical
Labour

4. Administrative
Staff

6. Social Status of each labour group (At least two from each group)

Labour Class	Age	Sex M F	Literacy status	Wage	Local/Migrant
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Permanent- 2.
2.

Casual- 1.
2.

Technical- 1.
2.

Official- 1.
2.

7. Proportion of child labour and nature of works (below 16 years of Age)

8. Technological Conditions:

(a) Irrigation: (i) Period of Irrigation:

(ii) Net irrigated area(H/A)

(iii) Gross Irrigated Area:

(iv) Source of Irrigation:

(v) Proportion of Irrigated area under different sources:

Tank:

Canal:

Others:

9. Machine Tools:

Types of Tools/ : Machines	Total No.	Cost(Annual)	
		Machine Cost	Maintenance cost

10. Fertilizer

Type of Fertilizer:	Amount used per hectare	Total Amount	Cost per Kg.
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11. Insecticide & Pesticide

Type	Amount per Hectare	Total Amount	Cost
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12. Tea Production:

Variety of Tea	Total Prodn (leave in Kg/ hectare	Raw yield (Per Kg.)	Cost of Prodn.:	Maximum (Expected Prodn.
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13. Tea Processing:

- (a) Total Production after processing.
- (b) Cost of production per Kg.
- (c) Current price per Kg.

14. Labour cost in the processing (Factory)

Class of Labour: Number: Age group: Sex : Literacy: Wage
M F Range

Permanent

Casual

Technical

Official

Child labour

15. Chemical cost if any, in the processes of production(Annual)

16. Transport cost:

- (a) Cost involved in the collection
- (b) Distribution
- (c) Others.

17. Problems/Constraints.

Dear Sir/Madam,

I should be very grateful to you if you would please indicate some problems that stand as constraints in increasing the cultivation and production of tea in your estate. Please mention the nature of problems covering the following aspects:

- (a) Labour
- (b) Finance
- (c) Social
- (d) Others.

Thanking you in anticipation.

Sincerely yours

(BIMAL BORAH)
Dept. of Geography
North Eastern Hill University
Shillong: Meghalaya

APPENDIX - II

APPENDIX II

Name of the Tea Estates	Area under tea (Hectares)	Name of the Tea Estates	Area under tea (Hectares)
1. Dufflaghur	662.30	24. Mijikajan	545.89
2. Nirmala	194.87	25. Sagara	38.47
3. Bholaguri	125.22	26. Tara juli	492.61
4. Gohpur	251.31	27. Dhendai	295.86
5. New Purupbari	218.11	28. Sona juli	555.21
6. Nya Gogra	384.87	29. Bor juli	552.88
7. Brahmajan	-	30. Thakurbari	-
8. Baghmari	375.95	31. Dhulapadung	662.30
9. Gingia	420.05	32. Rupa juli	340.13
10. Monabarie	1091.27	33. Ghoirallie	591.06
11. Ketala	292.50	34. Naharani	694.20
12. Borgang	913.71	35. Addabarie	659.73
13. Behali	454.95	36. Harchura	364.24
14. Halem	543.29	37. Phulbari	665.26
15. Bural	351.24	38. Bangaon	221.38
16. Tupia	53.05	39. Kacharigaon	412.89
17. Sakomatho	476.16	40. Kolony	376.19
18. Majuligarh	472.33	41. Texpur/Gogra	531.37
19. Pertabghur	656.77	42. Neorbarie	122.08
20. Dhullie	731.78	43. Durrung	303.75
21. Mahalakshmi	283.40	44. Sessa	636.34
22. Pabhoi	377.67	45. Sonabeel	392.50
23. Nilpur	141.57	46. Hoogra juli	323.97

Name of the Tea Estates	Area under tea (Hectares)
47. Shyamaguri	328.15
48. Monmohinipur	317.76
49. Monobag	189.23
50. Belsiri	340.75
51. Hirajuli	351.59
52. Panbarie	384.88
53. Sapoi	605.98
54. Narayanpur	452.71
55. Dherai	164.63
56. Julia	-
57. Tinkhorla	559.98
58. Borsola	146.40
59. Dhekiajuli	608.60
60. Arun	313.77
61. Singri	333.38

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