ABSTRACT

ON

POPULATION CHARACTERISTICS AND AGRICULTURAL DEVELOPMENT IN JORHAT DISTRICT, ASSAM

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1.0. Introduction:

Agricultural structure and subsequent development takes place due to the vast multiplicity of a number of interconnected biotic and abiotic components. Although all of them contribute for agricultural growth, yet they do not contribute equally in shaping the space-time variations of agricultural landscape. Hence, it is desirable to observe the dominant factors that may be decisive in conditioning the regional structure of agriculture. But the ranking of the factors according to the level of dominance over agricultural activities is a complex exercise requiring detail systematic investigation. Notwithstanding this complexity, there are some convenient ways of categorizing factors according to the level of significance and these provide ideal grounds for geographers to carry out systematic investigation. But, most geographical investigation on agriculture till today have tended to emphasize more on the role of physical factors and the resultant agricultural structure. However, a few of the geographers have attempted to incorporate non-physical factors including biotechnological, infrastructure and institutional, etc. and studied agricultural structure very recently. But much lesser work has been done on the pattern of interrelationship between population and agriculture. Since population is a decisive force of conditioning agricultural system, the closure examination of the impact of this force in patterning land-use of a given locality is definitely imperative for theoretical understanding and practical solution of many agricultural problems.

In the background stated above, the present work has been designed to deal with these two vital issues and their interconnections. It is to be noted here that there is an existence of two divergent views relating the population-agriculture relationship. The first

view sees population as a dependent force on agriculture while the second seems to take an opposite stand seeing population as an independent force. Some traditional propositions including the Malthusian doctrine are in favour of the former stand stating that food supply is the limiting factor of population growth while agricultural development is the result of autonomous invention. It further states that food supply increases due to inventions, which are independent of population, change (Kulkarni 1981). The simple explanation is that if the supply of food increases, population will increase and a new equilibrium would be achieved between the two. In a sense, if population is less than the food supply, population will expand and if it is already beyond the level of subsistence, it itself will come down to reach an equilibrium through the positive check (Lekhi 1996, p.84). Cipolla (1962) have strengthened this stand by stating that the number of people has been regulated by the availability of food throughout the greater part of the human history.

Another group of scholars adopts an opposite stance seeing population as an independent force. Prominent among them is Boserup (1965) who categorically maintains the view that although the production-increasing inventions may occur independently, the adoption of new knowledge depends on population "push". She suggests that agricultural development is due to some kind of compulsion and this compulsion relates to rising trend of population. According to Boserup (1965), "where there is a population pressure, population does not go down. It rather leads to various technical and other changes which result in agricultural growth and increase in food supply". She has supported this contention through an examination of agricultural development of some African and Latin American countries She stated that the transition from the pre-agricultural stage to the

agricultural stage as well as in the subsequent developments in agriculture was an outcome of the population pressure (Kulkarni 1981). This statement has been supported by Clark (1967) who explained the entire course of human history in the context of population growth.

These two different stands can be said to be complementary rather than mutually exclusive. Simon (1977) says that the Malthusian stand refers to invention, which are relatively labour saving, while the population push stand taken by Boserup and Clark refers to inventions that are output increasing but require more labour as well. Although the universal applicability of these stands are not too strong, yet it is not uncommon to see that some cases in history are better explained by the first while others by the second stand (Kulkarni 1981, p.341). The present work has been centered around the second stand as propounded by Boserup. Here it has been accepted that population is an independent force and contributes significantly towards change in agricultural structure. There is also a logic behind the acceptance of the Boserupian statement. Clark and Haswell (1970) say that the change in agricultural methods is not exogenous, rather results from the population growth. In order to demonstrate that this proposition is true, rather than converse, namely that new agricultural methods are discovered, and that population growth is the consequence of these discoveries (Malthus' theorem), we have the convincing case that nearly all these changes call for much greater effort on the part of the cultivator, who therefore is most unlikely to adopt them until he is compelled to by rising population (Clark and Haswell 1970, p.55). Clarke's statement has further been strengthened the proposition made by Trewartha (1953) who considers population as the point of reference

from which all other elements are observed and derive meaning and significance. This discussion simply indicates multifarious role of population - agriculture relationship. It is a fact that population is a producer as well as a consumer. It has impact on demand as well as on supply. Demand, in a simple way, comes out from absolute number of population. It indicates that more people will need more agricultural commodities and, as such more supply would be indispensable which again would be derived by making higher output. Thus, the supply would be enlarged but this enlargement cannot be considered an autonomous process. It basically comes through the effect on various inputs; effect on the pattern of landuse, on the supply of labour, investment, techniques of cultivation, etc. These attributes of agriculture-related change have been made possible only by the attributes of population, namely, its number, density, literacy, age-sex composition of population, etc. In this context population is seen as a determining force and the entire change in agricultural structure can be said to be dependent on it.

At this juncture also the problem is not over. The basic issue is as to how and in what ways the various attributes of population could be correlated with the attributes of agricultural development. Since the entire set of elements are not possible to incorporate nor has any relevancy to include, the study has been deliberately restricted to examine the interrelationship between a few attributes of population (viz., size and distribution of population, population pressure, age-sex composition, literacy and education, household and family structure, labour, etc.) and a few indicators of agricultural development (viz., land and labour productivity, intensiveness in the use of input, cropping pattern , etc.). In

order to examine the relationship between these two sets of attributes, the Jorhat district of Assam has been taken up as a micro areal unit of investigation.

2.0. The Study Area:

Jorhat is a centrally located district in the upper part of the Brahmaputra valley. It covers an area of about 2851 sq. km. (or 3.64 % of the total geographical area of the state). It also supports more than 8 lakh people representing 3.89 percent of the state's total population. Agriculture is the principal occupation and more than 80 percent of the total population depends on it as a way of living. Around 60 percent of the total land is used for the cultivation of crops mainly paddy, both summer and winter. Existing population of the district releases sufficient number of labour force for the operation of agriculture. In order to examine the population- agriculture relationship, the district can be taken up as an ideal unit of investigation because the agro-ecological conditions of the district are congenial both for the production of crops and human occupation.

3.0. Objectives:

In the light of above discussions, the present work has been designed to fulfil the following objectives as:

i. to examine the structure of agriculture in Jorhat ,
ii. to analyze the characteristics of population in Jorhat,
iii. to correlate the attributes of population with the attributes of agriculture,
iv. to examine the effect of population factors on agricultural conditions, and
v. to suggest the development strategy of agriculture in the light of the population

4.0. Hypotheses:

The study is basically related to the impact of population characteristics on agricultural ɔnditions. Therefore, putting forward the Boserup view (1965) of positive effects of ɔpulation on agricultural practices and development under the conditions of high population ɛnsity, the following hypotheses have been formulated to test the validity of the facts taking ɔrhat as an empirical unit of investigation:

1. Under the conditions of abundant labour supply to the agricultural practices, the land productivity moves up with the decline of labour productivity.
2. Intensity of agricultural land use at a greater scale is emanating from the higher pressure of population.

4.1. Justification: In the context of the objectives and hypotheses stated above, the Jorhat district of Assam is considered to be a suitable micro areal unit to test the validity of the Boserupian view of population-agriculture nexus. Although the variation in respect of the climatic conditions of the area is not pronounced, yet the existing soil types and population pressure seem to vary according to the variations of the altitude and slope from the flood plain belt of the north to the hilly ranges of the south of the district. Accordingly, Therefore, from the agro-ecological point of view, the district has been divided in to four zones such as moderately steep to steep land, piedmont, built-up and flood plain zones and the population-agriculture relationship of each zone has been examined and analysed. The way the population attributes is related to the agricultural attributes in various agro-ecological zones could be expected to be an interesting correlative study in its spatial dimensions. This would be helpful not only in understanding the pattern of relationship between the population and agriculture, but also give a new insight in solving many

practical problems faced by the people of the state at large and the people of Jorhat area in particular.

5.0. Sample Design and Methodology:

Since the basic purpose of the present study is to examine the relationship between population and agriculture, the greater emphasis is therefore given on to the collection of data from the field through sample technique. Following stages have been involved in the process of collecting data from the field.

5.1. Selection of Villages as Samples: In order to select villages for detail investigation, the district has been divided in to four agro-ecological zones and each zone has been taken up as strata so that the population-agriculture nexus of each strata can be examined and analysed. Then, on the basis of population size of the villages, remotivity and their (village's) distance from the nearest market/urban centres, a total of 19 villages (3.15% of the total villages of Jorhat) has been selected as samples. It is to be noted here that there are 606 villages in Jorhat (2.44% of the total villages of Assam) as per 1991 census and out of this, 396 villages are located in the built-up zone (zone C) and 150 in the flood plain zone (zone D). In the moderately steep to steep land zones, i.e., in zones A and B, the number of villages are few, only 21 and 41 respectively from each zone. Therefore, the proportions of villages selected as samples from each zone stand at 9.52, 4.88, 2.52 and 3.33 percent respectively for zones A, B, C and D. Thus, the proportions of villages taken up as sample from each zone are larger than the proportion of villages of Jorhat to the total villages of Assam. As such, this could be expected to be meaningful in achieving the objectives stated above.

5.2. Selection of Sample Households: After selecting villages for sample survey, the attention has now been directed towards the selection of households for conducting detail investigation. In selecting households no statistical technique has been introduced, rather the personal judgement has been applied. To have representation from all categories of households, the outer structure of the houses (whether RCC construction, Assam Type or simple thatched and bamboo made houses) has been taken up for consideration assuming the house structure as the reflection of the economic status of the farmers. Applying this simple logic, a few households from each structure has been selected and the heads (or any other representative in absence of heads) of these selected households have been approached for certain relevant information already designed for the purpose. Altogether, 406 number of households has been surveyed which are around 10 percent of the total households of the selected sample villages. The number of households taken up as sample from zone A is 49(10.43% of the total households of the sample villages), zone B is 51(14.92 %), zone C is 205(7.50 %) and from zone D is 101(10.71 %).

5.3. Collection and Processing of Data: In order to collect data from the sample households, a household schedule containing all relevant aspects for the purpose has been prepared and this (schedule) has become the main tool for collecting data. With this simple but systematically prepared schedule, the heads of the households have been approached for face to face interview. After explaining the basic purpose of the inquiry to the respondents whenever required, the latter was asked certain questions from the schedule in the order the questions are listed and the replies are recorded in the space meant for the purpose. In this way, the entire information have been collected from the

sample households and then the collected information have been tabulated and processed with the help of using computer.

5.4. Other Sources of Data: Besides the primary data collected from the field through the household schedules, some secondary data have also been used in the present work. These are collected from different sources including various governmental and non-governmental publications. The Statistical Handbook published by the Government of Assam, Guwahati and other census publications are the main sources of secondary data. Some other information has been collected from various books, journals and other periodicals.

5.5. Methods Used: With a view to examine the relationship between the population and agricultural attributes of the study region, certain statistical techniques are used. First, a few population and agricultural attributes are taken up as determinants to analyze the characteristics and pattern of change in other attributes included in the present study. Second, a correlation matrix of X_1, Xn dimension has been prepared in order to examine the degree and nature of relationship among the attributes. Third, multiple regression analysis (Kothari 1996) has been applied to estimate the value of Y (dependent variables related to agricultural attributes) with respect to the value of X (independent variables related to population characteristics) with the help of following equation,

$$Y = a + b_1X_1 + \ldots + bnXn \quad \ldots \quad \ldots \quad \ldots \quad (1).$$

Besides these statistical techniques, some other cartographic techniques like graphs and bar diagrams, are used to supplement the relevant analysis. Maps are also used to depict the spatial pattern of variation of population-agricultural nexus.

6.0. Arrangement of Materials:

The materials of the present study have been arranged in a coherent manner to have a better access to the analysis. Accordingly, the first chapter of the work deals with the statement of the problem along with its basic objectives, hypotheses and relevant methods used for the collection of primary data from the field. The second chapter is devoted entirely for examining the agro-ecological conditions of the study area including its population and agricultural characteristics. The third chapter incorporates the review of literature related to the field of population and agricultural relationship and through this; it has been attempted to identify the gap going to be filled up by the present work. The fourth chapter includes the interpretation of primary data regarding the characteristics of population and agriculture of different agro-ecological zones identified for the present purpose. The fifth chapter includes primarily the examination of the pattern of relationship between population and agriculture under different agro-ecological setting. Finally, conclusions and suggestions are included in the last chapter.

7.0. Findings:

The basic thrust of the present work is centered on two important issues-population and agriculture. In a developing country like India with agriculture as the base of the economy, the coordination of these two issues is inseparable. But except a few areas of the western part of the country where green revolution is successful, the nexus between population and agriculture is not satisfactorily developed. Assam is no exception and for that matter, the district Jorhat is also in the same line. After a detailed examination of the population and agricultural relationship of the area, it has come to the

notice that the quantitative and qualitative dimensions of the district's population are yet to be utilized for the development of agriculture inspite of having its suitable agro-ecological conditions. The present study has revealed a number of interesting facts regarding the nexus between population and agriculture. These are given below;

1. The population of the district has been increasing at a rate 33.10 percent (1971-1991). Although low in comparison to other districts of Assam, yet the present rate is enough to lead for higher pressure of population on existing land resources (306 persons/km^2, higher than the state's average of 286/km^2). Unfortunately, the agricultural structure of the area remains traditional except a certain variations. This indicated by the low use of high yielding variety of seeds and fertilizer and lower productivity of crops. For instance, the average yield of all kinds of paddy in the area is only 1560 kg/ha compared to more than 2000kg/ha in other parts of the country. Thus, the area remains in poverty in the midst of plenty as far as the potentials for agricultural development are concerned.
2. While examined population and agricultural characteristics of the samples of four agro-ecological zones in the light of five determinants, viz., family size, population density, literacy rate, size of land holding and crop intensity, then a few interesting features have come in to the notice which are common for all ecological zones. These are:
    a. With the increase in the size of family, the dependency ratio and the proportion of labour to the total population are found to be increasing. This has resulted more use of labour input per hectare of land than required. Among the agricultural attributes, the size of land holding is seen to be increasing with the

increase of family size. The causes are apparent, i.e.; larger family size means more dependents and more labourers as the persons below 19 years of age are also the potential labourers for agricultural practices. Moreover, large families are the joint families and yet to divide their agricultural land among themselves and as such larger holding size is seen among these families;

b. With the increase in the density of population, the educational status (high school and above) and the supply of labour is becoming abundant. But land holding size and production per unit of labour declines significantly. Higher density means higher pressure of population on agricultural land and, therefore, labour intensity is more on agricultural land resulting lower per capita output;

c. With the increase in the share of literate persons (below lower primary level) in the households, family size is becoming larger. This is attributable to the fact that poor educational status has caused for a lack of awareness among the people relating the benefit of small family norm. Since the educational background is poor, labour productivity is also lower;

d. The effects of land holdings are seen over both land and labour productivities. Larger the size, higher is the volume of production and productivity. This signifies the fact that productivity is basically a function of the horizontal expansion of agriculture rather than the vertical expansion, indicating a traditional structure in the prevailing agriculture.

e. Changes in crop intensity is seen to be developing due to the pressure of population, but the changes are not perceptible and have no specific pattern to be identified.

3. Examining the relationship between population and agricultural attributes through correlation matrix, following facts have been derived;

   a. Regardless of the type of agro-ecological conditions, the density of population (i.e. pressure) has emerged as the most influential factor in determining the intensity of labour structure. This suggests that whenever the pressure of population is more, the supply of labour to the agricultural practices is also more in a situation where agriculture is the main occupation and employment opportunities other than agricultural sectors is extremely limited.

   b. As soon as supply of labour is more to the agricultural operation, the intensity of labour input per hectare of land is also more leading to a decline of per man production, i.e. labour productivity. This is what exactly happening in the study area.

   c. The hypothesis proposed "under the conditions of abundant labour supply, land productivity moves up with the decline of labour productivity" is only partially valid. Because, with the increasing use of labour input per hectare of agricultural land in various agro-ecological zones, the land productivity is not moving up as expected in the hypothesis (although the relationship is positive, it is not significant even at 95 percent confidence level), but labour productivity is declining significantly. Thus the second part of the hypothesis is valid in the study area.

   d. Regarding the second hypothesis that the "intensity of cropping at a greater scale is emanating from the higher density of population" is also not strongly applicable. Although both density and crop intensity is positively related in all

agro-ecological zones of the area, yet the relatiionship is not significant even at 95 percent level of confidence. It indicates that whatever the change in crop intensity is taking place, it is not due to the higher density of population alone but due to the other physical and non-physical factors.

4. Examining the role of population factors on the development of agriculture through multiple regression analysis, the following facts have been obtained;
   a. The multiple effects of population factors on land productivity in the hilly zones (moderately steep to steep land and piedmont zones) are found stronger than that of the plain zones (built up and flood plain zones). More than 50 percent of variations in land productivity of the hilly zones are explained by population factors alone and only less than 50 percent of variations are explained by the other factors.
   b. Similarly the multiple effects of population factors on labour productivity in the hilly zones are stronger than that of the plain zones already stated. More than 70 percent variations in labour productivity are explained by population factors in the hilly zones while in the plain zones, less than 40 percent variations in labour productivity are explained by population factors.
   c. In determining crop intensity, population factors are again found to be playing significant role and more than 50 percent of variations in crop intensity in the hilly zones are being explained by population factors. In the plain zones, it is less than 40 percent and thus the role of other factors are seen to be more prominent (more than 60 percent).
5. The study has confirmed that the population and agricultural attributes are

interrelated. But depending on the nature of agro-ecological conditions, the degree of relationship tends to vary as reflected by the four agro-ecological zones of the area. Similarly, the impact of population factors on agricultural development also depends on the type of agro-ecological conditions. More suitable ecological setting means lesser effort of man, as the environment is easier to utilize and opposite is the case when environment is comparatively difficult.

8.0. Suggestions:

The present work reflects not only the population-agriculture nexus under different agro-ecological settings, but also reveals some interesting areas of research that a geographer can pursue to enrich the theoretical basis of the subject. In this context, the following suggestions can be made for conducting research in due course of time.

First, the distance factor can be incorporated in examining both the population and agriculture characteristics and also the variations of their relationship according to the variations of the distance either from the nearest nodal centres or from the main road. Distance is an important aspect in geography and it forms the basic dimension of space with considerable influence on the operation of the spatial system (Knowles et al.,1998). It is also stated that for the development of inherent agricultural potentialities, road accessibility is a dire needs (Singh and Dhillon, 1994, p. 173) which is determined by the distance both in time and cost perspectives. The fact is that with the increase of distance, the land use pattern tends to vary. Sandhu (1977) studied the variations in the intensity of sugar cane cultivation in the light of accessibility in Haryana. With a view to classify areas in the context of accessibility, the Chief Engineers (1958) recommendation (known as Nagpur Report) is seen to be relevant in Indian agricultural

context. It says that areas lying within 4 km from a transport point are treated as "fairly accessible", within 8 km as "simply accessible", but beyond 8 km as "inaccessible" and beyond 16 km as "highly inaccessible". The objectives of this classification is to see that in a highly developed agricultural area no village is more than 3 km away from a link road or more than 8 km away from a main road (Singh and Dhillon, 1994, p.173). In what ways the model is applicable in examining the agricultural structure of the state in general and Jorhat in particular is a vital question that the geographer of the region can answer for the betterment of the society.

Secondly, smaller and smaller areas can be taken up as a micro areal unit of investigation. The attributes of population and agriculture and their interconnection can be studied against the backdrop of the distance from the nearest urban centres located within the smaller regional unit. Thus a hierarchy in the regional system can be worked out which would be more meaningful in analyzing the spatial structure of agricultural activities in relation to the human population. In Jorhat, for instance, there are 223 villages in the Jorhat Thana itself over an area of 500 sq. km. Out of this total villages, 20 percent of villages lies within 8 km of distance, 50 percent lies within 8-16 km distance and 30 percent lies beyond 16 km distance from the Jorhat town (1991). How far these clusters of villages vary in terms of their population and agricultural characteristics and in what ways the distance factor contributing towards such variations, can be an interesting aspect for detail investigation. It will help in formulating models for planning and development of the area.

Thirdly, the study has also revealed that a large part of the population has been not properly utilized. This indicates that due to the abundant supply of labour to

the agricultural practices, there exists under utilization of labour input and the contribution of additional labourers to the production process is insignificant. Geographers have immense scope to formulate models that can give direction to the systematic use of the qualitative aspects of the population of the study area.

9.0. Conclusion:

Analyzing the present situation of population and agriculture of Jorhat, it can now be concluded that there is a need for micro level studies incorporating these vital issues. Reviewing the works on population-agriculture relationship, Kulkarni (1981, pp.355-356) commented that "it is essential to investigate whether agricultural change in a region is more a matter of a community's effort and of its attitudes to the adoption of new methods, and whether the human efforts and attitude are the result of the community's response to demographic pressure. At the same time, in those regions in which a notable agricultural development has taken place, it is essential to study the impact of this development has had on the demographic situation of that region". Although he is in favour of macro level studies, yet the basic issues relating population and agriculture and their interrelationship is highlighted as relevant in the developing countries like India. Agricultural development strategies should be formulated only after considering the population parameters because the latter is the basic input in agricultural development.

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I, ***SRI BIMAL BARAH***, hereby declare that the subject matter of this thesis is the record work done by me, that the content of this thesis did not form basis of the award of previous degree to me or to the best of my knowledge to anybody else and that the thesis has not been submitted by me for any research degree in any other University/Institution.

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CONTENTS

List of Tables

List of Figures

Chapter-I

Introduction

A perceptible change in the course of human history took place with the advent of the cultivation of crops and the rearing of animals, i e agriculture, by the people on the earth some 7000 to 10000 years ago Consequently, an inseparable relationship has been growing up between population and agriculture and dynamism in different spheres of the society appeared through time This gradual development of population-agriculture nexus has attracted the attention of scholars, and as a result, numerous studies have been appeared to evolve theories and models covering these two aspects Geographers' interest also subsequently develops over this issue, not only because the relationship varies spatially, but also because the pattern of relationship has itself been changing through time The space-time dimensions of the relationship between population and agriculture have been a central theme for long and even today the problem has not lost its significance mainly due to the fact that the future of many developing countries is closely related to this issue (Kulkarni 1981) However, before entering into the problem in detail, an attempt has been made first to conceptulise these two aspects, population characteristics and agricultural development, the main focus of the present work

In his first text on population geography, Clarke (1965) clearly categorises population characteristics into three main groups and, accordingly, the first group includes the absolute number of human population Clarke also states that the significance of this group lies in its locational (distribution) and proportional (density) context of the area concerned Second group of population characteristics includes a number of measurable attributes of population and can be classified as physical (age, sex, race, intelligence, etc), social (marital status, family, household, literacy and education, etc.), and economic (occupation, income, etc) The third group of population characteristics includes the dynamics of population consisting of fertility, mortality and migration The basic point is that if these population characteristics are studied only from the demographic viewpoint, it

will reflect a part of the reality because these are related directly or indirectly to the various economic activities of the people. If this is so, it becomes relevant in the present day context to concentrate attention on the link exists between the population attributes as stated above and any kind of economic activities. Agriculture being a primary economic activity and a huge absorber of human labour force has a specific pattern of link with the various population characteristics. Variations in the context of agricultural landscape that developed over the globe today can be said to be the product of the variations in population attributes, if other conditions being equal. For instance, the absolute number of human population can cause for the appearance of either extensive or intensive methods of farming, supply of labour to agriculture is directly related to the age-sex composition of population, intensiveness in the use of various inputs for better output is related to the demand coming out of population pressure, diffusion of the modern farm technology and its degree of acceptance by the farmers depends on the literacy and education level of the latter, and so on. Thus, the entire set of population characteristics is contributing either singly or collectively towards the development of agricultural conditions.

Let us turn our attention towards the concept of agricultural development and its various ways of measurement In general, agricultural productivity that is related to land, labour and capital has been considered as a reliable index of agricultural development. It is a relative concept and, hence, is useful for understanding and comparing agricultural performance of various agro-ecological regions. It also indicates the output in relation to input. Since the basic purpose of agriculture is to produce agricultural goods (output) either for consumption or for trade through the use of various inputs and since the efficient use of the latter (inputs) depends largely on the quantitative (number) and qualitative (education, intelligence, etc.) attributes of population, it is evident that the population-agriculture relationship is complex and multifarious. The present work is an attempt to

examine in what way this complexity exists and how far the various population attributes are playing decisive role in conditioning agriculture of a given area.

1.0. Statement of the Problem:

Agricultural structure and subsequent development takes place due to the vast multiplicity of a number of interconnected biotic and abiotic components. Although all of them contribute for agricultural growth, yet they do not contribute equally in shaping the space-time variations of agricultural landscape. Hence, it is desirable to observe the dominant factors that may be decisive in conditioning the regional structure of agriculture. But the ranking of the factors according to the level of dominance over agricultural activities is a complex exercise requiring detail systematic investigation. Notwithstanding this complexity, there are some convenient ways of categorising factors according to the level of significance and these provide ideal grounds for geographers to carry out systematic investigation. But, most geographical investigation on agriculture till today have tended to emphasise more on the role of physical factors and the resultant agricultural structure. However, a few of the geographers have attempted to incorporate non-physical factors including biotechnological, infrastructural, institutional, etc. studying agricultural structure very recently. But much lesser work has been done on the pattern of interrelationship between population and agriculture. Since population is a decisive force of conditioning agricultural system, the closure examination of the impact of this force in patterning land-use of a given locality is definitely imperative for theoretical understanding and practical solution of many agricultural problems.

In the background stated above, the present work has been designed to deal with these two vital issues and their interconnections. It is to be noted here that there is an existence of two divergent views relating the population-agriculture relationship. The first view sees population as a dependent force on agriculture while the second seems to take

an opposite stand seeing population as an independent force. Some traditional propositions including the Malthusian doctrine are in favour of the former stand stating that food supply is the limiting factor of population growth while agricultural development is the result of autonomous invention. It further states that food supply increases due to inventions, which are independent of population, change (Kulkarni 1981). The simple explanation is that if the supply of food increases, population will increase and a new equilibrium would be achieved between the two. In a sense, if population is less than the food supply, population will expand and if it is already beyond the level of subsistence, it itself will come down to reach an equilibrium through the positive check (Lekhi 1996, p.84) Cipolla (1962) have strengthened this stand by stating that the number of people has been regulated by the availability of food throughout the greater part of the human history.

Another group of scholars adopts an opposite stance seeing population as an independent force. Prominent among them is Boserup (1965) who categorically maintains the view that although the production-increasing inventions may occur independently, the adoption of new knowledge depends on population "push". She suggests that agricultural development is due to some kind of compulsion and this compulsion relates to rising trend of population. According to Boserup (1965), "where there is a population pressure, population does not go down. It rather leads to various technical and other changes which result in agricultural growth and increase in food supply". She has supported this contention through an examination of agricultural development of some African and Latin American countries. She stated that the transition from the pre-agricultural stage to the agricultural stage as well as in the subsequent developments in agriculture was an outcome of the population pressure (Kulkarni 1981). This statement has been supported by Clark

(1967) who explained the entire course of human history in the context of population growth.

These two different stands can be said to be complementary rather than mutually exclusive. Simon (1977) says that the Malthusian stand refers to invention, which are relatively labour saving, while the population push stand taken by Boserup and Clark refers to inventions that are output increasing but require more labour as well. Although the universal applicability of these stands are not too strong, yet it is not uncommon to see that some cases in history are better explained by the first while others by the second stand (Kulkarni 1981, p 341). The present work has been centered around the second stand as propounded by Boserup. Here it has been accepted that population is an independent force and contributes significantly towards change in agricultural structure There is also a logic behind the acceptance of the Boserupian statement. Clark and Haswell (1970) say that the change in agricultural methods is not exogenous, rather results from the population growth. In order to demonstrate that this proposition is true, rather than converse, namely that new agricultural methods are discovered, and that population growth is the consequence of these discoveries (Malthus' theorem), we have the convincing case that nearly all these changes call for much greater effort on the part of the cultivator, who therefore is most unlikely to adopt them until he is compelled to by rising population (Clark and Haswell 1970, p.55). Clarke's statement has further been strengthened the proposition made by Trewartha (1953) who considers population as the point of reference from which all other elements are observed and derive meaning and significance. This discussion simply indicates multifarious role of population - agriculture relationship. It is a fact that population is a producer as well as a consumer. It has impact on demand as well as on supply. Demand, in a simple way, comes out from absolute number of population. It

indicates that more people will need more agricultural commodities and, as such more supply would be indispensable which again would be derived by making higher output. Thus, the supply would be enlarged but this enlargement cannot be considered an autonomous process. It basically comes through the effect on various inputs-effect on the pattern of landuse, on the supply of labour, investment, techniques of cultivation, etc. These attributes of agriculture-related change have been made possible only by the attributes of population, namely, its number, density, literacy, age-sex composition of population, etc In this context population is seen as a determining force and the entire change in agricultural structure can be said to be dependent on it.

At this juncture also the problem is not over. The basic issue is as to how and in what ways the various attributes of population (as stated by Clarke 1965) could be correlated with the attributes of agricultural development. Since the entire set of elements are not possible to incorporate nor has any relevancy to include, the study has been deliberately restricted to examine the interrelationship between a few attributes of population (viz., size and distribution of population, population pressure, age-sex composition, literacy and education, household and family structure, labour, etc.) and a few indicators of agricultural development (viz., land and labour productivity, intensiveness in the use of input, cropping pattern , etc.). In order to examine the relationship between these two sets of attributes, the Jorhat district of Assam has been taken up as a micro areal unit of investigation.

2.0. The Study Area:

Jorhat is a centrally located district in the upper part of the Brahmaputra valley. It covers an area of about 2851 sq. km. (or 3.64 % of the total geographical area of the state).

It also supports more than 8 lakh people representing 3.89 percent of the state's total population. Agriculture is the principal occupation and more than 80 percent of the total population depends on it as a way of living. Around 60 percent of the total land is used for the cultivation of crops mainly paddy, both summer and winter. Existing population of the district releases sufficient number of labour force for the operation of agriculture. In order to examine the population- agriculture relationship, the district can be taken up as an ideal unit of investigation because the agro-ecological conditions of the district are congenial both for the production of crops and human occupation. However, in the present analysis of population-agriculture nexus, Majuli has been excluded from the analysis because the latter itself has a specific set of agro-ecological conditions with insular location not comparable with other parts of the state. The details of the study area are presented in Chapter-II of the present work.

3.0. Objectives:

In the light of above discussions, the present work has been designed to fulfil the following objectives as:

i. to examine the structure of agriculture in Jorhat ,

ii. to analyze the characteristics of population in Jorhat,

iii. to correlate the attributes of population with the attributes of agriculture stated in the statement of the problem,

iv. to examine the effect of population factors on agricultural conditions, and

v. to suggest the development strategy of agriculture in the light of the population.

4.0.Hypotheses:

The study is basically related to the impact of population characteristics on agricultural conditions Therefore, putting forward the Boserup view (1965) of positive effects of population on agricultural practices and development under the conditions of high population density, the following hypotheses have been formulated to test the validity of the facts taking Jorhat as an empirical unit of investigation

1. *Under the conditions of abundant labour supply to the agricultural practices, the land* productivity moves up with the decline of labour productivity
2 Intensity of agricultural land use at a greater scale is emanating from the higher pressure of population

4.1. Justification: In the context of the objectives and hypotheses stated above, the Jorhat district of Assam is considered to be a suitable micro areal unit to test the validity of the Boserupian view of population-agriculture nexus Although the variation in respect of the climatic conditions of the area is not pronounced, yet the existing soil types and population pressure seem to vary according to the variations of the altitude and slope from the flood plain belt of the north to the hilly ranges of the south of the district Therefore, the identified agro-ecological zones of the district (presented in chapter-II) are distinct micro areal unit with a specific set of man-nature relationship The way the population attributes is related to the agricultural attributes in various agro-ecological zones could be expected to be an interesting correlative study in its spatial dimensions This would be helpful not only in understanding the pattern of relationship between the population and agriculture, but also give a new insight in solving many practical problems faced by the people of the state at large and the people of Jorhat area in particular.

5.0. Sample Design and Methodology:

Since the basic purpose of the present study is to examine the relationship between population and agriculture, the greater emphasis is therefore given on to the collection of data from the field through sample technique It is also true that a complete enumeration is not possible for an individual researcher due to the limitations of money, time and energy (Kothari 1990). At the same time, the survey of that kind is not required in the context of a universe characterized by homogeneous conditions In this situation, a part of the universe can explain the reality and as such sampling becomes an indispensable tool for a researcher. In the present work, the samples are attempted to draw in such a way that can successfully explain the population-agriculture relationship of the study area and help in achieving valid and reliable conclusions. Therefore, the sample design to be used in the present study has been decided by the researcher by considering the basic objectives of the inquiry proposed earlier along with other related factors. The various stages involved in designing the samples are presented below.

5.1. Selection of Villages as Samples: In order to select villages for detail investigation, the four agro-ecological zones (stated in Chapter II) of the district have been taken up as strata so that the population-agriculture nexus of each strata can be examined and analysed Then, on the basis of population size of the villages, remotivity and their (village's) distance from the nearest market/urban centres, a total of 19 villages (3 15% of the total villages of Jorhat) has been selected as samples (Table-1 1) It is to be noted here that there are 606 villages in Jorhat (2.44% of the total villages of Assam) as per 1991 census and out of this, 396 villages are located in the built-up zone (zone C) and 150 in the flood plain zone (zone D) In the moderately steep to steep land zones, i.e., in zones A and B, the number of villages are few, only 21 and 41 respectively from each zone. Therefore, the proportions of villages selected as samples from each zone stand at 9.52, 4.88, 2.52

Table-1.1: Basic Information of the Sample Villages.

Zones	Name of the SampleVillages	Population Size	Households T	SH	(%)	Remotivity (km)	Distance from Jorhat Town (km)
A	1.Lahing Gaon	939	198	21	10.65	05	19
	2.Kankhowa	1358	272	28	10.29	06	20
B	1.Medeluajan	218	41	09	21.95	02	15
	2 Paninora	1552	301	42	13.95	05	13
C	1.Gajpuria	1136	214	18	8.41	02	10
	2 Bebejia	2191	418	29	6.94	02	05
	3 Sologuri	2024	327	23	7.03	02	06
	4.Mohimabari	1412	240	22	9.17	03	25
	5.Phalengichuk	1030	168	13	7.74	01	15
	6.Sonari Gaon	1142	202	21	10.40	02	05
	7.Kharikatia	1932	765	46	6.01	02	04
	8.Baghmoria	1481	274	18	6.87	03	03
	9.Pukhuripara	155	29	5	17.24	04	10
	10.Dhekiakhowa	559	98	1	11.22	03	18
D	1.Neul Gaon	891	76	10	13.15	03	11
	2.Pakhimora	1069	199	25	12.56	01	09
	3.Balichapori	1976	352	36	10 22	02	08
	4.Hukimora	1355	243	22	9.05	05	08
	5 Borkhat	376	73	8	10.96	05	10

Abbreviations: T= Total Households, SH= Sample Households.

and 3.33 percent respectively for zones A, B, C and D. Thus, the proportions of villages taken up as sample from each zone are larger than the proportion of villages of Jorhat to the total villages of Assam. Although the size of the samples is seen lower in percentage term, it can be considered representative because there exists homogeneity within each zone in respect of prevailing agro-ecological conditions.

So far as the size of the population is concerned, the villages of the study area have been categorized first according to the size of the population (Table-1.2) and then a few villages from each size class have been selected randomly as samples. It is seen that the representation of villages from the large sized class is more than the remaining classes.

Table-1.2: Total and Sample Villages according to their Size of Population.

Size Class	Category	Total Villages	Sample Villages	
			No	%
0---500	Small Size Village	163 (26.72)	03	1.84
501-1000	Medium Size Village	175 (28.63)	03	1.72
1001-3000	Large Size Village	245 (40.16)	12	4.89
Above 3000	Very Large Size Village	27 (04.43)	01	3.57
Total villages of all size classes		**606 (100.00)**	**19**	**3.14**

NB: Bracketed figures indicate percentage of villages to total villages of Jorhat district.

This is because of the existence of more villages (245 or 40.16%) in this particular size class than other classes. Moreover, it was also intended to select at least one- percent village as sample from each 10 percent of the total villages of the study area. But due to the limitations of time, money and energy as already stated, it becomes difficult to have achieved the desired target. However, 1.84 percent villages from its small size (0-500) class, 1.72 percent from medium size (501-1000), 4.89 percent from large size (1001-3000) and 3.57 percent from very large size (above 3000) have been taken up as sample villages for detail investigation. Since the items of the universe of the present are homogeneous and attempted to study intensively, a small sample can be expected to yield real representation of the universe.

In order to understand the remotivity of the villages, the distance from the nearest motorable road (in km) either the national highway or the state or district roads, is taken up for consideration. The remoteness of the villages is expected to indicate the probable

impact on the agricultural activities of the inhabitants. Thus, depending on the distance, three categories of villages have been identified, viz., very less remotivity (within 2 km), moderate remotivity (2-4 km) and high remotivity (4-6 km). Accordingly, 9 villages from the very less remotivity, 5 from the moderate and 5 from the high remotivity categories have been selected (Table-1.1). So far as the distance of the villages from the nearest market/urban centres is concerned, attempts have been made to select villages from various distance range. As evident from the Table-1.1, the 3 villages have been selected from above 20 km distance, 4 villages from 15-20 km distance range, 4 from 10-15 km, 4 from 5-10 km and another 4 from within 5 km distance range. This categorization, according to the distance, has been done in order to understand the impact of urban/market centres on existing land use pattern of the villages.

5.2. Selection of Sample Households: After selecting villages for sample survey, the attention has now been directed towards the selection of households for conducting detail investigation. In selecting households no statistical technique has been introduced, rather the personal judgement has been applied. To have representation from all categories of households, the outer structure of the houses (whether RCC construction, Assam Type or simple thatched and bamboo made houses) has been taken up for consideration assuming the house structure as the reflection of the economic status of the farmers. Applying this simple logic, a few households from each structure has been selected and the heads (or any other representative in absence of heads) of these selected households have been approached for certain relevant information already designed for the purpose. Altogether, 406 number of households has been surveyed which are around 10 percent of the total households of the selected sample villages. The number of households taken up as sample from zone A is 49(10.43% of the total households of the sample villages), zone B is 51(14.92 %), zone C is 205(7.50 %) and from zone D is 101(10.71 %).

5.3. Collection and Processing of Data: In order to collect data from the sample households, a household schedule (Appendix-I) containing all relevant aspects for the purpose has been prepared and this (schedule) has become the main tool for collecting data. With this simple but systematically prepared schedule, the heads of the households have been approached for face to face interview After explaining the basic purpose of the inquiry to the respondents whenever required, the latter was asked certain questions from the schedule in the order the questions are listed and the replies are recorded in the space meant for the purpose In this way, the entire information have been collected from the sample households and then the collected information have been tabulated and processed with the help of using computer

5.4. Other Sources of Data: Besides the primary data collected from the field through the household schedules, some secondary data have also been used in the present work These are collected from different sources including various governmental and non-governmental publications. The Statistical Handbook published by the Government of Assam, Guwahati and other census publications are the main sources of secondary data. Some other information has been collected from various books, journals and other periodicals.

5.5. Testing of Sample Characteristics: Whether the sample characteristics collected for the purpose are reflective of the reality or not, are necessary to test at this juncture. In doing this no statistical technique has been applied rather the mean of the sample and the mean of the universe have been calculated and compared. If the mean of the sample is found closer to the mean of the universe, the representation is expected to be reliable for drawing meaningful conclusion. Keeping this in view, the characteristics of samples are tested and retained for analysis. In Table-1.3 the socio-cultural characteristics of the samples are presented.

Table-1.3: Socio-cultural Characteristics of the Sample Households.

Characteristics	Sample Total	Households (%)	District (%)	Deviation (%)
Caste				
General Caste	103 }			
OBC	235 }	83.25	80.30	+2.35
ST	47	11 57	12.09	-0.52
SC	21	5.47	7.61	-2.14
Religion				
Hinduism	392	96.55	95.59	+2.96
Islam	12	2.95	4.32	-1.37
Christian	02	0 50	1 52	-1.02

Abbreviations: OBC= Other Backward castes, ST= Scheduled Tribe, SC= Scheduled Caste.

It is now evident from the data that the caste wise representation of samples from the study area is quite reflective of the existing caste composition. The proportion of population belonging to the general and Other Backward Caste (OBC) in the district is 80 30 percent (1991) while the proportion of samples from these two categories stand at 83.25 percent, slightly higher than the district average. In the context of the Scheduled Tribe (ST) and Scheduled Caste (SC) groups, the district has 12.09 and 7.61 percent share respectively in the total population. The proportions of samples from these two groups are very close to the district average as 11.57 and 5.47 percent respectively. Although there are variations of the mean of the universe and the mean of the samples, the difference is seen to be within ±3 percent, which is very much closer to the reality. Religion wise, there are 96 percent samples from the Hindus, 2.95 percent from Islam and only 0.50 percent from the Christians Theirs strength to the total population of the district stand at 93, 4.32 and 1.52 percent respectively. In this context also, the variations seem to lie within ±3 and, therefore, the samples can be considered representative from the societal background of the study area.

As far as the basic population characteristics of the samples are concerned, these are also found to be meaningful for testing the hypotheses proposed in the present study. The

validity of the collected sample households for representing the population conditions of the district can be understood from the scenario presented in Table-1.4.

Table-1.4: Population Attributes of the Sample and the District.

Attributes of Population	Sample No	(%)	District % to total popn.	Deviation
Distribution				
Zone A	281	11.50	4.42	+7.08
Zone B	340	13.91	6.79	+7.12
Zone C	1189	48.66	64.15	-15.49
Zone D	633	25.91	24.62	+1.29
Total of All Zones	2443	0.33	3.34	-3.00
	Sample		District	Deviation
Density(persons/h)	3.32		3.03	+0.29
Sex Ratio	949		928	+21.00
Average Family Size	6.00		5.80	+ 0.02
Literacy Rate	88.41		65.51	+22.09
Main Workers(%)	37.86		34.38	+3.48

As indicated by the data given in Table-1.4, there has been a good representation of population from all agro-ecological zones of the study area because the deviations of the sample households means lie within ± 7 percent except the zone C where the mean greatly deviates from the district average. But this is still within a tolerable limit in the sense that the characteristics of the universe are homogeneous As far as the density of population of the samples is concerned, it is seen that the density of the samples is very close to the district average (deviation is only .29 percent). Similarly, the average size of the family and the proportion of total main workers to total population of the samples are also very close to the district average with a deviation of only .02 persons per family and 3.48 percent respectively and as such, the representation could be considered reflective of these population attributes of the study area. Significant variations have been noticed only in the context of the sex ratio and the literacy rate of the samples. It is not uncommon to have a

deviation between the sex ratio of the samples and the sex ratio of the population of the study area. Because, the former reflects the ratio typical of the rural population while the latter is the average condition of both rural and urban areas The rural out migration has caused for a larger number female per thousand of males in the rural area due the sex selective nature of migrants Therefore, the sex ratio of the sample, which is entirely collected from the rural area, is seen larger than the average ratio of the district In the context of the literacy rate, the collected samples show greater proportion of literate persons than that of the study area as a whole After the completion of the "Total Literacy Campaign" in Jorhat, the position of the district in educational front becomes quite impressive and the district is now one of the highly literate districts of Assam In that context, the samples are successfully representing the educational reality of the district Considering the population attributes of the samples and comparing these with the district averages, it can be concluded that the size of the samples are quite reflective of the prevailing population conditions of the district and hence would be valid for testing the hypotheses proposed in the present study

After testing the population characteristics, it has now been attempted to test the validity of the agricultural characteristics collected through household sampling Because the basic purpose of the of the present study is to examine the population-agriculture relationship in Jorhat by collecting relevant information through sampling Therefore, there should be a good representation of both population and agriculture-related aspects of the district In this background, testing of the sample household characteristics related to agriculture is equally imperative However, in the context of the total geographical area, the district covers about 3.63 percent of the total geographical area of Assam, but the area covered by the sample is only 0.25 percent of the total geographical area of the district (Table-1 5). In general, the coverage seems to be very less but this does not mean that it

fails to represent reality The area under possession of a household is different from the area under possession of a district The total area of any district covers the areas of all kinds including the area under forest, marshes and swamps, water bodies etc besides crop lands, while the area under possession of each household generally covers only the crop land and hardly have ownership of forests or other plantation areas Therefore, the comparison of the mean of the sample and that of the universe is not relevant Similarly the proportion of land not available for cultivation of the samples is significantly deviating from the proportion of the district (-39 01 percent) Of the total land of the samples, 18 56 percent is seen to be not available for cultivation due to the use of this land for dwelling houses The wastelands as well as fallow land among the samples are practically nil indicating that the entire land has been used for the cultivation and production of crops Because of this, the share of the net sown area to the total area of the sample is very high, around 81 percent against the district average of 42 42 percent The area sown more than once in a year among the samples is 14 48 percent, but this share is seen to be lower than the district average of 27 percent Thus it is clear that in terms of the total area and the area not available for cultivation, the means of the samples are lower than the means of the universe but in the context of the net sown area the mean of the sample is larger Similarly, the mean of the total cropped area of the sample household is larger than the mean of the universe However, the higher or lower values of mean in these cases are less relevant to test the validity of the samples What is important here is to examine the representation from each category and theirs relative share to the total land and in this context it is evident from the data (Table-1 5) that the size of the samples are sufficient to test the hypotheses Because of the total land of the samples of 0 25 percent, only 18 56 percent are not available for cultivation while 80.96 percent is the net sown area That the area is

suitable for cultivation and production of crops can be understood from this and the collected sample households are therefore a good representative of the prevailing realities.

Table-1.5: Agricultural Characteristics of the Samples Households (SH).

Land Categories	Total Land of the SH (in hectares)	Total Land of the SH (in p.c.)	District Total (in p.c.)	Deviation
Total Land	735.84	0.25	3.63 *	-3.38
Land not available for Cultivation	136.59	18.56	57.57 **	-39.01
Net Sown Area	595.77	80.96	42.42 **	38.54
ASMO	106.61	14.48	27.00	-12.52
Total Cropped Area	701.78	95.37	58.32	37.05

* percentage to total geographical area of the state. ** percentage to total geographical area of the district. ASMO-area sown more than once.

5.6. Methods Used: With a view to examine the relationship between the population and agricultural attributes of the study region, certain statistical techniques are used. First, a few population and agricultural attributes are taken up as determinants to analyze the characteristics and pattern of change in other attributes included in the present study. Second, a correlation matrix of X_1. Xn dimension has been prepared in order to examine the degree and nature of relationship among the attributes. Third, multiple regression analysis (Kothari 1996) has been applied to estimate the value of Y (dependent variables related to agricultural attributes) with respect to the value of X (independent variables related to population characteristics) with the help of following equation,

$$Y = a + b_1X_1 + \ldots + bnXn \quad \ldots \quad \ldots \quad \ldots \quad (1).$$

Besides these statistical techniques, some other cartographic techniques like graphs and bar diagrams, are used to supplement the relevant analysis. Maps are also used to depict the spatial pattern of variation of population-agricultural nexus.

6.0. Arrangement of Materials:

The materials of the present study have been arranged in a coherent manner to have a better access to the analysis Accordingly, the first chapter of the work deals with the statement of the problem along with its basic objectives, hypotheses and relevant methods used for the collection of primary data from the field The second chapter is devoted entirely for examining the agro-ecological conditions of the study area including its population and agricultural characteristics The third chapter incorporates the review of literature related to the field of population and agricultural relationship and through this, it has been attempted to identify the gap going to be filled up by the present work The fourth chapter includes the interpretation of primary data regarding the characteristics of population and agriculture of different agro-ecological zones identified for the present purpose. The fifth chapter includes primarily the examination of the pattern of relationship between population and agriculture under different agro-ecological setting Finally, conclusions and suggestions are included in the last chapter.

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Chapter-II

Geographical Personality

1.0. Introduction:

The geographical personality of an area or district may be described by interpreting physiographic attributes and socio-economic setup of the people. Agro-ecological conditions are important to highlight here to provide the background of the study area for the explanation of population-agriculture relationship. The conspicuous components of agro-ecology are soils and climate and the resultant vegetation types The relationship of these attributes determines the extent and magnitude of usefulness of arable land for different agricultural purposes, the number of people engaged in farming and making a living out of it, and the types and number of crops that can be grown on the same field in the course of an agricultural year (Singh 1974). Among the ecological attributes, climate is most significant in the sense that it influences on the formation of soils, crops and livestock. Therefore, an understanding of the existing agro-ecological conditions of the study area is seen inevitable for a systematic evaluation of the population-agriculture nexus and in the light of this, the basic agro-ecological aspects of Jorhat has been highlighted.

2.0.Location and Extent:

Jorhat district is located between 26°20' N and 27°15' N latitudes, and between 94°00' E and 94°35' E longitudes. On the north, it is bounded by Lakhimpur, east by Sibsagar, west by Golaghat districts of Assam and on the south by Nagaland State (Fig-2.1). It is a centrally located district in the upper Brahmaputra valley with an area of 2851 sq. km. (3.64 % of the state area) and supports about 8.7 lakh population (3.89 % of the state in 1991) The density of population was 306 persons per sq km. in 1991 against the

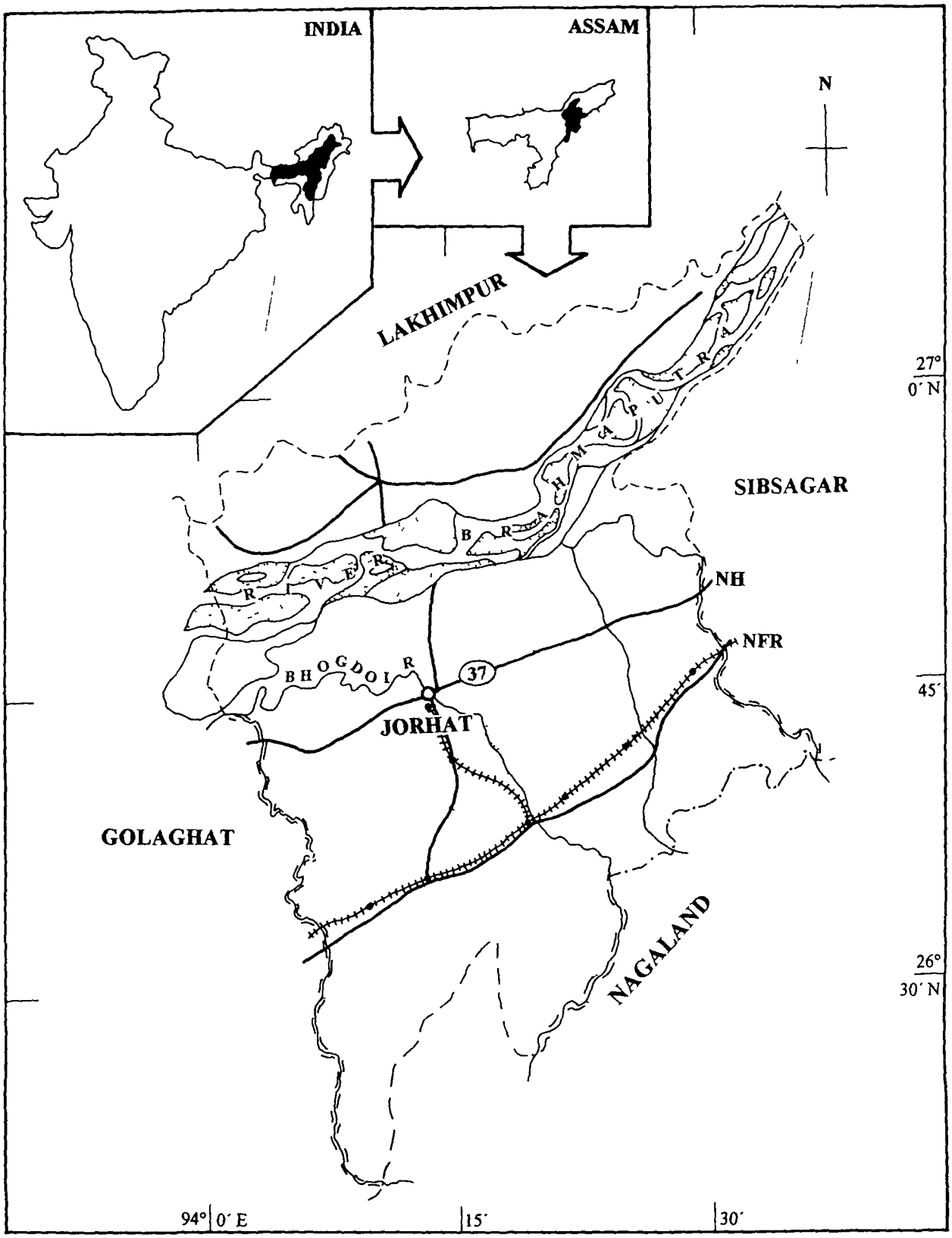


Fig.-2.1: LOCATION OF JORHAT DISTRICT, ASSAM.

state's average density of 286 persons per sq. km. The decadal change of population was recorded 33.10 percent during 1971-1991, lower than the state's average of 53.26 percent. The district has two sub-divisions, viz. Jorhat and Majuli with a total geographical area of 1553 sq.km. and 1295 sq.km. respectively. The Jorhat City is the headquarters of the district and is well connected by rail, road and air transport with the rest of the country.

3.0. Physiography:

It includes geological structure, relief features, soils, climate and vegetation as given below in detail;

3.1. Geological Structure: The entire north-east India has been divided in to three distinct geological units, namely, the rigid massif of the Meghalaya and Karbi Plateaus (an extended part of the peninsular Gondwanaland), the folded hills and mountains of Tertiary origin born out of the Tethyan geosyncline (hills of Arunachal, Nagalnd, Manipur and Mizoram), and narrow foreland (rift valley) that represents the fertile Brahmaputra plain (Taher 1986, pp.1-19). Jorhat is located over this geological unit and hence it retains the characteristics of a typical plain. It is stated that the geological history of the upper Brahmaputra valley and for that matter of the Jorhat area, is related to the two long narrow subsiding troughs (geosyncline) lying on either side of an old rigid continental shield (foreland). The foreland is geologically a north-eastern continuation of the Shillong and Mikir hills plateaus and is connected in the valley by a great thickness of the alluvium and Tertiary rocks. To the north of this main land of Archaean rocks was an ancient central geosynclinal sea known as the Tethys. The geological history of the rest of Assam region is fragmentary up to the Tertiary time. An arm of a sea invaded Assam from the south in the Cretaceous time. With the beginning of the Tertiary era, the

sea extended further northeast and submerged the greater part of Assam. But for the occasional and temporary retreat of the sea, marine conditions prevailed till about the

Miocene time. Thousands of feet of sediments were deposited on the forelands as well as in the geosynclines, the floors of all of which were slowly but continuously sinking. Geological surveys, aided by drilling for oil, have shown that under the recent deposits, there are many thousands of feet of Tertiary sediments which lie over an Archaean basement complex. These Tertiary rocks represent the foreland facies and are distinguishable from the geosynclinal facies of Tertiary rocks which form the hills on the south and south-east of the district (Gazetteer 1967 pp.20-21.).

The geological history stated above indicates that comparatively new alluvium deposits cover most part of Jorhat. The river Brahmaputra and its tributaries like Bhogdoi, Kakadonga, Dhansiri, etc. have deposited these alluviums. The older alluvium mainly of the Pleistocene period consists of reddish to brownish sandy clay with coarse particles of sand, silt and clay along the plains of the Brahmaputra River. There is a thin strip of rock along the southern boundary of the district. It is believed to be formed during the Miocene period and locally known as the Tipam series of sedimentary rocks characterized mainly by coarse to gritty, ferrugnius sandstone and shales (NBSS and LUP 1993).

3.2.Drainage: The Brahmaputra is the main river of the district. The whole of the drainage of the district ultimately finds its way into this main river. As it flows past from east to west on the north of Jorhat, it forms the Majuli Island, believed to be biggest in the world. The principal tributaries of the Brahmaputra that flow through the district are Bhogdoi, Jhanji and Kakadonga. The Bhogdoi is the largest river in the district, the maximum discharge of the river is estimated at 6072 cusecs. The Kakadonga is a sub-tributary of Bhogdoi and forms the boundary between Jorhat and Golaghat districts. The Jhanji is the tributary of Brahmaputra and forms the boundary between Jorhat and Sivsagar districts. Its maximum discharge is estimated at 8797 cusecs. All these tributaries are forming alluvial plains along their respective courses. All the tributaries of the Brahmaputra on the southern bank and for

that matter, the tributaries located in Jorhat, have comparatively flatter gradient and meandering channels over the plains. The also have longer courses over the plain but short courses over the hills, and have beds and banks composed of fine alluvial soils (Bora 2001, p.39).

3.3. Soils: The soils of the district are basically alluvium. But this is not a complete picture of the soils of the district. Different soil forming factors like geological structure, relief, climate, vegetation, etc. are contributing towards the formation of soils of the area. However, the soils of Jorhat are developed under humid sub-tropical climate with mean annual rainfall of 1950 mm and mean annual temperature of 23.5° C. The area receives well distributed and high rainfall from April to September leading to excessive leaching in hill soils and water stagnation and flooding in the valley areas, qualifying for both "Udic" and "Aquic" soil moisture regime respectively (NBSS & LUP 1993). This suggests that there are variations regarding the morphological, physical and chemical properties of the soils in different parts of district and the variations are basically the product of the district's geological structure and topography.

3.4. Climate: Describing the weather and climatic conditions of the northeast, Borthakur (1986, pp.20-27) remarks that the entire region has a distinctive climatological attributes not comparable with any other parts of the sub-continent. This distinctiveness, according to him, has resulted mainly from the region's geographical location and its physiography. Based on these local conditions, he has classified the region's climate into four main types, viz., humid continental severe winter, moist in all seasons and short summer (Dfh); sub-tropical monsoon, mild and dry winter, warm and humid summer (Cwb); sub-tropical monsoon, mild and dry winter (Cwa); and sub-tropical monsoon with very heavy rain (Cwm). Assam is under the influence of the Cwb type of climate (Borthakur 1986). In common with the rest of the state, the Jorhat district enjoys a climate characterized by the

highly humid atmosphere, abundant rains and general coolness (Gazetteer 1967, pp.31-32). Consequently, Jorhat enjoys congenial climatic conditions for the cultivation and production of different crops.

Like other parts of the state, the weather of the district can be grouped in to four conspicuous seasons. The cold (winter) season continues from December to February. Weather remains fair but occasionally associated with fogs and haze. This season is followed by a season of severe thunderstorms (pre-monsoon) from March to May. With the migration of the depression over the Bay of Bengal and incursion of the air masses over the entire northeast, the frequency of the storm increases. The nor'westers locally called *"Bordoichila"* start during this period. After the pre-monsoon, the southwest monsoon begins and continues from June to October. From the agricultural point of view, this season is very much significant for the farmers. There is no fixed date for the outbreak of monsoon. It depends on the appearance trough line over northern India. As soon as the line reaches the Himalayas, monsoon breaks in the northeast India. High rainfall, high temperature and humidity accompany the southwest monsoon. Accordingly, the district also experiences high rainfall and temperature as that of the rest part of the state. Subsequently, the monsoon withdraws in the last week of September or the first week of October. It is the period of the retreating monsoon. Following the monsoon withdrawals, light unsteady winds are experienced which become northeasterly (Borthakur 1986).

3.4.(i). Rainfall: The district receives rainfall mainly from the south-west monsoon during the period of monsoon as stated. Sufficient rainfall is the basic feature of the period. Paddy is cultivated extensively in this season through out the district. The mean annual rainfall based on 10-year record from 1990-1999 is found to be at 2100 mm., lower than state average of 2700 mm. It has been observed that about 72.34 percent actual rainfall is received during the monsoon season (June to September), 18.8 percent during the pre-

monsoon and about 10 percent during retreating monsoon and the winter season. Since the rainfall is high in summer and some amount of rainfall is received during the winter too, the soil moisture control section seldom becomes dry in some parts for more than 90 cumulative days and, therefore, the area qualifies for 'udic' soil moisture regime (NBSS and LUP 1993, p 5). On an average, there are about 140 rainy days in a year with the intensity of rainfall being 20 mm per day. The annual variation of rainfall is less, but it significantly varies from season to season as in the other parts of the state.

3.4.(ii). Temperature and Humidity: The records of temperature and other meteorological conditions available at Tocklai Experimental Station, Jorhat, can be taken up as representative data set of general weather conditions of Jorhat. The available data show that the mean annual temperature of the district is 23.5°C. January is the coldest month of the year with mean daily maximum and minimum of 21.0 and 9.8 °C respectively. The highest temperature is recorded during the summer season and July is the hottest month with mean daily maximum of 32.3°C and minimum of 26°C. Temperature begins to rise from the month of March and after attaining the highest level in July, it again begins to decline and reaches the lowest level by January. But with the withdrawal of south-west monsoon by about the second week of October, the weather gradually becomes fair providing scope for the cultivation of *rabi* and other vegetable crops. The atmosphere is highly humid throughout the year. The relative huidity in the morning and in the evening stands at 93 and 65 percent respectively (Fig.-2.2).

3.4.(iii). Sky Conditions: Sky conditions vary from season to season in the district. It is heavily clouded to overcast in the southwest monsoon season but moderately clouded during the post monsoon and winter seasons The period from March to May, the moderate to heavily clouded sky is a common phenomenon. The thunderstorms, which come during this period, are similar to that of the norwesters of west Bengal. These are

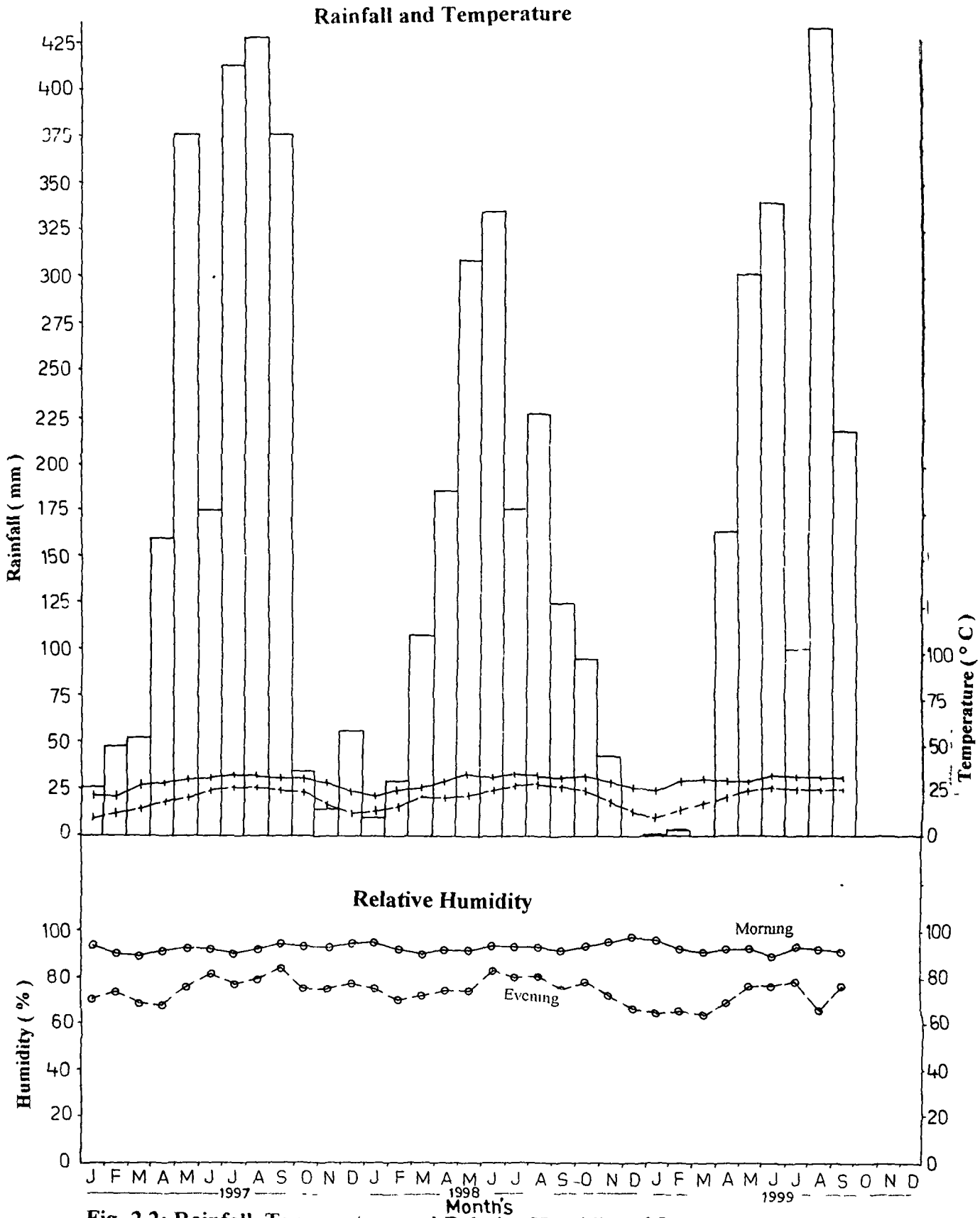


Fig.-2.2: Rainfall, Temperature and Relative Humidity of Jorhat District, 1997-1999.

sometimes violent and accompanied by occasional hail. Fog is frequent in the post-monsoon and winter seasons (Gazetteer 1967, pp.31-32.).

The climatic conditions and soil moisture regime of the district discussed so far favour for both the *'Kharif'* and *'Rabi'* cultivation without much supplemental irrigation (NBSS and LUP 1993, p.5). The low-lying areas are subject to flooding and water logging during the rainy season and as such the cultivation of paddy becomes problematic. In short, the variations of temperature, rainfall and humidity in different seasons provide ample opportunities for the farmers to cultivate and produce a variety of crops.

3.5. Natural Vegetation: The climatic and soil conditions stated above are seen to be conducive for the growth and development of a variety of natural vegetation including deciduous and evergreen trees, several shrubs and herbs and some grasses. In the hilly ranges and piedmont zones, reserve forests like *Disoi, Tiru, Kakadonga* , etc. are located These forests are characterized by the dominance of a number of valuable tree species including *Ajhar(Lagesrstroemia flosreginae). Boga Koroi (Alvizzia procera), Khokan(Duabhanga sonneratioides), Nahar(Mesua ferrea),* etc. The common shrubs and herbs are *Bon Agora(Triumfelta), jatibet(Calamus tenuis), Dhekialata (Stenochola),* etc. Besides these, the up lands are also characterized by the dominance of the tea crops. The valley is found to be suitable for the cultivation of a variety of crops with the dominance of paddy. Varieties of tropical and sub-tropical fruits are also grown in the highlands of the district.

3.6. Physiographic Units: The whole of Jorhat is level plain except its southern narrow portion. Based on the geological structure and resultant topographical conditions, the district has been divided into three physiographic units, namely, the Brahmaputra flood plain, southern foot hill along Naga hills and the southern built-up zone in between the flood plain and foot hill (Taher 1986, pp.1-19). But, a more detailed physiographic

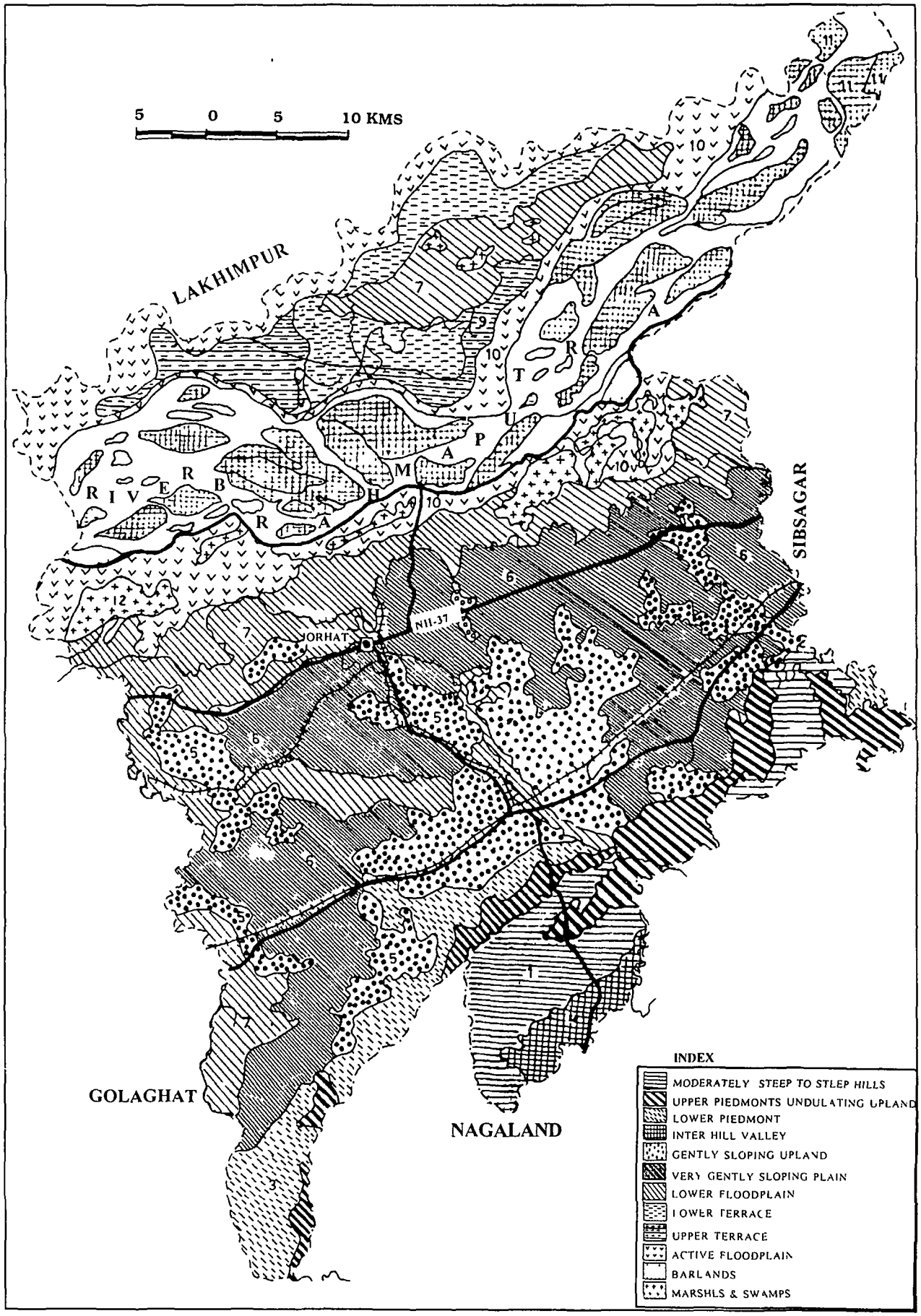
framework of Jorhat has been presented by the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), North-Eastern Regional Centre, Jorhat in 1993 On the basis of slope and soil conditions of Jorhat, the NBSS and LUP has divided the area in to twelve physiographic units (Fig -2 3) This scheme of classification is given in Table-2 1

Table- 2.1: Physiographic units of Jorhat District.

sl No.	Physiographic Units	Total Area (in hectare)	P.C. of Area to total Geographical Area
1	Moderately steep to steep land	12286 3	4 3
2	Upper Piedmont and Undulating Upland	11384 5	3 9
3	Lower Piedmont	13722 1	4 8
4	Interhill Valley	2602 9	0 9
5	Gently Sloping Upland	36713 8	12 8
6	Very Gently Sloping Land	59501 9	24 0
7	Lower Flood Plain	32103 6	10 5
8	Lower Terrace	16493 3	5 8
9	Upper Terrace	2760 9	1 0
10	Activ Flood Plain	30120 3	10 6
11	Bar Lands	22472 3	7 9
12	Marshes and Swamps	6304 7	2 2
	River Courses	32044 3	11 2
Total Geographical Area of the District		**278510.3**	**100.00**

(Source NBSS and LUP, 1993)

Physiographically, Jorhat is a level plain Only 4 3 percent of the area of the district is hilly having moderately steep slope (8 to 10 %) This lies at the southern margin of the district Both the upper and lower piedmont of the hills covers about 9 percent of the total area The Disoi Valley Reserve Forest, the Tiru Reserve Forest and the Kakadonga Reserve Forest are located at this belt Some of the areas of this piedmont have been used for the cultivation of tea Inter-hill valley region covers a very small segment of the total geographical area of Jorhat (0 9 %) All these four physiographic units fall within the southern foothill belt as identified by Taher (1986) in his physiographic framework of North-Eastern Region

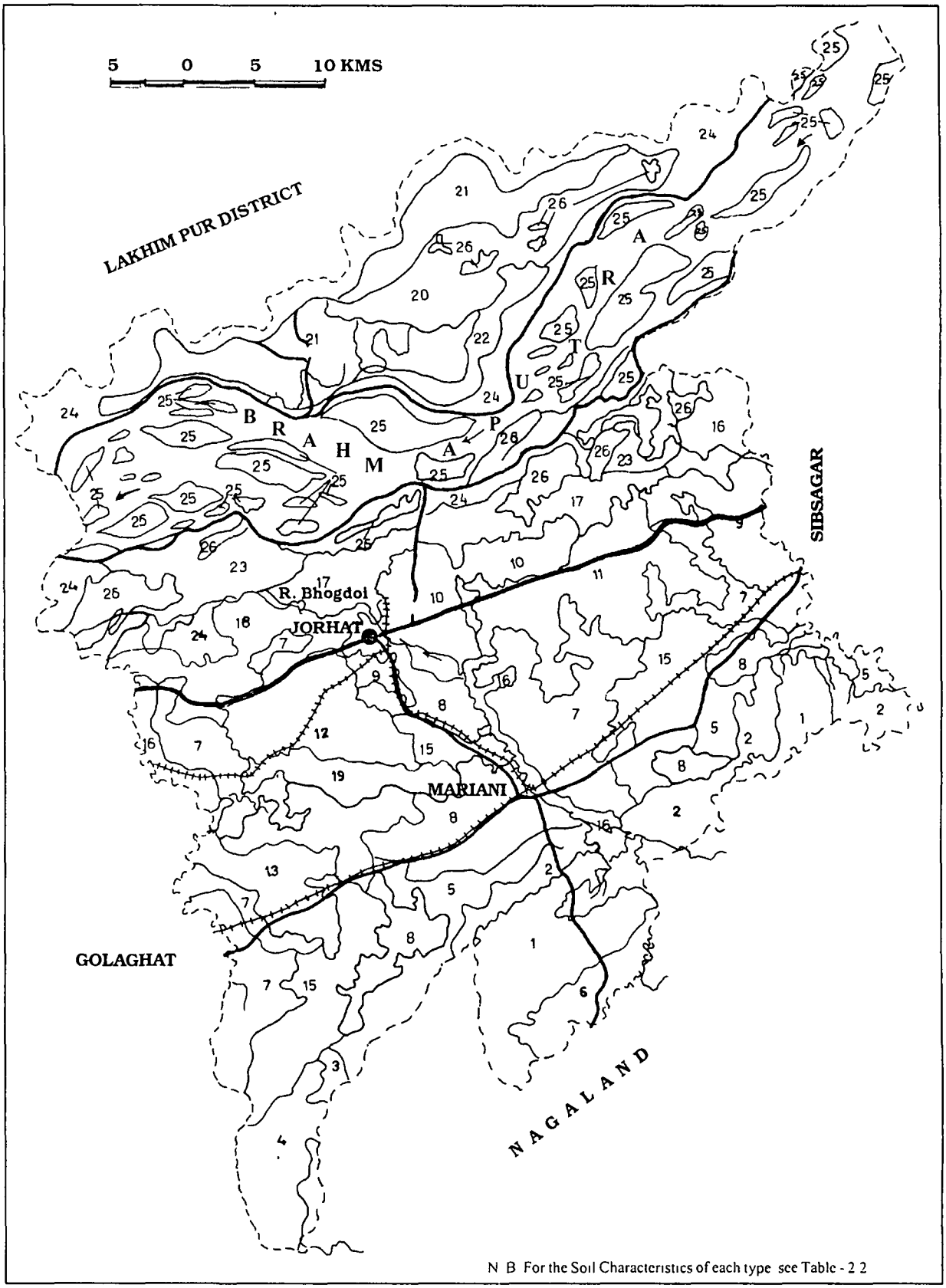


(SOURCE NBSS & LUP JORHAT)

Fig. - 2.3 : PHYSIOGRAPHIC UNITS OF JORHAT DISTRICT

Most of the areas of the district have a very gently slope and it is in this area that the entire human activities are concentrated. The proportions of gently sloping (3 to 8 %) and very gently sloping (1 to 3 %) land to the total geographical area of the district are 12.8 and 24.0 percent respectively. They together constitute about 36 percent of the land area and the entire area of this category falls within the southern built-up zone, as suggested by Taher (1986). However, a significant proportion of the land area of the district lies either at 1 percent or below slope category. Lower flood plain belt belongs to this category of land and covers about 11.00 percent of the total land. It is to be noted that the land area of this belt is used for summer rice, winter rice and other *rabi* and pulses. But the other physiographic units like upper and lower terraces, bar lands, marshes and swamps are practically unfit for cultivation. They together cover about 12 percent of the total area of Jorhat. The active flood plain belt covers about 10 percent of the area and the use of the land here is highly seasonal and dependent on retreat of monsoon. The physiographic units including the lower and upper terraces, active flood plain, bar lands, marshes and swamps are found largely in the Majuli sub-division of Jorhat.

3.6.(i). Soil-physiography Relationship: The physiographic divisions stated above have significant bearing on the formation of soils in the district with a variety of morphological properties. The NBSS and LUP of Jorhat Branch has conducted detailed soil survey of the area covering 21 soil series. In its report, it is said that the soils of Jorhat developed under the humid sub-tropical climate with mean annual rainfall of 1950 mm and mean annual temperature of 23.5 °C. The identified soils of the area have been classified by NBSS and LUP in to two orders (Entisols occupying 51 percent and inceptisols occupying 35.6 percent), 6 sub-orders, 8 great groups, 14 sub- groups and 19 families (NBSS & LUP 1993,pp.17-19). The physiography-soil relationship of Jorhat district is described in Table-2.2 given below and Fig-.2.4).



(Source NBSS & LUP JORHAT)

Fig. - 2.4 : SOIL CHARACTERISTICS OF JORHAT DISTRICT

Table-2.2: Soil Characteristics in various Physiographic Zones of Jorhat District.

Physiographic Unit	Soil Mapping Symbol	Brief description of Soils
Moderately Steep to Steep hill	1	Very deep, well drained, brownish yellow, fine Loamy soils with coarse fragments of 5-10p c on the hill slope of 10-15 % having sandy loam surface soils with moderate erosion hazard and gravelly coarseloamy soils on 33-50% hillslope with severe erosion hazard
Upper Piedmont and Undulating Upland	2	Very deep, well-drained, yellowish-brown soil on 3-5 % hill slope having sandy-loam cover with moderate erosion hazard
	3	Very deep, moderately well-drained, strong brown to reddish yellow, coarse-loamy soils on 1-3 % slope with moderate erosion hazard
Lower Piedmont	4	Very deep, imperfectly drained, yellowish-brown to light-brownish gray, fine loamy soils on 0-1 % slope having loam surface soils with slight erosion hazard
	5	Very deep, imperfectly drained, yellowish-brown to strong brown, coarse-loamy soils on 0-1% slope having sandy-loam surface with moderate flood and slight erosion hazard
Inter-hill Valley	6	Very deep, poorly to imperfectly drained, gray to light gray, coarse loamy soils over sand with yellowish brown to strong brown mottles on 0-1 p c slope with high ground water table within one meter and slight erosion hazard
Gently Sloping Upland	7	Very deep, moderately well-drained, brownish-yellow, fine silty soils on 1-3 % slope having silt loam surface soils with slight to moderate erosion hazard
	8	As given above
Very Gently Sloping Land	9	Very deep, imperfectly to poorly drained, light gray to gray, coarse loamy over coarse silty soils on 0-1 % slope with moderate flood and slight erosion hazard
	10	As given above
	11	Very deep, imperfectly drained, yellowish brown to brown, coarse silty over fine loamy soils on 1-3 % slope with slight erosion hazard

	12	Very deep, poorly to imperfectly drained, gray to dark gray, fine loamy soils on 0-1 % slope with moderate to severe flood hazard
	13	As given above
	14	Very deep, poorly drained, gray to light gray, clayey soils on 0-1 % slope with high ground water table and moderate flood hazard
	15	As given above
Lower Flood Plain	16	Very deep, imperfectly drained, yellowish brown to gray, sand over fine loamy soils on 1-3% slope with moderate to severe erosion hazard
	17	As given above
	18	Moderately deep to deep, well-drained, dark-yellowish brown to light gray sandy soils with grayish mottles on 1-3% slope having sandy loam surface soils with severe flood and moderate to severe erosion hazard
	19	As given above
	20	Deep, poorly drained, gray to light gray, coarse loamy soils with severe erosion hazard
Lower Terrace	21	As given above
Upper Terrace	22	Coarse loamy soils with severe erosion hazard
Active Flood Plain	23	As given above
	24	As above
Bar Lands	25	Coarse loamy soils, severe erosion hazard
Marshes and Swamps	26	Extremely sand, mud and water bodies

(Source NBSS&LUP, 1993)

Soil analysis of the district reveal that in the hill ranges and in the piedmont zones, soils are basically deep to very deep, coarse loamy or fine loamy in texture and brown to yellowish brown in colour The pH value ranges from 4 5 to 5 5 indicating moderate acidity of the soil On the other hand, the soils of the built-up zone and the flood plain area is characterised by the dominance of sand and silt with a pH value ranges from 5 5 to 6 5 reflecting slight acidity in the soil

4.0. Agricultural Conditions:

4.1. Existing Landuse Pattern: Land is an important component of life-support system. It meets our basic needs of food, fiber and fuel. Its analysis is meaningful because it reflects the cumulative outcome of historical events, the interaction of economic forces with the natural environment, and the value of society (Singh and Dhillon 1984, p.344). The landuse pattern of the district has been analysed against the background of this immense significance.

The total geographical area of the district, as already stated, is 285100 hectares. This extensive land area of the district has been used for different purposes (Table-2.3). The land covered by forest is about 28203 ha (i.e., 9.89 % to total district area as in 1997-98) against the state's coverage of 24.60 percent. This indicates that the area under forest of the district has gradually been declining due to the expansion of cultivated land over the years. For instance, during 1981-82, the area under forest was about 12.6 percent and this has now been reduced to 9 percent, reflecting a decline of 2.71 percent over the last sixteen years. What is most striking here is that a sizable portion of the total land of the district has already been put to non-agricultural purposes and, thus, the land not available for cultivation covers one-third area (36 % of the total land of the district against the state's average of 31.78 %). Over the years, the share of this category of land has been increasing. It was 32.7 percent in 1981-82, but rose to 36 percent in 1997-98 (i.e., nearly a total of 4 % increase over the last sixteen years) Due to the growth of population, the demands on land have been increasing for purposes like supporting settlement, government buildings, factories, transport and communication, etc. and these have subsequently enlarged the share of land for non-agricultural purposes.

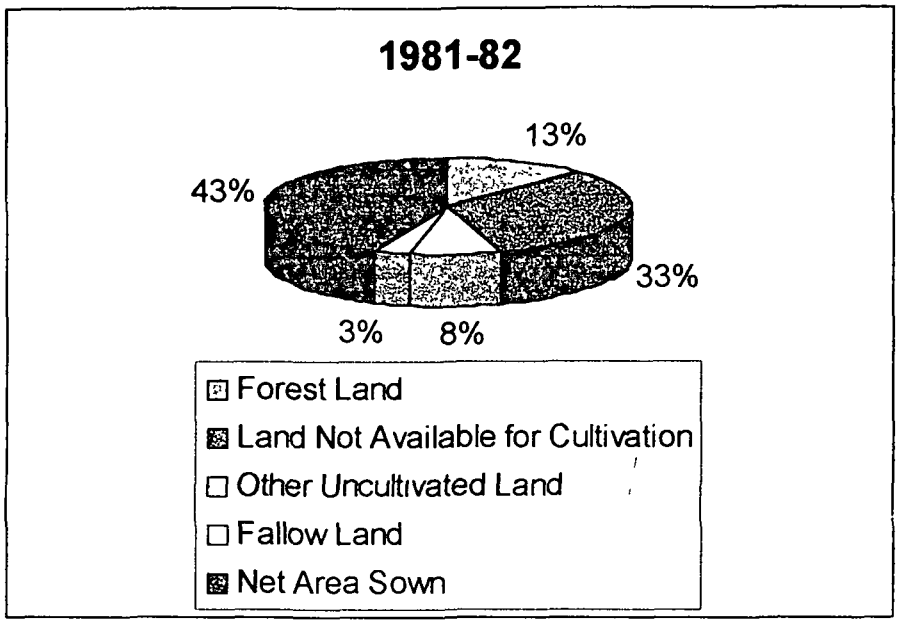
Other uncultivated land excluding fallow land but inclusive of pastures and grazing, miscellaneous trees, grooves and cultivable wasteland constitute about 7.6 percent

Table- 2.3: Land Use Pattern of Jorhat District, 1981-82 and 1997-98.

Sl No.	Land Category	Area (hectare) 1981-82	Area (hectare) 1997-98	P.C. of Total Area 1981-82	P.C. of Total Area 1997-98
1	Total Geographical Area	285930	285100	100 00	100 00
2	Forest	36194	28203	12 60	9 89
3	Land Not Available for Cultivation				
	a Land put to non-agricultural uses	72267	81627	25 30	28 63
	b Barren and uncultivated land	21136	21060	7 40	7 30
4	Other Uncultivated Land Excluding Fallow Land				
	a Permanent pastures & grazing land	4406	4406	1 60	1 50
	b Land under misc tree & grooves	9792	9364	3 40	3 20
	c Cultivable waste land	8823	7910	3 10	2 80
5	Fallow Land				
	a Fallow other than current fallow	5624	4643	2 00	1 60
	b Current fallow	3781	6947	1 30	2 40
6	Net Sown Area	123907	120940	43 40	42 40
7	Area Sown More Than Once	34000	45336	11 90	15 90
8	Total Cropped Area	158000	66276	55 00	58 32

Source Statistical Handbook, Directorate of Economics and Statistics, Govt of Assam Guwahati 1981 & 1997

of the total land area of the district In this context, the share is almost equal to that of the state's average of 6 17 percent Fallow land covers about 1 62 percent, larger than the state's share of 0 86 percent But the proportion of this category of land has also been declining from 2 00 percent in 1981-82 to 1 62 percent in 1997-98 Most of the cultivable waste lands and the fallow lands are concentrated in the flood plain belt of the district The net sown area, which is meaningful from the viewpoint of agriculture, covers 42 42 percent of the total geographical area, however higher than the state's proportion of 35 07 percent Unfortunately, this category of land has been declining from 43 3 percent in 1981-82 to 42 42 percent in 1997-98 As a result, the area not available for cultivation has been increasing Contrary to this, area sown more than once has been increasing, it was 11 92 percent in 1981-82 but rose to 15 90 percent in 1997-98, almost equal to the state average of 15 84 percent The total cropped area (net sown area plus area sown more than



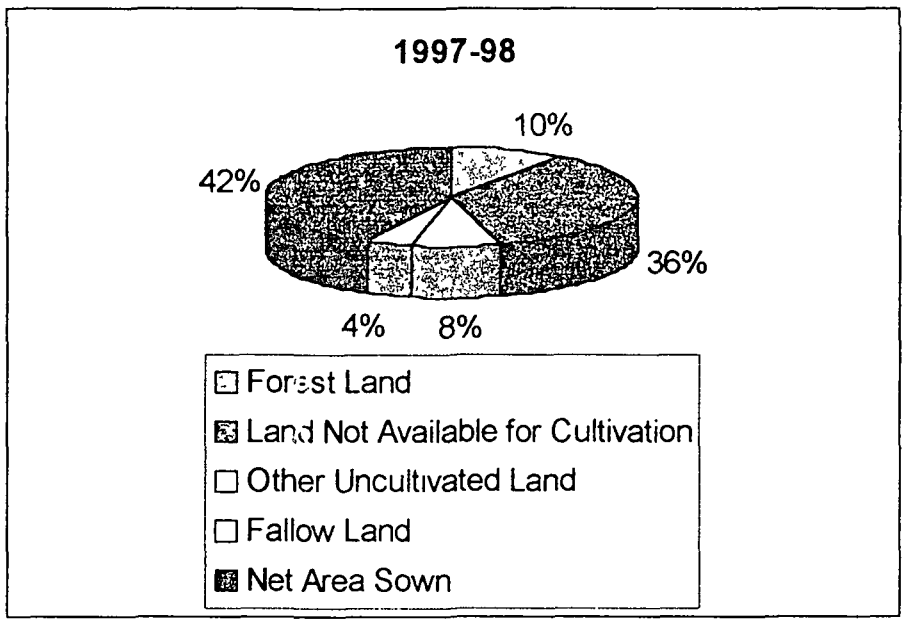


Fig.-2.5: Landuse Pattern in Jorhat District.

once) of the district stood at 58.32 percent in 1997-98 against the state average of 50.91 percent. It has been increasing at a rate of .30 percent per annum from 1981-82 to 1997-98 (Fig.-2.5).

4.2. Agricultural Land Use: Besides examining the general land use pattern of the district, it has now been attempted to analyse the land used for producing different crops. It is important because, as suggested by Das and Datta (1986), agricultural land use in any developing region like North-East India means the cultivation of soil for growing crops only, leaving an insignificant area for grass land, poultry farming, horticulture, pisciculture and dairy farming unlike in the developed regions of the world (Das et al 1986, p 32)

In Jorhat district, out of the total cropped area of 167 thousand ha (1997), about 83 percent has been used for producing food crops only of which cereals cover 80 percent and pulses about 3 percent (Table-2. 4) The area under different oil seeds is estimated at 8 percent, fibre 11 percent, vegetables about 2 8 percent and miscellaneous tree crops around 8 percent On the other hand, the state as a whole has 79.6 percent of area under food crops (76 % under cereals and about 4% under pulses), 8.75 percent under oil seeds, 2.93 percent under fiber, 4.78 percent under vegetables and 3.94 percent under miscellaneous tree crops As seen from the data, the agricultural land of the district is mainly devoted for the production of food crops with little commercialization in agriculture The major crops of the area include paddy, mustard, wheat, sesamum, black gram, green gram. lentil. peas, chillies, turmeric, sugar cane and a variety of horticultural and vegetable crops. Among the paddy, winter rice (*sali dhan*) is extensively cultivated (more than 70 % of rice area) followed by summer (*ahu dhan*) and autumn rice (*boro dhan*). These together cover about 78 percent to the total cultivated area. It is notable that the Borhola-Titabar area (Zone B) of Jorhat is identified as the 'granary' of the district because of its huge production and productivity. The land of this area is highly suitable

Table-2.4: Area and Yield of Principal Crops (1997-98).

Crops	Area (in hectares)	Yield (in kg/ha)
Autumn Rice	5370	1326
Winter Rice	84250	1548
Summer Rice	9560	1797
Total Rice	**99180**	**1560**
Maize	52	520
Wheat	2100	1209
Other cereals	25	367
Total	**2177**	**699**
Tur	20	613
Gram	11	378
Black Gram	980	348
GreenGram	230	480
Lentil	292	497
Peas	2080	418
Other Rabi Pulses	180	410
Total Pulses	**3793**	**411**
Castor	35	393
Sesamum	125	454
Rape and Mustard	9950	634
Total Oil Seeds	**10110**	**631**
Jute	125	1720
Cotton	3	70
Total Fiber	**128**	**900**
Sugar Cane	600	44111
Topeoca	5	5000
Potato	2950	5645
Sweet Potato	60	2900
Tobacco	10	530
Chillies	174	531
Onion	140	2200
Turmeric	260	630
Banana	2450	13459
Papaya	135	15500
Orange	95	11537
Pine Apple	200	16055
Arecanut	2700	144
Coconut	415	24
Total	**10194**	

Source: Basic Agricultural Statistics, Directorate of Agriculture. Govt. of Assam,1997-98.

for the cultivation and production of paddy. Moreover, the Rice Experimental Station of Assam was established here in 1922 to study the different varieties of paddy grown in Assam and this centre has an impact in changing the production pattern of the area (Gazetteer 1967, p.121.).

During the winter season, crops other than paddy are cultivated extensively. Pulses cover about 3 percent of total cropped area. This includes gram, black gram, green gram, lentil, peas, etc Oil seeds occupy a significant position in the cropping system of the district by covering an area of 8 percent of the total cultivated area. Rape and mustard is the dominant crop which cover an area of 9950 hectare. But the area under fiber crops is extremely less, that is only 11 percent to the total cropped area What is important here is that a variety of tropical and sub-tropical fruits including banana, coconut, arecanut, mangos, jackfruit, papaya, orange, pine apple, etc. has been grown to a larger extent in the district. Besides, several medicinal plants are found growing in wild conditions in the forests and aromatic grass like citronola is also grown in tea garden areas (NBSS&LUP Report 1993, p.13.). Vegetables are cultivated not only in the flood plain belt, but also in the highlands located along the southern margin of the district.

4.3. Crop Production and Yield: The district produces sufficient amount of paddy, oilseeds, and a number of vegetable crops. Paddy is the dominant crop and during 1997-98, the district produced about 153 thousand tones of paddy of all kinds, which are nearly 4 percent of the state's total production. The total production of cereals for the said period was 156 thousand tones against the state total of 3401 thousand tones, representing 4.56 percent of the state total production The production of pulses of all types was recorded 1558 tons which is 2.64 percent of the state as a whole. The total volume of production of oil seeds, fiber, sugar cane, potato and sweet potato was 3074, 1196, 26467 and 16651

tones during 1997-98 representing one percent, 1.87 percent, 1.75 percent and 2.94 percent respectively. The production of arecanut reached the level of 174 tones (56 % of the state) while the amount of chillies produced was 92 tones (1.02 % of the state). On the whole, the volume of production of all crops has been increasing over the years.

Since the mere volume of production cannot reflect the level of development of agriculture, it is therefore essential to examine the level of productivity or yield of different crops (Table-2.4). In the context of paddy, which is the staple food of the people of Assam, the yield rate is seen comparatively higher than the average yield of the state. The average yield of autumn rice stands at 1326 kg/ha, winter rice 1548 kg/ha and summer rice 1797 kg/ha and fortunately, all these rates are found higher than the state's average of 973, 1472 and 1615 kg/ha respectively. But the yield of wheat is recorded only 1209 kg/ha, lower than the state average of 1290 kg/ha Similarly, the yield of jute and potato is also found lower, 1720 kg/ha and 5645 kg/ha against the state average of 1832 and 7854 kg/ha respectively. On the other hand, the yield rates of rape and mustard and sugar cane are satisfactory which stand at 634 and 44111 kg/ha against the state's average of 533 and 42223 kg/ha respectively. The yield of all crops has been gradually increasing over the last fifty years. For instance, the yield rice in the district was around 1000 kg/ha in 1950-51, but now it has reached level of around 1500 kg/ha But unfortunately, the rate of increase of yield is not continuous, rather fluctuating from time to time The last ten years yield rate of rice (Table-2.5) simply reveals the truth As indicated by the data, the yield of rice in 1988-89 was 1121 kg/ha, but it rose to 1408 kg/ha in 1989-90 and thence to 1929 kg/ha in 1990-91 After that, the yield has declined to 1715 kg/ha in 1991-92, 1441 kg/ha in 1992-93 and again moved up to 1660 kg/ha in 1993-94 followed by a decline in 1994-95 (1479 kg/ha) and again by a rise in 1995 –96, 1996-97. Such fluctuations are seen to be associated with the yields of different types of paddy and other crops also. The

fluctuations thus emerged are the product of the natural factors, mainly the occurrence of monsoon rain in time.

4.4. Irrigation: In any monsoon climatic region, the importance of irrigation is quite significant which can enlarge the scope of producing a variety crop during an agricultural year. But it is disheartening to note that the gross irrigated area in the district is only 7 57 percent of the total cropped area against the state's average of 13 97 percent (1994-95) The medium and large irrigation projects are practically nil in the district. There are a number of minor irrigation projects in the area but that too is currently not working properly. During the period of survey, the farmers have reported that they were not benefited at all from the minor irrigation facilities due to the non-functioning of the project. Because of this, the intensity of land use in the sample is found very less

4.5. Fertilizer Input: The habit of using fertilizer in agriculture is not pronounced in Assam. It is seen that per hectare use of fertilizer in the state is around 10-12 kg However, the position of Jorhat in the context of fertilizer use is better, around 20 kg/h The commonly used chemical fertilizers of the district are Nitrogen, Phosphorous and Potassium. The consumption of fertilizer of all these categories stood at 1932 tones during the *"kharif"* season while during the *"rabi"* season, it was only 197 tones against the state consumption of 25008 and 5257 tones respectively for the years 1993-94 Thus the total consumption of fertilizer in that year was 2890 tones, about 7 percent of the state total consumption of 43172 tones

4.6. Use of HYV Seeds: The use of High Yielding Variety (HYV) of paddy in Assam has been increasing In Assam, about 115 thousand hectares of total rice area have been under these new varieties, thus representing around 46 percent of the total rice area In Jorhat, the area under "HYV" of paddy stood at 42448 hectares in 1993-94 that was around 47 percent of the total paddy area. Of the total area under High Yielding Variety of paddy in

Assam (i.e., 1144128 ha), the Jorhat district represents about 4 percent. The commonly used varieties of paddy in the district are IR-8, IR 20, *Jaya, Bahadur, Pankaj, Biplav, etc.*

Over the years, the agricultural landscape of Jorhat has been changing, but on a lower scale. The traditional bullock plough, paddy-weeder and other farm implements are still there. But along with these, new machineries like tractors, power tillers, sprinklers, pump sets etc. are being been used and the popularity of these implements among the farmers have gradually been increasing. How far these changes are being influenced by the population factors would be an interesting aspect for a geographer to reveal the spatial pattern of relationship between population and agriculture.

5.0. Population Characteristics:

The total population of the district was 8,71,206 in 1991 of which 4,55,525 (53.29%) were males and 4,15,681 (47.72 %) were females. Around 85 percent of the population live in the rural areas in 1,32,051 households, while 15 percent are the urban dwellers. The persons living in the rural areas have more relevance to the present study as it is a correlative study of population and agriculture. However, both the total population and the density of population of the district have been growing since the beginning of this century The total population stood at 1.9 lakh in 1901, then increased to 4 34 lakh in 1951 and thence to 8.71 lakh in 1991, an increase of about 343 percent over a period of 90 years Similarly, the density of population has also been increasing from 70 persons/sq.km. in 1901 to 153 in 1951 and then to 306 persons/sq km in 1991, a five time increase during the last 90 years. Fortunately, the growth rate of population of the district is not too high as that of the state. During the decade 1901-11, the rate of growth in Jorhat was 16.62 percent, which substantially declined to only 8.88 percent during 1921-31. But during the said decades, the rates of growth for the state as a whole were 16.99 and 19.91 percent respectively. Immediately after the country's independence in 1947, the growth

rate of population in the district was recorded at 15.03 percent (1941-51) against the state's rate of 19.93 percent. The 1951-61 and 1961-71 were the decades characterized by the explosive rate of population growth not only in Assam, but the country as a whole. Even during these two demographically important decades, the growth rate of population in Jorhat was significantly lower than that of the state average. It was recorded to be at 24.17 percent (34.98% for the state) and 17. 47 percent (34.95 % for the state) respectively for the decades 1951-61 and 1961-71. During the last two decades between 1971-91 (no census in Assam in 1981), the district's growth rate of population was 33.10 percent against the state's average growth rate of 53.26 percent.

From the viewpoint of agriculture, the rural density of population is more meaningful which is found to be at 265 persons/sq.km. in rural area. It is higher than the rural density of the state as 257 persons/sq.km. (1991). The rural area of the district in terms of the percentage to the total geographical area is 97 percent. This indicates that 85 percent of the rural population of Jorhat is concentrated over this 97 percent of the area by taking agriculture as the main stay of occupation. So far as the male-female ratio is concerned, it is seen that the ratio is in favour of male, i.e. 913 females per thousand of males. This overall sex ratio is observed to be lower than the state average of 923. But the rural sex ratio is calculated at 929, again lower than the state rural sex ratio of 933. In the educational sphere, Jorhat enjoys a comfortable position among the districts of Assam. The literacy rate for males and females stood at 73 and 56 percent respectively (1991) against the state's average of 61 and 43 percent. The literacy rate for the total population of the district (65 %) is also higher than the rate of the state (52 %). The number of total rural literate in the Jorhat district is recorded 3,84,591 persons and, out of this, 60 percent is constituted by males and 40 percent by females.

As far as the working population of the district is concerned, the scenario is very much striking. Out of the total population, its 38 percent share belongs to the workers category against the state proportion of 36 percent. Again, out of the total workers, the share of male is 70 p.c. while that of the female is 30 percent, almost similar to the state's proportion of 71 and 29 percent. Cultivators, agricultural labourers and other workers form the main working group and this along with the marginal workers constitute the strength of total working force. In the rural part of the district, total workers' share to the total rural population is around 35 percent, slightly lower than the state's average of 36 percent. Of this total rural working force, the males' share is 67 percent against the females' share of 33 percent. The proportion of cultivators and agricultural labourers to the total rural workers in the district are found to be at 51 and 6 percent respectively. On the other hand, the share of other workers to the total rural workers is stood at 43 percent. Nearly 12 percent of the workers belong to the category of marginal workers which is lower than the state's proportion of 14 percent. The share of marginal workers to the total population of the district is about 5 percent against the state's share of around 6 percent.

The sex differentials of workers in the district need special attention. In this context, sharp contrast has been noticed between male and female workers' strength. For instance, out of the total cultivators of 1,31,482 persons in the rural areas, 64 percent is seen to be constituted by male and remaining 36 percent by females. Similarly, of the total agricultural labourers in the area, male-female shares are 66 and 34 percent. On the other hand, 73 percent of the males belong to the other worker category while the females' strength is 27 percent. Contrary to this, male marginal workers are found to be at 24 percent against the females' strength of 76 percent, a typical feature of the economy based on the subsistence system of agriculture. What is most staggering here is the existence of a significant proportion of non-workers to the total population of the district (around 62 %).

There are more female non-workers (65 %) than that of the male counter part (45 %). The ratios are almost equal to that of the state as a whole.

6.0. Transport and Communication:

Mere existence of ecological conditions and abundant human population cannot accelerate the pace of development of any economic activity including agriculture Modernization in agriculture comes along with the development of infrastructure, basically transport and communication, which provide scope for the movement of goods, ideas and people In this context, the existing system needs to be evaluated in order to understand the associated problems and prospects

The district is well connected with the rest of the state by both road and railways In the context of rail transport, the district has a glorious history. After the construction of 80 km long Dibru-Sadiya (Dibrugarh District) metre gauge railway line in 1882 in Assam for the first time, Jorhat witnessed the second 30 miles (49 5 km.) long 2 feet wide Jorhat Provincial Railway running from Kokilamukh on the Brahmaputra river to Mariani and Titabar in 1885 (Gazetteer 1967,p 236.). Although the part of this railway line (Kokilamukh and Jorhat) has been abandoned today, it opened up a new chapter in the history of the development of rail transport in the district as well as in the state The remaining part of this line from Jorhat to Mariani has been still working and converted into broad gauge in 1997-98 The line belongs to the North East Frontier Railway with its headquarters at Maligaon

So far as the road transport is concerned, it is seen that the National Highway No 37 which runs from Pancharatna via Guwahati to Saikhowaghat, traverses through the district from east to west Besides this National Highway, a good number of state highways is running both east-west and north-south directions touching almost all parts of the district's agricultural land The system has further been strengthened by the existence

of a number of village roads. The total surface roads in the district are 324 km. i.e., 3 7 percent of the state's surface roads The un-surfaced roads length in the district is recorded 1394 km (5.78% of the state) However, out of the total road length of Jorhat, 18 85 percent is found to be surfaced road The length of the National Highway in the district is 52 km , state highway 173 km and other P W D roads 1493 km In relation to the population, the district has a commendable position Road length per lakh of population in Jorhat is 197 km against the state average of 147 km On the other hand, road length per hundred sq km of geographical area in the district is 60 km , higher than the state's average of only 41 9 km

There is also the inland water transport system connecting Jorhat with Majuli subdivision of the district through Neemati-Kamalabari Ghat (river port) The air field at Rowriah provides facilities for communication to the rest of the state as well as the nation In short, the district has a good transport and communication network

The agro-ecological conditions and human activities including infrastructure stated above simply reflect the suitability of the area for agricultural activities It is in this back ground that the district has been selected as a spatial unit of investigation in order to examine the proposed hypotheses

7.0. Agro-Ecological Zones:

Assam has been divided into six agro-climatic zones, viz , the Upper Brahmaputra Valley Zone, the Central Brahmaputra Valley Zone, the Lower Brahmaputra Valley Zone, the North Bank Plain Zone, the Barak Valley Zone and the Hill Zone Each agro-climatic zone has again been divided in to a number of smaller (micro) zones and for that matter, the Upper Brahmaputra Valley Zone at which Jorhat is located, has also been divided in to three zones, namely the rain-fed upland, the rain-fed medium land and the rain-fed low land situations resembling the zones of foot hills, built up and flood plain zones given by

Table-2.5: Agro-Ecological Zones of Jorhat District.

Nomenclature		Agro-ecological conditions of various zones.
Zone A	Moderately steep hilly Terrain	Humid sub-tropical climate with heavy rainfall from March to September, high summer air temperature(June to August) from 17 to 28 7°C, very deep, well drained fine loamy soils with coarse fragments, moderate pH value(4 5-5 5), luxuriant growth of deciduous and evergreen trees, tea cultivation and a number of horticultural rops along with the cultivation of paddy Altitude ranges from 180 to 450m above mean sea level(msl) Population density is moderate
Zone B	Piedmont Zone	Same type of climatic conditions, coarse loamy soils with common reddish brown soft iron nodules, tea cultivation dominates the area, paddy and other horticultural crops are grown Altitude ranges from 150 to 180 m above msl, Moderately acidic, Moderate population density
Zone C	Built Up Area	Similar climatic conditions with that of A, Very deep, coarse-loamy, fine-loamy, clayey and stratified soils with light gray to gray colour, slightly acidic(5 5 to 6 5 pH value), poorly drained, paddy crop dominates the landscape followed by other vegetables crops, altitude ranges from 90 to 150 m above msl Density of population is high, above 500 persons per sq km
Zone D	Flood plain Belt	Climatic conditions remain same, fine loamy soils with moderate to severe erosion hazard, slightly acidic, paddy is dominant followed by pulses and vegetables, altitude below 90 m

(Source NBSS&LUP 1993)

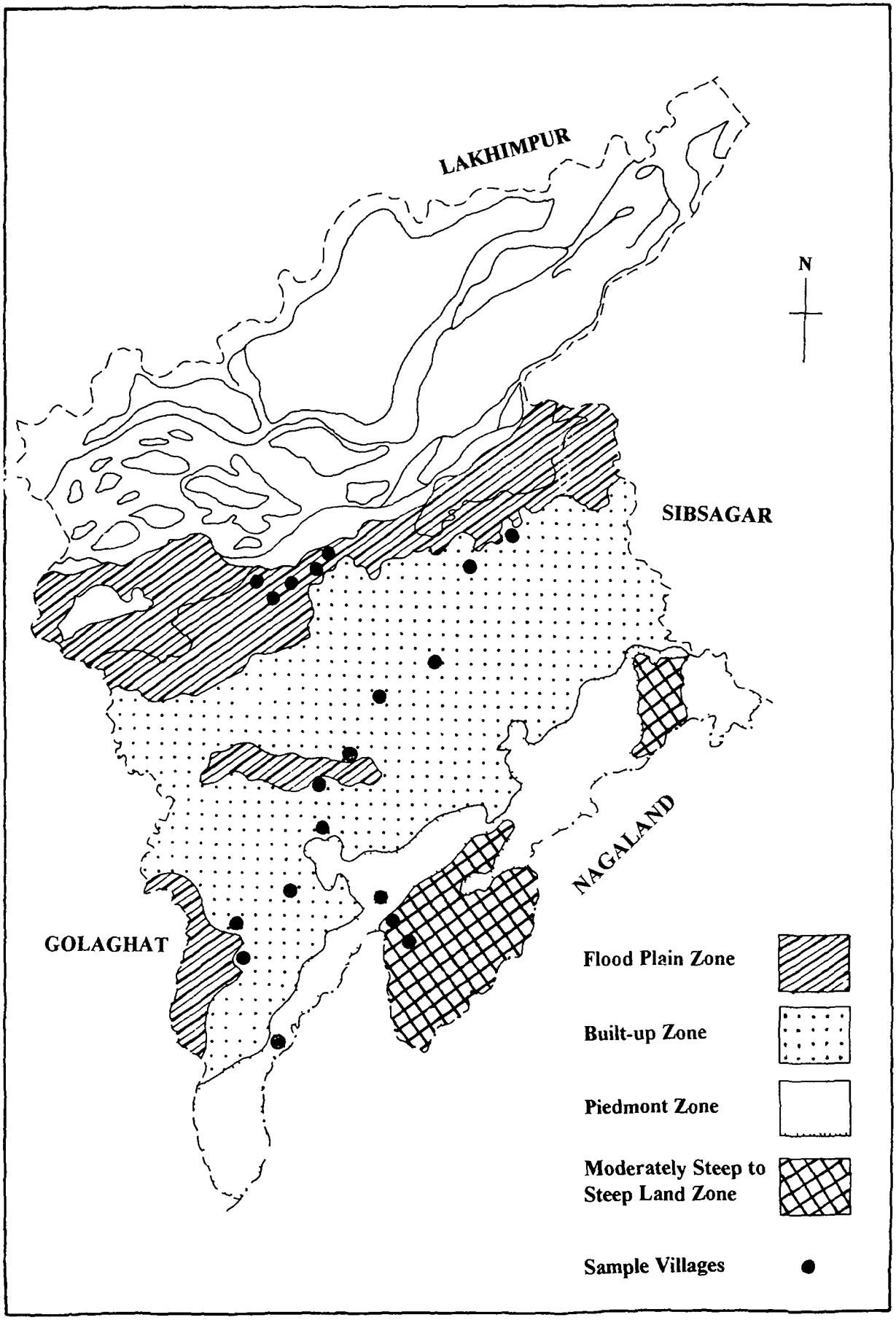


Fig.-2.6: AGRO-ECOLOGICAL ZONES OF JORHAT DISTRICT.

Taher (1986). However, considering the physiographic, climatic, soils and human activities, the district for the present study has been divided into four agro-ecological zones (Fig.-2.6, Table-2.5). The purpose of making such zones in the district is to examine in what ways, the population and agricultural attributes are related to each other and how the relationships vary according to the variations of agro-ecological conditions

7.1. Characteristics of Agro-Ecological Zones: Although the four agro-ecological zones as stated above have been characterized by different conditions, yet the differences are not too sharp to have significant impact both on population and agricultural fronts. However, the existing variations can be seen in the context of soils and vegetation resulting from the variations of altitude and slopes.

Accordingly, the moderately steep to steep land zones located at the southern margin of the district covers an area of about 120 sq. km. (i e , about 7 percent of the total area of Jorhat district) A few areas of this zone exhibits low hill ranges, believed to be the continuation of the Naga Hills with an altitude ranging from 150 to 450 m above mean sea level. The hills are dissected and forested but moderately to steeply slopping in various parts The soils are generally coarse textured and moderately acidic. The piedmont zone, on the other hand, covers an area of about 250 sq. km. (15 percent of Jorhat's total area). This zone is also dissected and forested, basically by deciduous forest. Tea is extensively cultivated in the area Soils are deep to very deep and coarse loamy in texture The built up zone is gently slopping and some parts are very gently slopping with both coarse-loamy and fine-loamy in texture Agricultural activities are prominent due to the levelness of the topography and high population density. To the south of this belt lies the flood plain zone of the district supporting a number of *beels*, marshes and swamps While the bed of the Brahmaputra itself is more than 3 kms. wide on the average, its flood plains extend to a distance of 5-10 km on each bank (Gazetteer 1967, p.22). Thus, the characteristics of each

agro-ecological zones of Jorhat vary slightly depending on the relief conditions The hill slopes have normal to excessive relief, the piedmonts have normal relief ant both the built-up and flood plain zones have sub-normal to flat or concave relief The general slope of the area is from southeast to northwest (NBSS&LUP 1993, p 2)

In the following sections, the population-agriculture nexus would be attempted to examine after analysing the basic population and agricultural characteristics Before that, a review of the work done in this direction by many researchers may be examined to identify the gap already left and going to be filled up the present study

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Chapter-III

Review of Literature

1.0. Introduction

Before dealing with the problem of population-agriculture nexus of the study region, it is desirable to review the research works already undertaken by different researchers on related issues This is essential, as Kothari (1996) points out, to find out what data and other materials, if any, are available for operational processes Robert and Verdoorn (1962) say that knowing what data are available often serves to narrow the problem itself as well as the techniques that might be used This helps to know if there are certain gaps in theories, or whether the existing theories applicable to the problem under study are inconsistent with each other, or whether the findings of the different studies do not follow a pattern consistent with the theoretical expectations and so on (Kothari 1996) Moreover, reviewing of works already done is also useful for indicating the type of difficulties that might be encountered in the present study as also the possible analytical shortcomings In this background, a detail review of the works available at different sources like academic journals, books, conference proceedings, government reports, etc has been attempted to undertake by the researcher

2.0. Extent of the Research Works:

The relationship between population and agriculture is as old as the history of human settlement on the earth itself But the works covering these two aspects have been increasing only in the last few decades The principle of Malthus (1978) might be the first systematic work in exposing the population-agriculture nexus in a more coherent manner But since then a couple of decades collapsed and it is from the first half of 20th century that a good number of works covering these two aspects appeared extensively Mention may be made of the works of Cipolla (1962), Boserup (1965), Clark (1967), Clark et, al

(1970), etc. who have attempted for conceptualization of the issue against the backdrop of world demographic and agricultural scenarios. Even then, the literature on the issue is not abundant in comparison to the seriousness of the issue. The situation seems to be more deplorable in India where population and agriculture has always been the central issue of development planning In his observations, Desai (1975) states that out of the total 3,594 articles/research papers appeared in various publications in India till 1970, only 73 (2.03 %) of these are related to the relationship between population and agriculture in some way or the another In his article on Some Aspects of Agricultural Economics: A Trend Report, Shah (1975) presents a topic wise classification of 1,918 references of research works appeared during 1955-1971. But he observes that the relationship between population and agriculture does not appear as a separate title in this classification. Kulkarni (1981) says that there has been the relative paucity of research work in the field of population-agriculture relationship. However, the scenario begins to change gradually and a few works appeared in various publications. But still the works are not extensive and yet to cover the multifaceted dimensions of population and agriculture. However, examining the existing literatures on the said issue, a four-fold classification of the works can be presented as studies relating to:

* the impact of population pressure on agricultural structure,
* the impact of agriculture development on demographic behaviour,
* the socio-economic factors and agricultural conditions, and
* the regionalization of agriculture based on the levels of productivity and development.

3.0. Population and Agriculture:

The first group of studies relates to the impact of population pressure on agricultural conditions. In this context, Myrdal's (1968) greatest work "Asian Drama" can be cited as a classic example. The author attempts to highlight the relationship between the density of

population and the cropping pattern of the developing countries. He clearly states that the wet paddy cultivation and plantation agriculture are the product of the higher density of population while the sedentary dry farming and the shifting cultivation proceed along with the lower density. Narrating the impact of population density on the productivity of labour, he further states that the higher density of population means the underutilization of labour force and even then they are at work, their productivity is usually low because of the lower level of technology. Under such circumstances, output per head is maintained only by drawing fresh lands under production until and unless physical conditions permit Although he highlights the basic fabric of population-agriculture nexus, this does not deal with how various population attributes can contribute towards the development of agriculture as a whole. Besides this classic work of Myrdal, there are also some experimental studies designed chiefly to explore the particular aspect of population and its impact on agriculture. Mention may be made of the work of Dandekar et al. (1972) who have attempted to observe the relationship between the density of rural population and the pattern of land use in 309 districts of India for the year 1961.Theirs hypothesis is that land under different uses, has different capacity to support the human population, and that this fact is reflected in the different densities of rural population under study. A simple multiple regression analysis reveals that the rural population density is highly correlated with the pattern of land use. Sarkar (1972) conducted a different kind of study in West Bengal and examined how population growth between 1951-71 brought about a change in the man-land ratio, the utilization of land for agricultural purposes and the availability of food grains. The author concludes that agricultural development in the 16 districts of West Bengal has been greatly affected by the dissimilar growth in population during the decades 1951-61 and 1961-71.

Taking Assam as an empirical unit, Das (1979) studies the impact of population pressure on the intensity of cropping. He observes that the rural population of Assam is increasing at a rapid rate and in the absence of non-agricultural works, the cultivated land is overcrowded by the surplus agricultural labourers along with their dependents. Such a pressure of population on agricultural land has a tendency to intensify the cultivation of limited land with two or more crops during an agricultural year in order to compensate the decrease in man land ratio. Using correlation and regression analysis, he comes to the conclusion that the variation in population densities accounts for about 48 percent of the variation in the intensity of cropping. The remaining 52 percent is due to the other independent physio-socio-economic variables. Similar kind of a study is conducted by Ray (1985) in Uttar Pradesh in which the author observes the relationship between population pressure and agricultural intensification. He reveals that a progressive diversification of cropped area from food grains to non-food grains production has typically characterized the process of intensification of agriculture in the plains of Uttar Pradesh. Being a staple food for subsistence, he says, the area under food grains is expected to have strong positive association with population density. But he observes that in Uttar Pradesh, the association gradually becomes weak as the districts progressively move to higher level of intensification in agriculture. Movement from higher to lower level of intensification in agriculture, in turn, is obtained through a series of induced changes in the environment for crop production which of course, must have varied from district to district and thus caused spatial variations in the intensification of agriculture. Behind this, population pressure is seen to be working in a dominant way. Another study of this kind is conducted by Rahman and Rumi (2001) in Bangladesh With the help of correlation and regression analysis, they observe that the intensity of cropping in Bangladesh is positively as well as significantly related to the pressure of population on agricultural land. Gatade and Kumbhar (1993)

states that the rate of growth of rural population and food production in developing countries including India is not matching at all due to the pressure of population and the individual decision making in the cropping system. Taking the Krishna basin as a spatial unit of investigation, the authors observe the relationship between population and food production. Tiwari (1997) also examines the relationship between the growth rate of population and food production in the Jharkhand region. Examining the relationship between the two, he concludes that like most parts of the world as well as in India, the rate of population growth and the rate of increase in food production in the study region are not at all matching and therefore, the author suggests for the replacement of traditional system of agriculture by modern farming system.

These studies are related to the population pressure and its impact on agricultural conditions in some way or the other. Here population pressure is taken up as a determining force and agricultural structure is examined in the context of this force.

4.0. Agricultural Development and Demography:

The second group of studies relates to the impact of agricultural development on demographic/ socio-economic behaviour. Unfortunately, a few works have been done in this field inspite of having its immense potentialities. However, some of these studies are related to the impact of new agricultural technology on the use of labour input, and some are related to the agricultural development and population growth. Among the first category, Bardhan's (1970) work is a good example. The author studies the impact of Intensive Area Development Programme (IADP) on the use of labour. He has shown that among the districts covered by the programme, only Ludhiana and West Godavari are reported to have shown a significant rise in labour employment per hectare between 1962-63 and 1967-68. Similar kind of a study is conducted by Rudra (1970) in Punjab. On the basis of a survey undertaken during 1968-69, he observes that of the 261 farms in Punjab

with operated holdings of more than 20 acres, only mechanised farms with tractors and those with tube wells and pumps but without tractors employed more labourers of both permanent and casual in nature than non-mechanized farms. There is not much variation in the intensity of the use of permanent servants per acre of land; but the mechanized farms use less casual labour than the non-mechanized ones. These studies simply indicate how the change in agricultural technology leads towards a change in the use of labour input. But in the second category of studies, one finds the impact of agricultural development on the demographic behaviour of population. Basu et al. (1979) analysed the relationship between agricultural development and fertility behaviour of rural population of Gujarat. In doing this, the author first selected two sets of villages-agriculturally developed and agriculturally underdeveloped on the basis of population size, caste/community composition, main economic activity, urban influence, land holdings and landuse pattern. Second, they calculated the cumulative fertility index of population and observed that agriculturally developed villages have a lower cumulative fertility index than underdeveloped villages due to the higher mean age at marriage and lower marital fertility. Tewari (1970) examines the impact of agricultural development on the growth rate of population in Uttar Pradesh. He states that both these variables are mutually related and the change of population is leading toward the change of landuse pattern in the state.

5.0. Socio-cultural Factors and Landuse Pattern:

Sharma (1979) studies the relationship between literacy and agricultural growth of Manipur. Considering the growth of literacy along with the growth of agriculture (a change from subsistence to commercial farming as defined by the author), he states that both of them are inversely related He observes that in the cultivating households particularly in the small and marginal farmers, the attendance/enrolment of children in primary schools is adversely affected by the demands for increase manpower either due to

the extensive farming operation or due the intensive farming viz., rotation of HYV (high yielding variety) and short duration seeds. This indicates that if the literacy ratio is attempted to enlarge, the agricultural activities tend to decline and if the latter has to be intensified, the former gets stagnant. This is the main problem of development in Manipur both in the spheres of agriculture and literacy. Das (1984) studied in detail the land use pattern in Assam and the impact of various factors including socio-economic and demographic on the pattern of land use has been examined and analyzed. In an another work, Tilak (1993) highlights systematically the role of education on agricultural productivity in Asian countries. Narrating the situation, he comments that rural development strategies that overrated land and underrated human beings have not succeeded considerably. It is realised that the fundamental problem of agricultural growth is an education problem. The need for education arises for rural development in general and agricultural development in particular. He suggests that education for peasants is indispensable because it improves their skills, replaces their traditional attitudes with modern ones and improve their innovative allocative abilities. He observed a positive relationship between education and agricultural growth in South Korea, Malayasia, Nepal, Thailand, India, Taiwan and Philippines. Duraisami (1992) also examines the effects of education and extension contacts on agricultural development in Tamilnadu and observes a positive and significant relationship between the two. He estimates the economic contribution of education and extension contacts on farm production using farm level data and shows the effects of education on multiple crop production Some of the researchers have examined that the educated farm family member, especially those with high school education and above in the age group of 15-59 years, can contribute more towards the process of mechanization and bio-chemicalization of farms Ojha et al. (1991) have observed that the share of high school literate and above was low in the lower size classes

(around 10%) and high in the upper size classes (around 25%) in the 15-59 age group. The low literacy rate in the former size class can explain the difficulties faced by the Extension Service Centres in the propagation of green revolution technology among them. It was also noted that the education level was high in the wheat, rice, sugarcane and cotton producing areas and low in the subsistence farming areas. The high literacy rate in the former has brought about a large scale diffusion of modern farm technology vis-à-vis the latter where traditional methods of farming were in vogue. These are examples of understanding the impact of education on agriculture. Besides these, some other studies are related to the socio-cultural factors and their influence on land use pattern.

Analyzing the role of human element, Singh et al.(1994) states that the same is more significant in those countries where national economy largely implies agricultural development. While travelling through India, he says, one still comes across lethargic farmers with miserable standard of living in certain states like Assam, Madhya Pradesh, Eastern Uttar Pradesh and Rajasthan. Contrary to this, one also finds energetic and enterprising farmers in states like Punjab and Haryana who have turned soils in to gold. The variations of this nature have resulted from the variations of human element. Nair (1961), Randhawa (1970), Krishna (1971), Singh (1979), etc. have studied the role of human element in changing the traditional structure of Indian agriculture with specific reference to the agricultural development in Punjab. There are also a number of studies relating to the impact of human labour on agricultural development. Bhattacharya (1985) examines the production pattern of agriculture in central and south-east Punjab and shows how the production of crops in the region is being influenced by the use of family labour. Santra (1999) studies the landuse pattern of Haora and the impact of 14 variables over it. Out of these variables, three are related to population. viz rural population, rural literacy and rural work force. He observes that the impact of these three variables in intensifying

the existing landuse is more significant than others. Moreover, quite a good number of studies are found to be related to the technological factors and production of crops. Omkar and Rao (1997) examine the impact of irrigation on land use pattern of Sriramsagar area ; Singh et al. (1991) studies the impact of irrigation on cropping pattern in Punjab; Prasad (1990) analyses the overall agricultural development against the background of irrigation; Tamilarasan (1993) examines the relationship between irrigation and cropping pattern, etc. are a few examples. These studies simply indicate the impact of a specific set of variables over the landuse and cropping pattern, the relative contribution of variables towards agricultural development is not highlighted.

6.0. Level of Agricultural Production and Productivity and Their Regional Variation:

The work of Mitra et al.(1971) is a good reference in this context. In this work, the authors attempt to correlate the total population of 277 districts of India with a number of agricultural variables, viz., the growth rate of agriculture, land and labour productivity, use of fertilizer, etc. Using correlation technique, the authors observe that the total population of the districts bears quite significant and positive relationship with the total foodgrain production, use of fretilizer, are under irrigation and land productivity. Hiremath et al. (1978) also conducted a similar kind of study in Karnataka. However, they emphasize more in measuring the pattern of land utilization and food efficiency in relation to total population, man-soil density, potential cultivable land and future requirements so as to gauge the existing land resource situation and future potential in Karnataka state Sadhukaran's (1978) study on the role of geo-economic factors in changing agricultural structure is a more systematic work in understanding the levels of agricultural production in South Indian states Through the multi-variate analysis of 7 agro-demographic variables, namely, the percentage of agricultural labourers, density of population,

percentage of cultivators, yield of rice, yield of cereals, percentage of area under cereals and percentage of irrigated area; the author closely examine the pattern of relationship among these variables and their relative cintribution in channelizing the volume of production and productivity.

Besides these empirical works, some researchers attempt to examine the regional variations in agricultural development and the associated factors. Gupta's (1982) work is an example of this kind. He analyses the regional variations in the agricultural sector of Punjab, Haryana and Bihar and concludes that the technological factors play dominant role in creating intra-regional variations in agricultural development. Kabra (1982) also examines the inter-state disparities in production and per capita availability of food in India in the light of certain government measures like procurement and PDS (Public Distribution Systam) for the period 1950-76. Singh (1994) makes a humble attempt to generate the relevant variables for agricultural regionalisation in India and analyses the regional character of agriculture in view of proper utilization of agricultural growth potential for preparing regional investment strategy. Sawant (1997) makes a national and state level analysis of aggregate growth performance of crop and livestock combined and emerging regional pattern of growth and diversification of crops. Sardana et al. (1997) have also proceeded on the similar line. However, they studied the agricultural performance of different districts of Haryana during the green revolution and post-green revolution period Reddy (1997) examines the spatio-temporal variations of costs and productivity of paddy in Andhra Pradesh He observes that relatively lower prices of modern inputs have enabled the farmers to substitute the modern inputs for traditional inputs and there by to obtain higher yields at lower costs In this way, more and more works covering agricultural performance and regional variations appeared during the last decade of the 20th century Shafiqullah (1999) examines the levels of agricultural

development in the Gonda district and attempts to identify the spatial variation of agricultural development from 1984-85 to 1992-93 with the help of Block-wise published data. Bhaskar et al. (2001) examines the agricultural efficiency pattern in Andhra Pradesh and concludes that physiological density, concentration of agricultural workers and size of holdings are the major determinants of the agricultural efficiency in the area. Bhalla and Alagh (1979) examines agricultural data for 282 districts of India for the period from 1962 to 1973. Covering 19 major crops, they examined the regional variations of agricultural productivity and growth and also evaluated various socio-economic and ecological factors responsible for such spatial variations.

7.0. Conclusion:

Reviewing the research works relating population and agriculture, it becomes clear that comparatively less works have been conducted so far incorporating the interconnections between these two vital issues. Whatever the literature available so far mainly deal with either with the implications of population growth and other population attributes on the structure of agriculture or the development of agriculture on the demographic behaviour in different political units of the country and abroad. Some of the studies are related to the regional variations of agricultural productivity and the factors contributing towards it in which population as a strong determinant has not been examined. In this context, the present work is deviating from the approach already adopted in the sense that here the main emphasis is given on to the interrelationship between the population attributes/characteristics and agricultural attributes reflecting development in different agro-ecological setting of the study area It is, in fact, an integrated approach designed chiefly to examine the pattern of relationship among the variables of population and agriculture and also emphasise significantly to elaborate how the relationship of the variables varies according to the variation of agro-ecological conditions It is, therefore,

expected to fill up the gap already left by the researchers belonging to the field of spatial science, i.e. geography.

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Chapter-IV

Population and Agricultural Characteristics

1.0. Introduction:

Since the basic purpose of the present work is to study the existing agricultural structure of Jorhat against the background of population characteristics, it becomes necessary to select a number of attributes both from population and agricultural spheres so that the relationship between them (population and agriculture) can be established, examined and analyzed. In order to achive the given end, the emphasis is now given on to the relevancy of the attributes, which can successfully explain the population-agriculture nexus and help in exploring the pattern of relationship in different agro-ecological zones Keeping this in view, a number of population and agricultural attributes has been selected on the basis of the data collected from the field through random sampling (see section 5 0 as Sample Design and Methodology of Chapter-I for more detail).

2.0. Selection of Population and Agricultural Attributes:

Population attributes are many. Starting from its absolute number, as Clarke (1972) states, it embraces physical (age, sex, race, etc.), social (family, households, literacy, language, religion, etc), economic (income, occupation, etc.), and also population dynamics (fertility, mortality, migration, etc.). But all these attributes are not equally influential in changing the agricultural structure of any locality and, therefore, the selection of the attributes is made on the basis of the relevancy of the attributes for the present purpose.

Similarly, attributes representing agricultural development are also many But the intensity of cropping and productivity of land, labour and capital are found to be more meaningful than others Therefore, these two have been selected for the analysis of agricultural development scenario of the study area Further, the use of fertilizer, size of

Table-4.1: Name of the Attributes.

Attributes	Unit
Demographic Attributes:	
1. Density of Population(Den)	Persons per hectare
2. Sex ratio(SR)	Females per thousand males
3. Dependency Ratio(DR)	in % (persons aged below 15 and above 59 per hundred adults between age group 15-59).
4. Adult Ratio(AR)	in % (adults/hundred of dependents in the family).
5. Annual Family Growth(AFG)	in % (based on birth and death rates of last three years prior to the date of survey).
Socio-Economic Attributes:	
1. Size of the Family(SF)	in numbers.
2. Literacy Rate below LP* Level(LR)	in % (literate persons below LP level per hundred of total population).
3. Educational Status above LP Level(ES)	in % (persons above LP level per hundred of total population).
4. Intensity of Family Labour(IFL)	no.of family labour used/hectare of land.
6. Intensity of Hired Labour(IHL)	no. of hired labour used/hectare of land.
7. Intensity of Total Labour(ITL)	average no.of both family and hired labour/hectare.
8. Intensity of Working Days of Family Labourers	in average no. of days in a year by a single labour.
9. Intensity of Working Days of Hired Labourers.	in average no. of days in a year by a single labour.
10. Intensity of Working Days of both family and Hired Labour.	in average no. of days in a year by a single labour.
11. Mandays	no. of workers per hectare per year.
12. Hired-Family Labour Ratio	in fraction.
Agricultural Attributes:	
1. Size of the Holding	in ha
2. Uncultivated Land to Total Land	in %.
3. Cultivated Land to Total Land	in %.
4. Intensity of Cropping	in %.
5. Volume of Production	in kg.
6. Land Productivity	Rs./ha
7. Labour Productivity	Rs./person
8. Use of Fertilizer	kg./ha

*LP- Lower Primary Education.

land holding, irrigation, etc are also contributing towards agricultural development of any area. Depending on the availability of information at the household level and considering the importance of information in the context of the present study, a few agricultural attributes have been identified and their associations with the population

attributes have been examined. Finally, twelve population and eight agricultural attributes (Table-4.1) of the sample households have been selected to study their pattern of interrelationship in various agro-ecological zones of the district.

3.0. Relevancy of the Attributes:

Among the demographic attributes density, age-sex composition and annual growth rate of family have been considered for the present work. Since the density is proportional, it is highly significant in understanding the pressure of population on agricultural land, which in turn, determines the pattern of land use. Age structure of population is important because it determines the potential man-power of a given population which have significant bearings on the supply of labour and resultant land use. Further, the dependency and adult ratios, which are connected with the age structure of population, have been taken up as variables for the purpose. Sex ratio is also considered as variable in the present work because it affects the social and economic relationship within a community (Chandna 1980). In order to understand the growth pattern of population, the annual family growth rate (based on three years average) is attempted to obtain so that future pressure of population on land can be evaluated. Thus, the demographic variables selected for the present study are found to be interrelated and have significant effect on the development of agriculture. The socio-economic variables included in the study are also related to the demographic attributes stated above and both of these contribute towards the conditions of agricultural structure The size of the family is an important social aspect and is being influenced by the annual growth rate of the family. On the other hand, the intensiveness in the use of inputs like labour, capital, etc for agricultural development is related to the size of the family. Moreover, the educational background of the inhabitants of the samples is also examined because it determines the level of awareness of the farmers Two categories of respondents, viz respondents with below lower primary level

and above lower primary level have been identified to see the effects of education on agricultural development. The intensity of labour input is an important aspect in conditioning the growth of agriculture. Therefore, the use of family labour and also the hired labour per hectare of agricultural land as variables have been selected for the purpose. Along with these, the average number days worked by an individual labour in a year has been considered as a variable. Thus, the socio-economic variables included in the work are seen to be relevant in understanding the agricultural scenario of the area and therefore, taken up for systematic evaluation.

In order to understand the structure of agriculture of the study area, the general land use pattern has been considered first and then a number of attributes have been derived. The size of the holding (Dantwala 1959), the proportion of the net sown area, intensity of land use, land and labour productivity, volume of production, use of fertilizer, are some of the attributes of agriculture related directly or indirectly to the population characteristics. Two attributes, namely, productivity of land (Khusro 1964) and labour, and the intensity of cropping are the reflection of agricultural development and therefore, included for the analysis. Other attributes like the size of the holding, fertilizer used, etc. provides conditions for agricultural development and hence included for the analysis to observe the structure of agriculture. Considering the pattern of interrelationship among the attributes selected for the present work, it can be concluded that the variables would be quite helpful in achieving the desired objectives stated in Chapter-I.

4.0. Selection of Determinants:

After selecting attributes both from the population and agricultural fronts, the population as well as agricultural characteristics are highlighted classifying the data of these attributes by considering five determinants related to population phenomena. These are (a) the size of the family, (b) the density of population, (c) the literacy rate, (d) the size

of the holding and (e) the crop intensity. These determinants are major socio-economic indicators of farmers' development. The data of 406 households of the selected attributes are collected agro-ecological zone-wise considering these determinants as bases of classification. Population and agricultural characteristics based on each of these determinants are examined in the following manner.

4.1. Population Characteristics according to the Family Size: In order to examine the population characteristics of the samples of various agro-ecological zones of the study area against the backdrop of family size, the latter itself has been classed in to five categories. These classes include, i) very small size (VS) families with 3 persons or less than that, ii) small size (SM) families with 4-5 persons, iii) medium size (MED) families with 6-7 persons, iv) large size (LS) families with 8-9 persons, and v) very large size(VLS) families with 10 persons or more. The number of sample households (frequency, i.e., f) in each family size class has been obtained and then the mean (x) value of selected population/agricultural characteristics has been calculated against each family size class. The distribution of frequencies (households) against each family size category for four agro-ecological zones is shown in Table-4.2. The mean value of a specific population attribute in a particular class has been compared with the mean value of all classes of the zone for that specific population attribute and then the characteristics of population has been analyzed as given below.

Higher concentration of frequencies (households) is seen in the small size category of family with 4-5 persons/family in all agro-ecological zones. The piedmont zone (zone B) is slightly deviating from the remaining zones in the context of the concentration of frequencies (6-7 persons/family). With the increase in the number of persons in the family, the number of households is declining. This suggests that there has been a proportional representation of households from different categories of family in the

Table-4.2: Distribution of Frequencies (Households) in Different Size Categories of Family under Various Agro-ecological Zones.

Category of Family	Class Size persons/family	Frequency (Household) Distribution in Zone A	Zone B	Zone C	Zone D
Very Small Size (VS)	< 3	07	05	18	13
Small Size (SM)	4-5	21	15	88	43
Medium Size (MED)	6-7	17	17	62	23
Large Size (LS)	8-9	04	07	28	12
Very Large (VLS)	>10	00	07	09	12
Total No. of Households		**49**	**51**	**205**	**101**

area (Table-4 2) Accordingly, the pressure of population (density) in the moderately steep to steep land (zone A) and in the piedmont zone (zone B) is found higher than the zonal average in the medium and large size family classes (Appendix-II, a). Even the built up area (zone C) of the district shows higher pressure of population in the said two size classes (more than 6 persons per hectare) than other classes. Families of these two size classes have comparatively smaller size of the holdings in respect of their population and consequently witnessed heavy concentration of human population. However, in the flood plains (zone D), high density of population is seen in the very small size family class indicating the paucity of land among the small size families. In other family size classes, the mean value of population density is closer to the zonal average of 5.8 persons/ha. So far as the sex ratio is concerned, the preponderance of females over males is seen higher only in the medium size family class (more than 1000 females per thousand males) in all agro-ecological zones except zone A where the ratio goes in favour of females both in the small and large size family classes What is important to note here is that the dependency ratio in all agro-ecological zones is higher in the medium size family class only where the number of persons is 6 to 7 This is because of the higher annual family growth rate of

population (.40 %) in this particular class. However, large number of dependents are also seen to be in the very large size family class of zone C and D not only due to the high birth rate, but also to the fact that the proportion of persons above 60 years of age in this class is comparatively higher indicating higher life expectancy of the people.

The population characteristics stated above are seen to be related with the other socio-economic aspects of the people of different family size classes in all agro-ecological zones. The share of persons with negligible educational level (below L.P. level) is highly concentrated (above 40%) in medium size family class both in zone A and B, but the same is seen to be higher in the large and very large size family classes in zone C and D This is mainly due to the concentration more dependents in the said classes who normally have very low educational background. In general, the size class of the family where the dependents are more, the intensity of family labour is expected to be less (less than 2 persons / ha), rather the intensity of family labour can be expected to be higher in the class where the proportion of adults to the total dependents is larger (more than 100 %). But the proposition is not in consonance with the reality of the study area. Here the intensity of family labour is related either to the sex ratio or the adult ratio of the people. In zone A, the family labour input per hectare is high (above 3) in small size family class where the sex ratio is high. In zone B, C and D, the intensity of family labour is high where the proportion of adults to the total dependents is larger. Contrary to this, the use of hired labour per hectare of land in zone A and B is high in the large size family class, while the same is high in the very small to medium size family classes in zone C and D. This suggests that in the moderately steep to steep land (A) and in the piedmont zones (B) where horticultural crops are extensively grown, the large number of hired labour throughout the year is indispensable to look after the crops. Those who have substantial amount of money and land for cultivation, on the other hand, can afford the hired labour

As indicated earlier, the large families of these zones have larger size of holdings and this means that these farmers are agriculturally rich and in need of hired labour in order to cultivate their land. The situation is different in zone C and D characterized by the gently to very gently sloping level and fertile land with paddy as the dominant crop. Since the crop is seasonal and dependent on monsoon, the small and medium size families with less number of family labour find it difficult to arrange the required labour of its own during the peak season of the crop and hence depends on hired labour to a greater extent. The average number of days worked by hired labour in a year depends on the nature of works and crops being cultivated. As stated, hired labour in small and medium size family classes of zone A and B works for more than 100 days in a year where there are a number of standing crops but in zone C and D, the same works for less than 70 days in a year where the cultivation is seasonal.

Thus, it is now apparent that the demographic and socio-economic attributes included for the present study show some sort of relationship among them and the characteristics of each set of attributes tend to vary according to the variations of the size of the family in four agro-ecological zones. The important features in the context of family size can be summarized as follows:

a. The size of the family has effects on demographic attributes, especially on the dependency ratio. Smaller the size of the family, greater is the proportion of adults and hence the lower is the share of dependents.

b. Family size is seen to be influencing the supply of labour, because with the increase of family size, the intensity of labour and the number of working days of the labour force of the household are also seen to be increasing.

c. The pressure of population in the family (density) and family size is seen to be related positively because increasing family size increases population density while land of the household is almost constant.

4.2.Population Characteristics according to the Population Density: The population characteristics of the farmers' households are interpreted by considering population density of their families. It will show increasing population pressure to the occupancy of land of a farmer family. With a view to examine the population characteristics of all agro-ecological zones against the background of density of population, the latter itself has been categorized into six convenient groups according to the number of persons per hectare. These groups are, i) very low density (VLD) of population with less than 1.99 persons/ha, ii) low density (LD) between 2 and 2.99, iii) moderate density (MOD) between 3 and 3.99, iv) high density (HD) between 4 and 4.99, v) fairly high density (FHD) between 5 and 5.99 and vi) very high density (VHD) of above 6 persons/ha (Appendix-II, b). The distribution of frequencies (households) against each category of density of population is given in Table-4.3. As evident from the data, the higher concentration of frequencies (households) in the moderately steep to steep land (zone A) and the built-up area (zone C) is seen in the very high density category while in the piedmont (zone B) and the flood plains (zone D), the concentration goes in favour of very low and low density categories respectively. This indicates that there are variations regarding the distribution of households both within and between different agro-ecological conditions. Now, the characteristics of population against each of the density group for different agro-ecological conditions of the study area are presented below.

There are no sharp variation regarding the size of the family against various density groups as already stated. It is ranging from 5 to 6 persons per family in the

moderately steep to steep land (A) and the built-up zone (C). In the piedmont (B) and the flood plain zone (D), a slight variation exists between them relating the size of the family.

Table-4.3: Distribution of Frequencies (Households) in Different Categories of Density of Population under Various Agro-ecological Zones.

Category of Density	Class Size persons/ha	Frequency (Household) Distribution in Zone A	Zone B	Zone C	Zone D
Very Low Density(VLD)	0-1.99	10	15	23	22
Low Density(LD)	2-2.99	08	05	35	25
Moderate Density(MOD)	3-3.99	09	07	25	15
High Density(HD)	4-4.99	03	06	27	12
Fairly High Density(FHD)	5-5.99	05	05	24	15
Very High Density(VHD)	>6.00	14	13	71	12
Total No. of Households		**49**	**51**	**205**	**101**

Families having 7 persons or more are there in the very low, low and fairly high density groups in zone B and moderate and high density groups in zone D. A comparatively larger size of the family in the said density groups of the piedmont and flood plain belts is primarily due to the existence of a few samples from the scheduled tribes who have traditionally been characterized by the predominance of a large number of children. Other demographic attributes against various density classes have reflected no specific pattern. Sex ratio, for instance, is higher than the zonal mean value (above 1000 female/thousand males) in the low, moderate and fairly high density classes in zone A but low and high density classes in zone B. While the ratio is very high (above 1200 females/thousand males) in the very high density class in zone C, the same is higher than the mean in high to very high density classes in zone D. Similarly, more dependents are seen in the low and fairly high density classes of zone A, very high density class of zone B, moderate to very high density classes of zone C and D. Literate persons with LP background are more

pronounced in low density group where the dependents are also more in other low density classes. In zones B, C, and D where the literacy rate is observed more than 50, 20 and 40 percents respectively in high and fairly high-density classes, the dependency ratio is also seen higher in these classes Thus it can be stated that the literacy rate, i e. the proportion of persons with lower primary level education seem to be influenced either by the dominance of females' or dependents share to the total population

Intensity of labour input tends to vary according to the variations of density classes in all agro-ecological zones In zone A and B, the intensity of family labour is more than 6 persons/ha in very high density class and in other density classes, the intensity is less than the zonal average of 2 75 and 5 5 persons/ha respectively Contrary to this, the intensity of hired labour is (around 2 persons/ha) more in very low density class of zone A and very low to moderate density classes in zone B In zone C and D, i e , in the built up and flood plain zones of the study area, the intensity family labour is higher both in the fairly high and very high density classes while the more hired labour are used in the low density classes. Another associated feature is that where the intensity of lobour input on land is more, the average number of days worked by an individual labour in a year is also found to be more An individual labour of the zone A works for about 210 days in a year in the high density class while in zone B, C, and D, the working days are 279, 110 and 58 respectively. However the zone D is deviating slightly from the norm reflected by other zones Here, the labourers from the low density class works more than other classes Thus, it is seen that the population characteristics against the background of density seem to vary according to the variations of density classes in four agro-ecological zones identified in the study area The salient features can be summed up as follows

a With the increase of population density of the household, its labour intensity also seen increases irrespective of the type of agro-ecological conditions

b Literacy rate, i e. the share of persons below lower primary level is seen to be increasing while the share of persons with higher educational background declines with the increase of population density

c The effects of density have been noticed on the dependency ratio It means population density increases with more number of children in the family who increases dependency on the working population of the farmers' family

4.3. Population Characteristics according to the Literacy rate: The population characteristics of the four agro-ecological zones have also been examined taking the literacy rate as determinant by classifying the total observations into five classes These classes include, i) very low literacy rate (VL) with less than 20 percent, ii) low literacy rate (L) between 20 and 40 percent, iii) medium literacy rate (MED) between 40 and 60 percent, iv) high literacy rate (H) between 60 and 80 percent and v) very high literacy rate (VH) of above 80 percent The distribution of frequencies (households) in literacy categories for various agro-ecological zones are presented is presented in Table-4 4. The distribution of households in all agro-ecological zones is found to be concentrated either in very low literacy (such as zones A, B and D) or low literacy category (such as zone C) This is indicative of the fact that most of the households of the study area are characterized basically by the higher concentration of literate persons with only lower primary background of education The characteristics of population against each literacy class have been presented below.

The size of the family in the moderately steep to steep land zone (A) is higher than the zonal average of 5 3 in the high literacy class but in the piedmont area (zone B), built up (zone C) and flood plains (zone D), low literacy class witnesses the higher family size of more than 6 persons per family(Appendix-II, c)

Table-4.4: Distribution of Frequencies (Households) in Different Categories of Literacy Rate under Various Agro-ecological Zones.

Category of Literacy Rate	Class Size in %	Frequency (Household) Distribution in Zone A	Zone B	Zone C	Zone D
Very Low (VL)	0-20	12	15	84	36
Low (L)	20-40	07	15	86	29
Medium (MED)	40-60	05	11	28	24
High (H)	60-80	09	07	05	05
Very High (VH)	>80	06	03	02	07
Total No. of Households		**49**	**51**	**205**	**101**

Higher literacy class means the more proportion of the persons with only lower primary background and smaller proportion of persons with above lower primary background and *vice-versa*. In the steep land zone (A), large family size in the high literacy class is primarily due to the existence of smaller share of persons with high educational status, a phenomenon common to all developing areas of the country. On the other hand, low literacy rate means more persons with higher educational status and as such the deliberate control of family size is an expected phenomenon seen in zones B, C and D of the study area. As far as the pressure of population (density) is concerned, the medium size literacy class of all agro-ecological zones reflects higher pressure of population (more than 8/ha) than the averages of their respective zones. In the context of sex ratio, very low literacy classes of zone A, medium literacy class of zones B and D, and high literacy class of zone C indicate more females than males (more than 1000). Dependency ratio is seen stronger in all agro-ecological zone in the high or very high literacy classes (above50 %) Variations of these kinds can be the product of a number of socio-economic factors

Use of family labour per hectare of land is seen to be higher in medium size literacy class of zones A, C, and D, and while in the low literacy class of zone B. As soon as the intensity of family labour is high, the intensity of hired labour is low The assumption is seen to be applicable in all zones irrespective of theirs agro-ecological conditions. But man days per hectare per year in zone A and B are higher than the zonal average (about 150 days) in the medium and high literacy classes, but in zones C and D the same is higher in the very low literacy class. The basic features are given below:

a. The positive effects of literacy rate are seen over the availability of labour input and the size of the family.

b. Literacy rate and the availability of family labour show positive associations.

c Average number of days worked by a labour is seen to be effected by the literacy rate.

4.4. Population Characteristics according to the Size of Land Holding: After examining the population characteristics in the context of demographic and social attributes stated above, now the attention has been focussed to see the same in relation to the size of land holding of the collected samples. In order to see the characteristics, the size of holdings have been categorized in to five groups, viz., i) below marginal holding (<MH; less than 0.99 ha.), ii) marginal holding (M; between 1.00 and 1.99 ha), iii) small holding (SH; 2.00 and 2.99 ha), iv) small medium holding (SMH; 3.00 and 3.99 ha) and v) medium holding (MDH; above 4.00 ha). The zone wise distribution of frequencies (households) against each size category of land holdings is shown in Table-4.5.

Frequencies (i.e., households) are found to be concentrated mainly in the below marginal (as in zones A, B and C) and marginal category (as in zone D) of holdings with less than 2 ha/household. As the size category of holdings goes up, the number of

Table-4.5: Distribution of Frequencies (Households) in Different Categories of Land Holdings under Various Agro-ecological Zones.

Category of Land Holdings	Class Size (in ha)	Frequency (Household) Distribution in Zone A	Zone B	Zone C	Zone D
Below Marginal (<M)	0-0 99	17	15	77	20
Marginal (M)	1-1.99	17	14	65	38
Small Holdings (SM)	2-2.99	09	05	27	25
Small Medium (SMH)	3-3.99	03	10	16	04
Medium Holdings(MDH)	>4 00	03	07	20	14
Total No. of Households		**49**	**51**	**205**	**101**

households tends to decline in all agro-ecological zones. This is a common phenomenon as far as the distribution of households into various land holding sizes are concerned in the state. In the context of the distribution of frequencies into various classes of holdings, the population characteristics of the households are examined as presented below.

Very Large size of holding (above 6 ha) is practically absent in the study area. Most of the farmers have either small, marginal or below marginal size of holding and the population characteristics according to the size of the holdings are seen to be different. Households with below marginal size of holdings show greater concentration of population (more than 10 persons/ha) than the remaining size classes of holdings not only in the moderately steep to steep land (A) and the piedmont zone (B), but also in the flood plain belt (D). Contrary to this, the built up zone (C) with gently sloping land reflect higher concentration of population both in the small and small medium holding classes. This suggests that the area characterized by the suitable agro-ecological conditions have more population pressure on the land where the size ranges from 2 00 to 4.00 ha. Size of the family, on the other hand, stands larger (above 6 persons) in the medium size holding

classes in all agro-ecological zones indicating positive relationship between the size of the holding and the size of the family. Dominance of females over males (sex ratio) are seen stronger (more than 1000) either in the below marginal or marginal size holding classes in all zones indicating no direct connection between the agro-ecological conditions and the sex ratio of population The proportions of dependents to the total population in zone A is more (52 %) in the small and small medium holding classes, in zone B in the below marginal and marginal size holding classes (more than 80 %), in zone C in the small medium and medium size holding classes (more than 70 %) and in zone D in the below marginal and small size holding classes (more than 60 %) The variations regarding the dependency ratio among the various size classes of holdings in different agro-ecological zones are not too stronger to draw any meaningful conclusion. The annual rate of family growth in zone A and B is seen higher in the below marginal and marginal size holding classes respectively But in zone C and D, the rate is seen higher in the small and small medium size holding classes

Examining the technological and socio-economic changes in agriculture of India, Ojha et al (1991) has observed that the share of high school literate was low in the lower size holding classes (around 10 %) and high in the upper size classes. In the present work, the share of persons with higher educational background (above LP level) in zone A and B is larger in small and medium size holding classes (more than 40 %) in C in the below marginal and marginal size holding classes (60 %) and in D in the small size holding class (70 %). While examined the levels of education by land size category in a predominantly tribal socio-economic setup of Aravalli, Chotanagpur and Dandakaranya regions of India, Dash (2001) observed the higher share of persons with high school background in the land size category of 4-10 hectares in one of the villages of Chotanagpur region. In an another tribal village of Aravalli region, the share was found

higher in the category of 0.50-1.00 ha of land size. In Dandakaranya region; the tribal villages show no literate persons with high school education background. Although the agro-ecological setting of the present study area is different from the tribal regions stated above, the share of high school literate is seen higher in the category where the size is more than three hectares. Thus, the land size and educational status has a positive link in any kind of agro-ecological conditions. The educational status in the various size classes of holdings indicates relationship with the availability of labour of the households. Households with higher proportions of persons above LP background are characterized by the paucity of family labour and as such the intensity hired labour input becomes stronger. For instance, in zone A where educational status of the persons (in below marginal holding class) is low, the intensity of family labour is high (6 persons/ha) and where the educational status is high (medium size holding class), the intensity of family labour is low (1 persons/ha) but the hired labour is high (5 persons/ha). In zone B, the educational status is higher in small to medium size holding classes, but the use of family labour in these size classes of land is lower (less than 1 persons/ha). This indicates that the lower intensity of family labour results from the higher level of educational status either because of the more number of schools going children or the involvement of the educated groups in other sectors of the economy. So far as the use of total labour input is concerned irrespective of the family or hired labour, the intensity seems to be higher in the below marginal or marginal size of holding classes in all agro-ecological zones. Similarly man-days per hectare per year is higher only in the marginal or small size of holdings. However, the important features can be summed up as follows:

a. With the increase in the land holding size of the farmers' family, the mean values of family size are also seen to be increasing.

b Density and holding size shows negative association.

c. Holding size also indicates negative association with the labour intensity and working days.

4.5. Population Characteristics according to the Intensity of Cropping: With a view to examine the population characteristics against the background of the intensity of cropping, the latter has been categorized in to five classes, viz., i) very low intensity of cropping (VL; less than115 %), ii) low intensity of cropping (L; 115-130 %), iii) moderate intensity of cropping (MOD;130-145 %), iv) high intensity of cropping (H; 145-160 %) and v) very high intensity of cropping (VH; above 160 %). The distribution of frequencies (households) against each category crop intensity in different zones is given in Table-4.6.

Table-4.6: Distribution of Frequencies (Households) in Different Categories of Crop Intensity under Various Agro-ecological Zones.

Category of Crop Intensity	Class Size	Frequency (Household) Distribution in			
		Zone A	Zone B	Zone C	Zone D
Very Low Intensity (VL)	<115	17	11	117	59
Low Intensity (L)	116-130	11	10	32	16
Moderate Intensity (MOD)	131-145	09	03	10	08
High Intensity (H)	146-160	06	07	12	08
Very High Intensity (VH)	>160	06	20	34	10
Total No. of Households		**49**	**51**	**205**	**101**

The interesting scenario that emerge from the distribution pattern of the frequencies (households) in different categories of crop intensity in various zones is that, households are basically concentrated in the very low intensity of cropping in all zones. As the level of crop intensity increases, the number of households decreases indicating that potentiality of enhancing land productivity through intensive land use in the area is still large. Against the backdrop of the present distribution pattern of the frequencies in various crop intensity

categories, the demographic and socio-economic attributes and their characteristics are examined and analyzed as given below.

Pressure of population (density) is found to be stronger (more than 7 persons/ha) in the high and very high intensity of cropping categories of steep land zone (zone A), piedmont zone (zone B) and the flood plain zone (zone D), while low intensity of cropping category in the built up zone (zone C). In the gently sloping topography (C) with fertile land, the intensity of cropping is not high inspite of having its pressure of population on land. This may be due to the sufficient production of a single crop for the farmers or due to the involvement of the persons in other sectors of the economy as the zone is closer to the Jorhat urban center. Females' share to the males shows no clear-cut link with that of various intensity of cropping classes. In the steep land zone (A), the ratio goes in favour of females (above 1000 females/thousand males) in the high and very high intensity of cropping classes. Similarly, in zones B, C and D, the ratios are in favour of females in the high, very high and very low intensity of cropping categories respectively. In the context of the dependency ratio, more dependents are seen in the moderate to high intensity of cropping in zone A, moderate and very high intensity of cropping in zone B, high intensity of cropping in zone C and D (above 36 percent in zone A, 100 percent in zone B, 60 percent in zone C and 50 percent in zone D). Interestingly enough, the proportion of literate persons (below LP level) to total population is seen to be higher in the high and very high intensity of cropping (above 40 percent) in all agro-ecological zones of the area. More literacy ratio means abundant supply of labour with no alternative employment potentials other than agriculture for day to day living.

As far as labour input pattern is concerned, the scenario is something different according to the variations of crop intensity categories of various agro-ecological zones of the area. The very high intensity of cropping class of zone A has higher proportion of

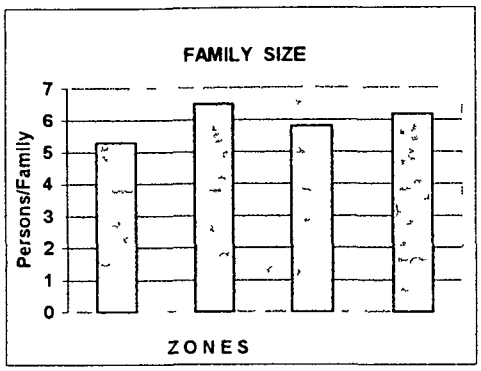
family labour input per hectare of land (more than 3 persons/ha). But, hired labour is seen to be highly used (2persons/ha) in the very low intensity category of land use. Similar picture has been reflected by zone B, i.e., the piedmont zone. In the built up zone (C), family labour used per hectare of land is higher in the high and very high intensity of cropping categories (3 persons/ha) while the use of hired labour is more in the low and moderate intensity of cropping categories (one person/ha). Both family and hired labour intensity is seen to be stronger in the flood plain zone of the area in the very low intensity of cropping categories. The salient features are as follows:

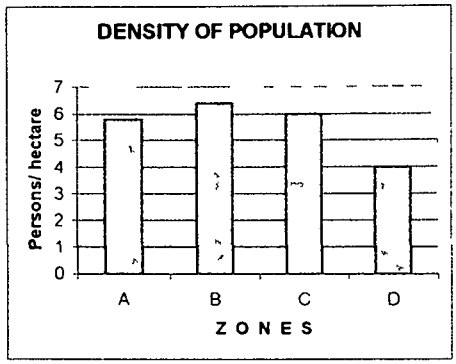
a. Crop intensity is seen to be effected by the persons with lower education background and the availability of family labour.
b. Number of days worked by an individual labour in year is influencing the intensity of cropping.

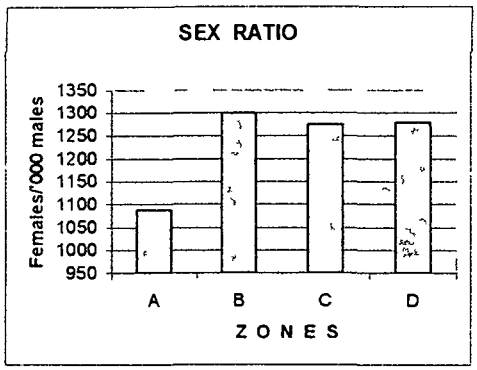
5.0. Population Characteristics in Different Agro-ecological Zones:

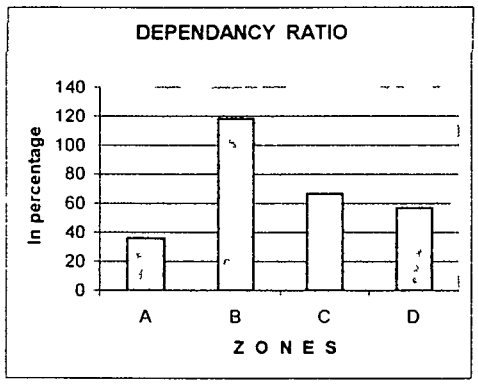
After examining the population characteristics of various zones against each classes/categories of the determinants stated above, the emphasis is now given on towards the analysis of population characteristics of four agro-ecological zones. In analyzing the characteristics of selected demographic and socio-economic attributes included in the present work, the mean values of different attributes have been calculated and then compared. Accordingly, the average family size for the moderately steep to steep land zone (zoneA) stands at 5.32, for piedmont zone (zone B) at 6.52, for built up zone (zone C) at 5.8 and for the flood plain zone (zone D) at 6.2. The mean values relating the size of the families show no sharp contrast, as the range is less than one between highest and lowest sizes of family. The mean value of the share of females per thousand males varies significantly from zone to zone, ranging from 1088 in zone A to 1300 in zone B. On the other hand, the share of dependents in zone A is 36 percent, 118 percent in B, 67 percent

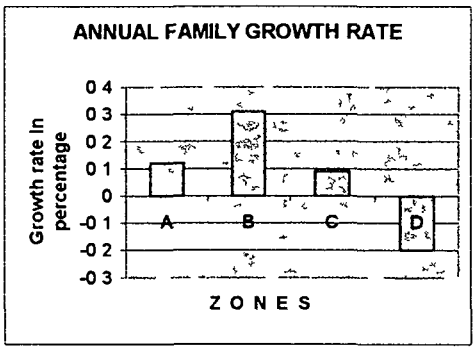
in C and 57 percent in zone D. In the piedmont zone, there exists more dependents than remaining zones. So far as the annual family growth rate is concerned, it is interesting to note that in all agro-ecological zones the rate is extremely lower (less than .50 percent) and in fact negative in the flood plain zone due to the out migration of people. Literacy rate is highest in zone A (43 percent), followed by Zone B (38 percent), D (36 percent), and C (24 percent). Contrary to this, the share of literate persons with above LP background is highest in zone C (67 percent) and this is followed by zone D (65 percent), B (44 percent) and zone A (33 percent). Persons with higher educational status are higher in C and D because these zones are closer to the Jorhat City and hence the impact of urbanization is stronger here than other zones. The use of labour input per hectare of land irrespective of family and hired type, is high both in zones A and B (above 4 persons/ha) but low in zones C and D (less than 4 persons/ha). The hilly land with comparatively rugged topography demands more labourers as in the case of zones A and B, while the level land with fertile topography needs less amount labourers as in zones C and D. Similarly, the average number of days worked by an individual labour in a year is higher in zone A and B, i.e. in the moderately steep to steep land zone and the piedmont zone (more than 150 days in a year), but lower in zones C and D, i.e. in the built up and flood plain zones (around 70 days). Man-days per hectare per year is high in zones A and B (140 days/ha/y) and low in zones C and D (about 100 days/ha/y). Hilly lands are agro-ecologically suitable for the cultivation of horticultural crops, which require constant vigil throughout the year, and consequently the zones have been characterized by the higher mandays. Thus, the characteristics of population attributes tend to vary according to the variations of agro-ecological conditions, but the variation is minimum (Fig.-4.1).

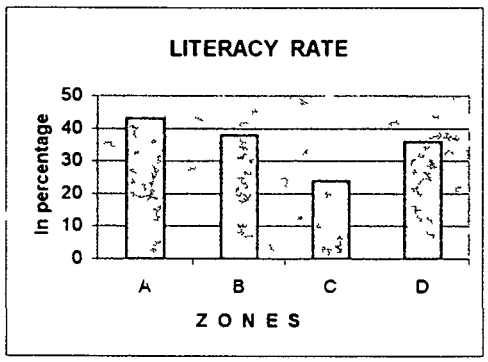

FAMILY SIZE
Persons/Family
7
6
5
4
3
2
1
0
ZONES

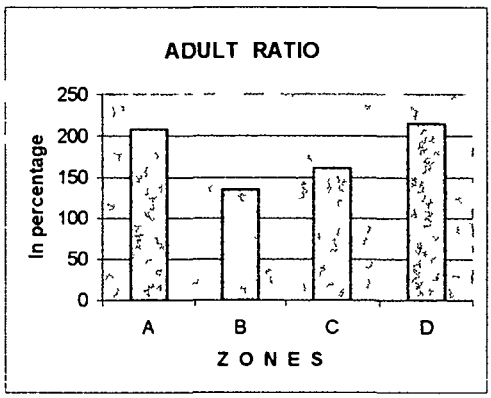

DENSITY OF POPULATION
Persons/ hectare
7
6
5
4
3
2
1
0
A
B
C
D
ZONES

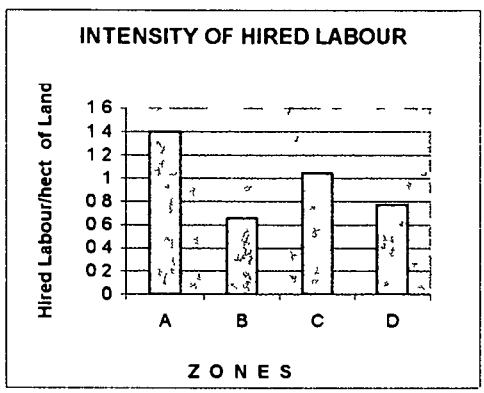

SEX RATIO
Females/'000 males
1350
1300
1250
1200
1150
1100
1050
1000
950
A
B
C
D
ZONES

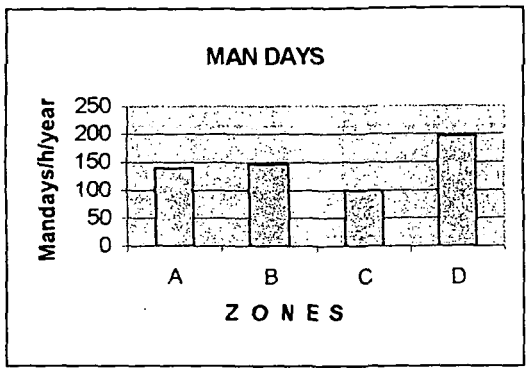

DEPENDANCY RATIO
In percentage
140
120
100
80
60
40
20
0
A
B
C
D
ZONES

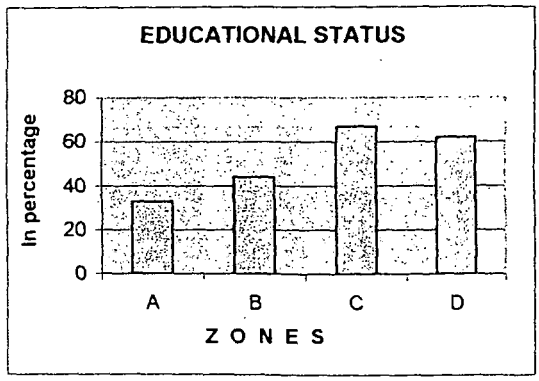

ANNUAL FAMILY GROWTH RATE
Growth rate In percentage
0 4
0 3
0 2
0 1
0
-0 1
-0 2
-0 3
A
B
C
D
ZONES

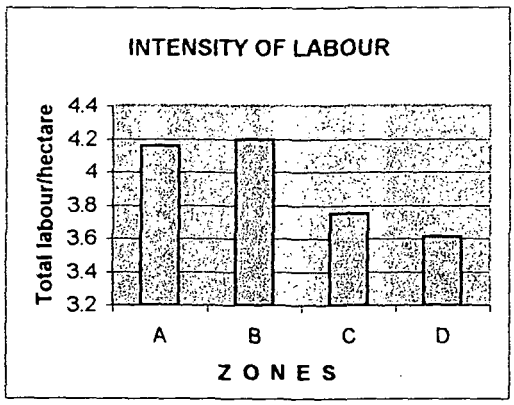

LITERACY RATE
In percentage
50
40
30
20
10
0
A
B
C
D
ZONES

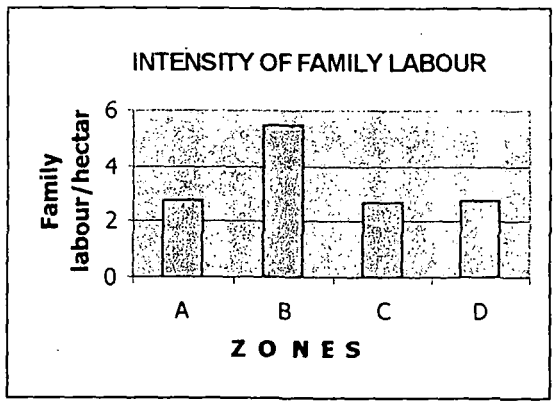

ADULT RATIO
In percentage
250
200
150
100
50
0
A
B
C
D
ZONES

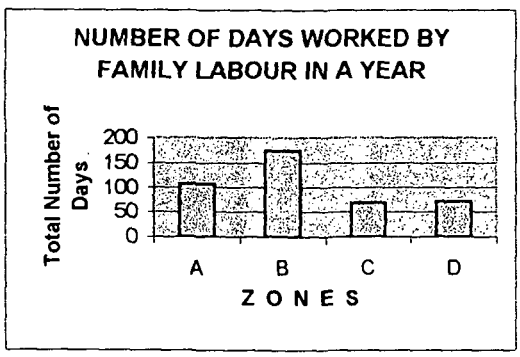

INTENSITY OF HIRED LABOUR
Hired Labour/hect of Land
1 6
1 4
1 2
1
0 8
0 6
0 4
0 2
0
A
B
C
D
ZONES











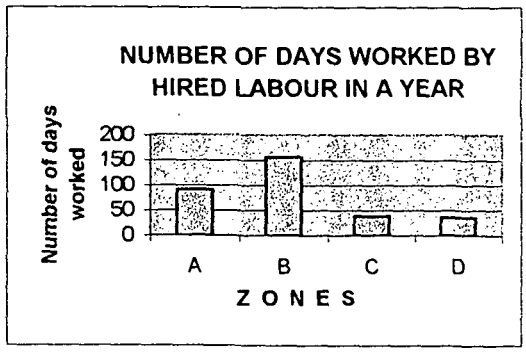


Fig.-4.1: Population Characteristics of Different Agro-ecological Zones of Jorhat District.

6.0. Agricultural Characteristics:

Agricultural characteristics against the background of already stated determinants are presented in this section with a view to assess the variations among different classes of the determinants and zones as a whole. The same process has been applied in calculating mean values of agricultural characteristics (with same number of frequencies as found in categorizing five determinants, i.e., family size, population density, literacy rate, land holdings and crop intensity) as done in the context of population characteristics (Appendix-III).

6.1. Agricultural Characteristics according to the Family Size: Large size of land holding (2.8 ha) is found to exist in the large size family class (8-9 persons/family) in the moderately steep to steep land zone (A) but in the piedmont zone (B), the same is found to be higher than the zonal average in the medium size family class (6-7 persons/family). In the built up (C) and the flood plain zones (D), the large size of holding (above 1.8 ha in zone C and 2.00 ha in D) is seen to exist both in the large and very large size (above 10 persons/family) of family classes. This indicates that the large families of the study area are agriculturally rich in terms of their land holding size. Although the holding size is identified as large, it is not too large to be recognized as economically viable holding which is estimated to be 4 hectare in Indian agricultural conditions (Singh, 1994, p.144). While the share of uncultivated land to the total land is concerned, the very small size family class (less than 3 persons/family) of zone A and large size family class of zone B has more share of it (around 40 %). This indicates that, in the foothill conditions, the lower size of families have lower size of holdings in the aforesaid two classes (1.1 ha in A and .90 ha in B) and, consequently, after using land for different purposes other than agriculture, the lower proportion of land is being left for the cultivation of crops. But in the gently sloping land like zone C and the flood plain belt like zone D, the share of

uncultivated land is small (around 20 % or less than that) in all size classes of family and contrary to this, the share of cultivated land to the total land is more than 70 percent in all classes. Since the topographical barrier is less in these two zones, the cultivated land is recorded higher. In fact, the share of cultivated land of the latter two zones (C and D) is higher in the very large size family classes. In zones A and B, it is higher in the small size family classes. As far as the intensity of cropping is concerned, small and very small size family classes of zone A and B reflect higher intensity of cropping (above 130 %) than other classes. Even in zones C and D, the higher intensity of cropping has been noticed in the very small size family class. But the exception is that in the latter two zones (C and D), higher intensity is seen in the large size family classes too. A smaller family with smaller size of holding needs to produce more food for subsistence by intensive use of land and consequently the intensity of land use becomes higher.

While examined the land productivity, the large size families of zone A show higher land productivity (more than Rs.24,000/ha). Land productivity is also seen higher in the medium size family class of zone B, but the amount is lower than the zone A (Rs.11,028/ha). This is because of the type of crops being produced by the farmers. More horticultural crops along with tea nurseries provide opportunities to the farmers of zone A to earn more and more money from the same piece of land throughout the year. In zone B, paddy and vegetables dominate the landscape and the price earned by the farmers is comparatively less due to the seasonal nature of the crops. In zone C with fertile level land, winter paddy dominates the entire agricultural landscape and although the productivity of paddy is high, the price of the paddy is comparatively lower than other crops. However, the very large family class of zone C and large size family class of zone D witnessed higher productivity of land (Rs.11387 and Rs.7124/ha). In zone D, vegetables and mustard are extensively produced along with paddy because this is the flood plain

zone characterized by high fertility of soils. Labour productivity of zones A and B stands higher in the large and medium size family classes (around Rs.5000 and Rs.8000/labour) but in zones C and D, it is higher in the very small and large size family classes (Rs.4370 and Rs.2774/labor respectively). In the former, i.e., in zones A and B, pressure of population on land is comparatively lower in the large size families resulting less number of labour input/ha. As the intensity of labour decreases, the production goes up. Even in zones C and D, pressure of population is seen to be lesser in the very small and large families and consequently the labour input /ha is becoming lower indicating higher production per labour. Use of fertilizer is almost uniform in all family classes of all zones, but there are zonal variations (Appendix-III.a) seems to be influenced by the agro-ecological conditions of the respective zones. The salient features now can be summed up as follows:

a. With the increase of the family size, the land holding size of the households is increasing in all agro-ecological zones.
b. The effects of the size of land holdings are seen over crop intensity, i.e. a change in the former is leading towards an inverse change in the latter.
c. Medium size family classes of all zones are in a better position in increasing their land and labour productivity.

6.2. Agricultural Characteristics according to the Density of Population: The size of the land holding seems to be higher (more than 2 ha) in the very low and low population density (0-1.99 and 2.00-2.99 persons per ha respectively) categories of the moderately steep to steep land zone (A), but in the piedmont zone (B) it is high in the high density category (more than 3 ha). Again in the built up zone (C), the land holding size seems to be higher (more than 2 ha) in the moderate density category, while in the flood plain zone (D), the same stands higher (more than 3 ha) in the very low-density category. It is

important to note that, higher density leads towards the fragmentation of land holding and as a result, the holding size is becoming smaller. This is a common phenomenon in Indian agricultural landscape. But the smaller size of holding against the lower density of population in the floodplain and hilly zones are the product of the topographic conditions rather than the demographic factors. The proportion of uncultivated land to the total land remains higher (more than 20 %) in the very high-density classes of zones A, C and D, while in B, it is larger in high-density category. On the other hand, the share of cultivated land to the total land stands larger (more than 75 %) in the low and moderate density categories of zone A, moderate and high density categories of zone B, very low density category of zone C and very low and moderate density categories of zone D. The share of this category of land and its availability depends not only on the population factor alone, but to a greater extent on the ecological conditions of the area. One common phenomenon is that the intensity of cropping in all agro-ecological zones stands higher (more than 120 %) in the high and very high-density categories. Thus, higher the density, higher is the intensity of cropping regardless of the other physical factors. So far as the productivity of land is concerned, the fairly high population density class of zone A and moderate density class of zone B witnessed higher land productivity (above Rs.9000/ha), but in zones C and D, it remains higher in fairly high and low population density classes. Since the higher density is accompanied by the abundant labour input on land, the labour productivity tends to be lower As such, in all agro-ecological zones the labour productivity seems to be higher either in the low or moderate density categories (Appendix-III.b).

The use of fertilizer seems to depend on the socio-economic conditions of the area. The farmers belonging to the very low to moderate density categories of zone A and B use more fertilizer (about 40 kg/ha), high-density category of zones C and D (less than 40 kg/ha) In all the categories of population density where the fertilizer input per hectare

is higher, the educational status of the people is also seen higher indicating the impact of education in generating necessary awareness among the farmers in changing highly traditional structure of agriculture. Thus, the basic features are as follows.

a. The effects of population density are seen over the size of land holding; increasing population density leads for decline in land size of the households in Jorhat district.

b. Labour productivity is seen to be inversely related to the density of population

6.3. Agricultural Characteristics according to the Literacy Rate: By examining the agricultural characteristics against the backdrop of literacy rate (persons below lower primary level of education), a few interesting phenomenon has been obtained So far as the size of holding is concerned, very low and low literacy rate classes of the moderately steep and steep land zone (A), piedmont zone (B) and the flood plain zone (D) reflect higher size of land holding (more than 1.8 ha) than the averages of their respective zones. In the built up zone (C) of the area, low, moderate and the very high literacy rate classes are seen to be characterized by the larger holding size (more than 2 ha). Larger land holding size against lower literacy classes mean higher level of educational status of the persons of these specific classes. Thus, the size of holding and the level of education are seen to be interrelated irrespective of the type of agro-ecological conditions. On the other hand, the share of uncultivated land to the total land is directly related both to the population and agro-ecological factors. For instance, in zone C and D where the share of uncultivated land is higher (more than 27 %) in the high or very high literacy rate classes, the density of population is less and since the pressure of population is low, there remains greater proportion of land without cultivation. But in the hilly areas (zones A and B) where the share of uncultivated land to total land (more than 30 %) is seen higher in the moderate and high literacy rate classes, the density of population is also high. In those circumstances, the share of uncultivated land to total land could be expected to be higher

than other classes. But in reality this is not so because of the topographic restriction of these zones. Contrary to this, the share of cultivated land to total land is higher where the size of holding is lower.

As far as the intensity of cropping is concerned, either high or very high literacy rate classes of all zones show larger intensity of cropping Since the persons below LP level have no employment potential other than agriculture, theirs involvement in this particular sector are more than the educated ones Therefore, regardless of the ecological conditions the intensity of cropping tends to vary according to the variations of the literacy composition. Another aspect to be noted here is that the intensity of cropping of zones A and B which are higher in the said literacy rate classes; the sex ratios are also seen to be higher (more than 1200 females per thousand males) but in zones C and D, the situation is different in the sense that in the said literacy rate classes the sex ratios are much more lower (around 700 females per thousand males) than the zonal averages. This indicates that under the conditions of hilly terrain with moderately slopping land, females' participation in agricultural activities is more than the conditions of agriculture of the level and fertile land.

So far as the productivity of land and labour is concerned, it varies from one literacy class to another. In zone A, land productivity is seen to be higher in the high literacy class (more than Rs.10,000/ha), in B and C in the very low literacy class (above Rs.8000/ha), and in D in the medium literacy classes (above Rs 5000/h). The higher productivity of land of these classes is the product of the average number of working days in a year by an individual family labour (around 130 days in a year). More number of family labour per hectare of land means proper maintenance of the land input for higher productivity of land as this is linked with the day to day living of the families. Labour productivity, on the other hand seems to be higher in the very low literacy classes of zones

A and B (above Rs. 3000/labour). Two factors are seen to be responsible for this; first the use of labour input/ha of land and the second, the use of fertilizer/ha of land. In zone C and D, the labour productivity is higher in the very high and medium literacy classes, around Rs.3000/labour and Rs 4000/labour respectively. Here also, the labour input and the fertilizer used per hectare of land are proportionally higher than other classes If the use of fertilizer against the backdrop of the literacy rate is examined, it is becoming apparent that in zones A, B, C and D, very low literacy rate class has been characterized by the more use of fertilizer/ha of land As already indicated, lower proportion of literate below LP level means the higher proportion of educated (above LP level) persons in the family and as such the use of fertilizer is seen to be related to the status of education (Appendix-III.c). The important features are:

a. Increase of the literacy rate is instigating for a decline in the use of fertilizer.
b. No regularities or pattern of change can be observed of other agricultural characteristics with the change of literacy rate

6.4. Agricultural Characteristics according to the Size of Land Holding: Both population and agricultural characteristics tend to vary according to the variations of land holding size of the families. In all agro-ecological zones of the study area, the share of uncultivated land to total land is seen to be more than 25 percent in the below marginal holding classes (Appendix-III.d) The basic factor behind this is the pressure of population on land of this size class of holding ranging from 5 persons/ha in zone C to more than 10 persons/ha in zone B. Heavy pressure of population on the smaller size of land holding is leading toward the crisis of agricultural land due to the use of land for other constructional purposes including the houses for dwelling. As the size of holding is larger, the share of cultivated land is becoming higher due to the lower pressure of population. As evident from the data, marginal to the medium size of land holding classes of all zones have been

characterized by the higher proportion of land under cultivation. In the context of the intensity of cropping, marginal size holding class of zones A, B and C and small and small medium size holding classes of zone C are reflective of the higher intensity of cropping. This is mainly due to the higher pressure of population on land in the said holding classes. Moreover, the use of labour input/ha is also seen to be responsible for the higher mean value of crop intensity.

In the context of the land productivity, both medium and below marginal holding classes of zones A and B are characterized by the higher productivity of land (more than Rs.24000 and Rs.8000/ha) than other classes of holdings. Larger proportion of labour input/ha of land resulting from the heavy pressure of population causes for the higher land productivity of land of these zones. In the built-up and flood plain zones (C and D), the crop intensity is higher in the small and small medium size of land holding classes. Same population factors are seen to be operative in determining the level of land productivity of these zones. On the other hand, where the size of holding is larger, labour productivity is also higher. In all agro-ecological zones, per labour production is seen to be higher either in the small medium and medium size holding classes (around Rs.4000/labour). This is again attributable to the lower pressure of population on land and less number of labour input/ha. The use of fertilizer per hectare of cultivated land in zone A is higher in the small and medium size of land holding classes (more than 40 kg/ha), in zone B in the medium size holding classes (around 24 kg/ha), in C in the marginal size holding class and in D in the marginal size of land holding class (around 18 kg/ha). The dominance of the educated persons with high school background (more than 70 %) is the determining force behind the use of more fertilizer per unit of land.

6.5. Agricultural Characteristics according to the Intensity of Cropping: While examined the sample households according to the levels of crop intensity, some important

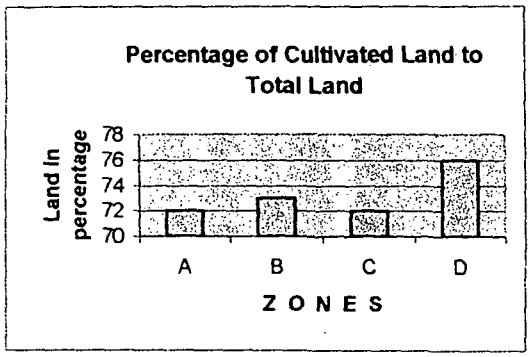
features have come to the notice. First, the size of the land holding is found to be larger (2.08 ha) in the lower intensity of cropping (115-130 %) class in zone A, moderate intensity of cropping class (130-145 %) in zone B (3.90 ha), low intensity of cropping class in zone C (2.09 ha) and very low and low intensity of cropping classes in zone D (2.09 and 3.24 ha respectively). Intensity of cropping is seen to be inversely related to the size of the holding of all agro-ecological zones of the study area. Second, the proportion of cultivated land to the total land is higher (more than 75 %) both in the low and moderate crop intensity classes of all zones and where the proportion of this category of land is comparatively lower, crop intensity is higher. Third, land productivity is higher (above Rs.8000/ha) in the lower intensity of cropping class of zone A and B, high intensity of cropping classes of zones C (above Rs. 6000/ha) and D (above Rs.4000/ha). Thus, the crop intensity and land productivity are positively related. Third, labour productivity is high (around Rs. 3500/labour) in the low intensity of cropping class of zone A, moderate and high intensity of cropping classes of zone B (around Rs. 45500/labour) and C, and high intensity of cropping in zone D (Rs. 2000/labour). Use of fertilizer and high intensity of family labour input per hectare of land is determinants of the higher intensity of cropping in these classes (Appendix-III.e). Thus, the intensity of cropping is seen to be related to the agro-ecological as well as population factors of the study area.

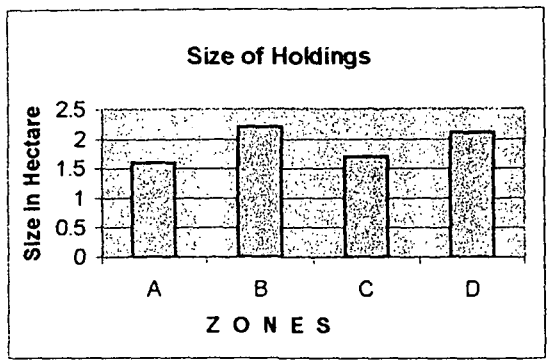
7.0. Agricultural Characteristics of Different Agro-ecological zones:

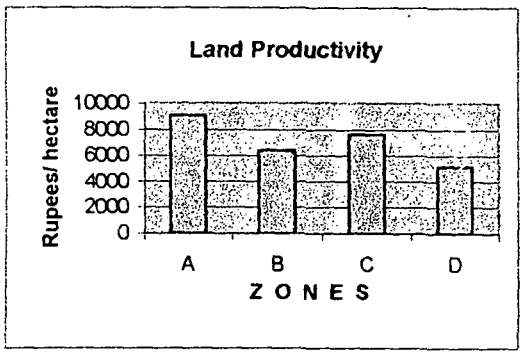
In this section, the average conditions of various agricultural characteristics have been presented for evaluation. Accordingly, the size of holding tends to vary according to the variations of agro-ecological conditions of the area. The size of holding is an important factor which influences the farmers' decisions regarding agricultural work and determines his income from farming. Unfortunately, the minimum size of the holding for most of the

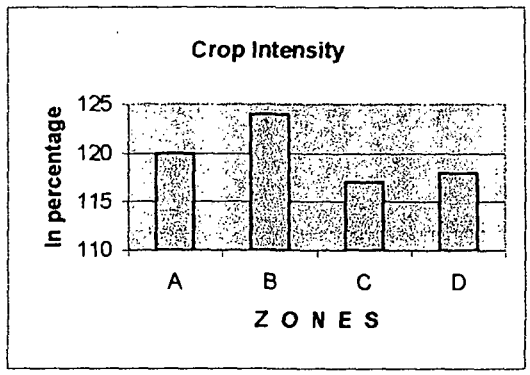
household samples (around 90 %) is below 4 ha i.e., below the minimum subsistence level for a family under Indian agricultural setup as already estimated (Singh 1994, p.144). Even in Assam as a whole, around 4 percent of the total individual holdings have an average size of more than 4 hectares (1996 Statistical Handbook). In the present work, it has been observed that around 10 percent of the households have large size of holdings of above 4 ha. But at an average, the size of land holding in zone A stands at 1 6 ha, zone B at 2 2 ha, zone C at 1.7 ha and in zone D at 2.18 ha. The variations relating the size of land holding among different zones are the product of pressure of population and prevailing topographical conditions of the area

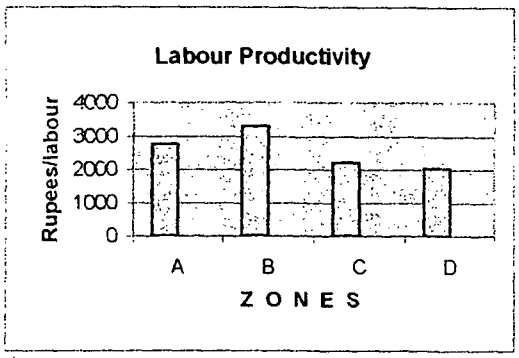
In the context of the cultivated land to the total land, zone C and D have more proportion of this category of land (76 %) than zone A and B (73 %). This can also be explained in the context of the pressure of population. However, ecological conditions are also responsible for such variations of the cultivated land. Comparatively, crop intensity is higher in the hilly zones, i.e , in zones A and B (120 and 124 % respectively) and lower in the plain zones, i.e., in zones C and D (less than 120 %). Larger family size and higher intensity of labour input in the hilly zones encourage the farmers to utilize the land for production of variety crops including paddy, vegetables and horticultural crops. Both land as well as labour productivities decline according to the decrease of the altitude and slope of the area. In this context the work of Singh and Singh (1997) on the determinants of labour productivity can be cited The authors observe the higher levels of labour productivity in the areas of up land agro-ecological conditions and lower in the low lying areas of around Loktak lake in Manipur. Suitability of agro-ecological conditions are found to be determining force in the occurrence of such type of variations. In the present work, land productivity is calculated at Rs. 9066/ha in zone A, Rs.6384/ha in zone B, Rs.7611/ha in zone C and Rs.5166/ha in zone D. In physical terms, the productivity of











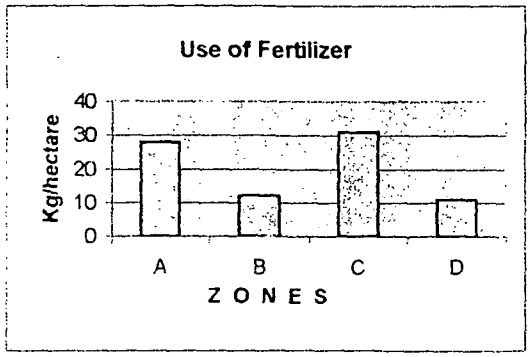


Fig.-4.2: Agricultural Characteristics of Different Agro-ecological Zones of Jorhat District.

paddy is higher in the plain zones but these zones are devoid of horticultural crops which can give more output to the farmers in terms of money. In the hilly zones, most of the farmers are opening tea nurseries in the high lands and this has accelerated the level of land productivity of these zones. The labour productivity of zone B (i.e., piedmont zone) is higher (Rs.3303/labour) than other zones; Rs.2757/labour in zone A (i.e., foothill), Rs.2212/labour in zone C (i.e., built up zone)and Rs.2040/labour in zone D (i.e., flood plain). This indicates that labour productivity is related to crop productivity and intensity of labour in the agricultural production process (Bhalla & Tyagi 1989). Since crop productivity in monetary term in the stated zones (i.e., A and B) is higher, the labour productivity is also found higher. The agro-ecological conditions of zones C and D make the zones fit for the cultivation of paddy and other food crops. Even the use of HYV (High Yielding Variety) of paddy is limited in these zones resulting lower level of both land and labour productivity. Ultimately, the output per unit of land in monetary terms is seen to be lower than that of zones A and B where the standing crops like banana, apple, tea nurseries, etc. along with paddy gives more return to the farmers. Fertilizer is extensively used in the hilly zones but in the plains, it is less frequently used. Moreover, the population factors like the size of the family, density of population, availability of labour are some other important factors contributing towards the variations of agricultural structure of the study area (Fig.-4.2).

8.0. Conclusion:

Examining the population and agricultural characteristics of the samples of various agro-ecological zones, it can be concluded that both of these tend to vary according to the variations of agro-ecological conditions. Further, the variations of agricultural characteristics within each agro-ecological zone vary according to the variations of

population factors. In what ways the population and agricultural attributes of different zones are related to each other would be examined in the next section by using a number of statistical techniques.

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Chapter-V

Population-Agriculture Relationship

1.0. Introduction:

After examining the basic population and agricultural characteristics in four agro-ecological zones of Jorhat district, it is now attempted to examine the degree and nature of relationship between these two aspects. In order to measure the relationship, the identification of variables from each aspect, population and agriculture, is becoming essential. Keeping in view the basic objectives and proposed hypotheses of the present work, this section has been divided in to four parts in a coherent manner The first part deals with the identification and relevancy of the variables related to population and agriculture. The second part is devoted to analyze the nature of relationship among the selected variables by using correlation matrix. This would also be accompanied by the testing of hypotheses and its validity under different agro-ecological settings. The third part of this chapter is related to the multiple regression analysis in which selected agricultural variables are considered as dependent and population variables as independent variables. In what ways the agricultural variables are being influenced by the population variables would be examined in this section. This last part of this section will include the basic findings of the present work.

2.0. Identification of variables:

While examined the characteristics of population and agriculture, it becomes clear that certain attributes both from population and agricultural fronts have emerged as more powerful and meaningful in estimating the pattern of change of attributes along with the change of the selected determinants. For instance, examining the demographic and labour input against the backdrop of family size as determinant for each agro-ecological zones, it has come to the notice that the dependency ratio, population density, intensity of labour

input, working days, etc. are getting changed along with the change of the family size. Similarly, the crop intensity, land and labour productivities, etc. are also seen changing while density of population has been considered as determinant. Thus, by analyzing the pattern of change of the attributes in relation to the selected determinants (as shown in Chapter-IV), some attributes are now seen to be more meaningful in the context of the present work on population-agriculture nexus. Therefore, instead of taking all attributes as variables for correlation analysis, it seems reasonable to drop certain less meaningful variables. Finally, considering the relevancy of the variables, following ten variables (Table-5.1) are selected for studying the nature of relationship among them by using correlation matrix These variables are:

Table-5.1: Population and Agricultural Variables.

Population related variables	Agriculture related variables
1. Family Size (FS)	7. Size of the Land Holding (SH)
2. Adult Ratio (AR)	8. Intensity of Cropping (IC)
3. Density of Population (Den)	9. Land Productivity (LP)
4. Literacy Rate (LR)	10. Labour Productivity (LabP)
5. Intensity of Labour Input (IL)	
6. Man days/h/year (MD)	

2.1. Relevancy of the Variables: In the context of the proposed hypotheses of the labour-productivity relationship and the intensity of cropping under the conditions of abundant labour supply, the variables cited above are found to be relevant than others. For instance, the adult ratio is related to the age structure of population, which in turn influences over the availability of labour input for agriculture. Similarly, the density of population is related to the pressure of population that can generate necessary stimuli for instigating change in agriculture. Size of the family and literacy rate, on the other hand, indicates the necessary awareness among the farmers regarding the benefit of small family norm against the background of present rate of population growth. Literacy rate provides basis for the

farmers for understanding the situation related either to the agricultural development or to any other economic aspects. The quantity as well as quality of labour and the number of days used for agricultural purposes in a year is unavoidable conditions in the context of agriculture. Therefore, these variables have been taken up from population front to examine their relationship with agriculture.

Among the agricultural attributes, the size of the land holding is considered a variable because it is an important factor in determining the level of agricultural production and productivity. Larger the size, greater the risk a farmer is willing to take in using inputs for higher output (Singh and Dhillon 1994). Other agricultural variables like crop intensity, land and labour productivity are the reflections of prevailing agricultural conditions and, therefore, these are considered as variables for the present study. After identifying the variables, an attempt has been made now to examine the pattern of relationship among them.

3.0. Exploring Population-Agriculture Nexus:

In exploring the population-agriculture nexus in the light of the objectives and hypotheses proposed, a correlation matrix (Mahmood 1977) of 10X10 dimensions (since total number of variables is 10) has been worked out for each agro-ecological zone and the relationship among the variables have been earmarked for analysis. A degree of relatedness (DR) of each variable is calculated by adding the strength of coefficient of correlation and converting it into relative values as percentage. By observing the correlation matrix (Table-5.2.a, b, c, and d), three important features have been obtained. First, the relationship within the variables is significant with higher degree of its relatedness towards the density of population in the farmers' family. Second, the relationships within the variables also exist with higher degree of relatedness of agriculture, and third, the relationship between population and agricultural variables is

Table-5.2.(a): Population-agriculture Relationship in the Moderately Steep to Steep Land Zone.

Variables	SF	Den	AR	LR	IL	MD	SH	IC	LP	LabP
SF	1	0.05	0.35	0.21	0.05	0.03	0.42*	0.01	0.25	0.25
Den		1	0.18	0.37*	0.84*	0.90*	-0.59*	0.07	0.02	-0.36*
AR			1	0.07	0.31**	0.17	0.2	0.19	0.09	0.11
LR				1	0.21	0.15	0.2	0.2	0.01	0.11
IL					1	0.92*	-0.26**	0.19	0.08	-0.26**
MD						1	0.31**	0.1	0 13	0.18
SH							1	-0.26**	0.05	0.48*
IC								1	0.33**	0.32**
LP									1	0.56*
LabP										1
DR	2.62	4.38	2.63	2.52	4.12	3.89	3.77	2.67	2.52	3.63
(DR in%)	7.99	13.4	8.02	7.72	12.6	11.8	11.5	8.15	7.69	11.06

N.B. : *Significant at 1 %, **significant at 5 %, DR= Degree of Relatedness, N=49.

Table-5.2.(b): Population-agriculture Relationship in the Piedmont Zone.

Variables	SF	Den	AR	LR	IL	MD	SH	IC	LP	LabP
SF	1	0.02	0.21	0.32**	0.1	0.14	0.55*	0.07	-0.02	0.43*
Den		1	0.04	0.2	0.9*	0.72*	-0.44*	0.03	0.25	-0.33**
AR			1	-0.3**	0.26	0.01	0.33**	0.34**	0.08	0.34**
LR				1	0.01	-0.14	-0.5*	0.08	-0.24	-0.45*
IL					1	0.9	-0.21	0.22	0.05	-0.51*
MD						1	-0.06	-0.2	-0.11	0.24
SH							1	-0.02	0.05	0.81*
IC								1	0.26**	-0.14
LP									1	0.49*
LabP										1
DR	2.86	3.95	2.88	3.21	4.16	3.52	3.97	2.36	3.55	4.74
(DR in%)	8.36	11.5	8.42	9.38	12.1	10.29	11.6	6.9	7.49	13.85

N.B. : *Significant at 1 %, **significant at 5 %, DR= Degree of Relatedness, N=51.

Table-5 2 (c) Population-agriculture Relationship in the Built-Up Zone

Variables	SF	Den	AR	LR	IL	MD	SH	IC	LP	LabP
SF	1	0 04	0 05	-0 16**	-0 12	-0 07	0 01	0 34*	-0 02	0 06
Den		1	-0 1	0 06	0 67*	-0 08	-0 14**	0 04	0 06	-0 48*
AR			1	-0 34*	0 06	0 05	0 06	-0 13	0 03	0 05
LR				1	0 01	0 08	-0 06	0 11	-0 05	-0 03
IL					1	0 68*	-0 05	0 17**	0 03	-0 65*
MD						1	-0 01	0 16**	0 07	-0 38*
SH							1	-0 06	0 04	0 19
IC								1	0 19*	0 17**
LP									1	0 39*
LabP										1
DR	1 89	2 63	1 86	1 89	3 44	2 58	1 52	2 37	1 88	3 3
(DR in%)	8 09	11 3	7 96	8 09	14 7	11 07	6 5	10 1	8 1	14 1

N B *Significant at 1 %, **significant at 5 %, DR= Degree of Relatedness, N=205

Table-5 2 (d) Population-agriculture Relationship in the Flood Plain Zone

Variables	SF	Den	AR	LR	IL	MD	SH	IC	LP	LabP
SF	1	0 01	0 05	-0 01	-0 18	-0 24**	0 62*	-0 1	0 08	0 13
Den		1	-0 01	-0 19	0 43*	0 19	-0 43*	0 19	-0 23**	-0 31*
AR			1	-0 4*	0 13	0 03	0 1	-0 15	0 02	-0 17
LR				1	-0 08	-0 06	-0 1	0 2**	-0 02	-0 12
IL					1	0 67*	-0 46*	0 33*	0 06	-0 44*
MD						1	-0 39*	-0 27*	0 13	-0 28*
SH							1	-0 04	0 02	0 36*
IC								1	0 09	0 14
LP									1	0 6*
LabP										1
DR	2 55	3	2 2	2 34	3 78	3 26	3 52	2 43	2 25	3 58
(DR in%)	8 82	10 4	7 61	8 09	13 1	11 28	12 18	8 41	7 78	12 32

N B *Significant at 1 %, **significant at 5 %, DR= Degree of Relatedness, N=101

equally important to note. It has also been noted that although all variables are related to each other in some way or the other, the degree of relatedness of the variables varies from variable to variable and from zone to zone. Certain variables emerge as more powerful with more than 10 percent degree of relatedness. These include population density, intensity of labour input, size of holding and labour productivity. This suggests that there are at least four "clusters of variables" (Kothari 1996) that correlated highly with one another, as given below;

3.1. Density-centric Cluster of Variables: Density of population with high degree of relatedness has emerged as the most powerful variable irrespective of the type of agro-ecological conditions of different zones. This is reflective of the fact that the density, i.e. the pressure of population on land has impact not only on agriculture but also on the population variables, especially on the structure of labour. The point to be noted here is that higher density means the availability of labour for agricultural purposes in an atmosphere where agriculture is the main stay of occupation for the inhabitants. Moreover, abundant supply of labour means the use of more labour per hectare of land for producing agricultural commodities since alternatives other than agriculture are extremely limited to put the additional labourers in other sectors of the economy. What is most striking here is that the higher density of population is seen to be leading for a decline in the size of holdings and consequently, intensification of land use is becoming higher in order to grow more crops from the small plot of land. Thus the land productivity tends to increase but the productivity of labour seems to decline. This is what exactly prevailing in different agro-ecological zones of the study area. As evident from the matrix, density and intensity of labour input is highly related, "r" being .90, .72, .67 and .43 respectively for moderately steep to steep land zone (A), piedmont zone (B), built up zone(C) and flood plain zone (D). What is more important is that, the values are significant at 99 percent confidence

level in all zones This simply indicates the validity of the fact that under the conditions of high population pressure, the supply of labour to the agricultural practices becomes higher Taking the density of population as independent (x) and labour intensity as dependent variable (y), the relationships between these two have been presented through scatter diagram, as in Fig -5 1, a, b, c and d Another important feature is that the size of the holding is inversely related to the density of population in all zones But the relationship is found stronger in the steep land (A), piedmont (B) and flood plain (D) zones, "r" being - 59 and - 44 and - 43 respectively which is significant at 99 percent level However, the relationship is weak in the built up (C) zone, "r" stands at - 14 and significant only at 95 percent confidence level Although not significant even at 95 percent level of confidence, yet the intensity of cropping and the land productivity are seen to be increasing with the increase of the pressure of population indicating a positive relationship between these two Interestingly enough, the density of population and the labour productivity is inversely related in all agro-ecological zones The degree of relationship between these two stands at -.36 in the steep land zone (A), - 33 in the piedmont zone (B), - 48 in the built up zone(C) and -.31 in the flood plain zone (D) These are all significant at 99 percent level of confidence Thus, it is seen that certain variables related to population and agriculture is clustered around the density of population It means increasing density of population in the family increases labour force intensity faster than the production increase Consequently, labour productivity diminishes

3.2. Labour-centric Cluster of Variables: Use of labour per hectare of land shows high degree of relatedness with other variables In all agro-ecological zones, labour input and the density of population indicates high degree of positive relationship as already stated But the labour input reflects relationship with the proportion of adults to the total population In the foothill zones (both in zones A and B), the "r" values stand at 31 and

Fig -5 1 (a) Population Density and Labour Intensity in Moderately Steep to Steep Land Area (Zone A)

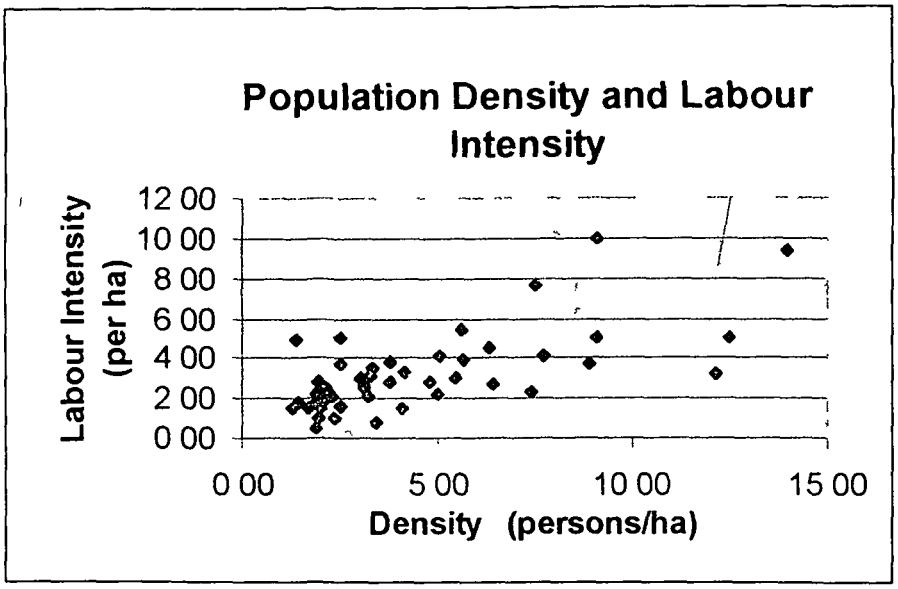


Fig -5 1 (b) Population Density and Labour Intensity in Piedmont Area (Zone B)

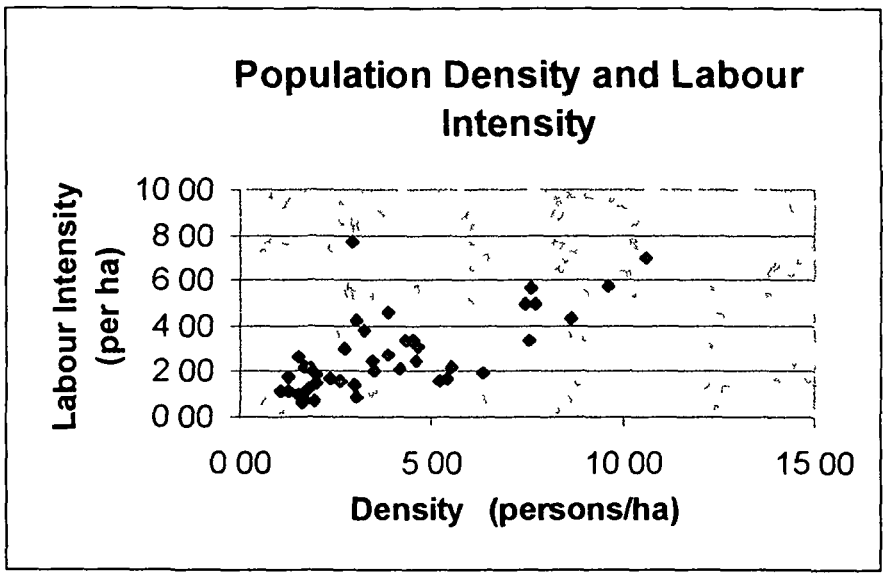


Fig.-5.1.(c): Population Density and Labour Intensity in Built-up Area (Zone C).

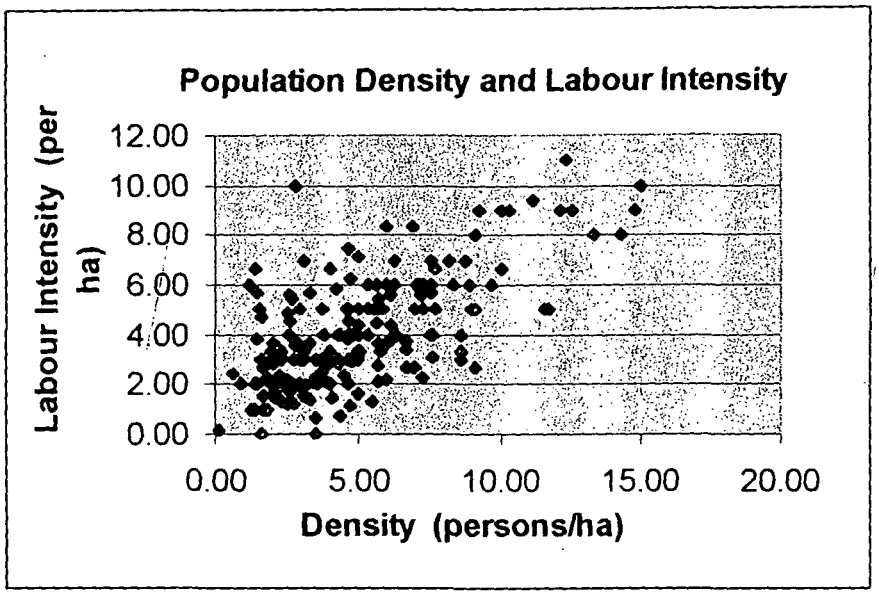
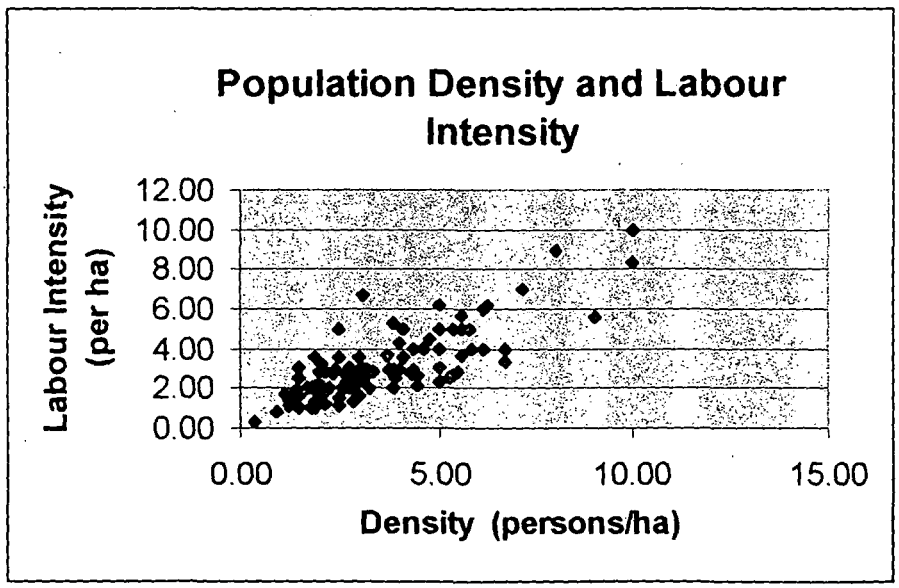


Fig.-5.1.(d): Population Density and Labour Intensity in Flood Plain Area (Zone D).



.26 respectively with 95 percent confidence level. Contrary to this, the flood plain and the built up zones reflect no significant relationship between these two. Another point is that there is no significant relationship between the labour input and the literacy rate. However, the latter is related to the size of family and the density of population, but it varies according to the variations of agro-ecological conditions. In the foothill zones (A and B), literacy rate and family size is positively related (95 percent level of confidence) indicating that larger the number of persons in a family, higher the proportion of persons with LP background but lower with high school background. In the plain zones (C and D), the situation is opposite to that of the hilly zones Non availability of higher educational institutions and greater distance from the nearest urban centre (Jorhat) might be the factors affecting inversely for the development of higher education in the hilly zones. Like the density of population, intensity of labour input is negatively related to the size of land holding, but it is significant (95 percent level) only in the moderately steep to steep land (A) and the flood plain (D) zones. Although not significant, yet the same pattern of relationship exists in the plain zones also. This suggests that as the holding size increases, the intensity of labour decreases and *vice versa*. Since the number of labour used per unit of land increases with the decrease in the size of the holding, the production per unit of labour naturally tends to be declining. This is exactly happening in the study region, i.e., the intensity of labour and labour productivity is inversely related, as shown in Fig 5.2, a, b, c and d. In the moderately steep to steep land zone (A), "r" stands at -.26, in the piedmont zone (B), "r" is -.51, in the built up zone(C), "r" is found at -.65 and in the flood plain zone (D), "r" stands at -.44 and all are significant at 99 percent level. Thus, the labour productivity seems to decline with the use of more labour per unit of land.

3.3. Land Holding-centric Cluster of Variables: The farmers' land holding size is an important variable in determining the structure of agriculture and in the study area, the

Fig.-5.2.(a): Labour Intensity and Labour Productivity in Moderately Steep to Steep Land Area (Zone A).

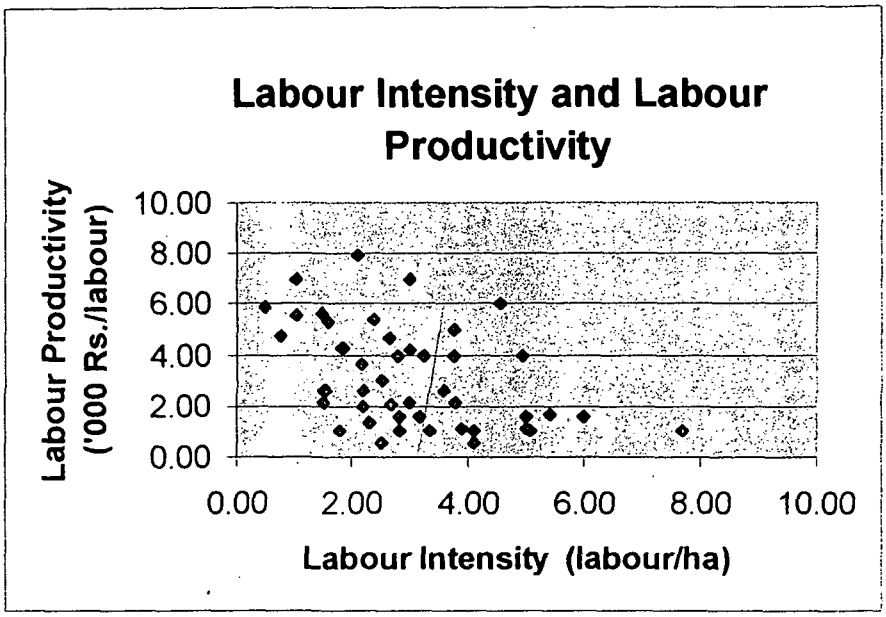


Fig.-5.2.(b): Labour Intensity and Labour Productivity in Piedmont Area (Zone B).

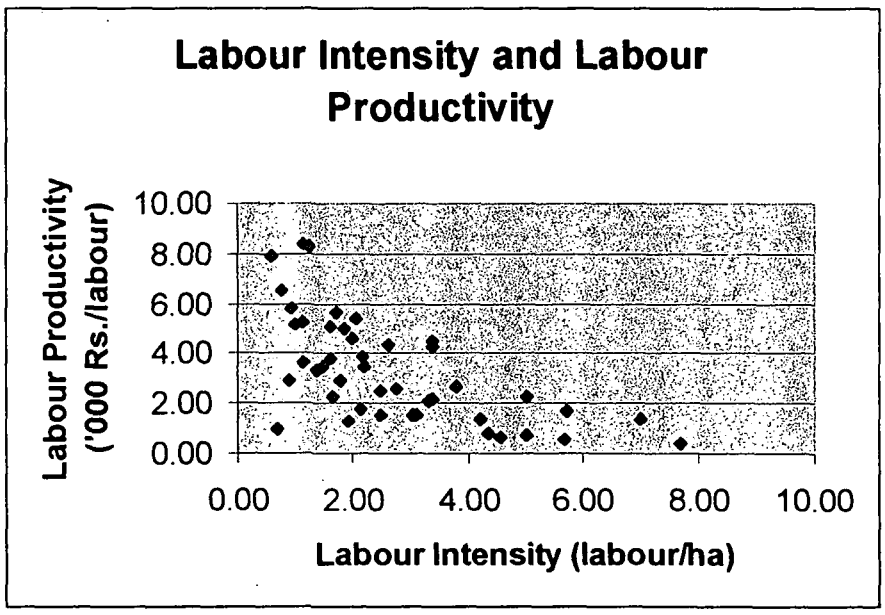


Fig -5 2 (c) Labour Intensity and Labour Productivity in Built-up Area (Zone C)

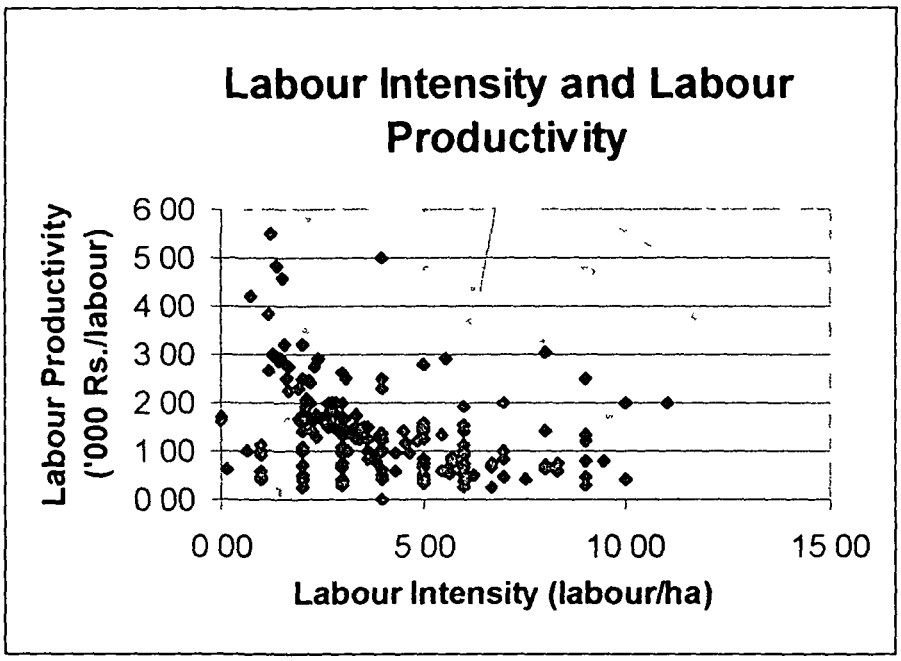
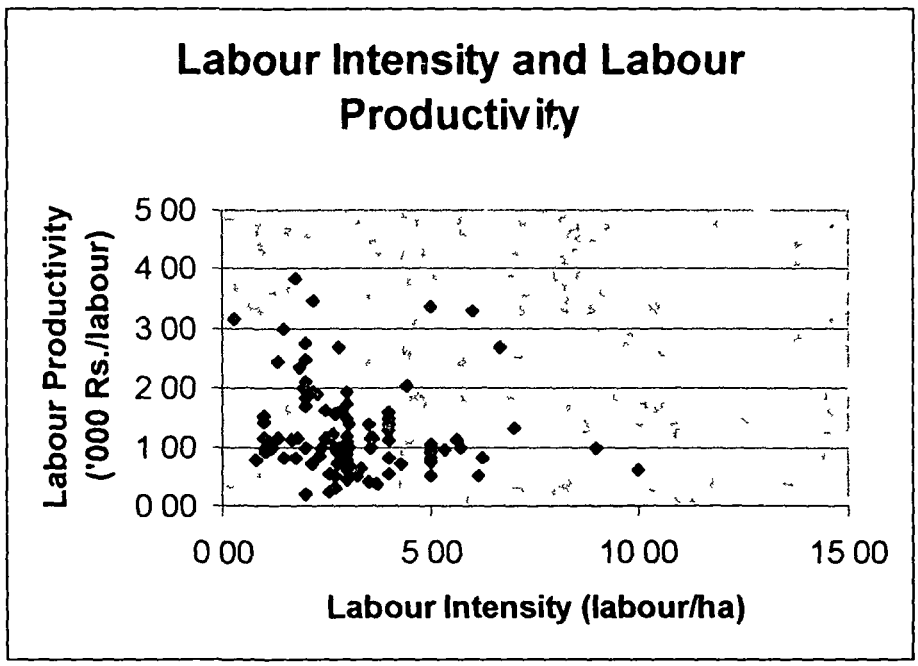


Fig -5 2 (d) Labour Intensity and Labour Productivity in Flood Plain Area (Zone D)



holding size has emerged as a powerful variable with more than 10 percent degree of relatedness. The variables centered on the size of the holding are the family size, adult ratio, literacy rate and productivity. The common phenomenon is that the size of the family is positively related to the size of the holding, "r" being .42 in the steep land zone (A), .55 in the piedmont zone (B), and .62 in the flood plain zone (D). In all these cases, "r" is significant at 99 percent confidence level. The built up zone(C) is different from other zones in the context of the degree of relationship between the family size and holding size. In this zone, "r" is not significant. Another aspect emerging from the correlation matrix is that the families with larger size of holdings have lower proportion of persons below lower primary (LP) level of education, however significant at 95 percent level only in the piedmont zone. Two agriculture-related variables are seen to be positively associated with the size of land holdings, i.e., land and labour productivities. Although not significant, the land productivity is positively related to the size of the holdings. It is a fact that the size-productivity relationship can be significant in the context of the commercial agricultural system where larger land size offers scope to the farmer for taking greater risk in the matters of input investment for larger output. Examining the relationship between the size of the tea garden and productivity of tea in Sonitpur district of Assam, Barah (1998) observes a positive and significant (at 95 % level of confidence) relationship between the two. Since, tea is a commercial type of farming, the hypothesis of size-productivity relationship is found to be valid. But in the context of traditional agricultural system, the relationship between the land size and land productivity is generally not significant as in the case of present study. Here, the land productivity is determined by other agro-ecological conditions. On the other hand, land and labour productivity is seen to be positively related and found to be significant at 99 percent level of confidence in all agro-ecological zones'; the degree of relationship i.e., "r" ranges from .29 in the built up

zone to .81 in the piedmont zone. This is mainly due to the fact that the labour input per hectare of land decreases with the increasing size of holding. Since the intensity of labour input is less over larger size of land holdings where the total volume of production is more, per labour production seems to be higher. Analyzing the pattern of labour productivity in the lower Brahmaputra valey of Assam, Das and Singh (2000) observe a positive relationship between land and labour productivity They suggest that agro-ecological conditions of land influence the labour productivity.

3.4. Productivity-centric Cluster of Variables: The variables centered around labour productivity are density of population, literacy rate, labour intensity, holding size, man days/h/year and land productivity. Density and intensity of labour input shows inverse relationship with the labour productivity as already indicated. The one important aspect in all zones of the study area is that the labour productivity and mandays are positively related, but not significant even at 95 percent level. However, a significant relationship exists between land and labour productivity in all zones (Fig.-5.3. a, b, c and d), "r" being .56 in zone A, .49 in zone B, .39 in zone C and .60 in zone D. It means that the levels of agricultural labour productivity can only be raised by increasing the levels of land productivity (Rahman and Singh 1991-92). It has been confirmed from various studies that land productivity can only be increased by the application of agro-technological production factors (Singh 1994, Binswanger 1978). Thus, proper seed-fertilizer package of modern technology is required for the enhancement of land productivity in the humid conditions of Assam plains (Rahman and Singh 1995, Singh 1999). The land and labour productivity relationship found in the present work indicates that farmers of the region choose only those areas for increasing productivity where land productivity is high due to the favourable conditions of land. The point is that labour productivity declines only in the context of the number of labour used per unit of land, i.e., more labour than required, not

Fig -5 3 (a) Land and Labour Productivity in Moderately Steep to Stee Land Area (Zone A)

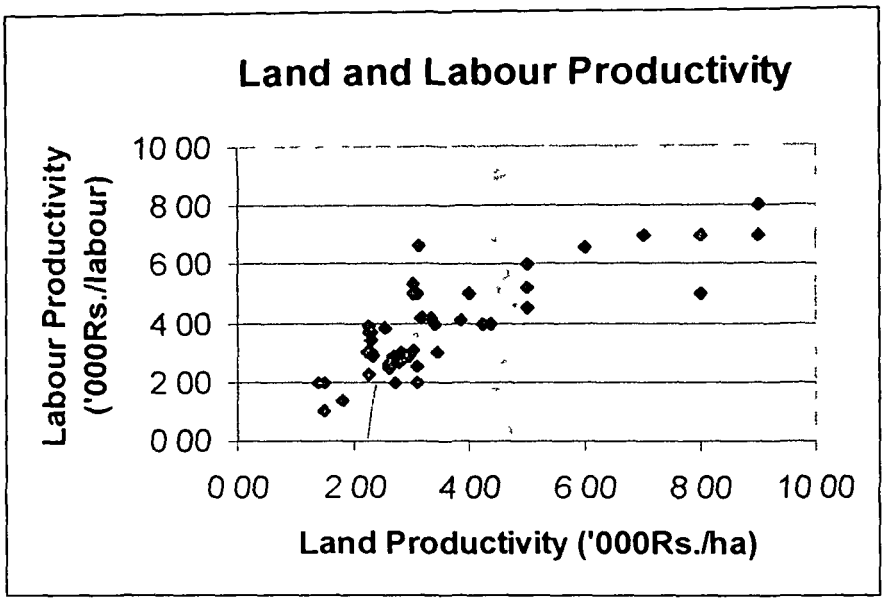


Fig -5 3 (b) Land and Labour Productivity in Piedmont Area (Zone B)

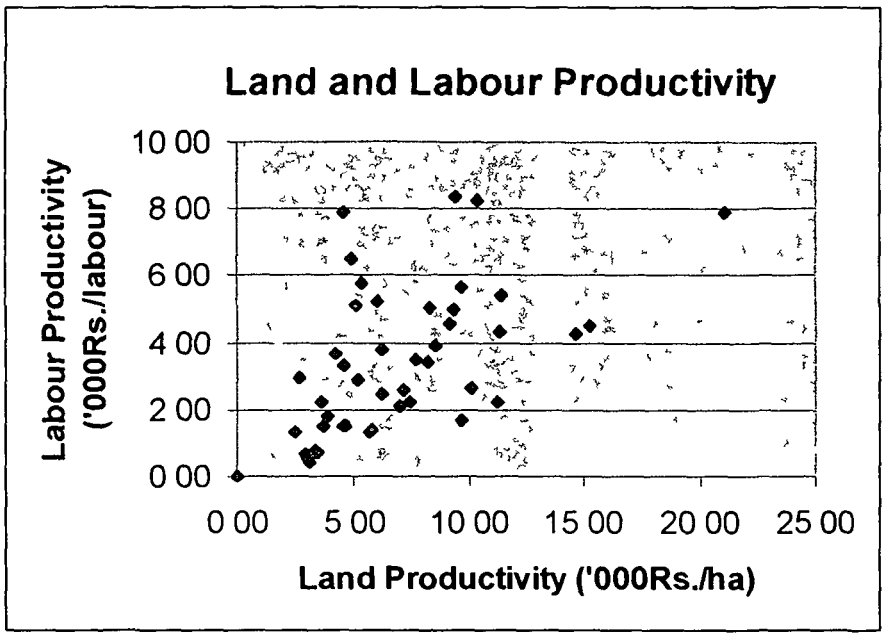


Fig.-5.3.(c): Land and Labour Productivity in Built-up Area (Zone C).

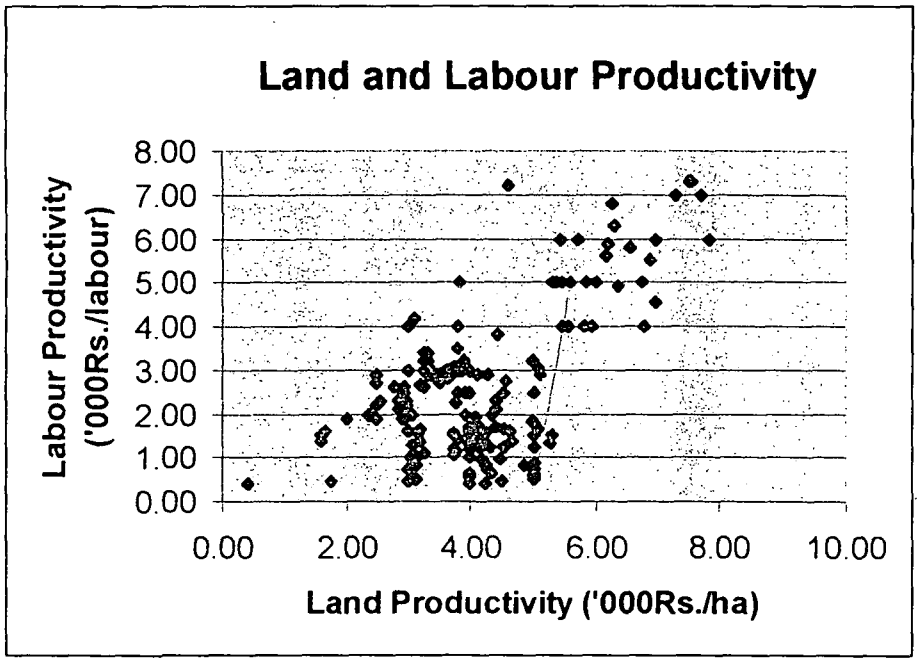
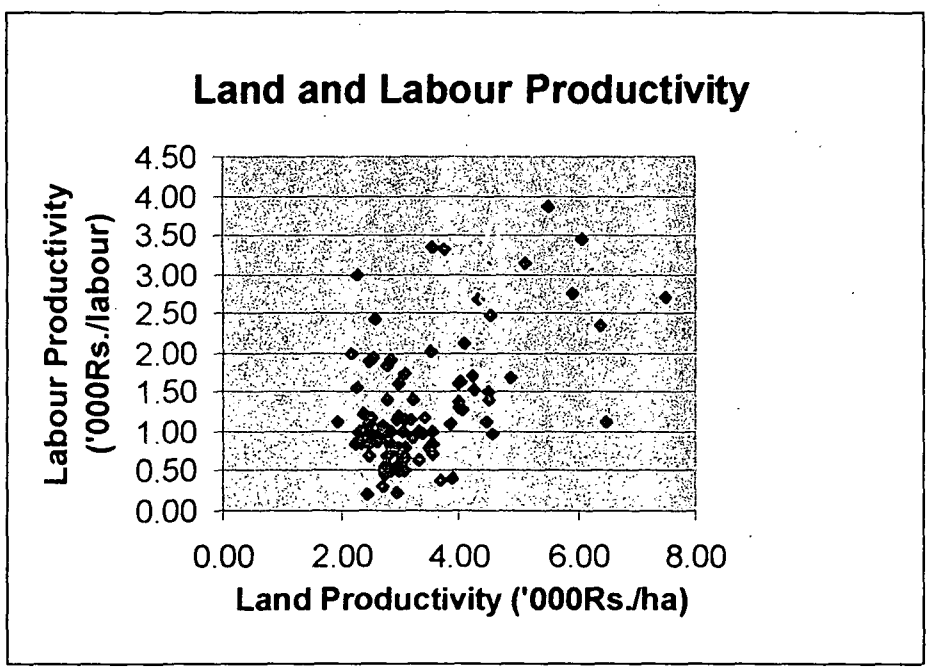


Fig.-5.3.(d): Land and Labour Productivity in Flood Plain Area (Zone D).



in the context of production per unit of land. This indicates the traditional structure of agriculture in the study area.

3.5. Analysis of the Pattern of Relationship: Analyzing the degree and nature of relationship among the population and agricultural variables of all zones, following features have come into the focus

i) The relationship within the population variables and its pattern which does not vary much among the four agro-ecological zones, has been identified significant For instance, pressure of population is related to the availability of labour for agricultural practices, man days is seen to be related to the availability of labour and the latter also related to the proportion of adults in a family. Size of the family is related to the literacy rate and again literacy rate is associated with the availability and quality or efficiency of labour Thus, the population variables are seen to be interrelated

ii) The relationships among the agricultural variables are significant. For instance, size of the farmers' land holding is related to the intensity of cropping as well as to the land and labour productivities. Land and labour productivities are interrelated, i.e., increase in one leads to the increase of other.

iii) The relationship between population and agricultural variables seems significant. For instance, size of the land holding is positively related the size of the family but negatively related to the density of population Intensity of labour input is inversely related to the productivity of labour but positively related to the productivity of land. Thus, variables related to the population and agriculture cannot be separated from each other.

iv) The proposed hypotheses that "under the conditions of abundant labour supply to the agricultural practices, land productivity moves up with the decline of labour

productivity" are only partially valid. Of course, the Boserupian view of abundant labour supply resulting from higher density of population is significant in present context. Because, the density and the intensity of labour input in all agro-ecological zones of the study area shows positive association with higher degree of confidence. But with the use of more labour per unit of land in the area, there is no significant change in the productivity of land. Land productivity is seen to be dependent only on the existing agro-ecological conditions of the area. Since there is no significant relationship between the intensity of labour and land productivity, the first part of the hypothesis cannot be said to be valid. But the second part of the hypothesis that labour productivity declines with the increasing number of labour input per unit of land is said to be valid in the study area. Because in all zones irrespective of the type of agro-ecological conditions, labour productivity shows inverse relationship with that of intensity of labour input which is significant at 99 percent confidence level. This simply indicates that the contribution of additional labour to the production process is insignificant due to the traditional nature of agriculture.

v) The second hypothesis that " intensity of cropping at a greater scale is emanating from the higher density of population" is also not valid. Although there exists relationship between density and intensity of cropping in all agro-ecological zones, the degree of relationship is not significant even at 95 percent confidence level and therefore, cannot be considered as valid under the existing ecological set up.

4.0. Population Verses Agriculture:

Through the correlation matrix, the degree and nature of relationship between population and agricultural variables have been obtained. But in what ways the population factors are influencing to the agricultural conditions of the study area are yet to be

ascertained. In order to fulfil this objective, six population factors (given in Table-5.1), viz., size of the family (SF), density of population (Den), adult ratio (AR), literacy rate (LR), intensity of labour input (IL) and man days (MD) have been considered as independent variables (X_1 to X_6 respectively), and three agriculture related variables reflecting the level of agricultural development, viz., land productivity (LP), labour productivity (LabP) and crop intensity (CI), have been considered as dependent variables (Y_1, Y_2 and Y_3 respectively). The independent variables are related to the demographic, social and labour structure of the population and as such can be considered as relevant for testing the hypothesis. After identifying these two sets of both dependent and independent variables, a multiple regression analysis technique has been used to see the multiple effects of population factors on agricultural development by using the equation (1) given in 5.6 as Methods Used of Chapter-1 (Kothari 1996). With the help of this equation, each dependent variable would be explained in the context of the independent variables for different agro-ecological zones of the study area.

4.1. Multiple Effects of Population Factors on Land Productivity: Land productivity is basically a function of ecological conditions. If conditions were in consonance with the production process, the role of human factors would be less and *vice versa*. In the study region, it has been observed that the role of population factors in determining land productivity tends to vary according to the variations of agro-ecological conditions. For instance, in the moderately steep to steep land zone(A) located along the southern margin of the district, the multiple effects of six population factors included in the present study on land productivity is 0.81 (i.e., multiple "r" is 0.81), as shown in Table-5.3. This suggests that the coefficient of determination (r^2) is 68.89 percent indicating that 68.89 percent of variations in land productivity of the said zone is being influenced or explained

Table-5.3: Multiple Effects of Population Factors on Land and Labour Productivity and Crop Intensity of various Agro-ecological Zones of Jorhat.

Pop Factors	Zone A b (t values)	Zone B b (t values)	Zone C b (t values)	Zone D b (t values)	Y
FS	49 00 (17)	78 31 (31)	77 73 (1 50)	338 4 (56)	
Den	-139 1(-1 35)	-180 70(-2 18)**	-127 1(-6 33)*	-329 3(- 66)	Y_1
AR	359 1(1 73)	-1 49 (- 34)	40 (49)	-6 11 (- 05)	Land
LR	3 17 (17)	-58 5 (-1 63)	6 19 (67)	-64 96(- 09)	Productivity
IL	-32 2 (001)	-1034 2(- 67)	-175 25(001)	738 1 (6 55)*	
MD	-3 48 (2 39)**	1 14 (1 35)	75 (45)	108 8 (30)	
Mult.R	**.83**	**.59**	**.47**	**.19**	
R^2	**87.00**	**35.00**	**22.09**	**4.00**	
FS	-48 69 (- 17)	248 2 (1 89)	15 20 (51)	-224 11 (- 57)	
Den	-251 6(-2 5)**	-79 65 (-1 83)	-46 97 (-4 1)*	-218 7 (- 67)	Y_2
AR	276 58 (1 79)	1 67 (72)	68 (1 49)	-3 95 (- 06)	Labour
LR	11 82 (64)	6 79 (36)	-6 74 (-1 28)	-41 79 (- 09)	Productivity
IL	-287 66(001)	-561 8 (- 69)	-74 79 (001)	-484 0 (6 55)**	
MD	- 42 (- 29)	58 (1 29)	-2 04 (-2 15)**	-77 8 (- 32)	
Mult.R	**.71**	**.81**	**.60**	**.20**	
R^2	**50.41**	**65.00**	**36.00**	**4.00**	
SF	5 04 (1 09)	3 40 (1 31)	4 19 (4 52)*	1 37 (1 03)	Y_3
Den	14 (09)	-3 42 (-3 98)*	-2 99 (-8 33)*	-4 37 (-5 31)*	Crop
AR	6 13 (1 9)	- 01 9- 02)	- 001 9- 91)	- 04 (-1 81)	Intensity
LR	- 21 (- 69)	50 (1 36)	13 (90)	12 (1 01)	
IL	5 70 (001)	8 23 (51)	1 48 (001)	100 89 (6 53)*	
MD	09 (3 96)*	01 (1 12)	- 04 (1 42)	04 (66)	
Mult.R	**.76**	**.75**	**.61**	**.62**	
R^2	**58.00**	**56.00**	**38.00**	**39.00**	

** Significant at 5 % level, * significant at 1 % level

by the population factors of which man days is significant at 95 percent level of confidence This is not a poor explanation but to be noted that 31 11 percent of variations in land productivity is yet to be explained which might be the product of other agro-ecological conditions of the zone In the piedmont zone (B), the multiple effects of

population factors on land productivity is seen to be at .59 (i.e., multiple "r" .59), i.e., the coefficient of determination is 35 percent. It means that 65 percent of variations in land productivity is being explained by other factors. However in both the zones, the role of population factors in determining land productivity is seen to be higher than the other two zones located over the plains. The point is that the areas where the agro-ecological conditions are not completely in consonance for agricultural practices, human factor have to play a determining role for crop production.

Contrary to this, in the built up zone(C), the multiple effects of population factors on land productivity is .47 (i.e., multiple "r" .47) and it is only 19 in the flood plain zone (D). This indicates that 22 percent (r^2 is 22.09) of variations in land productivity in zone C and 4 percent (r^2 is 4.00) in zone D are being explained by the population factors and 78 percent and 96 percent of variations in the respective zones are explained by other ecological factors. This is indicative of the fact that land productivity of the latter two zones is the out come of environmental factors.

4.2. Multiple Effects of Population Factors on Labour Productivity: Taking labour productivity as dependent variable and six population factors as independent variables, an attempt has now been made to see the influence of the latter (independent variables) over the former. Accordingly, in the moderately steep to steep land zone (A), the multiple effects of population factors on land productivity is calculated to be at .71 (i.e., multiple "r" is .71), in the piedmont zone (B) the same is found to be at .81 (i.e., multiple "r" is 81) while in the built up (C) and flood plain zone (D), the multiple "r" is seen to be at .60 and .20 respectively. Thus in zones A and B, more than 50 percent of variations (i.e. r^2 is 50.41 percent in A and 65 percent in B) in land productivity are explained by population factors but in zones C and D less than 50 percent (36 percent in C and 20 percent in B) of

variations are explained by population factors included for the present study Again the role of human factors is seen to be stronger in the zones characterized by the comparatively rugged terrain than the plain and fertile zones The existing ecological conditions of the said zones necessitated more action on the part of human labour to perform agricultural operations

4.3. Multiple Effects of Population Factors on Crop Intensity: Taking crop intensity as dependent variable and population factors as independent variables, the influence of the latter over the former has been attempted to examine It is seen that the multiple effects of population factors on crop intensity in the moderately steep to steep land zone (A) is 76 (i e , multiple "r" is 76), in the piedmont zone (B) the multiple "r" is 75, in the built up zone(C) 61 and in the flood plain zone (D), the multiple "r" is 62 The r^2 (coefficient of determination) for the respective zones stand at 58, 56, 38 and 39 percents It indicates that around 56-58 percent of variations in crop intensity in zones A and B is being explained by population factors and as such 42-44 percent of variations is explained by other factors However, the role of population factors over crop intensity in these zones is stronger than other factors But in zones C and D, around 38 percent of variations in crop intensity are being explained by population factors and therefore, the role of other factor stand at 62 percent Thus population factors are less influential than other ecological factors Because, the ecological conditions are so suitable that the inhabitants need no more labour for agricultural operations However, the potentialities of utilizing these zones at a larger scale for agricultural activities are still wide

5.0. Analysis of the Scenario:

After examining the multiple effects of population factors on land and labour productivity and crop intensity of various agro-ecological zones of the study area, two important conclusions can be derived from the present analysis First, the role of

population on agriculture varies according to the variations of agro-ecological conditions. People of the region works only under compulsion, i.e. if conditions are good for agriculture then the effort of man is less as reflected by the fertile plain region and *vice versa* as reflected by the hilly region. Analyzing the system of agriculture, Singh and Dhillon (1994) remarks that in the continents of Asia and Africa, in general, agricultural traditions continue unchanged. Even simple methods are not available to increase productivity per person, per unit of land or per unit of capital invested. Second, agriculture is entirely dependent on ecological conditions. People work only for subsistence not for commercial purposes and therefore remain satisfied with what can be derived under existing natural conditions. This indicates the traditional nature of agriculture.

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Chapter-VI

Findings, Suggestions and Conclusions

The basic thrust of the present work is centered around two important issues-population and agriculture. In a developing country like India with agriculture as the base of the economy, the coordination of these two issues is inseparable. But except a few areas of the western part of the country where green revolution is successful, the nexus between population and agriculture is not satisfactorily developed. Assam is no exception and for that matter, the district Jorhat is also in the same line. After a detailed examination of the population and agricultural relationship of the area, it has come to the notice that the quantitative and qualitative dimensions of the district's population are yet to be utilized for the development of agriculture inspite of having its suitable agro-ecological conditions. The present study has revealed a number of interesting facts regarding the nexus between population and agriculture. These are given below;

1. The population of the district has been increasing at a rate 33.10 percent (1971-1991). Although low in comparison to other districts of Assam, yet the present rate is enough to lead for higher pressure of population on existing land resources (306 persons/km^2, higher than the state's average of 286/km^2). Unfortunately, the agricultural structure of the area remains traditional except a certain variations. This indicated by the low use of high yielding variety of seeds and fertilizer and lower productivity of crops. For instance, the average yield of all kinds of paddy in the area is only 1560 kg/ha compared to more than 2000kg/ha in other parts of the country. Thus, the area remains in poverty in the midst of plenty as far as the potentials for agricultural development are concerned.

2. While examined population and agricultural characteristics of the samples of four agro-ecological zones in the light of five determinants, viz., family size, population density, literacy rate, size of land holding and crop intensity, then a few interesting features have come in to the notice which are common for all ecological zones. These are:

   a. With the increase in the size of family, the dependency ratio and the proportion of labour to the total population are found to be increasing. This has resulted more use of labour input per hectare of land than required. Among the agricultural attributes, the size of land holding is seen to be increasing with the increase of family size. The causes are apparent, i.e.; larger family size means more dependents and more labourers as the persons below 19 years of age are also the potential labourers for agricultural practices. Moreover, large families are the joint families and yet to divide their agricultural land among themselves and as such larger holding size is seen among these families;

   b. With the increase in the density of population, the educational status (high school and above) and the supply of labour is becoming abundant. But land holding size and production per unit of labour declines significantly. Higher density means higher pressure of population on agricultural land and, therefore, labour intensity is more on agricultural land resulting lower per capita output;

   c. With the increase in the share of literate persons (below lower primary level) in the households, family size is becoming larger. This is attributable to the fact that poor educational status has caused for a lack of awareness among the people relating the benefit of small family norm. Since the educational background is poor, labour productivity is also lower;

d The effects of land holdings are seen over both land and labour productivities Larger the size, higher is the volume of production and productivity This signifies the fact that productivity is basically a function of the horizontal expansion of agriculture rather than the vertical expansion, indicating a traditional structure in the prevailing agriculture

e Changes in crop intensity is seen to be developing due to the pressure of population, but the changes are not perceptible and have no specific pattern to be identified

3 Examining the relationship between population and agricultural attributes through correlation matrix, following facts have been derived,

a Regardless of the type of agro-ecological conditions, the density of population (i e pressure) has emerged as the most influential factor in determining the intensity of labour structure This suggests that whenever the pressure of population is more, the supply of labour to the agricultural practices is also more in a situation where agriculture is the main occupation and employment opportunities other than agricultural sectors is extremely limited

b As soon as supply of labour is more to the agricultural operation, the intensity of labour input per hectare of land is also more leading to a decline of per man production, i e labour productivity This is what exactly happening in the study area

c The hypothesis proposed "under the conditions of abundant labour supply, land productivity moves up with the decline of labour productivity" is only partially valid Because, with the increasing use of labour input per hectare of agricultural land in various agro-ecological zones, the land productivity is not moving up as expected in the hypothesis (although the relationship is positive, it is not significant

even at 95 percent confidence level), but labour productivity is declining significantly. Thus the second part of the hypothesis is valid in the study area.

d. Regarding the second hypothesis that the "intensity of cropping at a greater scale is emanating from the higher density of population" is also not strongly applicable. Although both density and crop intensity is positively related in all agro-ecological zones of the area, yet the relatiionship is not significant even at 95 percent level of confidence. It indicates that whatever the change in crop intensity is taking place, it is not due to the higher density of population alone but due to the other physical and non-physical factors.

4 Examining the role of population factors on the development of agriculture through multiple regression analysis, the following facts have been obtained;

a. The multiple effects of population factors on land productivity in the hilly zones (moderately steep to steep land and piedmont zones) are found stronger than that of the plain zones (built up and flood plain zones). More than 50 percent of variations in land productivity of the hilly zones are explained by population factors alone and only less than 50 percent of variations are explained by the other factors.

b. Similarly the multiple effects of population factors on labour productivity in the hilly zones are stronger than that of the plain zones already stated. More than 70 percent variations in labour productivity are explained by population factors in the hilly zones while in the plain zones, less than 40 percent variations in labour productivity are explained by population factors.

c. In determining crop intensity, population factors are again found to be playing significant role and more than 50 percent of variations in crop intensity in the hilly zones are being explained by population factors. In the plain zones, it is less than

40 percent and thus the role of other factors are seen to be more prominent (more than 60 percent).

5. The study has confirmed that the population and agricultural attributes are interrelated. But depending on the nature of agro-ecological conditions, the degree of relationship tends to vary as reflected by the four agro-ecological zones of the area. Similarly, the impact of population factors on agricultural development also depends on the type of agro-ecological conditions. More suitable ecological setting means lesser effort of man, as the environment is easier to utilize and opposite is the case when environment is comparatively difficult.

Suggestions:

The present work reflects not only the population-agriculture nexus under different agro-ecological settings, but also reveals some interesting areas of research that a geographer can pursue to enrich the theoretical basis of the subject. In this context, the following suggestions can be made for conducting research in due course of time.

First, the distance factor can be incorporated in examining both the population and agriculture characteristics and also the variations of their relationship according to the variations of the distance either from the nearest nodal centres or from the main road. Distance is an important aspect in geography and it forms the basic dimension of space with considerable influence on the operation of the spatial system (Knowles et al.,1998). It is also stated that for the development of inherent agricultural potentialities, road accessibility is a dire needs (Singh and Dhillon, 1994, p. 173) which is determined by the distance both in time and cost perspectives. The fact is that with the increase of distance, the land use pattern tends to vary. Sandhu (1977) studied the variations in the intensity of sugar cane cultivation in the light of accessibility in Haryana. With a view to classify areas in the context of accessibility, the Chief Engineers (1958) recommendation (known as

Nagpur Report) is seen to be relevant in Indian agricultural context. It says that areas lying within 4 km from a transport point are treated as "fairly accessible", within 8 km as "simply accessible", but beyond 8 km as "inaccessible" and beyond 16 km as "highly inaccessible". The objectives of this classification is to see that in a highly developed agricultural area no village is more than 3 km away from a link road or more than 8 km away from a main road (Singh and Dhillon, 1994, p.173). In what ways the model is applicable in examining the agricultural structure of the state in general and Jorhat in particular is a vital question that the geographer of the region can answer for the betterment of the society.

Secondly, smaller and smaller areas can be taken up as a micro areal unit of investigation. The attributes of population and agriculture and their interconnection can be studied against the backdrop of the distance from the nearest urban centres located within the smaller regional unit. Thus a hierarchy in the regional system can be worked out which would be more meaningful in analyzing the spatial structure of agricultural activities in relation to the human population. In Jorhat, for instance, there are 223 villages in the Jorhat Thana itself over an area of 500 sq. km. Out of this total villages, 20 percent of villages lies within 8 km of distance, 50 percent lies within 8-16 km distance and 30 percent lies beyond 16 km distance from the Jorhat town (1991). How far these clusters of villages vary in terms of their population and agricultural characteristics and in what ways the distance factor contributing towards such variations, can be an interesting aspect for detail investigation. It will help in formulating models for planning and development of the area.

Thirdly, the study has also revealed that a large part of the population has been not properly utilized. This indicates that due to the abundant supply of labour to the agricultural practices, there exists under utilization of labour input and the contribution of

additional labourers to the production process is insignificant. Geographers have immense scope to formulate models that can give direction to the systematic use of the qualitative aspects of the population of the study area.

Conclusion:

Analyzing the present situation of population and agriculture of Jorhat, it can now be concluded that there is a need for micro level studies incorporating these vital issues. Reviewing the works on population-agriculture relationship, Kulkarni (1981, pp 355-356) commented that "it is essential to investigate whether agricultural change in a region is more a matter of a community's effort and of its attitudes to the adoption of new methods, and whether the human efforts and attitude are the result of the community's response to demographic pressure. At the same time, in those regions in which a notable agricultural development has taken place, it is essential to study the impact of this development has had on the demographic situation of that region". Although he is in favour of macro level studies, yet the basic issues relating population and agriculture and their interrelationship is highlighted as relevant in the developing countries like India. Agricultural development strategies should be formulated only after considering the population parameters because the latter is the basic input in agricultural development.

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APPENDICES

Appendix-I:

HOUSEHOLD SCHEDULE

Name of the Village Block

Religion Mixed/Hindu/Islam/ Others Caste GC/OBC/SC/ST

1 Head of the Household Age Sex Caste Religion

Whether joint family or individual family

2 Whether original resident or migrated ? If migrated, then year of migration

Purpose of migration migrated from

3 Population structure of the household

Sl no	Age	Sex		Relationship	Educational	Occupational
		M	F	with head of HH	Qualification	structure
1						
2						

4 No of births took place during 1997 1998 1999

5 No of deaths took place during 1997 1998 1999

6 Land use pattern of the HH (in bighas)

Bari Land	Barren Land	Grazing Land	Fallow Land	Crop	NSA	ASMO	Others

7 Cropping pattern

Sl No	Paddy crops			Rabi crops	HYV	Others
	Ahu	Sali	Others			
Area						
Production						
Irrigation						
Fertilizer/h						
Marketed						
Others						

8 Methods of cultivation·

a. Power tiller/bullock plough/tractors/others.

b Mode of irrigation

c Sufficient/deficit in food production

d Fertilizer used/not used

9 Labour Condition

a Family labour employed in agricultural activities

Sl No	Age	Sex	Education	No of days worked

10 Hired labour in agricultural activities

Sl No	Age & Sex	Education	Wage/month	Working days	Caste & Religion

11 Hired labour recruited from the village itself/out side the vilage

10 Do you think that existing population-land relationship of your HH is ideal? Yes/No

11 Do have any shortage of labour? yes/no or land? yes/ no

12 How do you like to improve your agricultural productivity?

a through intensive cropping,

b rotation of crops,

c use of HYV,

d through all,

e any other methods

13 your comment on your agricultural system

Appendix-II.

(a): Population Characteristics according to Family Size in various Agro-ecological Zones of Jorhat District.

Zones	Cat.	Cls.	H.H.	F. S.	Den.	S.R.	D.R.	A.R.	L.R.	E.S.	I.F.L.	I.H.L.	I.T.L.	D.W.F.	D.W.H.	D.W.T.	M.D.	H/F.
	VS	< 3	7	2.8	5.7	1428	28.5	114	23	26	1.86	1.36	3.22	136	77	140	121	0.45
	SM	4 5	21	4.8	6.8	1206	32.5	191	45	29	3.69	1.21	4.9	80	100	138	151	0.68
A	MED	6 7	17	6.2	9.5	757	44.9	228	49	34	2.11	1.11	3.22	117	94	140	121	0.38
	LS	8 9	4	8.2	5.2	1283	32.7	375	43	60	2.1	3.76	5.87	145	43	160	135	0.05
	VLS	>10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	AV	**xxx**	**49**	**5.3**	**5.8**	**1088**	**36.2**	**208**	**43**	**33**	**2.75**	**1.4**	**4.16**	**106**	**91**	**145**	**138**	**0.49**
	VS	< 3	5	2.8	4.7	1000	50	133	66	13	3.8	0.19	4	109	80	139	140	0.62
	SM	4 5	15	4.6	6.8	1072	138	171	35	54	2.1	0.63	2.9	195	89	174	187	0.86
B	MED	6 7	17	6.3	7.5	1886		119	42	34	2.1	0.65	2.8	272	180	252	300	0.51
	LS	8 9	7	8.2	6.9	957	100	140	27	51	2.9	0.94	3.3	120	46	70	98	0.38
	VLS	>10	7	12	3.6	921	65	218	23	61	1	0.76	1.8	102	115	100	88	0.52
	AV	**xxx**	**51**	**6.5**	**6.4**	**1300**	**118**	135	**38**	**44**	**2.5**	**0.66**	**4.2**	**174**	**156**	**195**	**146**	**0.48**
	VS	< 3	18	2.7	5.5	1388	38	168	16	78	2.5	1.4	4.1	95	89	164	139	2.61
	SM	4 5	88	4.5	5.7	1190	60	199	22	71	3	1.2	4.3	94	60	101	96	0.67
C	MED	6 7	62	6.3	6.5	1431	81	191	27	65	2.65	0.92	3.5	67	76	80	72	0.73
	LS	8 9	28	8.5	6.8	1226	65	216	28	63	3.05	0.98	4	55	54	57	57	0.98
	VLS	>10	9	12.3	5	939	113	111	30	54	1.85	0.65	2.5	85	96	49	50	0.58
	AV	**xxx**	**205**	**5.8**	**6.09**	**1274**	**67.5**	**161**	**24**	**67**	**2.69**	**1.05**	**3.75**	**68.5**	**38.1**	**59.4**	**101**	**0.7**
	VS	< 3	13	2.8	4.8	861	41	193	58	99	2.9	0.48	3.4	67	38	76	202	0.17
	SM	4 5	41	4.5	4.1	1109	54	222	33	55	3.6	0.81	4.4	81	35	73	237	0.23
	MED	6 7	23	6.3	3.7	2143	63	275	21	62	2.2	1.09	3.3	71	28	65	178	0.27
D	LS	8 9	12	8.4	4.3	1037	53	214	35	50	2.3	0.9	3.2	69	52	70	182	0.25
	VLS	>10	12	13.2	3.1	970	64	258	50	58	2.1	0.32	2.5	50	46	57	121	0.18
	AV	**xxx**	**101**	**6.2**	**4.03**	**1279**	**57**	**215**	**36**	**62**	**2.8**	**0.77**	**3.61**	**71.6**	**36.6**	**71.5**	**195**	**0.23**

Cat-Categories of Family, Cls-Class interval, HH-Household, Den-Density, FS-Family Size, SR-Sex Ratio, DR-Dependency Ratio, AR-Adult Ratio LR-Literacy Rate, ES-Educational Status, IFL-Intensity of Family Labour, IHL-Intensity of Hired Labour, ITL-Intensity of Total Labour, DWF-No.of Days Worked by Family Labour in a Year, DWH-No.of Days worked by Hired Labour in a Year, DWT- No. of Days Worked by Total Labour in a year, MD-Mandays per Hectare per Year, H/F-Ratio between Hired and Family Labour.

(b): Population Characteristics according to Density of Population in various Agro-ecological Zones of Jorhat District.

Zones	Cat	Cls	HH	Den	FS	S.R.	D.R.	A.R.	L.R.	E.S.	I.F.L.	I.H.L.	I.T.L.	D.W.F.	D.W.H.	D.W.T.	M.D.	H/F.
	VLD	0-1.99	10	1.7	5.1	1183	30.9	241	18	50	0.65	2.61	3.26	139	125	136	129	0.9
	LD	2-2.99	8	2.3	5.6	910	58.3	175	56	32	0.86	1.66	2.52	105	159	149	149	2
	MOD	3-3.99	9	3.3	5	1203	35.1	211	38	36	1.91	0.8	2.71	104	85	100	96	0.39
A	HD	4-4.99	3	4.3	5.6	777	13.3	250	38	38	2.06	0.5	2.57	97	180	125	112	0.24
	FHD	5-5.99	5	5.3	6	1250	43.3	200	39	34	2.2	1.6	3.72	70	55	71	79	0.15
	VHD	> 6	14	13	5.2	1065	30.5	218	59	18	7.31	1	8.35	191	192	210	164	0.16
	AV	**xxxx**	**49**	**5.8**	**5.3**	**1088**	**36.2**	**208**	**43**	**33**	**2.75**	**1.4**	**4.16**	**106**	**91**	**145**	**138**	**0.49**
	VLD	0-1.99	15	1.6	6.8	804	57	217	15	68	0.53	0.9	1.44	161	51	86	88	1
	LD	2-2.99	5	2.6	7.4	1400	62	184	47	36	1.97	1.1	3	114	132	111	116	0.31
	MOD	3-3.99	7	3.3	6.1	1552	118	148	37	38	1.54	1.42	2.9	84	190	90	88	0.46
B	HD	4-4.99	6	4.4	5.3	2500	68	190	56	37	2.17	0.81	2.9	209	100	210	140	0.7
	FHD	5-5.99	5	5.4	7.4	1313	114	160	37	26	2.88	0	2.8	56	150	207	135	0.76
	VHD	> 6	13	14	6.2	1115	233	118	53	31	12.9	0.3	12.1	236	80	279	148	0.38
	AV	**xxxx**	**51**	**6.4**	**6.5**	**1300**	**118**	**135**	**38**	**44**	**5.5**	**0.66**	**4.2**	**174**	**156**	**195**	**146**	**0.48**
	VLD	0-1.99	23	1.3	5.2	1039	59	194	21	70	0.72	1.3	2.02	74	49	76	112	0.81
	LD	2-2.99	35	2.5	5.5	1150	46	212	21	72	1.67	1.2	2.87	69	64	61	138	0.45
	MOD	3-3.99	25	3.5	5.7	1292	71	185	26	67	1.57	1.61	3.1	68	83	93	161	0.28
C	HD	4-4.99	27	4.4	6.1	1386	77	170	27	65	2.1	1.28	3.38	106	76	95	95	0.79
	FHD	5-5.99	24	5.4	5.5	1109	76	175	28	64	3.36	0.81	4.17	74	26	91	80	0.74
	VHD	> 6	71	11.3	6	1410	73	201	23	68	5.01	0.82	5.83	82	110	110	100	0.67
	AV	**xxxx**	**205**	**6**	**5.8**	**1274**	**67**	**161**	**24**	**67**	**2.69**	**1.05**	**3.75**	**68.5**	**38.1**	**59.4**	**101**	**0.7**
	VLD	0-1.99	22	1.5	5.5	869	51	218	50	96	1.35	0.89	2.25	98	48	71	166	0.49
	LD	2-2.99	25	2.5	6.3	1121	52	296	25	62	2.14	0.58	2.73	62	34	56	143	0.12
	MOD	3-3.99	15	3.4	7.4	983	67	238	25	58	2.52	1.17	3.69	63	31	52	188	0.35
D	HD	4-4.99	12	4.3	6.5	2824	50	247	35	53	2.45	1	3.46	75	26	61	201	0.23
	FHD	5-5.99	15	5.2	6.3	1400	62	205	43	46	4.55	0.32	4.88	62	27	56	159	0.03
	VHD	> 6	12	10.5	5.3	1128	69	177	35	34	6.72	0.93	7.66	63	31	58	233	0.07
	AV	**xxxx**	**101**	**4**	**6.2**	**1279**	**57**	**215**	**36**	**62**	**2.8**	**0.77**	**3.61**	**71.6**	**36.6**	**71.5**	**195**	**0.23**

(c):Population Characteristics according to the Literacy Rate in various Agro-ecological Zones of Jorhat District.

Zones	Cat	Cls	HH	Den	FS	S.R.	D.R.	A.R.	L.R.	E.S.	I.F.L.	I.H.L.	I.T.L.	D.W.F.	D.W.H.	D.W.T.	M.D.	H/F.
A	VL	0-20	12	2.7	4.4	1337	34	255	6	50	1.1	2.5	3.7	111	102	111	111	0.7
	L	20-40	7	4.3	5.5	967	25	159	32	46	2.1	1	3.1	109	145	142	130	0.5
	MED	40-60	5	11.7	5.6	746	43	238	57	22	8.5	2.1	10.7	135	184	164	157	0.2
	H	60-80	9	8.3	6.3	1148	45	274	70	12	4.2	0.19	4.4	189	95	181	168	0.07
	VH	>80	6	7.7	4.6	1130	51	191	97	3	1.7	1.57	3.2	138	148	154	123	1
	AV	**xxx**	**49**	**5.8**	**5.3**	**1088**	**36.2**	**208**	**43**	**33**	**2.75**	**1.4**	**4.16**	**106**	**91**	**145**	**138**	**0.49**
B	VL	0-20	15	2.3	6.5	889	43	240	8	76	0.86	1.07	1.94	99	105	121	121	0.7
	L	20-40	15	6.5	7.8	1435	136	135	29	47	17	0.48	17.5	106	155	152	140	0.5
	MED	40-60	11	13	6	1069	92	196	53	27	2.7	0.58	3.3	102	194	174	167	0.3
	H	60-80	7	4.7	4.8	2023	300	87	70	12	2.5	1.09	7.6	83	150	191	178	0.1
	VH	>80	3	5.5	3.6	1843	66	50	99	1	3.3	0.2	3.5	55	168	164	133	1
	AV	**xxx**	**51**	**6.4**	**6.5**	**1300**	**118**	**135**	**38**	**44**	**5.5**	**0.66**	**4.2**	**174**	**156**	**195**	**146**	**0.48**
C	VL	0-20	84	5.1	5	1138	37	209	5	88	2.5	1.2	3.8	83	46	94	157	0.6
	L	20-40	86	7.4	6.5	1288	81	178	31	58	2.9	1	4	69	89	84	100	0.8
	MED	40-60	28	5.5	6	1471	111	114	49	48	3.4	0.74	4.1	106	48	97	80	0.8
	H	60-80	5	4.5	6	2500	106	148	66	33	2.9	1.7	4.6	50	150	41	70	0.1
	VH	>80	2	3.1	3	667	33	150	99	1	2	0.75	2.7	75	47	28	90	0.5
	AV	**xxx**	**205**	**6**	**5.8**	**1274**	**67**	**161**	**24**	**67**	**2.69**	**1.05**	**3.75**	**68.5**	**38.1**	**59.4**	**101**	**0.7**
D	VL	0-20	36	4.2	6.1	935	30	350	7	76	2.9	1.3	4.2	81	34	67	234	0.3
	L	20-40	29	3.1	7.4	2000	66	198	31	58	2.1	0.57	2.7	67	47	67	154	0.2
	MED	40-60	24	5.1	6.2	1090	90	138	52	34	3.2	0.44	3.6	68	35	63	191	0.1
	H	60-80	5	2.4	3.6	1100	60	150	66	20	2.3	1.03	3.3	62	51	63	195	0.4
	VH	>80	7	3.5	4	772	48	213	99	13	4.5	0.09	4.6	69	20	80	200	0.1
	AV	**xxx**	**101**	**4**	**6.2**	**1279**	**57**	**215**	**36**	**62**	**2.8**	**0.77**	**3.61**	**71.6**	**36.6**	**71.5**	**195**	**0.23**

(d) : Population Characteristics according to Size of Land Holdings in various Agro-ecological Zones of Jorhat.

Zones	Cat	Cls	HH	Den	FS	S.R.	D.R.	A.R.	L.R.	E.S.	I.F.L.	I.H.L.	I.T.L.	D.W.F.	D.W.H.	D.W.T.
A	<MH	0-.99	17	11.5	5	1161	32	296	51	22	6.1	1	7.1	180	149	194
	MH	1-1.99	17	3.5	5	1278	28	240	38	32	1.8	1.2	3.1	87	111	99
	SH	2-2.99	9	2.2	5.4	772	52	264	39	44	0.8	1.5	2.4	133	116	152
	SMH	3-3.99	3	2	6.6	761	56	155	58	19	0.7	0.4	1.2	157	115	155
	MH	>4	3	1.6	7.3	877	29	133	25	76	0.6	5.2	5.8	108	90	105
	AV	**xxx**	**49**	**5.8**	**5.3**	**1088**	**36.2**	**208**	**43**	**33**	**2.75**	**1.4**	**4.1**	**106**	**91**	**145**
B	<MH	0-.99	15	14.6	5	1222	196	131	57	29	21.8	0.07	21.8	77	160	180
	MH	1-1.99	14	4.4	6.4	1683	119	140	39	32	2	1.3	3.4	101	153	190
	SH	2-2.99	5	2.2	5.4	1965	78	155	28	71	1.2	0.79	2	98	118	200
	SMH	3-3.99	10	2	6.8	958	70	134	24	57	0.8	0.83	1.6	97	159	188
	MH	>4	7	1.6	9.8	692	47	128	15	63	0.3	0.6	0.9	116	150	200
	AV	**xxx**	**51**	**6.4**	**6.5**	**1300**	**118**	**135**	**38**	**44**	**5.5**	**0.66**	**4.2**	**174**	**156**	**195**
C	<MH	0-.99	77	5.6	5.7	1438	63	222	22	71	2.6	1.3	4	56	36	52
	MH	1-1.99	65	6	5.6	1191	71	170	24	68	2.9	1.1	4	93	54	95
	SH	2-2.99	27	7.7	6	1212	54	212	26	64	2.7	0.7	3.4	83	77	90
	SMH	3-3.99	16	6.4	5.5	1183	72	153	29	65	2	1.4	3.4	120	25	79
	MH	>4	20	5	6.2	1070	85	154	26	62	3.5	0.49	4.4	87	30	60
	AV	**xxx**	**205**	**6**	**5.8**	**1274**	**67**	**161**	**24**	**67**	**2.69**	**1.05**	**3.75**	**68.5**	**38.1**	**59.4**
D	<MH	0-.99	20	8	4.4	1065	62	175	41	36	5.9	0.51	6.4	68	31	66
	MH	1-1.99	38	3.7	5.2	1738	55	240	35	53	2.7	0.92	3.6	68	32	56
	SH	2-2.99	25	2.6	6.5	976	61	246	26	98	1.9	0.9	2.8	87	33	64
	SMH	3-3.99	4	2.7	9.7	1102	41	281	32	58	1.8	0.83	2.6	63	30	46
	MH	>4	14	1.8	9.9	1007	54	273	34	60	1.3	0.56	1.9	68	57	58
	AV	**xxx**	**101**	**4**	**6.2**	**1279**	**57**	**215**	**36**	**62**	**2.8**	**0.77**	**3.61**	**71.6**	**36.6**	**71.5**

(e) Population Characteristics according to Crop Intensity of various Agro-ecological Zones of Jorhat District

Zones	Cat	Cls	HH	Den	FS	S R	D R	A R	L R	E S	I F L	I H L	I T L	D W F	D W H	D W T
	VL	<115	17	6 2	5 4	617	37	212	38	38	4	2 7	6 76	123	158	152
	L	116-1	11	2 9	5 3	1575	31	125	37	44	1 8	0 73	2 55	98	125	107
A	Mod	131-1	9	4 1	5	1057	39	233	31	34	1 7	0 93	2 69	113	121	137
	H	146-1	6	7	5 6	1277	40	298	66	14	2 7	0 71	3 49	165	103	159
	VH	>160	6	10 5	5 1	1388	33	296	63	24	3 5	0 9	3 5	207	60	198
	AV	**xxx**	**49**	**5.8**	**5.3**	**1088**	**36.2**	**208**	**43**	**33**	**2.75**	**1.4**	**4.16**	**106**	**91**	**145**
	VL	<115	11	4 8	5 6	1231	74	158	36	47	2 4	1 2	3 6	188	182	192
	L	116-1	10	3 3	7 2	1151	95	115	30	51	1 5	0 8	2 4	188	108	208
B	Mod	131-1	3	1 8	7	1111	141	83	28	30	0 6	0 6	1 2	192	173	173
	H	146-1	7	4 3	6 5	1842	115	147	41	44	1 62	0 5	2 1	195	163	195
	VH	>160	20	10 3	6 6	1250	151	242	43	40	10 7	0 5	11 2	107	204	200
	AV	**xxx**	**51**	**6.4**	**6.5**	**1300**	**118**	**135**	**38**	**44**	**5.5**	**0 66**	**4.2**	**174**	**156**	**195**
	VL	<115	117	5 8	5 7	1264	68	195	25	68	2 9	0 98	3 8	59	37	79
	L	116-1	32	8 7	6	1158	62	189	18	68	2 6	1 48	4 1	113	39	97
C	Mod	131-1	10	4 1	5 6	1228	75	157	23	73	2 2	1 74	4	89	66	90
	H	146-1	12	5 4	6 5	1468	69	166	31	64	3 3	0 88	4 2	123	27	104
	VH	>160	34	5 6	5 4	1363	68	204	25	66	2 8	1 13	3 9	109	43	122
	AV	**xxx**	**205**	**6**	**5.8**	**1274**	**67**	**161**	**24**	**67**	**2.69**	**1.05**	**3.75**	**68.5**	**38.1**	**59.4**
	VL	<115	59	3 8	6	1450	53	252	31	68	3 3	1 2	4 4	77	42	69
	L	116-1	16	2 7	8 4	930	60	268	30	66	2	0 6	2 76	58	29	69
D	Mod	131-1	8	3 5	6 2	852	66	138	38	66	2 1	0	2 1	57	0	57
	H	146-1	8	2 7	5	1302	92	175	43	55	1 9	0 33	2 2	63	35	61
	VH	>160	10	8 7	5 1	1277	46	166	44	60	2 7	0	2 7	85	0	85
	AV	**xxx**	**101**	**4**	**6.2**	**1279**	**57**	**215**	**36**	**62**	**2.8**	**0.77**	**3.61**	**71.6**	**36**	**71.5**

Appendix-III.

(a): Agricultural Characteristics according to Family Size in Jorhat District.

Zones	Cat.	Cls.	HH	SH	UCL	CL	IC	LP	LabP	F/h
	VS	< 3	7	1.17	21	62	108	7322	2193	31
	SM	4--5	21	1.33	23	78	129	6762	2489	29
A	MED	6--7	17	1.85	30	71	119	6734	2796	22
	LS	8-- 9	4	2.9	26	69	120	24000	4981	39
	VLS	>10	0	0	0	0	0	0	0	0
	Av	**xx**	**49**	**1.6**	**26**	**72**	**120**	**9066**	**2757**	**28**
	VS	< 3	5	1.45	17	84	131	5909	3018	20
	SM	4-- 5	15	1.6	27	67	136	7563	2485	13
B	MED	6-- 7	17	5.5	23	75	128	11028	8093	19
	LS	8-- 9	7	0.9	41	57	122	10177	2232	10
	VLS	>10	7	2.1	19	80	113	8594	2212	18
	Av	**xx**	**51**	**2.2**	**24**	**73**	**124**	**6384**	**3303**	**12**
	VS	< 3	18	1.7	24	71	121	6629	4370	35
	SM	4-- 5	88	1.6	24	72	117	5839	2075	36
C	MED	6-- 7	62	1.8	25	74	119	6605	2447	38
	LS	8-- 9	28	1.9	20	72	108	6968	2040	23
	VLS	>10	9	1.9	25	75	121	11387	2327	22
	Av	**xx**	**205**	**1.7**	**24**	**72**	**117**	**7611**	**2212**	**31**
	VS	< 3	13	1.2	23	70	125	4019	1181	9
	SM	4-- 5	41	1.6	23	76	110	6196	2540	12
D	MED	6-- 7	23	1.9	22	77	117	5271	2155	17
	LS	8-- 9	12	2.8	24	75	124	7124	2774	8
	VLS	>10	12	4.8	19	81	116	5925	2646	8
	Av	**xx**	**101**	**2.1**	**23**	**76**	**118**	**5166**	**2040**	**11**

HH-Households, SH-Size of Land Holding,UCL-Percentage of Uncultivated Land to Total Land, CL-Percentage of Cultivated Land to Total Land, LP-Land productivity, LabP-Labour Productivity, IC-Intensity of Cropping, F/H-Fertilizer Used (kg/ha).

(b) : Agricultural Characteristics according to Density of Population in Jorhat District..

Zones	Cat.	Cls.	HH	SH	UCL	CL	IC	LP	LabP	F/h
A	VLD	0-1.99	10	2.9	25	71	129	8678	4340	42
	LD	2-2.99	8	2.4	21	80	113	8226	3899	43
	MOD	3-3.99	9	1.5	20	80	132	7052	2147	36
	HD	4-4.99	3	1.3	21	72	122	8798	2091	24
	FHD	5-5.99	5	1.1	24	77	118	9879	2071	16
	VHD	> 6	14	0.49	34	62	136	9464	1753	10
	Av	**xx**	**49**	**1.6**	**26**	**72**	**120**	**9066**	**2757**	**28**
B	VLD	0-1.99	15	1.5	29	70	127	11972	2338	19
	LD	2-2.99	5	1.4	36	63	135	4439	1442	11
	MOD	3-3.99	7	2	26	68	133	17318	3389	14
	HD	4-4.99	6	10.8	30	72	124	6386	1518	10
	FHD	5-5.99	5	2.1	22	77	101	5002	1976	10
	VHD	> 6	13	1.4	17	78	134	6146	4621	14
	Av	**xx**	**51**	**2.2**	**24**	**73**	**124**	**6384**	**3303**	**12**
C	VLD	0-1.99	23	1.5	22	77	123	7838	2745	33
	LD	2-2.99	35	1.4	24	72	117	6912	1889	28
	MOD	3-3.99	25	2.2	25	75	117	8921	3433	35
	HD	4-4.99	27	1.6	18	75	116	5500	2070	41
	FHD	5-5.99	24	1.5	26	74	114	9022	1502	35
	VHD	> 6	71	1.8	27	71	117	7475	2392	34
	Av	**xx**	**205**	**1.7**	**24**	**72**	**117**	**7611**	**2212**	**31**
D	VLD	0-1.99	22	3.7	18	82	117	4700	1825	12
	LD	2-2.99	25	2.4	21	79	124	7469	4135	9
	MOD	3-3.99	15	2.1	26	78	113	4645	1603	17
	HD	4-4.99	12	1.5	18	83	123	4041	1963	15
	FHD	5-5.99	15	1.1	25	73	113	4090	1822	12
	VHD	> 6	12	0.6	30	65	120	6050	1730	8
	Av	**xx**	**101**	**2.1**	**23**	**76**	**118**	**5166**	**2040**	**11**

(c): Agricultural Characteristics according to Literacy Rate in Jorhat District.

Zones	Cat.	Cls.	HH	SH	UCL	CL	IC	LP	LabP	F/h
A	VL	0-20	12	1.8	26	72	123	14873	3209	52
	L	20-40	7	1.8	23	76	125	6819	2712	27
	MED	40-60	5	0.9	18	81	107	4309	1905	5
	H	60-80	9	1.6	23	68	148	10772	2591	11
	VH	>80	6	1.5	41	59	127	8419	2934	31
	AV	**xxx**	**49**	**1.6**	**26**	**72**	**120**	**9066**	**2757**	**28**
B	VL	0-20	15	3.5	15	86	124	8300	5506	21
	L	20-40	15	2.2	18	75	147	7114	3566	13
	MED	40-60	11	1.4	34	67	113	8201	2221	9
	H	60-80	7	1.1	27	72	146	3018	1845	0
	VH	>80	3	0.7	27	73	148	6562	2750	0
	Av	**xx**	**51**	**2.2**	**24**	**73**	**124**	**6384**	**3303**	**12**
C	VL	0-20	84	1.5	25	73	117	8111	2294	31
	L	20-40	86	1.8	24	74	118	6004	2406	37
	MED	40-60	28	1.9	23	75	113	7568	2017	32
	H	60-80	5	1.2	34	62	112	7295	1856	26
	VH	>80	2	2	19	81	146	6706	3143	34
	Av	**xx**	**205**	**1.7**	**24**	**72**	**117**	**7611**	**2212**	**31**
D	VL	0-20	36	2.1	22	76	112	4809	1556	13
	L	20-40	29	2.7	20	79	123	3409	1663	11
	MED	40-60	24	1.6	26	74	115	7027	4282	11
	H	60-80	5	1.8	19	81	129	4931	1772	8
	VH	>80	7	1.8	27	70	140	5363	1953	9
	Av	**xx**	**101**	**2.1**	**23**	**76**	**118**	**5166**	**2040**	**11**

(d): Agricultural Characteristics according to Size of Holdings in Jorhat District.

Zone	Cat.	Cls.	HH	SH	UCL	CL	IC	LP	LabP	F/h
	<MH	0-.99	17	0.57	32	65	133	9270	1600	14
	M	1-1.99	17	1.4	23	77	126	9141	2600	28
A	SH	2-2.99	9	2.4	21	79	117	8518	3757	42
	SMH	3-3.99	3	3.2	23	77	150	4774	4466	28
	MH	>4	3	4.4	21	64	111	24264	4466	36
	AV	**xxx**	**49**	**1.6**	**26**	**72**	**120**	**9066**	**2757**	**28**
	<MH	0-.99	15	1.5	37	63	143	8277	1878	0
	M	1-1.99	14	1.4	23	68	120	6793	2310	5
B	SH	2-2.99	5	2.4	13	87	113	6915	3360	21
	SMH	3-3.99	10	3	14	81	123	6385	4070	24
	MH	>4	7	6.6	9	91	123	7923	6995	24
	Av	**xx**	**51**	**2.2**	**24**	**73**	**124**	**6384**	**3303**	**12**
	<MH	0-.99	77	0.56	34	60	110	7912	1624	33
	M	1-1.99	65	1.4	19	78	118	5989	1826	37
C	SH	2-2.99	27	2.3	19	81	119	6086	2345	37
	SMH	3-3.99	16	3.3	13	85	127	7066	2951	28
	MH	>4	20	6	17	85	128	8154	2665	30
	Av	**xx**	**205**	**1.7**	**24**	**72**	**117**	**7611**	**2212**	**31**
	<MH	0-.99	20	0.69	31	65	116	4998	1521	8
		1-1.99	38	1.4	20	80	120	5368	2780	17
D	SH	2-2.99	25	2 4	22	77	122	4528	1780	11
	SMH	3-3.99	4	3.5	25	75	108	3856	1570	18
	MH	>4	14	5.4	17	83	116	4939	2190	9
	Av	**xx**	**101**	**2.1**	**24**	**76**	**118**	**5166**	**2040**	**11**

(e): Agricultural Characteristics according to Crop Intensity in Jorhat District.

Zones	Cat.	Cls.	HH	SH	UCL	CL	IC	LP	LabP	F/h
A	VL	<115	17	1.6	29	68	101	12229	2726	28
	L	116-130	11	2	15	85	123	8419	3480	27
	Mod	131-145	9	1.5	25	76	135	6318	2843	41
	H	146-160	6	1.1	26	73	151	9388	2831	18
	VH	>160	6	1	36	62	180	7630	1310	23
	AV	**xxx**	**49**	**1.6**	**26**	**72**	**120**	**9066**	**2757**	**28**
B	VL	<115	11	2	25	75	103	8276	3171	9
	L	116-130	10	2.6	16	84	123	6456	3134	19
	Mod	131-145	3	3.9	18	78	138	6467	5500	21
	H	146-160	7	2.2	15	85	150	7346	4267	19
	VH	>160	20	1.8	28	70	178	7082	3174	6
	Av	**xx**	**51**	**2.2**	**24**	**73**	**124**	**6384**	**3303**	**12**
C	VL	<115	117	1.5	23	76	101	5961	1374	38
	L	116-130	32	2	18	82	123	6729	2870	34
	Mod	131-145	10	2.4	14	85	138	6974	4370	33
	H	146-160	12	1.8	19	79	151	8074	4388	38
	VH	>160	34	1.7	39	60	160	8529	3794	10
	Av	**xx**	**205**	**1.7**	**24**	**72**	**117**	**7611**	**2212**	**31**
D	VL	<115	59	2	21	78	101	4961	2193	11
	L	116-130	16	3.2	21	79	122	5792	1943	15
	Mod	131-145	8	2.1	22	78	137	6405	2067	7
	H	146-160	8	2	21	79	152	6420	2267	19
	VH	>160	10	1.1	32	67	169	5325	1869	2
	Av	xx	**101**	**2.1**	**23**	**76**	**118**	**5166**	**2040**	**11**