

Spatial Variation in Productivity of Tea Gardens in Upper Brahmaputra Valley

Abstract

By

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Thesis

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Statement of the Problem:

Tea is considered to be the most well organized agro-based industry. It provides direct employment to workers of which a sizeable number are women. Besides this, people derive their livelihood from ancillary activities associated with production value addition and marketing of tea. Substantial foreign exchange earnings with negligible import content and contribution to state and central exchequers are the other important economic features of the Indian tea industry.

But with high cost of production, low prices, stagnating domestic demand, declining exports and loss in foreign exchange earnings and India's position in world market is under severe threat are the major problems faced by Indian tea industry.

Thus, the health of the tea industry has an immediate socio-economic impact in the tea growing areas of Upper Brahmaputra Valley where most of the tea gardens are located.

Objectives:

The proposed study focuses attention towards the following objectives:

- (1) to examine the variation in production and productivity level of tea, and.
- (2) to find out causes of their areal variations.

Research Questions:

There may be a good deal of explanation of the problems of optimization of tea production with respect to its factors. However, the following two research questions are posed here to stream line the discussion and explanations to fulfil the objectives.

- (a) How do the physical factors responsible for the variation in the level of production and productivity?
- (b) What are the socio-economic characteristics of Gardens labourers and how it influences the tea production in different agro-ecological conditions of tea cultivation.

Methods Used and Data Collection:

The geographical explanation and answers of such research questions may be given by viewing the physical factors of land and their areal variations to specify the areas of various agro-ecological conditions to find out the causes of areal differentiations in tea productivity. The main parameters of physiographic personality of the study area, namely, relief features, soil and climatic conditions, vegetal cover conditions and agricultural practices have been considered to identify the areal variations of such parameters. Agro-ecological zonation are prepared to show the homogeneous physical conditions. It would be helpful in explaining the areal variations accruing in the productivity of tea in the area.

Secondly, the question is closely related to the study of socio-economic characteristics of labourers and their families residing in the gardens and influencing

directly or indirectly the production processes of tea cultivation. The detail answer of this question and explanations of socio-economic characteristics of gardens labourers have been extended at two stages:

(a) The first stage explanation is forwarded by considering the parameter of the each and every gardener, which are related to:

- (i) the tenurial system prevailing in the gardens
- (ii) the productivity attributes,
- (iii) the demographic features of the gardens, and
- (iv) the social amenities available for the people of tea gardens.

(b) The second stage explanation of the problems as posed in the research questions is forwarded by adopting sample design of the gardens and the house-hold surveys of selected households. The following criteria have been adopted to choose the gardens

- (i) Remotivity/accessibility of garden from road size
- (ii) Size of the garden
- (iii) Available infrastructure

The sample tea gardens five from each agro-ecological zones are selected by adopting above bases of garden selection. Further, 15 household from each sample garden are chose randomly considering household size and its socio-economic level, so as to include the variety of households to infer the results.

Further, the primary survey of these selected households was conducted by preparing the schedule/questionnaire. After collecting data, the tabulation was done by processing the raw data into required formats through computer.

As far as required data are concerned for the same procedure, the information required have been collected from the following sources:

1. the geographic information for delineation of agro-ecological zones of the study area have been generated from R. F. 1/1 million map of the Upper Brahmaputra valley. Drainage pattern, micro relief features and geomorphic conditions are interpreted from these maps.
2. District wise soil series data are collected from the Regional Office, Natural Bureau of Soil Survey and Landuse Planning, Jorhat. The soil profile properties of different soils of the tea gardens are analysed by 'Toklai Tea Research Institute'. The published materials available there have been used to highlight the soil and climatic conditions of the area.
3. The garden-wise survey was conducted during the fieldwork. With the help of B.A./B.Sc. students during the years 1997-98 and 1998-99, a garden-to-garden survey was conducted to collect the data of socio-economic and landuse parameters of the gardens.
4. The primary socio-economic survey of selected households also conducted to give more detail explanations of causes of low levels of productivity in the tea gardens.

Chapterization:

The content of the present study are organized into the following chapters:

Chapter I deals with introduction, performance of tea in state economy has been discussed. Since tea is both plantation-cum-industry, the role of tea to the agricultural and industrial development of Assam has been discussed considering data of 46 years (1953-54 to 1998-99), statement of the problem, objectives and research question.

In Chapter II, a review of relevant literature has been carried out.

Chapter III deals with the geographical and non-geographical factors influencing the production of tea.

Chapter IV includes the socio-economic characteristics of the tea gardens. It has been examined from five different angles like land productivity, labour productivity, garden size, density of population and family size.

Chapter V deals with production and productivity. In this chapter a comparative study has been made between land productivity and size of the garden and labour productivity and labour intensity to analyse the socio-economic conditions in the different agro-ecological conditions.

Chapter VI includes findings, suggestions and conclusion.

3.0: Findings:

After a detailed investigation of the production and productivity pattern against the backdrop of physical as well as socio-economic characteristics of tea gardens, the following facts have been derived:

3.1: Physiographic Attributes and Tea Production:

While examining agro-ecological conditions, more specifically, the impact of climatic elements, (temperature, rainfall, humidity, evaporation and sunshine) on the productivity of tea in the study area, the following facts have been derived as:

(i) The fluctuations of climatic factors over time shows that rainfall has the most fluctuating tendency (cv = 87.72%) in the valley followed by evaporation (cv = 34.60%) due to monsoon characteristics of climate. However, annual temperature does not vary much, ranging from 22.60°C (1985) to a maximum of 24.20°C (1994). Sunshine is fluctuating significantly. However, it has a great impact on yield.

(ii) The correlation matrix of these elements reveals that rainfall and evaporation, as the main elements of climate, are highly and positively correlated with temperature, while sunshine is negatively related with rainfall ($r = -0.5997$). It indicates that, during the rainy season, the atmosphere becomes cloudier and, consequently, there is no sunshine. However, higher degree of radiation can be observed during the monsoon period. As a result, the gardens are having 'shadow trees'. The temperature ranging between 23°C and 25°C, rainfall between 200 and 250 mm with 5 to 6 hours of daily available sunshine, are the most suitable climatic conditions for the growth of tea in the valley.

(iii) The regression analysis of these climatic elements (considered as independent variables) with tea yield (dependent variable) shows interestingly that these five climatic elements have an overall effect of 20.11% to the total growth of tea production. Out of the total, the effect of temperature is calculated as 3.35% and that of evaporation is 11.09%. The analysis shows that evaporation is the most determining factor of tea yield rather than sunshine and relative humidity. Undoubtedly, evaporation is controlled by temperature and rainfall. Therefore, all the three elements of climate (Temperature, Rainfall and Evaporation) have a significant effect of 16.77% out of total 20.11%.

3.2: After examining the characteristics of soil of different agro-ecological zones of the study area and their relationship with the cultivation of tea, the following facts have been emerged:

(i) There are areal variations in the textural properties of the soils. For instance, the coarse sand is dominant in the flood plains ranging from its 80 to 92% in the aggregate size particles in the soils. It is followed by old alluvium ranging from 84 to 89% in the “Built-up” area of central parts and then the foothill areas where coarse sand varies from 63.5% to 73.1% in the soil aggregate composition.

(ii) It is noticed, that the aggregate size of top soil particles of below 1 mm diameter are dominant in the new alluvial soils of Flood Plain and in the adjacent areas of Central Plain of old alluvium. Bigger size of soil particles above 5 mm diameter are recorded very less in the soils of old alluvial and sub-montane Foot Hill soils. It is found that the particles of topsoil are moderate in its size (2-5 mm diameter) and account for about one-third soil particles in almost all type of soils in the study area. It shows that the infiltration

rate is lesser in the Flood Plain because of dominance of coarse sand (size of soil particles below 1.0 mm diameter) and higher in foothill zone of sub-montane where bigger soil particles constitute the composition of soil texture.

(iii) So far as the chemical properties of the soil are concerned, it reveals that the soil of the valley is highly acidic in nature, as the pH value ranges from 3 to 5. The highest pH value is recorded in the old alluvial, which is 4.7 followed by Foot Hill soil with 4.5. In the Flood Plain soil, it is 3.9. However, soils are rich in calcium and magnesium, especially in the Flood Plain and Central Plain areas due to lesser effect of leaching. The C/M ratio is normal in these plains with 15 and 13 respectively. The content of phosphorous penta-oxide (P_2O_5) is recorded high with the moderate quantity of potassium dioxide (K_2O) in the soils of foothill areas. Presence of high organic carbon in the soil indicates suitability for tea cultivation. The Central Plain has a balance distribution of all the soil minerals. So it shows, that central part of the alluvial plain provides most suited soil for tea cultivation.

(iv) Land productivity is noticed very high (5394 kg/ha) in the fertile soil conditions of Central Plain where pH is recorded 4.7 with suitable organic carbon contents in the soil. The soil conditions of Flood Plain of new alluvium are also favourable for tea production. Hence, the land productivity is marked moderate (5033 kg/ha) in these areas.

3.3: The soil and climatic conditions of land are the major driving factors of tea production and level of productivity. The favourable land conditions prevail in the “Built-Up” areas of Central Plain with old alluvial deposits, where about 49.5% of the total gardens have been accounted for. The moderate conditions of land are prevailing in the

Flood Plain of new alluvial deposits, where 31.6% gardens are located. While the number of gardens are registered about 84 in number (i.e. 18.8%) only in the Foot Hill zone.

4.0: Socio-economic Characteristics:

In order to examine the socio-economic characteristics of gardens in the light of the selected parameters (namely garden size, land and labour productivity, population density and family size), the following facts have been drawn:

4.1: Considering farm size as determinant, it has been observed that:

(i) Population density is recorded higher (as 4-5 persons per ha) in the medium size gardens (400-800 ha) in all the agro-ecological zones.

(ii) The higher percentage of child labour, i.e. more than 3% to the total work force, is prevalent in the smaller-size gardens (200-400 ha) of the Foot Hill areas and medium to large- size (400-1000ha) gardens of the Flood Plain. It shows that the gardens of Flood Plain areas employ more percentage share of child labour. It is because of prevalence of illiteracy, poverty and high population pressure in the frequent flood areas.

(iii) Pressure on hospitals and schools are recorded very high in the large and very large size of tea gardens in all the agro-ecological zones. It shows that the social amenities are poor in larger gardens.

(iv) So far as economic characteristics of tea gardens are concerned, it is found, that land as well as labour productivity vary significantly in different agro-ecological zones. However, the levels of land as well as labour productivity are recorded very high (above 2000 kg/ha and even 2000 kg/person) in the small size of gardens (below 200 kg/ha)

generally in all types of agro-ecological conditions. The level of land and labour productivity diminish as garden size increases. This decrease is recorded faster at smaller size gardens and *vice-versa*. It reveals that heterogeneous natural conditions of the larger gardens negatively influence the land productivity, while the large amount of labourers and high population density in the larger gardens tend to decrease the labour productivity in all the agro-ecological zones of the Upper Brahmaputra valley.

4.2: Examining socio-economic characteristics in relation to land productivity, it has been noticed that the land productivity is influenced not only by the conditions of land, but also the size of the gardens where a variety of land conditions prevail. Larger-size gardens have heterogeneity of land conditions and the smaller-size gardens are more homogeneous in their natural conditions, and consequently, they do not have much diverse conditions of economics of production scales.

(i) The size-wise distribution of gardens shows that the highest concentration of small to very small size of gardens (below 400 ha) is noticed in the central plains, where agro-ecological conditions are characterized with alluvium soils. Most of the gardens have low levels of productivity (below 3000 kg/ha) in these areas. The relationship between garden size and land productivity is found negative ($r = -0.7376$) throughout the study period. The average productivity level is recorded very low (2153 kg/ha) in the Foot Hill zone.

(ii) A major share of total tea production is contributed by the low productivity of small size gardens, which are characterized as the gardens of high concentration of population which supplies unlimited labour including the child-labour to the production processes with poor social amenities and low wage rates to the labourers. Within each agro-

ecological zone, the 75 gardens out of total 84 (i.e., nearly 88.2%) fall under the category of low to very low levels of land productivity (0-4000 kg/ha) in Foot Hill zone, the 183 gardens out of 218 (i.e., 83.9%) in the same category of land productivity in Central Plains and the 115 gardens out of 139 (i.e., 82.7%) in the Flood Plains. Therefore, the concentration of gardens is towards low to very low levels of land productivity and the major amount of tea production comes from these categories of low productivity levels. It means that the economy of tea production has been resting upon the low level of productivity in the gardens.

4.3: Considering socio-economic characteristics with respect to labour productivity, it is observed that the labour intensity does not vary much in different agro-ecological zones. However, high pressure of population and available labour force diminish the level of labour productivity in the gardens. Tea cultivation being labour intensive still has traditional method of tea processing. Main findings of socio-economic characteristics of the gardens in the light of labour productivity are summarized below.

(i) An average labour productivity level is recorded 4516 kg/person in the tea gardens of the study area. It varies areally according to the variations in agro-ecological conditions of gardens. The Central Plains of old alluvial has the highest level of labour productivity (5815 kg/person of labour force) while the Flood Plain of new alluvial soil has the productivity level very close to its average (4522 kg/person). The lowest labour productivity is observed in the Foot Hill zone. The labour intensity in the Central Plain is recorded much lower. On account of low labour intensity and favourable physical conditions of land, the labour productivity appears to be higher in this zone.

(ii) There is a large concentration of gardens (i.e., 87%) towards the categories of low to very low labour productivity (3000 kg/person) where population density is much higher. There is an unlimited pressure of labour supply, which diminish the level of labour productivity in the gardens.

(iii) It is found that the higher percentage of child labour (upto 4.5%) is employed in tea practices in the low labour productivity gardens of the Foot Hill zone. The population density is also recorded very high (350 persons/sq km) in these gardens of Flood Plain areas. The higher the population density, greater is the supply of more labour force to the garden. On account of high population density in the gardens of Flood Plain, the population pressure is greater due to the supply of more labour to the tea cultivation at lower wage rate, even some times, the supply of child labor also.

(iv) Labour productivity is a negative function of labour intensity. Areas of low labour intensity, found along the main line of communication, have high levels of labour productivity. On the other hand, the remote areas, where the transport and communication facilities are poor, have low level of labour productivity with high labour intensity. In the gardens of Foot Hill zone, the labour productivity is recorded low. The labour productivity is relatively higher in Central Plain zone with a few gardens having high labour productivity.

(v) The quality of labour is one of the parameters, which has been correlated with labour productivity. Low labour productivity in the Foot Hill as well as Flood Plain zones are observed because there is a greater share of unskilled labourers which increases the labour intensity.

In the end, it is observed that tea production of the gardens is labour dominated, supplied by the heavily loaded demographic expansion with high population density and poor availability of poor social amenities. The concentration of labour force with its high population density and higher supply of child labour has been noticed in the gardens of low labour productivity. It shows that population pressure (i.e., indication of higher labour intensity) influences the socio-economic status of labour and declines the level of labour productivity in the Upper Brahmaputra Valley.

4.4: After observing socio-economic attributes in relation with the population density, the following findings have been drawn.

(i) Generally, more than a half of the numbers of gardens falls under the category of low population density (below 3 persons/ha) in almost all the agro-ecological zones. However, the population is more concentrated in the gardens of medium population density (4.00-8.00 persons/ha).

(ii) The family size and the population density are positively related to each other. It means, bigger the size (4 to 8 persons/family), higher is the population density with more share of child labour in the gardens of Upper Brahmaputra Valley.

4.5: More characteristic features in the context of family size are given below.

(i) The medium size families (4 to 6 persons/family) dominate in the gardens of Foot Hills and Central Plain zones. However, more than 80% gardens fall under the category of small family size (1 to 3 persons). It is a fact, that bigger families have higher percentage share of labour force. As family size increases, it increases more non-working population, especially child labour, as it is a primary stage of growth. It indicates, that the

gardens of larger family size have high population concentration with high density, of which most of them are non-working population. It establishes the fact that the labour size in the bigger families with higher share of child labour (1–3%) noticed in all the agro-ecological zones.

(ii) Social amenities, like sanitation and medical facilities, are not proportionate to the family size. For example, one toilet serves two families of 6 persons in the gardens of Central Plain areas. Similarly, one doctor serves more than 2000 persons in the Central Plain and even more than 2500 persons in the gardens of Flood Plain. It means that the facilities are very poor in these gardens.

5.0: While Examining the productivity pattern in various agro-ecological zones the following facts have been emerged.

(i) There is low to very low level of land productivity (below 5000 kg/ha) in all the agro-ecological zones. About 86% of the tea gardens fall under these categories of low land productivity.

(ii) The areas of high and very high land productivity (above 7500 kg/ha) are located along the National High Way, especially in the southern Central Plain zone.

(iii) The amount of tea production is not uniformly distributed in the various productivity categories of gardens in the different agro-ecological zones. About 64% of the total volume of production comes from very low land productivity (0-2500 kg/ha) categories of almost all the agro-ecological zones. The very high category of land productivity (above 10,000 kg/ha) contributes only 7.6% of the total volume of production.

5.1: The nature of bi-variate frequency distribution (Land productivity vs. Garden size) reveals that there is imbalance in the average frequency distribution of tea gardens in the different agro-ecological zones. The following facts have been observed from the distribution:

- (i) The medium and large size gardens have low land productivity in all agro-ecological zones.
- (ii) A few small size gardens come under high and very high level of land productivity.

5.2: Physical Conditions of Land and Tea Leaf Growth:

There is direct effect of soil and climatic conditions on the growth of tealeaf in the different agro-ecological zones. The experiment on the growth of tealeaf of Foot Hill zone and Central Plain shows the following results. In the Foot Hill zone, the average rainfall, during the experimental period, (20.6.2001-26.6.2001) was recorded 0.79 mm per day, where as it was 6.5 mm per day in the Central Plain zone. Such significant differences in rainfall have a great impact on the leaf growth of a particular zone.

As far as the soil conditions are concerned, the Foot Hill zone is very much subjected to leaching processes. The intensive leaching, which continues in humid conditions, wash away the chemical properties of the soil which directly affect the proper growth of the roots and, accordingly, the growth of leaf. On the other hand, the soils of Central Plain zone formed by older alluvium, are very much suitable for root development and likely to be rapid percolation. Consequently, it appears a better root and leaf growth of tea plants.

(i) The average length and perimeter of tealeaves are 4.11 cm and 9.74 cm respectively in the Foot Hill zone, which is comparatively smaller than the zone, namely Central Plain where the average length and perimeter is about 5.11 cm and 11.8 cm respectively.

(ii) There is slower growth of tealeaf in less rain as observed from the experiment. The leaf growth is 4.11 sq cm/day in the Foot Hill when rainfall is recorded only 0.79 cm/day. In Central Plain, where rainfall is recorded 6.5 mm/day, the growth was 7.98 sq cm/day. It shows a direct affect of rain on the tealeaf growth.

5.3: Ground Water and Productivity of Tea:

Though the upper part of the Brahmaputra Valley is characterized by congenial agro-ecological conditions for tea cultivation, the impact of ground water on productivity of tea appeared to be less influential as the roots of tea plants do not grow much below the soil surface.

5.4: Effects of Fertilizers and Machines:

Besides the physical and socio-economic factors, the technological factors also play an important role in the cultivation and production of tea. The following observations are made from the present study:

(i) There is a positive relationship between land productivity and use of fertilizers. The urea is used intensively in Flood Plain zone (340 kg/ha annually) rather than in Foot Hill (264 kg/ha), while MoP (Mauriate of Potash) and Rock Phosphates are used more in Central Plain zone (146 kg/ha and 142 kg/ha) respectively. As a result, the highest land productivity is found in this particular zone, which is about 2.20 thousand kg/ha.

(ii) The lower level of tea productivity in Flood Plain zone is attributed to seasonal floods

at the peak of manufacturing seasons. In the Foot Hill zone, it is due to high vulnerability to the attack of pests and weeds being surrounded by forests.

(iii) It is noted, that though the machineries and the fertilizers are more intensively used in Flood Plain zone as compared to the other two zones, the land productivity is low due to natural flood hazards.

In the end, it can be said that the distributional patterns of land productivity as well as labour productivity of the tea gardens are not only the function of physical factors of land alone, but also concentration of population density and unlimited supply of labour, which is also attributed to the productivity level. In all type of agro-ecological conditions, the small size gardens employ more labour force, including child labour. High concentrations of population with low literacy and medical facilities also have negative impact on the level of labour productivity in these gardens.

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May, 2003


I, Tripti Chand Daimari, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of my previous degree to me or to the best of my knowledge to any body else, and the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to North-Eastern Hill University for the degree of Doctor of Philosophy in Geography



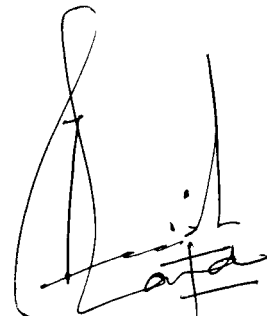
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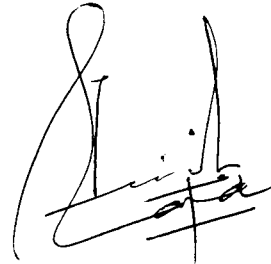
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Chapter-I

Introduction

Tea is the most important and non-alcoholic beverage, which is produced and consumed in a number of countries - both in tea producing as well as non-producing countries. Most of the production comes from South-East Asiatic and East African countries. India has a unique distinction of being the largest producer as well as the major consumer of tea. As Banerjee (1996) states, the plantation industry in India, which developed over 150 years, has a colonial origin, plantation agriculture relates more to the factory to the farm. However, it occupies a very small share of the total agricultural land of about 0.8 percent in the country. In spite of its insignificant areal extent, it contributes nearly 5 percent to the National Income in agriculture. Besides, tea plantation activities provide more employment per rupee of investment in the country than either in agriculture or industry. Among all the plantation crops, tea is considered to be the most well organised and labour intensive plantation crop.

There was a record annual increase in the production of tea in the world, which was 2535 million kg during 1990-91. A noticeable increase was also recorded in India (34 million kg), followed by Sri Lanka (8 million kg), and Turkey (7 million kg), with marginal increase in Malaya, Uganda, Iran and Malaysia. However, a regional variation can be observed in the country wise production. On the other hand, Indonesia and USSR have declined their production by 12 and 10 million kg, respectively during the same

period of time.

Tea production in India was 740 million kg in 2001. The North-Eastern part of the country produces about 75 percent of India's total production out of which Assam is the largest producer of tea having a share of more than 54 percent to the total production. Keeping these aspects in mind, the present discussion is devoted towards the growth of tea cultivation and its contribution to the state's economy with respect to its areal pattern.

The contribution of tea is considered here in two ways: first, tea as an agrarian activity which contributes the public sector of economy and is considered as the product of physical as well as socio-economic factors. Secondly, it is considered as an industrial activity of the area because of its processing, package and marketing. Therefore, it contributes to secondary as well as tertiary sectors of the economy. On account of considering tea as raw material for tea industry in Assam, it provides a sound base for the growth of allied industries (Fig.-1.1). Tea production being an organised sector of the state, which has link with other industries and has a long historical background, the production and productivity of tea cultivation is still not recorded very high. Its growth is not satisfactory even after more than fifty years of the country's independence. However, it plays a dominant role in the economic development of the state as well as the nation.

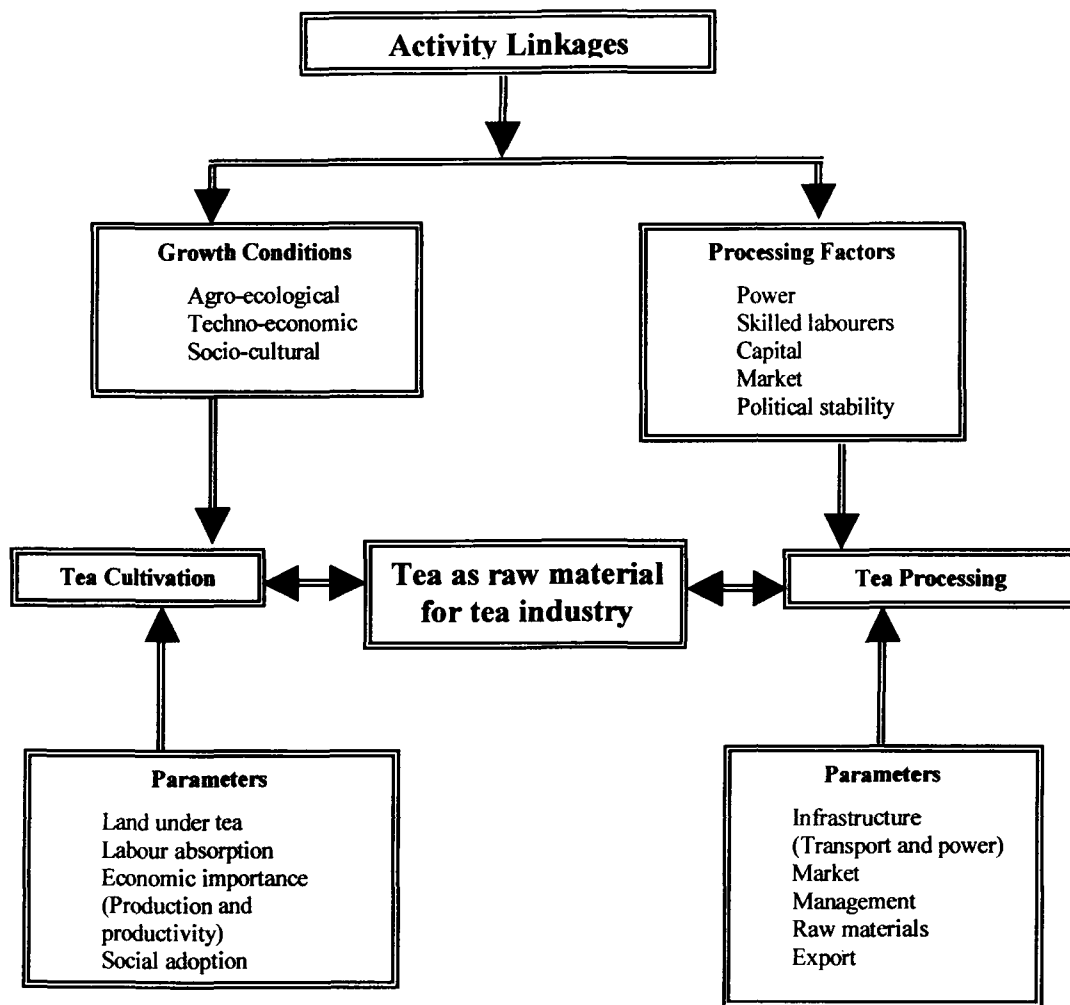


Fig.-1.1: Tea as Agricultural as well as Industrial Activities and its Linkages.

The present discussion imposes the following questions to answer regarding the development of tea activity in the state:

- 1) What is the overall performance of tea in the development of the state's economy?
- 2) Does tea sector has a significant impact on the state economy? And how does it shape the trend of its economic growth?

3) If its contribution to the economic growth and development is not significant, what are the main factors for its poor performance?

1.0 Sectoral Contribution to the State Income:

The estimation of income provides the most comprehensive single indicator of the level of development of a particular state. The sectoral contribution to the state income gives a clear idea about the contribution of various production sectors to the state income and its various sources. There are different methods of assessing the sectors' strength and their contribution to the state income. The sectoral strength may be studied by calculating total production of the various sectors' of economy in its physical term in the form of aggregation of different elements at sectors level. In this method, price-relatives are not considered. The sectors' income may be assessed by observing value of various commodities of the income contribution. This method is familiar and has been used by the economists for assessing the sectoral strength of the economy. Sectoral contribution which throws light on the State Domestic Product in Assam by industry origin at constant prices, shows its following salient features:

In 1970-71, the primary sector which comprises agriculture, mining, quarrying, forestry and fishery accounted for about Rs.175.8 crores (46.51%) of the total state income. But the contribution of agriculture alone was recorded Rs.123.1 crores (32.54%). The sector of mining, quarry, forestry and fishing together contributed Rs.52.7 crores (13.94%) to the total state income in the same point of time. In the same year, the contribution of the secondary sector accounted for Rs.79.5 crores (21.01%) to the income out of which manufacturing shares Rs.70.0 crores (18.5%) and construction, electricity,

gas and water supply accounted for Rs.9.5 crores (2.51%). The contribution of the tertiary sector recorded about Rs.132.9 crores (32.48%). It includes (a) the transport and communication which shares Rs.51.3 crores (13.56%), (b) the trade and financial institution with a share of Rs. 6.1 crores (1.761%) and (c) the community and personal services which shares Rs. 65.5 crores (17.31%) to the State Domestic Product in the State at the same point of time (Table-1.1).

Table-1.1: State Income from Major Heads of Economy and its Changes (at constant price).
(Rs in crores)

Sl. No	Major Heads of Economy	1970-71	1980-81	1990-91	Average Annual Growth 1970-71 to 1990-91
A	Primary Sector				
1	Agriculture	123.10 (32.57)	1183.00 (50.24)	1417.40 (35.69)	1294.30 (52.57)
2	Mining, Quarry, Forestry, Fishing	52.70 (13.94)	85.10 (3.61)	181.50 (4.57)	128.80 (12.22)
B	Secondary Sector				
3	Manufacturing	70.00 (18.53)	163.40 (6.93)	531.00 (13.37)	461.00 (32.92)
4	Construction, Electricity, Water Supply & Gas	9.50 (2.51)	113.60 (4.82)	241.20 (6.07)	231.70 (121.94)
C	Tertiary Sector				
5	Transport & Communication	51.30 (13.56)	316.00 (13.41)	567.90 (14.30)	516.60 (50.85)
6	Trade & Financial Institutions	6.20 (1.61)	265.10 (11.56)	499.60 (12.58)	493.50 (397.90)
7	Community & Personal Services	65.50 (17.32)	229.10 (9.72)	532.30 (13.40)	466.80 (35.63)
	Total	378.00 (100.00)	2356.00 (100.00)	3971.00 (100.00)	3593.00 (100.00)

N. B. (1) Values in parentheses show the percentages.

(2) Average annual growth has been calculated by taking 1970-71 as base year.

Source: Statistical Hand Book, Assam, 1973, 1975, 1996, Directorate of Economic and Basic Statistics of North-Eastern Region, N.E.C., Ministry of Home Affairs, 1995, Govt. of India, Shillong.

In 1980-81, the contribution of primary sector accounted for Rs. 1268.8 crores (53.85%), whereas the contribution of agriculture alone was recorded Rs.1183.7 (50.24%) and others was Rs.85.1 crores (3.61%). In the same year, the contribution of

secondary and tertiary sectors was observed Rs. 277.0 crores (11.75%) and Rs. 810.2 crores (34.69%) respectively. Thus, primary sector especially agriculture has played an important role and it has risen from Rs. 175.8 crores (1970-71) to Rs. 1268.8 crores in (1980-81).

There was a slight change in the sectoral contribution of state income as the tertiary sector contributed more than the other sectors. The tertiary sector contributed Rs. 1599.8 crores (40.28%) in the year 1990-91, where as the share of primary sectors was recorded Rs. 1598.9 crores (40.26%) almost equal to tertiary sector. The contribution of secondary sector was only Rs.772.20 crores (19.44%) during the early 1990s. The contribution of tertiary sector has increased considerably from Rs. 810.2 crores (34.69%) in 1980-81 to Rs. 1599.8 crores (40.28%) in 1990-91. The shares of other pursuits of tertiary sector were transport and communication that contributed Rs.567.9 crores (14.3%), trade and financial institution as Rs.499.6 crores (12.58%) and community and personal services as Rs.53.3 crores (13.4%) to the State Domestic Products of the State. But again the agriculture, which has been dominating the scenario of sectoral contribution, from the very beginning has contributed a lion's share with Rs. 1417.4 crores (35.69%) to State Domestic Product in the State in (1990-91).

As far as the average annual sectoral growth of the economy is concerned, the tertiary sector has a steady growth rate of nearly 60.04 percent during the last two decades (1970-71 to 1990-91). It is due to the overall development of transport and communication, increase in exports, opening of different financial institutions like bank loan facilities, co-operative societies, etc. which rose nearly four times in the last 20

years. In the primary sectors, the average annual growth of agriculture was recorded Rs 1294.30 (52.57%) which shows that the average annual growth rate of primary sector to state income has come down significantly over the years due to natural calamities and political instability in the state. However, in spite of several initiatives, the average annual growth of secondary sector was recorded Rs. 692.7 crores that is recorded as 43.57 percent during the same period of time.

So far as economic activities related to tea production are concerned, they play a dual-role in the economy of Assam by contributing in its primary as well as secondary sectors. Therefore, it has been strengthening the agricultural sector of primary activities and the manufacturing sector of secondary activities of the economy. These sectors are significantly bigger and contribute the larger shares to the state's economy as 35.69 percent and 13.37 percent respectively during the early 1990s. A significant increase of Rs. 1294.30 crores (52.57% annually) in agricultural sector and of an increase of Rs.461.0 crores in manufacturing sectors (i.e., 32.92% annually) have been noticed during the last 20 years (1970-71 to 1990-91). Since tea is a major component for the contribution to these both sectors, it is true that there are perhaps noticeable changes in tea production and its allied activities, which significantly contribute to the growth of these sectors. The performance of tea can be studied considering it as a major component of agriculture as well as non-agriculture sector separately.

1.1 (a) Contribution of Tea in Agriculture Sector:

For interpretation of results regarding the performance of tea in the share and growth of tea to the agriculture sector of the Assam state, the post-independent period of

46 years from 1953-54 (as base year because it had been the starting point of tea cultivation in Assam after independence) to 1998-99 (as current year for showing the changing trends of post-independent period) has been considered. According to the statistics provided by the Directorate of Economics and Statistics, Government of Assam, Guwahati, it is obvious that the share of total Gross Domestic Product (GDP) in agriculture sector has been recorded Rs.4950.14 crores (1991-92) and then Rs 11804.56 crores (1998-99). It shows that agriculture has dominance in state income, while it is fed from the outside states because of a large gap between Net Domestic Product (NDP, i.e., Income) and Gross Domestic Product (GDP) of the state.

So far as contribution of tea production to GDP of agriculture sector is concerned, it has been studied by accounting the production of tea as well as other agricultural production (which includes food crops, horticulture etc) separately for comparing the results. The Kuznets formula of growth-contribution is applied to show the contribution of tea (Kuznet 1964). The following results have been drawn from the changing trends of agricultural attributes:

(1) There has been simultaneous increase in the volume of tea production from Rs. 120.05 crores in 1953-54 to Rs. 3380.94 crores in 1998-99. This increase of Rs. 3260.89 crores (that is 2716.3%, nearly 27 times, during last 45 years) has a significant impact on the agricultural sector of the state. On the other hand, an increase of Rs. 8273.32 crores from Rs. 156.36 crores to Rs. 8423.62 crores has been recorded in agriculture production except tea during the same period of time. It is a record of 5514.4 percent, the 55 times during the same period of time. Therefore, there is comparatively slower growth of tea

production than the agricultural production in the state.

(2) There is fast increase in the production of tea, rather than the agricultural items of the economy and, consequently, total GDP of agriculture sector has been rising. However, there is a record decrease in the share of tea production from 44.41 percent in 1953-54 to 28.64 percent in 1998-99. It means that tea constituted nearly two-fifth share of the total GDP during the starting period of the first five-year plan. The contribution shrinks down to nearly one-fourth in the late 1990s during the 8th plan period. On the other hand, the share of agricultural product excluding tea rose to the same proportion because of the complementarity of these sectors to total GDP of agricultural sector (Table-1.2).

Table-1.2: Contribution of Tea to the Agricultural Growth in Assam ,

Year	Total Production		G.D.P. Agri. Sect	Share in		Annual rate in		Multiplier (%) (RtXRa)	d(GDP)	Contribution of Tea to Agricultural Growth(%)
	Tea	Agriculture		(%) Pt	(%) Pa	(%) Rt	(%) Ra			
1953-54	120.05	150.30	270.35	44.41	55.59	----	----	----	----	----
1954-55	148.22	171.48	319.70	46.36	53.64	23.47	14.09	3.31	49.35	6.70
1955-56	109.71	156.36	266.07	41.23	58.77	-25.98	-8.82	2.29	-53.63	-4.27
1956-57	145.21	178.94	324.15	44.80	55.20	32.36	14.44	4.67	58.08	8.05
1957-58	113.71	191.46	305.17	37.26	62.74	-21.69	7.00	-1.52	-18.98	8.00
1958-59	129.74	193.97	323.71	40.08	59.92	14.10	1.31	0.18	18.54	1.00
1959-60	129.06	213.16	342.22	37.71	62.29	-0.52	9.89	-0.05	18.51	-0.28
1960-61	122.29	222.21	344.50	35.50	64.50	-5.25	4.25	-0.22	2.28	-9.77
1961-62	122.17	219.32	341.49	35.78	64.22	-0.10	-1.30	0.00	-3.01	-0.04
1962-63	129.61	222.41	352.02	36.82	63.18	6.09	1.41	0.09	10.53	0.81
1963-64	123.08	270.32	393.40	31.29	68.71	-5.04	21.54	-1.09	41.38	-2.62
1964-65	124.63	279.41	404.04	30.85	69.15	1.26	3.36	0.04	10.64	0.40
1965-66	114.88	311.17	426.05	26.96	73.04	-7.82	11.37	-0.89	22.01	-4.04
1966-67	156.30	363.50	519.80	30.07	69.93	36.06	16.82	6.06	93.75	6.47
1967-68	180.15	437.84	617.99	29.15	70.85	15.26	20.45	3.12	98.19	3.18
1968-69	156.44	470.64	627.08	24.95	75.05	-13.16	7.49	-0.99	9.09	-10.85
1969-70	124.49	424.17	548.66	22.69	77.31	-20.42	-9.87	2.02	-78.42	-2.57

Table continued ...

1970-71	148.16	467.09	615.25	24.08	75.92	19.01	10.12	1.92	66.59	2.89
1971-72	160.95	499.27	660.22	24.38	75.62	8.63	6.89	0.59	44.97	1.32
1972-73	147.24	538.73	685.97	21.46	78.54	-8.52	7.90	-0.67	25.75	-2.61
1973-74	144.79	651.59	796.38	18.18	81.82	-1.66	20.95	-0.35	110.41	-0.32
1974-75	223.48	822.97	1046.45	21.36	78.64	54.35	26.30	14.29	250.07	5.72
1975-76	238.26	829.68	1067.94	22.31	77.69	6.61	0.82	0.05	21.49	0.25
1976-77	295.51	884.75	1180.26	25.04	74.96	24.03	6.64	1.59	112.32	1.42
1977-78	563.77	704.25	1268.02	44.46	55.54	90.78	-20.40	-18.52	87.76	-21.10
1978-79	359.09	949.57	1308.66	27.44	72.56	-36.31	34.83	-12.65	40.64	-31.12
1979-80	369.64	1004.17	1373.81	26.91	73.09	2.94	5.75	0.17	65.15	0.26
1980-81	435.20	1047.83	1483.03	29.35	70.65	17.74	4.35	0.77	109.22	0.71
1981-82	406.92	1055.43	1462.35	27.83	72.17	-6.50	0.73	-0.05	-20.68	0.23
1982-83	369.35	1230.65	1600.00	23.08	76.92	-9.23	16.60	-1.53	137.65	-1.11
1983-84	557.57	1495.60	2053.17	27.16	72.84	50.96	21.53	10.97	453.17	2.42
1984-85	771.34	1773.08	2544.42	30.31	69.69	38.34	18.55	7.11	491.25	1.45
1985-86	648.06	1790.00	2438.06	26.58	73.42	-15.98	0.95	-0.15	-106.36	0.14
1986-87	579.47	1856.62	2436.09	23.79	76.21	-10.58	3.72	-0.39	-1.97	20.00
1987-88	627.29	2042.99	2670.28	23.49	76.51	8.25	10.04	0.83	234.19	0.35
1988-89	635.69	2296.33	2932.02	21.68	78.32	1.34	12.40	0.17	261.74	0.06
1989-90	904.80	2648.56	3553.36	25.46	74.54	42.33	15.34	6.49	621.34	1.05
1990-91	1062.17	3165.86	4228.03	25.12	74.88	17.39	19.53	3.40	674.67	0.50
1991-92	1196.54	3753.60	4950.14	24.17	75.83	12.65	18.56	2.35	722.11	0.33
1992-93	1742.06	4675.53	6417.59	27.15	72.85	45.59	24.56	11.20	1467.45	0.76
1993-94	2161.32	5267.79	7429.11	29.09	70.91	24.07	12.67	3.05	1011.52	0.30
1994-95	1739.33	6516.83	8256.16	21.07	78.93	-19.52	23.71	-4.63	827.05	-0.56
1995-96	2055.73	7030.10	9085.83	22.63	77.37	18.19	7.88	1.43	829.67	0.17
1996-97	2161.07	7133.94	9295.01	23.25	76.75	5.12	1.48	0.08	209.18	0.04
1997-98	3070.42	8067.37	11137.79	27.57	72.43	42.08	13.08	5.51	1842.78	0.30
1998-99	3380.94	8423.62	11804.56	28.64	71.36	10.11	4.42	0.45	666.77	0.07

Source: Directorate of Economics and Statistics . Government of Assam, Guwahati, 1999. Tea Digest, Tea Board 1999,Kolkata,India.

Abbreviations:

Pt=Total Production of Tea, Pa=Total Agricultural Production(Excluding Tea)

Rt=Rate of change in Tea Production , Ra=Rate of change in Agricultural Production

GDP=Gross Domestic Product, d(GDP)=Annual change in GDP

But most highlighting feature of the declining trend of the share of tea production is that there is a significant fluctuation in share trends. For example, it (share of tea

product) was recorded lowest (18.18%) in 1973-74 and slight rise thereafter. Its highest share (46.36%) was recorded in 1954-55 (Table-1.2 & Fig.-1.2). Perhaps, it was the time when the economy of the state was shaping toward tea cultivation. Population migration and availability of cheap labour for tea cultivation and its allied activities might have raised tea production during the middle of the 1950s. After that, the saturation point of tea workers, which checked the labour productivity and other political factors, influence tea cultivation. As a result, its share declined till the year 1973-74. On the other hand, immigration problems increased the population density of the state and, consequently, more food is demanded to feed the increasing population and so there was an increase in the share of agricultural products especially in food grains production.

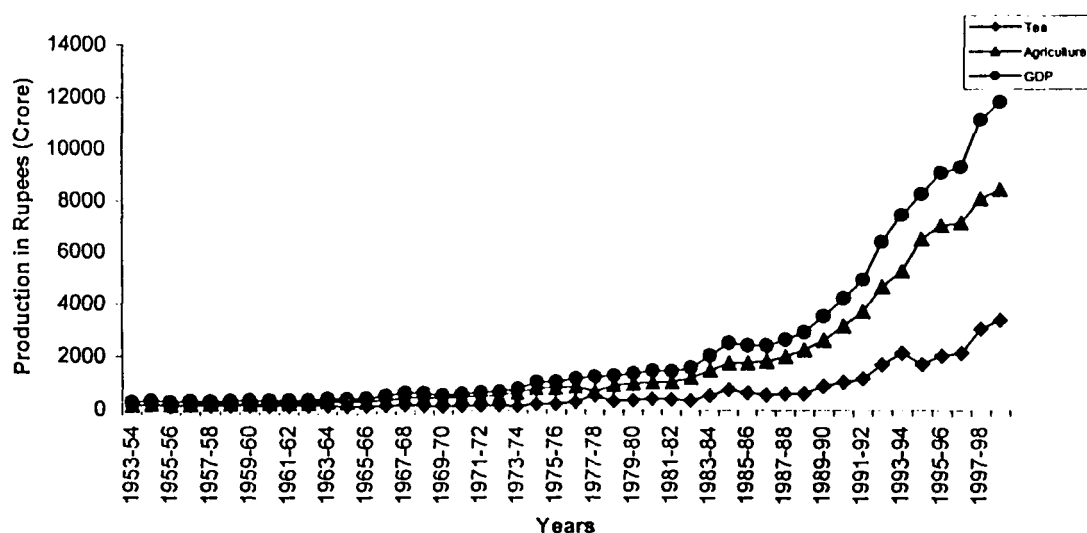


Fig.-1.2: Trends of Tea and Agricultural Growth in Assam.

However, an impact of green revolution may be seen in tea cultivation after 1972-73 when the share of tea products rose, giving more importance of new agricultural

technology. It now competes in cropping patterns not only in Assam but other hill-states of North-Eastern region and raising gradually its share in the GDP. On account of changing trends in the share of tea production, there have been record fluctuations in its annual growth.

(3) The annual change of any attribute is a symbol of fluctuation in total production. It has been calculated accordingly. It is found that there has been a record fluctuation in the changing trends of tea production from its highest value of +90.78 percent in 1977-78 to the lowest of -36.31 percent in the 1978-79. Therefore, the last part of the 1970s was recorded as the most fluctuating period in tea production. It may be because of bad weather conditions in the state. However, in general, a deceleration in the growth trend of tea production was observed specially in the first phase of declining its share in GDP. In late 1980s and early 1990s, there was a simultaneous increase in the share and production growth of tea in the state. The year 1989-90 was recorded the year of satisfactory growth of 42.42 percent.

On the other hand, an average annual growth of 8.93 percent was recorded for agricultural products excluding tea, which was slightly lesser than the average annual growth of tea production (i.e., 9.15%). The fluctuations in the growth pattern of agricultural product have specific characteristics like: (a) the negative growth is observed only in a few years of the study period, (b) the fluctuation is in the upper sector of the growth-pattern graph (Fig.-1.2) and (c) the degree of fluctuation in the agricultural products can be seen lesser than the fluctuation in tea products in Assam because the demand of agricultural food products is continuous, while tea is influenced by trade

activities and international market price-mechanism.

(4) The interaction factor of annual growth of both the sectors shows that tea cultivation contributes positively specially during the first five-year plan period and the early 1990s when both sectors flourished together. But the period of early 1980s was considered as conflicting trend of tea production growth. The periods of the four years of early phase of growth (1953-54 to 1956-57), the three years of middle phase (1974-75 to 1977-78) and the two-years of early 1980s (1983-84 to 1984-85) have been considered the time of positive values of interaction factor. It means both the sectors of agriculture, tea as well as food grains have flourished simultaneously. The same interaction pattern may also be observed in the last part of 1980s as well as 1990's.

(5) So far as contribution of the growth of tea production to the over all growth of GDP in agriculture sector is concerned, the value of interaction factor of sectoral growth is multiplied by the annual change of GDP. This index of tea contribution to GDP growth highlights that:

(a) The periods of first four years (1953-54 to 1957-58) and the last 24 years (1974-75 to 1998-99) have a positive impact in the GDP growth of agriculture sector. The contribution of the growth of tea production in the growth of GDP was recorded more than 8.0 percent annually in first four years while the contribution of this sector is insignificant in the last 24 years period except the year 1986-87 when the total GDP was recorded as Rs. 2436.09 crores in the state.

(b) The two years period of time 1968-9 to 1969-70 was recorded as negative effect of tea

production growth in GDP when GDP in agriculture sector declined to 9.09 percent in 1968-69 and then -78.42 percent in 1969-70 because of negative growth of its sectors, tea as well as agricultural food grains. However, the annual differentials of GDP have been increasing significantly in the last part of 1990's.

1.1 (b) Contribution of Tea in Industrial Growth:

In the preceding part of the present discussion, the contribution of tea in agriculture sector has been discussed. Since tea production is an integral part of the entire economy in Assam, it also contributes significantly to the industrial sector of the state's economy. Adopting the same method as used earlier for the assessment of its contribution in agricultural growth, the performance of tea production in GDP of industrial sector has been observed considering the same period of time (1952-53 to 1998-99). The following important trends of tea production as well as its contribution to the GDP of industrial sector are shown below:

1. It is evident from the data that there is a sharp increase in industrial production (excluding tea) in the state from Rs. 106.71 crores in 1953-54 to Rs.13371.53 crores in 1998-99. Its increasing trend during the post-independent period of 45 years shows another interesting feature as the rate of its increase is recorded faster than the agricultural sector of the state. Undoubtedly, during the first-half of the period (1953-54 to 1973-74) that is twenty years of the time of the first phase of development in GDP of industrial sector, it had been growing slower and its growth curve was lower than the curve of agriculture sector. It (industrial sector) has crossed the curve of agriculture sector in 1974-75. It grew much faster in the last phase of the growth of economy as these

production curves are compared (Table-1.3).

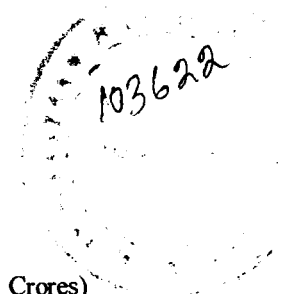


Table-1.3: Contribution of Tea to the Industrial Growth in Assam.

Year	Total Production		G.D.P. Ind. Sect	Share in		Annual rate in		Multiplier (%) (Rt X Ri)	d(GDP)	Contribution of Tea to Industrial Growth(%)
	Tea	Industry		(%) Pt	(%) Pi	(%) Pt	(%) Pi			
1953-54	120.05	106.71	226.76	52.94	47.06	---	---	---	---	---
1954-55	148.22	101.49	249.71	59.36	40.64	28.17	-4.89	-1.38	22.95	-6.00
1955-56	109.71	122.69	232.40	47.21	52.79	-25.98	20.89	-5.43	-17.31	31.35
1956-57	145.21	134.73	279.94	51.87	48.13	32.36	9.81	3.18	47.54	6.68
1957-58	113.71	141.45	255.16	44.56	55.44	-21.69	4.99	-1.08	-24.78	4.37
1958-59	129.74	152.27	282.01	46.01	53.99	14.10	7.65	1.08	26.85	4.02
1959-60	129.06	167.50	296.56	43.52	56.48	-0.52	10.00	-0.05	14.55	-0.36
1960-61	122.29	185.10	307.39	39.78	60.22	-5.25	10.51	-0.55	10.83	-5.09
1961-62	122.17	199.40	321.57	37.99	62.01	-0.10	7.73	-0.01	14.18	-0.05
1962-63	129.61	215.15	344.76	37.59	62.41	6.09	7.90	0.48	23.19	2.07
1963-64	123.08	239.27	362.35	33.97	66.03	-5.04	11.21	-0.56	17.59	-3.21
1964-65	124.63	265.00	389.63	31.99	68.01	1.26	10.75	0.14	27.28	0.50
1965-66	114.88	293.50	408.38	28.13	71.87	-7.82	10.75	-0.84	18.75	-4.49
1966-67	156.30	334.77	491.07	31.83	68.17	36.06	14.06	5.07	82.69	6.13
1967-68	180.15	378.88	559.03	32.23	67.77	15.26	13.18	2.01	67.96	2.96
1968-69	156.44	404.81	561.25	27.87	72.13	-13.16	6.84	-0.90	2.22	-40.57
1969-70	124.49	430.36	554.85	22.44	77.56	-20.42	6.31	-1.29	-6.40	20.14
1970-71	148.16	449.51	597.67	24.79	75.21	19.01	4.45	0.85	42.82	1.98
1971-72	160.95	474.64	635.59	25.32	74.68	8.63	5.59	0.48	37.92	1.27
1972-73	147.24	544.02	691.26	21.30	78.70	-8.52	14.62	-1.25	55.67	-2.24
1973-74	144.79	618.19	762.98	18.98	81.02	-1.66	13.63	-0.23	71.72	-0.32
1974-75	223.48	802.49	1025.97	21.78	78.22	54.35	29.81	16.20	262.99	6.16
1975-76	238.26	900.93	1139.19	20.91	79.09	6.61	12.27	0.81	113.22	0.72
1976-77	295.51	1002.84	1298.35	22.76	77.24	24.03	11.31	2.72	159.16	1.71
1977-78	563.77	1123.04	1686.81	33.42	66.58	90.78	11.99	10.88	388.46	2.80
1978-79	359.09	1186.59	1545.68	23.23	76.77	-36.31	5.66	-2.05	-141.13	1.46
1979-80	369.64	1281.46	1651.10	22.39	77.61	2.94	8.00	0.23	105.42	0.22
1980-81	435.20	1476.75	1911.95	22.76	77.24	17.74	15.24	2.70	260.85	1.04
1981-82	406.92	2160.82	2567.74	15.85	84.15	-6.50	46.32	-3.01	655.79	-0.46
1982-83	369.35	2425.06	2794.41	13.22	86.78	-9.23	12.23	-1.13	226.67	-0.50
1983-84	557.57	2822.70	3380.27	16.49	83.51	50.96	16.40	8.36	585.86	1.43
1984-85	771.34	3317.34	4088.68	18.87	81.13	38.34	17.52	6.72	708.41	0.95
1985-86	648.06	3804.51	4452.57	14.55	85.45	-15.98	14.69	-2.35	363.89	-0.65
1986-87	579.47	4232.13	4811.60	12.04	87.96	-10.58	11.24	-1.19	359.03	-0.33

Table continued ...

1987-88	627.29	4790.39	5417.68	11.58	88.42	8.25	13.19	1.09	606.08	0.18
1988-89	635.69	5052.28	5687.97	11.18	88.82	1.34	5.47	0.07	270.29	0.03
1989-90	904.80	6120.84	7025.64	12.88	87.12	42.33	21.15	8.95	1,337.67	0.67
1990-91	1062.17	7063.92	8126.09	13.07	86.93	17.39	15.41	2.68	1,100.45	0.24
1991-92	1196.54	7591.28	8787.82	13.62	86.38	12.65	7.47	0.94	661.73	0.14
1992-93	1742.06	5603.60	7345.66	23.72	76.28	45.59	-26.18	-11.94	-1,442.16	0.83
1993-94	2161.32	8045.69	10207.01	21.17	78.83	24.07	43.58	10.49	2,861.35	0.37
1994-95	1739.33	9189.03	10928.36	15.92	84.08	-19.52	14.21	-2.77	721.35	-0.38
1995-96	2055.73	10428.02	12483.75	16.47	83.53	18.19	13.48	2.45	1,555.39	0.16
1996-97	2161.07	11943.80	14104.87	15.32	84.68	5.12	14.54	0.74	1,621.12	0.05
1997-98	3070.42	12427.86	15498.28	19.81	80.19	42.08	4.05	1.71	1,393.41	0.12
1998-99	3380.94	13371.53	16752.47	20.18	79.82	10.11	7.59	0.77	1,254.19	0.06

Source: Directorate of Economics and Statistics, Government of Assam, Guwahati, 1999. Tea digest Tea Board 1999, Kolkata, India.

Abbreviations:

Pt=Total Production of Tea, Pi=Total Industrial Production(Excluding Tea)

Rt=Rate of change in Tea Production, Ri=Rate of change in Industrial Production

GDP=Gross Domestic Product, d(GDP)=Annual change in GDP

2. So far as share of tea production in the total GDP of industrial sector is concerned, it is interesting to note that its (tea) share has been declining over time which was recorded nearly 59.38 percent to GDP of industrial sector in the early 1950s (specially in 1954-55). It later on declined to 25.32 percent in early 1970s, and then to 15.32 percent in late 1990s (Table-1.3). It means that the contribution of tea has been losing its ground in the industrial sector of the state. During the 1988-89, the share of the production was recorded lowest as 11.17 percent only. The performance of tea production shows that the other industrial activities have been increasing faster than the increase in tea production. Tea is not considered as a major industrial activity because of its declining share (Fig.- 1.3).

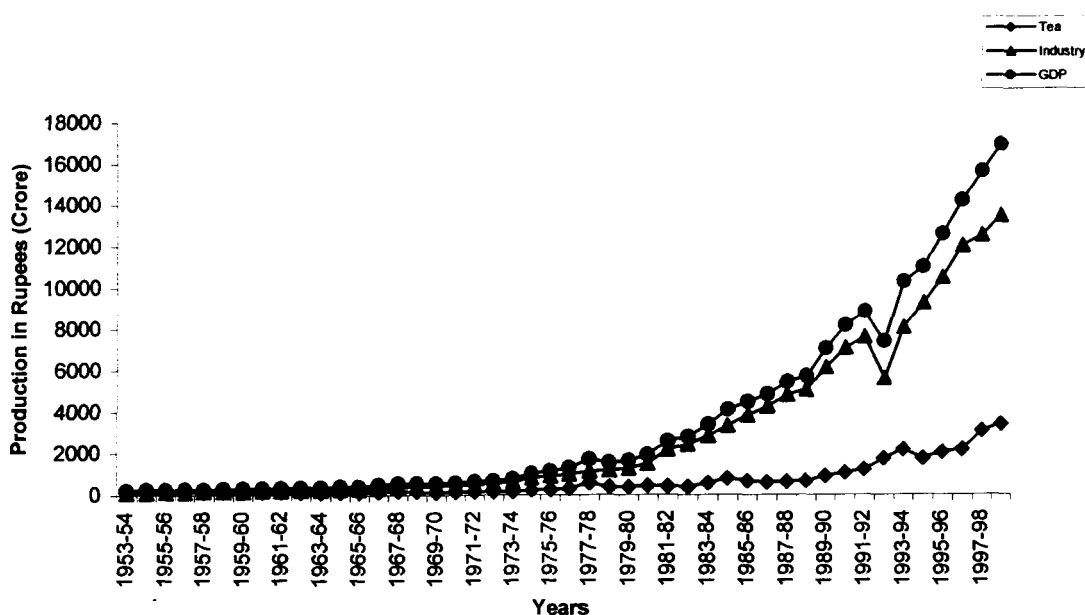


Fig.-1.3: Trends of Tea and Industrial Production in Assam.

The annual growth of tea production and its comparison with the growth rate of other industrial activities in the state shows that there is a large fluctuation in the annual growth of tea production as has already been studied in earlier section. However, the year 1977-78 is recorded as the year of its highest growth (90.78%) while the year 1978-79 is recorded as the highest decline rate of tea production (-36.31%) in the state. It shows a fluctuating tendency throughout. On the other hand, the growth of industrial production (excluding tea) comparatively has lesser fluctuation over time. During the same period of time, only the year 1954-55 was recorded as negative growth (-4.89%). While the fluctuation in growth is recorded moderate in the positive sector of the growth trend graph ranging from an annual growth rate of 4.99 percent (1957-58) to 46.2 percent (1981-82) in industrial sector of the economy.

The early 1980s period was recorded as golden time for faster growth of industrial

sector in Assam. However, the decelerated growth was recorded during the same period of time in tea production. It may be due to various factors to compensate the growth of tea with the growth of other industrial activities. The political climate of the state was also favourable for the industrial growth in the early 1980s.

3. In fact, the contribution of tea to the industrial sector is calculated by measuring the interaction factor of annual growth rate in tea and industrial production per unit of change in GDP. It is found that the period of early 1950s to 1970s, which has been the period of fast growth, the interaction factor was recorded negative almost in all the years. It is especially some of the higher degree of fluctuations in the annual growth rate of tea production. As a result, the contribution is also recorded negative in many of these years during the first phase of growth. In general, on account of favourable conditions of industrial growth in 1980s, there has been a record contribution of tea to the industrial sector of the state (i.e., 26%). It means that tea has a significant importance in the primary as well as secondary sectors of the economy. Its performance may be viewed considering population pressure, which provides labour to the cultivation and processing of tea.

1.2 Per Capita Tea and Agricultural Production in the Major Tea Producing Districts and its Change (1971-1991):

Tea industry, being the largest single industrial sector, has been playing a significant role in the economy of Assam. It is contributing larger share in the state economy. The regional pattern of its distribution and per capita production would show the areal extent of its performance.

The total production of tea in the major seven tea producing districts was recorded 2,23,659 thousand kg. in 1971 which was increased to 3,97,034 thousand kg. in 1991. The highest production in 1971 was recorded in the three districts, namely, Lakhimpur including Dibrugarh and Tinsukia with 91,949 thousand kg. (41.11%) and the lowest was in the district of Goalpara with 2422 thousand kg. (1.08%) in 1971. The other important tea producing districts were Sibsagar includes (N.C. Hills, Karbi Anglong, Jorhat and Golaghat) produced 55289 thousand kg tea. But during the last 20 years, the total production has increased from 22,3659 thousand kg. in 1971 to 397034 thousand kg in 1991 with its annual average growth of 3.88 percent. During the last twenty years, the production became doubled in all the districts except in Lakhimpur (including Dibrugarh and Tinsukia) and Nowgaon districts where it was raised from 91,949 to 1,50,486 thousand kg and from 7,423 to 11,870 thousand kg. only. However, there has been a gradual decline in its share in these two districts of high concentration of tea cultivation. Lakhimpur and Nagaon districts declined its share marginally by 4 percent during the last 20 years. The shares of tea production have increased in Darrang, Goalpara and Cachar districts during same period of time (Table-1.4). On the other hand, the share of food products decline in these districts in the lower Brahmaputra and Cachar areas. On the other hand the share of agriculture production is declined in Darrang (2.0%), Goalpara (2.0%) and Cachar (2.16%) and also in Lakhimpur (13.30%) during the last twenty year (1971-1991). It is increased in Sibsagar district including N.C. Hills, Karbi Anglong, Jorhat and Golaghat from 13.90 percent to 23.35 percent during same period of time. It means that tea cultivation is being substituted by food crops in the areas where tea has

dominance in landuse pattern of the state.

The population size and its growth are important factors to determine the feasibility of economic development of a country. The state of Assam, which covers an area of 2.4 percent to the total land of the country, gives shelters to about 2.6 percent population of the country as per the 1991 census. It means that density of population is more or less similar to the density figures of the country. However, increasing presence of population provides unlimited supply of labour to agricultural operation and stabilises wage rate, consequently, it influences socio-economic development of the state. This situation of population growth and increasing its pressure constantly on economy influences the growth of economy not only in India but also in entire South-Asian countries.

So far as population concentration of tea producing districts of Assam is concerned, it can be said that these seven districts account for a large share of state's population as 115.10 million population in 1971, which was rose to 136.67 million till 1991. If these seven districts are considered as domain of the study, it is obvious that Kamrup, Lakhimpur and Sibsagar districts include a large share of population of the domain. Undoubtedly, the size of population has been increasing in each tea-producing districts of the state. But its percentage share appears decreasing in most of the districts except Darrang and Lakhimpur. It means that population is concentrated in Darrang and Lakhimpur where population size was recorded moderate (Table-1.4).

On account of variations in concentration and growth of population, per capita production of tea as well other agricultural products are influenced. It is noted that, in

spite of increasing pressure of population, per capita tea and agricultural production have been increasing constantly in all tea-producing districts except Lakhimpur district where per capita agriculture production declines from 224 kg (1971) to 167 kg (1991) because of decrease in total agricultural production with increasing population pressure (Table-1.4). It is interesting to note that in these tea-producing districts, per capita production of tea is increased from 19.43 kg (1971) to 29.05 kg (1991) where there is an increase of agricultural food crops of 95.25 kg per capita from 150.0 kg to 245.0 kg during the same period of time. As a result, there is annual increase in per capita tea as well as agricultural production in these tea-producing districts of the state (Table-1.4).

Table-1.4: Per Capita Tea and Agricultural Production in Major Tea Producing Districts and its change (1971-1991)

District	Tea		Agriculture		Population		Production (Kg per capita)				Annual % change in Per capita production (1971-91)	
	1971	1991	1971	1991	1971	1991	Tea	1991	1971	Agriculture	1991	Tea
Darrang	41283 (18.43)	80907 (21.37)	286055 (16.57)	469488 (14.01)	1736 (11.95)	2723 (19.77)	24.00	30.00	165.00	172.00	1.25	0.21
Goalpara	2422 (1.08)	5410 (1.36)	141849 (8.22)	217403 (6.48)	664 (5.76)	668 (4.85)	4.00	8.00	214.00	325.00	5.00	2.59
Kamrup	2557 (1.14)	4774 (1.20)	148034 (8.57)	630268 (18.80)	883 (16.35)	2000 (14.52)	1.00	2.00	79.00	315.00	5.00	15.00
Lakhimpur	91949 (41.11)	150486 (37.90)	474993 (27.57)	444735 (13.27)	2123 (18.44)	2656 (19.29)	43.00	57.00	224.00	167.00	1.62	-1.40
Nagaon	7423 (3.31)	11870 (2.98)	249184 (14.44)	543402 (16.21)	1681 (14.60)	1893 (13.75)	4.00	6.00	148.00	287.00	2.50	4.70
Sibsagar	55289 (24.72)	102982 (25.93)	239884 (13.90)	782503 (23.35)	2292 (19.91)	1251 (8.24)	24.00	41.00	105.00	311.00	3.50	9.80
Cachar	22736 (10.16)	40605 (10.22)	185618 (10.75)	262954 (7.84)	131 (9.82)	1215 (8.80)	20.00	33.00	164.00	216.00	3.00	1.60
Total	223659 (100.00)	397034 (100.00)	1725617 (100.00)	3350753 (100.00)	11510 (100.00)	13667 (100.00)	19.43*	29.05*	149.92*	245.17*		

N. B. Agricultural Production includes major crops only.

1. Darrang District includes Sonitpur district.
2. Sibsaagar District includes N. C. Hills, Karbi Anglong, Jorhat and Golaghat.
3. Lakhimpur District includes Dibrugarh and Tinsukia districts.

(Percentage change in per capita is calculated by applying Growth Formula)

* Per Capita for total figures is calculated by dividing data of tea and agriculture by its corresponding population.

Sources: The figures of Tea production are compiled from Tea Statistics, 1991 and 1992, Tea Board, India. Agricultural Production Data are taken from Basic Agricultural Statistics, Statistical Wing, Directorate of Agricultural, Govt. of Assam, Guwahati.

2.0 Statement of the Problem:

Among all the plantation crops, tea is considered to be the most well organized and labour intensive plantation crop. Its reputation is being the 'biggest employer of women workers in India' with equal pay for equal works is another significant aspect of tea (Bhuyan 1989). It has been a potential factor for promotion of the economy of this region as well as the whole country. It is the largest organized sector providing a stable economic base for the state. The industrialization of Assam in lines started with tea during the British period. Development of this industry gave rise to the establishment of number of other linkage industries like plywood and tea chest production, general engineering services including railway transport (Choudhury 1991).

But inspite of favourable physiographic and economic conditions, production is yet to reach its expected target. India, being the largest consumer, affects the country's export profile directly or indirectly. Since Indian tea has a ready market at home, it should now put more emphasis on the International market. Although traditional item of export, tea as an exportable commodity has stood the test of the time and proved itself as the most reliable export items earning nearly Rs. 650-700 crore in foreign exchange. This achievement is further rewarding in view of the fact that the entire earnings come out of indigenous export without any import aid. As nations demand (national and international) is not keeping pace with the production, suitable strategies have to be adopted if the country is to continue as world's leading producer and exporter. According to Food and Agriculture Organisation (F.A.O.), the world's tea demand in 1990 was 2710 million kg and is likely to be 3000 million kg in 2000. A survey of tea market shows that the

consumption in the U. K. and E. E. C. is dropping. In the U.S.A., it is steady with some marginal growth. Major producers like Sri Lanka, Kenya and Malaya depend upon tea export for their foreign exchange earnings. While Sri Lanka production has been stagnant; the production of Kenya and Malawi is increasing steadily. In the absence of any domestic market and in excess of the demand, it is necessary for the tea producing areas to increase its productivity by application of modern techniques. Since, land is limited, the increase in crop has to come from the existing gardens and to encourage the cultivation in non-traditional areas.

The domestic consumption of tea in 2000 is estimated to be about 750 million kg and the target for the export is 250 million kg by the turn of the century. In this statistics, the share of North-Eastern India is expected to be 500 million kg. Since Assam alone produces more than 54% of the national total, it is required to increase its production level to maintain its glorious traditions.

Therefore, it is necessary to study the problems and prospects for the optimization of the production of tea cultivation in relation to physical and socio-economic factors. For this empirical study, the Upper Brahmaputra Valley has been selected as testing laboratory on the basis of these factors and dominance of tea cultivation and its land use pattern.

The Upper Brahmaputra Valley receives an average rainfall (annual) between 100-300 cm with temperature ranging between 15°C to 35°C. Tea cultivation requires high humidity during its harvesting season specially between June and November, which ranges from 60% to 95%. Higher the humidity, greater is the plant growth and larger will

be the production. During winter season when humidity declines to 60%, production decreases proportionately. Soil is another important ecological factor of tea production. On account of weak chemical reactions in the soils of this area (pH below normal that is 5 to 6) needs proper fertilizer treatment if tea is to grow well. All these factors are prevailing in the valley, however, productivity level is recorded low which is significantly affected by different diseases as the tea plant get older. Therefore regular checking of diseases, supply of water during dry season through irrigation and a regular provision for replanting are necessary as it lasts 50-60 years. Most of the tea plants in Upper Brahmaputra Valley were planted during the mid part of 18th century. As the tea plantation gets older, the productive power decreases over time. Thus irrigation, chemical fertilizers and pesticides are to be used to increase production and productivity. Since tea cultivation is declared as industry in Assam, the relationship between management and labour is one of the important factors for maintaining good yielding capacity of the tea gardens. It is needed because the demand of tea product has been increasing constantly in India and outside. There are stagnant conditions in tea cultivation in Assam. It is labour-intensive farming system with extensive use of farm technology. Therefore, labour and technology are major factors for optimizing production and productivity in tea cultivation.

3.0 Objectives:

The proposed study focuses attention towards the following objectives:

- (1) to examine the variation in production and productivity level of tea, and

(2) to find out causes of their areal variations.

4.0 Research Questions:

There may be a good deal of explanation of the problems of optimization of tea production with respect to its factors. However, the following two research questions are posed here to stream line the discussion and explanations to fulfil the objectives.

- (a) How do the physical factors responsible for the variation in the level of production and productivity?
- (b) What are the socio-economic characteristics of Gardens labourers, how it influences the tea production in different agro-ecological conditions of tea cultivation?

5.0 Methods Used and Data Collection:

The geographical explanation and answers of such research questions may be given by viewing the physical factors of land and their areal variations to specify the areas of various agro-ecological conditions finding out the causes of areal differentiations in tea productivity. The main parameters of physiographic personality of the study area, namely, relief features, soil and climatic conditions, vegetal cover conditions and agricultural practices have been considered to identify the areal variations of such parameters. Agro-ecological zonation is prepared to show the homogeneous physical conditions. It would be helpful in explaining the areal variations accruing in the productivity of tea in the area.

The question is closely related to the study of socio-economic characteristics of labourers and their families residing in the gardens and influencing directly or indirectly the production processes of tea cultivation. The detail answer of this question and explanations of socio-economic characteristics of gardens labourers have been extended at two stages:

(a) The first stage explanation is forwarded by considering the parameters of the each and every garden, which are related to:

- (i) the tenurial system prevailing in the gardens,
- (ii) the productivity attributes,
- (iii) the demographic features of the gardens, and
- (iv) the social amenities available for the people of tea gardens.

(b) The second stage explanation of the problems as posed in the research questions is forwarded by adopting sample design of the gardens and conducting house-hold surveys of selected households. The following criteria have been adopted to choose the gardens

- (i) Remotivity/accessibility of garden from road size,
- (ii) Size of the garden, and
- (iii) Available infrastructure

The five sample tea gardens from each agro-ecological zone are selected by adopting above bases of garden selection. Further, 15 households from each sample garden are chosen randomly considering household size and its socio-economic level, so as to include the variety of households to infer the results (Appendix).

Further, the primary survey of these selected households was conducted by preparing the schedule/questionnaire. After collecting data, the tabulation was done by processing the raw data into required formats through the computer programming.

As far as required data are concerned for the same procedure, the information required have been collected from the following sources:

1. the geographic information for delineation of agro-ecological zones of the study area have been generated from R. F. 1/1 million map of the Upper Brahmaputra valley. Drainage pattern, micro relief features and geomorphic conditions are interpreted from these maps.
2. District wise soil series data are collected from the Regional Office, Natural Bureau of Soil Survey and Landuse Planning, Jorhat. The soil profile properties of different soils of the tea gardens are analysed by 'Toklai Tea Research Institute'. The published materials available there have been used to highlight the soil and climatic conditions of the area.
3. The garden-wise survey was conducted during the fieldwork. With the help of B.A./B.Sc. students during the years 1997-98 and 1998-99, a garden-to-garden survey was conducted to collect the data of socio-economic and landuse parameters of the gardens.
4. The primary socio-economic survey of selected households also conducted to give more detail explanations of causes of low levels of productivity in the tea gardens.

6.0 Chapter Scheme:

The contents of the present study are organized into the following chapters:

Chapter I deals with introduction, statement of the problem, objectives and research question. Apart from these aspects, the performance of tea in state economy is discussed in this chapter. Since tea is both plantation-cum-industry, the role of tea to the agricultural and industrial development of Assam is also included in the same chapter. Sufficient literature is available on socio-economic problems and technological aspects of tea gardens. A Review of relevant literature is arranged in chapter II of the present work.

The geographical and non-geographical factors influencing the production of tea and creating areal differentiations in tea productivity, which have been included separately in Chapter-III.

Chapter-IV includes the socio-economic characteristics of the tea gardens. It has been examined from five different angles with respect to land productivity, labour productivity, farm size, density of population and family size for different agro-ecological conditions.

Chapter-V includes the pattern of production and productivity of tea gardens. In this chapter, a comparative study of land as well as labour productivity is arranged in such a way that the impact of socio-economic conditions on the productivity attributes may be visualized for the different agro-ecological zones. In the end, one chapter devotes to conclusions and findings.

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Chapter-II

Review of Literature

1.0 Introduction:

The tea plantation-cum-industry which developed under the British colonial rule during the early part of nineteenth century, has already marched a long way to acquire its present global status. Numerous studies and experiments have been undertaken by scientists and scholars at individual as well as government levels with a view to optimise the cultivation and production of tea and also to understand the various ecological and non-ecological factors contributing directly and indirectly towards its growth and development. Some of the studies are related to general in its nature, which are studied from historical and geographical point of view, while others are of experimental in nature conducted in relation to the growth, production and productivity of tea.

The main objective of the present chapter is to highlight the study done by considering various aspects, issues and problems not only of tea production in upper part of Brahmaputra Valley but also of the whole state of Assam. However, the studies, which are general in nature, have been included partially, so that the main ideas of tea plantation, methods of cultivation, role of ecological and non-ecological factors can be understood.

In order to make the work more convenient, the concerned literature has been reviewed here by putting into a number of specific categories:

2.0 Studies Related to General in Nature

Although the cultivation of tea and its production started in early parts of 19th century, no systematic studies have been made regarding the aspects of tea and its contribution to the national economy till the end of the same century.

The first half of the 19th century has been characterized by the scanty literature. But in the detail study on the early history of tea industry in North-East India, Mann (1934) attempted to focus attention on the growth and development of tea in Assam Valley and its contribution to the colonial economy.

After the independence, there have been a numerous studies both at government level as well as individual scholars on some aspects of the economics of tea production in India. A brief review of some of these studies has been presented in order to bring out and identify some of the distinguishing features of the present study.

A Report of the Plantation Enquiry Commission prepared in 1956 is based on a survey of economic conditions and problems of tea, coffee and rubber plantations in India for the period 1950-1953. The survey report is mainly in the nature of documentation of some primary and secondary data regarding each of these industries and lacks in any statistical analysis of the relationship of various economic and other variables with the final production variable. However, the report made two specific observations regarding the production of tea: (i) the higher yield per hectare was observed in *Dooars* and *Terai* regions of West Bengal as compared to North India till 1954 and, (ii) the increased production of tea could be possible as a result of improved methods of field and factory operations that increase the productivity of labour.

The Government of India constituted a Working Group of Plantation Crop (1956) for recommending appropriate development programme for the plantation industries during the Third and Fourth Five Year Plan periods. The report identifies some of the difficulties and areas of assistance to the tea estates for improving the production. The working group recommended replanting of a large part of the existing bushes and various other extension measures for tea cultivation. It also emphasizes the need for supplying fertilizer to the tea gardens at the right time, stabilization of wages and taxes 'drawback' of excise duty on exportable tea, etc.

A report of the Tea Finance Committee (1964) appointed by the government of India concluded that there had been a downward trend in the industry's net return and this had a dampening effect on incurring fresh development expenditure by the industry. Financial incentives are, therefore, necessary to encourage the tea industry for undertaking development and expansion, which only could help to achieve the production target set out in the Five Year Plans.

The Estimates Committee of the Lok Sabha (1971-72) in their report on Tea Board, also recommended for carrying out Techno-Economic Survey on various aspects of tea industry, on regular basis so as to have first hand reliable information about the affairs and problems of the industry in the various tea growing regions of India. Following the recommendations, the Tea Board of India has been undertaking Techno-Economic Surveys in various tea growing regions of the country including the Darjeeling and *Terai*. But these analyses and findings have stressed more on the agronomic and technological aspects of tea production rather than economic, geographical and other

factors like labour management relations. Although such surveys have collected sample data on a number of economic variables, the statistical tools and tests have not been used in any way to analyse the data to bring out the significance of each of these variables or groups of them in relations to fluctuations in tea production in the surveyed area.

Besides, there were a number of individual scholars who contributed in a general way. It has been reflected through the writings of Harlar (1956), which provides elaborate information regarding price and production. Goswami (1963) emphasized on the need for the systematic organization of the underdeveloped sectors of economy and for building up leadership in the various industrial sectors of economy. He tried to analyse the relation between the selling price and the costs of production of manufactured tea, which are of vital importance for the tea growers.

A multi-dimensional work on tea industries was done by Griffit (1967) highlighting various concepts related to historical development, production, labour problems, scientific research, marketing and taxation of tea. Sarkar (1972) describes the situation in relation to consumption, production, price and trade on world perspective. Sarkar (1981) has noticed positive correlation between size of the tea estates and their yield per acre in North India. This finding was based on data relating to a single year, 1966-67. In arriving at such an important economic observation, he did not define correctly 'yield' per hectare and considered the importance of size class of above 400 hectares Tea Estates' as Dwibedi observes (1999). Manohoron (1974) aimed at identifying the problems and explaining the factors for the growth of Indian tea industry and the effect of preset fiscal policy of government. Awasthi (1975) gave a detailed

account of the history, growth and development of tea plantation and processing with particular reference to Assam. He has considered almost all the relevant aspects based on secondary data, but has not employed any statistical tool and test to bring out the special significance of tea with respect to its production variables. Medhi (1978) tried to explain the impact of railway transport in the various sectors of economy, especially growth and development of tea industry and its export and import aspects. Bordoloi and Neog (1986) used statistical methods to find out the causes of low agricultural activity and came to conclusion that modern technology is the main factor to increase productivity level.

Roy (1988) attempts to review and ascertain the causes of Indian tea fluctuations in a wide historical perspective and criticized International Tea Agreement and the present structural arrangements and suggests a plan for long-term stable growth of tea industry. Deogun (1989) was probably first to deviate from the approach adopted by other scholars and tried to highlight the role of ecological factors as controlling agent of tea cultivation in a given area. He concludes that tea is not only an environmental friendly industry, but also it has significant impact on the economy of the state. Misra (1991) tried to analyse the relationship between the change in price and production of tea by taking some samples from the gardens of *Dooars* and Darjeeling. Chaudhury (1991) considering economic problem of Assam deals with the processes of industrialization with special reference to Assam and other linkage industries.

Mitra (1993) attempted to explain the observed trend in Indian Tea production, domestic consumption, export and prices of Indian tea in both domestic and international markets. Her study covered the period 1960-1980. According to the author, the observed

growth in Indian tea production appeared to be sluggish particularly in comparison with the steady rise in the domestic consumption of Indian tea. The observed behaviour of production apparently suggests the insensitivity of the supply of Indian tea to change in demand condition. The author has explained that the aggregate supply response of Indian tea in terms of factors that are likely to govern producers decision in the short and long run. The empirical results obtained by Banerjee (1996) show that, so far as decisions about yield rate are concerned, short-term profitability fails to provide a satisfactory explanation to the observed variations in the yield rates.

These above cited studies are general in its nature, which include almost all aspects from historical (the evolutionary processes) to geographical (existing factors) and then to economic aspects of tea activities in the country. There are some specific studies conducted for the specific objective to study deeper insides of the labour problems, ecological aspects of tea production, economic as well as social factors of growth and production. The concerned literature may also be cited on these aspects of tea cultivation.

3.0 Studies Related to Ecological factors:

The second group of studies relates to the various ecological factors like climate (temperature and rainfall), soil and drainage, influencing the production of tea. Mann (1907), Harison (1965) and Eden (1976) were of the opinion that, for the healthy growth of tea plant, the climatic conditions as to air, moisture and temperature within the soil-climate, are very essential. Apart from ideal climate, the proper drainage, very deep cultivation, deep trenching, green cropping and mulching etc. are important at the beginning of a tea plant which allow the roots to develop in a healthy and vigorous

manner for raising of crop productivity. Borbora (1971), using statistical methods in design and improvement, tried to explain that proper scientific drainage in tea is an important factor for sustained production. Ghose (1971), while elaborating Borbora's point in drainage in Cachar concludes that efficient drainage benefits the health and protection of tea as was evident in Cachar.

Biswas (1971) points out that proper rainfall distribution as also the soil type and depth of soil should be examined as it affects the annual yield of tea and stresses the need of irrigation to optimise the yield. Satyanarayana (1971) elaborates the effect of Cephaleurols Paraciticules Krast on the weak plants particularly young ones during the actively growing periods between April to July. He suggests that drainage can play important role by lowering the water level to prevent the injection. As the water is not well distributed throughout the year. Ghose (1971) suggests the need for drainage and studies the nature of drainage problems in 'The Control of Soil Water'. 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 affected by nitrogen, soil type and age of tree. The physical factors of tea gardens are equally important which vary yield pattern. In this connection, there are numerous studies. Chaudhury (1978) made a systematic attempt to understand the impact of physical factors over the volume of production. Biswas (1981) tried to study all these factors on experimental basis, which are based on 16 to 18 years of data of monthly yield, rainfall and related data, which were collected from the tea estates of N.E. India. Using statistical method, Borbora, *et. al.* (1992) concludes that there is a high degree positive correlation ($r = 0.93$) between monthly

temperature and crop production. Carr and Stephen (1992) are of the opinion that climate is the main determining factor for the growth and the potential yield. According to them climate determines where a crop is grown and the potential yield and the actual yield obtained depend on the prevailing weather conditions. Bora (1993) tried to explain how the ecological factors control the production and productivity of tea in Sonitpur district. Barman, *et. al.* (1994) try to explain how density of shade influences and physiology in the metabolic processes for higher yield in the studies entitled 'Influence of Shade on Physical Parameters in Tea'. They come to the conclusion that shade reduces the leaf temperature from full sun – 30% - 50% - 70% shade by 1⁰C in each case and the higher reduction of leaf temperature was found with 70% shade. They also observe that shade influences the plants to retain more water for higher turbidity of cells and the water potential is higher in shaded than unshaded conditions.

However, these studies do not cover all the aspects of ecological factors, which are more responsible for the higher productivity and yield. As it is seen, climate has been changing and most of the areas taken for the present study area suffer from flood during rainy season. In the present section of review, it may be said that most of the studies are area specific and based on some particular parameters of physical factors of land, which may not be applicable to all the areas, which results in negligence of integrated approach.

After reviewing the concerned literature on ecological and physiographical factors of tea cultivation in Assam, it may be concluded that the underground water, terrain conditions and climatic factors specially rainfall and temperature are major factors which influence the production and productivity of tea. The proper drainage and tree shades are

the common activities in the tea-farms to stabilize the effects of such physical factors and to regulate the growth of tea plants. However, in the conditions of globalization and economic liberalization, the techno-economic factors are equally important which may be reviewed separately in the next section.

4.0 Studies Related to Non-Ecological Factors:

The non-ecological factors derive its meaning and significance only when the ecological factors are favourable for a purpose and as such non-ecological factors cannot be studied separately.

North-East India has 45 percent share of tea production in India which is above 45 years old showing a declining trend in productivity. The scope of horizontal expansion of the industry being limited, it has been necessary to uproot, rehabilitate and replant at a rate to quickly replace the old tea plants.

As Basu and Sharma (1969) observe the low average yield in the plains of West Bengal, North bank, South bank and Cachar districts and find that, despite considerable improvements in agro-chemical techniques, the average yield is not going to increase at significant rate. Thus, it declines during the last two decades. With a view to finding out the possible reasons for low yields as well as its downward tendency, once the tea plant attains the age of 25 years it stabilizes its yield. They come to the conclusion that the plant age and kind of tea plant uprooting and replanting soil and soil management, infilling and management, shade and drainage are the main factors for increasing the yield rate. Hadfield (1971) tried to relate the age of tea plant and production and came to conclusion that the North-East Indian tea is above the age for optimum production.

Baruah and Mitra (1971) further added that 25 percent of the tea areas had passed their economic life due to old age and need early replacement. Jain (1977) observed and emphasized the need on increasing productivity of mature tea on regional basis. Analysing the field trends, he concluded that the young tea was most instrumental in emphasizing the trend of productivity level. Apart from environmental factors, Biswas (1977) is in the opinion that the field management factors play the important role which directly or indirectly affect the yield rate of tea. He tried to isolate the field management and environmental factors from long term effects on yield of tea to estimate their individual relative contribution to serve as guidelines to formulate the future advice and course of research and for increasing the yield of tea and ultimately to build up models for different environmental conditions for optimizing the yield of tea crop in Darjeeling. Borbora, Jain and Rahman (1981) tried to elucidate on experimental basis the same and concluded that with improvement in the cultural practices and management, the young tea could be brought into bearing earlier than before and more crop could be harvested during the formative years.

Tea bushes have long but limited span of life. Apart from heredity and environment, proper care is another factor that has an impact on the span of life on tea bushes. The tea bushes take three years from the time of it's planting to yield tea leaves for manufacturing tea. At present, a good number of estates own tea bushes aged around hundred years. According to Plantation Enquiry Commission Report (1956), the economic life of tea bushes receiving reasonable care may be about sixty years although the commission found in some estates that tea plants are to be over 80 years old and some

nearing 100 years. However, they are still giving fairly good yield. The general impression among experienced planters is that the upper limit of economic age of the tea bush is 50 years. According to them, yield of tea leaves from any bush will decline despite reasonable care if the said bush crosses the age of fifty years. Chakravartee (1971) and Manivel (1981) try to show how the pattern of crop distribution obtains from unpruned tea and pruned tea affect the yield of tea. They tried to relate the seasonal change in the direction of movement of photosynthates from the maintenance leaves of unpruned bushes and suggested that pruning is important operations, which decides the productivity of tea bushes. The following inferences can be drawn from their studies: (a) the October is the earliest possible month to commence resting of tea bushes prior to pruning. (b) the resting earlier than October does not help in building up starch reserve in the roots as the photosynthates from the maintenance leaf canopy are still moving upward. (c) Considering all these factors, December and January are to be ideal months for pruning tea bushes in North-East India. However, the adverse effect of unscientific pruning was observed by Chakravartee, Biswas and Bordoloi (1994) who attempted to evaluate the effects of pruning cycle of different lengths, both in plains and hills. They came to conclusion that for sustaining both crop and quality of tea, repeated adoption of pruning cycles of 3-4 years length may not sustain high productivity without due care to age, vigour and bush frame and 3 years cycle help sustaining productivity better than 4 years cycle.

Plucking standard has a direct bearing on yield and quality of tea. Increasing proportion of tender shoots in the harvest enhances the quality of tea as observe by

Borbora and Saikia (1989). They conclude that plucking standard should maintain balance between yield and quality. Borbora, Baruah and Kar (1994) emphasizes on mechanical plucking to maintain the plucking round during peak cropping season, which coincides with higher absenteeism of pluckers, to check the plucking cost and to provide an mechanical aid for increasing plucker's productivity, to harvest the increased production economically and, thereby, maintain the profitability of tea industry in long run.

Maximum gain in quality of tea can be observed with an increasing proportion of "two-and-a-bud" shoots in harvest during fast growing period and fast fermenting clone. However, equal proportions of both 'three-and-a-bud' and 'two-and-a-bud shoots' yield during the early and mid seasons and in the medium or low fermenting clones. During the late season, maximum gain in yield with minimum reduction in quality can be obtained in increasing the proportion of "three-and-a-bud" shoots in harvest. Biswas and Chakravarti (1992) opined that balanced fertilizer use for tea is an important measure for increasing productivity. While studying the Nitrogen-Phosphate-Potassium (NPK) manuring in mature tea, using yield-fertilizer relationship, they found that annual application of balanced dose of NPK is needed to maximize the productivity level. For sustaining a yield of about 23 q/ha in different regions, generally a dose of nitrogen in the range of 100-140 kg/ha, phosphate between 20-50 kg/ha and potash between 80-140 kg/ha would be required.

As the supply of sulphur is jesting limited by the use of urea and rock phosphate to the soil. Sinha, *et. al.* (1992) found that application of elemental sulphur 20-40 kg/h

increased significantly during three years of experimentation in tea estates in N. E. India. They suggested that sulphur should be introduced as a routine fertilizer input particularly in cases where SOA (ammonium sulphate) is not applied.

5.0 Studies Related to Labour Management Relations and Productivity of Tea:

Human engagement in tea production is important aspect because tea cultivation is labour intensive activity. Higher productivity requires modern machinery and skilled labour. It requires co-operative endeavour by workers and employers. Since tea is a labour intensive crop, the welfare of the labour force needs special attention. Any job to be of human value should be able to develop initiative and promote active and constructive co-operation between labour and management. 'Efficiency in the matter of running an industry and maintenance of productivity at a rising rate and at higher level, call for good labour relations throughout the process of production. This is where the human aspect of production efficiency comes in', as observed by Pylee and George (1997).

These aspects have been studied by Griffit (1967) to find out the various problems faced by the tea garden labourers like housing and their poor living style. Tea industry becomes too much important in the socio-economic life of the people of Assam be regarded as 'Planter Raj'. Guha (1971) forwarded valuable information and suggestions regarding economic and social exploitation of tea planters during those days. In the early stages of plantation industry during mid-eighteen century when plantation started during Colonial rule, the Government of India adopted a policy that favoured the planters. In Assam planters in an andeavour to over come their shortage of labour, sought to uproot

the local peasants from their lands. They appealed to the government to increase land revenue so that the peasantry around the tea plantation areas would give up their lands and seek work in the tea estates. Consequently, in 1868, the Bengal Government doubled the land revenue rates in those areas. This however, did not have intended effect, as the peasants rose in protests and refused to pay the enhanced rate (Guha, 1971). These studies are historical in nature, based on colonial exploitation by the Britishers, and unable to relate these factors affected production and productivity and failed to mention about the social security of the laborers.

Venkatakrishnan and Baruah (1981) tried to explain the relation between labour management and productivity. Human relations in the tea industry are not merely a sentimental requirement. They (tea labourers) are pre-requisites to higher productivity. With better understanding and teamwork, optimum production can be achieved at minimum cost. Their studies based on North-East India and had shown its importance in the cultivation of tea, but were unable to make any generalization on regional basis. Production of any agricultural product varies according to the size of the farm, and in this regard tea is not an exception. Mishra (1985) in his work, 'Low Productivity of Resources in East Bengal Tea Plantations – Causes and Cures' has analysed the extent of efficient use of available resources with labour input, expenditure on material inputs and expenditure on fixed capital in maximizing production of tea in the plantation areas of North Bengal with reference to only eight estates relating to a single year (1981) in the *Terai*, *Dooars* and Darjeeling tea growing areas. On the basis of his analysis, it is

observed that there exists a scope to divert investment from excessive use of human labour to intermediate material input and capital.

According to Mishra (1985), ‘... even under the existing technology, sufficient potential exists for improving the productivity through proper rational allocation of the existing resources particularly in small Darjeeling plantations’. However, this study did not consider the differences in the nature of employment of labour separately in the field and factory. In his study, he also mentioned the old age of tea bushes as one of the causes of low productivity in West Bengal without examining the nature and extent of its impact on productivity. Bhuyan (1989) analyses that tea is one of the labour intensive plantation crops and most well organized in the field of agriculture. It is a great source of employment as well as convenient base for earning foreign exchange. He categorically mentioned that it’s reputation being the ‘biggest employer of women workers in India with equal pay for equal work is another significant aspect of tea’. Though he emphasizes more on the employment of labour and their wages (both men and women) but he failed to discuss about the status of women in tea industry. Pio (1990) tried to highlight how socio-physical factors affect the production and productivity by considering three tea estates of Upper Assam. He mentions that various rules and regulations have been passed to improve the working and living conditions of the labourers. These rules and regulations have succeeded in bringing about a change in labour management relationship but not the living conditions of the labourers. He does not mention about the socio-economic factors, which play the important role in the production increase in tea estates. He considers a very small sample to test the validity of social and physical factors

of tea cultivation as only three tea estates out of a total 800 chosen from Upper Assam. A higher productivity can be achieved under different ecological conditions by studying the economic and social system prevalent in such areas. Therefore, the increase in the level of productivity is based on 'link-wage increased scheme'. It means that the increase in productivity levels should affect the increase in labour wage and their living conditions should be improved. By adopting this scheme of improvement in productivity level the quality as well as the quantity of tea can be improved.

Harlalka (1975) discussed several socio-political aspects of the tea garden labourers prior to their migration to the tea gardens. These various castes and tribes of Eastern and Central India were having their own identities. 'But due to lack of unity among themselves they could not play any significant role in the socio-political aspects of those places', as Pio (1990) observes. After their migration, they have come under common economic bond, which have helped them to get consolidated among themselves. Though at present, they play important role in electoral politics in the state due to socio-economic problems like low literacy, low standard of living, low income, identity crisis, etc., they are easily motivated by different political groups.

As tea tribes comprised not only from the peopling of Eastern and Central India, but also from within the state itself, it is not possible to generalize the tea-tribes of different origin. Another important fact, Harlalka (1975) fails to mention, is that the job of security of the labourers in the tea gardens.

An important contribution made by Kaortemprel and Dutta Roy (1990), on the role of *Adivasis* specially the *Santhals* and several tribes of Bihar, Bengal and Orissa and

their role in the economic development of the state is noticeable. Kar and Chattopadhyay (1998) deal with the labour migration and labour recruitment in the tea gardens. They are of the opinion that, as the population increases at alarming rate resulting in employment problem, they suggests the need for job opportunities and self employment and granting the stature of scheduled tribe. These studies are general in nature but deals mostly with migration of labourers from different parts of the country and problems faced by the labourers. They do not clarify how job opportunity, self employment, and high rate of growth of population and illiteracy will increase the productivity level, which, technically may not be possible. Chakravarty (1998) studied the socio-economic problems of the tea garden labourers of Assam, significance of tea and suggested solutions and remedial measures to overcome all these problems. However, it can be said that these suggestions are more general in its nature than technical solutions to adopt at present day situation. Since the problems of tea is a national and international problems, it will have to be solved from national and international perspective. Borah (1998) studies how the socio-economic factors of tea industry influences the surrounding regions of tea industry by considering four tea estates of Jorhat. He comes to the conclusion that the tea industry has not played any determining role in transforming the social and economic life of the surrounding regions due to lack of interaction between the villages and the tea industry, except in certain religious occasions. He suggested that certain welfare measures like employment, replacing the traditional agricultural practices providing modern inputs, encouraging small-scale industries and developing the infrastructure of the villages. But

he fails to clarify how these one-sided welfare measures would help in the overall development of tea industry.

Plantation is not only an economic unit but also a component of the socio-economic formation of a society. The production relations change when the socio-economic formation of that society changes (Kar 1998). The factors that are considered inherent in the plantation agriculture system are, in fact, allowed to exist or to protect because of the larger socio-economic system.

It is, thus, apparent that the economic characteristics and the nature of crop alone cannot decide the uniqueness of the plantation system. The social and the production relations, which spring forth from such a system, are important characteristics of the plantation agriculture.

6.0 Concluding Remarks:

The present review has done by considering various angles of the studies related to tea cultivation in Assam as well as India as a whole. A scientific study on the impact of climatic factors done by Borbora *et. al.* (1992) and came to conclusion that a highly positive relation exists between tea cultivation and temperature. But there are also other important elements of climate, which directly and indirectly affect the yield. In order to justify the statement of 'cause-effect' relationship data for a period of seven years (1985-91) relating to temperature differences, rainfall and evaporation (as the independent variables of climate) and the tea production per areal unit kg/ha have been collected for Dibrugarh district of Upper Brahmaputra Valley. It has been found that there are positive relations of tea production with precipitation ($r = 0.83$) and evaporation ($r = 0.65$) in the

Upper Brahmaputra Valley. However, some new features of the relationship can be visualized as (1) the humid period of years (when precipitation exceeds evaporation, diminishes tea production). But in the normal condition, the humidity does not affect much, due to proper drainage. (2) It is already referred that the temperature has a positive relation with the tea production. However, the annual difference of temperature (maximum-minimum) affects inversely. For example, the year 1986, with high temperature difference of about 23⁰C results in fall of production from 2020 kg/ha to 1930 kg/ha, but there was a steady growth as the temperature differences were normal.

Biswas and Chakravarti (1992) emphasized the effect of fertilizer on the tea and concluded that when high nitrogen dose is given to the plants, then there is a fast increase in the plant growth from two-and-a-bud to three-and-a-bud which increases the number of leaves and accordingly increases the production. Harlalka (1975) and Pio (1990) highlighted the labour problems and socio-economic aspects of tea gardens. They emphasized that low literacy, low standard of living low income, etc. are the main causes for labour unrest. As there is a condition of stagnancy, so labour problems crop up. Labour migration from outside the state may be one of the important reason for low labour productivity. Rapid increase in labour population also affect directly, the employment and standard of living.

In nutshell, it may be concluded that tea cultivation is more influenced by climatic conditions, while processing is affected by technological, management and labour actors. The tea plantation and industry is a complete agro-based industrial system and the socio-economic activities are transformed and highly bound by this system.

Economically low productivity would give low wage rate to its labourers and consequently low social status of labourers will prevail in the state. Therefore, it can be said that labour problems are production dependent. The variations in physical factors of land and labour problems are the main causes of emerging pattern of tea cultivation in the Upper Brahmaputra valley.

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Chapter–III

Geographical Personality

1.0 Introduction:

It is realised from the literature review in the preceding chapter that there is non-availability of sufficient literature on the scientific geographical studies on tea cultivation in Assam. In order to understand the causes of low productivity and declining performance of tea in the economy of Assam, it is important to know the geographical background of the area for its growth and spatial variation. This chapter is basically devoted to the geographical factors of the study area, which directly or indirectly influence the cultivation of tea in Upper Brahmaputra Valley. The physical factors of a region have a definite bearing on the human activities. Physical characteristics of any area are more or less closely associated with the general distribution of tea cultivation. As Pio (1990) observes that the spatial pattern of geographical phenomena particularly that of relief and bio-climatic relationships, have played a significant role in encouraging the tea industry in the state. The impact of such factors of land have significantly helped the state to its present dominating position in terms of area and production of tea both at the national as well as international levels. The geographical factors may be studied by elaborating physiographic as well as socio-economic attributes of Upper Brahmaputra valley as:

- a. the location and extent of study area which are related to the extent of the physical factors namely, relief, climate, drainage and soils, which influence the growth and productivity of tea, and
- b. non-physical factors, which include the population, labour, transportation and socio-economic problems of labour in the tea gardens.

2.0 Location and Extent:

The study area, namely, the Upper Brahmaputra Valley, bears transitional characteristics both physiographically as well as climatically. The study area, being located near the Tropic of Cancer, it should have been dry and desertic, as there are a number of deserts located in the same latitudinal zone. However, the area is more wet and humid comparatively due to its specific location within the eastern loop of the Eastern Himalayas. On account of its location surrounded by the high ranges of Eastern Himalayas, the physiographic features of the Upper Brahmaputra plains and its climatic conditions are influenced directly. As a result, tea cultivation is concentrated in the land use of this area.

The Upper Brahmaputra valley covers an area of about 21.67 lakh sq.km (35% area of the Assam state) and stretches from 25° 12" to 28° 0" N latitudes and from 89° 70" to 96° 0" E longitudes. It is surrounded on the north-east by Arunachal Pradesh, on the south by Nagaland and on the west by the districts of Sonitpur, Nowgoan and Karbi Anglong of Assam. It comprises seven districts of the state of Assam, namely, Jorhat, Golaghat, Sibsagar, Dibrugarh, Tinsukia, Lakhimpur and Dhemaji (Fig.-3.1). Owing to

the study area as meso-areal physiographic unit of the Brahmaputra plains, it has a variety of topographic as well as non-physical factors that create the areal variation in the growth and production of tea.

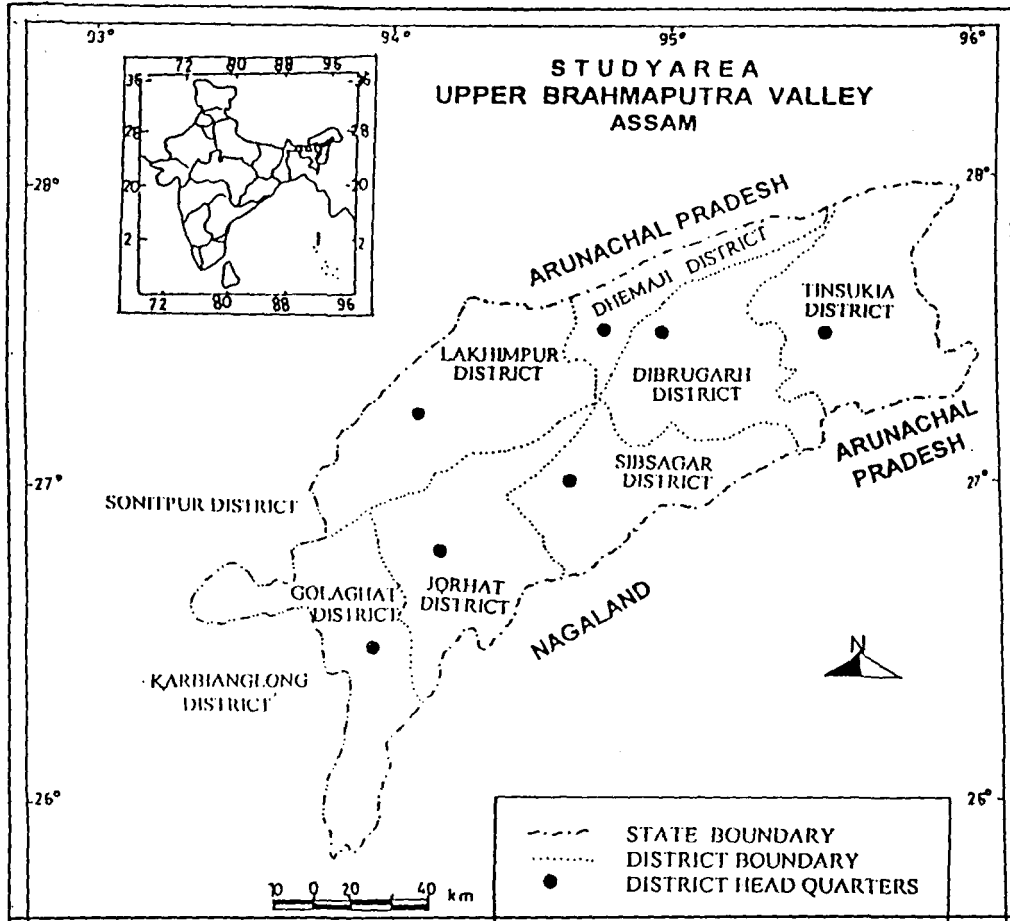


Fig.-3.1: Locational Map of the Study Area.

3.0 Physiography:

The physiographic conditions of land include the relief features, climate, soil and vegetal cover which are interrelated and form physiographic units and also influence the production and productivity not only tea cultivation but also the other human activities. It is true for the tea cultivation practising in the Upper Brahmaputra valley. Climatic

conditions and soil responses are more responsible for tea cultivation, which would be interpreted in detail in this chapter.

3.1 Relief Features: The study area is covered by the alluvium of about 100m thick. It is formed by the depositional work of the river Brahmaputra and its various tributaries. Its average elevation is 200 m above mean sea level with the length of the valley of about 315 km from Golaghat to Tinsukia and a width of about 35 km. There is gradual slope from north to south in the areas of northern bank of Brahmaputra while its southern counterpart has a gradual slope from south to north direction. The overall gradient from north-east to south-west as the longitudinal direction of the valley is observed 12.5 cm per km (i.e., .012%). The sluggish nature of the river with its very low gradient deposits, its sediments in its middle course thereby forming innumerable almond shaped rivers, locally known as '*chaporis*' or '*chars*'. During the rainy season, the flood water washes away most of the '*chaporis*', but they are replaced by new ones. More details about the physiographic features of the area are given below.

The Upper Brahmaputra valley is a well-defined physiographic unit. It comprises various relief features forming along with the east-west axis where the tea gardens are located. It shows remarkable parallel relief features which may be distinguished by elevation and relative heights. The northern boundary of the valley surrounded by Himalayan foothills and roughly touches the 150 meters contour line. The altitude of the valley varies along the southern boundary from towards the Naga Hills, while it reaches more than 225 meters further west. From the northern and southern boundaries it actually drops down towards the floodplains of the river Brahmaputra. One noticeable feature in

the eastern, south-eastern and southern section, parallel to *Tarai* zone, lays a strip of relatively highland of boulders and pebbles. 'These platforms or higher terraces are suitable sites for tea cultivation as they contain older alluvium. This may be referred to as the built up zone' as Taher (1986) elaborates.

Though most of the tea growing areas are located either in the middle plains of North bank or South bank, but there is a marked relief differences between them. While the tea plantation of the south bank is located on the older alluvium, the tea plantations of the north bank are located on the disconnected high grounds. Pio (1990) observes that, in the north bank, the innumerable tributaries coming down from eastern Himalayan ranges and Bhutan debouch abruptly to the valley and form a series of alluvial fans which obstruct the courses of the tributaries near the foot hills; the tributaries branch out in different channels till they form permanent courses further down stream. Before finding their ways into the river Brahmaputra, they run in almost parallel courses. Consequently, they have conspicuous meandering courses leading to the formation of ox-bow lakes and huge marshy tracts in the close surroundings of the river.

3.2 The Drainage: The drainage system of Upper Brahmaputra Valley is largely controlled by river Brahmaputra. With sizable catchment area, the river Brahmaputra comprises the tributaries of Subansiri, Dhansire, Lohit, Dihang, Noa-Dihang, Buri-Dihing, Disang, Dikhow, and Janji etc.

The plantation of tea requires a well-drained slope as the stagnant water is harmful and so hill slopes are preferred for tea cultivation. The Upper Brahmaputra

valley consists of a large number of tributaries coming down from the Himalayas and finds its way into the river Brahmaputra (Fig.-3.2).

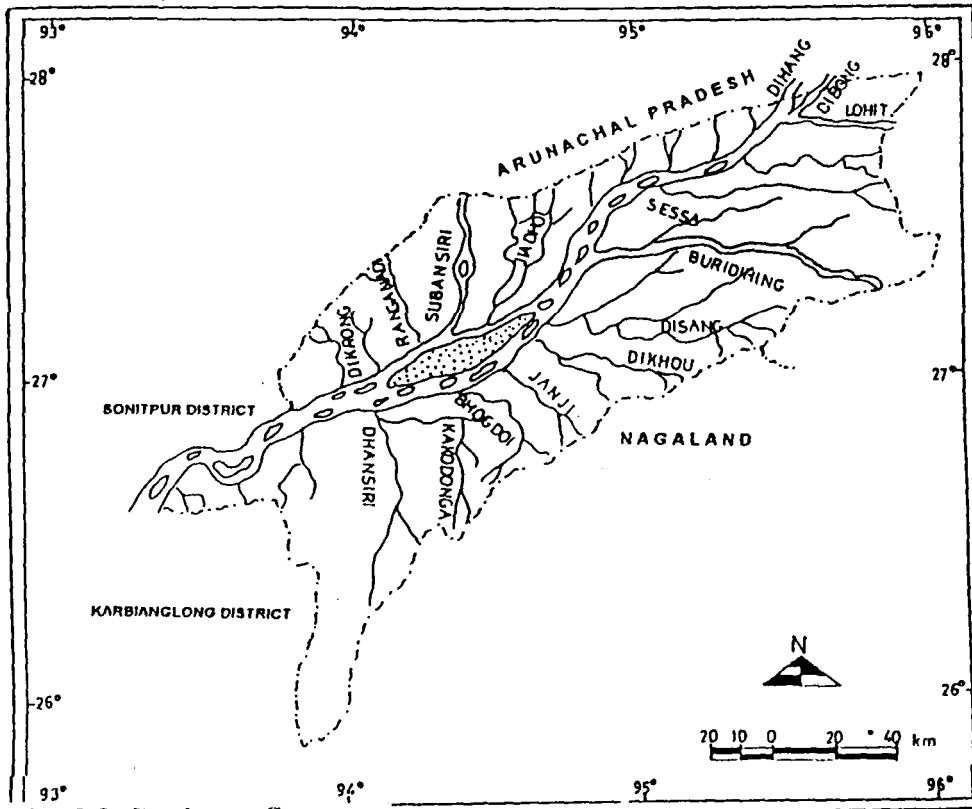


Fig.-3.2: Drainage System.

The foothill regions along Lohit, Tirap and Nagaland are well drained. It is mostly covered by forests. The area under tea cultivation is, thus, lesser in the Sibsagar-Tinsukia plains than the plain of Jorhat and Lakhimpur. The active flood plain zone that lies along the river Brahmaputra, experiences floods almost every year. The high lands of North bank and South bank by a number of tributaries are best suited for tea cultivation and in the largest single tea-producing region. The drainage system of these highlands of north bank and south bank shows some noticeable characteristics. The main rivers of north bank of Brahmaputra, namely, Dikrong, Ranganadi, Subansiri, Jadoi, and Dihong originate from the eastern Himalayas, while the south bank river namely, Dhansiri,

Kakodonga, Bhogdai, Janji, Dikhori, Disang, Buri-Dihing, Sessa and Dibang and Lohit have their origin from the Lohit, Nagaland and Patkai Hills. Most of the rivers of the north bank are perennial in nature. However, almost all the tributaries of north bank river take a converse sub-parallel to the Brahmaputra before opening into it. This is mainly due to the presence of an incipient level along most part of the north bank of Brahmaputra (Taher 1986).

3.3 The Climate: Tea is essentially a plant of the monsoon climate and grows well in the wetter parts on the higher elevations of the rainy areas. The upper Brahmaputra valley, in general, forms an integral part of the South-East Asiatic monsoon lands. The renowned climatologist Koppen (1900) distinguishes the climate of the valley as 'Cwg' or 'Humid Meso-thermal warm temperate with dry winter type'. Its sub-tropical location surrounded by the mountains in the north, northeast and eastern hills, contributes to the general climatic character of the region. While the lofty eastern Himalayan mountain ranges of the north protect the valley from the cold winds blowing from the Tibetan intermontane plateau during the winter, providing conducive conditions for orographic rainfall. The natural mountain barrier serves as obstacle to the warm moist south-west monsoonal winds and thereby the valley receives maximum rainfall during the summer months from June to September (Table-3.1). The climatic conditions in the valley exhibit a major deviation from those of the Ganga valley. The Upper part of the Brahmaputra valley receives the highest average rainfall of the valley that is largely associated with thunderstorms during pre-monsoon and monsoon periods. In winters due to depression in the Bay of Bengal, the valley receives very low rainfall, which is recorded about 27 mm

in the month of December and the less number of rainy days of about one week in the month.

Table: 3.1 Monthly Average Distributions of Temperature and Rainfall (1999) (Station-Dibrugarh).

Months	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	16.9	21.0	22.9	24.7	26.1	28.3	27.9	27.9	27.9	25.4	23.3	17.9
Rainfall (mm)	48.0	1.4	33.8	386.6	313.1	426.8	384.1	460.9	244.2	160.8	10.4	0.8

All these factors including orographic influence have developed a climatic distinctiveness for the entire Assam valley, which is different from the 'Cwg' or Humid Meso-thermal or the Ganga plain. Barthakur (1968) classified it as 'Cwb' or Humid Meso-thermal Brahmaputra valley type.

The valley experiences highest temperature in the month of June (i.e., 28.3°C) nearly during the period of monsoon along with abundant rain of about 460.9 mm with high humidity of 86% in the areas of Dibrugarh plain. The winter season starts in the month of December and lasts upto February, with the lowest temperature of 5.6° (Fig.-3.3).

The areas situated near the northern boundary receive relatively higher annual rainfall due to their location near the Himalayan foothills. More than 70% amount of the total annual rainfall is received during the monsoon period and its about 20% during the pre-monsoon period. The atmosphere remains highly humid as relative humidity is recorded above 80% throughout the year except the winter season (January to March) when it goes on decreasing to 60-65%.

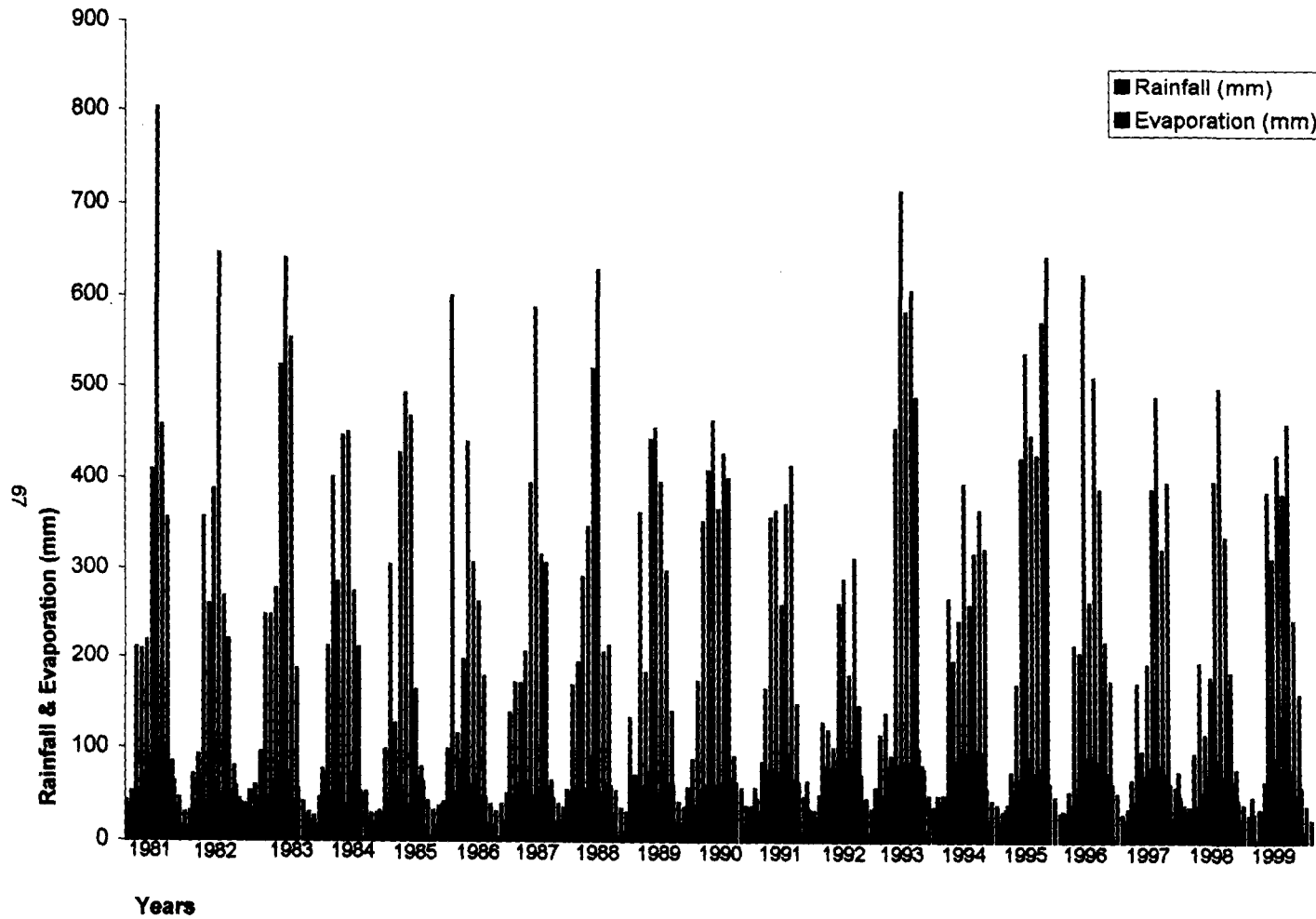


Fig-3.3: Monthly Trends of Rainfall and Evaporation at Dibrugarh (1981-1999).

3.3 (a) Climate and Tea Production: There are considerable variations in rainfall, temperature, humidity, evaporation and sunshine. The temporal as well as areal variations of such climatic conditions influence the yield of tea in the study area.

Climate is the most determining factor for tea cultivation production and productivity (Pio 1990). A detail study has been conducted by collecting data of 15 years (1985-1999) of these elements of climate, namely, temperate (X_1), rainfall (X_2), evaporation (X_3), relative humidity (X_4) and sunshine (X_5) (Table-3.2).

Table-3.2: Annual Climatic Data for 15 years.

Year	Temperature (°C)	Rainfall (mm)	Evaporation (mm)	Relative Humidity (%)	Sunshine (Hrs)	Yield (Kg/Ha)
1985	22.60	185.28	48.37	80.96	5.37	5176
1986	24.13	190.15	54.32	77.46	4.30	4739
1987	23.31	199.48	51.93	79.38	5.19	5332
1988	22.78	223.34	53.93	79.79	5.00	5353
1989	22.67	210.49	55.31	79.96	4.97	5380
1990	22.89	236.58	54.56	80.11	5.16	5477
1991	23.43	189.29	65.74	80.54	5.35	5515
1992	23.71	134.51	68.11	81.69	5.52	5651
1993	23.18	278.42	70.63	80.13	5.07	5592
1994	24.20	207.25	72.20	78.79	5.88	5553
1995	23.43	279.13	59.57	66.25	5.38	5676
1996	23.58	224.45	61.28	77.88	4.86	5795
1997	23.63	190.05	59.55	79.58	4.58	5713
1998	23.97	178.29	57.57	77.72	4.38	6107
1999	24.18	205.87	49.72	79.79	5.31	5493

Source: TRA, TES, Jorhat.

Infact, temperature influences the heat index and, consequently, rainfall and relative humidity, which are the elements provide moisture to the plant growth. The evaporation is directly related to the photosynthesis of the plants and the sunshine, which is indicator of heat influx is recorded in its availability of average hours in a day. During summers, there is a direct radiation of sunrays during the hours of sunshine. The temporal

fluctuation of these climatic elements is shown by calculating coefficient of variation and the relationships are observed by preparing matrix of correlation coefficients to show their associated nature (Table-3.3).

Table-3.3: Standard Deviation (S.D.), Mean, Coefficient of Variation (C.V.) and Correlation Matrix for Climatic Factors.

	Temperature (°C)	Rainfall (mm)	Evaporation (mm)	Relative Humidity (%)	Sunshine (Hrs)
S. D.	04.40	185.72	19.86	08.68	01.53
Mean	23.26	211.72	57.35	79.03	05.13
CV %	18.93	087.72	34.62	10.98	29.83
Correlation (r)	1.000	0.1785	0.7266	0.3762	-0.4310
		1.0000	0.5245	0.4248	-0.5997
			1.0000	0.2308	-0.2906
				1.0000	-0.3829
					1.0000

N. B. Based on 15 numbers of observations using annual data for 15 years (1985-1999).

The co-efficient of variability is found highest in rainfall distribution (87.72%), followed by evaporation (34.6%) and sunshine (29.83%) attributes of climate. It indicates that rainfall has the most fluctuating tendency in the valley followed by evaporation due to monsoonal characteristics of climate. However, annual temperature does not vary much, ranging from 22.60° C (1985) to a maximum of 24.20° C (1994). Sunshine has lesser degree of temporal fluctuation but has a great impact on yield.

The correlation matrix of each elements reveals that rainfall and evaporation are the main elements, which are highly and positively associated with temperature while sunshine is negatively related with rainfall ($R = -0.5997$). During the rainy season with high rainfall, the atmosphere becomes cloudier and, consequently, there is no sunshine. However, higher degree of radiation can be observed during the monsoonal period. As a result, the tea gardens are having 'shadow trees'. Therefore, the temperature ranging

between 23 and 25° C, rainfall between 200 and 250 mm with 5 to 6 hours of daily available sunshine is the most suitable climatic condition for the growth of tea in the valley.

3.3 (b) The Result of Regression Analysis: Considering tea yield (Y) as dependent variable and the five elements of climate (as interpreted above) as the independent variables, stepwise regression technique is applied to understand the impact of climate on tea production (Table-3.4).

Table-3.4: Effect of Climatic factors on Tea Production in Upper Brahmaputra Valley (Through Regression Analysis).

Climatic Factors	Regression (a)	Co-efficient (b)	t value for b	R ² (%)	Difference in variables (%)
X ₁ Temperature (°C)	3080.62	103.369	0.6711	3.35	3.35
X ₁ Temperature (°C)	2437.78	121.899	0.7366		
X ₂ Rainfall (mm)		0.994	0.4101	4.68	1.33
X ₁ Temperature (°C)	3418.21	46.698			
X ₂ Rainfall (mm)		0.4399			
X ₃ Evaporation (mm)		15.3069	1.2636	16.77	11.09
X ₁ Temperature (°C)	5974.83	1.289	0.00		
X ₂ Rainfall (mm)		-0.674	-0.2184		
X ₃ Evaporation (mm)		16.801	1.3117		
X ₄ Relative Humidity (%)		-17.155	-0.5457	19.17	2.40
X ₁ Temperature (°C)	6642.577	-13.196	-6.276		
X ₂ Rainfall (mm)		-0.726	-21.474		
X ₃ Evaporation (mm)		18.592	128.166		
X ₄ Relative Humidity (%)		-17.650	-53.441		
X ₅ Sunshine (hrs)		-75.451	-32.666	20.11	0.94

N.B. No. of observations are based on annual data of the variables (from 1985-1999), n = 15

The total five elements as mentioned above for the analysis has 20.11% effect on the growth of tea production. Out of this total, the effect of temperature is 3.35% and of evaporation is 11.09%. The analysis shows that evaporation is the most determining

factor on yield rather than sunshine and relative humidity. Undoubtedly evaporation is controlled by temperate and rainfall, and therefore all the three elements of climate (Temperature, Rainfall and Evaporation) has a significant effect of 16.77% out of total 20.11% (Table-3.4).

3.4 The Soils: Upper Brahmaputra Valley is composed mainly of alluvial soils of recent and sub-recent origin. The plains of the both sides north and south banks of Brahmaputra constitute the alluvial soils of recent origin. There is an elongated narrow patch of alluvial soil along the southern margin of north bank of the middle part of plain stretching from Golaghat to Dibrugarh district. In the northern part of the valley along with the foothills of the Arunachal Himalaya, a narrow patch of sub-montane tract is found in the Lakhimpur and Dhemaji districts. In the southern margin that borders the foothills of Naga hills mostly loamy and lateritic soils dominate. In between the alluvial and hill soils in the south bank, the old alluvial soil covers a major parts of Dibrugarh district.

In general, the soils of Upper Brahmaputra valley is acidic in nature with satisfactory contents of nitrogen and organic matters, which are indispensable for the growth of tea. Awasthi (1975) observes that tea thrives on an acidic soil and it is considered that the optimum pH in Assam is 5.4 and, in case of values above 6, the soil probably needs treatment if tea is to grow well.

It is obvious that the size of the soil particles is the main element of the soil texture, it provides water, air and moisture capacity for the proper growth of the plant as the root of the tea plant which penetrates more than 50 cm deep into the soil. A point in the history of tea cultivation has now been reached at which it is possible to lay down

with some approaches to the soil conditions, which are necessary for the production of the most vigorous tea bushes and the maximum production of leaf. First of these approaches undoubtedly is 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, 1987). But all these factors largely depend upon the physical and chemical characteristics of soil. Ghose, *et al.* (1994) rightly remarked that soil analysis was considered to be very valuable for achieving higher production of plants. The interpretation of soil analysis based on the relationship between the soil tests and the plant response that can be expected from the added fertilizers. The relationships of these soil elements with tea production would be studied separately in the forthcoming chapters. However, there is need of detail soil analysis in connection with size of soil particles and available minerals in different physiographic conditions in the Upper part of Brahmaputra valley.

The Tea Research Association, Jorhat, Assam conducted a special survey in the year 1967/68 (Soil Survey, 1969) to examine the soil characteristics by selecting six tea gardens of the valley. For present study, each of two gardens have been selected from three different physical conditions namely foot-hills, flood plain and central plain zones, which can show the variations in soil texture as well as in soil minerals for different soil zones. The following conclusions may be drawn from the soil survey.

1. Soil texture is one of the most important features of the physical properties of soil and is concerned with the size of the soil particles. It provides water, air and moisture capacity to the plants for the proper growth as the tea roots penetrates more than 30 cm deep into the soil.

- (a) The percentage of total aggregate size of soil particles are found in the flood plains of course-sand ranging from 79.70% to 91.75% followed by Central Plain of old alluvial ranging between 84.11% and 88.96% while the soil particles of foot hill areas varies in size between 63.53% and 73.08%. It indicates that the new alluvial soils of flood and central plain zones accommodate more organic matters with more void space of soils for air and water. As a result, there is less infiltration to provide moisture to the soil. This shows that the soils formed by new alluvium is suitable for tea cultivation.
- (b) It is noted that the aggregate size of top soil particles of below 1 mm diameter is dominated by flood plains new alluvial and central plains of old alluvial. The bigger size of soil particles (above 5 mm diameter) is recorded very less in the soils of old alluvial and sub-montane foothill soils.
- (c) It is found that the particles of topsoils are moderate in its size (5-2 mm diameter) and it accounts for about one-third soil particles in almost all type of soils in the study area. The soil particles have very small size of sand (below 1.0 mm size) characterized by silty loam, and coarse sandy loams have the dominance in the soils of the study area (Table-3.5).

Table-3.5: Aggregate Size of Top Soil Particles (0-30 cm).

Soil Types	Sl. No.	Location of sample Tea Gardens	Aggregate Size in (%)					Total aggregate
			>5 mm	5-2 mm	2-1 mm	1-0.5 mm	0.5- 0.25 mm	
A Foot Hill Soils (Tarai)	1	Bhamun	0.25	8.99	9.34	16.52	28.42	63.53
	2	Powai	0.00	18.81	12.79	16.46	25.12	73.08
B Central Plain Zone (Old Alluvium)	3	Keyhung	0.53	17.92	18.13	21.06	26.48	84.11
	4	Hansara	0.63	23.19	16.30	20.78	28.08	88.96
C Flood Plain Zone (New Alluvium)	5	Greenwood	0.61	19.01	16.95	24.35	18.88	79.70
	6	Panitola	0.31	16.16	16.21	22.84	36.24	91.70

N. B. Aggregate Analysis on the topsoil, 0-30 cm layers. (Data expressed as percentage on dry weight basis).

Source: Soil Survey, 1967/68, Tocklai Occasional Scientific Papers, No. 5, Jorhat, p.3.

2. So far as the chemical properties of the soil are concerned, the soil of the valley is highly acidic in nature, as the pH value ranges between 3 to 5. The highest pH value is recorded in the old alluvial, which is 4.7 followed by foothill soils with 4.5. In the flood plain soils, it is 3.9.

However, soils are rich in calcium and magnesium, especially in the Flood plain and Central plain areas due to lesser effect of leaching. The C/M ratio is normal in these plains with .15 and .13 respectively. The content of phosphorous pentoxide (P_2O_5) is recorded high with the moderate quantity of potassium dioxide (K_2O) in the Foot Hill soils found in this area. High degree of organic carbon indicates suitability for tea cultivation. The central plain has a balance distribution of all the soil minerals. So it may be concluded that central part of the alluvial plain may provide most suited soil fertility for tea cultivation (Table-3.6).

Table-3.6: Soil Minerals in Various Ecological zones.

Ecological Zones	Location of Tea gardens	pH	Calcium Kg/ha	Magne -sium Kg/ha	Nitrogen Kg/ha	Organic carbon Kg/ha	C/M ratio	P ₂ O ₅ Kg/ha	K ₂ O Kg/ha
A Foot-Hill Zones	Bhamun	3.9	680.50	108.00	6036.75	43680	.11	100	205
	Powai	4.5	288.00	67.50	7238.50	47376	.04	1456	235
B Central Plain Zone	Keyhung	3.2	744.75	222.75	5958.50	35829	.12	170	162
	Hansara	4.7	568.50	202.50	4547.25	37296	.13	505	109
C Flood Plain Zone	Greenwood	3.5	1283.75	270.00	5320.00	45674	.24	166	278
	Panitola	3.9	760.50	310.51	5039.75	48048	.15	170	213

Source: Tocklai Occasional Scientific Papers, No. 5. pp. 16, 21, 31. Soil survey 67-68, Jorhat, Assam

4.0 Socio-Economic Factors and Labour Problems:

The tea garden labour community constitutes an important segment of the population of Assam. The community comprises a heterogeneous population with a very high degree of internal diversification. The plantation is not only an economic unit, but also a component of the socio-economic formation of a society (Kar 1998). It is because the labourers of the tea gardens of Assam have migrated from different parts of the country, which belong to different tribes and caste groups that speak different languages. Due to their long stay in the tea gardens of Assam and process of social and cultural interaction, the differences have been reduced to a larger extent. It is generally found that most of the tea garden labourers are lacking behind the social adjustment with the local people. Harlalka (1975) observes that though most of the tea garden labourers migrated to Assam about 150 years ago, still social adjustment has not been developed to a significant extent. The local people also do not show any keen interest to mix with them socially.

Another important problem of labourers of tea gardens is related to finances and wage rates. The wages of tea labourer is comparatively lower than their works. These results in various problems like low standard of living, illiteracy, poverty etc, the lack of

education among the labourers have a negative impact in almost all spheres of the socio-economic life of the tea labour community (Pio 1990). A political instability and insurgency related problems have led the tea industries towards more backwardness. The tea industries in the region, inspite of being the prime producer, there was no auction centre in Assam. It minimizes the revenue from sales tax, employment opportunities directly from such a centre and indirectly from associated jobs in the brokerage, warehousing and transport sectors which are linked with the marketing of tea (Saikia and Sharma 1996). In the international market, the tea industry of Assam is also facing the problem of fall in the price of medium and plain tea. This is mostly resulted from the break-up of the U.S.S.R. leading to a loss of market of 120 million for the country as a whole. Such situation was created due to downward slide of prices all over the country following over production accompanied by shrinking of market (Dhar 1998). Therefore, India as a whole facing a stiff competition from China, Sri Lanka and other African countries and Indonesia. For that reason, India is loosing its monopoly position in the world market for tea (Chakraborty 1998). The rate of taxation imposed on the tea industry is excessive and discriminating. Tea industry is paying a higher tax rate (at about 70.5%) than any other industries. Moreover, the imposition of time bound payment of advance agricultural income tax levy and cess is also creating a serious problem for the tea gardens. Thus, high rate of taxes has been reducing the investible surplus of this industry.

Another problem faced by the tea industry in recent years is that the industry is facing an increasing trend in its cost of production. It is observed that the average cost of

inputs as well as increase in the price of food grains has led to an increase in the share of subsidies given to labourers by the tea estate.

5.0 Transportation:

The significance of the transport sector lies not only in specific services it renders, but more in unifying and integrating the influences it exerts upon the economy bringing rural regions closer to another ensuing productivity, widening the market and introducing new stimuli to the economy. However, the nature of such relationship varies from region to region depending on the various stages of economic development and different complex situations. The impact and counter impact of each different type transport facility upon the tea industries are discussed below:

The tea cultivation in Upper-Brahmaputra valley started in 1830's with the discovery of indigenous tea plants in Sadiya (situated in the northern side of the study area). As till the year 1853 carts and carriages were unknown, the roads were very few and were not suitable for transporting its products and raw materials, so the nascent tea industry was at the mercy of water transport. Until 1882, steamers played more important role than any other mode of transportation in export and import. In May 1882, the first railways was introduced from Dibrugarh steamer ghat to Jaipur Road and in 1884 it had been extended to the nearby coalfields from Doomdooma to Makum. With the introduction of railways in tea growing areas, the role of water transport became less. As the roadways were not properly developed, the railways became the key mode of transportation.

The partition between India and Pakistan in 1947 and the earthquake of 1950's dealt a severe blow to the steamer navigation of the river Brahmaputra. In the past the bulk of export and import trade of Assam to and from Calcutta was done by this river. From the above discussion, it is clear that before independence, even in the middle of 19th century, railways played the key role among all the mode of transportation. But so far as its role in the development of tea industry is concerned, it is the tea industry that provided an impetus to the development of transport in Assam during the 19th century. As Medhi (1978) observes the then Assam economy, 'it is not only the growth of industry which depends on transport innovation but the type and growth of transport system also depends on the expectation of industrial development and potentialities'. It is interesting to note that even in that period (1880) before the railways were introduced, there were as many as 763 tea gardens in Upper Brahmaputra valley. Therefore, in the 19th century, tea industry grew up in Assam mainly because of advantages of natural factors. The railways were not important as initiating factor. On the contrary, it appears that the existence of tea plantation-cum-industry was the main cause of improvement of transport and communication, which turned the course of history of the economy not only of the Upper Brahmaputra valley, but also the whole of Assam.

After the independence, as the Assam Trunk Road which connects Lower Assam and Upper Assam, the highways connecting Lower Assam and North bank areas of Brahmaputra upgraded and recognised as national highways, the importance was shifted towards the roadways and still playing major role in their respective sector. Recently, the

metre gauge railway connecting Tinsukia and Guwahati was changed into broad gauge and some new trains were introduced to cater the needs of the region.

The valley is served by all the different modes of transport. The total length of the roadways in the valley is about 1000 km (29.54%) of the total length of the road of Assam. It covers almost all the important towns of both banks of the valley. Owing to its topography, location, flood and proneness to earthquake, the air transports have improved its special significance among all the modes of transport in the valley.

6.0 Population Distribution:

Most prominent feature of the distribution of population in the valley is its unevenness and highly irregular spatial distribution. Distribution of population in the valley has an overwhelmingly rural bias. Among all the districts in the valley, the Dibrugarh district is most thickly populated district with a total population of 10,42,457 persons and the density of about 308 persons per sq. km (Table-3.7). The most thinly populated district is the Dhemaji, which sustained about 478830 persons with a density of 148 persons per sq km. The highest density is recorded as 340 persons per sq. km. in Sibsagar, where population is numbering at 9,07,983 persons which is the third highest among all the districts in the valley. The second lowest population concentration is found in the district of Lakhimpur, but its density is as high as 330 persons per sq. km., which is next to Sibsagar with 340 persons per sq. km. A moderate concentration of population can be seen in the districts of Tinsukia, Jorhat and Golaghat with a population numbering 962298, 871206, and 828093 persons respectively. In these three districts, density varies

from 236 persons per sq. km. in Golaghat to 306 persons per sq. km. in Jorhat, where as it is recorded at 254 persons per sq. km. in Tinsukia district.

Table-3.7: Population Characteristics (1991).

Districts	Total Population	Density Persons per sq. km	Sex		Sex Ratio	Literacy rate	
			M (%)	F (%)		M (%)	F (%)
Lakhimpur	751517	330	389125 (51.77)	362392 (48.22)	931	62.28	48.85
Dhemaji	478830	148	248457 (51.88)	230373 (48.11)	927	65.43	41.12
Golaghat	828093	236	431346 (52.08)	396750 (47.91)	920	66.50	49.75
Jorhat	871206	306	455525 (52.20)	415681 (47.71)	913	73.29	56.88
Sibsagar	909783	340	476009 (52.42)	431974 (47.50)	907	71.91	56.14
Dibrugarh	1042457	308	547266 (52.49)	495191 (47.50)	905	66.72	48.89
Tinsukia	962298	254	508948 (52.88)	453350 (47.11)	891	59.27	39.99

Source: Statistical Hand Book, Assam, 1996, pp. 16, 17.

Sex composition of population provides an insight of the efficiency of work force in the study area. The number of total males in Upper Brahmaputra valley as a whole marginally exceeds the number of females. The sex ratio is recorded as 913 females for per thousand males in the valley. This may be attributed to the universal fact of masculinity at birth. All the districts of the valley are characterised by preponderance of male. The district of Lakhimpur has the highest sex ratio as 931 females per thousand males. This figure is followed by Dhemaji (927), Golaghat (920), Jorhat (913), Sibsaagar (907) and Dibrugarh (905). Tinsukia district, on the other hand, had the largest deficiency of females, as there are only 891 females for every thousand males. The high deficiency of females is largely associated with higher mortality rate among the females in the sex composition of its population, wide differences in its rural-urban components, between

various religious groups, social groups. Thus, the valley is characterised by low participation of females in its labour force (Fig.-3.4).

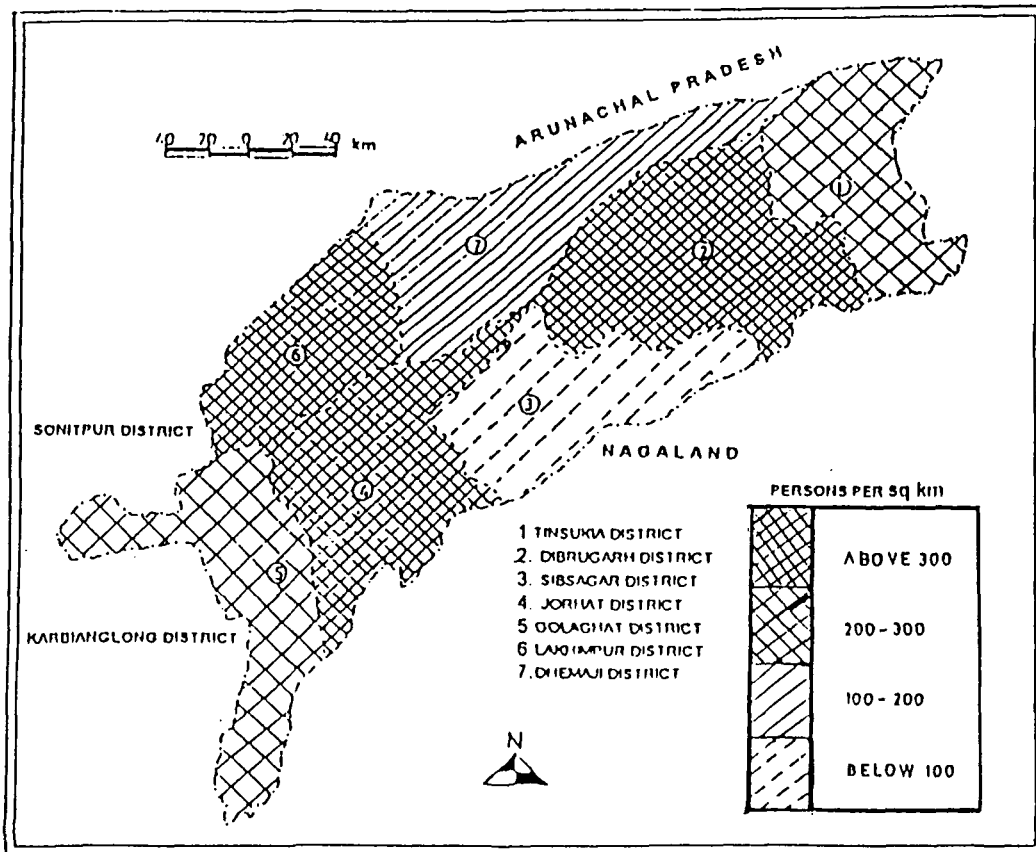


Fig.-3.4: Density of Population.

7.0 Literacy: Education and literacy play an important role in the skill development of labourers in any area. There are a number of factors which influence the literacy rate. Literacy rate in the valley is characterised by sharp differences between the literacy rates of males and females. While 66.48 percent of the male population is literate, the corresponding figure for the female is 48.80 percent. Among the districts of the valley,

there are sharp areal variations in the levels of literacy. The district Jorhat, which has significantly high degree of urbanization, has the highest rate of male as well as female literacy (73.29 and 56.88%) while, on the other hand, Tinsukia district comes on the lowest level on the scale of literacy variation (Table-3.7). It means there is a significant effect of urbanization on literacy rate. The literates (skilled labourers) for operation the tea cultivation in the study area are influenced by urbanization and, hence, the literacy rate is recorded higher near urban centers.

Further, it is obvious that female labour has dominance in plucking the tea leaves. Literacy rate in women section of the society in this region is low with a significant male-female rate-difference of about 17.65%. It is ideal in Dibrugarh district, low in Lakhimpur and very high in Dhemaji district.

8.0 Work Force Distribution:

Workforce is the main indicator of available labour for a particular activity. According to Census classification, the workforce is categorized into two: main and marginal workers. The non-working population is also an integral part of population, through which the dependency ratio is calculated for the study of population structure.

According to the census report of Assam 1991, the total number of work force in the study area is about 20,39,117 persons which constitutes about 34.72 % share to the total population, while the marginal workers accounts for only 6.57 % and the non-workers are about 34,47,303 persons which is about 58.66 % of the total population. It means that the main work force accounts for nearly 34.72 % to total population. It is almost uniformly distributed throughout the study area (Table-3.8). A close look at the

distribution of marginal workers indicates that (a) a total volume of 3.55 lakh persons are accounted for in this category which are nearly 6.09% to total population of the study area, (b) the distributional pattern of the share of marginal workers is diversified from 10.71% in Lakhimpur district of the northern parts to 3.93% in Jorhat as the urbanized district. It means unemployment of marginally or seasonally employed population is more in rural dominated economic conditions rather than the areas of urban influence.

Table-3.8: Dependency Ratio (1991).

Districts	Total population	Main workers	Marginal workers	Non-workers	Dependency Ratio
Lakhimpur	751517	241552 (32.14)	80525 (10.71)	429440 (57.14)	1.78
Dhemaji	478830	160833 (33.59)	54494 (11.38)	263503 (55.00)	1.64
Golaghat	828096	293248 (35.41)	46069 (5.56)	48879 (59.00)	1.67
Jorhat	871206	299539 (34.32)	34585 (3.93)	537082 (61.65)	1.79
Sibsagar	907983	331439 (36.50)	49310 (5.43)	527234 (58.07)	1.59
Dibrugarh	1042457	361269 (34.64)	50737 (4.80)	630451 (60.47)	1.75
Tinsukia	962298	351237 (36.49)	40247 (4.18)	570814 (59.32)	1.63
Total	5842387	2039117 (34.72)	355967 (6.57)	3447303 (58.66)	1.69

Source: Statistical Hand book, Assam, 1996. pp. 22, 23, 24.

N. B.: Figures in parentheses show percentage.

The third major component of population is the force of non-workers (children and aged population), which is noticed more than half of the share of total population (58.66%) in the study area. However, Dhemaji district has comparatively less percentage share of non-working population (55.00%) but, the dependency ratio is observed comparatively lower in Sibsaagar district, which is 1.59 only. The upper most part of the study area, the district of Dibrugarh, has very high share of non-worker population but

the dependency ratio is found to be the higher in Jorhat district, which is 1.79 because of the lowest share of main workers.

9.0 Occupational Structure:

Examination of 1991 occupational figures points to the fact that the occupational structure of the seven districts shows a predominance of cultivators. There is also considerable proportion of agricultural workers and in allied activities. It points to the high level of rural population. The work force engaged in mining and manufacturing activities is very small which forms less than 1% in the study area. Therefore, the structure of secondary activities associated with manufacturing is weak (Table-3.9).

Infact, in developing economies, there is shift of workforce from primary activities to secondary and then to tertiary activities. This shift maintains the balance and proportion in the occupational diversification. A higher degree of diversification denotes the concentration of workforce in one sector of economy and *vice-versa*. The census statistics of occupational categories of the study area show that there is concentration of workforce towards agriculture sector with its stagnant conditions in the economy. More than two-third workforce is engaged in agriculture (cultivators plus agricultural labourers). The secondary (i.e., industrial) sector is very weak. The tertiary sector accounts for nearly 10% employment opportunities because of development of trade, transport and service; a symbol of 'diffused economy' rather than 'self-sustained growth' of it. The areal variations of the share of cultivators to total workers may significantly be seen from 31.64 % (Dibrugarh district) to 68.16% (Lakhimpur district) in the study area (Table-3.9).

Table-3.9: Percentage of Working Force and Occupational Distribution in the Districts of Upper Brahmaputra Valley (1991).

Districts	Main workers	Cultivators	Agricultural Labourers	Livestock, forestry, Fishing, Hunting, Plantation Orchard.	Mining & Quarrying	Manufacturing, Construction, Processing, Servicing, Repairing, Household	Trade and Commerce	Trans- port, Storage, communication	Other Services
Lakhimpur	241552	68.16	6.17	6.14	0.06	1.51	4.88	1.32	11.76
Dhemaji	160833	79.68	4.97	0.99	0.00	1.11	4.32	0.88	08.05
Golaghat	293248	55.00	8.30	8.30	0.16	1.58	5.34	1.38	19.94
Jorhat	299539	44.23	5.33	5.33	0.55	2.97	7.51	2.65	31.43
Sibsagar	331439	44.58	6.24	6.24	3.39	1.45	5.43	1.65	31.02
Dibrugarh	361269	31.64	6.44	6.24	2.11	1.93	7.52	2.91	41.21
Tinsukia	351237	35.41	5.82	5.81	1.88	1.86	8.24	2.46	38.50
Total/average	2039117	51.24	6.18	5.58	1.16	1.77	6.18	1.89	25.98

Source: Census of India, 1991, Primary Census Abstract, Part II- B (1). General Population, Vol. 1, Series 1, pp. 198-230

Tea is one of the most important labour intensive industries in the world. The availability of labourers, its quantity and quality at the period of demand have influenced the cultivation of tea. Tea, being a plantation crop, involves the existence of a regular supply of labour force. Awasthi (1989-90) observes that labour cost in the tea industry is nearly 37% to the total costs involved in the process of production. Out of it, about 20% is paid in the form of cash wages, 2% as incentive plucking and the remaining 15% in the form of fringe benefits. Out of total agricultural workforce (that is accounted for 10,99,233 persons) of the study area, the tea labourers accounts for about 3,01,102 (27.39% to the total agricultural workforce). The maximum number of tea labourers that are enumerated about 15.5 lakhs is found in the district of Dibrugar and Tinsukia. They share more than 55% to the total agricultural workforce of the districts. It means that more than half of the agricultural workforce of this area is engaged in tea cultivation. The lowest share of tea labourers is recorded in the district of Lakhimpur and Dhemaji as 3.62%. The areas include Golaghat, Jorhat and Sibsagar districts stood on second rank with 13,4753 persons, (26.385%). Therefore, tea cultivation provides employment to a large section of agricultural workers (Table-3.10).

Table-3.10: Percentage Share of Tea Labourers to the Total Agricultural Workers (1991).

Districts	Total Workers	Agricultural	%	Tea Labourers	% to total Agricultural workers
Lakhimpur	179553		28.72	11087	3.62
Dhemaji	136164				
Golaghat	184922				
Jorhat	148453		45.65	134753	26.85
Sibsagar	168440				
Dibrugarh	136894		25.63	155262	55.11
Tinsukia	144807				
Total	10,99,233			301102	27.39

Source: Statistical Hand Book, Assam, 1996, Tea Digest, p. 6, 140.

N.B.: Total agricultural workers include cultivators and agricultural labourers.

10.0 General Land Use Pattern:

The nature of land use in an area reflects the level of socio-cultural and economic development of the people under different physico-cultural milieu (Das and Dutta 1986). The migration of people from the neighbouring countries and from other parts of the country at different times has altered the demographic structure, labour force proportions and socio-cultural traditions of the area. The causes of changing land use pattern are primarily related to increasing population pressure on land. Because of limited land and increasing demand of population, a slight intensification has been observed in agricultural land use in the study area.

The general land use pattern of the Upper Brahmaputra valley is crop dominated and, hence, a significant part of land is under NAS in each district. However, the share of NAS has been decreased over time during the 1990s (Table-3.11). A slight increase of land under tree crops is recorded during same period of time. It means, inspite of increasing food demand in the study area, the Net Area Sown decreases and has been converted into non-food crops.

The above analysis reveals that

- (a) There is dominance of net sown area (permanent cultivation) in the general land use categories.
- (b) There is no significant conversion of land from one to another category of land use. The temporal fluctuations in land use are very less.
- (c) The areal variations in land use do not have the significant changes.

Table-3.11: Changing Landuse Pattern in Upper Brahmaputra Valley (1992-93 to 1997-98).

Districts	Year	Area (in 000 ha)	Non-Agricultural Land (%)	Barren Land (%)	Permanent Pasture and Grazing Land (%)	Land under misc. Tree crops (%)	Cultivable Wasteland (%)	Fallow Land (%)	Current Fallow (%)	Net Area Sown (%)
Lakhimpur	92-93	228	18.42	12.7	1.75	0.88	0.87	0.87	0.44	42.10
	97-98	227	22.46	16.29	1.76	1.32	0.88	0.88	1.76	40.97
Dhemaji	92-93	324	25.30	15.43	4.94	5.25	5.56	0.61	1.23	21.60
	97-98	323	25.38	12.69	4.64	5.57	5.26	0.31	3.09	19.50
Golaghat	92-93	350	8.28	2.86	2.29	4.00	0.43	0.86	2.29	35.71
	97-98	350	8.28	3.14	2.29	3.71	0.43	1.71	2.29	33.42
Jorhat	92-93	285	28.77	1.40	1.40	3.15	2.46	1.40	1.05	43.86
	97-98	285	34.46	1.40	1.70	1.28	2.99	1.40	2.25	41.06
Sibsagar	92-93	267	14.98	3.37	2.62	7.87	0.37	1.12	0.75	53.68
	97-98	267	14.66	3.75	2.63	7.89	0.38	0.75	1.50	51.88
Dibrugarh	92-93	338	36.09	3.55	1.78	7.99	2.37	1.78	1.48	36.98
	97-98	338	36.09	3.84	1.78	7.69	2.07	1.18	0.59	37.28
Tinsukia	92-93	379	26.52	10.55	0.79	6.86	1.32	0.26	0.26	26.80
	97-98	379	19.26	10.29	0.79	7.39	0.79	0.26	1.06	24.00

Source: Statistical Hand Book, Assam, 1996, 1999, pp. 60.

(d) On account of increasing importance of tea cultivation in the area as tree crops, there is elastic demand of land under tree crops and gardens. A significant increase has been observed in this category of land use area under tea cultivation is increasing in all the districts (Table-3.12).

Table-3.12: Changes in Areal Extent of Tea Cultivation.

Districts	1995	1997	1998	1999
Lakhimpur	4494 (1.99)	4497 (1.96)	4500 (1.95)	4550 (1.96)
Sibsagar	62810 (27.76)	63196 (27.49)	63650 (27.57)	64000 (27.59)
Dibrugarh	68998 (30.49)	70806 (30.81)	71000 (30.76)	71500 (30.83)
Total Assam	226280	229843	230829	231940

Source: Tea Digest, 1999, Tea Board of India,

N. B.: 1. Figures in parenthesis indicate as percentages.

2. For the comparison of areal extent over time, the area under tea crop of present Dhemaji is included in Lakhimpur district, of present Golaghat and Jorhat in Sibsaagar and of the present Tinsukia district in Dibrugar district.

11.0 Agro-ecological Zones:

Based on the detail description of geographical factors, the entire study area is divided into the following three broad agro-ecological zones, which may be considered as basis for analyzing the effects of physiographic and socio-economic conditions on tea productivity. They are given below (Fig.-3.5):

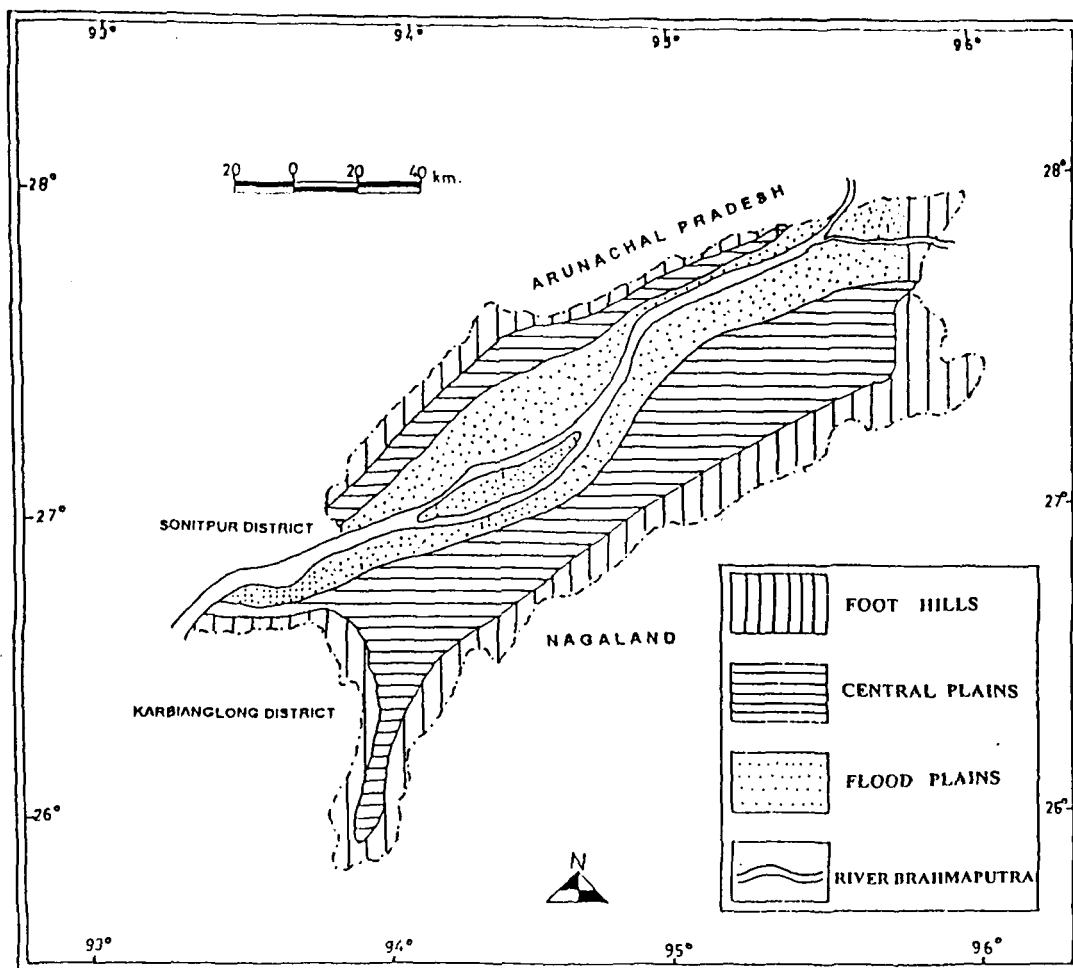


Fig.-3.5: Agro-ecological Zones.

(a) The Foot Hill Zone: It comprises the areas lying along the Himalayan foot hills in the north as well as the higher terraces, which lies on the southern part of Brahmaputra plain. This zone is approximately 10 km broad. Physiographically, it has a transitional characteristics, as the '*bhabar*' and '*tarai*' conditions prevailing in this zone. The aggregate size of soil particles is comparatively larger with more porosity.

(b) The Central Plain Zone: According to the Soil Survey (1969) conducted by T. R. A. Jorhat, this zone has fertile soil with suitable agricultural conditions. The soils of this zone have high organic matter with less infiltration and, therefore, it is suitable for tea cultivation.

(c) The Flood Plain Zone: They are the low-lying areas, situated largely along with the river Brhamaputra. On account of heavy floods and recent depositional processes, the soil particles in such areas are observed very small. The silty loam and coarse sandy soils are noticeable in this zone. It includes nearly one-fourth part of total study area. The ecological conditions of this zone are not favourable for tea cultivation. However, tea grows on the rounded hillocks.

12.0 Concluding Remarks:

There are a number of geographical factors prevailing in the Upper part of Brahmaputra Valley for the growth of tea cultivation; the Foot Hill Zone of transitional geographical characteristics, the Old Alluvial Plain of fertile land and the Flood Plains of new alluvium. Regional variations in physical conditions of land, socio-cultural dimensions and landuse pattern as shown in this chapter indicate that the socio-economic characteristics of tea gardens would be varying over space. The study of areal variations of socio-economic parameters may also be extended for different agro-climatic zones as delineated here which would give a criteria of showing the effects of ecological conditions on tea production as well as on socio-economic conditions of tea labourers. Further, the zonation is also providing the bases for the sample selection of tea gardens for the detail interpretation of labour problems.

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Chapter-IV

Socio-Economic Characteristics of the Tea Gardens

1.0 Introduction:

The geographical personality of the study area, which has been discussed in the preceding chapter, highlights a number of factors that are responsible for the spatial variations of production of tea in Upper Brahmaputra valley. It is persuaded in earlier discussion that there are three broad agro-ecological zones. These zones refer to different kind of conditions prevailing in the valley and a number of socio-economic factors directly or indirectly influencing to the production of tea. The tea industry has been intricately woven into the economy, society and way of life of Assam, (Saikia and Sharmah,1996). Therefore, such areal differentiation may help in understanding the general outlook of the problems of tea production areas. However, a quite large number of attributes of tea gardens may be included to understand the socio-economic characteristics of the tea gardens. It may help to solve many problems of tea planters, labourers living in tea gardens and also suggest economically viable cultivation.

The study reveals that not only the ecological conditions but also the tenorial system (land holding size and its tenancy), the demographic conditions of the gardens like population density, family size and the available infrastructure namely roads, water supply and electricity, social amenities and educational facilities are the attributes for

characterizing the socio-economic status of tea gardeners in the valley. Therefore, the present chapter focuses on a detail analysis of these socio-economic characteristics of tea gardens located in different agro-ecological conditions. For the same the data of socio-economic attributes have been collected by visiting every garden of the study area.

2.0 Criteria for Selection of Attributes and Choice of Variables:

As cited above, the characteristic features of the tea gardens of Upper Brahmaputra Valley are highlighted and examined by considering a set of socio-economic attributes and their variability prevailing in the different agro-ecological conditions of gardens. The agro-ecological conditions are considered as homogenous within the zone to study the variations in socio-economic characteristics subject to ecological conditions. The socio-economic attributes, which will explain the characteristic features, are considered as variables. It is to be noted here that the number of these total attributes are 29 considered at the initial stage of data collection from the gardens (Table-4.1).

Table-4.1: Name of the Attributes and their Units.

Sl. No.	Attributes	Units
1	Total registered area of the gardens	(hectare)
2	Total cultivated area of the gardens	(hectare)
3	Total production of tea gardens	(kg)
4	Total population of tea gardens	(number)
5	Total labourers of the gardens	(number)
6	Total adult labourers	(percent)
7	Total adolescence labourers	(percent)
8	Total child labourers	(percent)
9	Total families in the tea gardens	(number)
10	Total houses in the tea garden	(number)
11	Drinking water supplied by tap	(number)
12	Drinking water supplied by tube well	(number)
13	Drinking water supplied by ring well	(number)
14	Total hospitals	(number)

15	Total beds	(number)
16	Total dispensaries	(number)
17	Total doctors	(number)
18	Total veterinary doctors	(number)
19	Total nurses	(number)
20	Total pharmacists	(number)
21	Total mid wives	(number)
22	Total health assistants	(number)
23	Total crèches	(number)
24	Total clubs	(number)
25	Total canteens	(number)
26	Total sanitary latrines	(number)
27	Total schools	(number)
28	Total students	(number)
29	Total teachers	(number)

The characteristic features of tea production is analysed by considering five main basis of these attributes variation namely, the garden size, the land and labour productivities, the population density and the family size of the gardens. The justification for considering these as basis (or controlled variables) for highlighting the characteristic features is given below:

- (i) *Size of the garden* where a tenancy system prevails is important base for the variation of socio-economic factors of tea garden. There are a variety of economies and diseconomies prevailing because of homogeneities or heterogeneity of environmental conditions of different garden size (Visser 1999). The garden of small size has more homogeneity in its physiography, land conditions and landuse practices but diseconomies of production output. Inversely, the large size tea gardens have more heterogeneity of natural environment of land but restores better scale of economies by providing infrastructural facilities and good socio-economic conditions of farm labour.

These gardens may have concentration of more labour force and tea production and a few of them may be the big centers of production processings. Therefore, the amount of tea production produced by an individual garden is influenced directly by its areal size.

- (ii) The *land productivity* is the backbone of tea cultivation, which establishes relationship between natural conditions and socio-cultural milieu of a tea garden. Higher land productivity increases total volume of production and profits of the garden. As a result, the garden owners would be having better living standard rather than the labourers. It is expected that the gardens having high productivity levels would provide better infrastructural and social amenities to the tea garden labourers. In addition to it, it may be said that the favourable natural conditions increase land productivity of tea cultivation. These hypothetical statements may be tested here at the time of giving emphasis of characteristic features of tea cultivation.
- (iii) The *labour productivity* is also an important base for examining the socio-economic conditions of tea gardens because it is directly linked with the conditions of labour availability, their wage rates and technological inducements. The labour productivity in the tea gardens of Upper Brahmaputra Valley would be influenced by available skilled labour in the farm. The level of education, medical facilities, housing and sanitation are main factors of its variation in different agro-ecological conditions.

- (iv) The *population density* of tea garden is a good demographic indicator for the socio-economic characteristics of tea cultivation. Size and growth of population, its density, its age structure and its regional and occupational distribution are all closely related to economic development and growth (Lekhi,1996).
- (v) The *family size* is also a base, which provides the labour to the tea practices in gardens for plucking, cleaning, drying, processing and packing of tea. Many socio-economic problems like poverty, unemployment, low wage rate, use of child-labour, lack of social amenities (education and health) in the farm and so on are concerned with the family size. It is not only demographic indicator but also social unit, which are highly bound with social and economic constrains of the family to provide the labour to the production system. The family is the primary economic and social unit (Lingaiah, 1990).

The entire analysis is pursued on these bases of tea-cultivation, which would be able to highlight the major socio-economic characteristic features with respect to various agro-ecological conditions of the gardens.

3.0 The Choice of Variables:

The given data of twenty-nine variables has a large data domain from where some important attributes have been generated for detail description of socio-economic characteristics of the gardens. The attributes have been broadly classified into four broader groups, namely, the attributes related to (a) the areal size, (b) the productivity, (c)

the demographic and (d) the social amenities available in the gardens. The nomenclature of such attributes is given in Table-4.2.

Table-4.2: Name of the Attributes and their units.

Sl. No	Attributes	Units
A	Areal Size	
1	Total registered area	(ha)
2	Total cultivated area	(ha)
B	Productivity Attributes	
3	Land productivity	(kg per ha)
4	Labour productivity	(kg per person)
5	Total production of the Garden	(kg)
C	Demographic attributes	
6	Total population in the Garden	(persons)
7	Total labour in the Garden	(persons)
8	Share of child labour	(percent)
9	Family size	(number)
10	Density of population	(population/ha)
D	Social amenities/infrastructure	
11	Population per bed	(persons)
12	Population per doctor	(persons)
13	Family per house	(number)
14	Houses per tube well	(number)
15	Houses per toilet	(number)
16	Population per hospital	(persons)
17	Population per recreation center	(persons)
18	Students per school	(number)
19	Students per teacher	(number)

These nineteen attributes are considered to highlight the socio-economic characteristics of tea gardens. As mentioned above, out of these nineteen, five has been considered as the basis of classification of tea gardens to forward the characteristic features. The infrastructural facilities and the social amenities available in the tea gardens are also related to the efficiency to the work atmosphere for the people working in the tea gardens. The drinking water availability at home, the facility of sanitation and toilet and the medical facilities available in the garden are also taken into consideration as it directly or indirectly associated with the efficiency of the work force and are important

attributes relating to the socio-economic problems of the population employed in the tea gardens.

4.0 Arrangement of data:

The collected data of these attributes have been arranged systematically, according to the agro-ecological zones to show the areal variations of these attributes as well as to interpret the results of each zone. The total number of tea gardens in the study area are recorded as 440, out of which a nearly half of the tea gardens are located in the Central Plain Zone. While the Foothill Zone includes about 18.86% share of total gardens. About 31.59% tea gardens of the study area lie in its Flood Plain Zone (Table-4.3)

Table-4.3: Number of Tea Gardens in the Different Agro-Ecological Zones.

Zones	No. of the Tea Gardens	%
A Foot Hill	83	18.86
B Central Zone	218	49.50
C Flood Plain	139	31.59

The distributional characteristics of major attributes are important to note. The size of tea gardens are comparatively larger in Foot Hill Zone (473.54 ha) with low land productivity (2640 kg/ha) as well as low labour productivity (1632 kg/person). The coefficient of areal variations of these attributes are recorded lower in the Foot Hill Zone. It means variability is lesser within the zone (Table-4.4).

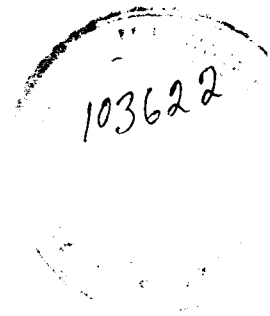


Table4.4: Mean, Standard Deviation (SD) and Coefficient of Variation (CV%) of Major Attributes in different Agro-Ecological Zones.

Zones	Garden Size (in ha)	Land Productivity (kg/ha)	Cultivated Area in (ha)	Labour Productivity (kg/person)	Labour Intensity (person/ha)	Percentage of labour to total population
Foot-Hill						
Mean	473.54	2639.80	322.49	1631.93	2.00	53.93
SD	414.40	2994.12	285.85	1899.35	1.00	19.64
CV (%)	87.50	113.42	88.60	116.39	50.70	36.42
Central Plain						
Mean	419.90	336.56	276.17	2190.69	2.10	52.92
SD	386.43	3462.499	254.21	3091.55	1.10	21.00
CV (%)	92.00	104.40	92.00	141.12	53.10	39.68
Flood Plain						
Mean	419.50	3070.57	288.63	2004.20	2.00	58.01
SD	362.43	3422.27	249.10	2555.51	1.10	18.14
CV (%)	86.40	111.45	86.30	127.51	54.00	31.27

N. B. Calculation based on the total number of 440 gardens (i.e., 83 for Foot Hill, 218 for Central Plain and 139 for Flood Plain Zones).

5.0 Socio-economic Characteristics of Tea Gardens by Garden Size:

It is highlighted in the previous discussion that the socio-economic characteristics of tea gardens are controlled by the garden size (i.e., the registered total area of a garden when the production processes are accelerated by the owner of the garden under specific environmental conditions). Garden size influences the total volume of production, productivity and intensity levels of input technology and even labour problems. The scale of economies and diseconomies can be observed in the different garden size because of heterogeneity/homogeneity of natural conditions of garden land. The small gardens have more homogeneity in its natural conditions than the bigger gardens where more differentiation can be seen in its micro-relief features, drainage conditions, soil fertility status and, even in some tea gardens, in their micro-climatic conditions. Further, it can be said that there are scale of economies in bigger gardens where land own develops common infrastructure facilities for enhancing production. While the small sized tea

gardens do not have opportunity to give all facilities to their farm labour and prove to less profitable with lesser volume of production (Visser, 1999).

(a) The procedure:

Socio-economic conditions of the gardens based on Garden Size are interpreted by considering nine attributes associated with the social and demographic conditions of labour force and productivity levels. They are as:

- (a) The availability of labour for the cultivation and processing tea production in the gardens. It includes three variables as (i) total volume of garden labour, (ii) the population density and (iii) the engagement of child labour.
- (b) The Educational and Health Facilities, which include (i) the population per bed (ii) the population per doctor in the hospitals, (iii) the students per school and (iv) the students per teacher in the each garden.
- (c) The economic attributes related to (i) land productivity and (ii) labour productivity in the garden.

Further, the collected data of the above mentioned attributes of all tea gardens have been arranged by the different categories of garden size as:

- (i) very small size of gardens (below 100 ha),
- (ii) small size (100-400 ha),
- (iii) medium size (400 – 800 ha),
- (iv) large size (800-1000 ha) and
- (v) very large size of gardens (above 1000 ha).

The results are interpreted on the bases of the categories of garden size in relation to different agro-ecological zones for showing the impact of ecological conditions on the social status of garden's population.

(b) The Analysis: It is observed from the table (Table-4.5) that the size of available labour increases as garden size increases because, obviously, when areal size of a garden is larger, it accommodates bigger amount of labour as well as population. However, it varies from 77 persons to 1758 persons per garden in the foot-hill areas, from 74 to 1604 persons per garden in central plains and from 65 to 1700 persons in flood plain areas in the Upper Brahmaputra Valley. It means that the areas of Central Plain have fewer variations in the total size of garden labour. The major characteristic features of labour structure in the gardens are given below:

- (i) The population density is recorded higher (as 4-5 persons per ha) in the medium size gardens (400-800 ha) in all the agro-ecological conditions.
- (ii) The higher percentage share of child-labour (more than 3% to total workforce) is prevalent in the smaller size gardens (200-400 ha) of the foothill areas and medium to larger size (400-1000ha) gardens of the flood plains. It shows that the gardens of flood areas employ more percentage share of child labour. It may be because of prevalence of conditions of illiteracy, poverty and high population density in the areas of frequent floods.
- (iii) The population pressure on hospital doctors, and the student's pressure on teacher as well as on the schools are recorded very high in the large and very

Table- 4.5:Socio-Economic Characteristics of Tea Gardens by Garden Size.

Agro-ecological Zone	Farm Size (ha)	Frequency	Registered Area (ha)	Size of Labours (Persons)	Population Density (per ha)	Land Productivity (Kg/ha)	Labour Productivity (Kg/P)	Child Labour (%)	Population Per bed	Population per Doctor	Students Per School	Students Per Teacher	
A	Fool-Hill Zone	Class											
		0-100	13	55.46	76.38	3.42	6456.53	3404.72	1.14	0.73	13.23	6.85	6.65
		101-200	16	142.81	205.31	2.42	2755.59	2167.53	0.03	4.11	63.50	3.88	15.53
		201-300	9	243.11	295.44	2.07	1855.26	1257.27	3.83	9.52	284.67	41.11	31.89
		301-400	3	331.67	305.67	1.51	1246.44	1884.90	3.51	0.02	158.35	45.00	32.50
		401-500	6	436.67	637.00	4.08	1449.44	762.40	0.69	27.99	1303.17	49.50	56.69
		501-600	12	541.00	819.75	3.83	1945.15	1111.29	0.70	20.50	1772.58	92.69	46.02
		601-700	6	659.67	1206.83	3.97	2028.46	907.89	1.49	24.34	2662.67	137.80	47.03
		701-800	3	734.67	956.33	2.39	790.71	672.37	0.00	0.09	1572.67	177.33	101.28
		801-900	3	889.00	1248.00	1.87	1896.14	814.38	0.00	0.16	1066.67	120.00	75.00
901-1000	4	928.75	1261.00	3.71	1931.86	967.47	2.45	31.46	1428.13	215.50	77.42		
1001-Above	8	1432.38	1757.5	2.14	1330.84	622.93	1.60	16.48	2517.94	205.00	64.61		
		83	581.38	797.47	2.85	2153.03	1324.80	1.40	12.26	1170.33	109.96	50.44	
B	Central Plain Zone	0-100	41	56.39	74.76	3.06	6697.95	4531.29	2.43	0.16	23.90	1.29	1.29
		101-200	46	141.09	204.46	2.95	2863.04	2670.30	4.65	0.21	88.82	31.85	22.28
		201-300	21	245.43	334.29	2.76	2342.53	1534.18	1.99	0.18	391.29	59.14	34.73
		301-400	21	353.00	663.90	3.45	2225.28	1064.78	3.00	0.05	993.76	71.90	42.27
		401-500	17	352.81	665.71	3.79	1708.61	762.54	2.70	0.07	1210.41	135.06	64.44
		501-600	15	445.94	900.53	4.24	1985.60	1059.23	3.31	0.06	1729.23	155.86	61.55
		601-700	17	544.07	934.06	4.14	2252.52	1085.56	3.21	0.05	2408.16	137.97	57.19
		701-800	14	646.71	964.36	2.75	2003.79	1143.16	4.12	0.04	1987.07	161.61	68.38
		801-900	1	759.93	772.00	4.40	2295.64	1361.92	0.00	0.02	3921.00	136.00	68.00
		901-1000	4	891.00	1004.00	2.84	1367.34	1048.14	3.72	0.01	1774.75	187.42	86.88
1001-Above	21	953.25	1605.29	2.58	1396.66	1315.37	2.26	0.05	2860.64	168.73	66.62		
		139	578.66	738.48	3.36	2648.99	1597.86	2.85	0.08	1580.82	113.34	52.14	
C	Flood Plain Zone	0-100	22	49.55	65.09	4.06	7933.40	4628.37	1.91	0.38	33.64	2.86	2.56
		101-200	25	147.36	138.20	1.97	2302.27	2263.84	1.85	0.13	86.40	27.32	19.94
		201-300	16	235.06	317.81	2.23	2733.05	1560.18	2.97	0.13	199.75	41.13	29.63
		301-400	19	345.47	569.81	3.14	2208.55	1201.71	3.86	0.06	911.37	67.50	41.54
		401-500	17	434	704.12	2.65	1392.75	1185.50	2.39	0.13	896.41	92.53	46.97
		501-600	4	534.5	728.00	2.38	1429.70	549.51	3.61	0.07	1008.25	119.00	48.50
		601-700	7	641.57	1137.43	2.50	3297.26	1424.04	5.93	0.08	1420.95	82.14	46.98
		701-800	7	744.14	1083.86	4.26	1870.61	1325.49	4.00	0.03	2237.14	175.79	65.12
		801-900	8	835.88	1417.13	2.75	1731.53	977.05	1.71	0.04	1799.44	138.42	46.94
		901-1000	2	919.00	67.00	1.15	1794.45	1801.41	0.00	0.08	1052.00	177.50	50.00
		1001-Above	12	1262.17	1699.17	2.68	1459.60	669.51	2.76	0.04	1920.29	204.29	64.00
				218	559.06	780.87	2.70	2604.83	1598.60	2.81	0.10	1051.42	102.58

large size of tea gardens in all the agro-ecological conditions. It means the availability of social amenities are not sufficient in larger size gardens.

- (iv) So far as economic characteristics of tea gardens are concerned, it is clear from Table-4.5, that land and labour productivities vary slightly in different agro-ecological conditions of land. However, the levels of land as well as labour productivities are recorded very high (above 2000 kg/ha and even 2000 kg/person of labour force) in the very small size of gardens (below 200 ha) generally in all types of agro-ecological zones in Upper Brahmaputra valley. The level of productivity (land and labour) diminishes as garden size increases. This decrease is recorded faster at smaller size and *vice-versa*. It reveals that heterogeneous natural conditions of land are influencing the land productivity, while the large amount of labourers and high population density in the bigger gardens tend to decrease the labour productivity in all the ecological zones of the Upper Brahmaputra valley. As Heady (1968) observes that if the size of economies are very great, other end may be extended only at a very great sacrifice. On the other hand, if scale economies are small or non-existent, small farms might be used with little sacrifice in attaining a more nearly equal distribution of farm wealth, political stability within agricultural and similar ends. There is, however, a need of detail elaboration of such facts.

6.0 Socio-Economic Characteristics of Tea Gardens by Land Productivity:

(a) The Procedure:

The productivity of land has a great impact on the socio-economic profiles of the people of tea gardens in the Upper Brahmaputra Valley. The level of productivity determines the nature of living conditions of the people residing in the tea gardens. The characteristics of tea gardens with reference to land productivity and its impact on the socio-economic conditions of tea gardens have been visualized by considering nine variables, namely, the garden size, volume of production, demographic, socio-economic as well as social amenities available in the tea gardens (Table-4.6).

The statistics of above variables have been clubbed together. Their mean values are calculated according to their productivity level. The present analysis is done on the basis of categorizing the areal units into five as the gardens of:

- (i) very low level of land productivity (below 1000 kg/ha),
- (ii) low (1000-4000 kg/ha),
- (iii) medium (4000-8000 kg/ha),
- (iv) high (8000-10,000 kg/ha) and
- (v) very high (above 10,000 kg/ha).

It would help in tracing out the characteristic features of tea gardens in response to land productivity.

Table 4.6: Socio-Economic Characteristics of Tea Gardens by Land Productivity.

Agro-ecological Zone	Land-Productivity (kg/ha)	Frequency	Land Productivity (Kg/ha)	Registered Area (ha)	Production (Kg)	Labour (total)	Population Density (P/ha)	Child Labour (%)	Population Per Bed	Population Per Doctor	Students Per School	Students Per Teacher
A. Foot-Hill class												
Zone	0-1000	10	549.41	674.70	243015.80	648.50	1.53	1.60	0.06	917.90	96.18	47.82
	1001-2000	44	1525.07	467.27	48982.75	571.14	2.93	0.76	9.00	979.69	99.77	40.82
	2001-3000	16	2371.45	612.69	926153.06	968.06	3.31	2.22	24.16	1755.59	85.94	51.47
	3001-4000	4	3639.94	0.00	0.00	0.00	0.00	1.18	46.08	686.00	59.50	20.13
	4001-5000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5001-6000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6001-7000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7001-8000	1	7133.71	16.00	99872.00	50.00	11.00	0.00	0.00	0.00	0.00	0.00
	8001-9000	2	8576.30	105.00	691037.50	182.00	2.57	2.15	4.17	0.00	14.00	14.00
	9001-10000	2	9459.61	53.00	390340.50	77.50	3.30	0.00	0.05	0.00	0.00	0.00
	10001-Above	4	12669.79	54.00	390264.50	86.00	3.17	2.64	0.04	84.00	0.00	0.00
Average		83	4175.02	180.24	293060.55	243.92	2.52	0.95	7.59	432.10	32.30	15.84
B. Central Class												
Zone	0-1000	14	574.57	617.93	233919.64	826.93	2.88	2.37	0.07	1022.21	102.50	58.83
	1001-2000	84	1577.93	402.81	416327.92	492.20	2.87	2.50	0.11	876.36	1.01.41	41.50
	2001-3000	68	2409.36	564.88	873016.75	877.66	3.80	3.98	0.07	1737.78	94.61	50.32
	3001-4000	17	3508.76	428.00	994355.00	576.82	3.74	2.53	0.07	832.94	74.98	30.17
	4001-5000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5001-6000	5	5256.24	152.00	446704.30	107.20	3.30	1.81	0.23	42.80	26.80	13.40
	6001-7000	1	6747.67	22.00	60729.00	12.00	2.09	0.00	0.00	0.00	0.00	0.00
	7001-8000	4	7772.66	122.25	646206.25	212.00	2.64	2.25	0.10	0.00	0.00	0.00
	8001-9000	5	8649.02	82.00	493922.40	115.00	2.11	3.18	0.80	138.40	21.80	21.80
	9001-10000	4	9486.80	68.00	491010.00	72.25	3.14	3.41	0.02	0.00	9.25	9.25
	10001-Above	16	13351.44	76.19	577177.94	82.06	2.66	5.24	0.32	58.31	0.00	0.00
Average		218	5393.95	230.55	475760.88	306.73	2.65	2.47	0.16	428.07	39.21	20.47
C. Flood Class												
Zone	0-1000	17	718.04	569.94	266913.29	791.47	2.00	1.62	0.13	1015.94	131.53	40.88
	1001-2000	52	1520.19	446.38	465565.77	611.37	2.14	2.07	0.12	650.39	87.37	40.88
	2001-3000	38	2409.06	500.58	783410.55	882.34	3.46	4.42	0.09	1279.14	77.73	43.28
	3001-4000	8	3449.23	417.13	939536.13	433.63	2.76	2.49	0.10	696.50	68.63	33.83
	4001-5000	7	4317.63	96.14	268621.00	129.57	2.69	2.70	0.24	60.14	18.43	18.43
	5001-6000	1	5049.58	37.00	121190.00	29.00	1.76	0.00	1.00	0.00	0.00	0.00
	6001-7000	4	6357.63	211.25	55898.50	132.00	1.17	0.00	0.14	35.00	11.00	5.50
	7001-8000	1	7624.00	111.00	373576.00	51.00	1.20	0.00	0.17	0.00	0.00	0.00
	8001-9000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9001-10000	2	9597.81	61.00	342410.50	84.00	4.08	0.00	0.04	132.00	0.00	0.00
	10001-Above	9	14321.32	104.67	1132451.21	185.44	6.47	4.26	0.25	217.25	0.00	0.00
Average		139	5033.13	232.28	477479.36	302.71	2.52	1.59	0.20	371.48	35.88	16.34

(b) The Analysis:

- (i) It can be observed from the Table-4.6, which provides a detail classification of socio-economic attributes for the different agro-ecological conditions, that the level of land productivity is recorded the highest (5394 kg/ha) in the central plains followed by the Flood Plains Zones in which productivity level is noticed 5033 kg/ha. The areas of foothill zones have the lowest level of productivity (4175 kg/ha). There can be a number of causes for the areal differentiation in the levels of land productivity. Physiographic factors of land may be important valid reasons of its variations because the measurement of tea production per unit of land is directly related to its physical factors, which generate land potential to produce more tea.

The present work reveals that the soil fertility status and soil moisture holding capacity are higher in the Central part of old alluvial soils with the moderate rainfall and sunshine conditions of weather. As a result, the land productivity of tea is recorded higher. The soils and climate of the foothill areas would be having its extreme conditions, which do not suit much to the tea cultivation. The number of tea gardens are registered less (only 84 i.e., 18.8% to total gardens) because of unfavourable land conditions for tea cultivation.

- (ii) Within each agro-ecological zone, the 75 gardens out of total 84 (i.e., nearly 88.2%) falls under the category of low to very low levels of land productivity (0-4000 kg/ha) in Foot Hill Zone; the 183 gardens out of 218 (i.e., 83.9%) in

the same category of land productivity in Central Plains and the 115 gardens out of 139 (i.e., 82.7%) in the Flood Plains. Therefore, the concentration of gardens is towards low to very low category of land productivity and the major amount of tea production comes from these categories of low productivity levels. It means that the economy of tea production has been resting upon a low level of productivity, which may not be able to attract more than the other agro-ecological zones of the study area. The comparison of student-teacher ratio and student-school ratio in different agro-ecological zones shows that the schools are of very small size in which average two teachers are available not only in foot-hill zone but in the gardens of other parts also.

(b) How does land productivity influence weak structure of social amenities in different agro-ecological conditions? It may be answered by analysing the available infrastructure in accordance with the different categories of land productivity for different zones. It is obvious from the Table 4.6 that there is concentration of higher ratios of all indicators of health and education towards the categories of low productivity in all agro-ecological zones with their slight variations. It means that the gardens of low land productivity have weak infrastructure. Such facilities are available satisfactorily in the gardens of high land productivity and marginally in the gardens of medium productivity. The ratio is very high for the Central Plains Zone; it means that the availability of such facilities is very weak in the low land productivity gardens of this area. It

may be because of very high population density in such gardens of low productivity.

In general, it can be concluded that the low land productivity gardens are characterized by higher production and higher percentage share of child labour. The density of population is very high in these gardens with weak infrastructural facilities and social amenities.

- (iii) The total available labour is concentrated more in the gardens of low and very low levels of productivity in all the zones. It varies from 648 to 968 workers per garden in the Foot Hill Zone, 492 to 877 in Central Plain Zone and from 433 to 882 persons per garden in Flood plain Zone. Thus, the availability of labour force does not vary much in the areas of different agro-ecological conditions. The higher productivity gardens of Flood Plain Zone with favourable soil and climatic conditions are more suitable for tea cultivation. It means that the gardens of higher land productivity, although they are few in number, have less population density. The population size of the gardens does not vary according to their productivity levels.
- (iv) There is characteristic feature of the distribution of child labour in the gardens of low productivity level. High percentage share of child labour concentrates in this level under different agro-ecological conditions. For example, it is recorded at 1.18 – 2.22% in the low to very low categories of the Foot Hill Zone, 2.5 – 4.00% and 1.6 – 4.4% in the Central and Flood Plain Zones respectively.

(v) Productivity of land influences the socio-economic conditions of the people living in the tea gardens directly or indirectly which can be examined by interpreting the results from the table. The levels of educational facilities available in the gardens have been considered for the purpose. The availability of beds as well as doctors for the population and the available schools and teachers for the students of the gardens are calculated as indexes of available infrastructure. It can be said that the larger size of population is served by per bed or per doctor in the garden. It shows lesser degree of its availability and *vice-versa*. The same is true for educational facilities also. It can be concluded from the distribution that:

(a) The gardens belonging to Foot Hill Zone have less health facilities because the population served by per bed and per doctor in the hospitals is recorded very high (8 persons per bed and 432 persons per doctor). However, the educational facilities are observed satisfactory. The students are recorded 32 per school and 16 per teacher in the gardens of this area. The student strength is comparatively lower.

(b) The Central Built up zone of fertile soils is characterized by less intensive social amenities where the number of students are recorded more per teacher as well as per school. Similar features of available social amenities may also be visualized in the Flood Plain Zone.

7.0 Socio-Economic Characteristics of Tea Gardens by Labour Productivity:

Tea cultivation is labour dominated. Each tea garden, therefore, has its own workers with their families. Thus, tea garden is a complete socio-economic unit and has integrated system of tea cultivation. The population of the garden supplies labour, to earn income from the same garden, spends it to raise the socio-economic standard and also increase the labour productivity of the garden. Therefore, total production and productivity of the gardens are largely influenced by the availability of labourers (unskilled as well as skilled). The physiographic conditions of land influence the land productivity as stated earlier. Likewise, the labour productivity is an index of production, which shows the effects of labour and socio-economic conditions of population residing in a garden. In order to understand and to characterize the labour productivity phenomena, the following indicators (that are called explanatory variables for the present case) have been considered.

1. The availability of labour in the garden.
2. The percentage share of child labour employed in tea production practices.
3. The density of population in the garden (that shows the demography).
4. The family size where worker and non-worker live together under a small socio-economic unit.
5. The available social amenities and infrastructure, that are:
 - (i) the population per bed as well as per doctor in the hospitals
 - (ii) the students per school and per teacher in the gardens.

These explanatory variables would indicate the socio-economic status of labour as well as demographic attributes of population residing in the gardens with respect to its labour productivity. The results are inferred to arrange statistics of these variables according to the eleven detail productivity categories for all three sets of agro-ecological zone wise data (Table-4.7). The description is based on five broad categories of the gardens as given below as the gardens of:

- (i) Very low labour productivity (below 1000 kg/person),
- (ii) Low productivity (1000-4000 kg/person),
- (iii) Medium productivity (4000-8000 kg/person),
- (iv) High productivity (8000-10000 kg/person), and
- (v) Very High labour productivity (above 10000 kg/person).

The category-wise classification of socio-economic aspects of gardens shows the interesting results as interpreted here:

- (1) An average level of labour productivity is recorded 4516 kg/person in the tea gardens of Upper Brahmaputra Valley. It varies regionally according to their variations in agro-ecological conditions. As noted in the Table-4.7, the Central Plains of old alluvial has the highest level of labour productivity (5815 kg/person of labour force) while the flood plains of new alluvial soils have the productivity level very close to its average (4522 kg/person). The lowest labour productivity is observed in the foothill zones in the valley.
- (2) In the distribution of gardens of various labour productivity classes, it can be said that more than a half of the numbers of total gardens are concentrated towards the

Table-4.7: Mean Value of Socio-Economic Attributes by Labour Productivity.

Agro-ecological Zones	Labour Productivity (Kg/p)	Frequency	Labour Productivity (Kg/p)	Labour (Total)	Population Density (per/ha)	Child Labour (%)	Family Size	Population per bed	Population Per Doctor	Students Per School	Students Per Teacher	
Class												
A Foot-Hill Zone	0-1000	49	648.64	873.20	2.98	1.19	2.00	7.50	1188.26	101.03	48.03	
	1001-2000	18	1420.95	555.17	3.81	0.68	3.63	27.16	1330.19	105.60	38.05	
	2001-3000	5	2387.77	163.20	2.27	3.25	1.78	7.68	247.80	29.20	21.00	
	3001-4000	3	3359.63	135.33	1.22	4.54	2.50	24.19	0.00	18.67	18.67	
	4001-5000	2	4541.56	83.50	1.89	0.00	1.16	0.05	0.00	0.00	0.00	
	5001-6000	3	5782.06	64.33	2.81	1.43	2.80	2.76	0.00	0.00	0.00	
	6001-7000	0	7778.03	61.00	1.02	0.00	3.03	0.00	0.00	0.00	0.00	
	7001-8000	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	8001-9000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	9001-10000	2	9497.75	28.50	1.31	0.00	3.01	0.05	24.00	22.50	22.50	
	10001-Above	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Average		83	3219.67	178.57	1.57	1.01	1.81	6.31	253.66	25.18	13.48	
Class												
B Central Plain Zone	0-1000	104	650.33	770.70	3.58	3.55	2.62	0.08	1124.25	103.00	47.75	
	1001-2000	65	1383.94	595.49	3.45	2.53	3.46	0.09	1400.30	88.73	42.81	
	2001-3000	9	2400.45	282.33	1.45	2.65	2.25	0.09	677.14	73.28	30.76	
	3001-4000	9	3410.52	201.67	3.93	1.90	2.02	0.58	630.22	43.50	27.81	
	4001-5000	5	4487.96	97.20	2.29	1.80	3.89	0.23	0.00	0.00	0.00	
	5001-6000	8	5453.91	81.13	2.13	2.49	2.58	0.36	68.50	16.75	8.38	
	6001-7000	2	6735.64	345.50	0.76	0.00	2.43	0.00	1023.50	90.00	20.00	
	7001-8000	2	7769.44	37.50	0.82	0.00	5.09	0.25	0.00	8.00	8.00	
	8001-9000	6	8832.03	108.00	1.34	14.60	1.66	0.04	141.50	0.00	0.00	
	9001-10000	2	9369.99	61.00	1.43	2.27	3.01	0.02	0.00	3.50	9.83	
	10001-Above	6	13471.28	44.50	1.76	7.13	3.79	0.10	0.00	0.00	0.00	
Average		218	5815.04	238.64	2.09	3.54	2.98	0.17	460.52	39.71	17.76	
Class												
C Flood Plain Zone	0-1000	70	627.97	908.27	2.79	94.00	1.93	0.10	1025.06	99.45	43.11	
	1001-2000	33	1391.94	502.39	2.78	100.00	2.26	0.15	993.57	39.30	43.22	
	2001-3000	11	2379.04	165.45	1.91	100.00	1.74	0.19	60.36	22.73	20.68	
	3001-4000	7	3428.67	131.00	1.15	98.05	1.80	0.08	69.43	18.86	16.00	
	4001-5000	9	4360.66	112.22	4.77	96.58	2.30	0.16	15.56	18.22	6.89	
	5001-6000	2	5380.07	677.00	2.75	96.44	1.44	0.05	1001.00	0.00	0.00	
	6001-7000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	7001-8000	3	7451.05	49.33	1.32	100.00	1.90	0.72	0.00	0.00	0.00	
	8001-9000	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	9001-10000	1	9686.57	42.00	19.86	100.00	2.54	0.00	0.00	0.00	0.00	
	10001-Above	3	15038.36	37.00	1.19	100.00	1.64	0.12	0.00	0.00	0.00	
	Average		139	4522.21	238.61	3.50	81.08	1.60	0.14	287.73	22.60	11.81

categories of low to very low labour productivity (3000 kg/ha). Therefore, a more than three-fourth share of the total labour force of the gardens is concentrated only in the gardens having low to very low level of their labour productivity. It can be justified by stating that the gardens of high concentration of labour force produce less tea per worker. It means there is an unlimited pressure of labour supply, which diminishes the level of labour productivity of the gardens.

- (3) The population density and child-labour employed in the tea cultivation practices in the gardens may be compared with the total available labour and the labour productivity. It is found that the higher percentage of child labour (upto 4.5%) is employed in tea practices in the low labour productivity gardens of the Foot Hill areas. Further, the population density is also recorded very high (350 persons/sq km) in the gardens of Flood Plain areas. We should say that higher the population density, greater is the pressure to supply more labour force to the garden. On account of high population density in the gardens of flood plains, the population pressure is greater which supplies more labour to the tea cultivation, even some times, the supply of child labour. It has been happening in the gardens of Flood Plain zone. But such demographic situations are not recognizable in the areas of foothills as well as in the central plains.
- (4) The distributional pattern of population density with regards to labour productivity of the gardens show that the density is comparatively higher in the low productivity gardens in all the cases of agro-ecological zones.

- (5) The family size, which is an important attribute of the tea gardens, is noticed small (2 persons per family). It is ideal even without any children. This may be true in the case of the gardens of Upper Brahmaputra valley because, the smaller family size may produce the small quantity of tea production. Infact, wherever the family size is observed larger (more than two persons per family) with high population density in the case of the gardens of Central plain agro-ecological conditions, the villages situated in these gardens are large in its size in these areas.
- (6) So far as the distribution of social infrastructure in the gardens of Upper Brahmaputra valley is concerned, it is obvious from the table that
- (a) The population per hospital bed comes very high (6 persons per bed) in the foothill zone. It means that the hospital facilities are very poor in the gardens of this zone. Likewise, population served by one-doctor in the hospitals is very high (460 persons per doctor) in the Central Plain Zone. It shows the poor medical facilities and, consequently, high level of mortality rate specially in the foot hill areas.
 - (b) Such situation of poor medical facilities is acute in the gardens of low and very low levels of labour productivity where the population-doctor ratio goes upto 1400 persons per doctor in the Central Plain Zone.
 - (c) The similar conditions of poor educational facilities may be seen specially in the low productivity gardens of all the agro-ecological zones but specially the Central plains.

In the end, it can be concluded that the tea production of the gardens is labour-dominated where high population density with poor conditions of social amenities prevail. The child labour is also being supplied by the labourer families for raising tea production. The concentration of labour force with its high population density and higher supply of child labour has been noticed in the gardens of low labour productivity. It shows that high population pressure (i.e., indication of higher labour intensity) influences the socio-economic status of labour and declines the level of labour productivity in the Upper Brahmaputra Valley. More facts about this statement may be produced separately by comparing and correlating these attributes of labour productivity separately in the forth-coming chapters.

8.0 Socio-Economic Characteristics of Tea Gardens by Population Density:

The density of population is a good indicator of demographic structure. It does not only show the size of population but also the population pressure on the land resources. Since population density refers to a unit of land which is a piece of resources and the gardens have a piece of land larger or smaller in its size, the population density must be associated with garden size and its total population residing in it. Further, population living in the gardens may be viewed by another angle that the population supplies labour force (skilled, unskilled and/or child labour) to the production processes. If population is conceived as an aggregation of various social units (i.e., family) then the family size determines the size and density of population in the gardens. Therefore, the following variables have been taken into account to study the characteristic features of gardens in accordance with the population density (Table-4.8).

- (i) The areal size (as registered area) of the garden.
- (ii) The population size (as total population residing in the garden which is solely dependent on the economy of the garden).
- (iii) Total available labour force which is being used for the production processes in the gardens.
- (iv) A segment of labour force (i.e., child labour) employed partially or wholly in the production activities of tea.
- (v) The family size, which is a social unit, includes working as well as non-working population of the family.

As the density of population that is calculated as the persons per hectare, differs from area to area, it has a great impact on the volume of production and other related aspects, which directly or indirectly influence the socio-economic conditions of the people living in Upper Brahmaputra Valley.

The socio-economic conditions of the tea gardens by density of population have been interpreted by considering five explanatory variables, namely,

- (i) Registered area (hectare), which reflects the size of the gardens.
- (ii) Total population including children.
- (iii) Total labour (temporary and permanent) and child labour, and
- (iv) Family size.

The collected data are arranged into different classes on the basis of persons per hectare. The total number of gardens are classified into eleven categories of population density and then the average values of selected variables are calculated to justify the results (Table-4.8). However, the results have been interpreted on the basis of following five broad categories of population density as:

- (i) Very low population density (below 1.00 person/ha),
- (ii) Low (1.00 – 4.00 persons/ha),
- (iii) Medium (4.00 – 8.00 persons/ha),
- (iv) High Class (8.00 – 10.00 persons/ha), and
- (v) Very High (10.00 persons/ha).

Table-4.8: Mean Value of Socio-Economic Attributes by Population Density

Agro-Ecological Zones	Class Persons/ha	Frequency	Registered Area (in ha)	Total Population	Labour (Total)	Family Size
A. FOOT-HILL	0-0.99	09	370.33	237.22	156.33	1.71
	1.00-1.99	19	592.89	878.11	633.11	1.90
	2.00-2.99	25	446.36	1070.04	652.68	2.23
	3.00-3.99	11	302.27	1026.91	557.00	1.87
	4.00-4.99	08	353.99	1580.41	515.90	2.48
	5.00-5.99	03	683.67	3687.00	1765.33	2.89
	6.00-6.99	03	491.00	3262.00	711.67	5.83
	7.00-7.99	04	384.50	2947.75	971.00	2.42
	8.00-8.99	00	0.00	0.00	0.00	0.00
	9.00-9.99	00	0.00	0.00	0.00	0.00
	10.00-Above	01	16.00	176.00	50.00	9.26
	Average	83	331.00	1351.40	546.64	2.78
B. CENTRAL PLAIN	0-0.99	18	279.22	209.83	140.83	2.20
	1.00-1.99	45	355.80	507.20	363.22	2.43
	2.00-2.99	64	454.69	1114.23	645.39	2.46
	3.00-3.99	32	572.91	1973.91	798.03	3.27
	4.00-4.99	22	489.23	2148.05	741.68	3.47
	5.00-5.99	16	310.00	1722.88	559.69	3.30
	6.00-6.99	12	329.17	2155.25	655.92	3.68
	7.00-7.99	04	543.75	3964.25	1286.00	4.03
	8.00-8.99	02	206.00	1712.50	449.50	4.51
	9.00-9.99	01	441.00	4281.00	782.00	1.96
	10.00-Above	02	88.00	1820.50	138.00	11.78
	Average	218	369.98	1964.51	596.39	3.92
C. FLOOD PLAIN	0-0.99	15	357.00	272.67	249.93	2.13
	1.00-1.99	42	388.74	597.43	423.74	1.65
	2.00-2.99	42	377.07	909.14	587.76	1.70
	3.00-3.99	15	638.53	2177.47	1117.80	2.27
	4.00-4.99	12	547.50	2476.42	1219.33	2.32
	5.00-5.99	05	483.00	2638.40	645.60	3.43
	6.00-6.99	05	304.60	1955.20	787.60	3.05
	7.00-7.99	00	0.00	0.00	0.00	0.00
	8.00-8.99	00	0.00	0.00	0.00	0.00
	9.00-9.99	00	0.00	0.00	0.00	0.00
	10.00-Above	03	128.33	1513.00	254.33	3.73
	Average	139	293.16	1139.97	480.55	1.84

The Results and Description:

Classification of tea gardens based on its population density for the different agro-ecological zones provides the following characteristic features.

- (i) The concentration of gardens in each zone is towards the categories of low to very low population density (below 3 persons per ha, that is 300 persons per sq. km which is even higher than the state density figure). It means that the population density level is higher of the garden population than the state average, which shows the population concentration in tea gardens. The concentration of population appears to be higher in tea gardens than the population concentration in the cultivated areas in the Upper Brahmaputra valley.
- (ii) The average garden size with reference to population density is almost similar in all three agro-ecological zones. For example, the average garden size is calculated 398 ha in Central Plain zone following the Foothills where it is 331 ha. The Flood Plain Zone has the smallest garden size as 293 ha. Further more, it can be said that the garden size is almost uniformly distributed among all the density categories with slight variations ranging from 302 to 683 ha in Foot Hill areas, from 150 to 579 ha in the Central plains and from 128 to 638 ha in the flood plains of Upper Brahmaputra valley. Generally, smaller garden size is seen in the categories of higher population density and *vice-versa*. It shows that the smaller size gardens accommodate higher population pressure in tea garden areas.

- (iii) The above discussion needs further details about the availability of population in the gardens. The figure given in the table shows the same fact as described above that the gardens having higher population density concentrate much population. As a result, the gardens of more than 4 persons per ha of population density have a standard population size of about 3000 to 4000 people in all the agro-ecological zones.
- (iv) Infact, high concentration of population will provide more labour force with higher percentage share of child labour. The same fact emerges from the Table-4.8. A significant size of labour force varying from 500 to 1000 persons is available in the gardens of high density of population. The same categories of high population density include a significant percentage of child labour varying from 1.0 to 3.0 percents in all three agro-ecological zones. It means that the gardens of high population density have high pressure of population which supplies its significant share as labour force to the garden and even children also engaged in the activities of tea production in these gardens because of sufficiently available child labour at cheaper rate.
- (v) The bigger family size of the population (4-6 persons size) is also observed in the gardens of high density.

It can be said that the increasing density of population in the gardens increases population as well as labour size and, consequently, provides abundant supply of labour in the gardens with large families where children are also employed in the productive activities in such gardens.

9.0 Socio-Economic Characteristics of Tea Gardens by Family Size:

As stated above that family is a social unit, it is tightly bound with the social customs and traditions under a common roof. It is also an economic unit with the diverse nature of occupations and earnings. Therefore, socio-economic impact on population residing in the gardens is closely linked with the size of family. It provides labour to work and includes non-workers (children and old people) in the population. It is also related to the production characteristics and available social infrastructure.

Considering these aspects of family size in mind, the nine variables have been chosen to examine the socio-economic characteristics of the people living in the tea gardens, namely, (a) the size of the gardens, (b) availability of labour as (i) the total labourers (permanent and temporary) and (ii) the child labour, (iii) the density of population to show the pressure of population on land as well as on resources and (c) the social amenities, namely (i) the houses per toilet, (ii) the population per bed as well as per doctor and (iii) the students per school as well teacher.

The collected data of these variables have been arranged into eleven detail categories of the family size. However, the results are interpreted from only five broad categories, v.i.z., (i) very small family size (1 person in the family), (ii) the small size (1 – 4 persons), (iii) medium size (4-8 persons), (iv) large size (8-10 persons) and (v) the very large family size (above 10.00 persons).

Results and Description:

(i) Generally, the gardens are concentrated within the categories of medium family size (4-8 persons per family) in all the zones except the areas of flood plains where more than

80% gardens are concentrated in the low family size (1-3 persons) categories. It is observed that the garden categories of smaller families have higher percentage share of labour force and *vice-versa*. As family size increases, the non-workers population increases and, consequently, the percentage of labour force in these family sizes become lesser. It diminishes the labour share of the population residing in these gardens.

(ii) On account of available high population pressure in the gardens having large-size families, the share of child labour seems higher from 1.0 to 3.00 percents in all the cases of different agro-ecological zones (Table-4.9).

(iii) The social amenities are observed poor in these gardens of large family size. For example, one toilet serves two families of 6 persons in the gardens of Central Plain areas. Similarly, one doctor in the hospital serves more than 2000 population of these gardens of large family size in the Central Plains and even more than 2500 persons in the gardens of large family size in Flood plains.

(iv) It has been found that the school strength in these gardens show poor educational facilities. There are fewer schools with large students, which indicate poor available services and *vice-versa*. The schools of these gardens of high family size have large student strength as the 250 students per school in Foothill areas and Flood Plains and the 100 students per school in the Central Plains. Likewise, near about 50 students are served by one teacher in the study area. Thus, teacher-pupil ratio is very high in these gardens specially in foothill areas of the valley.

Table-4.9: Socio-Economic Characteristics of Tea Gardens by Family Size.

Agro-ecological Zones	Family Size (Persons)	Frequency	Family Size	Registered Area (ha)	Labour (total)	Population Density (P/h)	Child Labour (%)	Houses Per Toilet	Population per Bed	Population per Doctor	Students Per School	Students per Teacher
A. Foot-hill Zone												
	Class											
	0.00-0.99	9	0.82	444.33	723.44	2.69	0.91	1.53	5.21	664.39	77.33	39.57
	1.00-1.99	39	1.41	502.82	622.00	2.50	1.08	1.94	3.41	782.65	34.76	37.43
	2.00-2.99	15	2.41	486.27	838.13	2.89	1.16	2.11	9.04	1397.73	66.47	41.47
	3.00-3.99	5	3.41	208.80	112.00	1.22	2.72	1.99	14.50	15.00	17.60	17.60
	4.00-4.99	6	4.41	439.17	649.67	3.94	1.37	2.82	22.17	1255.83	116.83	50.86
	5.00-5.99	5	5.50	573.60	899.00	4.33	1.92	3.46	44.41	2350.20	54.77	34.10
	6.00-6.99	2	6.52	458.50	629.00	6.77	1.78	2.21	92.30	3112.50	294.00	73.50
	7.00-7.99	1	7.66	921.00	878.00	4.51	1.94	0.87	48.26	0.00	368.00	92.00
	8.00-8.99	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9.00-9.99	1	9.26	16.00	50.00	11.00	0.00	9.67	0.00	0.00	0.00	0.00
	10.00-above	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Average	83	3.76	368.22	491.02	3.62	1.17	2.42	21.75	878.03	98.34	35.14
B. Central plain Zone												
	Class											
	0.00-0.99	17	0.73	475.35	788.88	2.64	3.79	4.41	0.09	944.33	74.22	41.33
	1.00-1.99	82	1.47	370.70	574.97	2.95	3.76	3.19	0.12	706.68	72.45	37.54
	2.00-2.99	46	2.34	413.00	484.96	2.41	2.16	2.39	0.13	761.79	57.04	30.08
	3.00-3.99	19	3.48	494.53	707.11	3.27	2.00	2.72	0.04	1393.00	97.35	35.33
	4.00-4.99	12	4.55	453.58	516.75	3.46	2.93	3.94	0.11	1320.64	97.58	43.82
	5.00-5.99	20	5.39	597.15	724.30	3.87	3.28	2.74	0.13	2056.85	122.86	54.08
	6.00-6.99	11	6.53	322.27	427.27	4.14	3.87	2.34	0.19	1440.27	99.18	36.95
	7.00-7.99	7	7.36	362.14	438.43	5.28	0.96	4.26	0.09	1488.71	124.71	47.52
	8.00-8.99	2	8.59	121.50	216.50	5.03	12.08	1.56	0.05	0.00	46.50	46.50
	9.00-9.99	1	9.00	616.00	740.00	4.68	0.00	0.72	0.05	2880.00	280.00	93.33
	10.00-above	1	16.37	150.00	129.00	22.26	3.88	17.33	0.50	0.00	300.00	75.00
	Average	218	5.98	397.84	522.09	5.45	3.53	4.15	0.14	1181.30	124.72	49.25
C. Flood plain Zone												
	Class											
	0.00-0.99	16	0.74	402.50	540.94	2.26	4.36	3.76	0.06	683.73	74.50	37.32
	1.00-1.99	81	1.47	410.91	650.44	2.60	3.04	2.38	0.14	687.02	65.35	33.03
	2.00-2.99	23	2.42	392.74	573.13	3.09	1.15	3.33	0.12	678.23	67.95	30.12
	3.00-3.99	8	3.21	275.13	239.13	3.11	2.26	2.38	0.23	173.13	45.50	24.25
	4.00-4.99	4	4.59	826.75	1256.00	4.48	2.88	2.53	0.02	3001.75	309.25	83.88
	5.00-5.99	1	5.96	312.00	439.00	6.30	1.59	0.81	0.08	1966.00	264.00	32.00
	6.00-6.99	3	6.36	492.33	446.33	1.73	0.14	7.22	0.34	0.00	43.00	17.20
	7.00-7.99	3	7.46	645.33	774.00	6.58	2.04	2.05	0.04	3655.33	160.17	65.61
	8.00-8.99	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9.00-9.99	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10.00-above	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Average	139	2.93	341.61	447.18	2.74	1.59	2.22	0.09	985.93	93.61	38.49

Concluding Remarks:

Consideration of five controlled variables of socio-economic attributes of tea gardens, namely, the areal size of garden (as indicator of heterogeneity versus homogeneity of natural conditions), the land and labour productivity, that are related to the physiographic conditions, and socio-economic conditions of labour, the population density as demographic indicator of population and the family size as social unit prevailing in the gardens – provides the basis of assessment of socio-economic characteristics of the gardens in relation to their population status, availability of work force and its dominance, fluctuation in the levels of tea productivity and available infrastructure and social facilities. Infact, it can be concluded in this chapter that the gardens of low land productivity have higher concentration of population as well as bigger labour size with the prevalence of large garden families and the more engagement of child labour. The infrastructure is poor and social amenities are insufficient in these gardens. The land productivity decreases as the garden size increases because of heterogeneous physiographic conditions of garden land. On the other hand, labour productivity is influenced by factors related to demographic conditions of population residing in the gardens and labour intensity. The gardens having high density of population occupy larger labour sizes with poor infrastructure in all the agro-ecological zones in the Upper Brahmaputra valley.

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Chapter-V

Tea Production and Productivity

1.0 Introduction:

Productivity is a relative term. It refers to the production with respect to production factors. The amount that is produced and the work, money etc. that is needed to produce it (Longman dictionary, 1992). Usually this ratio is in the form of an average, expressing the total output of some category of goods divided by the total input. For example, in present case, tea production in relation to land, labour and capital as the factors of production. The measurement of production with respect to its each factor is made separately which indicates the relative importance of one factor over the other. In general, productivity of a certain combined inputs to determine the productivity of labour and capital together, or the productivity of all factors combined shows a production function (Kudrik, 1961).

2.0 Measurement of Agricultural Productivity:

(a) The Land Productivity:

Land productivity refers to the agricultural output per unit of cultivated area that is the result of physical characteristics, socio-economic set up and application of modern agricultural technological attributes of the area/region (Singh, 1994). It is also an indicator of comparative rate of change among industries and products. Growth, in general, can be better understood if the relative contribution of individual industry and

the circumstances underlying productivity changes in each of these industries are understood. These circumstances together with expanding opportunities for trade have enabled some countries to overcome in substantial degree of handicaps of a meager agricultural endowment (Fabricant, 1942). The land productivity also indicates the impact of physiographic conditions of land with human responses to increase agricultural/tea production. It interprets agricultural production pattern in relation to agro-ecological conditions. It is dependent on the quality of the soil, extent of irrigation facilities favourable availabilities of natural conditions like rainfall, climate etc. It also depends on the efforts in incoming agricultural inputs and infrastructure. Differences in natural endowment can be narrowed down by human efforts, but it is not possible to eliminate them completely. Land productivity has, thus, simply been measured here dividing total tea production by its cultivated area.

(b) The Labour Productivity:

Labour Productivity is essentially a sensitive indicator of economizing process and is one of the main measurements used to chart an industry's economic advancements. Infact, labour is by far the commonest of the factors used in measuring productivity. The reason for this is the relatively large share of labour costs in the value of most products. A second reason is that labour input is measured more easily than certain others, such as capital. The emphasis on labour as an input is the fact that, historically, technological advancement has made itself felt through the displacement of labour – that is through increase in the 'labour productivity' – rather than through the displacement of other factors. Some kinds of labour productivity measures are, thus, valuable indicators of this

process and of the resulting improvements in man's material well being (Chumpeter 1947). An overall rise in a nation's labour productivity signifies the potential availability of a larger quantity of goods and services per worker than before and accordingly a potential for higher real income per worker. As Singh (1994) observes that labour productivity refers to the agricultural output per agricultural worker, which reflects the standard of living of agricultural workers, the effect of absolute use of agricultural force and the degree of labour absorption capacity of agricultural sector.

The socio-economic characteristics of tea gardens have been discussed in the preceding chapter in which it is concluded that land and labour productivities have a greater impact on the socio-economic status on the people, who solely depend on tea cultivation and production activities. In order to analyze the production processes and socio-economic conditions of the tea labourers, these two aspects of tea production are important to interpret, because:

(i) The land productivity is an indicator of the physical factors of land under which tea is produced. The physical size of the land occupied by the different activities, associated with tea cultivation, the scale of garden's economy and the quantity and quality of labour required for. Larger the garden size, greater is the heterogeneity in physical conditions of land (drainage, soil, micro relief and climate), which influences the scale of tea production (Visser, 1999). But on the other hand, such gardens of larger size have common infrastructure for tea production and also common social amenities for the people living in the gardens. The sizable gardens may only maintain an optimal limit of production due to the prevalence of dis-economies in garden size which have been

interpreted in the preceding chapter as a characteristic feature of tea gardens. It would be used as influencing factor of land productivity in present discussion.

(ii) The labour productivity, which shows relationship between tea production and labour employed for the purpose, is an important attribute of agricultural productivity. This attribute is interdependent. The socio-economic conditions of labour are very much dependant on the production processes. It reflects not only standard of living but also the performance and prospects of tea production of a particular garden. It means the families living in the garden contribute labour to accelerate the production process on one hand, and on the other hand, if the production increases, the labourers get more benefit from it.

Keeping all these aspects in mind, a detail study on tea production and productivity analysis of these attributes of different agro-ecological zones of the Upper Brahmaputra valley is persuaded here.

3.0 Methods Used

In fact, land productivity (i.e., production per unit of cultivated land) can be studied by classifying the gardens on the basis of different agro-ecological conditions as studied in the chapter-III. A zone wise comparison of land productivity would provide the basis of physical conditions of land in broader way. However, a detail interpretation of production increases with soil and climate in various garden sizes is required to justify the priorities of physical constraints and the factorial influences on tea growth. The procedure used for collection of data for the same is given below.

(i) **Selection of experimental gardens for environmental impact assessment on tea leaf growth:**

Two experimental tea gardens have been chosen from two different agro-ecological conditions and seven day experiment is conducted to collect the data of climatic elements namely temperature and rainfall, and on the other hand, the length and perimeter of the tea leaves to get the optimal level of leaf growth in a specific soil condition. The result of such experiment would provide the basis of leaf growth in relation to physical factors. The selected gardens are:

- (a) the Joboka Tea Estate which is located in the Foothill zone in Sibsagar district, and
- (b) the Dikom Tea Estate, which represents the Central Plain Zone and is located in Dibrugarh district.

(ii) **Selection of tea gardens for productivity assessment:**

A scientific explanation of land as well as labour productivity and distribution of tea production have been forwarded by conducting a detail survey on five gardens from each agro-ecological zone. The statistics regarding application of fertilizers and machineries on one hand and the demographic structures of households like family size, skilled and unskilled labourers and so on have been collected through preparing questionnaire/schedule for selected households.

The following bases were adapted for selection of sample gardens:

- (1) the size of the gardens,
- (2) the location of gardens with respect to distance from the town,
- (3) level of ground water table, and
- (4) use of fertilizers and machineries.

The second part of sampling design is to select the households. The selection of ten households from each garden is based on the following criteria:

- (1) the family size,
- (2) the age group,
- (3) the skilled and unskilled labourers, and
- (4) the occupations of the household (outdoor and indoor).

Collected statistics are used to justify the results for the analysis of land and labour productivities of tea gardens under different agro-ecological conditions. However, garden-wise collected data of tea production and production factors are also used to test the validity of these facts.

4.0 Distribution of Land Productivity:

The land productivity is studied by considering the areal size of the gardens, as garden size provides the micro-physiographic land conditions of garden to explain the variations in production and productivity levels. However, the physical environment of tea plant growth in each agro-ecological zones in the present context is equally important.

Therefore, the distributions of tea production and land productivity are analysed by interpreting productivity results at two levels of the physical conditions of land, namely, (a) the meso areal level, i.e., agro-ecological zone and (b) the micro-areal level, i.e., the garden size.

For the same, a size-wise classification of land productivity has been made for the various agro-ecological zones of Upper Brahmaputra valley. The salient features of the distributional pattern have been shown by 'bi-variety frequency distribution' of land productivity. The fact is also supported by the data collected through the sample survey. The main features of distribution are given below:

4.1 (a) Distribution of Tea Production: The production figures of tea in various agro-ecological zones show some interesting results as given below:

- (i) More than 86% tea gardens fall under the category of low to very low land productivity (below 5000 kg/ha) in all the agro-ecological zones. The dominance of low productivity gardens keeps over all productivity level low.
- (ii) The categories of high and very high land productivity (above 7500 kg/ha) are found along the National Highway No.37, especially in the southern 'Built up' zone of the valley (Fig.-5.1).

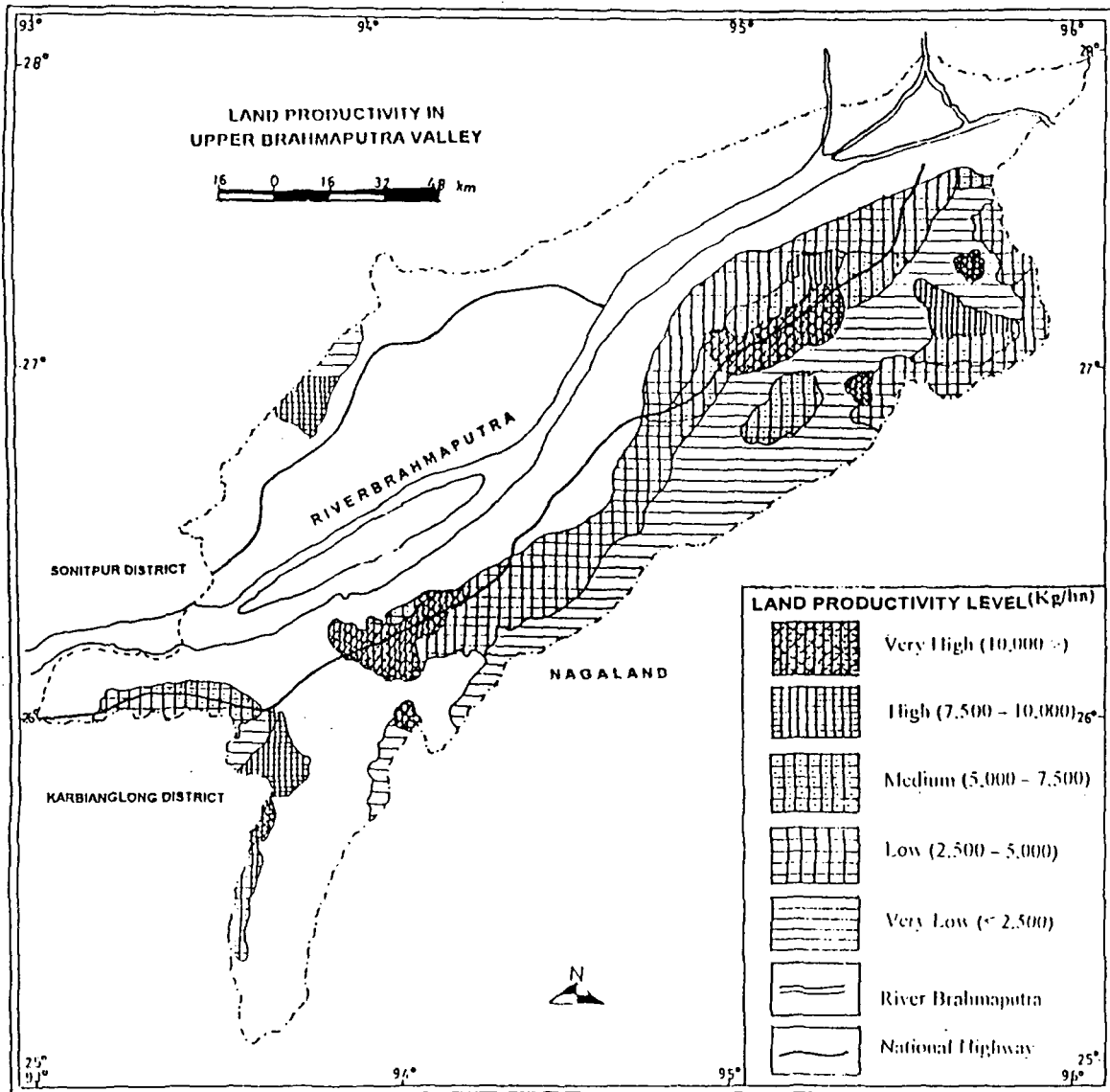


Fig.-5.1: Spatial Pattern of Land Productivity.

(iii) The amount of tea production is also unevenly distributed in the productivity categories of gardens of different agro-ecological zones. About 64% of the total volume of production is accounted for in the category of very low area land productivity (0-2500 kg/ha) areas of almost all the agro-ecological areas. The very high category of land productivity of tea (above 10,000 kg/ha) contributes only 7.6% of the total volume of production (Table-5.1, Fig.-5.2).

Table 5.1: Distribution of Total Tea Production in the Gardens of Different Productivity Level in Various Agro-Ecological zones.

Land Productivity (Kg/ha)	Foot Hill Zone			Central Plain Zone			Flood Plain Zone		
	Number of Tea Gardens	Production (Kg)	(%)	Number of Tea Gardens	Production (Kg)	(%)	Number of Tea Gardens	Production (Kg)	(%)
Very Low (Very Low) 0-2500	65	33824269	74.38	142	76495006	57.49	92	49149384	60.29
Low (Low) 2500-5000	9	7825025	17.21	41	38020588	28.57	30	18763799	23.03
Medium (Medium) 5000-7500	1	99872	0.22	7	3329768	2.50	5	2355584	2.89
High (High) 7500-10000	4	2162756	4.76	13	5982962	4.50	3	1058397	1.29
Very High (Very High) 10000-Above	4	1561058	3.43	15	9234847	6.94	9	10192061	12.50
Total	83	45472980	100.00	218	133063171	100	139	81519225	100.00

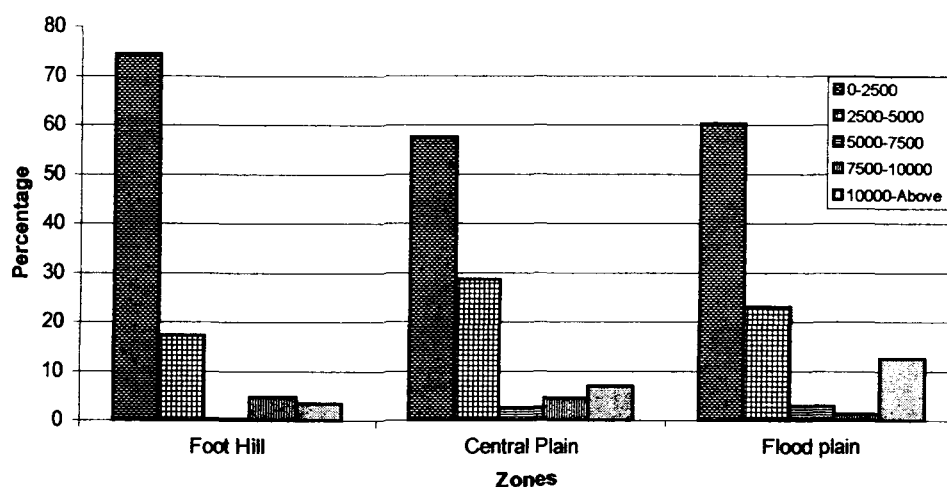


Fig.5.2: Tea Production in Different Productivity Categories.

4.1 (b) Nature of Bi-variate Frequency Distribution: The distribution of gardens of different land productivity in relation to various areal sizes explains a few interesting results (Table-5.2):

Table-5.2: Bi-variate Distribution of Tea Gardens: Land Productivity Vs Garden Size.

A. Foot Hill Zone		Garden Size (ha)				
Categories Land Productivity (Kg/ha)	Very Small (0-300)	Small (300-600)	Medium (600-900)	Large (900 above)	Total	
Very Low 0-2500	30	18	8	8	64	
Low 2500-5000	5	3	2	0	10	
Medium 5000-7500	1	0	0	0	1	
High 7500-10000	4	0	0	0	4	
Very High Above 10000	4	0	0	0	4	
Total	44	21	10	8	83	
B. Central Plain Zone		Garden Size (ha)				
Categories Land Productivity (Kg/ha)	Very Small (0-300)	Small (300-600)	Medium (600-900)	Large (900 above)	Total	
Very Low 0-2500	55	45	22	20	142	
Low 2500-5000	20	8	7	6	41	
Medium 5000-7500	5	1	0	0	6	
High 7500-10000	13	0	0	0	13	
Very High Above 10000	16	0	0	0	16	
Total	109	54	29	26	218	
C. Flood Plain Zone		Garden Size (ha)				
Categories Land Productivity (Kg/ha)	Very Small (0-300)	Small (300-600)	Medium (600-900)	Large (900 above)	Total	
Very Low 0-2500	32	28	16	12	88	
Low 2500-5000	16	11	2	1	30	
Medium 5000-7500	4	1	0	0	5	
High 7500-10000	2	0	0	0	2	
Very High Above 10000	12	0	2	0	14	
Total	66	40	20	13	139	

It seems there is imbalance in the bi-variate frequency distribution in all cases of different agro-ecological zones. As there are 20 cells (5x4) in each distribution, the average frequency of tea garden should be 4 gardens (83/20) in each cell of the distribution in the Foot Hill Zone, 7 gardens (139/20) for Flood plain Zone and 11 gardens (218/20) for the Central Plain Zone. A half of the cells of each distribution

belonging to down right part of it do not contribute even 1% frequencies of garden to the total. It indicates the gardens varying from small to large sizes belonging to low and very low categories of land productivity. It is surprising to note that the two-third gardens of very small size (30 out of 43) of the Foot Hill Zone have very low land productivity. It also true for the Central as well as Flood Plain Zones. It shows the concentration of garden frequencies towards the low productivity classes. In fact, small size gardens have low land productivity level. But it does not mean that the large size gardens have high land productivity (Fig.-5.3). Therefore, there is a weak relationship among them. However, it is noticed that (i) the medium and large size gardens have low productivity in all agro-ecological conditions and (ii) a few small size gardens have better production performances and comes under high and very high category of land productivity. It is observed from the tables that the large size gardens may be attributed to micro-relief features, like streams, embankments, ponds, marshy and barren lands and patches of poor land which reduces the share of land under tea. However, the general physical conditions of land for the growth of tea are favourable in such gardens (Table-5.3).

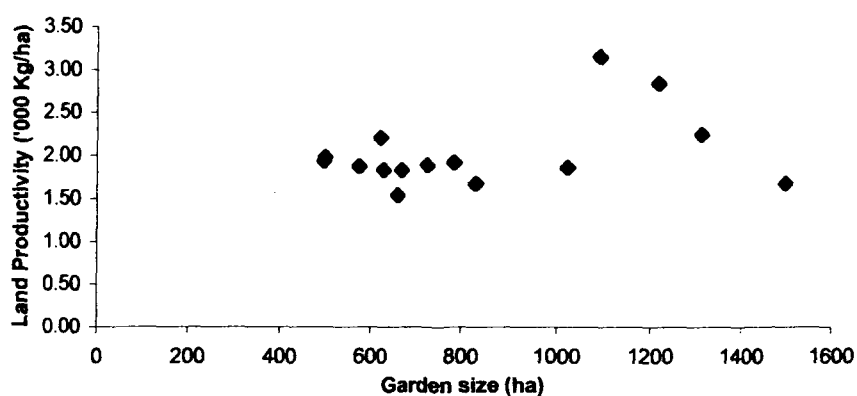


Fig.5.3: Land Productivity Vs Garden Size.

Table-5.3 : Garden Size, Production and General Land use in Sample Gardens.

Zones	Sl. No.	Size of the garden (ha)	Production of green leaves (000' Kg)	Production of processed tea (000' Kg)	Land under tea (in %)	Barren Land (in %)	Land under road / water / settlement	Land Productivity (000' Kg / per ha)
A. Foot Hill								
	1	786	5500	1400	93.00	1.65	5.35	1.92
	2	576	4500	1000	92.70	2.00	5.30	1.87
	3	831	4000	1200	86.50	1.80	11.70	1.67
	4	630	4000	1000	86.83	2.38	10.79	1.83
	5	623	5000	1100	80.26	4.83	14.91	2.20
Average		689	4600	1140	87.86	2.53	9.61	1.90
B. Central Plain								
	1	1091	7500	2500	72.96	5.68	21.36	3.14
	2	662	3200	900	88.15	4.38	7.47	1.54
	3	1216	9500	2400	69.81	10.28	19.91	2.83
	4	1500	6500	1800	71.27	13.33	15.40	1.67
	5	671	3400	1100	89.41	0.75	9.84	1.83
Average		1028	6020	1740	78.32	6.88	14.80	2.20
C. Flood Plain								
	1	1022	5500	1300	68.30	3.52	28.18	1.86
	2	1312	7500	1700	57.86	3.05	39.09	2.24
	3	497	5000	800	83.30	2.41	14.29	1.93
	4	728	6000	1300	94.23	2.06	3.71	1.89
	5	500	4000	900	90.80	2.00	7.20	1.98
Average		812	5600	1200	78.90	2.61	18.49	1.98

4.1 (c) Physical Conditions of Land and Tea Leaf Growth: There have been a number of studies, which show that the productivity of land is definitely related to the physical conditions of land. There is a direct affect of soil and climate on the growth of tealeaf, which ultimately gives rise to the production. An experiment has been conducted by selecting two tea estates namely, Joboka Tea Estate from Foot Hill Zone and Dikom from Central Plain as the selection procedure has been discussed in detail in preceeding parts of the present discussion. The daily data of temperature and rainfall are collected on one hand and at the same time, the area, length and perimeter of tealeaf have been measured

to relate the growth of tealeaf with climate while soil conditions are assumed as constant. The analysis of the tea leaf growth in relation to temperature and rainfall is given as below:

- (i) The leaf samples, which have been collected from the Foot Hill and Central plain respectively, show that the daily distribution of rainfall is not uniform. It varies from zone to zone widely. In the agro-ecological conditions of Foot Hill areas, the average rainfall in the last week of July 2001 was recorded 0.79 mm per day whereas it was about 6.5 mm per day in the Central Plain environment of the Upper Brahmaputra valley. Such significant differences in rainfall per day in study area may be because of orographic effects on micro-relief levels as well as of the topography.
- (ii) The table reveals that the average length and perimeter of tea leaf are 4.11 cm and 9.74 cm respectively in the Foot Hill Zone, which is comparatively smaller than the zone, namely Central Plain where the average length and perimeter is about 5.11 cm and 11.8 cm respectively (Table-5.4 a & b).
- (iii) There is slower growth of tealeaf in less rain as observed from the experiment. The leaf growth is observed 4.11 sq cm/day in the Foot Hills when rainfall occurred only .79 cm/day (Table-5.4a). In the rainfall of 6.5 mm/day in Central Plains, the growth was 7.98 sq cm/day. It means rain has its direct effect on the tealeaf growth.

As far as the soil conditions are concerned, the soil of Foot Hill Zone is much subjected to leaching processes. The areas of Foot Hill Zone have the soils belonging to the salty clay loam and silty loam classes. The intensive leaching which continues under

humid conditions, wash away the chemical properties like lime, magnesium and silica by percolating water, affects the proper growth of roots and, accordingly, the growth of leaf. On the other hand, the soils of Central Plain Zone, formed by older alluvium are very much suitable for root development and likely to be more conducive for rapid percolation and consequently good root growth (Soil Survey, 1967). In this zone, the growth of tealeaf is relatively faster (Table 5.4 a & b, Fig.-5.4 a & b).

Table 5.4(a) Growth of Tea Leaf in Foot Hill Zone.

Date	Temperature (0 C)	Rainfall (mm)	Leaf Area (Sq. cm)	Leaf Length (cms)	Leaf Perimeter (cm)
20.06.2001	32.00	2.50	0.64	2.00	5.00
21.06.2001	31.00	0.30	1.61	2.50	6.00
22.06.2001	32.00	0.00	2.80	3.00	7.60
23.06.2001	32.00	2.70	3.50	4.00	8.80
24.06.2001	33.00	0.00	4.30	4.60	10.00
25.06.2001	31.00	0.00	8.80	5.30	12.80
26.06.2001	29.00	0.00	14.15	7.40	18.00
Average	31.43	0.79	5.11	4.11	9.74

Source: Joboka Tea Estate, Sibsagar, Assam.

Table 5.4(b) Growth of Tea Leaf in Central Plain Zone.

Date	Temperature (0 C)	Rainfall (mm)	Leaf Area (Sq. cm)	Leaf Length (cms)	Leaf Perimeter (cm)
20.06.2001	29.20	10.80	0.51	2.10	6.00
21.06.2001	28.80	5.50	3.14	3.50	8.00
22.06.2001	29.10	3.50	4.84	4.40	10.00
23.06.2001	29.20	12.00	6.83	5.10	12.00
24.06.2001	30.30	10.00	8.00	5.50	12.80
25.06.2001	30.50	2.30	12.71	6.80	14.00
26.06.2001	28.80	1.30	19.81	8.40	20.00
Average	29.41	6.49	7.98	5.11	11.83

Source: TRA Meterology Department, Dikom Tea Estate, Dibrugarh, Assam.

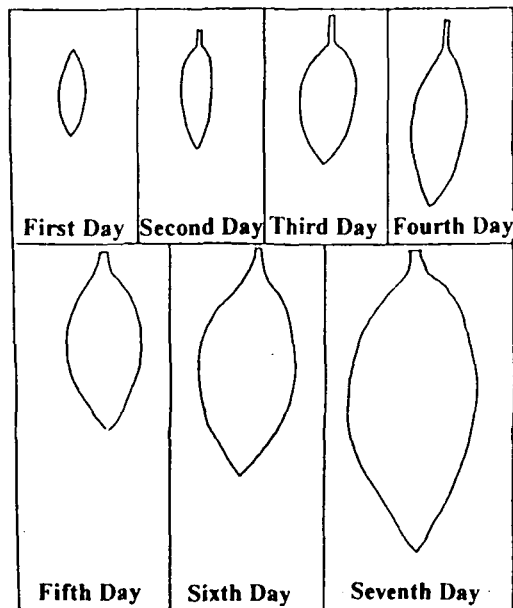


Fig.5.4 (a): Growth of Tea Leaf in Foot Hill Zone.

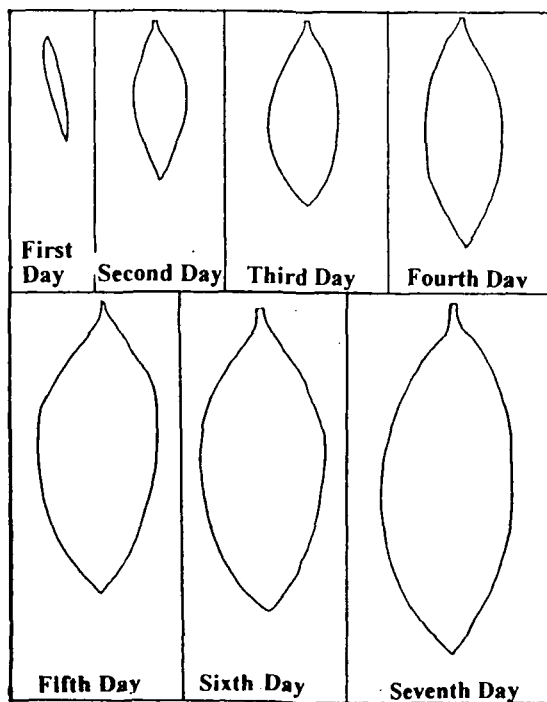


Fig.5.4 (b): Growth of Tea Leaf in Central Plain Zone.

4.2 Level of Ground Water and Productivity of Tea:

Productivity of tea depends to a great extent on a number of hydrological factors of which the availability of ground water is also one of them. But it should be noted that the ground water itself is less meaningful if other physical conditions like the altitude and slope, temperature and rainfall, soil, etc. are in consonant with the requirements of tea. Since the upper part of the Brahmaputra valley of Assam is characterized by congenial ecological conditions for tea, the impact of ground water on productivity of tea is seen to be less influential than other hydrological factors. For instance, the average ground water table of the Flood Plain belt of the valley remains below 10 m (summer seasons), while in the Central Plain and the Foot Hill Zones, the levels are below 18 m and 28 m respectively. But the productivity of land of these zones stand at 1.98 thousand kg/ha, 2.21 thousand kg/ha and 1.90 thousand kg/h respectively. This indicates that each zone characterized by the availability at ground water at lower depth is being characterized by the lower land productivity and *vice-versa*. There are wide variations in the levels of water table from season to season (Table-5.5) and from zone to zone and that kind of variations are not uncommon in a region dominated by varying water yielding capabilities of aquifers and in the depth at which adequate supply of water can be reached (Cantor, 1967). In spite of having varying ground water level of Foot Hill and Flood Plain zones, the level of production remains almost same, 1.90 thousand kg/h and 1.98 thousand kg/h respectively. Contrary to it, the 'built up' zone with water table at 18 m reflect highest land productivity (2.21 kg/h) among the zones. Thus, the more availability

of ground water is not very much influential in determining the productivity of tea in the study area.

Table-5.5: Level of Ground Water and Productivity of Land.

Garden Samples	Ground Water (metre)		Land Productivity (ooo'kg/ha)
	Winter	Summer	
(A) Foot Hill Zone			
1	40	28.0	1.92
2	45	42.0	1.87
3	40	28.0	1.67
4	40	28.0	1.83
5	40	28.0	2.20
Average	41	30.8	1.90
(B) Central Plain Zone			
1	25	18	3.14
2	25	18	1.54
3	25	18	2.83
4	25	18	1.67
5	25	18	1.83
Average	25	18	2.21
(C) Flood Plain Zone			
1	10	10	1.86
2	10	10	2.24
3	10	10	1.93
4	10	10	1.89
5	10	10	1.98
Average	10	10	1.98

Source: Self Surveyed.

4.3 Effects of Fertilizer, Chemicals and Machines: Besides the physical factors of land, the technological factors also play important role in the cultivation of the tea and influence the level of tea production. It includes the use of fertilizer and the machines used in the cultivation and processing of tea. Obviously the tealeaf has to undergo several physical and chemical changes before it is placed for consumption. It requires the provision of specially constructed buildings and machineries (Borah, 1993). Tea passes through different processing namely withering, rolling, fermentation, drying, shifting and

grading under close and strict provisions. The use of different kinds of fertilizers and machines in the different ecological zones are presented (Table-5.6).

Table-5.6: Use of Chemical fertilizers and Machines.

Zones	Sample No. (Kg / ha)	Urea (Kg / ha)	MoP (Kg / ha)	Rock Phosphate (Kg / ha)	Total	Machinery Used (no./ha)	Land Productivity (000' kg/ha)
A. Foot Hill							
	1	160	140	100	133	0.09	1.92
	2	240	100	110	150	0.05	1.87
	3	210	90	80	127	0.05	1.67
	4	370	110	100	193	0.06	1.83
	5	340	160	130	210	0.10	2.20
	Average	264	120	104	163	0.07	1.90
B. Central Plain							
	1	350	160	160	223	0.12	3.14
	2	170	90	90	117	0.07	1.54
	3	350	180	170	200	0.11	2.83
	4	380	190	160	177	0.09	1.67
	5	140	110	130	127	0.08	1.83
	Average	278	146	142	169	0.09	2.20
C. Flood Plain							
	1	430	210	140	260	0.13	1.86
	2	390	136	130	219	0.09	2.24
	3	240	90	90	140	0.07	1.93
	4	310	150	150	203	0.10	1.89
	5	330	130	120	193	0.10	1.98
	Average	340	143	126	203	0.10	1.98

The following conclusions can be drawn from the above given table as well as from the Scatter Diagram (Fig.-5.5):

- (1) There is a positive relationship between land productivity and use of fertilizer in tea cultivation. It means when use of fertilizers is intensified, the production per ha increases in almost all areas of different agro-ecological conditions.
- (2) The urea is used more intensively in Flood Plains (340 kg/ha annually) rather than in Foot Hills (264 kg/ha). While MoP and Rock Phosphate are used more in the

Central Plain area (146 kg/ha and 142 kg/ha) which have positive effects on the tea yield.

(3) The highest land productivity of tea is found in the Central Plain zone, which is about 2.20 thousand kg/ha because of the use of fertilizers like MoP and Rock Phosphate.

(4) The lower level of tea productivity of land in Flood Plain zone is attributed not because of the use of fertilizer but because of the seasonal floods at the peak of the manufacturing season. The low productivity in the Foot Hill areas is attributed mainly because it is much vulnerable to the attack of pests and weeds, as these gardens are surrounded by forests.

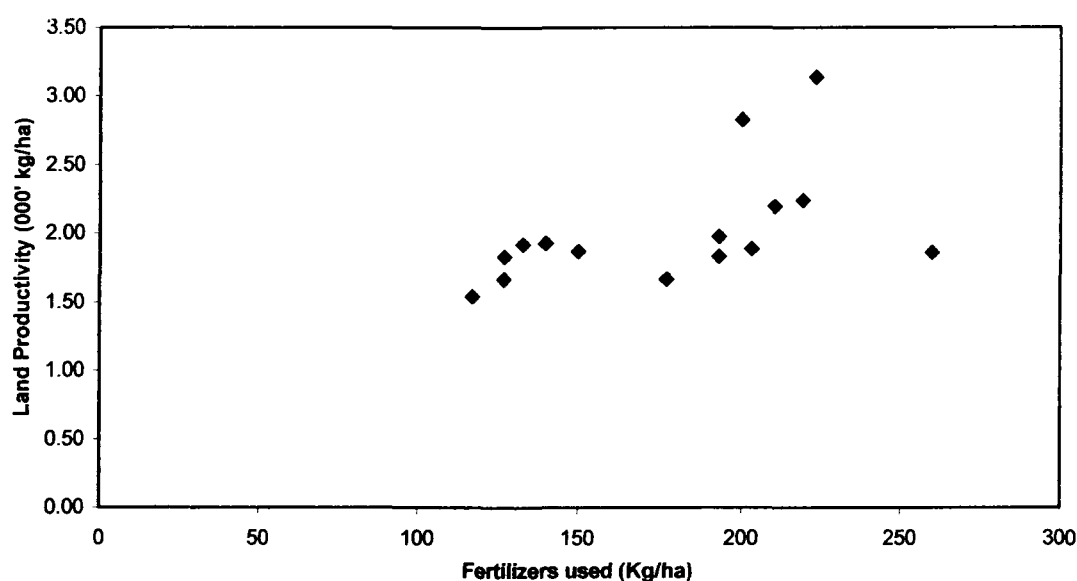


Fig.5.5: Land Productivity and Fertilizers-Machines Used.

So far as the use of machines for both cultivation and processing of tea is concerned, same picture can be observed from the Table-5.6. It is found that the machines per hectare are used intensively in the Flood Plain zone than other zones. It is interesting to note that in comparison to other two zones the use of fertilizers and machines are intensively used in Flood Plain Zone, but the land productivity is low in this zone because of natural flood hazards.

5.0 Distribution of Labour Productivity:

Tea, being a labour intensive cultivation, depends significantly on the use of labour input. So far as the level of labour productivity is concerned, it seems to vary from garden to garden and also from zone to zone. The variations are the reflection of the pressure of labour on tea production and viability of tea under unlimited supply of labour to tea gardens. Infact, labour productivity in tea cultivation is more influenced by labour employed (Kudrik 1961). Thus, there are three major aspects of labour productivity which are to be described in the present context.

5.1 (a) The Spatial Pattern: Since labour productivity is a negative function of labour intensity, the increasing labour pressure in the tea gardens decreases labour productivity. As a result, labour productivity is recorded very low (below 2500 kg/person) in the entire area of the Upper Brahmaputra valley except a few patches, which may be visualized along with the National Highway (Fig.-5.6).

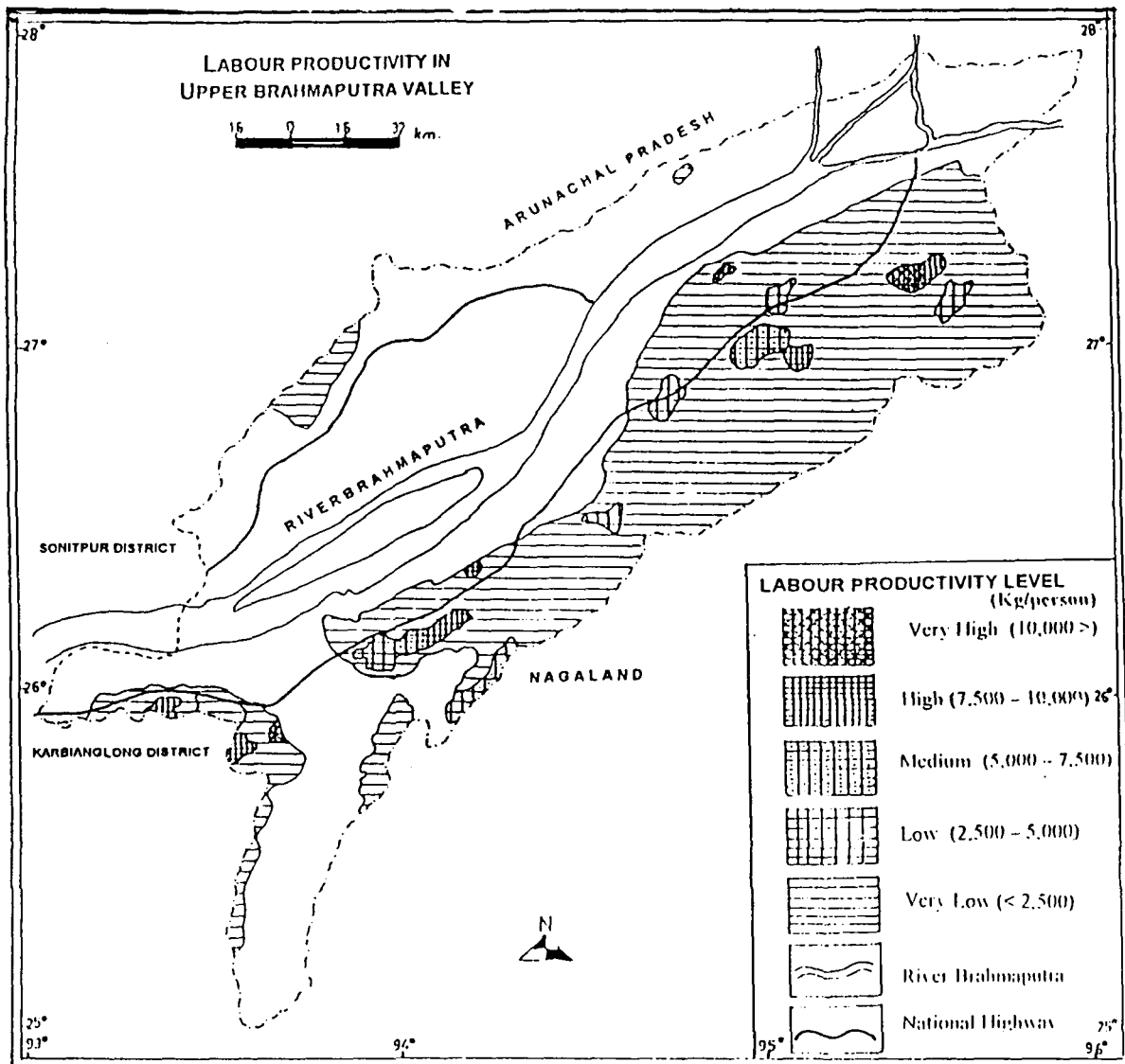


Fig.5.6: Distributional Pattern of Labour Productivity.

5.1 (b) Labour Productivity versus Labour Intensity: The bivariate frequency distribution of tea gardens with reference to labour productivity versus labour intensity of different agro-ecological conditions show some interesting results of inter and intra-zonal variations of labour productivity (Table-5.7). In Foot-Hill Zone, the concentration of tea gardens is noticed in the very low category of labour productivity where labour intensity is recorded low to medium (1-3 persons/ha). The same relationship may be seen in the Flood Plain Zone of the Upper Brahmaputra Valley. However, more dispersion in the distribution may be visualized in the central plain areas with a few gardens, which fall under the category of high productivity but low to medium labour intensity.

Table-5.7: Bi-variate Frequency Distribution - Labour Productivity Vs Labour Intensity.**A. Foot Hill Zone**

Categories	Labour Productivity (Kg/person)	Labour Intensity (Person/ha)					Total
		Very Low (0-1)	Low (1-2)	Medium (2-3)	High (3-4)	Very High (4 above)	
Very Low	0-2500	7	28	26	6	4	71
Low	2500-5000	4	1	1	0	0	6
Medium	5000-7500	0	3	0	0	0	3
High	7500-10000	1	2	0	0	0	3
Very High	Above 10000	0	0	0	0	0	0
Total		12	34	27	6	4	83

B. Central Plain Zone

Categories	Labour Productivity (Kg/person)	Labour Intensity (Person/ha)					Total
		Very Low (0-1)	Low (1-2)	Medium (2-3)	High (3-4)	Very High (4 above)	
Very Low	0-2500	11	68	63	24	11	177
Low	2500-5000	3	5	4	1	2	15
Medium	5000-7500	5	3	1	0	1	10
High	7500-10000	2	5	2	0	0	9
Very High	Above 10000	5	2	0	0	0	7
Total		26	83	70	25	14	218

C. Flood Plain Zone

Categories	Labour Productivity (Kg/person)	Labour Intensity (Person/ha)					Total
		Very Low (0-1)	Low (1-2)	Medium (2-3)	High (3-4)	Very High (4 above)	
Very Low	0-2500	8	35	45	17	4	109
Low	2500-5000	11	6	1	1	2	21
Medium	5000-7500	0	2	2	0	0	4
High	7500-10000	0	2	0	0	0	2
Very High	Above 10000	3	0	0	0	0	3
Total		22	45	48	18	6	139

The field survey data of 15 sample tea gardens, which are shown by scatter diagram also confirms the same fact of negative relationship (Fig.-5.7). The areas of high labour intensity have low level of labour productivity and *vice-versa*. There may be many causes of such negative relationship like the use of more unskilled and child labour, inefficient use of labour force, the proper substitution of machine for available labour and

so on. However, the details of skilled labour employed in the tea cultivation practices may be given here to support these facts.

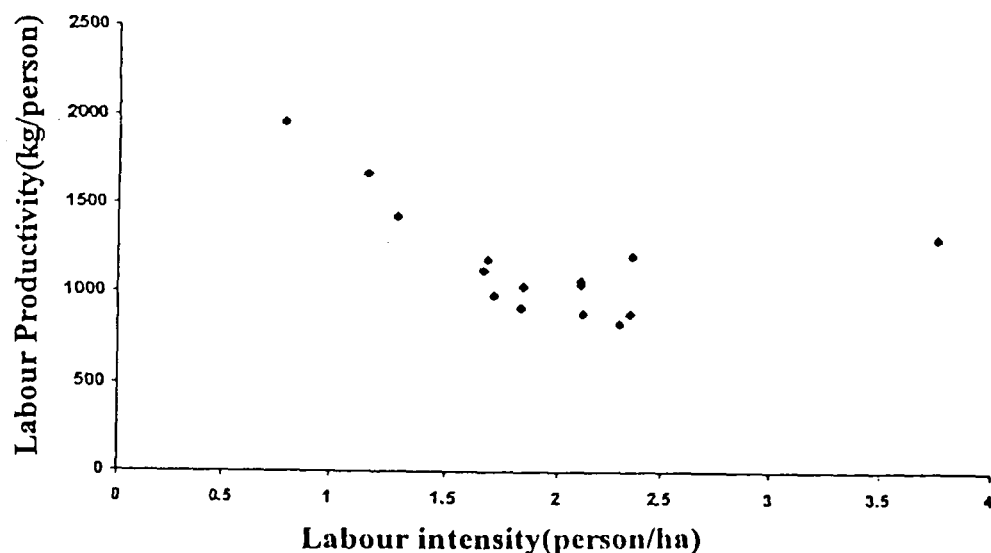


Fig.5.7: Labour Productivity Vs Labour Intensity.

5.1 (c) The Skilled-Unskilled Labour Distribution: The labour quality, which has been defined here by classifying labour into two: the skilled workers (who have higher technical and educational level) and the unskilled labourers only literates upto Total Literacy Campaign (TLC), is main factors for variations in the level of labour productivity. The (Table-5.8) reveals that high labour productivity is because of the employment of higher percentage share of skilled labour in all three agro-ecological zones. On account of employment of higher share of unskilled workers in tea gardens of different areas that is 86.77% in Foot Hill Zone, 85.16% in Flood Plains and 79.73% in Central Plains, the labour productivity of tea gardens is recorded very low (960 kg/person) in Foot Hill areas, low (1290 kg/person) in Flood plains and medium (1360 kg/person) in the central parts of Upper Brahmaputra Valley.

Table-5.8: Skilled-Unskilled Labourers and Labour Productivity.

Zones	Sample No.	Skilled Labour (Per / ha)	(%)	Unskilled Labour (Per / ha)	(%)	Labour Total	Labour Productivity (000' Kg / per)
A. Foot Hill							
	1	0.20	10.98	1.64	89.02	1348	1.03
	2	0.25	11.74	1.87	88.26	1133	0.88
	3	0.32	18.69	1.39	81.30	1230	0.98
	4	0.23	9.72	2.30	88.34	1286	0.88
	5	0.28	13.07	1.82	86.93	1056	1.04
	Average	0.26	12.84	1.80	86.77	1211	0.96
B. Central Plain							
	1	1.34	12.49	2.41	87.51	2194	1.30
	2	1.96	27.23	0.57	72.77	459	1.96
	3	1.20	15.00	2.00	85.00	2000	1.20
	4	0.91	24.08	1.39	75.97	1976	0.91
	5	1.42	22.58	1.00	77.42	775	1.41
	Average	1.37	20.28	1.47	79.73	1481	1.36
C. Flood Plain							
	1	1.12	21.51	1.31	78.48	1162	1.12
	2	1.15	15.89	1.77	84.11	1598	1.06
	3	1.66	14.69	0.99	85.30	483	1.66
	4	0.82	12.67	2.00	87.33	1578	0.82
	5	1.18	9.44	1.52	90.56	763	1.81
	Average	1.19	14.84	1.52	85.16	1117	1.29

Concluding Remarks:

The physical factors of land, especially the quality of soils, rainfall and temperature conditions have the positive affect on the growth of tea plant. Uses of fertilizer and modern machine, though it has not been used intensively in the present case, are major technological determinants to increase the tea production and raise land productivity in tea cultivation. Employment of unskilled labour influences negatively the over all level of labour productivity. However, unskilled labour may only be confined to only a few activities of the gardens like plucking, pruning, weeding and so on.

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Chapter-VI

Conclusion and Findings

1.0 Introduction:

Tea is a 'location specific', 'labour intensive' and highly remunerative and systematic form of cultivation. It is location specific in the sense that it is being cultivated in specific agro-ecological conditions. Therefore, the impact of agro-ecological conditions on the production and productivity of tea is very much significant. It is also labour intensive in the sense that each and every stage of tea cultivation and production requires constant vigil on the part of human labour so that entire system runs smoothly without interruption. Intensity of labour input depends on the availability of labour, which again comes from the pressure of population. Moreover, tea is a systematic form of agriculture, because, there exists a sequence of its cultivation from the field to the processing in the factory and each stage is followed by other stages. It is in this background that the present work has been undertaken by considering the upper Brahmaputra Valley of Assam as an area domain of investigation. This is one of the important tea-producing regions; not only in the state but also of the country and more significantly the region has a history of being first in the context of both cultivation and commercial production. This region is by far, the single largest tea-producing region in the country, which is considered to be the 'Home of Indian Tea Plant'. However, tea cultivation occupies only 1.79% of the total area of the state. Primary sector dominates

the state's economy that has been growing at a moderate rate. Despite of increasing tea production of the state from its very low level of Rs.120.00 crores in 1953-54 to Rs.3381.00 crores in 1998-99, its share in GDP has been declining gradually. It shows that the contribution of tea in the state's economy is declining.

With low prices and increasing cost of production, the tea industry is witnessing significant losses. Domestic demand has been stagnating and India's position in the world markets is under severe pressure. Declining exports and increasing costs of production exert immense pressure on prices, leading continued loss in profitability and loss in foreign exchange. These problems have immediate bearings on the socio-economic impact in tea gardens. Therefore, it is necessary for the tea industries to immediately adopt sustainable and low cost developmental strategy for improving production and productivity.

2.0: The Study Area:

The Upper Brahmaputra Valley as a single physiographic unit covers an area of about 35% of the total geographical area of the state. It is bounded by the Eastern Himalaya on the north-east, Nagaland on the south and Sunitpur, Nowgaon and Karbi Anglong districts on the west. Its longitudinal and latitudinal extent stretches from 89° 70' to 96° 0' E and 25° 12' to 28° 0' N respectively. The valley bears a transitional characteristic from geographical point of view. Owing to its specific location within the Eastern loop of the Eastern Himalaya, where dry and desertic conditions should have

been prevailed (as most of the deserts are located in the same latitudinal extent), but, due to its physiographic and climatic conditions, the valley remains humid.

On the basis of these criteria, the Upper Brahmaputra Valley has been divided into three broad agro-ecological zones, namely the Foot Hill zone, the Central Plain zone and the Flood Plain zone.

The Foot Hill zone lies along the Himalayan foothills on the north as well as the Naga Hills, which lies on the southern part of the Brahmaputra plains. This zone is approximately 8 to 10 km broad, characterized by '*Bhabar*' and '*Tarai*' conditions with higher terraces. The aggregate sizes of the soil particles are comparatively larger with more porosity.

The Central zone is also referred as '*Built-Up*' zone. This zone is characterized by older alluvium and lies between the Foot Hill zone and the Flood Plain zone on the both sides of the river Brahmaputra.

The Flood Plain zone is formed by new alluvium with low-lying areas, situated along both sides of river Brahmaputra. On account of heavy floods, the soil particles are observed very small. The silty loam and coarse sandy soils can be noticed in this zone.

3.0: Findings:

After a detailed investigation of the production and productivity pattern against the backdrop of physical as well as socio-economic characteristics of tea gardens, the following facts have been derived:

3.1: Physiographic Attributes and Tea Production:

While examining agro-ecological conditions, more specifically, the impact of climatic elements, (temperature, rainfall, humidity, evaporation and sunshine) on the productivity of tea in the study area, the following facts have been derived as:

(i) The fluctuations of climatic factors over time shows that rainfall has the most fluctuating tendency (cv = 87.72%) in the valley followed by evaporation (cv = 34.60%) due to monsoon characteristics of climate. However, annual temperature does not vary much, ranging from 22.60°C (1985) to a maximum of 24.20°C (1994). Sunshine is fluctuating significantly. However, it has a great impact on yield.

(ii) The correlation matrix of these elements reveals that rainfall and evaporation, as the main elements of climate, are highly and positively correlated with temperature, while sunshine is negatively related with rainfall ($r = -0.5997$). It indicates that, during the rainy season, the atmosphere becomes cloudier and, consequently, there is no sunshine. However, higher degree of radiation can be observed during the monsoon period. As a result, the gardens are having 'shadow trees'. The temperature ranging between 23°C and 25°C, rainfall between 200 and 250 mm with 5 to 6 hours of daily available sunshine, are the most suitable climatic conditions for the growth of tea in the valley.

(iii) The regression analysis of these climatic elements (considered as independent variables) with tea yield (dependent variable) shows interestingly that these five climatic elements have an overall effect of 20.11% to the total growth of tea production. Out of the total, the effect of temperature is calculated as 3.35% and that of evaporation is

11.09%. The analysis shows that evaporation is the most determining factor of tea yield rather than sunshine and relative humidity. Undoubtedly, evaporation is controlled by temperature and rainfall. Therefore, all the three elements of climate (Temperature, Rainfall and Evaporation) have a significant effect of 16.77% out of total 20.11%.

3.2: After examining the characteristics of soil of different agro-ecological zones of the study area and their relationship with the cultivation of tea, the following facts have been emerged:

(i) There are areal variations in the textural properties of the soils. For instance, the coarse sand is dominant in the flood plains ranging from its 80 to 92% in the aggregate size particles in the soils. It is followed by old alluvium ranging from 84 to 89% in the 'Built-up' area of central parts and then the foothill areas where coarse sand varies from 63.5% to 73.1% in the soil aggregate composition.

(ii) It is noticed, that the aggregate size of top soil particles of below 1 mm diameter are dominant in the new alluvial soils of Flood Plain and in the adjacent areas of Central Plain of old alluvium. Bigger size of soil particles above 5 mm diameter are recorded very less in the soils of old alluvial and sub-montane Foot Hill soils. It is found that the particles of topsoil are moderate in its size (2-5 mm diameter) and account for about one-third soil particles in almost all type of soils in the study area. It shows that the infiltration rate is lesser in the Flood Plain because of dominance of coarse sand (size of soil particles below 1.0 mm diameter) and higher in foothill zone of sub-montane where bigger soil particles constitute the composition of soil texture.

(iii) So far as the chemical properties of the soil are concerned, it reveals that the soil of the valley is highly acidic in nature, as the pH value ranges from 3 to 5. The highest pH value is recorded in the old alluvial, which is 4.7 followed by Foot Hill soil with 4.5. In the Flood Plain soil, it is 3.9. However, soils are rich in calcium and magnesium, especially in the Flood Plain and Central Plain areas due to lesser effect of leaching. The C/M ratio is normal in these plains with 15 and 13 respectively. The content of phosphorous penta-oxide (P_2O_5) is recorded high with the moderate quantity of potassium dioxide (K_2O) in the soils of foothill areas. Presence of high organic carbon in the soil indicates suitability for tea cultivation. The Central Plain has a balance distribution of all the soil minerals. So it shows, that central part of the alluvial plain provides most suited soil for tea cultivation.

(iv) Land productivity is noticed very high (5394 kg/ha) in the fertile soil conditions of Central Plain where pH is recorded 4.7 with suitable organic carbon contents in the soil. The soil conditions of Flood Plain of new alluvium are also favourable for tea production. Hence, the land productivity is marked moderate (5033 kg/ha) in these areas.

3.3: The soil and climatic conditions of land are the major driving factors of tea production and level of productivity. The favourable land conditions prevail in the 'Built-Up' areas of Central Plain with old alluvial deposits, where about 49.5% of the total gardens have been accounted for. The moderate conditions of land are prevailing in the Flood Plain of new alluvial deposits, where 31.6% gardens are located. While the number of gardens are registered about 84 in number (i.e. 18.8%) only in the Foot Hill zone.

4.0: Socio-economic Characteristics:

In order to examine the socio-economic characteristics of gardens in the light of the selected parameters (namely garden size, land and labour productivity, population density and family size), the following facts have been drawn:

4.1: Considering farm size as determinant, it has been observed that:

- (i) Population density is recorded higher (as 4-5 persons per ha) in the medium size gardens (400-800 ha) in all the agro-ecological zones.
- (ii) The higher percentage of child labour, i.e. more than 3% to the total work force, is prevalent in the smaller-size gardens (200-400 ha) of the Foot Hill areas and medium to large- size (400-1000ha) gardens of the Flood Plain. It shows that the gardens of Flood Plain areas employ more percentage share of child labour. It is because of prevalence of illiteracy, poverty and high population pressure in the frequent flood areas.
- (iii) Pressure on hospitals and schools are recorded very high in the large and very large size of tea gardens in all the agro-ecological zones. It shows that the social amenities are poor in larger gardens.
- (iv) So far as economic characteristics of tea gardens are concerned, it is found, that land as well as labour productivity vary significantly in different agro-ecological zones. However, the levels of land as well as labour productivity are recorded very high (above 2000 kg/ha and even 2000 kg/person) in the small size of gardens (below 200 kg/ha) generally in all types of agro-ecological conditions. The level of land and labour productivity diminish as garden size increases. This decrease is recorded faster at smaller size gardens and *vice-versa*. It reveals that heterogeneous natural conditions of the larger

gardens negatively influence the land productivity, while the large amount of labourers and high population density in the larger gardens tend to decrease the labour productivity in all the agro-ecological zones of the Upper Brahmaputra valley.

4.2: Examining socio-economic characteristics in relation to land productivity, it has been noticed that the land productivity is influenced not only by the conditions of land, but also the size of the gardens where a variety of land conditions prevail. Larger-size gardens have heterogeneity of land conditions and the smaller-size gardens are more homogeneous in their natural conditions, and consequently, they do not have much diverse conditions of economics of production scales.

(i) The size-wise distribution of gardens shows that the highest concentration of small to very small size of gardens (below 400 ha) is noticed in the central plains, where agro-ecological conditions are characterized with alluvium soils. Most of the gardens have low levels of productivity (below 3000 kg/ha) in these areas. The relationship between garden size and land productivity is found negative ($r = -0.7376$) throughout the study period. The average productivity level is recorded very low (2153 kg/ha) in the Foot Hill zone.

(ii) A major share of total tea production is contributed by the low productivity of small size gardens, which are characterized as the gardens of high concentration of population which supplies unlimited labour including the child-labour to the production processes with poor social amenities and low wage rates to the labourers. Within each agro-ecological zone, the 75 gardens out of total 84 (i.e., nearly 88.2%) fall under the category of low to very low levels of land productivity (0-4000 kg/ha) in Foot Hill zone, the 183 gardens out of 218 (i.e., 83.9%) in the same category of land productivity in Central

Plains and the 115 gardens out of 139 (i.e., 82.7%) in the Flood Plains. Therefore, the concentration of gardens is towards low to very low levels of land productivity and the major amount of tea production comes from these categories of low productivity levels. It means that the economy of tea production has been resting upon the low level of productivity in the gardens.

4.3: Considering socio-economic characteristics with respect to labour productivity, it is observed that the labour intensity does not vary much in different agro-ecological zones. However, high pressure of population and available labour force diminish the level of labour productivity in the gardens. Tea cultivation being labour intensive still has traditional method of tea processing. Main findings of socio-economic characteristics of the gardens in the light of labour productivity are summarized below.

(i) An average labour productivity level is recorded 4516 kg/person in the tea gardens of the study area. It varies areally according to the variations in agro-ecological conditions of gardens. The Central Plains of old alluvial has the highest level of labour productivity (5815 kg/person of labour force) while the Flood Plain of new alluvial soil has the productivity level very close to its average (4522 kg/person). The lowest labour productivity is observed in the Foot Hill zone. The labour intensity in the Central Plain is recorded much lower. On account of low labour intensity and favourable physical conditions of land, the labour productivity appears to be higher in this zone.

(ii) There is a large concentration of gardens (i.e., 87%) towards the categories of low to very low labour productivity (3000 kg/person) where population density is much higher.

There is an unlimited pressure of labour supply, which diminish the level of labour productivity in the gardens.

(iii) It is found that the higher percentage of child labour (upto 4.5%) is employed in tea practices in the low labour productivity gardens of the Foot Hill zone. The population density is also recorded very high (350 persons/sq km) in these gardens of Flood Plain areas. The higher the population density, greater is the supply of more labour force to the garden. On account of high population density in the gardens of Flood Plain, the population pressure is greater due to the supply of more labour to the tea cultivation at lower wage rate, even some times, the supply of child labor also.

(iv) Labour productivity is a negative function of labour intensity. Areas of low labour intensity, found along the main line of communication, have high levels of labour productivity. On the other hand, the remote areas, where the transport and communication facilities are poor, have low level of labour productivity with high labour intensity. In the gardens of Foot Hill zone, the labour productivity is recorded low. The labour productivity is relatively higher in Central Plain zone with a few gardens having high labour productivity.

(v) The quality of labour is one of the parameters, which has been correlated with labour productivity. Low labour productivity in the Foot Hill as well as Flood Plain zones are observed because there is a greater share of unskilled labourers which increases the labour intensity.

In the end, it is observed that tea production of the gardens is labour dominated, supplied by the heavily loaded demographic expansion with high population density and

poor availability of poor social amenities. The concentration of labour force with its high population density and higher supply of child labour has been noticed in the gardens of low labour productivity. It shows that population pressure (i.e., indication of higher labour intensity) influences the socio-economic status of labour and declines the level of labour productivity in the Upper Brahmaputra Valley.

4.4: After observing socio-economic attributes in relation with the population density, the following findings have been drawn.

(i) Generally, more than a half of the numbers of gardens falls under the category of low population density (below 3 persons/ha) in almost all the agro-ecological zones. However, the population is more concentrated in the gardens of medium population density (4.00-8.00 persons/ha).

(ii) The family size and the population density are positively related to each other. It means, bigger the size (4 to 8 persons/family), higher is the population density with more share of child labour in the gardens of Upper Brahmaputra Valley.

4.5: More characteristic features in the context of family size are given below.

(i) The medium size families (4 to 6 persons/family) dominate in the gardens of Foot Hills and Central Plain zones. However, more than 80% gardens fall under the category of small family size (1 to 3 persons). It is a fact, that bigger families have higher percentage share of labour force. As family size increases, it increases more non-working population, especially child labour, as it is a primary stage of growth. It indicates, that the gardens of larger family size have high population concentration with high density, of which most of them are non-working population. It establishes the fact that the labour

size in the bigger families with higher share of child labour (1–3%) noticed in all the agro-ecological zones.

(ii) Social amenities, like sanitation and medical facilities, are not proportionate to the family size. For example, one toilet serves two families of 6 persons in the gardens of Central Plain areas. Similarly, one doctor serves more than 2000 persons in the Central Plain and even more than 2500 persons in the gardens of Flood Plain. It means that the facilities are very poor in these gardens.

5.0: While Examining the productivity pattern in various agro-ecological zones the following facts have been emerged.

(i) There is low to very low level of land productivity (below 5000 kg/ha) in all the agro-ecological zones. About 86% of the tea gardens fall under these categories of low land productivity.

(ii) The areas of high and very high land productivity (above 7500 kg/ha) are located along the National High Way, especially in the southern Central Plain zone.

(iii) The amount of tea production is not uniformly distributed in the various productivity categories of gardens in the different agro-ecological zones. About 64% of the total volume of production comes from very low land productivity (0-2500 kg/ha) categories of almost all the agro-ecological zones. The very high category of land productivity (above 10,000 kg/ha) contributes only 7.6% of the total volume of production.

5.1: The nature of bi-variate frequency distribution (Land productivity vs. Garden size) reveals that there is imbalance in the average frequency distribution of tea gardens in the

different agro-ecological zones. The following facts have been observed from the distribution:

- (i) The medium and large size gardens have low land productivity in all agro-ecological zones.
- (ii) A few small size gardens come under high and very high level of land productivity.

5.2: Physical Conditions of Land and Tea Leaf Growth:

There is direct effect of soil and climatic conditions on the growth of tealeaf in the different agro-ecological zones. The experiment on the growth of tealeaf of Foot Hill zone and Central Plain shows the following results. In the Foot Hill zone, the average rainfall, during the experimental period, (20.6.2001-26.6.2001) was recorded 0.79 mm per day, where as it was 6.5 mm per day in the Central Plain zone. Such significant differences in rainfall have a great impact on the leaf growth of a particular zone.

As far as the soil conditions are concerned, the Foot Hill zone is very much subjected to leaching processes. The intensive leaching, which continues in humid conditions, wash away the chemical properties of the soil which directly affect the proper growth of the roots and, accordingly, the growth of leaf. On the other hand, the soils of Central Plain zone formed by older alluvium, are very much suitable for root development and likely to be rapid percolation. Consequently, it appears a better root and leaf growth of tea plants.

- (i) The average length and perimeter of tealeaves are 4.11 cm and 9.74 cm respectively in the Foot Hill zone, which is comparatively smaller than the zone, namely Central Plain where the average length and perimeter is about 5.11 cm and 11.8 cm respectively.

(ii) There is slower growth of tealeaf in less rain as observed from the experiment. The leaf growth is 4.11 sq cm/day in the Foot Hill when rainfall is recorded only 0.79 cm/day. In Central Plain, where rainfall is recorded 6.5 mm/day, the growth was 7.98 sq cm/day. It shows a direct affect of rain on the tealeaf growth.

5.3: Ground Water and Productivity of Tea:

Though the upper part of the Brahmaputra Valley is characterized by congenial agro-ecological conditions for tea cultivation, the impact of ground water on productivity of tea appeared to be less influential as the roots of tea plants do not grow much below the soil surface.

5.4: Effects of Fertilizers and Machines:

Besides the physical and socio-economic factors, the technological factors also play an important role in the cultivation and production of tea. The following observations are made from the present study:

(i) There is a positive relationship between land productivity and use of fertilizers. The urea is used intensively in Flood Plain zone (340 kg/ha annually) rather than in Foot Hill (264 kg/ha), while MoP (Mauriate of Potash) and Rock Phosphates are used more in Central Plain zone (146 kg/ha and 142 kg/ha) respectively. As a result, the highest land productivity is found in this particular zone, which is about 2.20 thousand kg/ha.

(ii) The lower level of tea productivity in Flood Plain zone is attributed to seasonal floods at the peak of manufacturing seasons. In the Foot Hill zone, it is due to high vulnerability to the attack of pests and weeds being surrounded by forests.

(iii) It is noted, that though the machineries and the fertilizers are more intensively used in Flood Plain zone as compared to the other two zones, the land productivity is low due to natural flood hazards.

In the end, it can be said that the distributional patterns of land productivity as well as labour productivity of the tea gardens are not only the function of physical factors of land alone, but also concentration of population density and unlimited supply of labour, which is also attributed to the productivity level. In all type of agro-ecological conditions, the small size gardens employ more labour force, including child labour. High concentrations of population with low literacy and medical facilities also have negative impact on the level of labour productivity in these gardens.

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Appendix

North-Eastern Hill University, Shillong
Spatial Variation in Productivity of Tea Gardens
in Upper Brahmaputra Valley,
Assam

Field Schedule

1. Identification of Tea Estate/Ecological Zone
Name of Tea Estate.....Block.....Dist,....., connected with pucca road or remote location.....distance (km).....Nearest town.....Distance.....
2. Size of Tea Estate.....
3. Age of Tea Bushes (in years).....
4. Tea Activities (tick out): (i) Plantation & Plucking (ii) Plantation and Processing
Name and Distance (in kms).....
5. General Land Use:
 - (i) Land under tea bushestotal (ha)%
 - (ii) Under Barren.....
 - (iii) Under Drainage.....
 - (iv) Under Road and Water
 - (v) Under Settlements and factory.....
 - (vi) Others (specify).....
6. Irrigated Area (in ha)....., Types of irrigation....., means of irrigation.....
7. Drainage conditions:
 - (i) Excellent
 - (ii) Very Good
 - (iii) Good
 - (iv) Bad
 - (v) Very Bad
8. Ground water table (in m):
 - (i) In winter(Dec-Jan)
 - (ii) In summer.....(April-May)

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(iii) Rainy season.....(July-Aug)

9. Total Production (in kgs):

- (i) Green Tea
- (ii) Processed Tea.....

10. Selling price in the estate (in Rs/kg).....

11. Use of Fertilizers:

- (a) Manure (in annually).....
- (b) Chemical fertilizers (total in qu).....
- (c) Type of fertilizers.....

12. Machines used:

- (a) For plantation Number of tractors.....small equipment.....others.....
- (b) For processing: machine/driers.....total costs.....life of machine (in years).....

13. Labour employment:

- (a) No. of house holds/families living in the estate.....
- (b) Total families of labour class (unskilled workers).....
- (c) Total families of skilled workers (engineers, administration).....
- (d) Number of school: Primary, Secondary.....
- (e) Means of entertainment: Number of Radio.....Number of TV.....
- (f) Number of hospital/dispensaries in the estate
- (g) Post office.....yes/no, (distance).....

House Hold Schedule (Selection of House hold from each estate)

Name of House holder:location of house.....electrified Y/N,
 Means of drinking water.....

Demographic Structures.

Family members / Relationship	Male / Female	Age	Educational Status	Year of Marriage	Occupation in Estate. Its nature	No. of working days	Daily wage in Rs	Problems