ABSTRACT

SPATIAL PATTERN OF AGRICULTURAL PRODUCTION IN THE ENVIRONS OF JORHAT CITY, ASSAM

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Introduction:

Land use is an important aspect of agricultural geography and is a reflection of its interactions prevailing in ecological and non-ecological conditions of the area. Although the physical factors like relief, soil, drainage, climate etc set outer limits to agricultural activities, within which an area of choice usually remains and, in such situations, social, economic and political factors also influence a farmer's final decision for the farm operation. There are numerous socio-economic factors, which influence significantly the agricultural pattern. Of course, the size of land holdings of the farmers, the extension services a farmer receives, the population characteristics of his/her family, the means of transport available at farm gate, the marketing services available at the nearest centre and the social environment which a farmer gets, are found to have a considerable impact on the agricultural intensification. The variations relating to the pattern and intensity of land use emerge either due to the variations in application of production factors or the effects of their combinations. It is also a fact that market plays a significant role in altering the land use pattern, production intensity and farming systems in its surroundings because of diffusion of agricultural innovations. These forces are either related to advancement of agricultural technology in production processes or to the improvement of transport network. Improvement in transportation linkages makes possible greater access to the market centre where the agricultural produces have to be reached. The location of farm and its accessibility to the market are major considerations in the decision making of a farmer for his farm. Therefore, transport network plays an important role in the agricultural development of any region. The application of the modern agricultural

technology defused through market centres in the agricultural landscape is a major aspect of spatial organization of agriculture (Visser, 1980, 1982). Modern transport technology reduces the transport costs of a commodity which is surplus at farm and transported to the nearby market. Therefore, transport costs which are integral part of inputs that influence the economic rent in the operation of agricultural production, is one of important factors for agricultural development. In the developing agricultural economies, the location of market centre has a significant impact on agricultural land uses. Therefore, the spatial characteristics of land use and production factors, which are influenced by the market forces, have a great significance. Being changing scenario of farm activities in the developing economies, the present studies of agricultural geography has a great significance. In this context, Von Thunen's contribution is noted as a classical work.

Statement of the Problem:

On the agricultural scenario prevailing in the Brahmaputra valley, the following observations are drawn by many researches which are quite relevant in the present context:

(a) Temporal land use statistics of the whole of Assam plain show that there is not much change in the general land use pattern in the last 20 years (1969-70 to 1998-99), which indicates that the processes of agricultural development have been stagnant during the last part of century. However, there is marked slight increase in the category of agricultural land during early 2000s, when land under Net Sown Area (N.S.A.) has increased by nearly 10.0 percent.

However, agricultural productivity and crop-intensity are noted very low (Singh & Sharma 2003: 5[illegible]2).

(b) The cropping pattern is almost mono-culture with less percentage share of agricultural area under the category of cropping 'more than once'.

(c) The level of agricultural productivity (that is, average yield of principal crops per unit of land) slightly rose by 10.75 percent from Rs. 8604/ha (1989-92) to Rs. 9286/ha (1998-01) during the 1990s because of favourable weather conditions for paddy cultivation rather than adoption of modern agricultural seed-fertilizer technology. Only 2.0 percent increase in the application of chemical fertilizers and 3.6 percent increase in the areas of HYVs during the same period of time show a slow speed of adoption of modern agricultural technology. The obliterated pattern of agricultural productivity show the concentration of high productivity areas in few pockets of Brahmaputra valley where the impact of bigger growth centres and state capital are visualised. Such market centres have been gradually expanding its peripheries for agricultural development (Sharma 2003).

(d) There is a sharp decline of 26.3percentin labour productivity during the 1990s from Rs. 4650/worker (1998-01) with a very high increase of about 113.0 percent in the agricultural labour intensity from 1513 persons/sq km to 2566 persons/sq. km during the same period of time (Sharma 2003). It shows a heavy pressure of agricultural labour force and unlimited supply of cheap labour to agricultural practices which may force the rural labour to migrate to

the nearby market centres and change the spatial pattern of agricultural production in the Assam plains.

(e) Agricultural productivity and growth must follow negatively relationship as per the Vordooren's law of balanced agricultural regional development. However, in some areas of Assam plains, agricultural productivity and growth are positively related that show the confined concentrated developmental processes of agriculture. Jorhat district comes under such category where land use changes are significant; agricultural productivity is recorded higher and production growth is observed faster. Thus, the importance of Jorhat as market town in agricultural development is recognisable in its surroundings (Sharma 2003).

On the basis of above facts, it may be said that the Jorhat area which includes the Upper southern part of the Brahmaputra valley is passing through the developing stage of agricultural economy where Jorhat market town has its own importance in diffusing the modern agricultural innovations to the surroundings

Objectives:

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

(i) to interpret the spatial pattern of agricultural land use in well- defined market region,

(ii) to analyse the spatial variation in agricultural intensity and its causes,

(iii) to show the effects of technological input prices and wage rates at market centre and technological advancements in alterations of spatial pattern of production intensity and agricultural land uses.

Hypotheses:

The study is basically related to the impact of technological improvement in agricultural production processes. Under some specific assumptions, Thunen considered as a landscape of 'isolated estate' where physical factors and soil fertility are almost homogenous throughout. Only one market centre is emerging for fulfilling the technological demands of farmers providing agricultural inputs to the farmers of the region and attracting rural labour force of the market region to the market centre. On the other hand, production surplus available at farm gate is supplied to the market centre only. In this situation, such two-ways processes of spatial pattern play significant role in the development of this structure. They are to be tested empirically taking Jorhat market region as a case of development of spatial pattern of agriculture in Upper Brahmaputra valley. The following hypotheses are tested for the purpose.

(a) 'Sensitivity (elasticity) of prices (of inputs) and wages alters the spatial input demand and, thereby, the price elasticity and wage elasticity change the spatial optimal limit of agricultural intensity'.

(b) 'Increase in transport network intensity intensifies agricultural activities and expands the spatial optimal limit of agricultural land use intensity in the market region.'

The Study Area:

The Jorhat market region generally includes the whole Jorhat district excluding Majuli sub-division. Jorhat city is centrally located in the region and connected with the other parts of the Brahmaputra valley.

Location and Extent:

It extends between 93° 35' E to 94° 37' E longitudes and 26° 20' N to 27° 15' N latitudes, with an area of about 2,851 sq. km (3.64 percent of the state area). It is bounded with the boundaries of Luhit suti and North Lakhimpur districts in its north, the state of Nagaland in its south, the district of Sivasagar in the east and Golahat in the west. As per Census Statistics 2001, the total population of the study area is enumerated approximately 1,009,197 (2001 census) of which 38 percent are workers. A large share of working population (cultivators and agricultural workers includes 39.54%) is engaged in agricultural activities and allied services. Economy of the study area is mostly based on agriculture and Jorhat city plays a major role in development of the area.

Administrative Unit:

The district is composed of 5 revenue circles, 8 Rural Development Blocks, 8 Police Stations, 3 sub divisions, 593 villages (inhibited) excluding Majuli as per the census records 2001.

Homogeneity in Physical Attributes:

With the exception of some undulating surface features due to the presence of foot hills of the Naga Hills in the extreme southern part of the study area, the entire district is

gentle plain with an insignificant altitudinal variations ranging from 90 m in the north parts along Brahmaputra river to 200 m in the southern parts of the districts. The gentler slope of less than one degree reflects a surface homogeneity of the area. The drainage patterns are evolved by the river Brahmaputra and its tributaries, viz, Jhanji, Bhogdoi and Kakodonga which originate from the Naga hills in the south. Drainage patterns do not have much significance in changing agricultural scenario, because some are seasonal tributaries and develop only the micro areal relief features. Distribution of drainage density almost evolves the uniform pattern. Being a part of upper Assam valley where monsoonal climate prevails, the district Jorhat also falls into the same climatic zone. It is characterised by high humid atmospheric abundant rains and general coolness. Records of rainfall, temperature and humidity in the district are available for one station (i.e., Assam Agricultural University, Jorhat) for period ten years (1993 to 2003). The details of the rainfall, temperature and humidity of the station situated in the district reveal that the summer and the winter seasons are quite distinct in respect of rainfall, temperature and humidity distribution and, thereby, that is facilitating the cultivation of a variety of crops during the two seasons of the year.

Methodology and Database:

In order to understand the spatial patterns of agricultural production in context with the above cited conditions of Jorhat market region, a proper thought in understanding the input factors, their operational costs and efficiency of existing transport network is to be given. More specifically, the given hypotheses are also related to these aspects of spatial agricultural pattern. The input demand function is an important aspect

to interpret the spatial optimal boundary conditions which are price-dependent (in case of technological demand filled by market centre) and wage-dependent (in case of labour demand at farm location and labour migration to non-agricultural sector prevalent at market centre). Since farmers buy technology from market centre and transport costs are involved to use technological inputs, the demand of such input factors diminish in its concave nature as distance from market increases because of involvement of additional transport costs and the net price paid by farmers at their farm-gate located at a certain distance from the market centre, s, noted as

$$P(s) = (Pm + \alpha s), \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where Pm = input factor price at market centre and α = freight rate subject to $\alpha > 0$, P = net price of input factor at farm gate.

On the other hand, agricultural labour intensity, L, is altered over space by the total available supply of labour force, which is influenced by rural-to-urban migration due to wage differentials (Nakagome 1986). Thus, net wage rate at the farm gate, W, is assumed to be a negative linear function of distance to market as

$$W(s) = (Wm - \beta s), \text{ subject to } (Wm - \beta s) > 0 \quad \ldots \quad \ldots \quad (2)$$

The spatial demand functions for the intensity of production factors, D and L, as suggested by Griffith (1986) are used in the following forms.

$$D(P, s) = Ao\,(Pm + \alpha s)^{-\eta} \quad \ldots \quad \ldots \quad (3)$$

and

$$L(W, s) = Lo\ (Wm - \beta s)^{-q} \qquad (4)$$

where η and q are price and wage elasticities and Ao and Lo are maximum level of factors when their demands are inelastic ($\beta = 0$, $q = 0$) (Singh 2002).The measurement of elasticity of prices are calculated by following its classical concept as the proportionate change in the input (say technological /labour) with respect to the proportionate change in their prices/wages as under

$(dD/D)/(dPm/Pm) = \eta$ and likewise, $(dL/L)/(dWm/Wm) = q$.

Economic rent of a piece of land is the most important attribute for the analysis of spatial agriculture structure which is measured to get the differentials between the total revenue and the total costs involved in the operation of a piece of agricultural land as

R =(Revenue – costs), ... (5)

where R is rent per unit of land (Rs/ha).Note that the simplified version of rent equation as given above shows that the value of total magnitude of revenue per unit of land and total production costs per unit of land including transport costs of out put are maim attributes of the rent calculation.

In operation of the land rent equation by distance, the statistics of the following attributes in their spatial manner are required:

1) Agricultural output, crop-pattern and crop-yield and market prices of agricultural commodities.

2) Attributes related to technological inputs (including costs of fertilizer, seed, irrigation, machine tools, etc)

3) Labour intensity and labour wage rates in rural areas as well as at market centre,

4) Freight rates and transport rates (bus/taxi/rikshaw fares)

The statistics of these attributes were collected by distance from Jorhat market centre to test the validity of these facts. The main observations were drawn by conducting the field survey during the years 2003 and 2004 keeping in mind the effects of the seasonality and avoiding the abnormal days.

Sample Design:

Since basic purpose of the present study is to examine the spatial pattern of agricultural land use using the location rent criteria as stated above. It is also true that to conduct the house- to -house survey for a complete enumeration is not possible due to the limitation 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 characterised by homogenous conditions as mentioned above. In such conditions, a part of the universe which can explain the reality called 'sample' may become an indispensable tool for a researcher. In the present work, the sampling method is attempted to draw the results in such a way that can be successfully explain the spatial pattern of production and its relationship with the market. Therefore, village and HH sample design is used in the present study for giving the explanations of the inquiry proposed earlier. Various stages are involved in choosing the samples as presented below

a) Selection of Sample Villages: In order to understand the spatial pattern of agricultural production for which distance from the market centre is a main factor, the basis of the selection of the sample villages follow three main criteria that are as:

i) Distance of the sample village from Jorhat city;

ii) Distance of the sample villages from the main road, since road network is an important factor for intensification of agricultural practices;

iii) The population size of the sample village, because bigger villages have their own initial infrastructure for the growth and development of agricultural activities while the smaller villages are solely dependent on them.

iv) Variations in the agricultural practices.

Following the above mentioned criteria, the sample villages that are 30 in numbers as accounts for 5.05 per cent to the total villages (numbered 593) in the universe, were selected for the present study. For the selection of sample villages, purposive sample method was used (Fig.-1.7). The basic information of sample villages have been compared with the universe to test the validity of the sample selection.

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 (Appendix-1). With the simple but systematically prepared schedule, the heads of the families living in the HHs were approached for personal interviews. 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 for the purpose. In this way, the entire information were fathered from the sample HHs and then the collected information were computed and processed with the help of using computer software.

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 relevant information has been collected from various books, journals and other periodicals.

Arrangement of Material:

The entire research material was arranged into six Chapters. The Chapter-I includes brief introduction to the research problem including objectives, hypotheses, area under study and methodology adopted in the present research. Chapter-II incorporates the detail review of literature while Chapter-III deals with the nature and characteristic features of agricultural production activities. Chapters-IV and V are more devoted to the analytical findings and synthesis of the facts that are supported by the tables, maps and

diagrams. In the end, the results of hypotheses testing and generalizations are arranged in Chapter-VI.

Initial Findings:

General Inferences:

Higher concentration of household is noticed in the small size of farmers' family (4-5 persons/family). Contrary to it, very large and large size of families (more than 10 persons) include only 21 percent of the total household. There are many characteristic features of subsistence peasant economy as given by many scientists. However, the some specific observations on the basis of farmers' family size, their landholdings and subsistence levels are drawn.

Subsistence level of Agriculture and Market Surplus:

Classifying a total number of sample household into five categories on the basis of percentage share of marketed surplus as: Subsistence (0-20% farm product as marketable surplus), Semi-subsistence (20-40%), Dual subsistence (40-60%), Semi-Commercial (60-80%) and Commercial (80-100%), it is found that there is a gradual increase in the cultivated area at farm level by converting waste and forest lands to the NSA. The crop yield also increases marginally over time. It means the processes of expansion and intensification started in the subsistence farming systems in the district. The particular findings are given below:

i. Commercialization in the farming system is positively related with the size of land holdings and family size. Larger families who have bigger size of land

holdings have started producing more marketable surplus (commercial activities) with the employment of the major part of their family labour who are educated and more mobile. Female dominates in the subsistence farm activities. Male adults contribute when there is change in the farming activities from subsistence to commercial.

ii. The duration of employment of hired labour increases as farm activities changes from subsistence to commercial. But commercial farm are labour consuming (especially hired labour) in the farms of commercial activities.

iii. General land use changes by increasing land under NSA from the plantation and miscellaneous tree crops when farming practices alters from subsistence to commercial. Winder paddy, potato contribute higher share of marketable surplus in then subsistence farming and Bettlenut and vegetables are growing for marketing surplus.

iv. The farmers occupying large size of landholdings practice intensive farming with commercial crops. At such large holding sizes of farms, a large share of land is under paddy crop which is grown as commercial crop because a very small share of total food grains are used for family consumption and remaining share of paddy product is used as marketable surplus. Beetlenut and vegetables are major commercial crops in these commercial farming practiced in the larger land holding sizes.

Preliminary Deductions:

1. As per the conducted survey and compilation of survey results, it is found that the farmers of the Jorhat city region are applying multiple inputs at their farms. The multiplicity ratio is recorded highest 4.12 for the application of irrigation following 3.89 for others like use of fertilizers, H.Y.V. seeds, pesticides and power tiller. It means a simultaneous adoption of input technology like fertilizer, H.Y.V. seeds, pesticides and power tiller are being used by most of the farmers of the region.

2. Use of inputs at farm level varies spatially. About 50 percent share of the total cost is invested only on four technological inputs, i.e., fertilizers, H.Y.V. seeds, pesticides and water pump (irrigation specially in winter season) at farms located in the close vicinity, while two inputs namely, fertilizer and H.Y.V. seeds account for more than 50 percent share of total input cost invested by the farmers in the outer peripheral areas. It is clear that total cost on the use of technological inputs diminishes as distance increases from the Jorhat market centre.

3. Out of a total of 21 crops that include an area of more than 95 percent GCA, the two peripheral zones which are located about 30 km from the market centre are found diversified which include 20 to 21 crops in its cropping pattern. The highly market accessible areas (3-6 km) are also having the significant number of crops with the prevalence of Cauliflower, Brinjal, Tomato, Jika, Ladies finger in its diversified crop pattern. The most accessible areas from the market centre (0-3

km) are dominated by commercial crops in its cropping pattern; only seven out of 21 crops appear in the cropping pattern of this area.

4. So far as crop yield is concerned, the average crop yield of the district based on collected data recorded highest in summer paddy (8985 kg/ha) within the group of food grain crops. However, the yield rates of the vegetables are remarkably high in the district. For example, Olkabi (Knolkhol) has the highest yield (i.e., 17,621 kg/ha) in the district with the significant variation from 30,000 kg/ha in the close vicinity of market to 5,242 kg/ha in the outer periphery.

5. Spatial margin of input, which was prepared by calculating the average input cost/ha for 30 sample villages and drawing Iso-cost lines, shows that the total input cost (including labour) increases as distance increases from the Jorhat market region. The pattern of Iso-cost lines is influenced by road network.

6. The same pattern emerges for Iso-transport cost also. However, the spatial margin of transport cost are more smooth in the peripheral areas.

7. There is record decrease in land productivity from Rs. 44,221/ha in the most accessible areas to a minimum of Rs. 7,732/ha in the most remote areas of the market region. Graph shows clearly that is almost decreasing at constant rate of Rs. 1000/ha/km when distance increases from the market.

Spatial Patterns of Revenue and Labour Productivity:

1. Labour productivity diminishes when distance increases from the town in the market region. It is recorded about Rs.52,000/person in the close vicinity of the

market and lowest as Rs.3,112/person in the peripheral areas of beyond 36 kms. Its pattern shows that it diminishes fast in the close vicinity of the market centre and slower in the peripheral areas. The pattern of decrease is slightly curvilinear rather than linear. The causes of decreasing in labour productivity are obvious that the total labour employment per HH increases by distance from the market centre and, consequently, the intensity of agricultural labour force also increase spatially from 78 persons/sq km to 218 persons/sq km as distance increases from the city. It decreases the productivity in its spatial pattern.

2. The maximum revenue a farmer is achieving at a very close distance from market, say 1.5 km, is calculated maximum (Rs. 45,221/ha). However, it diminishes curvilinear when distance increases from the market centre. On the other hand, total technological input costs are noticed constant in the spatial pattern which is nearly Rs. 3,500/ha.

3. There is a slight increase in labour cost and faster increase in transport cost in the peripheries of the market region. Thus, total input cost increases curve-linearly.

4. Land rent is considered as differential between the total revenue and the total costs. It (land rent) decreases from Rs 30,000/ha in the close surroundings of the market centre to Rs 3,700/ha in the outer peripheries of the region. This also decreases non-linearly in the market region.

In the end, it may be concluded that commercialization do occur in the growing agricultural economies as exist in the study area. The agricultural production activities

produce marketable surplus which is supplied to and the technological agricultural innovations which are diffused by the centrally located market centre (that is Jorhat town) are the part of the spatial patterns of agricultural land uses. These spatial patterns of agricultural activities follow the non-linear trends of agricultural land rent, labour and capital productivities as well as labour dominated pattern.

References:

Amedeo, D. and R. G. Golledge (1975): *An Introduction to Scientific Reasoning in Geography*, New York: John Wiley and Sons, Inc., pp. 299-306

Berry, B. J. L., E. C. Conkling and D. M. Ray (1993): *The Global Economy, Resource Use, Locational Choice and International Trade*, Printice Hall Englawood Cliffs, New Jersey, pp. 253-67.

Bora, B. (2002): *Population Characteristics & Agricultural Development in Jorhat District, Assam,* Unpublished PhD Thesis submitted to the Department of Geography, North Eastern Hill University, Shillong.

Chisholm (1979): The Von Thunen - Principle and Agricultural Zonation in Colonial Mexico, *Journal of Historical Geography*, Vol. 3, pp. 123-33.

Chouhan, T. S. (1987): *Agricultural Geography, A Study of Rajasthan State*, Academic Publishers, Jaipur, p. 27.

Directorate of Assam (1993): *Field Manual for Rain fed Agriculture in Assam*, Assam Agriculture University, Jorhat (Assam), p. 6.

Dunn, E. S. (1954): *The Location of Agricultural Production*, Gainesville, University of Florida Press, p. 6.

Ewald, U. (1977): The Von Thunen Principle and Agricultural Zonation in colonial Mexico, *Journal of Historical Geography*, pp. 123-33.

Ferber, R. and P. J. Verdoorn, (1962): *Research Methods in Economics and Business*, Macmillan Co, New York, pp. 33-34.

Griffith, D. A. (1986): Central Place Structure using Constant Elasticity of Substitution Demand Cones: The Infinite plane, *Economic Geography*, Vol. 62 (1), pp. 74-84.

Government of Assam (1967): *Assam District Gazetteer, Sivasagar District*, Shillong, p.21

Horvarth, R. J. (1969): Von Thunen's Isolated State and the area around Addis Ababa, Ethiopia, *Annals of the Association of American Geography*, Vol. 19, pp. 308-23.

Katzman, M. T. (1974): The Von Thunen Paradigm, The Industrial Urban Hypothesis and the Spatial Structure of Agriculture, *American Journal of Agricultural Economies*, Vol. 56, pp. 683-96.

Kellerman, A. (1983): Economic and Spatial Aspects of Von Thunen's Factor Intensity Theory, *Environment and Planning*, Vol. 15, pp.1521-30.

Kothari, C. R. (1990): *Quantitative Techniques*, Vikash Publishing, New Delhi, p. 108.

Kothari, C. R. (1996): *Research Methodology, Methods and Techniques*, Wishawa Publication, New Delhi, p. 35.

O'Kelly, M. E. (1988): Aggregate Rent and Surplus Measurement in a Von Thunen Model, *Geographical Analysis*, Vol.20, pp. 187-97.

Peet, J. R. (1969): The Spatial Expansion of Commercial Agriculture in the Nineteen Century - A Von Thunen Interpretation, *Economic Geography*, Vol. 45, pp. 283-301.

Sharma, B. (2003): *Changing Pattern of Agricultural Labour Productivity in the Brahmaputra Valley*, M. Phil Dissertation (Submitted to the Department of Geography, North Eastern Hill University, Shillong, pp. 52-103.

Singh, R. L. (ed) (1971): *India: A Regional Geography*, (1st Edition), National Geographical Journal of India, Varanasi, p.306.

Singh, S. (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 30(3), pp.229-244.

Singh, S. and B. Sharma (2003): Determinants of Crop Intensity in Assam Plain, *The Geographer*, Vol. 50(1), pp. 58-72.

Viser, S. (1982): On Agricultural Location Theory, *Geographical Analysis*, Vol.14, pp.167-76.

Visser, S. (1980-82): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol. 56, pp.311-19.

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I, **SHRI KAMALA KANTA GOGOI,** hereby declare that the subject matter of this thesis is the record 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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Chapter – I

INTRODUCTION

Land use is an important aspect of agricultural geography and is a reflection of its interactions prevailing in ecological and non-ecological conditions of the area. Although the physical factors like relief, soil, drainage, climate etc set outer limits to agricultural activities, within which an area of choice usually remains and, in such situations, social, economic and political factors also influence a farmer's final decision for the farm operation. There are numerous socio economic factors, which influence significantly the agricultural pattern. Of course, the size of land holdings of the farmers, the extension services a farmer receives, the population characteristics of his/her family, the means of transport available at farm gate, the marketing services available at the nearest centre and the social environment which a farmer gets, are found to have a considerable impact on the agricultural intensification. The variations relating to the pattern and intensity of land use emerge either due to the variations in application of production factors or the effects of their combinations. It is also a fact that market plays a significant role in altering the land use pattern, production intensity and farming systems in its surroundings because of diffusion of agricultural innovations. These forces are either related to advancement of agricultural technology in production processes or to the improvement of transport network. Improvement in transportation linkages makes possible greater access to the market centre where the agricultural produces have to be reached. The location of farm and its accessibility to the market are major considerations in the decision making of a farmer for his farm. Therefore, transport network plays an important role in the

agricultural development of any region. The application of the modern agricultural technology defused through market centres in the agricultural landscape is a major aspect of spatial organization of agriculture (Visser, 1980, 1982). Modern transport technology reduces the transport costs of a commodity which is surplus at farm and transported to the nearby market. Therefore, transport costs which are integral part of inputs that influence the economic rent in the operation of agricultural production, is one of important factors for agricultural development. In the developing agricultural economies, the location of market centre has a significant impact on agricultural land uses. Therefore, the spatial characteristics of land use and production factors, which are influenced by the market forces, have a great significance. Being changing scenario of farm activities in the developing economies, the present studies of agricultural geography has a great significance. In this context, Von Thunen's contribution is noted as a classical work.

Many technical terms which we use in day-to-day working in the research writing as well as will use in the present research, are to be defined in the present context. The term spatial pattern of agriculture refers to the attributes of agricultural land use and its intensification, which change their magnitudes with reference to distance from the market centre. Agricultural land use pattern by distance from the market centre in the agriculture region are ultimate outcome of the spatial structure of agricultural activities.

(i) The term 'land rent' refers to a basic rent criterion of Ricardo who defined rent as a scarcity payment for a piece of land which has been calculated by subtracting the total operational costs from the total revenue. Differential land rents are either due to productivity differences or location of land (i.e., farm)

at different distances from the market in market region (Berry, Conkling and Ray 1993: 255).

(ii) The term marginal productivity follows the classical concept of change in the agricultural production per unit of change in its production factors like land, labour, technology. In present case, more emphasis is given on marginal product of agricultural technology as well as labour inputs in characterising the spatial pattern of agricultural land intensity.

(iii) Input ratios refers to the proportions of one production factor to another to observe their effective use in changing the spatial pattern of agricultural activities.

(iv) The term 'farm' is used here in the sense that a farmer/cultivator occupies a piece of land on the basis of leased or owed land.

(v) Spatial optimal boundary of agricultural intensity refers to an optimal distance from market centre in market region at which demand factors of agricultural input are found optimum following basic rules of optimality.

1.1 Statement of the Problem:

On the agricultural scenario prevailing in the Brahmaputra valley, the following observations are drawn by many researches which are quite relevant in the present context:

(a) Temporal land use statist[illegible] of the whole of Assam plain show that there is not much change in the general land use pattern in the last 20 years (1969-70 to 1998-99), which indicates that the processes of agricultural development have

been stagnant during the last part of century. However, there is marked slight increase in the category of agricultural land during early 2000s, when land under Net Sown Area (N.S.A.) has increased by nearly 10.0 percent. However, agricultural productivity and crop-intensity are noted very low (Singh & Sharma 2003: 58-72).

(b) The cropping pattern is almost mono-culture with less percentage share of agricultural area under the category of cropping 'more than once'.

(c) The level of agricultural productivity (that is, average yield of principal crops per unit of land) slightly rose by 10.75 percent from Rs. 8604/ha (1989-92) to Rs. 9286/ha (1998-01) during the 1990s because of favourable weather conditions for paddy cultivation rather than adoption of modern agricultural seed-fertilizer technology. Only 2.0 percent increase in the application of chemical fertilizers and 3.6 percent increase in the areas of HYVs during the same period of time show a slow speed of adoption of modern agricultural technology. The obliterated pattern of agricultural productivity show the concentration of high productivity areas in few pockets of Brahmaputra valley where the impact of bigger growth centres and state capital are visualised. Such market centres have been gradually expanding its peripheries for agricultural development (Sharma 2003).

(d) There is a sharp decline of 26.3 percent in labour productivity during the 1990s from Rs. 4650/worker (1998-01) with a very high increase of about 113.0 percent in the agricultural labour intensity from 1513 persons/sq km to

2566 persons/sq. km during the same period of time (Sharma 2003). It shows a heavy pressure of agricultural labour force and unlimited supply of cheap labour to agricultural practices which may force the rural labour to migrate to the nearby market centres and change the spatial pattern of agricultural production in the Assam plains.

(e) Agricultural productivity and growth must follow negatively relationship as per the Vordooren's law of balanced agricultural regional development. However, in some areas of Assam plains, agricultural productivity and growth are positively related that show the confined concentrated developmental processes of agriculture. Jorhat district comes under such category where land use changes are significant; agricultural productivity is recorded higher and production growth is observed faster. Thus, the importance of Jorhat as market town in agricultural development is recognisable in its surroundings (Sharma 2003).

(f) On the basis of above facts, it may be said that the Jorhat area which includes the Upper southern part of the Brahmaputra valley is passing through the developing stage of agricultural economy where Jorhat market town has its own importance in diffusing the modern agricultural innovations to the surroundings (Table-1.1).

Table-1.1: Changes in the Agricultural Production Processes and Transformation in Agricultural Land Uses

Stages	Production Factors	Use of technology
I Initial Stage	Agricultural production is under control of physical factors of agricultural landscape.	No use of fertilizers, irrigation, H.Y.V. seeds and pesticides.
II Developing Stage	Agricultural production is influenced by physical factors and market forces. Input supply through near by market.	Use of inputs; Technology and intensification through increasing crop yield; insignificant marketable surplus products in agricultural practices. However, farmers go to nearby market centre to exchange their agricultural products and to buy technological inputs.
III Advancement in agriculture	Physiography of landscape is homogeneous and land us intensification through stronger market forces and fast technology mobilization through the well-connected transport network.	Production factor intensification and consideration of (i) Input costs, labour wage rate and transport costs, and (ii) supply of surplus production to nearby market which involves production and transportation costs to market and rent maximisation.

The above Table reveals the transformation of agricultural land use through time. In the initial stage (1st stage), agricultural production processes is fully under the control of nature and the farmers too, also governed by the physical factors and, hence, they do not know how to practice irrigation, fertilizers, H.Y.V. seeds and pesticides in agricultural operation. In the developing stage (II stage), agricultural production is controlled both by physical factors and market forces. Inputs are supplied through the market centres. Intensification in agricultural production processes increases the crop yield. But no surplus production in agricultural land use. However, farmers of the surroundings come to the market centre to exchange their products. In the advancements in agricultural land use (III stage), considering homogeneous physiographic conditions

intensification in agricultural land use, production processes take place through market forces and technology mobilization by distances (transport costs). As a result, production factor and (i) input costs, labour wage rate, transport costs, and (ii) supply of surplus production to the nearby market which involves production prices and transportation costs are to be taken into consideration.

It is realised that distance between the farm and market centre plays a significant role in spatial pattern of agricultural activities. Since transport costs are directly related to distance and the means of transportation are associated with the fast supply of agricultural output from the farm to market centre, the degree of agricultural intensification decreases by distance from the market as generally analysed by many scientists. Borah (2002) found that, in the plains of Jorhat district, factors related to population pressure explain nearly 50 percent of crop intensity in the form of variation in productivity and the remaining 50percent variability is being occurred due to application of modern technological factors (H.Y.V., irrigation, pesticides, power tiller etc). Thunen's idea provides a useful frame work for examining such facts of agriculture prevailing in Jorhat area, while his theory has been modified (Peet, 1969; Kellerman, 1983) and applied at different geographical scales (Horvath, 1969; Ewald, 1977, Chisholm, 1979; O' Kelly 1988; 1989) in different parts of the world.

Considering 'Jorhat city' as a market centre from where technological inputs are being diffused to the farmers residing in the surrounding areas and rural labour residing in its periphery is being absorbed in non-farm activities at this market centre, an attempt is made here to analyse the spatial patterns of agricultural activities brought by the

influence of the market centre applying the classical location theory. Market area of Jorhat centre is considered as homogenous in its physiographic conditions. It does not have much areal variations in soil and weather conditions. As a result, spatial patterns of agriculture are supposed to be homogeneous in respect of physical conditions of land. However, they are not uniform in the market region being the influence of either by the variations in input costs or production prices which are dependent on market price, labour wage and freight rates of commodities. In fact, the spatial trends of technological factors and employment of labour in the production processes may provide a sound base of agricultural intensification through the use of technological demand function approach to analyse the effect of production costs in its spatial organization of agricultural land use.

Objectives:

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

(i) to interpret the spatial pattern of agricultural land use in well- defined market region,

(ii) to analyse the spatial variation in agricultural intensity and its causes,

(iii) to show the effects of technological input prices and wage rates at market centre and technological advancements in alterations of spatial pattern of production intensity and agricultural land uses.

1.3 Hypotheses:

The study is basically related to the impact of technological improvement in agricultural production processes. Under some specific assumptions, Thunen considered

as a landscape of 'isolated estate' where physical factors and soil fertility are almost homogenous throughout. Only one market centre is emerging for fulfilling the technological demands of farmers providing agricultural inputs to the farmers of the region and attracting rural labour force of the market region to the market centre. On the other hand, production surplus available at farm gate is supplied to the market centre only. In this situation, such two-ways processes of spatial pattern play significant role in the development of this structure. They are to be tested empirically taking Jorhat market region as a case of development of spatial pattern of agriculture in Upper Brahmaputra valley. The following hypotheses are tested for the purpose.

(a) 'Sensitivity (elasticity) of prices (of inputs) and wages alters the spatial input demand and, thereby, the price elasticity and wage elasticity change the spatial optimal limit of agricultural intensity'.

Justification:

This hypothesis is more concerned with the economic factors of agricultural development in the market region. These are the market prices of technological inputs such as irrigation equipment, machine tools, seeds, fertilizer, etc which are being used by the farmer of the market region and bought by him from the centrally located market centre. Labour wage is also another factor which influences the labour input engaging at farm and also the labour intensity for agricultural intensification. In order to observe the effects of changes in the prices of technological inputs and labour wages at market centre on the spatial optimal limits of agricultural intensification prevalent in the developing agricultural economy of Upper Brahmaputra valley is the main aspect of this hypothesis.

(b) 'Increase in transport network intensity intensifies agricultural activities and expands the spatial optimal limit of agricultural land use intensity in the market region.'

Justifications:

In general, this hypothesis is valid in almost all scenarios of regional development and use of transport infrastructure for the development of all type of activities in a region. However, the validity of such fact may be tested in the agricultural development in its spatial context. As it is widely accepted that agricultural intensity diminishes linearly or curve linearly with distance from the market (Dunn 1954, Katzman 1974, Amedeo and Golledge 1975, Visser 1980), it is to prove upto what extent the spatial gradients of agricultural production are being influenced by expansion of transport network and how do the transport costs alter the spatial optimal limits of agricultural intensification in the market region.

The test of the validity of these hypotheses may provide a sound base of understanding the structural changes and alterations in spatial optimal boundaries of (a) input demand factors namely, technology (as capital) and labour, (b) the capital-labour ratio, (c) the effects of input commodity prices and wages and (d) the spatial pattern of farmers' land rent in the market region. It would help in accelerating the decision-making processes in the agricultural development in its spatial context. Before discussing detail methodological aspects of the present research, the geographical background of an imagined *isotropic* surface of market region, where farmers' income is unchanged and factor demand is inelastic; all the farmers buy inputs from centrally located market and use them fully for agricultural production at their farm location and also sell their

agricultural products in this centrally located market and use them fully for agricultural production at their farm location and also sell their agricultural products in this centrally located market, is to be interpreted.

1.4 The Study Area:

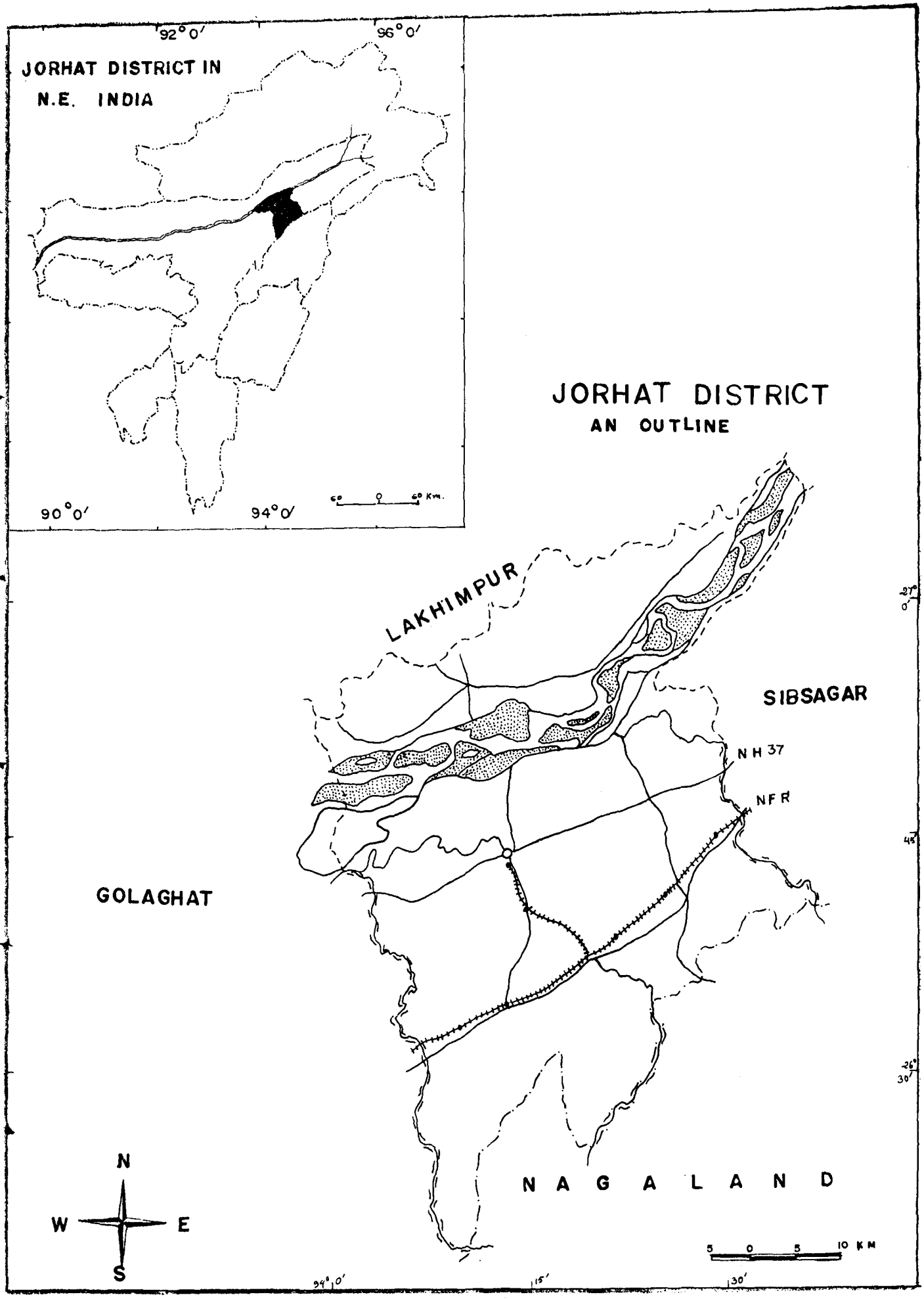
The Jorhat market region generally includes the whole Jorhat district excluding Majuli sub-division. Jorhat city is centrally located in the region and connected with the other parts of the Brahmaputra valley.

1.4 (1) Location and Extent:

It extends between 93° 35' E to 94° 37' E longitudes and 26° 20' N to 27° 15' N latitudes, with an area of about 2,851 sq. km (3.64 percent of the state area). It is bounded with the boundaries of Luhit suti and North Lakhimpur districts in its north, the state of Nagaland in its south, the district of Sivasagar in the east and Golahat in the west (Fig.-1.1). As per Census Statistics 2001, the total population of the study area is enumerated approximately 1,009,197 (2001 census) of which 38 percent are workers. A large share of working population (cultivators and agricultural workers includes 39.54%) is engaged in agricultural activities and allied services. Economy of the study area is mostly based on agriculture and Jorhat city plays a major role in development of the area.

1.4 (2) Administrative Unit:

The district is composed of 5 revenue circles, 8 Rural Development Blocks, 8 Police Stations, 3 sub divisions, 593 villages (inhibited) excluding Majuli as per the census records 2001.



SOURCE: NBSS & LUP JORHAT

Fig. 1.1

1.4 (3) Homogeneity in Physical Attributes:

With the exception of some undulating surface features due to the presence of foot hills of the Naga Hills in the extreme southern part of the study area, the entire district is gentle plain with an insignificant altitudinal variations ranging from 90 m in the north parts along Brahmaputra river to 200 m in the southern parts of the districts. The gentler slope of less than one degree reflects a surface homogeneity of the area. The drainage patterns are evolved by the river Brahmaputra and its tributaries, viz, Jhanji, Bhogdoi and Kakodonga which originate from the Naga hills in the south (Fig.-1.2). Drainage patterns do not have much significance in changing agricultural scenario, because some are seasonal tributaries and develop only the micro areal relief features (Fig.-1.3). Distribution of drainage density almost evolves the uniform pattern. Being a part of upper Assam valley where monsoonal climate prevails, the district Jorhat also falls into the same climatic zone. It is characterised by high humid atmospheric abundant rains and general coolness. Records of rainfall, temperature and humidity in the district are available for one station (i.e., Assam Agricultural University, Jorhat) for period ten years (1993 to 2003). The details of the rainfall, temperature and humidity of the station situated in the district reveal that the summer and the winter seasons are quite distinct in respect of rainfall, temperature and humidity distribution and, thereby, that is facilitating the cultivation of a variety of crops during the two seasons of the year (Figs.-1.4 and1.5). Thus, giving a seasonal rhythm of the agricultural activities in the district, the district grows many crops with diversified cropping pattern. As regards to soil characteristics, soils are acidic in nature (pH value ranges from 4.2 to 5.5). The soils are fertile and the

texture of the soil varies from sandy loam to clayey loam with sufficient amount of nitrogen contents. It is seen that there is not much areal variation in soil fertility of the district as stated by NBSS & LUP, Regional Centre, Jorhat (Fig.-1.6, Table-1.3).

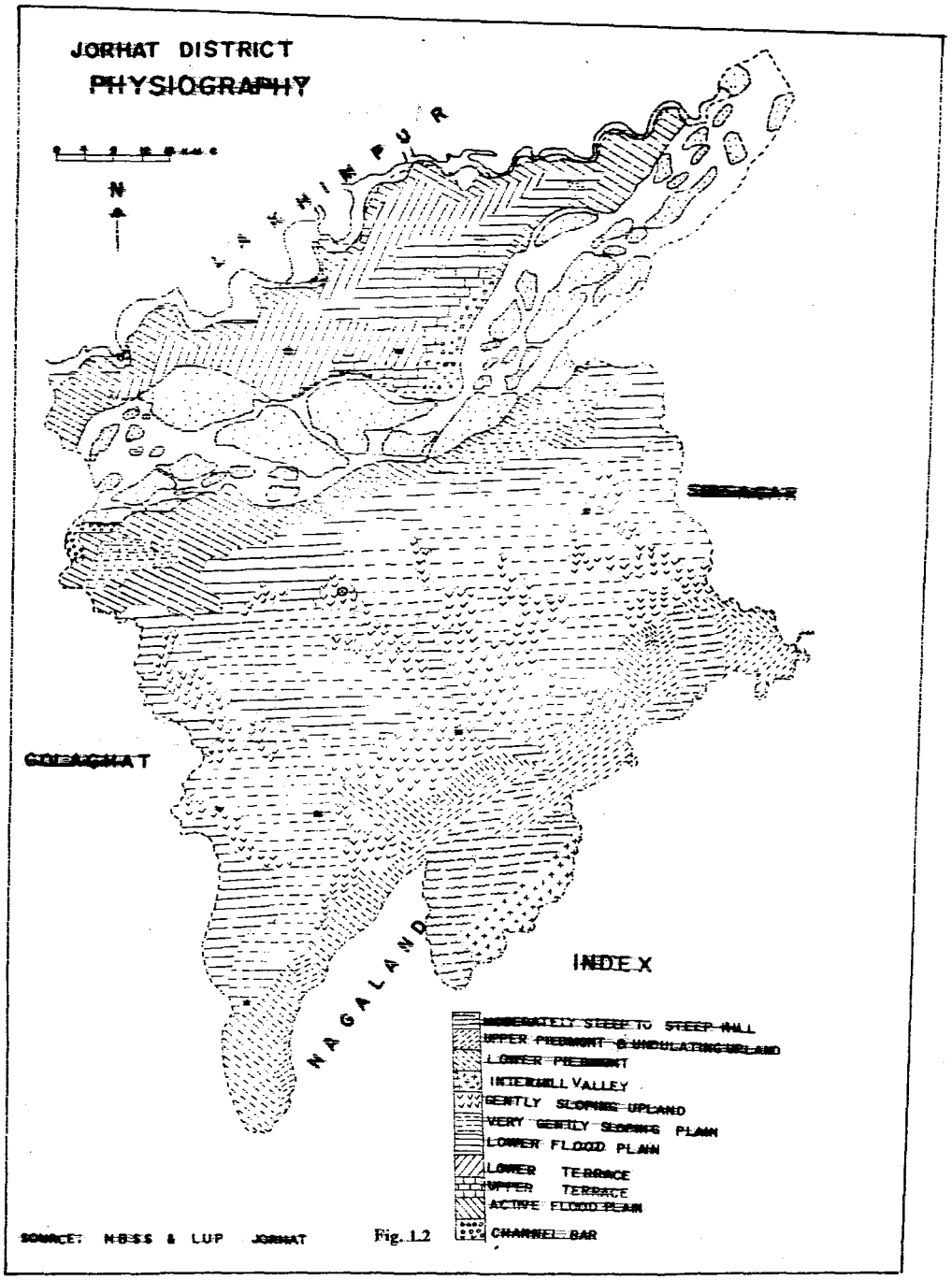
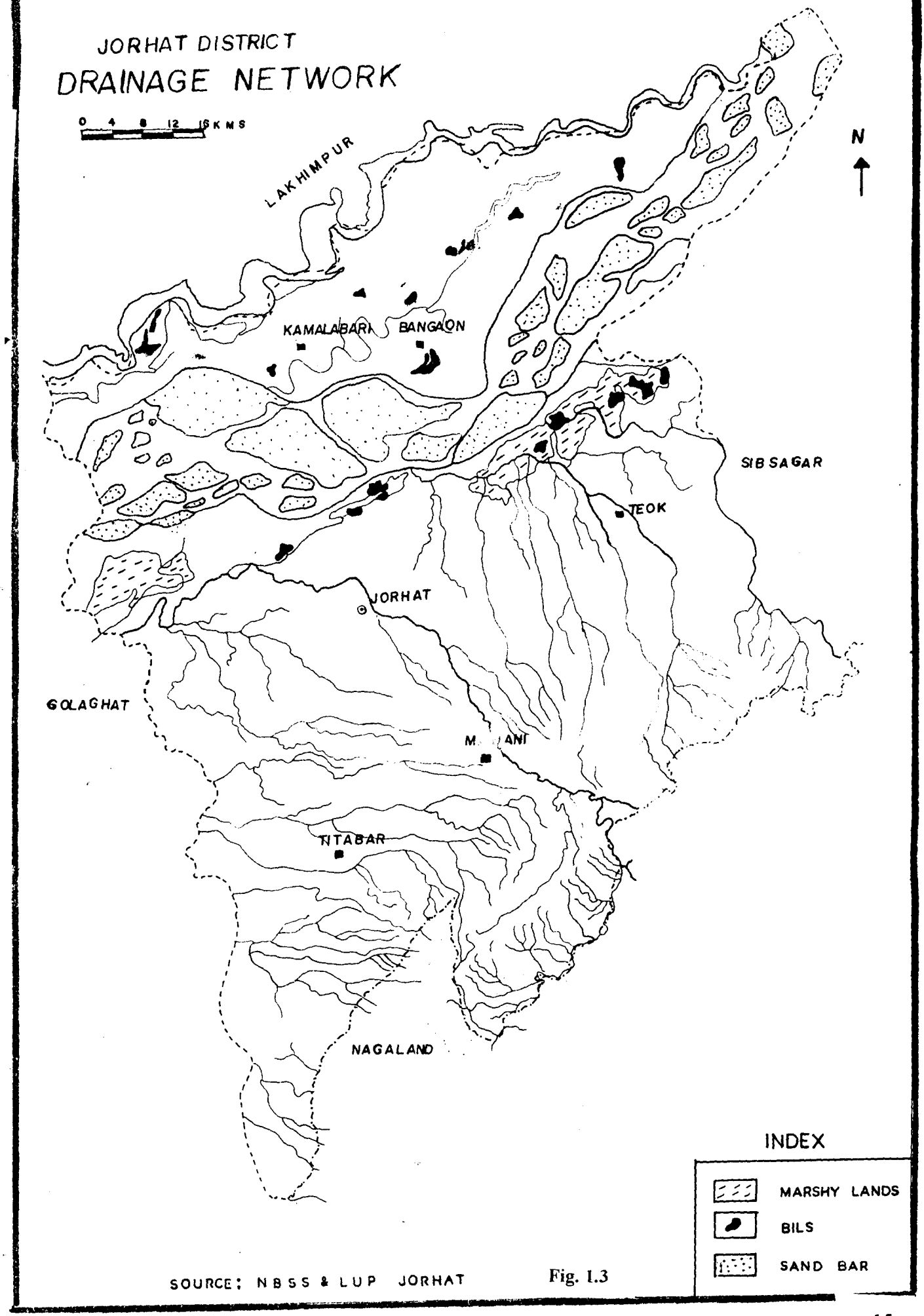


Fig. 1.2



SOURCE: NBSS & LUP JORHAT

Fig. 1.3

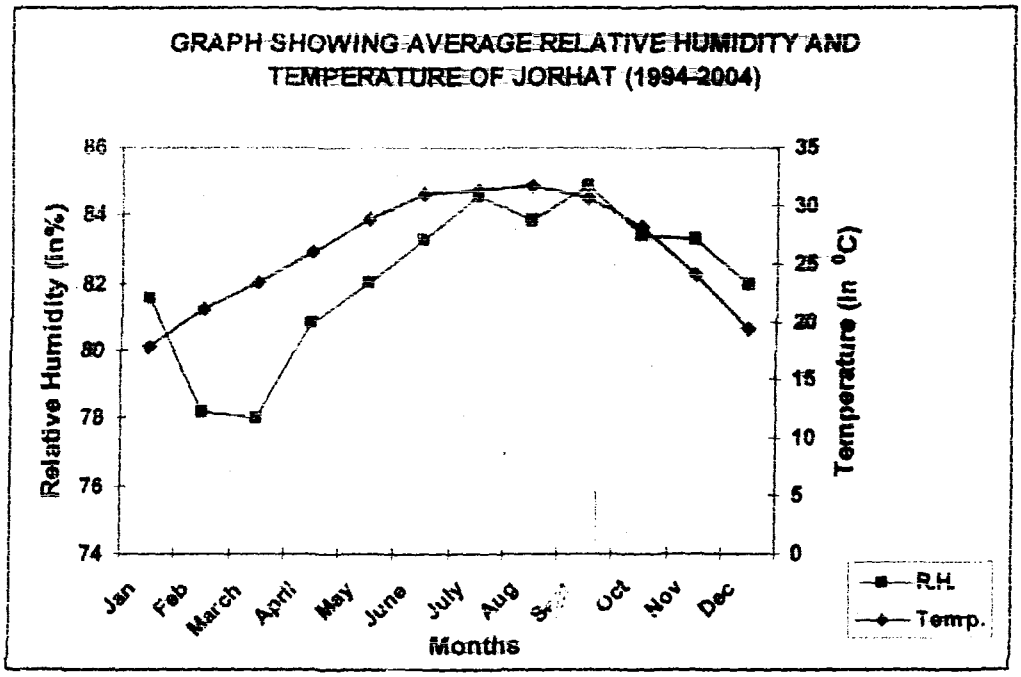
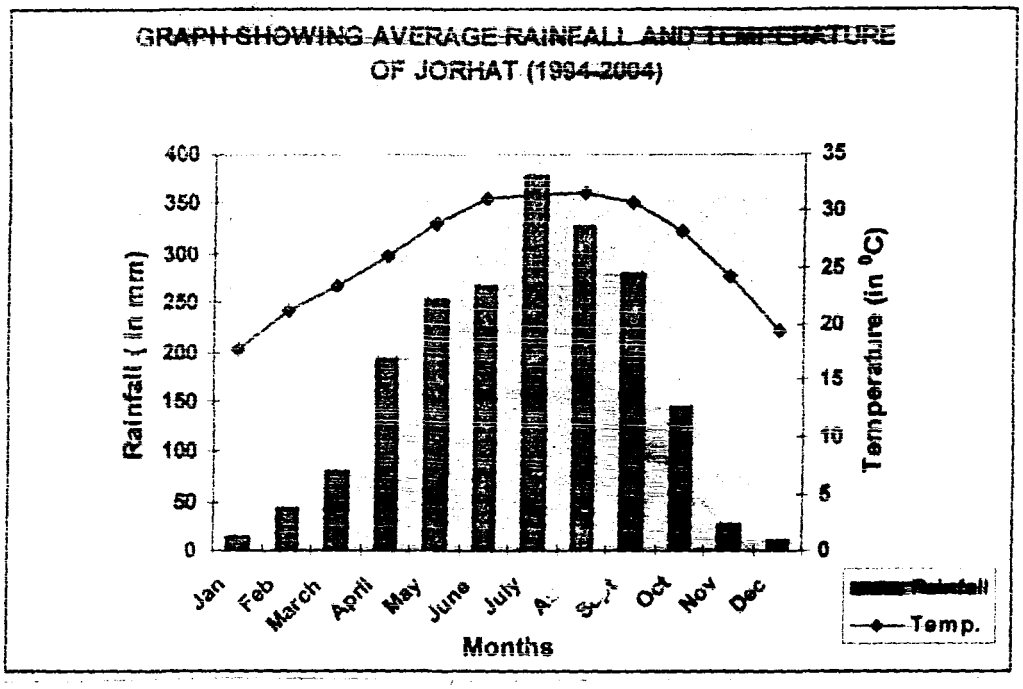
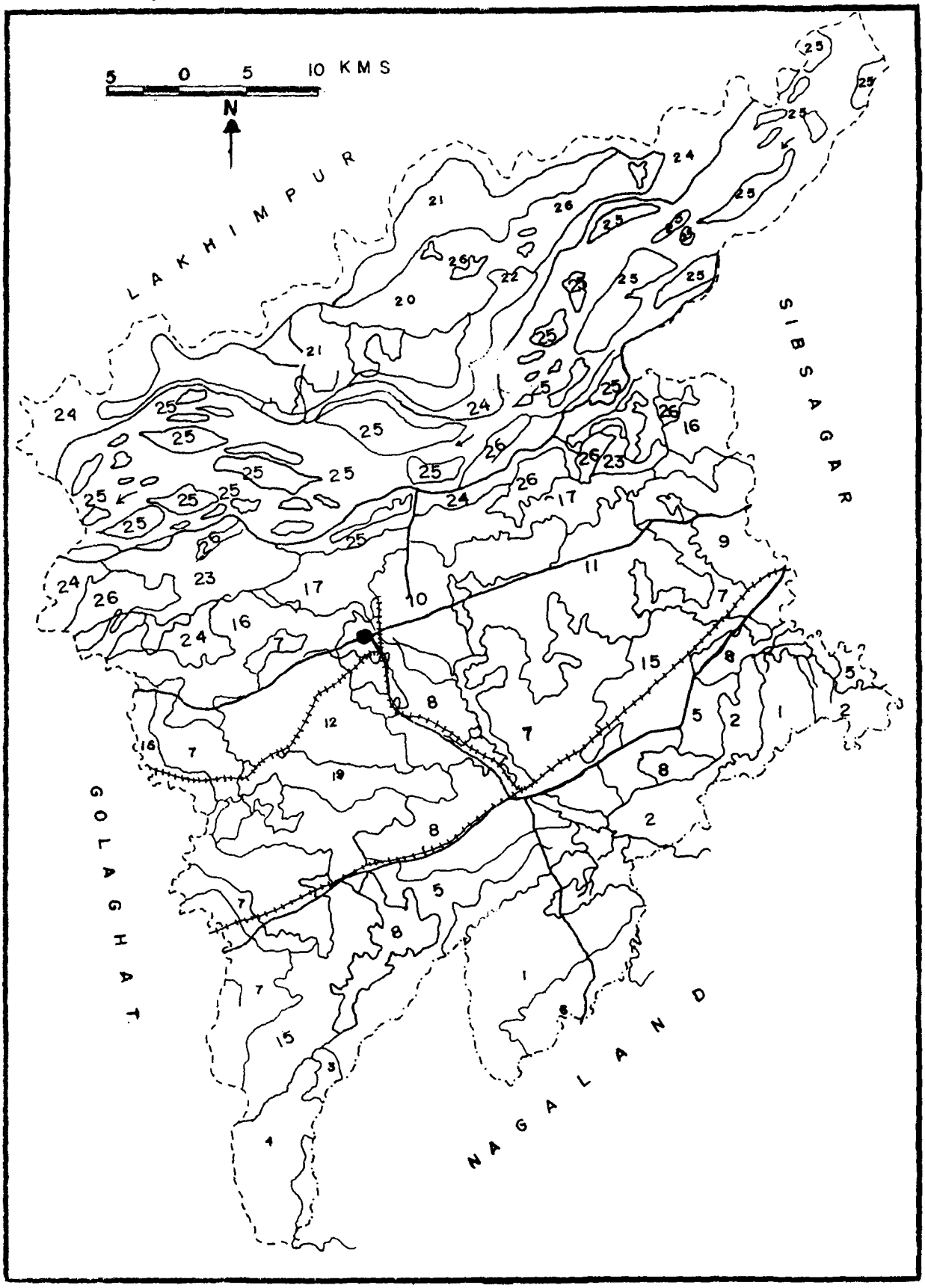

GRAPH SHOWING AVERAGE RELATIVE HUMIDITY AND TEMPERATURE OF JORHAT (1994-2004)
Relative Humidity (in%)
86
84
82
80
78
76
74
Temperature (in °C)
35
30
25
20
15
10
5
0
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Months
R.H.
Temp.

Fig. 1.4


GRAPH SHOWING AVERAGE RAINFALL AND TEMPERATURE
OF JORHAT (1994-2004)
Rainfall (in mm)
Temperature (in °C)
400
350
300
250
200
150
100
50
0
35
30
25
20
15
10
5
0
Jan
Feb
March
April
May
June
July
Oct
Nov
Dec
Months
Temp.

SOIL CHARACTERISTICS OF JORHAT DISTRICT



Source: NBSS & LUP JORHAT

Fig. 1.6

Table-1.2: 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 5-10 pc on the hill slope of 10-15% having sandy loam surface soils with moderate erosion hazard and gravelly coarse loamy soils on 33-50% hill slope 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 sandy-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 ray, coarse loamy soils over sand with yellowish brown to strong brown mottles on 0-1 p.c. slope with high round 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 ray 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 reveals 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 characterized by the dominance of sand and silt with a pH value ranges from 5.5 to 6.5 reflecting slight acidity in the soil.

Further, Jorhat market centre is centrally situated in the area and has been growing faster on the left bank of Brahmaputra to cater the needs of the population; most of them are farmers because of their dominance in agriculture residing in the market region. It (Jorhat market centre) has its historical importance developed from small *hat* (i.e., called bazaar/market) as its name indicates and, now, it is growing central place of the region. The Jorhat market region produces a total amount of food of 155 thousand

tones annually with 1560 tones pulses, 3075 tones oilseeds (details in Table-3.4 in Chapter-III). The agricultural economy of the Jorhat market region is food grain dominated. However, there seems to be the marketable surplus because of modernisation in the agricultural practices. As a result, Jorhat market centre is much active in diffusing the innovative technology to the farmers as well as collection of marketable agricultural surplus from the region. Only jute is commercial product and more than 90 percent share of it is sent to market centre for sell.

1.5 Methodology and Database:

In order to understand the spatial patterns of agricultural production in context with the above cited conditions of Jorhat market region, a proper thought in understanding the input factors, their operational costs and efficiency of existing transport network is to be given. More specifically, the given hypotheses are also related to these aspects of spatial agricultural pattern. The input demand function is an important aspect to interpret the spatial optimal boundary conditions which are price-dependent (in case of technological demand filled by market centre) and wage-dependent (in case of labour demand at farm location and labour migration to non-agricultural sector prevalent at market centre). Since farmers buy technology from market centre and transport costs are involved to use technological inputs, the demand of such input factors diminish in its concave nature as distance from market increases because of involvement of additional transport costs and the net price paid by farmers at their farm-gate located at a certain distance from the market centre, s, noted as

$$P(s) = (Pm + \alpha s), \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where Pm = input factor price at market centre and α = freight rate subject to $\alpha >$ 0, P = net price of input factor at farm gate.

On the other hand, agricultural labour intensity, L, is altered over space by the total available supply of labour force, which is influenced by rural-to-urban migration due to wage differentials (Nakagome 1986). Thus, net wage rate at the farm gate, W, is assumed to be a negative linear function of distance to market as

$$W(s) = (Wm - \beta s), \text{ subject to } (Wm - \beta s) > 0 \quad \ldots \quad \ldots \quad (2)$$

The spatial demand functions for the intensity of production factors, D and L, as suggested by Griffith (1986) are used in the following forms.

$$D(P, s) = Ao\,(Pm + \alpha s)^{-\eta} \quad \ldots \quad \ldots \quad (3)$$

and

$$L(W, s) = Lo\,(Wm - \beta s)^{-q} \quad \ldots \quad \ldots \quad (4)$$

where η and q are price and wage elasticities and Ao and Lo are maximum level of factors when their demands are inelastic (β= 0, q = 0) (Singh 2002).The measurement of elasticity of prices are calculated by following its classical concept as the proportionate change in the input (say technological /labour) with respect to the proportionate change in their prices/wages as under

$(dD/D)/(dPm/Pm) = \eta$ and likewise, $(dL/L)/(dWm/Wm) = q$.

Economic rent of a piece of land is the most important attribute for the analysis of spatial agriculture structure which is measured to get the differentials between the total revenue and the total costs involved in the operation of a piece of agricultural land as

$$R = (\text{Revenue} - \text{costs}), \quad \ldots \quad \ldots \quad (5)$$

where R is rent per unit of land (Rs/ha).Note that the simplified version of rent equation as given above shows that the value of total magnitude of revenue per unit of land and total production costs per unit of land including transport costs of out put are maim attributes of the rent calculation.

In operation of the land rent equation by distance, the statistics of the following attributes in their spatial manner are required:

1) Agricultural output, crop-pattern and crop-yield and market prices of agricultural commodities.
2) Attributes related to technological inputs (including costs of fertilizer, seed, irrigation, machine tools, etc)
3) Labour intensity and labour wage rates in rural areas as well as at market centre,
4) Freight rates and transport rates (bus/taxi/rikshaw fares)

The statistics of these attributes were collected by distance from Jorhat market centre to test the validity of these facts. The main observations were drawn by conducting the field survey during the years 2003 and 2004 keeping in mind the effects of the seasonality and avoiding the abnormal days.

1.6 Sample Design:

Since basic purpose of the present study is to examine the spatial pattern of agricultural land use using the location rent criteria as stated above. It is also true that to conduct the house- to -house survey for a complete enumeration is not possible due to the limitation 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 characterised by homogenous conditions

as mentioned above. In such conditions, a part of the universe which can explain the reality called 'sample' may become an indispensable tool for a researcher. In the present work, the sampling method is attempted to draw the results in such a way that can be successfully explain the spatial pattern of production and its relationship with the market. Therefore, village and HH sample design is used in the present study for giving the explanations of the inquiry proposed earlier. Various stages are involved in choosing the samples as presented below

a) Selection of Sample Villages: In order to understand the spatial pattern of agricultural production for which distance from the market centre is a main factor, the basis of the selection of the sample villages follow three main criteria that are as:

i) Distance of the sample village from Jorhat city;

ii) Distance of the sample villages from the main road, since road network is an important factor for intensification of agricultural practices;

iii) The population size of the sample village, because bigger villages have their own initial infrastructure for the growth and development of agricultural activities while the smaller villages are solely dependent on them.

iv) Variations in the agricultural practices.

Following the above mentioned criteria, the sample villages that are 30 in numbers as accounts for 5.05 per cent to the total villages (numbered 593) in the universe, were selected for the present study. For the selection of sample villages, purposive sample method was used (Fig.-1.7). The basic information of sample villages

have been compared with the universe to test the validity of the sample selection (Table-1.3)

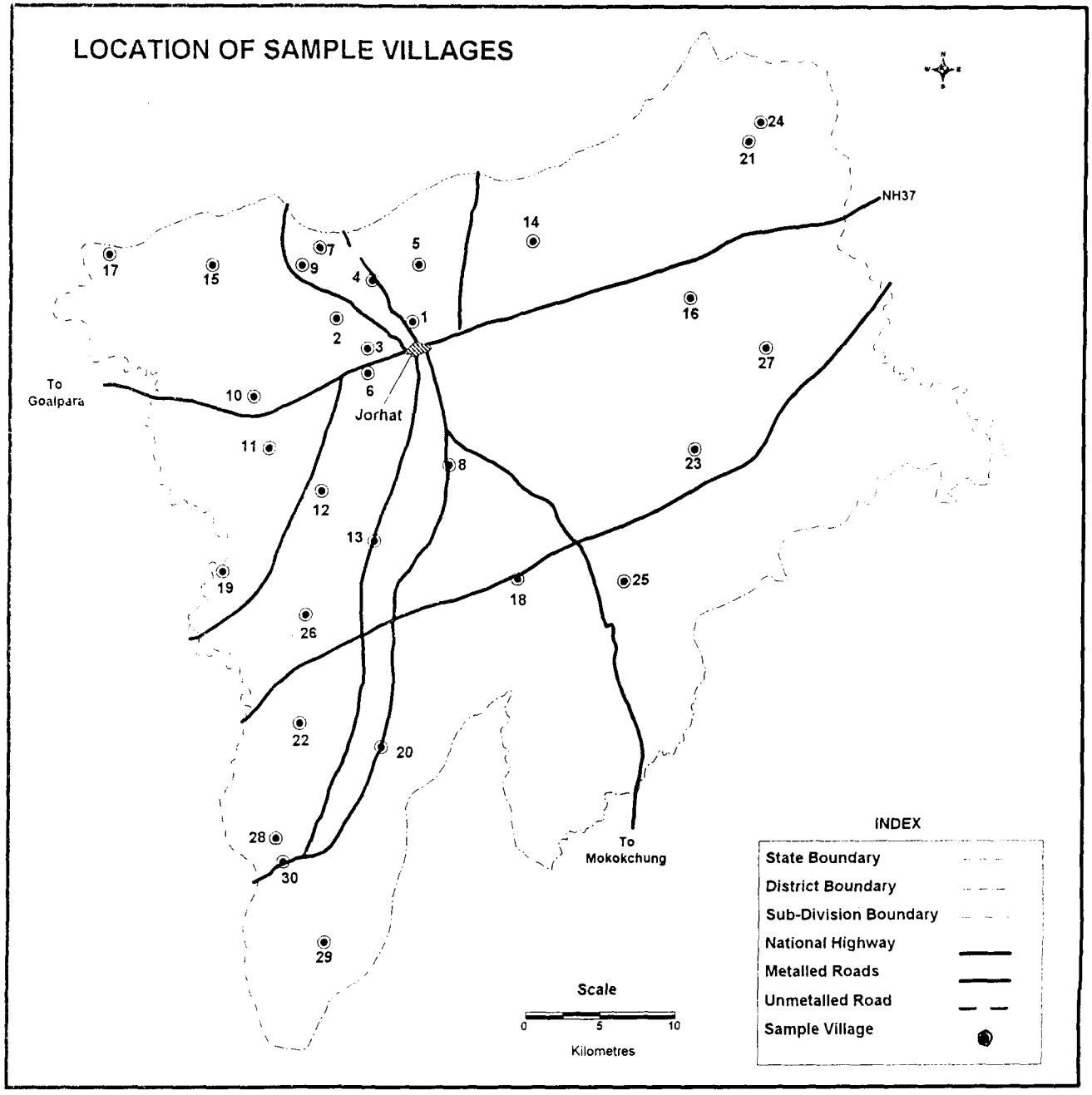


Fig. 1.7

Table-1.3: Parametric Values of Village Samples and Universe (Jorhat District)

Sl. No.	Name of the Parameters	Sample Villages	Jorhat District
1	Total population (persons)	22,981	6,79,343
2	ST/SC population (% to Total Population)	5.66	21.63
3	Sex Ratio (females per 1000 males)	943	903
4	Literacy Rate (%)	90.70	77.91
5	Total workers (%to total population)	43.20	41.39
6	Agricultural Worker (cultivator + agricultural labourers) (% to total workers)	61.28	62.54
7	Average Family Size (persons)	4.98	5.80
8	Population Density (person per ha)	3.35	3.04

b) Selection of Households from Sample Villages: In selecting the Households (HHs) from sample villages, the following five bases which fully reflect the facts of the agricultural scenario in the study area at HH level, adopted here as given below:

I. Farmers' family size,

II. Farmers' land holding size

III. Selection of households based on their ethnic and caste groups

IV. Agricultural surplus produced by the farmer

V. Engagement of family labour in agricultural practices

On the basis of the above criteria, a total number of 300 HHs (average 10 HHs from each sample village) were selected for the detail study (Table-1.4).

1.7 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 (Appendix-1). With the simple but systematically prepared schedule, the heads of the families living in the HHs were approached for personal interviews. 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 for the purpose. In this way, the entire information were fathered from the sample HHs and then the collected information were computed and processed with the help of using computer software.

Table 1.4: Basic Information of the Sample Villages

Sl. No	Name of the Village	Population Size (in persons)	Distance from Motorable road (in km)	Actual Distance from Jorhat Town
1	Chakihat	475	0.20	3
2	Bohatia	1250	1.00	4
3	Chirotia	630	1.00	5
4	Nizbaligaon	1402	0.50	6
5	Potiagoan	675	0.50	6
6	Gharphalia	420	2.00	8
7	Nahatia	503	1.50	3
8	Karanga	645	0.50	3
9	Alengmora	1140	2.20	12
10	BarAhomgaon	903	1.20	12
11	Bahekgaon	1125	1.20	13
12	Hongiagaon	925	2.00	15
13	Jalukonibari	720	1.40	15
14	Barkhat	496	2.00	17
15	Kalbari	645	2.00	18
16	Pirakota	540	1.00	19
17	Neolgaon	725	4.00	22
18	Nogadhuli	400	0.50	22
19	Chungigaon	620	2.30	23
20	Lohanbabejia	601	1.20	24
21	Bonai	541	4.00	29
22	Chakial	725	4.00	29
23	Nakachari	995	1.50	29
24	Robigaon	748	4.50	30
25	Nagajanka	465	1.00	30
26	Birnasayak	1275	3.50	35
27	Eragaon	720	3.00	35
28	Ikarani	1340	1.50	35
29	Bekajan Nahati	702	7.00	36
30	Borhalla	630	0.20	38

1.8 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 relevant information has been collected from various books, journals and other periodicals.

1.9 Arrangement of Material:

The entire research material was arranged into six Chapters. The Chapter-I includes brief introduction to the research problem including objectives, hypotheses, area under study and methodology adopted in the present research. Chapter-II incorporates the detail review of literature while Chapter-III deals with the nature and characteristic features of agricultural production activities. Chapters-IV and V are more devoted to the analytical findings and synthesis of the facts that are supported by the tables, maps and diagrams. In the end, the results of hypotheses testing and generalizations are arranged in Chapter VI.

1.10 Concluding Remarks:

There are many aspects of interpreting the characteristics of agricultural land use in its spatial manner. The spatial patterns of agricultural practices within the specific agro-ecological frame and technological inducement especially in the developing economies operating now in the upper part of the Brahmaputra valley are interpreted for

which a suitable conceptual frame and methodological aspects have been described in this chapter. In order to highlight the deficiency in the literature relating to such themes of the present research, there is a need to go through the literature review in detail that may be presented separately in the next chapter.

References:

Amedeo, D. and R. G. Golledge (1975): *An Introduction to Scientific Reasoning in Geography*, New York: John Wiley and Sons, Inc., pp. 299-306

Berry, B. J. L., E. C. Conkling and D. M. Ray (1993): *The Global Economy, Resource Use, Locational Choice and International Trade*, Printice Hall Englawood Cliffs, New Jersey, pp. 253-67.

Bora, B. (2002): *Population Characteristics & Agricultural Development in Jorhat District, Assam,* Unpublished PhD Thesis submitted to the Department of Geography, North Eastern Hill University, Shillong.

Chisholm (1979): The Von Thunen - Principle and Agricultural Zonation in Colonial Mexico, *Journal of Historical Geography*, Vol. 3, pp. 123-33.

Chouhan, T. S. (1987): *Agricultural Geography, A Study of Rajasthan State*, Academic Publishers, Jaipur, p. 27.

Directorate of Assam (1993): *Field Manual for Rain fed Agriculture in Assam*, Assam Agriculture University, Jorhat (Assam), p. 6.

Dunn, E. S. (1954): *The Location of Agricultural Production*, Gainesville, **FL**; University of Florida Press, p. 6.

Ewald, U. (1977): The Von Thunen Principle and Agricultural Zonation in colonial Mexico, *Journal of Historical Geography*, pp. 123-33.

Ferber, R. and P. J. Verdoorn, (1962): *Research Methods in Economics and Business*, Macmillan Co, New York, pp. 33-34.

Griffith, D. A. (1986): Central Place Structure using Constant Elasticity of Substitution Demand Cones: The Infinite plane, *Economic Geography*, Vol. 62 (1), pp. 74-84.

Government of Assam (1967): *Assam District Gazetteer, Sivasagar District*, Shillong, p.21

Horvarth, R. J. (1969): Von Thunen's Isolated State and the area around Addis Ababa, Ethiopia, *Annals of the Association of American Geography*, Vol. 19, pp. 308-23.

Katzman, M. T. (1974): The Von Thunen Paradigm, The Industrial Urban Hypothesis and the Spatial Structure of Agriculture, *American Journal of Agricultural Economies*, Vol. 56, pp. 683-96.

Kellerman, A. (1983): Economic and Spatial Aspects of Von Thunen's Factor Intensity Theory, *Environment and Planning*, Vol. 15, pp.1521-30.

Kothari, C. R. (1990): *Quantitative Techniques*, Vikash Publishing, New Delhi, p. 108.

Kothari, C. R. (1996): *Research Methodology, Methods and Techniques*, Wishawa Publication, New Delhi, p. 35.

O'Kelly, M. E. (1988): Aggregate Rent and Surplus Measurement in a Von Thunen Model, *Geographical Analysis*, Vol.20, pp. 187-97.

Peet, J. R. (1969): The Spatial Expansion of Commercial Agriculture in the Nineteen Century - A Von Thunen Interpretation, *Economic Geography*, Vol. 45, pp. 283-301.

Sharma, B. (2003): *Changing Pattern of Agricultural Labour Productivity in the Brahmaputra Valley*, M. Phil Dissertation (Submitted to the Department of Geography, North Eastern Hill University, Shillong, pp. 52-103.

Singh, R. L. (ed) (1971): *India: A Regional Geography*, (1st Edition), National Geographical Journal of India, Varanasi, p.306.

Singh, S. (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 30(3), pp.229-244.

Singh, S. and B. Sharma (2003): Determinants of Crop Intensity in Assam Plain, *The Geographer*, Vol. 50(1), pp. 58-72.

Viser, S. (1982): On Agricultural Location Theory, *Geographical Analysis*, Vol.14, pp.167-76.

Visser, S. (1980-82): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol. 56, pp.311-19.

Chapter – II

Review of Literature

2.1 Introduction:

The research works already undertaken by different researchers in understanding agricultural production processes and demand factors for agricultural intensification are of great importance and may be reviewed in a variety of ways. The review may be theme-oriented, content-oriented, finding-oriented or/an area specific. In fact, the area under investigation is the representative of agricultural aspects of Brahmaputra valley where such research work on spatial organisation of agricultural land use has not undertaken till now. The review of concerned literature may be considered to refer the world-wide literature on such aspects of agricultural development. The specific studies done in India and especially in the North-Eastern region are to include in the review to highlight the area-specific findings on the studies of agricultural production processes. Moreover, reviewing the concerned literature already available 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 work available of different sources like academic journals, books, conferences proceedings, government reports, etc. has been attempted in this Chapter.

2.2 Studies on Regional Dimensions of Agriculture:

Development of agricultural geography is of recent origin. Its development dates back to the increasing concerns of geographers for the study of food resources in the

context of population exploration. This branch of geography developed as a part of economic geography with emphasis on understanding the man's relationship with food resources, raw materials and other commodities. The classical works of Strabo, Plato and the Arab geographers in the Middle Ages were confined to describe the regional variations of agricultural activities in the countries of the dominance. During the great age of discovery, similar contextual work appeared in England (Young 1770) and Germany (Schwernz 1816).

A real beginning was initiated by the founder of modern geography Humboldt in 1807. He considered agriculture as a part of systematic Botany. Similarly, Von Thunen (1826) and other German scientists gave in depth consideration to the regional as well locational dimensions of agricultural activities. Engelbrecht (1883) prepared the crop region of North America. The first seed of agricultural geography was sown by Waibel (1933) to write an article on problems on agricultural geography". Timmons (1914) divided the world into 14 types of agricultural regions. Helburn (1957) suggested eleven criteria for delineating the agricultural regions. Weaver's method (1954), initially designed for the investigation of agricultural activities in the United States mid west was widely applied in other areas. Coppock (1964) applied Weaver's 'least deviation method' for agricultural diversification in U. K. and in the Tropical Africa. The same was used by Singh (1976) in his study of agricultural geography of Haryana.

During the inter war period (1919-39), pioneer works in this field had been pursued by many eminent geographers like Baker (1926-33), Jonasson (1925-26), Jones (1928-30), Von Valkenburg (1931-36), and Taylor (1930). Their contribution published

in *Economic Geography* which was considered as significant in the fields of agriculture geography. Most of the pioneer works were devoted mainly to agriculture regionalisation in order to establish the broad spatial pattern of this activity. Besides, the work of Whittlesey (1936) and Shantz (1940-43) were worth mentioning in this context.

In recent years, several conceptual, methodological and fact-finding researches were conducted. The studies done during the last part of the 20th century laid much emphasis on theoretical and methodological aspects. Such studies show less concern for topical and regional narrations (Bunge 1962, Burton 1963, Harvey 1966). Retreating from a deterministic interpretation (Walpart 1964, Mohammad 1978, Shafi 1972) to a probabilistic approach and statistical analysis (King 1964, Mohammad and Amani 1970), an interdisciplinary prospective on agricultural development (Desai 1966), typology of agriculture as interfaces (Kostrowicki 1964, 1968, Shafi 1956) and the revival of ecosystem approach of agriculture (Stoddart 1965, Harris 1969, Simmons 1966) were some of the worth mentioning aspects of modern agricultural geography.

An overview of contemporary works in the field of agricultural geography implies a multiplicity in its approach context, methodology and scale of study. Agricultural data are fast accumulated both by the government and by non-governmental agencies. Almost every aspect of physical zone, cultural and economic activities are covered by regular censuses conducted at an interval of ten years. International Associations of agricultural economists published an authentic World Atlas of Agriculture (1969) which was followed by several publications of World Health Organisation (WHO), Food and Agricultural Organisation (FAO) and other regional agencies of the United Nations. The

national governments have also taken up the task of publishing agricultural atlas together with back ground information. In this connection, Indian agricultural statistics are also well documented right from village level to state and national level which would help in filling the gaps of theory generation in agricultural geography (Kothari 1996, Robert and Verdoorn 1962).

Coming to review of literature on agricultural geography in India, it may be mentioned that no intensive study has been made so far based on deductive explanation of models and theory development. An important development in the field of agricultural geography in India was the appointment of National Commission on Agriculture in 1976. The Commission has already published several reports on the status of agriculture in India based on simply interpretation of facts. Shafi (1956, 1984), Singh (1974, 1976, 1982, 1984), Bharadwaj (1956), Tewari (1965, 1966), Hussain (1979, 1982), Chauhan (1984), Mohammad (1981) initiated investigation on various aspects of agricultural geography in different parts of India during the 1960s and 1970s. Unfortunately, most of these researches were oriented towards observational analysis of a particular aspect rather then presenting a complete synthesis. However, a good deal of regional synthesis of agricultural phenomena was produced by Singh (1994) to analyse regional personality of Indian agriculture. Regional description of Indian agriculture was presented in book form by many geographers namely Singh and Dhillon (1984), Singh and Fazal (1998), Chauhan (1987), Hussain (1996), Singh (1974-75, 1976). A few researches done so far on agricultural geography of Assam, are noticeable. Goswami (1965), considering the economic factors in the development of agriculture, focussed on the agrarian structure of

development of agriculture and land tenure systems in Assam. In the context of agricultural production and its factors, Das (1970) described an account of agriculture of the state, while Taher (1975) highlighted the physical basis for agricultural development in the Brahmaputra valley. Das (1984) elaborated the physio-socio-economic aspects of peasant agriculture in Assam based on empirical observations. Phukan (1990) attempted to understand the nature of agriculture and analysed the process of agricultural development taking into account a period of 35 years 1950-51 to 1984-85. Later on, a few dissertations on agricultural development was submitted to North-Eastern Hill University, Shillong. Deka (1996) analysed the impact of Ago-ecological conditions on rice cultivation on Majuli. Rahman (1994) attempted to study on Regional Pattern of Labour Productivity in Assam. However, the work on spatial organisation of agriculture land use was not taken until now. It opens a new dimension of discussion on Assam agriculture.

Only a few attempts were initiated in the other parts of India by Shafi (1972) and Singh (1983) to understand the spatial pattern and effects of market centres, Sharma and Archana (1980) used the concept of Von Thunen paradigm to identify the zones of influence of the Sagar city and its surrounding agricultural land use. They proved that distance does play a significant role in the location of agriculture around the city since most of the land near Sagar was under horticultural crops. Other crops were also influenced by this variable. The work done by Shafi (1977) in this direction needs special mention. He assessed Thunen's theory in Indian conditions. On the basis of the study of cropping patterns in 35 villages of Koil Tahsil in Aligarh district (Uttar Pradesh), he

concluded that intensity of land use could not increase with increase in distance from the market city, rather it is affected more by distance from the source of irrigation. His idea was strongly supported by Fakhruddin and Khan (1981) in their locational analysis of agricultural land use in case of Unnao *tahsil* of Unnau district (Uttar Pradesh). They also proved that Thunen's model had little relevance in Indian context. Singh (1983) developed a model of spatial organisation of crops in a north Indian village. He analysed the location of crops with respect to village settlement, source of water and the approach road. The study concluded that all those crops which are intensive in water and labours are concentrated nearly the source of water. Similarly, fodder tends to be so near the settlement and approach roads as possible. Having reviewed literature at national level especially the case studies from the great plains either from Haryana, Uttar Pradesh or Punjab, it is obvious that spatial organisation of land use is influenced by market centres which are centre of diffusion of agricultural innovations for altering land use patterns and intensifying the production processes. There is still deficiency in the literature on these lines to test the validity of facts why green revolution has failed so early in the plains where modern technology is required and it may only be diffused through market centres in their surroundings. It may be reviewed here in consideration with the developing conditions of Indian agriculture and impact of Green Revolution on land use changes.

2.3 Spatial Dimensions of Agriculture with reference to Thunen's Paradigm:

There are different dimensions of Thunen paradigm to be reviewed in context to methodological development in the literature on spatial organisation and location theory of land use as given below

2.3 (1) Role of Distance:

Accessibility aspect of agriculture activities that have relevance in context with distance of farm from market centre, have been widely used at different levels and in different environmental set-ups. It is widely accepted that agricultural intensity decreases with distance from the market (Dunn 1954, Garrison and Marble 1957; Katzman 1974). In the classical theories of agricultural location, spatial structure of land use is conveniently analysed by determining economic rent per unit of land. These studies emphasised the intensity of land use with scant regards to the availability and demand for inputs. For example, assuming the effects of other factors, that affect agricultural intensity as constant and considering a single output care, Thunen (c.f. Hall 1966; Amedeo and Golledge 1973) and Dunn (1954) found a linear but negative relationship between economic rent and distance from the market. Many scientists drew such observations on land use and distance from the market centre. Chisholm's (1976) view of location of farmstead and decreasing soil fertility from this location, Blaikie's (1971) concept of changing types of crops grown by individual farmers from the farmstead location, the Norton and Conkling's (1974) emphasis on diminishing land value from the market centre and the Leaman and Conkling's (1975) spatial analysis of agricultural production specialization confirm that the agricultural land use patterns change and the economic rents of the crops diminish at different spatial gradients as distance of a farm location increases from the market centre in market region. More detailed review on these aspects was made by Brinkmann (1979) to consider locational importance and transport costs in the spatial agriculture land use structure. His thesis on local comparative

advantage assures that increasing locational importance as transport cost decline under non-homogeneous conditions. The result, which was tested in the western part of New York State between 1840 and 1860 by using canonical correlation model on agricultural data, distance measures and land capability, confirmed the hypothesis that transport costs were inversely associated with degree of specialization. Trade factor loading were calculated for a period of twenty years (1840-60) and found that specialization of crops in cropping pattern is distance dependent.

Furthermore, Visser's (1980, 1982) thesis that technology reduces the transport costs and influences the land use intensification in its spatial structure, is valid for developing as well as developed agricultural economies. Visser (1982) found that agricultural intensity decreases at decreasing rate as distance to the market increases when diminishing marginal return is operative in agricultural practices. This model is a synthesis on the relationship between agricultural intensity and market access (Casetti 1972, Katzman 1974).

2.3 (2) Role of Input Availability and Spatial Input Demand:

Availability of agricultural inputs (technology and labour) which is based on market centre and input demand that is based on the volume of inputs required in the market region, include two major attributes that accelerate developmental processes in the spatial structure of agricultural land use. Such attributes have great significance in developing agricultural economies where market centre has to play a role to diffuse the modern technological inputs to the farmers living in the market region. Demands of such agricultural inputs are controlled by their prices at market centres and it is distance-

dependent because farmers of the market region buy inputs (fertilizer, seed, irrigation equipments and machine tools) from the nearby market centre. Inversely, the labour available in the market region (i.e., an input to agricultural practices) is also influenced by way of its wage differences. Transport costs influence the spatial demand of technological inputs as well as labour mobility from rural-to-urban. Such premises are tested by many scientists. In the present research work, we may also test the validity of such facts in growing agricultural economy of Upper Brahmaputra valley. The logical details of such premises are given in preceding Chapter.

Agricultural scientists are generally in the opinion that modern technology reduces the transport cost of the commodity supplied to the farm and farm output transported to the market. Therefore, transport costs which are the part of inputs of the farmers and influence the economic rent in the operation of agricultural production processes are important factors for agricultural intensification. Many agricultural economists have established the relationship between input and output through agricultural production to assess the agricultural pattern.

Berry, Conkling and Ray (1993) revealed that transportation has a powerful effect in spatial organization and also opined that resource and culture added a textured richness to human use of the earth. Leaman and Conkling (1975) advocated that, as transport costs decrease and because of technological advancements and comfortable mode of transport for mobility of man over time, it is expected that the spatial limits of man and material movement in market region are expanded. The higher transport costs reduce the remuneration of agricultural crops, which affect directly and indirectly the farmers'

revenue and, consequently, their profitability. O' Kelly (1988) examines the impact of transportation improvement on agricultural production under the preview of Thunen model by relaxing homogeneous transport costs assumption and notes that road improvement tends to produce increase commodity prices at farm gate in the market region. It affects long-term equilibrium of commodity prices at market centres. The market prices decrease as a result of increasing supply of marketable commodities assuming that demand remains constant. O'Sullivan and Ralston (1980) opined that the surplus value arising from the use of transport facilities is the most pertinent measures of social welfare for many spatial economic problems. Eddowes (1969) listed the following features as the main controllable one affecting the land use pattern and crop production in a given environment: seed, fertilizer and machines, mechanical powers, chemical power and the sequence of crops.

On the whole, spatial patterns of agricultural production are primarily controlled by inputs that are considered as technological variables plus skill hired labourers and its created demand especially in developing agricultural economies still prevalent in Indian scenarios. Technological use means here as the use of fertilizers, modern inputs such as H.Y.V. seeds, irrigation, machine tools, pesticides etc. Kaur (1990) argued that intensification is found only those areas where assured irrigation facilities are available because application of technology is a package for maximisation of farmers' profit.

2.3 (3) Role of Market Forces:

Market plays a significant role in spatial organisation of land use pattern-production nexus. It is one of the most important factors greatly stimulating agricultural

production of an area and a farmer always needs an efficient market wherein to sell his surplus produce and buy technological inputs.

Market performs multivariate activities and is a centre not only of supplying the inputs to the farmers but also interaction point of social and cultural activities of the area. The growth of centrally situated market centre in the market region is mainly dependent on migration either from outside the region or from inside rural areas of the market region many studies on the role of market forces were conducted for the growth and socio-economic development of plain areas of the North East. Phukan (1992) emphasised on spatio-functional organisation and role of market centre in the development of Golaghat district, Assam. Singh (1998) gave insights of the growth of market centres and their impact on agricultural development in Manipur valley. These studies concluded that market forces were still week to diffuse the technological innovations in the North East India.

Indeed, within the market region, the intensity of technological inputs (i.e., called capital investment by a farmer at his farm) decreases and intensity of farm labour increases as increasing distance from the market centre. Therefore, capital-labour ratio diminishes fast and, consequently, the farmers living in the areas of the immediate surroundings of market centre operate their farms with intensive technological uses, while the peripheral farms have labour intensive operations with less profitability (Singh 2002). Such conclusions of theoretical research may be tested in researches for providing a sound base of understanding and strengthening the spatial structure of agricultural production prevalent in the Brahmaputra valley.

2.4 Land Rent and its Effect on Land Use Pattern:

The rental value of land acts as a parameter of change or shift of a particular economy i.e., land use pattern. Theories of land use and land rent interpretations with hypothesis have long been studied by a number of French and German economists and later by geographers, namely Docke (1969), Ricardo (1819), Marx (1933) and so on. Whereas considerable attempts concerning land rent and land use were made by economists like Vauban, Boisguillebut, Cantillon, Quesnay, Malthus and Physiocvates. Chisholm (1962) gave a very precise account of the land use and land rent system in geographical perspective and argued that the areal distribution of crops and livestock and types of farming were largely dependent on competitions evolved between products and farming systems for the use of any particular plot of land. Docke (1969) gave a vivid account of the Thunen's concentric ring of agricultural land use and emphasized the conceptual development of the land rent. Scott (1976) attempted to identify rent as an agricultural surplus remaining after basic substances recurred as surplus to the net product. It is represented as the revenue due to landed property as such. As regards the conceptual development of the land rent theory according to Ricardo and Marx as pioneer writers and economists of the nineteenth century holds the price of land and land products as prime aspects involving quality of land as the principle of production.

Ricardo's land rent theory is based on the differential rent approach. He also described that land rent is difference of revenue and total cost of a piece of land. Market prices of transported marketable surplus and inputs including transport costs are main determinants of land rent. On the other hand, Marx concept of land rent which is

primarily based on the land, labour and capital holds that 'the land has no value but 'price' and human labour produce the economic value of the land'. The production system is organised by capitalists and manned by workers who are waged that is less than the total value produced. The resulting excess value is designated total surplus value. Part of this surplus value becomes the profit and part of it becomes the rent (Marx 1971).

In the modern frame work of land rent approaches, land is considered to be the factor of earning as source and, therefore, earning are made through different kinds of land dealings. This has been treated in various ways as rent is surplus, absolute rent, gross rent, contract rent, etc.

2.5 Conclusion:

Reviewing the research material pertaining to the economic aspects of Von Thunen's paradigm of spatial organization of land use, it becomes clear that comparatively less works are conducted so far in India as well as in Assam. Whatever the literature available so far, it mainly deals either with the implications of influence of market or with the role of distance in the spatial structure of land use. In order to understand more detail relationship between intensity and spatial organization of agriculture, the proper forms and parameters of the agricultural production function must be investigated. The effects of technological changes (both in agriculture and transportation) on the spatial structure of agriculture also need to be explained in more detail. It is, therefore, expected to fill up the gap already left by the researchers belonging to the field of spatial science, i.e., Geography.

It appears that there is a deficiency in the literature on the aspects of spatial organisation of agricultural practices in developing economies prevalent in India. Secondly, most of the works done in western world are more related to market surplus and profit maximisation as highlighted in the review. The less emphasis is made on input costs, technological uses in land use practices specially modern technology and labour intensification in special context of Indian situation where agricultural economy is at the cross road of change its scenario from labour intensive to capital-intensive through the use of modern technology. Spatial structure of agriculture may be viewed in this connection preparing a proper spatial strategy of agricultural intensification. Input price differences, wage-differentials, variations in the spatial gradients of agricultural production and farmers profit at different farm locations are major aspects of spatial structure of agriculture production which are to be tested in connection with spatial strategy of agricultural intensification in the Upper Brahmaputra valley.

References:

Amedeo, D & R. G. Golledge (1975): *An Introduction to Scientific Reasoning in Geography*, John Wiley and Sons, Inc., New York, pp. 299-306.

Baker, O. E. (1926-1933): Agricultural Regions of North America, *Economic Geography*, Vol. II, pp. 459-493; Vol. III, pp. 50-86, 309-339, 447-465; Vol. IV, pp. 44-73, 399-443; Vol. V., pp. 3639; Vol. VII, pp. 109-153, 325-394; Vol. VIII, 325-377 and Vol. IX, pp. 167-197.

Berry, B. J. L., E. C. Conkling, D. M. Ray (1993): *The Spatial Organisation of Land use: The Global Economy Resource Use, Locational Choice and International Trade*, Printice Hall, Englo Wood Cliffs, New Jersey.

Bharadwaj, O. P. (1956): *Land use and Soil erosion problems of Bias Jalander Doab*, Unpublished Ph.D Thesis, London School of Economics, Delhi University, Delhi, pp 66-72.

Blaike, P. (1971): Spatial Organisation of Agriculture in some North Indian Villages, Part-I, *Transactions*, Institute of British Geographers, Vol. 52, pp. 1-40.

Brookfield, H. C. (1964): Question on the Human Frontier of Geography, *Economic Geography*, Vol.40, pp. 283-303.

Bunge, W. (1962): *Theoretical Geography*, Lund (Sweden): Lund Studies in Geography, Series C, General and Mathematical Geography, University of Lund, Sweden.

Burton, I. (1963): The Quantitative Revolution and Theoretical Geography, *Canadian Geographer*, Vol. VII, pp. 151-62.

Casetti, E. (1972): Spatial Equilibrium Distribution of Agricultural Production and Land Values, *Economic Geography*, Vol. 48, pp. 193-98.

Chisholm, M. (1962): *Rural Settlement and Land use*, Hutchins on Lib. London, pp. 11-12.

Chouhan, T. S. (1984): Agricultural and Livestock Development in Western Rajasthan: A Case Study of the Malani Region, *The Indian Journal of Geography*, Vol. XIV (1), pp. 68-78.

Chouhan, T. S. (1987): *Agricultural Geography*, Academic Publishing, Jaipur.

Coppock, J. T. (1964): *An Agricultural Atlas of England and Wales*, London: Faber

Das, H. P. (1970): *Geography of Assam*, National Book Trust, New Delhi.

Das, M. M. (1984): *Peasant Agriculture in Assam, A Structural Synthesis*, Inter India Publications, New Delhi.

Day, R. H. and E. H. Tinney (1969): A Dynamic Von Thunen Model, *Geographical Analysis*, Vol. I, pp. 137-151.

Dayal, E. (1984): Agricultural Productivity in India, A Spatial Analysis, *Annals of the Associations of American Geographer*, Vol.74, pp. 98-123.

Deka, N. (1996): *Impact of Agro-Ecological Conditions on Rice Cultivation in Majuli River Island (Assam)*, unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill University, Shillong.

Desai, D. K. (1966): Technological Change and its Diffusions in Agriculture, *Indian Journal of Agricultural Economics*, Vol. XXI, pp. 134-142.

Docke's, P. (1969): L'Espace dans la pensee economique du XVIe an XVII e Siecle, Paris, Flammarion.

Dunn, E. S. (1954): *The Location of Agricultural Production*, University of Florida Press, Gainesville, p. 6.

Engelbrecht, T. H. (1883): *Crop Regions of North America,* c.f. Hussain, M.(1996): *Systematic Agricultural Geography*, Rawat Publications, Jaipur, pp. 17-44.

Ewald, U. (1977): The Von Thunen Principle and Agricultural Zonation in Colonial Mexico, *Journal of Historical Geography*, Vol.3, pp.123-33.

Ferber, R. & Verdorm, P. J. (1962): *Research Methods in Economics and Business*, Macmillan Co. New York, pp. 33-34.

Garrison, W. L., & D. F. Marble (1957): The Spatial Structure of Agricultural Activities, *Annals of the Association of American Geographers*, Vol. 47, pp.137-44.

Goswami, P. C. (1963): *Economic Development of Assam*, Asia Publishing House, New Delhi.

Hall, P. (1966): *Von Thunen's Isolated State*, translated by C. M. Warthenberg, Oxford, Pergamon.

Harris, D. R. (1969): Agricultural System Ecosystems and the Origin of Agriculture, In Ucko, P. J. and Dimbleby, G. W. (ed): *The Domestication and Exploitation of Plants and Animals*, Vol. VI, pp. 2-7.

Harvey, D. W. (1966): Theoretical Concepts and the Analysis of Agricultural Land use Pattern in Geography, *Annals of the Association of American Geographers*, Vol. 56, pp. 361-74.

Helburn, N. (1957): The Bases for a Classification of World Agriculture, *Professional Geographer*, Vol. IX, pp. 2-7.

Husain, M. (1979): *Agricultural Geography*, Inter India Publications, Delhi.

Husain, M. (1979): *Crop Combination in India; A Study*, Concept Publishing Co. New Delhi.

Jonasson, O. (1925-26): Agricultural Regions of Europe, *Economic Geography*, Vol. XII, pp. 227-314, Vol. II, pp. 19-48.

Jones, C. F. (1928-30): Agricultural R ns of South America, quoted from M. Hussain (1996): Systematic *Agricultural Geography*, Rawat Publications, Jaipur and New Delhi, p.24.

Katzman, M. T. (1974): The Von Thunen Paradigm, In the Industrial Urban Hypothesis and Spatial Structure of Agriculture, *American Journal of Agricultural Economics*, Vol.56, pp 683-96.

King, L. J. (1964): *Statistical Analysis in Geography*, Englewood Cliffs Prentice Hall Inc.

Kostriwcki, J. (1968): Agricultural Typology, Agricultural Regionalisation Development, *Geographia Polonica*, Vol. XXVI, pp. 265-74.

Kostrowicki, J. (1964): Geographical Typology of Agriculture, Principles and Methods, *Geographia Polonica*, Vol. III, pp. 146

Kothari, C. R. (1996): *Research Methodology, Methods and Techniques*, Wishwa Publications, New Delhi, p.35

Marx, K. (1933): *Capital*, Vol. B, Charles Kerr & Co, Chicago,

Marx, K. (1971): *Principle d'une Critique to Economic Politique*, cited from Cavailhes.

Mohammed, A. (ed) (1978): *Dynamics of India*, Concept Publishing Co., New Delhi.

Mohammed, N. and Amani, K. Z. (1970): Crop Combination in the Trans-Ghaghara Plain, *Graphical Review of India*, Vol. XXXII, pp. 47-59.

Mohammad, N. (ed) (1981): *Perspective in Agricultural Geography*, Vol. V, Concept Publishing Co., New Delhi.

O'Kelly, M. E. & D. Bryan (1996): *Agricultural Location Theory: Von Thunen's Contribution to Economic Geography*, Progress in Human Geography, Vol.20 (4), pp. 457-475.

Peet, J. R. (1969): The Spatial Expansion of Commercial Agriculture in the Nineteen Century: A Von Thunen Interpretation, *Longman Geography*, Vol.45, pp. 283 and 301.

Phukan, U. (1990): *Agricultural Development in Assam*, Mittal Publications, New Delhi.

Phukan, P.K. (1992): Role of Growth Centres in Agricultural Development in Golaghat District (Assam), Unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill university, Shillong,

Rahman, R. (1994): *Levels of Agricultural Development in Assam*, unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill University, Shillong.

Scott, A. J. (1976): Land and Land Rent: An Interpretation Review of the French Literature, *Progress in Geography*, Vol. 9, pp. 101-139.

Schernz, J. N. (1816): Beschveibung der land Wirtzchaft in Niederelsars Parey, Berlin (Quoted from Geography of Agriculture: Themes in Research, p.1)

Shafi, M. (1972): Measurement of Agricultural Productivity of the Great Indian Plains, *The Geographer*, Vol. XIX, pp. 4-13.

Shafi, M. (1984): *Agricultural Productivity and Regional Imbalance, A Study of Uttar Pradesh*, Concept Publishing Co., New Delhi.

Shantz, H. L. (1943): Agricultural Regions of Africa, *Economic Geography*, Vol.16, pp. 1-47, 122-161and.341-389; Vol. 17, pp. 217-249 and 353-379; Vol. 18, pp.229-246; Vol. 19, pp. 77-100 and 217-269.

Sharma, B. L. (1991): *Applied Agricultural Geography*, Rawat Publications, Jaipur.

Simmous, I. G. (1966): *Ecology and Land Use Transaction of the Institute of British Geographers*, Vol. 38, pp. 59-72.

Singh, Jasbir (1976): An Agricultural Geography of Haryana, Vishal Publication, Kurukshetra.

Singh, Jasbir & Dhillon, S. S. (1984): *Agricultural Geography*, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Singh, Jasbir (1974): *An Agricultural Atlas of India- A Geographical Analysis*, Vishal Publications, Kurukshetra, India.

Singh, Jasbir, *et. al.* (1982): *Determinants of Agricultural Productivity, A Sample Study of Operational Holdings for Land Use Planning*, Vishal Publications, Kurukshetra.

Singh, Surendra (1994): *Agricultural Development in India, A Regional Analysis*, Kaushal Publications, Shillong.

Singh, Surendra (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 34 (3), pp. 229-244.

Singh, L. S. (1998): Role of Growth Centres in agricultural Development in Imphal Valley, Unpublished Ph. D. Thesis submitted to the Department of Geography, North Eastern Hill university, Shillong,

Stoddart, D. R. (1965): Geography and the Ecological Approach- the Ecosystem as Geographical Principle and Method, *Economic Geography*, Vol. 50, pp. 242-51.

Taher, M. (1975): Regional Basis of Agricultural Planning in the Brahmaputra Valley, *Journal of North East India Geographical Society*, Vol. 8, pp. 122.

Taylor, G. (1930): Agricultural Regions of Australia, *Economic Geography*, Vol. 6, pp. 109-134 and 213-142.

Tewari, A. K. (1965-66): Land Utilization in Jaunsar Bawar, *The Deccan Geographer*, Vol. III, pp. 1-128.

Timmons, J. F. (1944): Distribution of World Land Resources, *Land Policy Review*, pp. 8-14.

Visser, S. (1980): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol. 56, pp. 311-19.

Visser, S. (1982): On Agricultural Location Theory, *Geography Analysis*, Vol.14, pp. 167-76.

Von Humboldt, A. (1807*): Land use in Cuba and South America*, c.f. Hussain, M. (1996): *Systematic Agricultural Geography*, Rawat Publications, Jaipur, pp. 17-44.

Von Thunen, J. H. (1826): Der Isolierte Staat in Besiehung auf Landwirtschafts and National Okonomie, Quoted from W. B. Morgan and R. J. C. Munton (1972): *Agricultural Geography*, Methuen and Co, London.

Von Valkenburg, S. (1931-36): Agricultural Region of Asia, *Economic Geography*, Vol. 7 (1931); pp. 217-237, Vol. 8 (1932); pp. 109-133, Vol. 9 (1933); pp. 1-18, 109-135, Vol. 10 (1934); pp. 14-34, Vol. 11 (1935); pp. 227-246, 325-337, & Vol. 12 (1936); pp. 27-44, 231-249.

Walpert, J. (1964): The Decision Process in a Spatial Context, *Annals of The Association of American Geographers*, Vol. 54, pp. 537-58.

Weaver, John C. (1954): Crop Combination Regions in the Middle West, *Geographical Review*, Vol. 44 (2), pp. 537-58.

Whittlesey, D. (1936): Major Agricultural Regions of the Earth, *Annals of the Association of American Geographers*, Vol. 54, pp. 531-58.

Young, A. (1770): The Farmer's farm though the east of England, Vol. 4, Strahan, London

Chapter – III

Nature and Characteristics of Agricultural Production

3.0 Introduction:

Analysing nature and characteristics of agriculture production for the district of Jorhat which is generally a representative of whole of Assam, is a difficult task. However, many scientists and agronomists have characterised agriculture considering its different aspects. The production processes and their accelerations are one of the important bases which were adopted by many geographers and economists, namely, Tress (1939), Conkling (1963), Mavi (1963), Gibbs and Martin (1962), Shears (1965), Bhatia (1965) and Singh (1994). The size of landholdings and its tenancy were also used to characterise the agricultural practices and its problems of sustainable development. Undoubtedly, this sector (agriculture) has prime importance in the state economy and contributes nearly half of the State's Domestic Product. Moreover, it accommodates about 65 percent of the State total working force excluding tea plantation. The rural population exhibit a kind of farming in their owned land, which may be called 'small scale agriculture'. It is characterized as small size of landholding with low level of technological uses in the farming practices. Small size of land holdings that are too fragmented into several scattered plots to create a situation quite detrimental for adoption of modern agricultural practice. Such dimensions of agriculture along other socio-economic factors of the families limit the size of agricultural output resulting in a

disability of the sector to keep pace with the increasing demand for crops (Bhagabati, 1990).

In Assam, there are large number of farmers operating very small to marginal and medium size of land holdings. On rough estimate, the optimal subsistence level of landholding size under the present condition is considered to be 4.00 hectares (Singh and Dhillon, 1984). As per Agricultural Census 1990-91, the average size of operational land holdings in Assam is recorded only 1.28 ha. A fairly larger number of farmers (about 95%) has piece of land below 4.0 ha. As a matter of fact, various efforts have been made by the government towards the improvement of the conditions of subsistence small farmers through land reforms and a number of agricultural modernisation programmes, Assam is still dominated largely by small land holdings and less productive farming system. Only a small section of rich farmers who has, larger size of landholdings, produces farm surplus. The subsistence mode of cultivation has been in transition from predominantly traditional to a modernised one. Considering Jorhat district as good sample representative of agriculture of Brahmaputra/Assam valley, it is estimated that, in terms of percentage, the rural area covers 97.00 percent to the total geographical area. The percentage of total rural population to the total population is approximately 85.00 percent taking agriculture as a major occupation as well as most important source of livelihood. In fact, broadly two types of farming systems have been in practice in the district: (a) small scale peasant farming for the agricultural products, and (b) large scale tea plantation farming. Between the two, the small-scale farming is taken into consideration for the present study and its characteristic features are highlighted by taking

in to account the agricultural crops rather than plantation. Further, it can be said here that the characteristic features are more related to land use factors, workforce employment and the demographic characteristics of employed labour. Land holding size, family size of farm operators and the level of subsistence of the farmers/households have been considered as the basis for characterising the agricultural phenomena prevalent in the Jorhat district. In order to highlight such characteristic features, the entire discussion is devoted to many aspects of agricultural land use which has been arranged into two following sections.

Section-A: General Land Use Characteristics

3.1 Land Use Processes:

Two processes which play significant role in the agricultural land use changes are: (a) the process of agricultural land use *expansion* through which non-agricultural land is converted into agricultural practices when it is required to get more production, and (b) the *intensification* which is more related to modern agricultural technology to increase the crop yield for agricultural production enhancement. The cropping pattern, crop production and crop yield of the study area are major attributes (say determinants) for agricultural intensification. Moreover, the rural density of population, literacy rate, occupational structure, dependency ratio, percentage of agricultural workforce, intensity of agricultural workforce have special significance in land operations and agricultural production. These attributes are discussed here thoroughly.

3.1 (a) General Land Use Patterns and Changes Therein:

The general land use statistics of the district show that there is a dominance of agricultural practices in the land use under which nearly a half of the share of total geographical land has been used. According to National Land use Policy documents; about 25 to 30 percent share of land in the district is to be put under forests land. The percentage share of forests land under the general land use categories in the district is loosing foot ground with the reduction of its percentage from 12.6 (1981-82) to 10.38 (1991-92) and further to 9.89 percent (2000-01) (Table-3.1). It (forests land) was recorded far lower than the state average (i.e., 24.60%).

What is most striking here is that a sizable portion of the total land of the district, i.e., more than one-third share of total geographical area has already been put to non-agricultural purposes. Over the years the share of uncultivated land has been increasing. It was reported by the District Agricultural Department as it was 25.27 percent (1981-82), 28.63 percent (1991-92), but rose to 30.04 percent during the early 2000s (2000-01). Due to the increase in total population in the district, the demand on land has been increasing for the purposes like expansion of settlements, establishment of new factories and various government offices, intensification of transport, communication and market areas. Such activities subsequently consume more space under non-agricultural purposes. However, there is still a scope of conversion of land from this category to agricultural land use.

The land under permanent pasture and grazing activities and land under miscellaneous trees and groves and cultivable wastelands altogether cover about 7.6 percent to the total land area in the district. In this context, this share is almost equal to or marginally higher than that of the state's average (6.17%). Fallow land covers about 1.62 percent which is marginally larger than state's figures (0.86 %). But the proportion of this category of land has also been declining from 2.00 percent (1981-82) to 1.62 percent (2000-01). Most of the cultivable waste and fallow lands of the district found to be concentrated in the neighbouring tracts in flood prone belt.

The Net Sown Area (NSA), which is meaningful from intensification point of view in agriculture, covers 42.42 percent to the total geographical area (higher than the state's average, i.e., 35.07 %). It is almost constant during the 20 years (1981-82 to 2000-02). On account of fast increase in Gross Cultivated Area (GCA) from 157,907 ha (1981-

82) to 178,910 ha (2000-01), the crop intensity rose from 127.4 percent in 1981-82 to 138.41 percent in 2000-01. It means the processes of intensification have significantly been accelerated in the district through the application of modern technology. Such processes of land use changes and agricultural intensification alter the cropping pattern and crop-yield pattern in the district.

Table- 3.1: Land Use Pattern of Jorhat district, 1981-82, 1991-92 and 2000-01

Land Category	1981-82		1991-92		2000-01	
	Area (ha)	%	Area	%	Area	%
Total Geographical Area	285,930	100.00	285,100	100.00	285,100	100.00
Forests	36,194	12.60	29,580	10.38	28,203	9.89
Land not available for cultivation						
a) Land put to non-agricultural uses	72,267	25.27	81,627	28.63	85,650	30.04
b) Barren and uncultivated land	21,136	7.40	21,060	7.30	20,265	7.10
Other cultivated land excluding fallow land						
a) Permanent Pastures and grazing land	4,406	1.60	4,406	1.54	4,300	1.50
b) Land under miscellaneous tree and groves	9,792	3.42	9,364	3.28	9,025	3.16
c) Cultivable wasteland	8,823	3.10	7,910	2.80	7,260	2.55
Fallow land						
a) Fallow other than current fallow	5,624	2.00	4,643	1.6	3,725	1.30
b) Current fallow	3,781	1.30	6,947	2.40	7,530	2.64
Net Sown Area	123,907	43.44	120,940	42.40	129,260	45.33
Area Sown more than once	34,000	11.90	45,336	–	49,650	–
Total Gross Cropped Area	15,7907	–	166,276	–	178,910	–
Cropping Intensity (%)		127.43		137.48		138.41

Source: Statistical Handbook, Directorate of Economics and Statistics, Government of Assam, Guwahati, 1981-82, 1991-92 and 2000-01.

3.1 (b) The Cropping Pattern:

The study of cropping pattern is not only important to describe the number of crops grown in the area but also to know their importance as per the food requirement in the area. As suggested by Das and Datta (1986), agricultural land use in any developing region like North-East India means the cultivation of soils for growing crops only, leaving a significant area for grassland, poultry farming, horticulture, pisciculture and diary farming unlike in the developed regions of the world (Das *et. al.*, 1986, p. 32). Das (1984) wisely remarked that agricultural land use in Assam is characterised by a low percentage of cultivable land predominantly high percentage of total agricultural land under rice, low crop intensity and low yield of crops per unit area.

Paddy, being the major staple food of the people, accounts for nearly 78.0 percent of the total agricultural area in 2000-01 (Table-3.2). This is because paddy is sown extensively in every C. D. Block of the district throughout the year. But unlike the other agriculturally developed areas of the country, paddy cultivation is labour intensive with limited modernization. Three crops of paddy are grown in the year in the district. These are winter paddy (*Salidhan*, May to October), summer paddy (*Ahudhan*, March to July) and autumn paddy (*Borodhan*, October to March). Agro-ecological conditions, especially seasonal temperature which does not vary much with a required soil moisture, provide a suitable base for the growth of three paddy crops in a year not only in the district but whole of the state (Fig.-3.1).

Among the three kinds of paddy, winter paddy* is the most important occupying

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* It is grown in summer season but harvested in the winter time in October, so it is called winter paddy

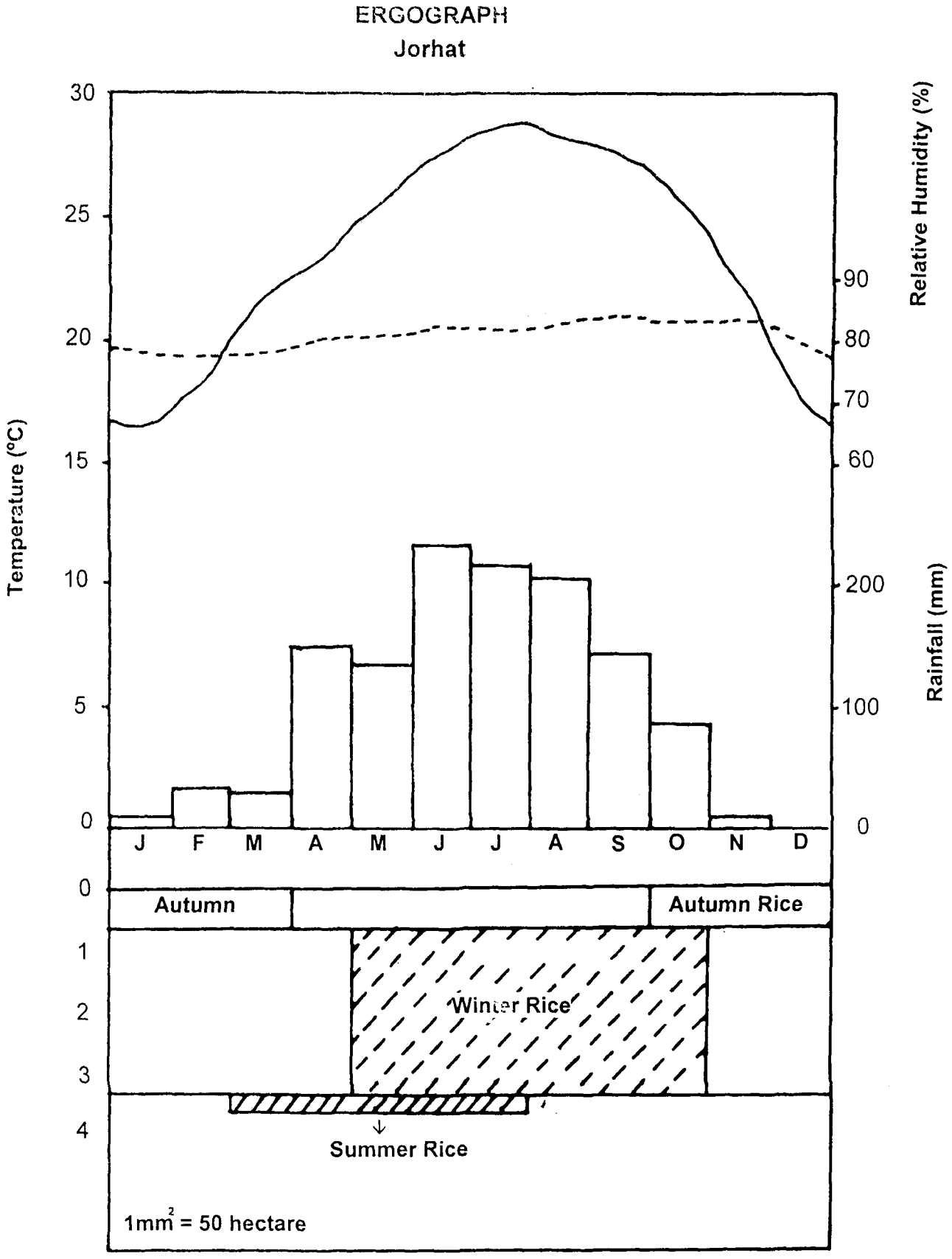

ERGOGRAPH
Jorhat
Temperature (°C)
Relative Humidity (%)
Rainfall (mm)
30
25
20
15
10
5
0
90
80
70
60
200
100
0
J F M A M J J A S O N D
0
Autumn
Autumn Rice
1
2
3
4
Winter Rice
Summer Rice
1mm² = 50 hectare

Fig. 3.1

as high as 70 percent of the total cropped area. The share of summer paddy is recorded only 6.5 percent, while autumn paddy accounts for only 1.5 percent. It is notable that the Titabor-Borholla area of Jorhat is identified as the 'rice bowl' of the district because of its huge production and productivity. The land of this area is highly suitable for the cultivation and production of rice. Moreover, the Rice Experimental Station of Assam, Titabor was established here in 1922 to study the different varieties of paddy grown in Assam and this centre has an impact in changing production of paddy cultivation (Gazetteer, 1967, p.121).

Jorhat district follows a diversified cropping pattern, but only a few crops are significant at the aggregate level. Out of total cropped area of about 178 thousand ha of the district (i. e., 83.00% in 2001-02) has been used for producing food crops. More than three fourth of this crop are (about 80%) is under cereals. On account of dominance of paddy in cropping pattern, mono-cropping pattern is prevalent in the district. However, the farmers of the district started growing other remunerative crops, through the use of seed-fertilizer technology. Paddy is also being considered as remunerative crop for the farmers who have larger size of the land holdings. It means that a significant diversification with technological inducement has been observed in the district (Table-3.2). The percentage share of area under different crops are estimated as under oilseeds 8.0 percent, fibre crop 1.1 percent, vegetables 2.8 percent and miscellaneous tree crop around 5.1 percent in the district. Besides these crops, other crops of the district include mustard, wheat, sesamum, black gram, green gram, lentil, peas, chillies, turmeric, sugarcane and a variety of horticultural and vegetable crops.

3.2 Changes in Crop Yield and Crop Production:

The level of agricultural productivity (i.e. average yield) as a concept related to the degree to which the economic, cultural and techno-organizational variables are able to exploit the abiotic resources of an area for agricultural production (Singh, 1979). It is dynamic as any modification in the physical factors and improvement in non-physical bases definitely affects the output of crops per unit of area over time (Singh and Dhillon, 1984).

Since mere volume of production cannot reflect the level of agricultural development, it is therefore essential to examine the level of productivity which is the interactive function of crop are and crop yield. Changing pattern of crop area has been interpreted in the preceding part of this chapter. The yield of different crops are to be describe here. In the context of paddy, the average yield of Autumn paddy in the district stood 1,110 kg/ha in the year 1998-99 which declined to 879 kg/ha but again rise to 1043 kg/ha in 2000-01. In the case of winter paddy, it was 1,757 kg/ha in 1998-99, 1,867 kg/ha in 1999-00 and 1,887 kg/ha in 2000-01. The average yield of summer paddy has fluctuating trend from year to year. It was recorded 1,817 kg/ha in 1998-99, 2,145 kg/ha in 1999-00, but declined to 1,495 kg/ha in 2000-01. The yield of wheat is recorded almost constant throughout the period of time of study (about 1,215 kg/ha). The yield of jute and potato are found to be increasing from 1,723 kg/ha and 5,652 k/ha respectively in 1998-99 to 1,748 kg/ha and 5,685 kg/ha respectively in 2000-01.

The yield of sugarcane and rape and mustard crops are quite encouraging which stand as 44,132 kg/ha and 646 kg/ha respectively. The yield of most of the crops have

gradually been increasing over the last 50 years. For instance, the yield of rice in the district was around 1,000 kg/ha in 1950-51, but it has reached now upto a level of 1,475 kg/ha in 2000-01. Unfortunately, the rate of increase of yield is not continuous, rather fluctuating from time to time (Table-3.2). As crop yield statistics show that the yields of paddy and other crops have significant fluctuations in the district over time. Such temporal fluctuations thus emerged are the product of the natural factors, mainly the fluctuating trends of monsoon rain during the period of time under consideration.

3.3 The Employment of Labour Force in Agricultural Practices:

There is a dominance of rural population (85.0 % in 2001) in rural-urban composition in the district with the fast emergence of town population. There are 7 towns in which Jorhat is the biggest market center (1,35,091 persons) and performs functions for the agricultural development of the entire area. In spite of immigration of population from rural to urban within the district, the demographic characteristics show that people's engagement is more towards agriculture dominated rural activities. Non-farm activities are negligible but emerging now gradually because of diversification in the agriculture through the use of modern technology. Calculating village wise statistics from District Census Handbook (2001), the composition and distributional pattern of labour force reveal the following facts:

Table- 3.2: Area and Yield of Principal Crops (Area in ha, Yield in kg/ha)

Crops	1988-89		1989-90		1990-91		1991-92		1992-93	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Paddy	85951	1181	100602	1277	106602	1603	109570	1610	108074	1408
Wheat	3255	1462	2325	686	1804	17237	2127	1551	1000	811
Pulses	--	--	15	408	--	--	20	408	68	408
Sugarcane	369	35241	700	39691	605	33965	725	37370	698	34452
Potato	2032	8257	1995	7053	2438	6514	3015	11037	2900	4394
Jute	65	1265	175	1509	185	1632	150	1537	300	2011
Rape & Mustard	14390	636	12775	515	13000	820	13470	1136	12208	278

Contd ...

1993-94		1994-95		1995-96		1996-97		1997-98	
Area	Yield	Area	Yield	Area	Yield	Area	Yield	Yield	[illegible]
[illegible]050	1468	102050	1415	95460	1364	94260	1389	98306	[illegible]56
1290	866	960	1082	1500	1177	3150	1325	1330	1512
26	408	65	408	75	410	10	410	75	410
560	39796	655	45774	670	37689	600	375	605	38565
2800	5376	3380	5998	3380	4106	3100	7388	3150	7653
140	1598	120	1832	155	1715	122	1537	127	1553
10920	332	13000	556	14150	742	9800	396	16210	398

Contd ...

998-99		1999-2000		2000-01	
Area	Yield	Area	Yield	Area	Yield
81,440	1,436	111,015	1,404	91,743	1,475
962	1,215	965	1,206	969	1,256
172	370	175	375	163	425
601	42,730	608	43,132	610	44,132
3,562	7,399	3,210	5,652	3,392	5,685
125	1,720	123	1,723	125	1,748
13,200	632	13,120	635	13,052	646

Source: Basic Agricultural Statistics, Directorate of Agriculture, Govt. of Assam (1988-89 to 2000-01)

3.3 (a) Share of Workforce:

As far as the working population of the district is concerned, the scenario is very much pronounced. A significant share of population (39.23 %) belongs to the workers category in which males are dominant (70.0 %). The male dominated labour force dominates in different categories of occupational structure. For example, male cultivators and agricultural labourers dominate the occupational structure. Near about 12.0 percent of total workers belongs to the category of marginal workers, i.e. lower than the state's proportion (14.0 %). Spatial pattern of workers distribution shows that the villages located near the market centre, the share of workers to total population and the agricultural workers to total workforce are recorded low (below 25.0%) because of migration of rural agricultural work force to the nearby towns (Figs. 3.2 and 3.3) The centrally situated Jorhat market centre has been observed a pool of non agricultural activities. The rural labour of nearby areas migrates to this town for the non-agricultural activities, which are considered more remunerative. Wage-differentials are major causes of spatial variability in this phenomenon. As distance from the market centre (i.e., Jorhat) increases, the percentage share of working population increases. On the other hand, outer peripheral areas and less-accessible areas to the roads like the areas of Neulgaon, Solmora, Randhanijan, Janjimukh, Bekajan, Ikarani, Eragaon, Gabharuparbat, Chetiagaon etc in the district have high percentage share of work force because of stagnant conditions in the agricultural activities (Fig.-3.3). Some pockets in the district especially located in the southeastern parts as well as in the northern margins have the highest percentage share of work force (i.e., more than 75%).

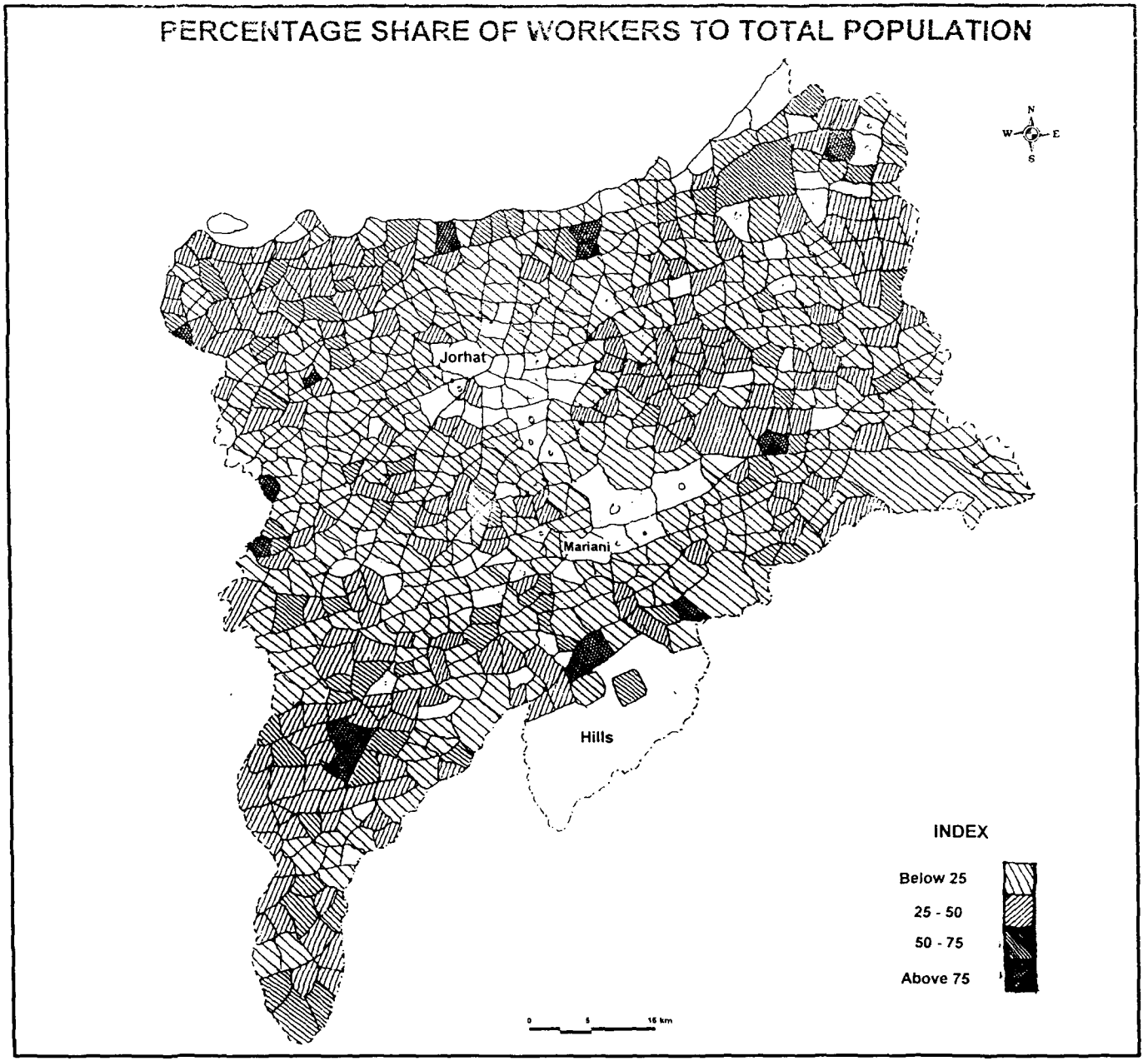

PERCENTAGE SHARE OF WORKERS TO TOTAL POPULATION
N
W
E
S
Jorhat
Mariani
Hills
INDEX
Below 25
25 - 50
50 - 75
Above 75
0
5
15 km

Fig. 3.2

Agricultural workforce intensity indicates labour intensity available for agricultural operation for per areal unit of cultivated land (persons/ha). Under the condition of unlimited supply of labour in agricultural operations because of supply of abundance labour at higher level of population density, there are many problems of raising agricultural productivity, crop-yield and use of modern technologies. In the district as a whole, agriculture workforce intensity is recorded 14 workers/ha in 2001 which varies spatially.

3.3 (c) Literacy Rate:

Literacy rate is found to be significantly high in the study areas as it ranks first (79.9%) in the state of Assam. So far the spatial variation in literacy rate of the district is concerned it is observed that a few pockets located in the extreme southern part (neighbouring area of Nagaland) have low literacy rate (below 25%). The pattern shows that literacy rate is high and very high (above 50%) in the surrounding villages of the main towns (Fig.-3.4).

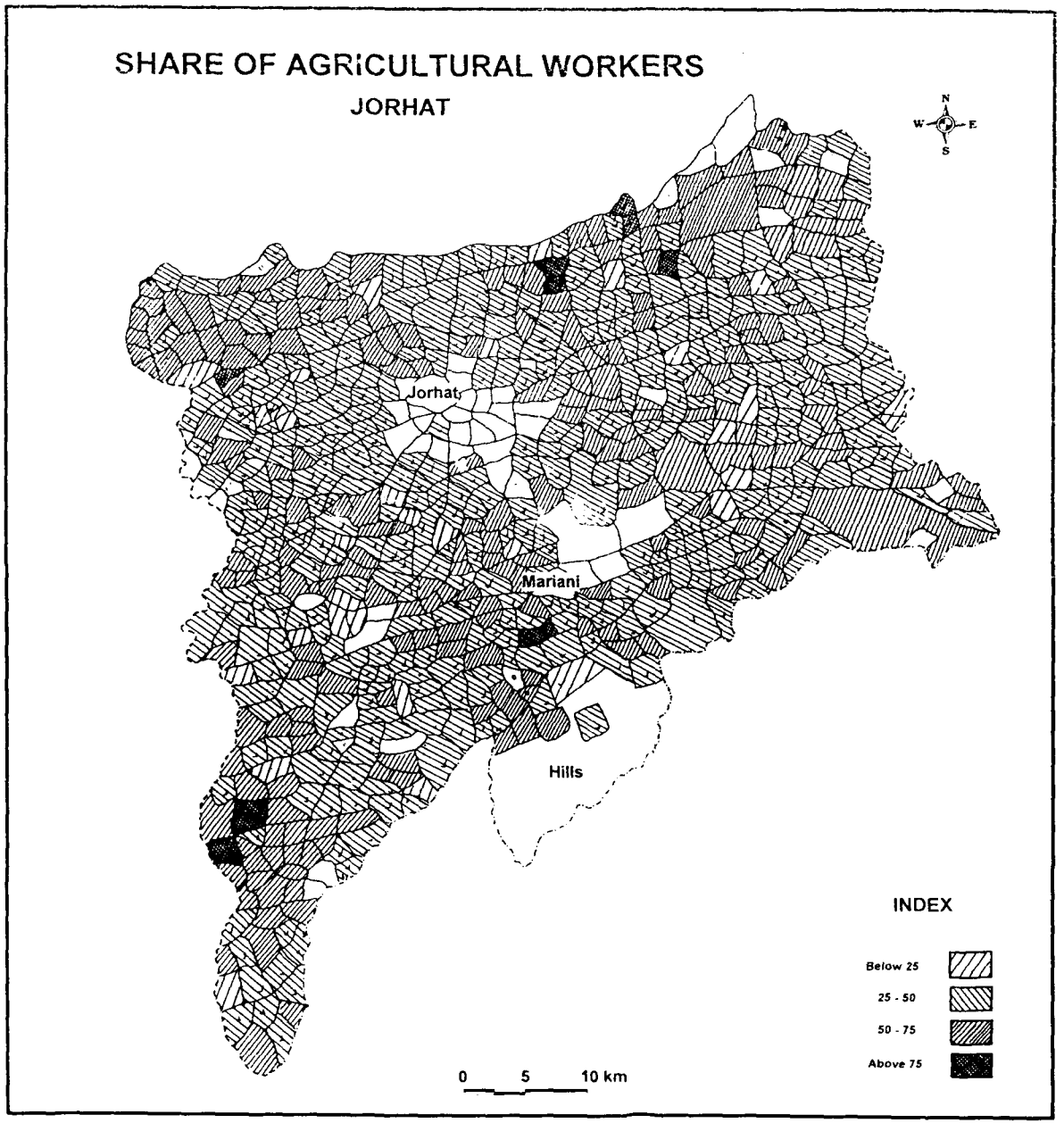

SHARE OF AGRICULTURAL WORKERS
JORHAT
N
W
E
S
Jorhat
Mariani
Hills
INDEX
Below 25
25 - 50
50 - 75
Above 75
0
5
10 km

Fig. 3.3

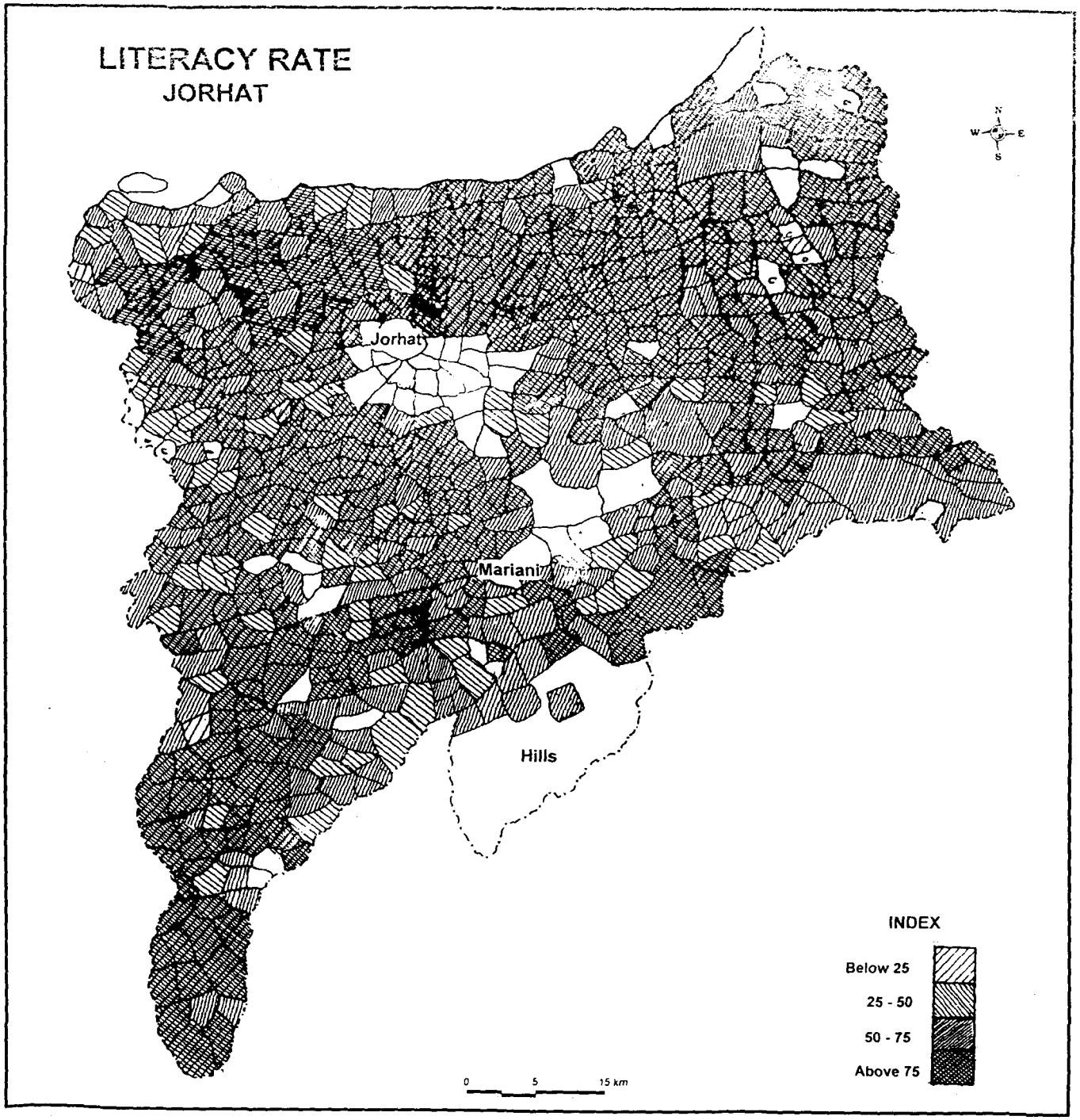

LITERACY RATE
JORHAT
Jorhat
Mariani
Hills
INDEX
Below 25
25 - 50
50 - 75
Above 75
0
5
15 km

Fig 3.4

Section-B: Agricultural Production Characteristics

Agricultural operations and economic efficiency of farm are determined by the size of landholdings of the farmers' families who hold the land and produce a kind of production at farm and the use of farm products for domestic purpose or partially supply to the market (i.e., degree of commercialisation). Considering these three main aspects of agriculture production, the nature and characteristics of agricultural practices are described in this section. The attributes related to demographic, occupational and land use characteristics are considered as 'dependent variables' and size of landholdings, family size and the subsistence level of farmers as 'explanatory variables' for the present analysis. Such explanatory variables/parameters must provide a sound base of characterising agriculture at farm level as:

(a) *The size of land holding* decides the degree of risk that a farm operator can bear. In general, greater is the capacity of the peasants to take the risk at the farm of the larger size. This, in turn, affects the extent of specialization and also the nature of technology and equipments (tractors, power tiller, pump set, thrashers, harvesters etc) to be used at farm (Gupta, 2005). Moreover, size of holding is linked with the pressure of population, the economic requirements and the fertility of land. The farm size acts as a critical limiting factor for agricultural development not only in Jorhat or in Assam but everywhere in the world (Singh and Daimari 2005). It is the determining factor for differentiating the nature of agriculture whether it is subsistence or commercial. In Assam, the average size of holding is very small. In fact, nearly 70 percent of the total holdings are below one and a half hectare. The average standard size of holding that can

give better agricultural returns cannot be maintained because of demographic expansion of rural population and the prevalence of the law of inheritance.

The agricultural landscape of Assam is divided into innumerable operational holdings consisting of a mosaic of fields of different shapes and sizes surrounding the settlements (Das, 1984). The size of a standard operational holding determines the socio-economic conditions of the farmer in accordance with the type of farming practised. In reality, it is found that, in different countries, the standard size varies enormously in accordance with the pressure of cultivators on the cultivated area (Singh, 1974). In Assam and especially in Jorhat, it is not possible to maintain a definite standard size of farm because of the increasing pressure of agricultural population on arable land. Fragmentation of farms and reduction of landholding size are continuous processes of decrease the landholding sizes. Khusro (1973) arrived at some estimate of farm size below which a farm is palpably inefficient and uneconomical so long as techniques of production remain what they are at present. There must be a size of holding below which its output is too small to maintain the family at a reasonable standard of living and this minimum size represent the concept of a minimum income unit of land.

(b) *The size of the farmers' family* is an important social component and performs a pivotal role in the agricultural production processes. On the other hand, the intensive use of inputs like labour, capital etc for agricultural development is related to the size of the family. It influences the supply of labour. The quantity and quality of human effort modify farm practices and the economy prevailing at the farm. A study of the farm family structure provides basis for understanding the relationship of the human resources with

variations in the economies of agriculture in operational holdings of different sizes. Agriculture being the dominant occupation of the rural HHs, the larger size of labour contribution for the agricultural practices is engaged from the HH family. Even persons below 15 years and above 60 years are often positive contributors of labour in family farms when peak agricultural seasons comes. In certain situations, a farmer retires only when it is impossible to work due to old age or infirmity (Das 1984). Hence, it is difficult to know precisely the position of actual labour use in agriculture especially in Assam. The manpower needed for agricultural activities for an area can be expected from within the family members or from hired labour. In Assam, the family is the basic unit of the rural society. The social organisation of agriculture has been stamped by the characteristics of the family system. The peasant family system bears the fundamental traits of subsistence economy.

(c) *The subsistence level of the farmers* is more related to production surplus at farm. It influences the characteristics of spatial organisation in agricultural activities. Subsistence agriculture is a self-contained and self-sufficient unit where the most of the share of farm production is consumed by the family of peasant farmers. Pure subsistence is characterised as absence of commercialisation and modernization. Pure subsistence shows the close relationship between farm and home or shorter cycle of production – consumption of farm products.

Subsistence farms cover some 40 percent of cultivated land and feed 60 percent population in the world. Since there is limited market participation in peasant economies (i.e. subsistence and peasant farmers), there is less involvement of the peasants in

participating in the market activities in connection with their weak buying and selling capacity.

3.4 Demographic and Agricultural Pattern of Farmers by their Size of Land Holdings:

3.4(a) Demographic Characteristics of farmers by their Size of Landholding:

Following the basis of All India Agricultural Census Report on the classification of land holding size as (i) Marginal size of landholdings (M; upto 1.0 ha), (ii) small size (S.S.; 1.0 ha to 2.0 ha), (iii) semi-medium size (SM; 2.0 ha to 4.0 ha), (iv) medium size (MS; 4.0 ha to 10.0 ha) and large size of land holding (LH; 10.0 ha and above), the total number of sample HHs (that are 300 in number) was classified to describe the demographic and agricultural characteristics of the farmers. There is a dominance of the farmers belonging to the small and semi medium landholding sizes (1.0-4.0 ha). The farmers of marginal landholding size contribute 20.6 percent to the distribution of total sample HHs.

It is further observed that, there is an increase in the family size of HHs from 5 persons per HH to 8 persons per HH and the sex ratio of the respondents also increases from 959 females per 1000 of males to 1008 females per 1000 males as size of holding increases (Table-3.3). As regards to age group in relation to size of land holdings is concerned, it is clear from the classification that in semi medium and medium land holding sizes the concentration of HH population is towards the adults (age group of 15-

59). It may be concluded that there is dominance of female adults in the larger families where farmers have fairly good size of land holdings (Semi Medium of 2.0- 4.0 ha).

Table-3.3: Demographic Pattern of Respondents

Category	Number of HH		Family Size	Total Male	Total Female	Sex Ratio	Dependency Ratio
	Total	%					
Marginal (upto 1 ha)	62	20.6	4.78	2.44 (51.04)	2.34 (48.95)	959	1.4471
Small Holding (1- 2 ha)	102	34.0	5.59	2.78 (49.82)	2.80 (52.17)	1007	1.4183
Semi Medium (2-4 ha)	109	36.3	6.78	3.37 (49.79)	3.40 (56.20)	1008	1.4945
Medium Holding (4-10 ha)	27	9.0	7.69	3.90 (50.71)	3.79 (49.29)	972	1.4257
Large Holding	-		-	-	-	-	-

N.B.: Figures in brackets indicate percentages

3.4(b) Educational Status of farmers by their Size of Landholdings:

The study area is basically characterized by the higher concentration of literates. The percentage of illiterate persons increased as the size of land holding increased except the families of medium landholding size where literacy rate was recorded 7.85 percent. The major share of marginal and small farmers (upto 68%) are educated upto higher secondary level, while this share is recorded higher among the farmers belonging to Semi Medium size of landholdings (Table-3.4). The one- third farmers of this category of Semi Medium size go up to High school level.

Table-3.4: Literacy Pattern in Different Land Holding Size

Category	Total HH	%	Illiterate	Upto H.S.L.C	H.S. +
Marginal (upto 1 ha)	62	20.6	.35 (7.88)	2.89 (65.10)	1.20 (27.0)
Small Holding (1- 2 ha)	102	34.0	.55 (9.62)	3.89 (68.35)	1.25 (22.0)
Semi Medium (2-4 ha)	109	36.3	.675 (10.04)	4.81 (71.65)	1.23 (10.30)
Medium Holding (4-10 ha)	27	9.0	.55 (7.85)	3.86 (54.63)	2.65 (37.51)
Large Holding	-	-	-	-	-

N.B.: Figures in parentheses indicate percentages

3.4(c) General land Use and Cropping Pattern of HHs by their Land Holding Size:

On an average, the district has 7.40 percent share of land under the category of *bari* (settlement) and 45.33 percent land under NSA (2001). There is a change in the general land use pattern of the farmers in the district as their landholding size increases. This share of *bari* land diminishes and the share of NSA including Fallow land increase as the farmers' landholding size increases from marginal to medium. It is a fact that when a farmer has larger size of landholding he uses smaller share of the piece of his land size under the settlement. As a result, the percentage share of *bari* land in the general land use categories is found highest in marginal category (14.81%) and lowest in the category of medium land holding size (3.20%). This indicates that the farmers of medium size of land holding might be fully utilised land under NSA for different types of crops to support the family members. Land under Plantation and miscellaneous tree crops is recorded nearly 25 to 30 percent. (Table-3.5).

Table-3.5: General Landuse (in ha and in %) according to Size of Land Holdings

Category of holding	No of HH	Bari land	Plantation & Miscellaneous	Fallow land	N.S.A.	Average Size
Marginal (upto 1 ha)	62	.08 (14.81)	.14 (25.89)	0.0	0.33(59.82)	0.54(100.0)
Small Holding (1ha to 2 ha)	102	.07 (4.51)	.46 (30.89)	0.0	0.9 (64.45)	1.50(100.0)
Semi-Medium (2-4 ha)	109	.01 (3.36)	.84 (28.51)	.01 (0.34)	2.02(67.78)	2.88(100.0)
Medium holding (4 ha-10 ha)	27	.19 (3.20)	1.23 (20.80)	.29 (4.93)	4.2 (71.09)	5.90(100.0)
Large Holding	–	–	–	–	–	–

N.B. 1. Classification of land use is based on the Purposive criterion which follows 4 categories.
2. Bari land includes homestead.
3. Figures in parenthesis show percentage

Crop land including harvested areas is an assessment of potential as well as current use (Eastal 1976). Crop diversification and intensive crop pattern indicate a kind of scenario where farmer wishes to change the farm technology. It varies with the size of land holdings. Farmers who have marginal landholdings alter their cropping pattern as per the food-fodder requirements of their families, while the farmers who hold larger farm size wish to diversify cropping patterns as per the requirements of the market. In the study area, winter paddy and vegetables dominate in cropping pattern in marginal size of land holding as 26.74 and 69.76 percents respectively. In small landholding, the winter paddy ranks first (44.48%), vegetables crops ranks second (44.13%). Besides, summer paddy (5.51%), potato (2.41%), pulses (1.36%) and other cash crops are also cultivated for the family requirements. In small marginal land holding, two crops namely the winter paddy and vegetable cover maximum area and dominate the cropping pattern. Besides paddy, the wheat (1.23%), sugarcane (1.46%) and jute (1.35%) are also cultivated as cash crops, though these crops account for a small share of farmers' land belonging to semi

medium land holding size. In medium land holding sizes, the winter paddy gets priority (65%) as rice is the staple food of the family. But the share of vegetable crops found lower in this category as because the family members give priority to other cash crop like potato, pulses, jute and sugarcane. Thus, it is obvious that increasing the size of land holding diversifies cropping pattern towards commercial crops (Table-3.6). The products of such crops generally used as marketable surplus in the farming community of the Medium size of land holdings.

3.5 Demographic and Agricultural Pattern of Farmers according to their Family Size:

In order to examine the agricultural characteristics depending upon the demographic composition and supply of labour to the operation of farm systems, the sampled HHs have been classed into five categories on the basis of their family size. These classes are as: (i) Very Small Size (VS; families with 3 persons or less), (ii) Small Size (SM; families with 4 to 5 persons), (iii) Medium Size (MED; families with 6 to 7 persons), (iv) Large Size (LS; families with 8 to 9 persons) and (v) Very Large Size (VLS; families with 10 persons or more). The HHs distribution as per their family size shows that higher concentration of household is noticed in the category of Small family Sizes (4-5 persons/HH) which accounts for a total number of 127 HHs (42.35%). Moreover, in Medium family Size (i.e., 6-7 persons/HH) covers 80 numbers of total HHs (26.7%). In Large Size and Very Large Size of HH Families, the number of the sample HHs is accounted for only 35 (11.66%) and 29 HHs (9.66%) respectively. It is due to prevailing joint family system in the large as well as very large family sizes (Table-3.7).

Table-3.6: Cropping Pattern according to Size of Holding

Category of size of holding	Autumn paddy	Summer paddy	Winter paddy	Wheat	Sugarcane	Jute	Pulses	Potato	Vegetables	
Marginal (upto 1 ha)	0.0 (0)	.01 (1.16)	.23 (26.74)	.005 (0.58)	.005 (0.58)	.005 (0.58)	0	.005 (0.58)	.60 (69.76)	.86
Small Holding (1- 2 ha)	0.0 (0)	.08 (5.51)	.645 (44.48)	.01 (0.68)	.01 (0.68)	.01 (0.68)	.02 (1.36)	.035 (2.41)	.64 (44.13)	1.46
Semi Medium (2-4 ha)	.047 (2.13)	.242 (10.92)	1.315 (59.23)	.027 (1.23)	.032 (1.46)	.03 (1.35)	.017 (0.78)	.065 (2.92)	.467 (21.05)	2.22
Medium Holding (4-10 ha)	.015 (0.37)	.302 (7.55)	2.605 (65.0)	.027 (0.68)	.07 (1.74)	.07 (1.74)	.072 (1.81)	.14 (3.99)	.66 (16.47)	3.96
Large Holding	0	0	0	0	0	0	0	0	0	0

3.5 (a) Demographic Structure of Farmers by their Family Size:

A total members of family/ HH shows labour requirement of the farm and also the supply of labour to non farm activities at farm or at near by towns. It is obvious from the Table that the sex ratio is recorded marginally higher in the medium size of HH families (1018 females per 1000 males) and lower in small as well as very high size of HH families (891 to 981 females per 1000 males). It shows that there is higher percentage share of males in the medium size of HH family as elaborated in earlier section also (Table-3.7). The male female composition of population at smaller size of families shows male dominance. Same is the case for the larger size of families. The families have higher share of its population among adults category (15-59 yrs). The dependency ratio does not vary much among the farmers of different family sizes. However, small families have more burden of the children with marginally higher dependency ratio (1.56) (Table-3.7).

Table-3.7: Demographic Pattern according to Family Size.

Family Size (persons)	No of HH	%	Males	Females	Sex Ratio	Dependency Ratio
Very Small (<3)	29	9.66	1.31 (51.98)	1.21 (48.0)	923	1.560
Semi Medium (4-5)	127	42.33	2.33 (51.89)	2.16 (48.10)	926	1409
Medium (6-7)	80	26.66	3.13 (48.60)	3.31 (49.52)	1018	1.492
Large (8-9)	35	11.66	4.29 (50.47)	4.21 (49.52)	981	1.300
Very Large > 9	29	9.66	6.34 (52.87)	5.65 (47.12)	891	1.306

3.5 (b) Literacy Rate:

The variation in literacy rate depending on the size of the family. The literacy rate is found to be maximum among small size family but the percentage of HHs of the large size is noted higher (75.0%) at the secondary education (HSLC) level. In all categories, it is observed that the percentage of literacy is found quite satisfactory (Table-3.8).

Table- 3.8: Literacy Rate (per family) according to Family Size

Category of family size (Persons)	Illiterate		Upto HSLC		HS+	
	Total	%	Total	%	Total	%
Very Small (<3)	0.655	(20.30)	1.52	(47.13)	1.05	(32.55)
Small 4-5	0.395	(8.44)	3.185	(68.0)	1.10	(23.50)
Medium 6-7	0.52	(8.42)	4.44	(71.96)	1.21	(19.61)
Large 8-9	0.55	(7.23)	5.79	(75.55)	1.32	(15.77)
Very Large) > 9	0.91	(7.72)	7.93	(67.62)	2.89	(24.64)

3.5(c) General Land Use and Cropping Pattern:

In general, about three-fourth of the share of total land of HHs is under NSA which varies with variations in HHs family size. The percentage share of land under NSA increases with reducing of the share of fallow land as family size of the farmers increases. Settlements (*bari*) occupies larger piece of land when family size increases but its percentage share declines from 5.39 percent for small medium families to 1.43% for very large family size (Table-3.9). It shows that larger family sizes intensify the cultivation with the required larger piece of land under settlements through reducing fallow and miscellaneous crop lands.

Paddy, summer as well as winter, and vegetables including potato are the principal crops. Winter paddy (May-October) occupies the largest share of land (56.0%) and vegetables stood on second rank in the study area. Generally, the farmers grow food grains and vegetables for their own consumption. However, the changing cropping patter by the family size of the farmers show that winter paddy, jute and vegetable crops cover increasingly high percentage share of cultivated land as the family size increases. This finding appears contradictory to the generalisation made by others as crop pattern becomes commercial in the small family and domestic for the larger families. But here the area under commercial crops like jute and vegetables increases as family size increases. It may be because of farmers of the larger family size would have larger land holding sizes; there might be positive correlation between them. Such facts may be tested later on in the present discussion. (Table-3.9).

Table-3.9: General Land use Pattern (in ha and %) according to Family size.

Category of family size	Bari Land	Plantation & Miscellaneous	Fallow Land	NSA	Total Land
Very Small (<3)	0.045(3.62)	0.445(35.8)	0(0)	0.75(60.4)	1.24(100)
Small Medium (4-5)	0.105(5.39)	0.605(31.10)	0.005(0.25)	1.23(63.23)	1.95(100)
Medium (6-7)	0.115(5.10)	0.605(22.34)	0.005(0.22)	1.23(73.21)	1.95(100)
Large (8-9)	0.07(3.19)	0.65(29.68)	0.025(1.14)	1.445(65.98)	2.19(100)
Very Large (> 9)	0.44(1.43)	0.658(21.53)	0.074(2.42)	2.28(74.60)	3.056(100)

Table-3.10: Cropping pattern (ha and %) according to Family Size

Category of family size	A. Paddy	S. Paddy	W. Paddy	Wheat	Sugarcane	Jute	Pulses	Potato	Vegetables	Total
Very Small	0	0.025	0.505	0	0.03	0.005	0	0.03	5.75	1.17
(<3)	(0)	(2.13)	(43.16)	(0)	(2.56)	(0.42)	(0)	(2.56)	(49.14)	
Small	0.015	0.125	0.82	0.015	0.015	0.02	0.01	0.045	0.585	1.65
(4-5)	(0.90)	(7.57)	(49.69)	(0.90)	(0.90)	(1.21)	(0.60)	(2.72)	(35.45)	
Medium	0.015	0.175	1.115	0.005	6.03	0.035	0.02	0.055	0.56	2.01
(6-7)	(0.74)	(8.70)	(55.47)	(0.24)	(1.49)	(1.74)	(0.99)	(2.73)	(27.86)	
Large	0.03	0.18	0.865	[illegible]	0.005	0.025	8.04	0.035	0.455	1.65
(8-9)	(1.81)	(10.87)	(52.26)	(1.20)	(0.30)	(1.51)	(2.41)	(2.11)	(27.49)	
Very Large	0.024	0.256	1.63	0.01	0.028	0.036	0.026	0.072	0.642	2.71
> 9	(0.89)	(9.50)	(60.50)	(0.37)	(1.03)	(0.96)	(0.96)	(2.67)	(23.83)	

3.6 Subsistence Agriculture and Market Surplus:

3.6(a) Demographic and Social Characteristics of Farmers according to their Subsistence Levels:

There are various criteria of describing the characters of the marketable surplus. The classification may be made by considering either the total amount of marketable surplus or its percentage share. The share of marketable surplus to total farm production is considered as important base of classification. The sample HHs have been classified into 7 categories on the basis of their share of marketable surplus, namely, (1) Pure subsistence (complete absence of commercial activities at farm, zero percent production of farm commodities as marketable surplus), (2) Subsistence (0-20% farm commodities marketable surplus), (3) Semi-subsistence (20-40%), (4) Dual farmers (40-60%), (5)

Semi-commercial (60-80%), (6) Commercial ~~(60-80%), and (7) Pure-commercial (8~~0-100% marketable surplus of farm commodities).

Distribution of sample households as per their marketable surplus production available at farm shows that a significant percentage share of HHs population (more than 70 %) belongs to different categories of subsistence farmers. Less than 10 percent farmers in the district are included under category of commercial farming system. The results inferred from the Table- 3.11 are as follows:

a) The figures of Sex ratio in different categories of degree of subsistence in the farming activities show that there is female dominance in the subsistence farming and inversely male dominance in the commercial farming. While family size remains almost constant throughout (Table 3.10) family labour is involved in family activities specially in the subsistence level of farms.

b) Adults contribute almost equal share in the age-group distribution. However, the percentage share of female aged people (60+) increases and percentage share of male children (0-14) decreases at farms. This statement shows that commercialization raises the family income and which is being used for health care of the female in the farming commonly adopting commercial farm activities contrary to it, the share (0-2) of male children become lesser in the commercial activities. It means that children population is less

c) Higher level of education (HS +) and higher percentage share of family workers engaged in business (non-farm activities either at farms or in the nearby towns)

- have high degree of commercial activity at farms. It appears that education and non-farm activities influences directly to commercialisation in the district. It is obvious that educated farmers adopt modern technology and the farms who are partly or fully engaged in business have extra income to invest in the farm for commercial activities.

3.6(b) Land Uses and Cropping Pattern at Different Subsistence Levels:

There is a conversion of the share of land from plantation and tree crops to NSA as commercial activities intensified at farm. It means that the commercial activities are more related to intensification of land uses rather than expansion process of land. Table-3.13 reveals that paddy crops dominate in all categories of subsistence farming levels. The second rank crops are brinjal, ladies finger at subsistence level for domestic consumption, bettlenut and vegetables are the second ranking crops at commercial level. Such crops are grown for marketable surplus. It is noted that the commercialisation in the agricultural activities occurs intensely at the larger farm sizes. For example, land holding size increases from 1.2 ha to 3.15 ha as the level of marketable surplus changes from subsistence to commercial farming system (Table- 3.12)

On the other hand, it can be said that, when commercial activities start at farm, the land use pattern changes in contributing marketable products from vegetables to betel nut and rice. The paddy is also considered as commercial crop and HHs supply major share of paddy to the nearby market to increase their family income (Table- 3.13).

Table-3.11: Demographic and Occupational Characteristics of Subsistence Farmers

% of Marketable surplus)	Degree of subsistence	Total No. of HH	HH Size (Persons)	Sex ratio	Age Groups (%)						Education (%)			Occupation (%)				
					0-14		15-59		60+									
					M%	F%	M%	F%	M%	F%	Illiterate	HSLC	HS+	Cultivation	Services	Business	House Wife	Others Students
(0)	Pure Subsistence	10	5	1220	40	21	84	74	12	5	14.2	78.7	7.1	0	18.2	15.9	27.3	38.6
(0-20)	Subsistence	23	5	1221	27	27	59	68	14	5	8.9	72.5	18.6	5.3	21.6	6.7	22.4	45
(20-40)	Semi-Subsistence	42	6	1107	20	20	70	75	10	5	9.3	70.2	20.5	13.7	14.9	10.8	20.3	44.7
(40-60)	Dual Farmers	96	6	965	16	18	71	72	13	10	7.8	65.1	27.1	13.2	16.4	11.8	24.1	36.5
(60-80)	Semi Commercial	94	6	923	21	21	70	73	9	6	8.8	62.5	28.7	11.4	17.9	7.5	21.5	41.7
(80-100)	Commercial	35	6	764	16	17	66	73	18	10	8.5	61.2	30.3	10.3	16.7	11.5	24.3	37.2

Table-3.12: General Landuse Pattern in Different Subsistence Level (%)

Subsistence level	Total no. of Household	Bari land	Plantation & miscellaneous	Fallow land	Net Sown Area	Total Land
Pure Subsistence (0-0)	10	0.06 (5.88)	0.83 (81.37)	0.00 (0.00)	0.13 (12.74)	1.02 (100)
Subsistence (0-20)	23	0.12 (10.81)	0.44 (39.63)	0.00 (0.00)	0.56 (50.45)	1.11 (100)
Semi-subsistence (20-40)	42	0.08 (5.44)	0.47 (31.97)	0.00 (0.00)	0.93 (63.26)	1.47 (100)
Dual Farmers (40-60)	96	0.10 (4.50)	0.73 (32.88)	0.02 (0.90)	1.37 (61.71)	2.22 (100)
Semi Commercial (60-80)	94	0.07 (2.92)	0.46 (19.24)	0.03 (1.25)	1.83 (76.56)	2.39 (100)
Commercial (80-100)	35	0.14 (4.44)	0.70 (22.22)	0.01 (0.32)	2.31(73.33)	3.15 (100)

N.B.: Figures in bracket represents percentage.

3.6(c) Pattern of Marketable Surplus:

The importance of crops contributed to the marketable surplus at different farm activities is highlighted by calculating total quantity of crop production produced for marketable surplus per HH. Table- 3.14reveals that (a) the subsistence farmers produced marketable surplus of an average amount of 500 kg/HH/year while the farmers belonging to the commercial farming contribute to the market an amount of about 10,000 kg/HH/year, i. e., 20 times higher than the contribution of the subsistence farmers; (b) winter paddy crop contributes the highest quantity as marketable surplus in all farming community; (c) the potato is second ranking crop contributing to the marketable surplus especially in the category of the subsistence farming, while bettlenut and vegetable contribute to the market supply in the commercial farming activities

Table – 3.13: Cropping Pattern (Area under Different Crops) at different Subsistence Levels (Figs in %)

Sl. No.	Subsistence levels based on the marked surplus (Area/HH and %)											
	Pure Subsistence		Subsistence		Semi-Subsistence		Dual Farmers		Semi-Commercial		Commercial	
	ha	%	0-20		20-40		40-60		60-80		80-100	
1 Autumn paddy	0.00	0.00	0.00	0.00	0.01	0.76	0.03	1.67	0.01	0.42	0.03	1.11
2 Summer paddy	0.05	4.42	0.09	12.16	0.05	3.79	0.18	10.00	0.18	7.59	0.24	8.86
3 Winter paddy	0.05	4.42	0.44	[illegible]	0.67	50.76	0.82	45.56	1.22	51.48	1.67	61.62
4 Wheat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	1.69	0.00	0.00
5 Sugarcane	0.00	0.00	0.02	2.70	0.01	0.76	0.03	0.76	0.02	0.84	0.01	0.37
6 Jute	0.00	0.00	0.00	0.00	0.04	3.03	0.01	0.56	0.04	1.69	0.03	1.11
7 Coconut	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.56	0.02	0.84	0.01	0.37
8 Pulses	0.00	0.00	0.02	2.70	0.01	0.76	0.01	0.56	0.02	0.84	0.03	1.11
9 Potato	0.00	0.00	0.04	5.41	0.03	2.27	0.01	0.56	0.07	2.95	0.05	1.85
10 Bettlenut	0.00	0.00	0.02	2.70	0.01	0.76	0.02	1.11	0.05	2.11	0.06	2.21
11 Cabbage	0.00	0.00	0.02	2.70	0.02	1.52	0.05	2.78	0.05	2.11	0.04	1.48
12 Cauliflower	0.00	0.00	0.01	1.35	0.00	0.00	0.04	2.22	0.02	0.84	0.01	0.37
13 Olkabi	0.00	0.00	0.01	1.35	0.00	0.00	0.04	2.22	0.01	0.42	0.01	0.37
14 Brinjal	0.00	0.00	0.01	1.35	0.00	0.00	0.01	0.56	0.02	0.84	0.01	0.37
15 Radish	0.00	0.00	0.00	0.00	0.01	0.76	0.01	0.56	0.00	0.00	0.01	0.37
16 Pattal	0.00	0.00	0.01	1.35	0.01	0.76	0.01	0.56	0.01	0.42	0.02	0.74
17 Ladies finger	0.00	0.00	0.01	1.35	0.00	0.00	0.01	0.56	0.00	0.00	0.01	0.37
18 Jika	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.11	0.01	0.42	0.01	0.37
19 Squash	0.00	0.00	0.01	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20 Pumpkin	0.01	0.88	0.01	1.35	0.01	0.76	0.01	0.56	0.02	0.84	0.03	1.11
21 Tomato	0.02	1.77	0.01	1.35	0.01	0.76	0.01	0.56	0.01	0.42	0.01	0.37
22 Others	1.00	88.50	0.01	[illegible]	0.43	32.58	0.47	26.11	0.55	23.21	0.42	15.50
	1.13	100.00	0.74	100.00	1.32	100.00	1.80	100.00	2.37	100.00	2.71	100.00

Table- 3.14: Surplus Production (kg/ Household and in %) at Different Levels of Subsistence Agriculture

Sl. No.	Crops	KG (in %)	0-20		20-40		40-60		60-80		80-100	
1	Autumn paddy		0.00	0.00	15.48	1.23	33.02	0.96	12.77	0.20	54.29	0.54
2	Summer paddy		7.83	1.57	96.19	7.66	336.77	9.75	385.64	5.99	556.57	5.52
3	Winter paddy		86.09	17.22	726.33	57.88	1656.92	47.97	3679.20	57.15	6110.06	60.62
4	Wheat		0.00	0.00	0.00	0.00	5.21	0.15	139.36	2.16	0.00	0.00
5	Sugarcane		73.04	14.61	23.26	1.85	65.42	1.89	30.84	0.48	19.22	0.19
6	Jute		0.00	0.00	23.81	1.90	55.00	1.59	68.40	1.06	120.00	1.19
7	Coconut		0.00	0.00	1.19	0.09	177.08	5.13	530.16	8.23	822.14	8.16
8	Pulses		3.26	0.65	1.67	0.13	3.56	0.10	3.80	0.06	9.00	0.09
9	Potato		114.61	22.93	86.31	6.88	94.16	2.73	117.07	1.82	280.00	2.78
10	Bettlenut		0.00	0.00	50.71	4.04	461.46	13.36	653.99	10.16	1124.29	11.15
11	Cabbage		51.30	10.26	66.12	5.27	141.54	4.10	285.34	4.43	308.17	3.06
12	Cauliflower		15.43	3.09	13.38	1.07	74.89	2.17	101.64	1.58	68.57	0.68
13	Olkabi		40.35	8.07	17.67	1.41	64.06	1.85	89.45	1.39	175.00	1.74
14	Brinjal		27.39	5.48	18.45	1.47	89.20	2.58	154.65	2.40	167.57	1.66
15	Radish		3.26	0.65	4.29	0.34	28.69	0.83	7.49	0.12	22.60	0.22
16	Pattal		5.00	1.00	6.07	0.48	3.99	0.12	5.22	0.08	14.97	0.15
17	Ladies finger		38.26	7.65	32.64	2.60	58.05	1.68	27.07	0.42	54.20	0.54
18	Jika		28.30	5.66	2.26	0.18	11.88	0.34	12.60	0.20	5.57	0.06
19	Squash		0.00	0.00	7.14	0.57	4.38	0.13	10.32	0.16	4.00	0.04
20	Pumpkin		2.17	0.43	43.79	3.49	75.42	2.18	99.84	1.55	154.43	1.53
21	Tomato		1.74	0.35	8.62	0.69	6.36	0.18	8.59	0.13	4.64	0.05
22	Others		1.83	0.37	9.60	0.76	7.06	0.20	14.77	0.23	4.14	0.04
			499.86	100.00	1254.98	100.00	3454.12	100.00	6438.21	100.00	10079.43	100.00

3.6(d) Labour Employment in Different Subsistence Levels of Agriculture:

Farming operations are labour intensive as interpreted earlier that more than 2/3rd share of total workers (in some pockets in the district it was recorded more than 75%, see Fig.- 3.3) is engaged in agricultural activities. Almost a half of the total labour engaged at farms belongs to family and remaining half is hired labour for the farm operations. This share is almost constant in all the farming categories. However, it appears to be the

seasonal variations in the employment of the hired labour as: (a) the duration of employment of hired labour at farm increases from 35–40 days to 90-95 days in a year as farming activities changes from subsistence to commercial, (b) the labour is generally hired for short durations (10-15 days in a year) in summers (July to September) and winters (January to march) by subsistence farmers because extra labour required for paddy plantation, and for long duration (25-30 days in a year) in the Summers and autumns by the farmers having commercial activities at their farms due to summer paddy and autumn crops like vegetables which are grown for the commercial purposes, and (c) the labour consuming (hired) farm activities are performed at commercial farms in the district (Table – 3. 15)

Table- 3.15: Labour Characteristics at Different Levels of Subsistence Agriculture

Sl. No.	Subsistence level	Total Labour employed per H.H.			No. of days for hired labours in different seasons				Total
		Family Labour	Hired Labour	Total	July to September	October to December	January to March	April to June	
1	Pure Subsistence 0-	0.50 (45.45)	0.60 (54.54)	1.10 (100)	13.00 (34.94)	10.00 (26.88)	14.20 (33.17)	0.00	37.20
2	Subsistence 0-20	0.43 (43.0)	0.57 (57.0)	1.00 (100)	11.74 (29.57)	9.22 (23.23)	11.13 (28.09)	7.60 (19.14)	39.69
3	Semi-Subsistence 20-40	1.17 (58.12)	0.55 (41.37)	1.72 (100)	13.36 (33.96)	12.40 (31.52)	9.98 (25.36)	3.60 (9.15)	39.34
4	Dual Farmers 40-60	1.09 (51.41)	1.03 (48.58)	2.12 (100)	21.85 (28.27)	21.94 (28.38)	19.46 (25.17)	14.04 (18.16)	77.29
5	Semi Commercial 60-80	1.17 54.16)	0.99 (45.83)	2.16 (100)	21.85 (27.77)	22.10 (28.08)	17.76 (22.57)	16.97 (21.56)	78.68
6	Commercial 80-100	1.37 (55.24)	1.11 (44.73)	2.48 (100)	29.94 (31.68)	24.26 (25.67)	21.43 (22.67)	18.86 (19.95)	94.49

N.B.: Figures in bracket represents percentage

3.7 Concluding Remarks:

There are many characteristic features of subsistence peasant economy as given by many scientists. However, the some specific observations on the basis of farmers' family size, their landholdings and subsistence levels are drawn in this chapter. The important deductions from the above discussion are put forward as given below:

1. There is a gradual increase in the cultivated area at farm level by converting waste and forest lands to the NSA. The crop yield also increases marginally over time. It means the processes of expansion and intensification started in the subsistence farming systems in the district.

2. Commercialization in the farming system is positively related with the size of land holdings and family size. Larger families who have bigger size of land holdings have started producing more marketable surplus (commercial activities) with the employment of the major part of their family labour who are educated and more mobile. Female dominates in the subsistence farm activities. Male adults contribute when there is change in the farming activities from subsistence to commercial.

3. The duration of employment of hired labour increases as farm activities changes from subsistence to commercial. But commercial farm are labour consuming (especially hired labour) in the farms of commercial activities.

4. General land use changes by increasing land under NSA from the plantation and miscellaneous tree crops when farming practices alters from subsistence to

commercial. Winder paddy, potato contribute higher share of marketable surplus in then subsistence farming and Bettlenut and vegetables are growing for marketing surplus.

5. The farmers occupying large size of landholdings practice intensive farming with commercial crops. At such large holding sizes of farms, a large share of land is under paddy crop which is grown as commercial crop because a very small share of total food grains are used for family consumption and remaining share of paddy product is used as marketable surplus. Beetlenut and vegetables are major commercial crops in these commercial farming practiced in the larger land holding sizes.

In the end, it may be said that commercialization do occur in the growing agricultural economies as exist in the study area. The agricultural production activities produced marketable surplus which is supplied to and the technological agricultural innovations which are diffused by the centrally located market centre (that is Jorhat town) are the part of the spatial patterns of agricultural land uses. These spatial processes must be analyzed in detail separately in the next chapter.

References:

Bhagabati, A. K. (1990): *Spatial Analysis of Small Scale Agriculture in Assam: A Case Study of Nalbari District*, Unpublished Ph.D. Dissertation, Gauhati University, Guwahati.

Bhalla, G. S. and Tyagi, D. S. (1989): *Patterns in Indian Agricultural Development – A District Level Study*, ISID, New Delhi.

Bhatia, S. S. (1965): Patterns of Crop Concentration and Diversification in India, *Economic Geography*, Vol.41, pp. 40-56

Butler, J. B. (1960): *Profit and Purpose Informing (A Study of Farms and Small Holdings in parts of North Riding)*, University of Leeds, Department of Economics, p-68.

Conkling, E. C. (1963): South Wales: A Case Study in Industrial Diversification, *Economic Geography*, Vol. 53, p.221-240

Das, I. T. and Das, M. M. (1989): Land Use Patter in the Pagladia – Puthimari Basin, *North Eastern Geographer*, Vol.21 (1&2), pp. 9-25.

Das, M. M. (1984): Peasant Agriculture in Assam, Inter India Publications, New Delhi.

Das, M. M. (1995): *Land Holding Structure: A Problem in Peasant Agriculture in Assam*, Konark Publishers Pvt. Ltd, New Delhi, pp. 37-98.

Das, M. M. and Datta, L. (1986): Landuse and Agriculture in North-East India, *North Eastern Geographer*, Vol. 18, (No. 1&2), pp. 28-48.

Dayal, E. (1984): Agricultural Productivity in India – A Spatial Analysis, *Annals of the Association of American Geographers*, Vol. 74 (1), pp. 98-123.

Estal, R. (1976): *A Modern Geography of United States*, Penguin Books, Middlesex, England.

Gazetter of India, Assam State, Sibsagar District (1967), Govt. of Assam, Shillong, pp. 20-21, 31-32, 121 and 236.

Gibbs, J. and Martin, W. (1962): Urbanisation, Technology and the Division of Labour: International Patterns, *American Sociological Review*, Vol.27, pp. 126-140.

Grigg, D. (1969): The Geography of Farm Size, A Preliminary Survey, *Economic Geography*, Vol.42, pp.205-235.

Gupta, J. P. (2005): Crop Diversification in Panchkula District, Haryana, *Hill Geographer*, Vol. XXI (1&2), pp. 11-23.

Haloi, K. (1985): Structure and Pattern of Land Holding in Arunachal Pradesh, *Hill Geographer*, Vol.IV (2), pp. 22-31.

Kakati, B. K. (1985): *Impact of Agricultural Innovation on Socio-Economic Structure of Bajali Block*, Unpublished M. Phil Dissertation submitted to the Department of Geography, Gauhati University, Guwahati, pp. 8-13.

Khusro, A. M. (1973): *Economics of Land Reform and Farm Size in India*, Macmillan, India.

Mavi, H. Singh (1963): Crop Concentration and Diversification in Nainital District, U.P. Himalaya, *National Geographical Journal of India*, 33(2), pp.160-167.

Rahman, R. and Singh, S. (1992): Changing Patterns of Agricultural Labour Productivity in Assam, *Hill Geographer*, Vol. IX (No.1&2), pp. 25-31.

Saikia, H. (1987): *Size of Holding and Productivity: A Case Study of Nowghon District*, unpublished M. Phil. Dissertation Submitted to the Department of Geography, North Eastern Hill University, Shillong.

Sharma, B. (2003): *Changing Pattern of Agricultural Labour Productivity in Brahmaputra Valley*, Unpublished M. Phil. Dissertation submitted to Department. of Geography, North Eastern Hill University, Shillong.

Shear, James A. (1965): A General Measure of Diversity, *The Professional Geographer*, Vol.17, pp.14-17.

Singh, G. B. (1979): *Transformation of Agriculture*, Vishal Publication, Kurukshetra, pp. 77-79.

Singh, J. (1974): *An Agricultural Geography of Haryana*, Vishal Publications, Kurukshetra.

Singh, J. (1979): A New Technique of Delimiting Agricultural Production Typology in Food Crop Dominated Economy, *Geographila Polonica*, Vol. 40, p.21.

Singh, J. and Dhillon, S. S. (1984): *Agricultural Geography*, New Delhi, Tata McGraw Hill Publishing Company, pp. 175-206.

Statistical Handbook (1971, 1981, 1995, 1998, 2000, 2001): Directorate of Economics and Statistics, Govt. of Assam, Guwahati.

Tress, R. C. (1939): Unemployment and the Diversification of Industries, *The Manchester School*, Vol.9, pp.140-152.

Chapter – IV

Spatial Pattern of Agricultural Inputs and Transport Costs

4.0 Introduction:

In the earlier Chapter, we have thoroughly discussed the characteristic features of farming system and surplus production for accelerating the spatial processes of agricultural land uses. Preceding discussion reveals that peasant subsistence mode of farming begins to change with passage of time and the farmers of the district use diversified crops in the agricultural field. As a result, yield and output of some of the crops increase fast with the use of modern technological inputs in the district. As already assumed that the study area is almost homogeneous in respect of physical and edaphic factors, and, the application of technological inputs and variation of labour intensity bring changes in the structure of agricultural production. It is only the technological inputs and labour employment, which accelerate the mechanism in spatial pattern. Since centrally located market plays great role in diffusing the technological inputs and also attracts the rural labour force and the centre regulates the surplus production of agriculture in its region, the market prices of inputs (i.e. input costs for buyers/farmers), the labour wages and transport costs are important factors influencing the spatial patterns of agricultural production as stated by Thunen (1826), Hall (1966), Casetti (1972) and Singh (2002). The technological factors of production such as irrigation, H.Y.V. seeds, wedicides, pesticides are significant in the study area which are price-dependent and location specific. Like-wise, labour migrates from rural to urban and is controlled by labour wages

at market centre. Therefore, prices of the input commodities which farmers use and the labour wage which stimulates the labour to move are major economic factors. Such factors influence the entire functioning of the spatial structure of agriculture. In earlier Chapter, it is concluded that a small percentage share of farmers who have larger landholdings is engaged in producing marketable surplus and their economy is directly influenced by the market centre in two ways as: (a) they supply the most of their surplus farm products to the market and also buy technological inputs from the market centre and (b) the larger section of subsistence farmers buys only inputs for intensification of farm activities but does not have surplus at their farms to supplied to the market because they consume it locally. It is the case of the majority of farmers in the study area. Viewing it, it is fact that the spatial patters of agricultural production are more influenced by the use of technological factors rather than production surplus at farm.

An attempt is made here to deal with not only the importance of input factors of agricultural production, their spatial pattern but also the spatial pattern of transport costs which involve in altering the over all production costs in the spatial organisation of agricultural activities. The classification of sample HHs was made on the basis of considering the technological as well as labour cost attributes by distance factor to understand the spatial pattern of production intensification.

4.1 Adoption of Technological inputs at Farm Level:

Das (1984) defined technological inputs as the use of modern agricultural production factors such as fertilizes, H.Y.V. seeds, insecticides and pesticides, tractors, irrigation, pump sets, threshers and harvester combines and so on. A cross-sectional view

of adoption of technological inputs in the Jorhat area has been highlighted by classifying the total sample HHs (i.e. respondents) into the categories of their percentages in adoption of various inputs by their farm distances from the centrally located Jorhat market town.

It is interesting to note that the use of modern plough has been adopted by most of the farmers irrespective of distance and size of landholding. Nearly three-fourth share of the total HHs respondents responded towards the use of fertilizer. Likewise, the use of H.Y.V. seeds and pesticides come under third and fourth priorities in Jorhat Area. It is observed that the intensity of use of such inputs diminishes as distance from the market increases because of involvement of transport costs to transport such inputs from the market centre to the farm. It is obvious that the combination of these three i.e., HYV seed- fertilizer- pesticides, is the appropriate package for the farmers of this area (Table-4.1 and 4.2) as also highlighted by Das (1984).

Table-4.1: Adoption of Technological inputs at Farms (by Distance)

Inputs	Technology Used		Distance wise adoption of technological inputs per HH (Respondents in %)										
	Total	%	0-3 km	3-6 km	6-9 km	9-12 km	12-15 km	15-18 km	18-21 km	21-24 km	24-30 km	30-36 km	36> km
Irrigation	3.00	.34	0	0	0	0	0	0	0	3	0	0	0
H.Y.V.	204	68.0	80	65	100	98	77	15	30	55	62	65	70
Tractor	7	2.33	0	3	10	5	3	0	0	3	2	0	0
Power Tiller	102	34.0	40	48	60	38	53	75	30	53	36	23	10
Cart	89	29.6	0	53	30	13	7	0	55	95	0	10	30
Water pump	118	39.3	0	63	60	20	37	0	85	98	20	13	0
Fertilizer	213	71.0	90	48	100	95	93	90	60	5	75	88	80
Pesticides	145	48.3	60	23	90	83	87	87	5	0	44	68	30
Plough	290	96.3	100	93	100	100	100	85	100	95	78	100	100
Others	23	7.3	0	5	10	23	30	5	0	0	0	15	10
Total	**1192**												
Intensity	**3.97**												

Table-4.2: Adoption of Cultivation Implements for Tillage Operation

Implements	Household Number		Distance wise adoption of implements from the market (Adoption in %)(Distance in Kms)										
	Total	%	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-30	30-36	36>
Bullock plough	289	96.33	100	93	100	100	100	85	100	95	78	100	100
Power tiller	132	44.0	40	48	60	38	53	75	30	53	36	23	10
Tractor	7	2.33	0	3	10	5	3	0	0	3	2	0	0

4.2 Characteristics of Labour Employment:

Labour is one of the most important factors of production in traditional small scale agriculture. As has been noted, agriculture in India/Assam is a family affair and the proportion of hired labour in the total workforce is small. In agricultural workforce, every tenth worker is a hired hand. The help of permanent hired labour on an annual basis is also sought in large farm size where family labour is insufficient to cope with the farm work. The labour force engaged on the farm are generally categorised as (i) family labour, and (ii) hired labour. The same categorisation is adopted to analyse the spatial pattern of labour force.

Employment of family members in agriculture is one of the most important characteristics of peasant agriculture. Members of the family who form the labour force perform a major part of the field work. At small farms, the family labour acts as an input in agricultural operation. The marginal farmers also largely depend on family labour. Sometimes, casual hired labour is also employed during peak agricultural seasons for quick completion of certain farming operations, such as transplantation of paddy seedlings, weeding and harvesting.

4.2(i) Distribution of Family Labour and Hired Labour:

Going through the Table-4.3, it is found that the percentage share of family labour increases as distance from market increases at the farm gate. It is found the highest in the less accessible (30-36 kms) parts where 71.42 percent of the family labour perform works in the field and 28.58 percent of hired labour is engaged in the farm activities (Fig.-4.1). But the spatial pattern of the share of family labour is clear and shows that it (share of family labour employment) increases as from market centre Jorhat to outside. It was recorded 53.33 percent in highly accessible areas and 71.42 percent in the most remote areas. It is interesting to note that the pattern of labour intensity follows the inverse pattern. The labour intensity in agricultural intensity is counted very low (103 persons/sq km) in the highly accessible areas and the highest (245 persons/sq km) in the outer parts of the market region (30-36 kms distances). As a result, hired-family labour ratio diminishes by distance (Table-4.3). It indicates that agricultural activities are more labour dominant in the outer periphery of the market region.

4.2(ii) Seasonal Variation of Labour Employment:

There are mainly two crops seasons in a calendar year in Jorhat region. One is called *Kharif* crops (April to September: Summer) and the other is known as *Rabi* crops (Oct to March: Winter). There is seasonal variation in labour employment in agricultural farm employed by the head of the family. The number of days of the use of hired labour is found highest in winter season, i.e., 47.36 days in case of highly market accessible areas (0-6 km) and 42.18 days, 40.30 days in moderately market accessible areas (6-12 km) and Accessible distance (12-18 km) respectively. The number of days for hired

labour are reduced to 32 days in the outer peripheries of extremely less accessible part (Table-4.4). As regards to summer season, that the number of days for the hired labour is some what lesser (45.22 days/annually. The hired labour engaged in agricultural activities during summers is only 30.50 days in extremely less accessible areas (30-36 km). The seasonal variation is because of changes in the cropping pattern and availability of cheap labour in the remote areas. From November onwards the harvesting season of paddy begins and it still continues to December. Moreover from October to March, each of the family members cultivates different types of vegetable crops, not to mitigate the demand of the family but for selling purpose also. So, hired labour is engaged more during winter season. But in summer season, hired labour is only required during the field preparation time and transplantation of paddy. In this period (April to September), vegetable crops are grown with the help of family labour. So, the farmers do not require the hired labour for the farm operation.

Table-4.3: Labour Employed in Agricultural Operation

Market Accessibility	Labour Employment (persons/HH)		Total (persons/HH)	Hired Farming Labour Ratio	N.S.A. (ha)	Labour Intensity (person/ha)
	Family	Hired				
Highly Accessible (0-6 km)	1.04 (53.33)	.91 (46.67)	1.95 (100.0)	.875	1.89	1.03
Moderately Accessible (6-12 km)	.87 (55.42)	.70 (44.58)	1.57 (100.0)	.804	1.36	1.15
Accessible (12-18 km)	1.74 (55.59)	1.39 (44.41)	3.13 (100.0)	.798	1.66	1.88
Less Accessible (18-24 km)	1.00 (60.9)	.64 (39.02)	1.84 (100.0)	.640	.94	1.95
Very Less Accessible (24-30 km)	1.90 (66.21)	.97 (33.19)	2.87 (100.0)	.510	1.45	1.97
Extremely less Accessible (30- 36 km)	2.50 (71.42)	1.00 (28.58)	3.50 (100.0)	.400	1.44	2.43

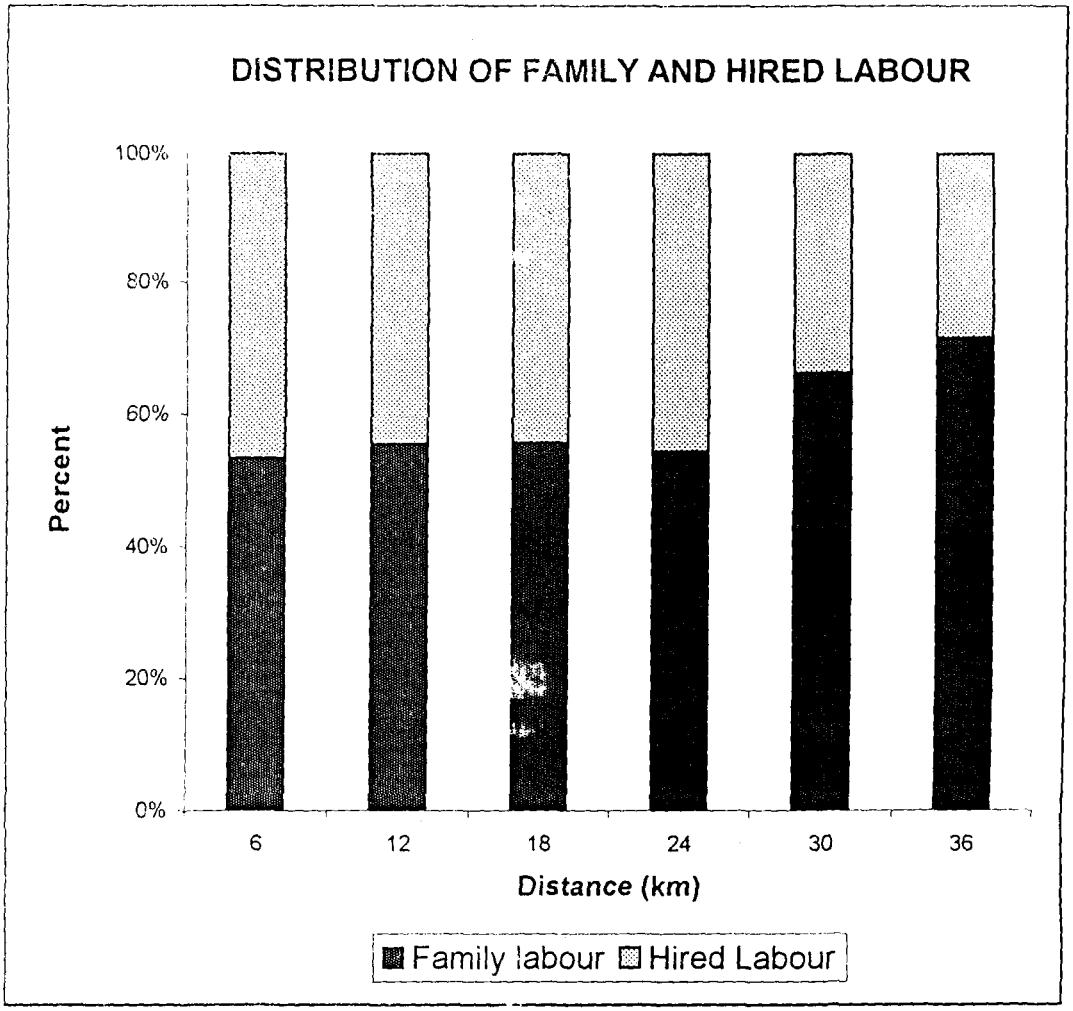

DISTRIBUTION OF FAMILY AND HIRED LABOUR
100%
80%
60%
40%
20%
0%
Percent
6
12
18
24
30
36
Distance (km)
Family labour
Hired Labour

Fig. 4.1

4.2 (iii) Seasonal Variation in Labour Wage Rate:

Seasonal variation in wage rate of the hired labour is also noticeable. The wage rate in the highly accessible areas (0-6 km distance) is counted Rs 80.45/day during the winter season; it is recorded Rs. 80.00/day in summer season at the same distance. In general, it is fact that the wage rates of the agriculture labour decreases as the distance from market increases. It is true for many reasons and one of them is the involvement of freight rates

Table-4.4: Number of Days and Wage Rates for the Hired Labour in Different Seasons

Market Accessibility	No. of days for Hired Labour		Wage Rate (Rs/day)	
	Summer	Winter	Summer	Winter
Highly Accessible	45.22	47.36	80.00	80.45
Moderately Accessible	40.07	42.18	76.56	78.20
Accessible	37.19	40.30	73.09	75.08
Less Accessible	35.16	38.70	72.04	68.08
Very Less Accessible	33.04	34.08	43.31	46.20
Extremely less Accessible	30.50	32.10	40.50	42.50

4.2 (iv) The Generalisation:

It is generally realised in the studies carried out by agricultural scientists that the higher concentration of population and dominance of paddy in crop-pattern are positively related as more labour is needed for paddy crop operations (Hagen 1975). So the hired workers also work at low wages in such conditions. But the larger share of family labour is employed in such operations. It is also true for the case of Jorhat district where paddy is dominating crop in the subsistence peasant economy. The distributional characteristics of labour employment in agricultural production processes are given below:

(i) As per the compiled data table of labour statistics by the market accessibility, it is clear that there are spatial variations in the employment of total labour in the farm activities from 157 persons per 100 HHs in moderately market accessible areas to 350 persons per 100 HHs in extremely less accessible (i.e., remote) areas, in which family labour shares generally 70 percent in such less accessible areas in the Jorhat region. It means that the proportionate share of hired labour in agricultural operations diminishes, though its volume increases and, hence, hired labour-family labour ratio also declines as elaborated earlier (Table-4.3).

(ii) Hired labour is employed in agricultural operations almost 50 days in summer as well as in winter seasons in the close areas from the market centre, while the employment of number of days diminishes to 30 in the remote areas in the district.

(iii) There is not much seasonal difference in wage rates of hired labour force in the district. However, wage-rate diminishes as distance from the market increases.

(iv) An average labour intensity of 173 workers per sq km of NSA was recorded for the agricultural operations in the district which increases from 103 workers/sq km in highly accessible areas to 243 workers engagement/sq km in most remote areas as distance from market increases.

4.3 Spatial Pattern of Input Costs:

On the basis of the main technology inputs which the farmers use at their farms, the concentration of respondent was calculated by dividing the number of respondents responded for the use of specific input category to their total number of input used. Further, it is realised that the farmers use many inputs simultaneously. So the 'multiplicity ratio' for the input use (MR) was also calculated dividing the percentage share of respondent used specific input by the percentage concentration of the respondents. It is formulated as

MR = [(% respondents used specific inputs to net total respondents) / (% respondents used specific input to Gross total respondents concentration)]

Secondly, the spatial pattern of the adoption of technology were shown by calculating percentage of respondent of each technology input to the total respondents accounted for in the specific category of the market accessibility in the form of distance from Jorhat. The salient features of the adoption of technology input in the study area are given below:

4.3 (i) Multiplicity of Input use:

Going through the Table-4.5, it is found that the farmers of the study area adopt different kinds of technological inputs such as fertilizer, pesticides, H.Y.V. seeds, power tiller, water pump etc in their farm operations to increase production of crops. Though the total net number of respondents are 300 in number, the total gross respondents are counted 1169, as because the same of them use varieties of inputs with their different combinations. The intensity of input use (in unitary term) is recorded 3.90,

means that each farmer has been using four different inputs together for raising production at farm level. The combination of four inputs may vary at different farm, however, the concentration of respondent shows that bullock plough, H.Y.V. seeds, fertilizer and pesticides are main technological inputs used frequently by most of the farmers of the area.

Table-4.5: Adoption of Technological Inputs and its Multiplicity

		Household Concentration		
Inputs used	Total Respondents	% of respondents concentration	% respondents to Net total respondents	Multiplicity Ratio
Irrigation	1	0.08	0.33	4.125
Water pump	118	10.09	39.33	3.102
H.Y.V. seeds	204	17.45	68.00	3.896
Bullock plough	102	8.72	34.00	3.899
Power tiller	89	7.61	29.66	3.897
Bullock cart	7	0.60	2.33	3.883
Tractor	213	18.22	71.00	3.896
Fertilizer	213	18.22	71.00	3.896
Pesticides	145	12.40	48.30	3.895
Total	1169	100.00	–	–
Intensity of Input users	3.90	–	–	–

N.B.: Multiplicity Ratio = (% Respondents to Net Total Respondents)/(% Respondents to Gross Total Respondent Concentration)

So far as 'multiplicity ratio' of technological input is concerned it is clear that 'multiplicity ratio' is almost similar for all technological inputs. However, the use of irrigation which is not adopted by the farmers in the area, because of humid climatic condition, though 'multiplicity ratio' is recorded the highest (4.125) for the adoption of irrigation also. It is pertinent to note that a few farmers of the area use irrigation especially in the winter to raise the productivity and production at farms and they use irrigation frequently. The other inputs like modern bullock plough, H.Y.V. seeds,

fertilizer and pesticides have an average multiplicity of 3.89. It shows that the farmers use four inputs simultaneously in the year.

4.3 (ii) Spatial Pattern of Adoption of inputs:

Use of technological input varies by distance from the market. The use of inputs by distance is analysed by preparing the tables into two ways. First, the percentage share of respondents were calculated for each accessibility class for different input uses to show the importance of input use in different accessibility classes. Secondly, the classification of respondents were made by categorizing them by accessibility class for each input. The percentages are calculated to show the concentration of respondents for the use of specific inputs by distance from the market. Such basis of classification would provide two important aspects of adoption of technology in the market region: first, what kind of technological inputs used by the farmers at different distance. Secondly, the concentration of the respondents adopting these inputs in different market accessibility zones.

As per earlier discussion, regarding the multiplicity ratio in Jorhat, it is obvious that multiplicity ratio moves around 4.0 for almost all the technological inputs considered in the present study. In fact, it is true that bullock- plough, use of fertilizer, H.Y.V. seeds and pesticides are the main inputs which are being adopted in the market region, but their intensity of adoption varies by distance from the market. For example, the farmers have intensive use of bullock- plough, use of fertilizer and H.Y.V. seeds in the close vicinity of Jorhat city (0-3 km). Contrary to it, the highest intensity of input adoption of bullock plough, fertilizer and H.Y.V. seeds are also found in the outer areas

of the district (24-30 km) and after that intensity of input adoption for almost all inputs fall down excluding bullock plough which is used by the almost all farmers in this zone (Table 4.6).

So far as, concentration of adoption of the respondents of adoption of individual input is concerned, it is clear that bullock plough is the cheapest and most adoptable technology which is being used uniformly throughout the region. However, the spatial gradients of other inputs like H.Y.Vs, Fertilizer use and pesticides adoption fall down faster as distance increases from the Jorhat city. For instance, the farmers have high concentration (10 to 20 percent) high concentration of adoptions for the use of the fertilizer in the close vicinity of Jorhat town while the degree of concentration is recorded very low are recorded (0.68%) in the most outer part of the city region. Likewise, the percentage share of H.Y.V. adopters decreases from 13% in 6-12 km to 2.05% in 36 km and above.

It may be concluded that the rate of adoption of H.Y.V. seeds and fertilizer decreases as distance increases from the city because of involvement of the transport costs, while the prices of fertilizers and H.Y.V. seeds are constant at market centre. The cost structure of such technological inputs would be discussed separately in the proceeding parts.

Table 4.6: Adoption of Inputs by Distance from the Market

Distance in Km	No. of House hold	Total Number of respondents per 100 respondents								
		Irrigation	H.Y.V.	Tractor	Power Tiller	Cart	Water pump	Bullock plough	Fertilizer	Pesticides
Highly accessible (0-6)	10	–	80 (10.92)	–	40 (11.02)	–	–	100 (9.56)	90 (10.83)	60 (10.13)
	40	–	68 (8.29)	3 16.66)	23 (6.34)	53 (14.92)	62 (14.32)	92 (8.79)	47 (5.65)	22 (3.72)
Moderately accessible (6-12)	10	–	100 (13.66)	–	70 (19.28)	40 (11.26)	70 (16.16)	100 (9.56)	100 (12.03)	90 (15.20)
	40	–	100 (13.66)	13 (72.22)	23 (5.31)	13 (3.66)	23 (5.31)	100 (9.56)	95 (11.43)	82 (13.85)
Accessible (12-18)	30	–	80 (10.42)	-	37 (8.54)	7 (1.97)	37 (8.54)	100 (9.56)	93 (11.19)	87 (14.69)
	20	–	70 (9.50)	-	10 (2.30)	5 (1.41)	10 (2.30)	75 (7.17)	88 (10.58)	71 (11.99)
Less Accessible (18-24)	10	–	60 (8.11)	-	100 (23.09)	100 (28.16)	100 (23.09)	100 (9.56)	92 (11.07)	60 (10.13)
	40	3 (100.00)	55 (7.51)	-	98 (22.63)	95 (26.76)	98 (22.63)	93 (8.89)	88 (9.62)	40 (6.75)
Very less accessible (24-30)	50	–	66 (9.02)	2 (11.11)	20 (4.62)	2 (.56)	20 (4.62)	86 (8.22)	78 (9.38)	35 (5.91)
	40	–	38 (5.19)	–	13 (3.00)	10 (2.82)	13 (3.00)	100 (9.56)	55 (6.61)	30 (5.06)
Extremely Less accessible (30-36)	10	–	15 (2.05)	–	–	30 (8.45)	–	100 (9.56)	5 (.60)	15 (2.52)
		3 (.06)	732 (16.58)	18 (.41)	433 (9.81)	355 (8.04)	433 (9.81)	1046 (23.69)	831 (18.82)	592 (13.41)

Figures in parentheses show percentages

4.4 Spatial Pattern of Operational Costs:

As per the statistics collected by conducting primary survey for the input cost structure of the farmers and its classification according to the market accessibility classes, the following aspects of technological inputs are analysed.

(i) Intensity of the use of agricultural inputs and

(ii) The pattern of input costs by distance from the Jorhat market centre.

In fact, the use of technological inputs is largely dependent on many factors. A farmer decides to use the quantity and frequent of the use of a particular input considering many socio-economic factor for operation and intensification of such inputs. The family consumption, demand of the product at market centre and income elasticity to input prices are major factors to decide their uses. Such factors vary the intensity and variety of the use of inputs in the region. Input cost is the interactive function of two major attributes, namely the quantity demanded and market price of the input (O'Kelly 1996). If market price is assumed constant the spatial variability in the intensity and total input costs occurs due to the variation in the quantity used by the farmers. In view of these factors, the intensity of total input cost (Rs/ha), costs per hectare for different inputs as well as their patterns by market accessibility analysed in the following manner.

4.4 (i) Spatial Variation in Total Input Costs Intensity:

The total costs per areal unit of NSA involved in the production processes per HH diminishes from Rs. 1600/- per hectare annually in highly accessible areas to Rs. 516/ha in the remote areas (Table- 4.7). This variation in input costs is influenced by two factors:

one is the involvement of transport costs and the another one is the farmers income and its share which is invested as input for agricultural activities. Borah (1983) indicated that in Jorhat district of Assam the farming activities are much depends on the capability of the Village Level Extension Workers (VLEW) to keep the interest of the contact farmers to adopt new technology. The degree of transfer of technology beyond the contact farmers in the less accessible areas becomes very low. This brings the variations in inputs costs by distant factor.

Table-4.7: Inputs Costs (Rs/HH) and Intensity (Rs/ha)

Market Accessibility	Fertilizer	HYV	Water pump	Power tiller	Pesticides	Others	Total (Rs/HH)	NSA	Total Cost (Rs /ha)
Highly Accessible (0-6 km)	867.00 (28.70)	696.87 (23.07)	382.50 (12.66)	275.62 (9.12)	101.87 (3.37)	696.11 (23.05)	3019.97 (100.0)	1.89	1597.86
Moderately Accessible (6-12 km)	735.02 (27.04)	500.00 (18.39)	362.00 (13.31)	445.27 (16.37)	100.45 (3.69)	575.92 (21.18)	2718.66 (100.0)	1.36	1999.01
Accessible (12-18 km)	696.41 (25.69)	476.00 (17.56)	189.83 (7.00	902.91 (33.30)	129.76 (4.78)	315.72 (11.64)	2710.63 (100.0)	1.66	1632.90
Less Accessible (18-24 km)	480.00 (31.87)	405.00 (26.89)	170.55 (11.32)	47.50 (3.15)	107.20 (7.11)	295.57 (19.62)	1505.82 (100.0)	.94	1601.93
Very Less Accessible (24-30 km)	350.00 (24.56)	390.00 (27.37)	136.00 (9.54)	197.5 (13.86)	110.37 (7.74)	241.00 (16.91)	1424.87 (100.0)	1.45	982.66
Extremely less Accessible (30-36 km)	200.00 (26.90)	250.00 (33.63)	102.00 (13.72)	110.35 (14.84)	11.00 (1.47)	70.00 (9.42)	743.35 (100.0)	1.44	516.21

N.B.: Figures in parentheses show percentage shares.

4.4(ii) Variations in Total Cost and its Intensity of Different Inputs:

There is a significant variation in the cost structure in the study area. It is already described that fertilizer, H.Y.V. seeds inputs are adopted significantly at higher level. Similarly, the cost variation of various inputs shows that, in general, the significant share

of total costs of inputs was spent only on two inputs, namely, the fertilizer and H.Y.V. seeds, in almost all the accessibility categories. For instance, the farmers whose farms are located in the very close vicinity of the market (0-6 km) spent more than 50 percent share of their total input costs on fertilizer and H.Y.V. seeds annually. The farmers who have their farms in the moderately accessible areas (12-18 km) far from the city spent nearly 1/3 share of their input costs in power tiller and ¼ share of it on the use of fertilizer. In more details, the following are the salient features on spatial patterns of input costs in the area (Table-4.8).

a) Input cost per HH as well as the cost intensity per ha of each and every input considered for the present study decrease as distance increases from the market centre. More details regarding the spatial gradients of input costs would be interpreted separately.

b) The importance of use of fertilizers and H.Y.V. seeds is marked because of the farmers of all accessible classes spent more than 50% share of their total input costs on only these two inputs. (iii) Total costs per HH of inputs also decrease from Rs. 3020 per household to Rs. 743 per HH as distance increases from the Jorhat market centre.

Table-4.8: Use of Inputs per HH and their Cost

Market Accessibility		Fertilizer	HYV seeds	Water pump	Power tiller	Pesticides	Others	Total	NSA (in ha)	Cost Intensity (Rs/ha)
Highly accessible (0-6)	Total cost (Rs)	867	696.87	382.50	275.62	101.87	696.11	3019.97 (100.00)	1.89	1597.86
	%	28.70	23.07	12.65	9.12	3.37	23.05			
	Cost per ha	458.73	368.71	202.38	145.83	53.89	368.31			
Moderately accessible (6-12)	Total cost (Rs)	735.02	500.00	362.00	445.27	100.45	575.92	2718.66 (100.00)	1.36	1999.01
	%	27.04	18.39	13.31	16.37	3.69	21.18			
	Cost per ha	540.45	367.64	266.17	327.40	73.86	423.47			
Accessible (12-18)	Total cost (Rs)	696.41	476.00	189.83	902.91	129.76	315.72	2710.63 (100.00)	1.66	1632.90
	%	25.69	17.56	7.00	33.30	4.78	11.64			
	Cost per ha	419.52	286.74	114.35	543.92	78.19	190.19			
Less Accessible (18-24)	Total cost (Rs)	480	405.00	170.55	47.50	107.20	295.57	1505.82 (100.00)	0.94	1601.93
	%	31.87	26.89	11.32	3.15	7.12	19.62			
	Cost per ha	510.63	430.85	181.44	50.53	114.04	314.44			
Very less accessible (24-30)	Total cost (Rs)	350.00	390.00	136.00	197.50	110.04	241.00	1424.87 (100.00)	1.45	982.66
	%	24.56	27.37	9.54	13.86	7.14	16.91			
	Cost per ha	241.38	268.96	93.79	136.21	76.12	166.21			
Extremely Less accessible (30-36)	Total cost (Rs)	200.00	250.03	102.00	110.35	11.00	70.00	743.35 (100.00)	1.44	516.21
	%	26.40	33.63	13.72	14.84	1.47	9.42			
	Cost per ha	138.88	173.63	78.83	76.63	7.63	48.61			

N.B.: The category 'others' includes the costs relating to bullock plough, cart, irrigation and machines used by the House holds.

4.4 (iii) Spatial Gradient of Input Cost Intensity:

Spatial gradients for cost intensity of each input were calculated following the linear concept of change in the cost structure of inputs used. Therefore, the rate of change in the input costs per unit of distance is formulated as the difference the maximum and minimum values of cost intensity per unit of distance as

It is found that there is a decrease in the cost intensity as described in the preceding paragraph. However, spatial gradient vary for different input costs. Table-4.9 reveals that there is a fast decrease at a rate of Rs. 26 per ha/km for the use of power tiller, while the farmers spent very less share of costs on such inputs. It means that power tiller is intensively used only in the close vicinity of the market centre. The value of the spatial gradient for the use of fertilizer is recorded Rs. 17.45 per ha/km which also falls at a faster rate with a decrease of cost intensity of Rs. 540/ha in the close vicinity to Rs.139/ha in the peripheral areas.

It is interesting to note though H.Y.V. is a significant input used by the farmers by spending more than ¼ share of their total costs. However, the value of cost gradient is recorded the lowest as Rs.6.50/ha/km. It means that the farmers of the whole region are using this technology throughout. As a result, the variation in the input costs for the use of H.Y.V. seeds is recorded less (Table 4.9: Fig.-4.2).

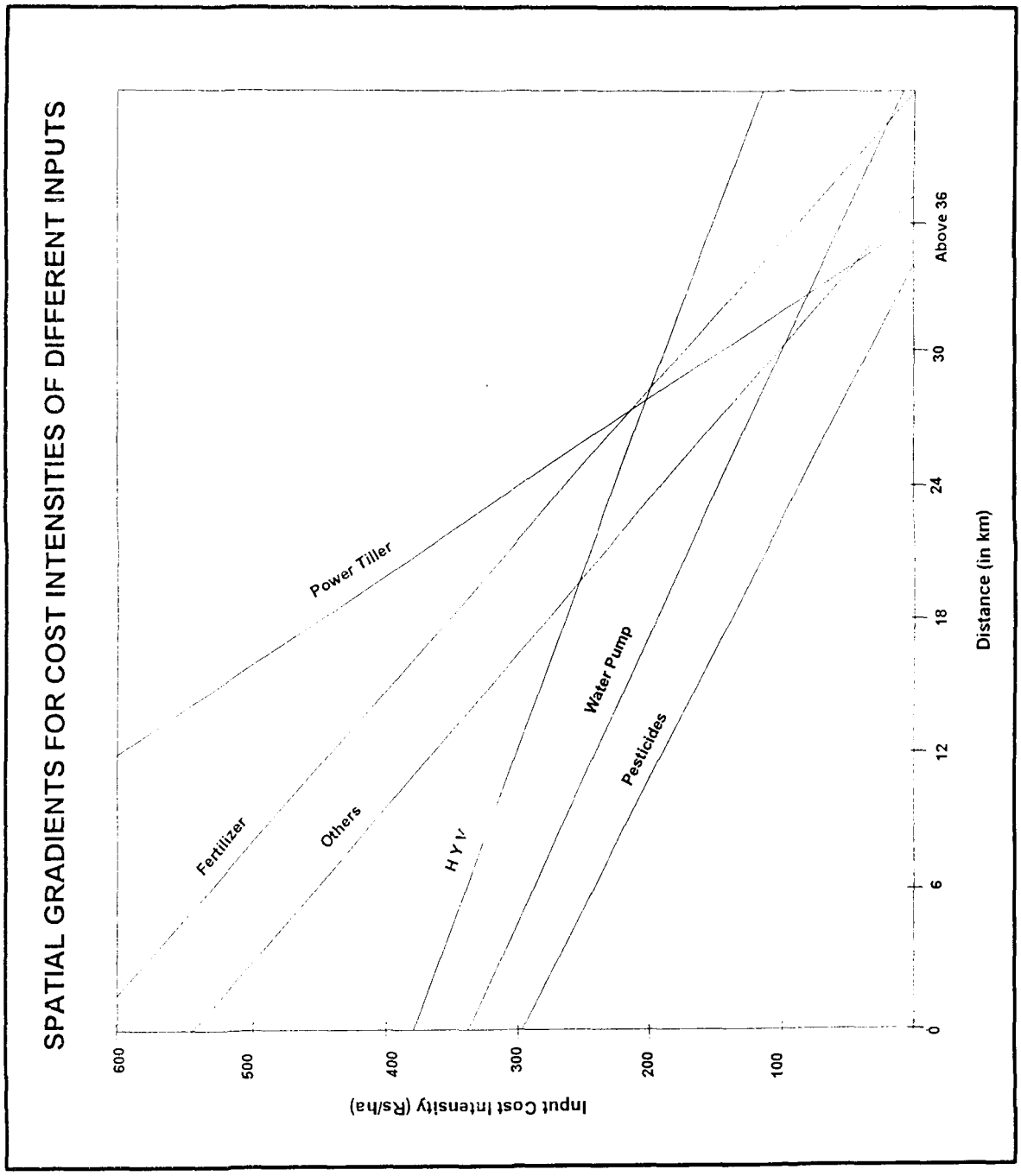

SPATIAL GRADIENTS FOR COST INTENSITIES OF DIFFERENT INPUTS
Input Cost Intensity (Rs/ha)
600
500
400
300
200
100
0
6
12
18
24
30
Above 36
Distance (in km)
Power Tiller
Fertilizer
Others
H Y V
Water Pump
Pesticides

Fig. 4.2

Table 4.9: Spatial Gradients of Cost Intensity

Name of Inputs	Costs Intensity and its location from market centre				Spatial gradient of costs (Rs/ha/km) intensity
	Maximum costs (Rs/ha)	Distance (Km)	Minimum costs (Rs/ha)	Distance (Km)	
Fertilizer	540.45	9	1388.88	33	-17.45
H.Y.V. seeds	368.71	3	173.63	33	-6.50
Water pump	266.17	9	78.83	33	-8.14
Power tiller	543.92	15	76.63	33	-25.96
Pesticides	114.04	21	7.63	33	-8.86
Others	423.47	9	48.61	33	-16.29

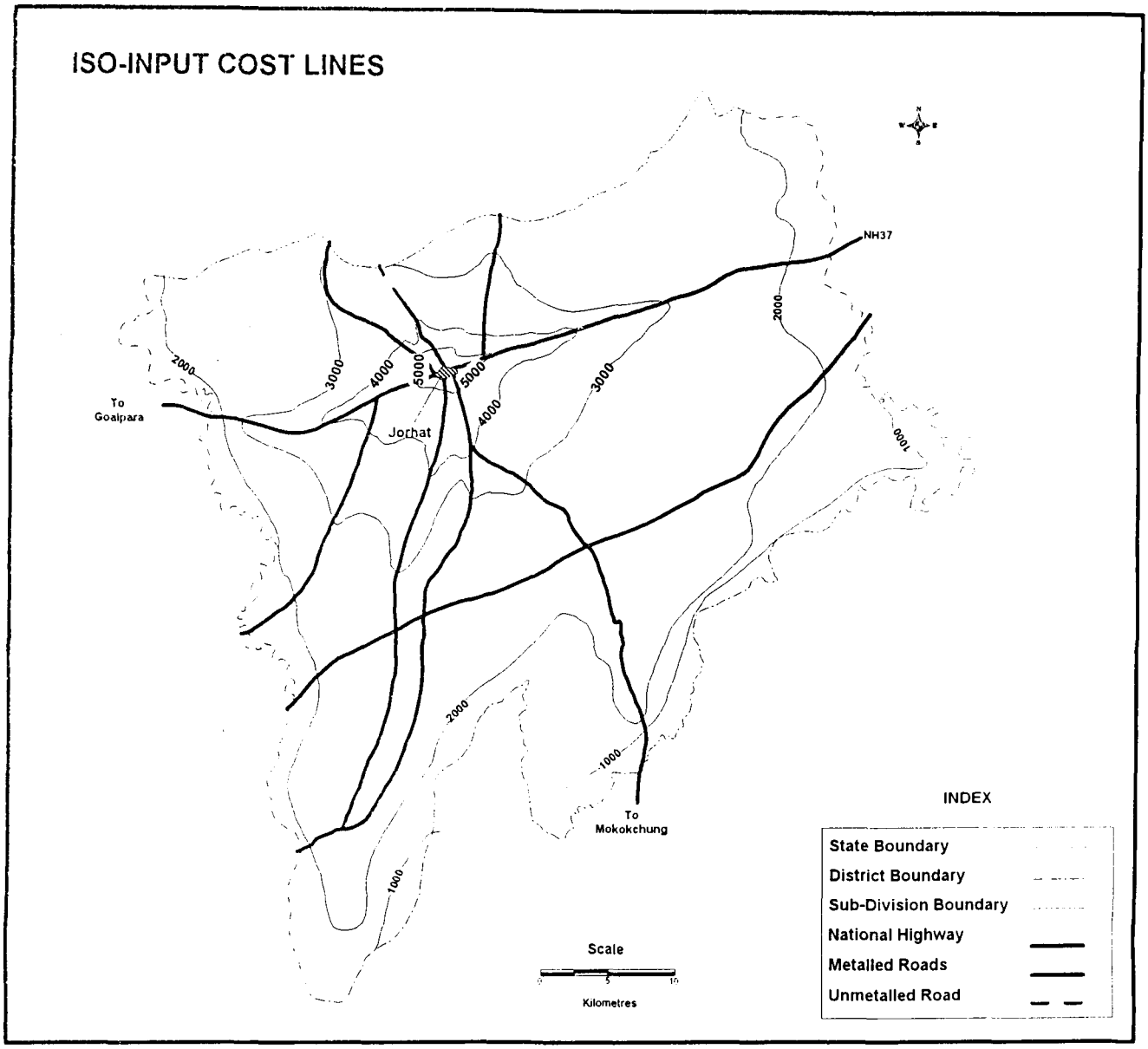
N.B.: Spatial Gradient are calculated taking differences between maximum and minimum value of cost intensity and dividing them by the difference of the distance between the same spatial categories, formulated as G=(maximum-minimum costs intensity/Δ d, where G is spatial cost intensity gradient and d = distance from market

4.4 (iv) Spatial Margins of Total Input Cost:

Spatial margins indicates the effects of distance of the location of a farm where farmer invests for intensification of farm activities. The spatial margins of total input costs show that National Highway and other state roads changes the pattern of these spatial margins. The outer margin of input costs of Rs. 1000 passes through the foothill boundary of the Northern part (Fig.-4.3).

4.5 (i) Road Accessibility and Rural Socio-economic Structure:

Road is a prime attribute not only for agricultural development but also for non-agricultural sectors of economy of an area. Road network and its pattern are major aspects of road accessibility. It is widely recognised that road network helps in transformation of rural economy specially in developing countries where non-agricultural sectors of economy appear to be weak (Francisco & Routray, 1992). The spatial pattern of road accessibility were shown classifying the villages of the district by the distance from the road. The villages are categorised into five categories, namely: Very highly accessible (0-1 km), Highly accessible (1-2 km), Moderately accessible (2-3 km), Less accessible (3-4 km), Least accessible (4 +) (Fig.-4.4).



NB: (i) The Iso Cost values are in Rs/ha/year
(ii) Iso Cost Interval in Rs 1000/ha/yr

Fig. 4.3

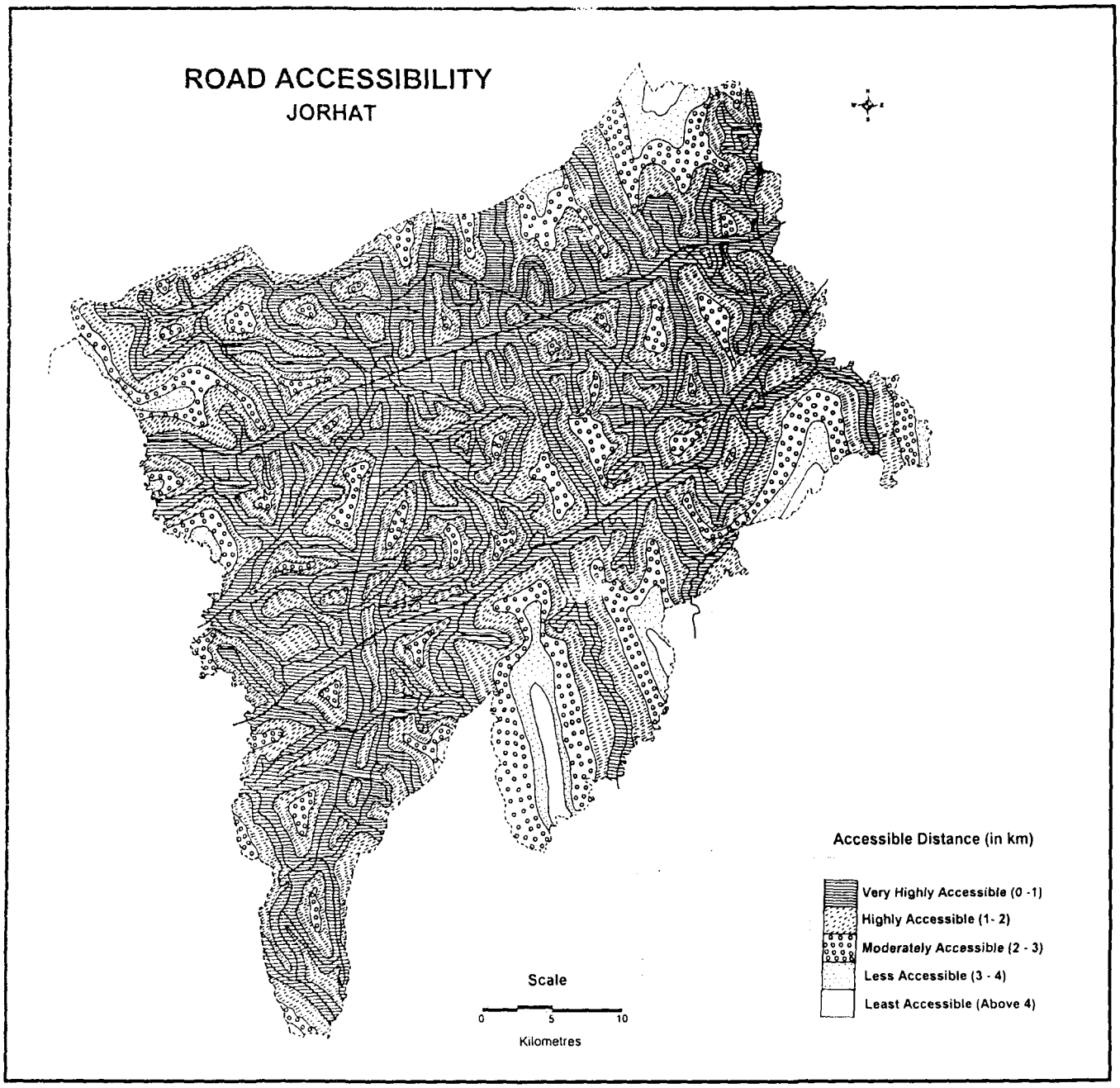

ROAD ACCESSIBILITY
JORHAT
Accessible Distance (in km)
Very Highly Accessible (0 -1)
Highly Accessible (1- 2)
Moderately Accessible (2 - 3)
Less Accessible (3 - 4)
Least Accessible (Above 4)
Scale
0
5
10
Kilometres

Fig. 4.4

Using Primary Census Abstract, 2004 statistics of demographic and occupational attributes for every village of Jorhat district, and classifying the villages into above given categories, the impact of road network on rural economy has been interpreted as given below:

(i) There is a high concentration of rural population along the roadside in the very highly and highly road accessible categories. It is interesting to note that about 82.0% of the total number of villages and nearly 48.8% share of total population are concentrated only in the highly accessible areas (0-2 km) in the district. It means that rural road connectivity is significantly high and most of the villages are connected with *pucca* road whether it is district level or National Highway. It is to be noted that the N.H. No. 37 passes through the study area which has direct impact on rural economy of this district.

(ii) The literacy-rate diminishes gradually as the distance from road increases. It falls about 6.0% per km increasing distance from nearby roads.

Table-4.10: Demographic Structure of Rural Population by Road Accessibility (2001)

Accessible Classes	No. of villages		Population		Literates	Total workers	Sex Ratio in working class	Main workers	Dependency ratio
	Total	%	Total	%		%		%	
V. Highly accessible (0-1km)	269	45.36	1264.87	26.12	70.57	38.11	464.74	69.88	1.83
Highly accessible (1-2km)	217	36.59	1103.78	22.79	63.50	42.33	545.07	69.48	1.67
Moderately accessible (2-3km)	71	11.97	953.82	19.69	57.09	45.97	576.72	59.40	1.37
Less accessible (3-4km)	20	3.37	949.15	19.60	47.07	49.42	704.89	54.22	1.15
Least accessible (4+)	16	2.69	570.69	11.78	59.71	53.23	641.49	65.30	1.15
Total	593	100	4842.31	100.00					

(iii) Dependency ratio falls down faster from 1.83 in very highly accessible zone to 1.37 in moderately accessible zone and then stabilizes in the least accessible zone. It means that the share of non-working population (0-18 years and 60 year +) is higher than workers in the highly accessible areas. Workers move towards nearby market centres where fairly high wage rates and more livelihood facilities are available. Sex ratio in the working class is recorded low in the district because the rural women works, by definition, were not counted in working category.

(iv) There is clear-cut depiction of the figures of differences in occupational structure by road accessibility classes. Percentage share of cultivators becomes more than double from 30.8 to 69.3 while agricultural labourers engaged constantly about as distance of village locations increase from the nearby road. Contrary to it, the percentage share of workers engaged in non farm agricultural activities (HH industries, Trade and Transport and other services) has been marked decreases (Table-4.10). The economy of least accessible areas of road network are solely dependent on agriculture, while the emergence of non-agricultural activities may be visualized in highly accessible areas. Thus, road transport helps in transforming the stagnant economy into progressive one.

Table-4.11: Occupational Structure of Rural Population by Road Accessibility (2001)

Accessibility Classes (in km)	Cultivators %	Agricultural Labourers %	Household % Intensity	Trade & Transport %	Others %
Very Highly Accessible (0-1)	30.80	3.53	2.75	31.18	62.92
Highly Accessible (1-2)	33.44	4.00	2.11	31.04	60.44
Moderately Accessible (2-3)	43.23	5.78	1.88	18.96	49.10
Less Accessible (3-4)	67.84	5.44	1.30	15.13	25.43
Inaccessible (4+)	69.33	0.07	1.14	3.69	29.47

4.5 (ii) Spatial Pattern of Transport Costs:

There is an involvement of a variety of means of transport in the transportation of the agricultural products, mobility of labour force and supply of technological input factors from market to the farm location. Calculating annual cost of each mode which is used by the farmer, it is very clear from the compiled table that

(a) The total transport costs per HH as well as per unit of land increase from Rs.1838/HH to Rs. 4143 HH and from Rs. 972/ha to Rs. 2877/ha respectively as distance increases from Jorhat market centre (Table-4.12). It means that the distance is directly involved in increasing transport costs.

(b) There are three main modes of transport, namely, the Bus, Mini-truck and Full truck, which shares more than 50 percent in transporting and/or mobilizing the rural labour in the market region.

(c) The percentage share of transport costs on Bus and Full truck increases as distance increases from Jorhat town. Obviously, the bus is the main means of transport for people's mobility and full truck is useful in transporting the marketable surplus from the farm to Jorhat town.

4.5 (iii) Spatial Margins of Transport Costs:

In fact, total transport costs is negatively related to distance from the market centre. However, the road network influences its spatial margins. The ~~maximum~~ Minimum iso-cost line (Rs. 4000) passes in the surroundings of Jorhat town. The iso-cost line of the ~~minimum~~ Maximum value (i.e., Rs.4000) passes in the outer peripheries where foothills of the north and flood plains of the southern part of the district are more influential factors of the spatial margins of transport costs (Fig.-4.5).

Table-4.12: Transport Costs of Different Means of Transportation by Market Accessibility Classes

Market Accessibility	Rikshaw	Scooter	Autobus	Vikram	Zeep	Taxi	Bus	Thela	Cylce	Bullock Cart	Mini Truck	Truck	Others	Total	NSA (ha)	Transport Cost /ha
Highly Accessible (0-6 km)	28.75 (1.56)	87.50 (4.76)	67.50 (3.67)	90.00 (4.89)	60.00 (3.26)	120.00 (6.52)	535.50 (29.13)	75.25 (4.09)	128.44 (6.98)	35.00 (1.90)	275.35 (14.97)	150.00 (8.16)	184.94 (10.06)	1838.23 (100.00)	1.89	972.60
Moderately Accessible (6-12 km)	17.00 (.87)	137.13 (7.09)	45.75 (2.36)	28.17 (1.45)	72.00 (3.72)	68.75 (3.55)	600.75 (31.08)	65.60 (3.39)	145.10 (7.50)	95.00 (4.91)	290.22 (15.01)	175.00 (9.05)	192.00 (9.93)	1932.47 (100.0)	1.36	1420.93
Accessible (12-18 km)	0	188.33 (7.05)	103.75 (3.88)	330.00 (12.35)	75.00 (2.80)	96.66 (3.62)	745.25 (27.89)	50.00 (1.87)	135.75 (5.08)	100.20 (3.75)	393.87 (14.74)	200.00 (7.48)	178.00 (6.66)	2671.06 (100.0)	1.66	1609.07
Less Accessible (18-24 km)	0	95.00 (3.38)	102.50 (3.65)	191.00 (6.81)	130.75 (4.66)	75.00 (2.67)	1010.00 (36.02)	45.00 (1.60)	128.52 (4.58)	75.25 (2.68)	455.71 (16.25)	300.00 (10.70)	195.00 (6.95)	2803.73 (100.0)	.94	2982.69
Very Less Accessible (24-30 km)	0	89.75 (2.42)	42.00 (1.13)	40.00 (1.08)	180.50 (4.87)	110.00 (2.97)	1950.00 (52.65)	-	98.25 (2.63)		572.10 (15.44)	420.00 (11.34)	200.00 (5.40)	3702.6 (100.0)	1.45	2553.35
Extremely less Accessible (30-36 km)	0	55.00 (1.32)	0		267.25 (6.45)	54.00 (1.30)	2200.00 (53.09)	-	94.00 (2.26)		695.90 (16.79)	502.00 (12.11)	275.00 (6.630	4143.15 (100.0)	1.44	2877.18

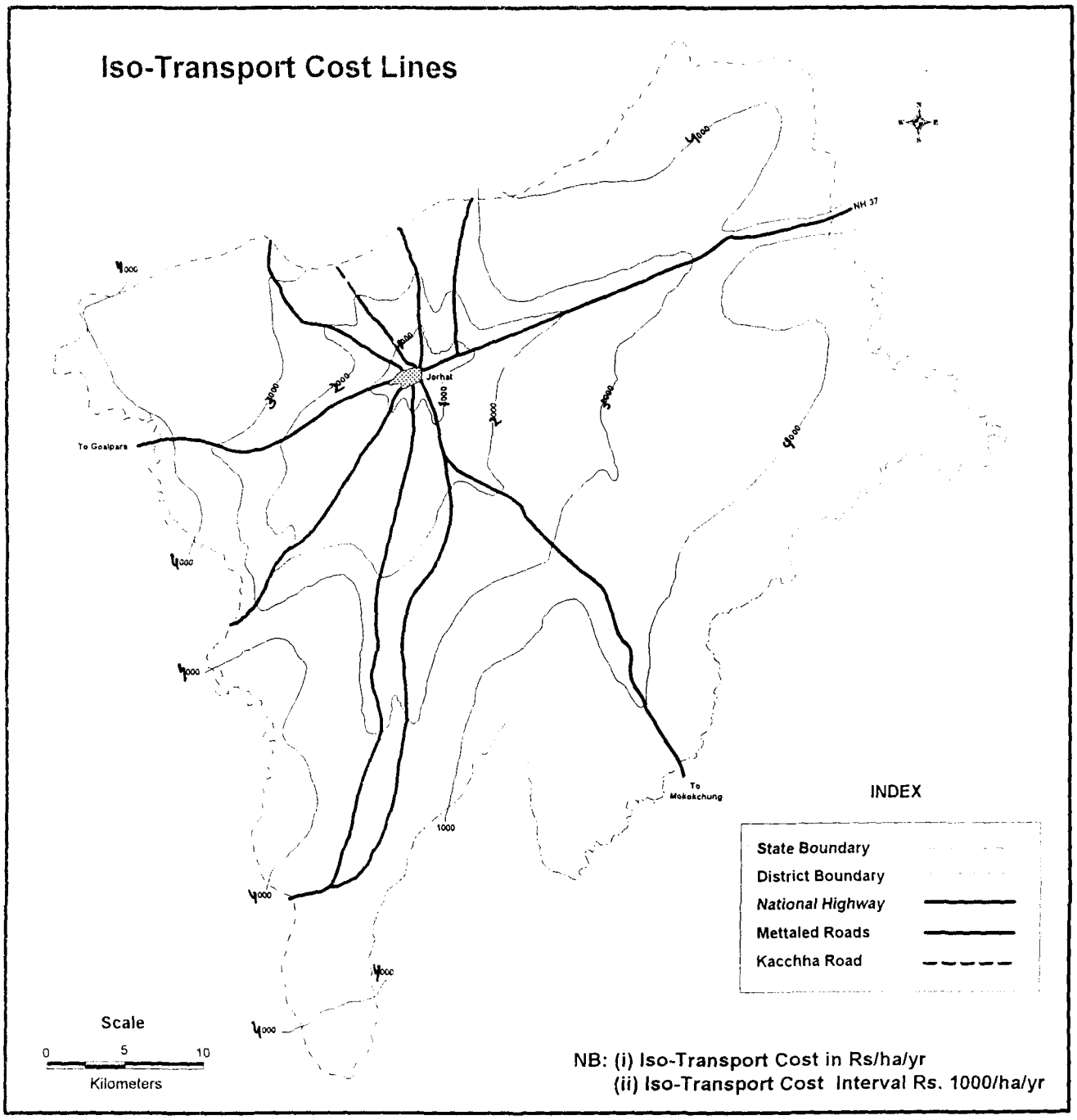

Iso-Transport Cost Lines
NH 37
Jorhat
To Golaghat
To Mokokchung
INDEX
State Boundary
District Boundary
National Highway
Mettaled Roads
Kacchha Road
Scale
0 5 10
Kilometers
NB: (i) Iso-Transport Cost in Rs/ha/yr
(ii) Iso-Transport Cost Interval Rs. 1000/ha/yr

Fig. 4.5

It may be concluded that the spatial gradients of different attributes of agricultural inputs and transport costs are sharply decreasing in their spatial patterns. It shows primacy in the spatial distribution. Road network is a main factor which directly influence the spatial gradients of this phenomena of agriculture activities.

References:

Blaikie, P.M. (1971): Spatial Organisation of Agriculture in Some North Indian Villages, The Institute of British Geographer, *Transaction*, Vol.52 pp.1-40.

Borah, D. (1983): *Role of Contact Farmers on Transfer of Technology to follower Farmers under T & V System*: AERC for N.E. India, Assam Agricultural University, Jorhat.

Casetti, E. (1972): Spatial Equilibrium Distribution of Agricultural Production and Land Values, *Economic Geography*, Vol. 48, pp. 193-98.

Das, M.M. (1984): *Peasant Agriculture in Assam*, Inter India Publications, New Delhi.

Francisco, S.A.J. and J.K. Routray (1992): *Road Transport and Rural Development – A Case Study of the Philippines*, HSD Research Report-28, AIT, Bangkok, pp. 33-52

Grigg David (1982): *The Dynamics of Agricultural Change, The Historical Experience*,

O' Kelly, Morton. E. and Bryan, D. (1996): *Progress in Human Geography*, Vol.20 (4), pp. 457-475.

Hagen, E. E. (1975): *The Economics of Development*, Richard D. Irwin, Inc., London.

Hall, P. (ed) (1966): Von Thunen's Isolated State: An English Edition of Des Isolierte Staat, Pergamon Press, London.

Phukan, V. (1990): *Agricultural Development in Assam*, Mittal Publications, New Delhi.

Sidhu, H. S. (1991): *Agricultural Development and Rural Labour, A Case Study of Punjab and Haryana*, Concept Publishing Company, New Delhi.

Singh, S. (1994): *Agricultural Development in India – A Regional Analysis*, Kaushal Publications, Shillong.

Thoman Richard & Corbin Peter B. (1962): *The Geography of Economic Activity*

Vickerman, R. W. (1979): *The Micro-Economic Foundations of Urban & Transport Economics*, Vol. I, pp. 30-59.

Visser, S. (1980): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol.56 (4), pp. 311-319.

Chapter – V

Spatial Pattern of Agricultural Production

5.0 Introduction:

Spatial patterns of land use are generally altered by the use of technological factors which vary spatially. Consequently, the agriculture intensity also varies from the market centre (Dunn 1954, Garrison and Marble 1957, Katzman 1974). In the previous Chapter, the spatial patterns of input as well as transport costs invested in agricultural practices have been analysed. Another dimension of the discussion is to be more related to a detail interpretation of the spatial aspects of agricultural production and productivity, that are implicit attribute of agricultural production system. In this connection, the spatial patterns of general land use, crop area, crop yields, marketable surplus and, finally, the agricultural productivity (land as well as labour) are major attributes to understand the spatial processes of agricultural intensification in the growing agricultural economy as prevalent in the Jorhat region. Thus, the present Chapter is devoted to such aspects of the discussion.

5.1 Spatial Pattern of Land Use and Crop Pattern:

It has been described in the earlier discussion in Chapter-III that the land uses in the district are based on the process of expansion and intensification and cropping pattern are diversified with the dominance of paddy crops. The spatial pattern of such attributes may provide a sound base and may give the clues to understand the causes of agricultural intensification in its spatial manner in the study area. The discussions on such aspects proceed as follows.

5.1(a) Land Use Pattern and Crop Intensity:

Present study highlights the interesting results of general land use pattern and crop intensity as given below:

1. It is a fact, in the entire district, the N.S.A. occupies the highest share of land of the total land occupied by the farmers. This fact was also described earlier from the statistics collected from secondary sources. More than two-third area of the district is recorded under N.S.A. Fallow land occupies insignificant share varying from 1.30 to 1.60 percent. The land under plantation and miscellaneous tree crop categories was recorded 27.0 percent in the district. The size of land holding is recorded very small (i.e., 2.22 ha) in which a farmer cannot use modern technological inputs efficiently. The spatial patterns of landholding size are well recognized. The land holding size varies insignificantly from 1.44 ha in the areas of moderately accessible from the market (6 to 9 km) to 3.61 ha in highly accessible areas of very highly (0-3 km). In the peripheral parts of the market region (25-36km), generally 2 to 2.5 ha is an ideal size of land holding.

2. N.S.A. is dominated in all the market accessible zones. The moderately accessible zones have more than 80 percent land under N.S.A., while plantation and miscellaneous tress crops are dominant in the less accessible zones (18-24 km).

3. So far as the spatial pattern of crop intensity is concerned, it is interesting to note that the general pattern of intensity, increases by distance from market, which is not in consonance with the results of other studies. Such studies suggest that intensity decreases as distance increases from the market centre

(O' Kelly and Bryan, D. 1996). The very high degree of intensity (148.0 to 175.0 %) have been recorded in the peripheral zones (30 km and above from the market centre). However, land holding sizes are moderate about 2.0 ha per household in such zones of low accessibility. The causes of high crop intensity in the outer market zone may be interpreted by giving the details of cropping pattern in different accessibility zones.

Table-5.1: General Land Use Pattern and Crop Intensity by Market Accessibility

Distance (kms)	Bari land	Plantation & Miscellaneous	Fallow land	N.S.A.	Land holding size	Area sown more than once	G.S.A.	Crop Intensity (%)
Very Highly Accessible (0-3)	.33 (9.14)	1.06 (29.36)	–	2.23 (61.77)	3.61	.33	2.56	114.79
Highly Accessible (3-6)	.06 (2.66)	.65 (28.88)	–	1.55 (68.88)	2.25	.42	1.97	127.09
Accessible (6-9)	.06 (4.16)	.14 (9.72)	–	1.24 (86.11)	1.44	.20	1.44	116.13
Moderately Accessible (9-12)	.06 (3.33)	.26 (14.44)	–	1.48 (82.22)	1.80	.20	1.68	113.51
Moderately Less Accessible (12-15)	.05 (1.70)	.37 (12.62)	.17 (5.80)	2.34 (79.86)	2.93	.22	2.56	109.40
Less Accessible (15-18)	.04 (3.60)	.08 (7.21)	.01 (.90)	.98 (88.28)	1.11	.29	1.27	129.59
Least Accessible (18-21)	.04 (2.31)	.77 (49.50)	–	.92 (53.17)	1.73	.44	1.36	147.83
Extremely Least Accessible (21-24)	.04 (2.00)	.99 (34.83)	–	.97 (48.5)	2.00	.65	1.62	167.01
High Extremely Least Accessible (24-30)	.25 (10.24)	.85	–	1.34 (54.92)	2.44	.97	2.31	172.38
30-36	.04 (1.92)	.47 (22.59)	-	1.57	2.08	.62	2.19	139.49
36 above	.05 (2.47)	.54 (26.73)	-	1.44 (71.28)	2.02	1.31	2.75	190.97
Average %	.09 (4.05)	.06 (21.00)	.02 (.90)	1.51 (68.00)	2.22 (100.00)	.54	2.05	135.76

5.1(b) Cropping Pattern:

Calculating the average crop area per household by market accessibility, converting the crop area figures into its percentage share to total Gross Cropped Area (G.C.A.) and classifying the individual household into distance categories from the market centre, the important salient features of cropping patterns are emerged as given below:

(i) Out of a total 21 crops that include an area of more than 95.0 percent of G.C.A., the two peripheral zones which are located about 30 km from the market centre are found most diversified which include 20 to 21 crops in its cropping pattern. The highly market accessible areas (3-6 km) are also having a significant number of crops with the prevalence of cauliflower, brinjal, jika and ladies finger in its diversified crop pattern. The most accessible areas (0-3 km) have been recorded specialised in its cropping pattern. Only seven, out of 21 crops namely, tomato, Cabbage, Pumpkin, Ladies finger, Potato and autumn paddy appear in the spatial crop pattern.

(ii) The concentration of crop area in the crop pattern shows that, inspite of domination of winter paddy in almost all the zones, potato, cabbage are the major vegetables in the most accessible zones of the city surroundings.

(iii) Potato, pulses and jute are the second-ranking dominating crops in the peripheral areas. The cropping pattern shows that the peripheral areas are significantly dominated by the commercial crops like jute, pulses and potato.

In general, it can be said that the close vicinity of the market centre is dominated by vegetable crops like cauliflower, *jika* radish, *pattal*, brinjal etc, while the crop pattern in the peripheral areas are more diversified in nature but food grain crops have their dominance in it. It may be concluded that the farmers who are residing close to the market centre have more production surplus to supply it to the market as interpreted in the earlier chapter. Secondly, the land uses dominated by vegetable crops are noticed in the close surroundings because of the perishable items which could have been given more remuneration to the farmers in this zone of market influence. The peripheral farmers grow variety of food grains for their family requirements.

5.2 Spatial Gradients of Crop Revenue and Market Surplus:

In order to probe into the spatial pattern in detail for assessing the market surplus and its spatial distribution, one has to go through three main aspects of the distribution of agricultural production: the spatial tendencies of (a) the crop yield that is major element of agricultural intensification, (b) the revenue which is earned from a specific crop (i.e., the interaction of crop yield with the market price) and (c) the marketable crop surplus production which is being supplied to the market centre. If these three dimensions of the present study of agricultural production are taken into consideration, we find the following facts:

5.2 (a) Crop-Yield Pattern: Average crop yield based on the collected data is recorded highest for the summer paddy (8985 kg/ha) within the group of food grain crops. However, the yields of the vegetables are remarkably high in the district. For example, *Olkabi* has the highest yield (i.e., 17,621 kg/ha) in the district with a

significant spatial variation from 30,000 kg/ha in the close vicinity of the market to 5,242 kg/ha in the outer periphery. As a result, it shows a very high negative gradient of 4126 kg/ha/km (Table-5.2). It is also seen that the spatial gradients of the yield of food grains increase as distance from the market increases including some vegetables like *pattal*, ladies finger, *squash* which might have been used for local consumption. It is obvious from the above discussion that the spatial pattern of the yield of food grain crops are altered by increasing their yield by distance from the market. It means the yields of the food grains increase by distance which shows that they contribute to the household economy and their domestic consumption in the peripheral areas of the market. On the other hand, the yield of the commercial crops most likely vegetables are more influenced by the market forces with their steeply negative spatial gradients (Table-5.2 and Fig. 5.1).

Table-5.2: Spatial Gradients of Yield (kg/ha) of Different Crops

Crops	Crop Yield			Distance (in km)	Spatial Gradient (km/ha/km)
	Maximum (kg/ha)	Minimum (kg/ha)	Average (kg/ha)		
Autumn Paddy	3409	2985	3197	3	+141
Summer Paddy	14925	2985	8955	27	+442
Winter Paddy	6373	3291	4832	33	+93
Wheat	5224	5139	5181	30	+3
Sugarcane	34328	13515	23921	33	-631
Jute	5970	746	3358	3	-1741
Coconut	89552	1221	45386	15	+5889
Pulses	750	454	602	3	-99
Potato	5599	2175	3887	3	-1141
Bettlenut	22388	5709	14048	12	-1390
Cabbage	9911	7784	8847	3	-709
Cauliflower	20000	3731	11865	12	-1355
Olkabi	30000	5242	17621	6	-4126
Brinjal	20000	7354	13677	15	-844
Radish	10000	3645	6822	12	-530
Pattal	3827	1803	2815	12	+169
Ladies Finger	13050	10478	1176	3	+857
Jika	4182	778	2480	6	-567
Squash	6000	4545	5272	6	+1455
Pumpkin	10000	6364	8182	3	+1212
Tomato	2500	263	1381	3	-745

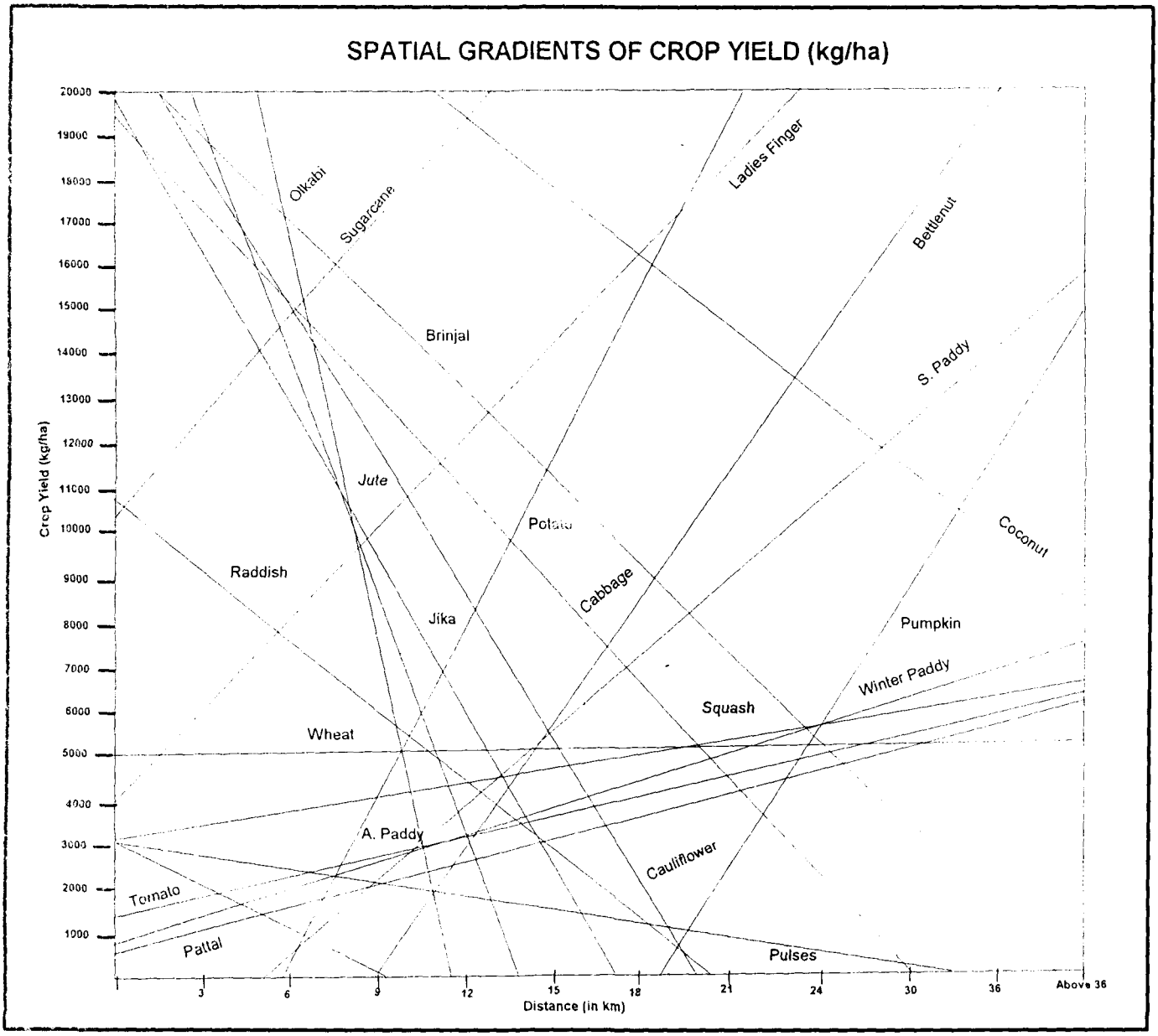

SPATIAL GRADIENTS OF CROP YIELD (kg/ha)
Crop Yield (kg/ha)
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
Olkabi
Sugarcane
Ladies Finger
Bettlenut
Brinjal
S. Paddy
Jute
Potato
Coconut
Raddish
Cabbage
Jika
Pumpkin
Winter Paddy
Squash
Wheat
A. Paddy
Cauliflower
Tomato
Pattal
Pulses
1
3
6
9
12
15
18
21
24
30
36
Above 36
Distance (in km)

Fig. 5.1

5.2 (b) The Crop Revenue Pattern: Since the crop revenue is the interaction of crop yield and market price of the crop product, the spatial patterns of crop revenue should follow the same pattern as interpreted for spatial pattern of crop yield. However, the degree of spatial gradients of the revenue of different crops find much steeper than the gradients of the crop yields (Fig.-5.2). Vegetable crops which are having negative spatial gradients for their crop yield are found positive gradient for crop-revenue. It means that crop prices of these vegetable crops are much higher in the outer peripheral areas of the market region. The spatial gradients of food grain crops remain positive in both the cases. It is clear from the analysis that prices of the food grains do not vary much in the market region. However, there is noticeable increase in the prices of vegetables as distance increases from the market (Table-5.3 and Fig.-5.2).

Table-5.3: Spatial Gradient of Crop Revenue (Rs/ha)

Crops	Crop Revenue Maximum (Rs/ha)	Minimum (Rs/ha)	Average (Rs/ha)	Distance (in km)	Spatial Gradient (Rs/ha/km)
Autumn Paddy	10945	6716	8830	6	+704
Summer Paddy	33582	4229	18905	15	+1956
Winter Paddy	24249	8776	16512	22	+703
Wheat	21269	20149	20709	3	-373
Sugarcane	35181	13275	24238	6	+3651
Jute	39446	4925	22185	6	-5753
Coconut	37313	3149	20231	12	+2847
Pulses	1772	798	1285	33	+29
Potato	21814	2687	12250	30	+637
Bettlenut	237469	11023	12424	9	+25160
Cabbage	34173	7373	20773	3	+8933
Cauliflower	60000	10582	35291	9	-5490
Olkabi	110000	16136	63058	6	-15644
Brinjal	73387	6562	39974	3	-22275
Radish	31500	3125	17312	6	-4729
Pattal	11355	1091	6223	33	+311
Ladies Finger	74670	14268	44649	12	+5033
Jika	17343	1880	9611	12	+1288
Squash	18939	889	9914	18	-1002
Pumpkin	69161	2928	26044	9	-7359
Tomato	19928	1863	10895	9	+2007

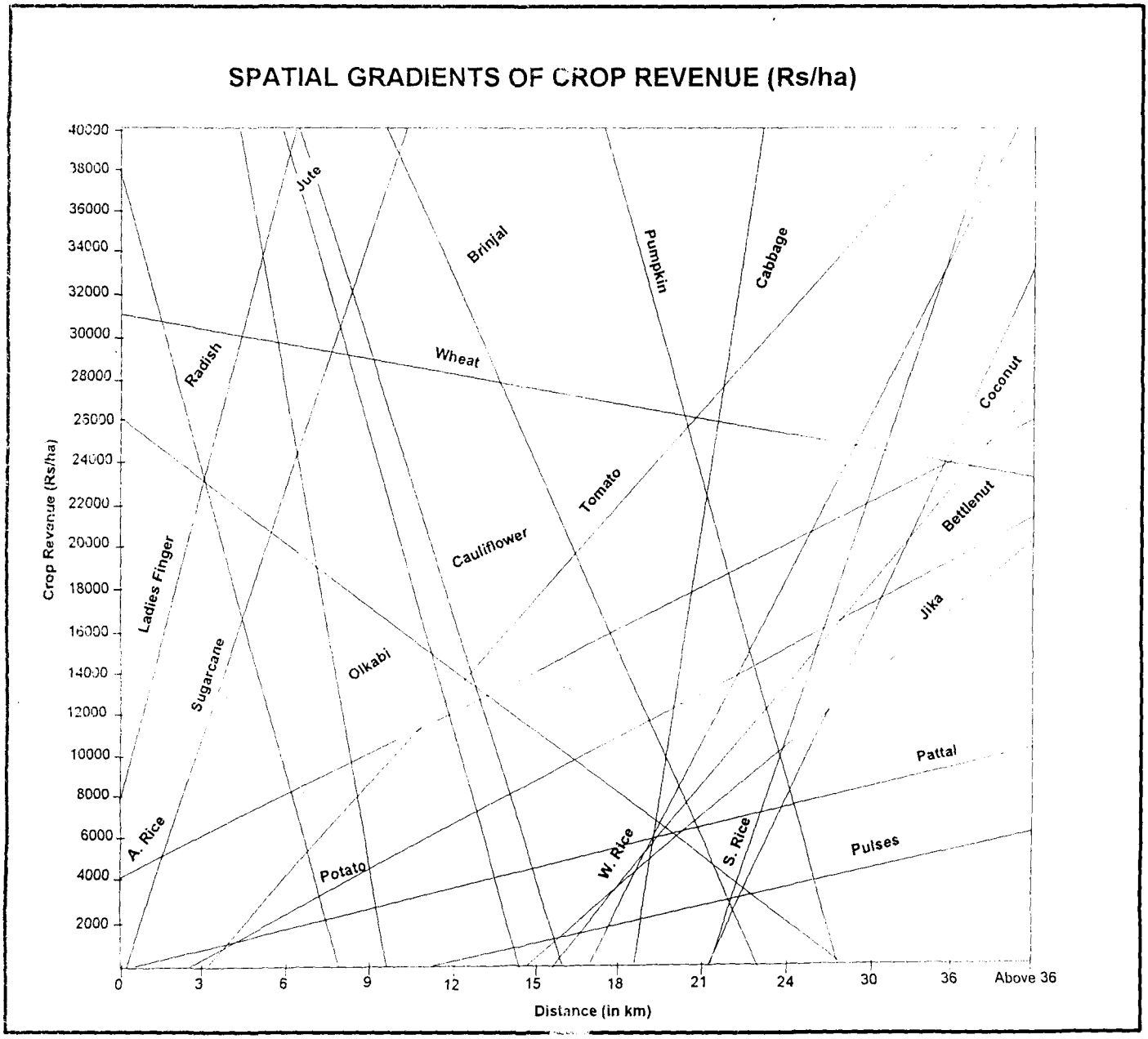

SPATIAL GRADIENTS OF CROP REVENUE (Rs/ha)
Crop Revenue (Rs/ha)
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
Jute
Brinjal
Pumpkin
Cabbage
Radish
Wheat
Coconut
Tomato
Bettlenut
Cauliflower
Ladies Finger
Jika
Sugarcane
Olkabi
Pattal
A. Rice
Potato
W. Rice
S. Rice
Pulses
0
3
6
9
12
15
18
21
24
30
36
Above 36
Distance (in km)

Fig. 5.2

5.2 (c) The Spatial Pattern of Marketable Surplus:

Marketable surplus is assessed by subtracting the total domestic household consumption from the total crop yield. The values of maximum, minimum and average for each market accessible class in the market region are arranged by the distance. The highest value of the maximum marketable surplus in the market region is recorded highest for sugarcane (22, 410 kg/ha), followed by *olkabi* (15, 623 kg/ha) with the average of marketable surplus for these crops 19,614 kg/ha and 21.068 kg/ha respectively. However, the spatial gradients of marketable surplus are negative almost for all the crops except wheat, sugarcane, jute, bettlenut, cabbage and *pattal*. It is noted that the crop *pattal*, squash, cabbages are not much significant in the existing cropping pattern. Therefore, these crops do not have much surplus and are used for local consumption in the farmers' families. On the other hand, wheat is the food grain and does not have much market surplus in the market region. Sugarcane and jute are commercial crops, but they also have the positive spatial gradients. The market surplus of sugarcane is recorded 16,799 kg/ha in the central part of the market region while it was recorded 22,410 kg/ha in the extreme outer peripheral areas. This crop is not significant in the close vicinity of the market region. It shows that sugarcane surplus increases at an average rate of 873 kg/ha/km when distance from the market centre increases. The same case is noticed for surplus of jute crop which has 370 kg/ha/km increase in the market region. In spite of commercial crops, the crops are producing more surplus in the peripheries because the farmers processed sugarcane for making '*gur*' and processing jute raw product from the crop, because of cheap

available labour force outside.* Further, it is observed that paddy product does not dominate for the market surplus. The crops, namely, autumn paddy, summer paddy and winter paddy, have much le percentage share of crop yield as marketable surplus, that are 26.70, 6.60 and 18.39 percents respectively. However, the surpluses of these food grain crops are recorded decreasing as distance from the market increases at the rate of 123 kg/ha/km for autumn paddy, 65 kg/ha/km for summer paddy and 84 kg/ha/km for the winter paddy (Table-5.4 and Fig.-5.3).

Table-5.4: Spatial Gradient of Marketable Surplus

Crops	Marketable Surplus				Distance in Km	Gradients (kg/ha/km)
	Maximum (k/ha)	Minimum (kg/ha)	Average	% to total Kg of yield		
Autumn Paddy	987	235	611	19.1	6	-125
Summer Paddy	2311	763	1537	17.16	24	-64.5
Winter Paddy	1645	633	1139	23.64	12	-84
Wheat	760	215	487	9.39	24	+45.5
Sugarcane	22410	16799	19604	82	15	+374
Jute	3254	2668	2961	88.17	9	+65
Coconut	43446	40365	41905	92.33	6	+513
Pulses	445	[illegible]	301	50	24	+12
Potato	2165	2020	2082	52.5	15	+9.6
Bettlenut	12240	11100	11670	83	24	+47
Cabbage	6243	2242	4242	48	30	+133
Cauliflower	8564	4638	6601	55.63	6	-654
Olkabi	15623	6445	21068	59.7	6	-1529
Brinjal	4220	2360	3290	48.22	24	+77.5
Radish	5512	2366	3939	57.7	13	-95
Pattal	2043	1245	1644	58.40	6	+133
Ladies Finger	875	320	597	50.7	6	+92.5
Jika	2240	978	1109	44.71	12	+105
Squash	4532	2260	3396	64	9	-252
Pumpkin	7220	6440	6830	80	6	-130
Tomato	1222	932	1077	78	18	+8

* Sugarcane is the ten months' crop, harvesting during winter and it is locally being processed by the farmers using small engine crusher for extracting sugarcane juice and making *'gur'*.

*Jute is a crop which has hard stem with thin skin. It has two stages of separating the jute product from the jute crop: (a) it is first put into deep [illegible] r for at least two months for softening the hard stem and (b) the skin is separated by local labour for keeping them into bales. The raw materials of jute is generally used for cooking food in the kitchen during winter season after drying it. Further, it is observed that paddy product

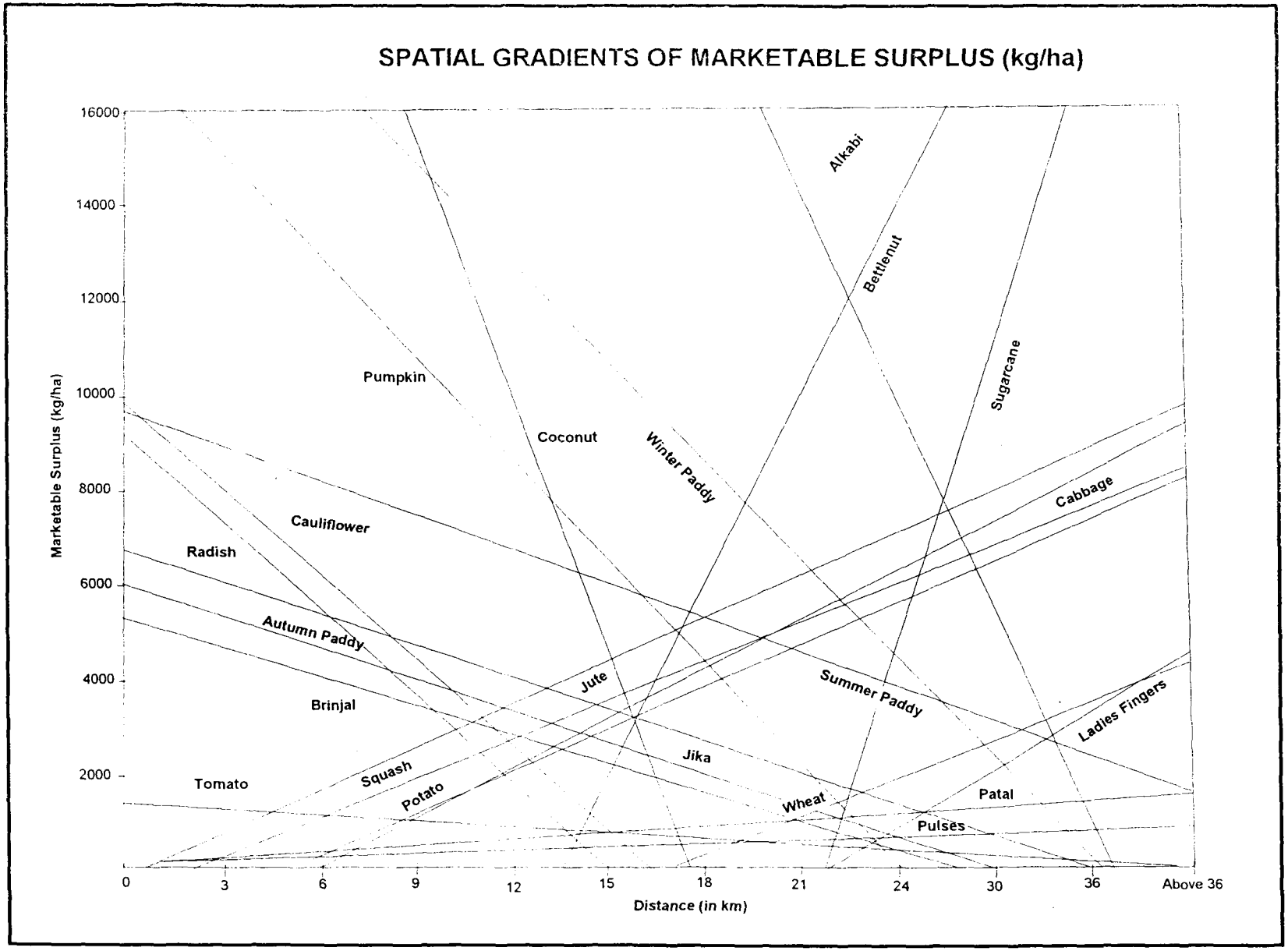

SPATIAL GRADIENTS OF MARKETABLE SURPLUS (kg/ha)
Marketable Surplus (kg/ha)
16000
14000
12000
10000
8000
6000
4000
2000
Pumpkin
Coconut
Winter Paddy
Alkabi
Bettlenut
Sugarcane
Cabbage
Cauliflower
Radish
Autumn Paddy
Brinjal
Tomato
Squash
Potato
Jute
Jika
Summer Paddy
Wheat
Patal
Pulses
Ladies Fingers
0
3
6
9
12
15
18
21
24
30
36
Above 36
Distance (in km)

Fig. 5.3

It is interesting to note that, due to the adoption of new technology in the district, the district is now capable of producing surplus even for the main crops. As a result, the importance of the market has been realised more for regulating the surplus in the area.

5.3 Spatial Variation in Agricultural Productivity:

It has been discussed in the first Chapter under the section of methodology that agricultural productivity is a relative term and has been viewed in relation to various agricultural production factors like land (as physical factor of production), labour, which involves in the production processes and capital in the form of technological inputs for the intensification of production processes. There is a difficulty to isolate the effects of such production factors influencing jointly to the production processes. However, the effects of different production factors are isolated to understand the productivity of each factor separately like land productivity, labour productivity and capital productivity in the agricultural production systems prevalent in Jorhat district. The productivities of these factors have been calculated by subtracting the costs of the remaining other factors in the following manner.

Land productivity is simply calculated by adding the total crop products in terms of Rs/ha of GCA, while labour productivity is measured by subtracting the total costs of input investment including transport cost from the total output produced per person of the labour force engage in this system. Similarly, capital productivity is calculated subtracting total labour costs from the total output gained per unit of investment of capital in the form of technological input to the agricultural production system. These are given in the following equations.

Land Productivity (Rs/ha) = Total Output/ Total GCA

Labour Productivity (Rs/person) = (Total Output – Input Cost)/Total Labour Employed

Capital Productivity (Rs/Rs) = (Total Output – Labour Cost)/Total Capital Investment

Furthermore, it is also interesting to note here that the values of above given agricultural productivity measurements are calculated for each and every category of market accessibility to analyse and interpret the spatial variation of these attributes of agricultural productivity.

The results of these parameters of agricultural productivity are shown as under:

(1) There is a record decrease in land productivity from Rs. 45,221/ha in the most accessible areas to the market in the market region to a minimum of Rs 7,732/ha in the most remote areas of the market region. Graph reveals that it is almost decreasing at constant rate of Rs. 1,000/ha/km when distance increases from the market. It decreases fast in the close vicinity and slower in the outer periphery in the market region, so it follows curvilinear pattern (Fig.-5.4).

(2) Labour productivity also diminishes when distance increases from the town in the market region. It is recorded about Rs. 52,000/person in the close vicinity of the market and lowest as Rs. 3,112/person in the peripheral areas of beyond 36 km. The spatial pattern of labour productivity shows that it diminishes fast in the close vicinity of the market centre and slower in the peripheral areas. The pattern of decrease are slightly curvilinear rather than linear. The causes of decreasing in labour productivity are obvious from the Table 5.5 that the total labour-employment per HH increases by distance from the market centre

and, consequently, the intensity of agricultural labour force also increases spatially from 78 persons/sq km to 218 persons/sq km as distance increases from the market centre

(3) Input cost is an important attribute which influences the labour as well as labour productivity because it acts as subtraction in the numerator of labour productivity and also act inversely in the equation of capital productivity where it is placed in the denominator side in equation. Since input cost as well as transport costs per HH decreases, it diminishes the intensity of input cost from Rs. 3900/ha to its very low as Rs. 947/ha by distance from the market. It means that the fast decrease in the intensity of input cost diminishes labour productivity very fast in the close vicinity of market centre and slower in the outer peripheral areas as shown in the Fig.-5.4.

(4) Capital productivity is very low as it was recorded Rs. 622 for the investment of Rs.100 on technology. However, it also falls by distance from the market from Rs. 875 for investment of Rs. 100/ha in the close surroundings to the tune of Rs.234 only for Rs.100/ha investment in the outer zone of the market region.

5 It may be generalized that capital productivity is still lower than the labour as well as land productivities. There is influence of technology and labour on the agricultural practises in this region, however the biophysical factors of land are more important to produce more production in the area.

Table-5.5: Spatial Patterns of Land, Labour and Capital Productivities

Distance in km	Land productivity (Rs/ha)	Total Cost Per HH (in Rs)			Input costs* (Rs/ha)	Total Labour Employment (person/HH)	Labour engaged** (persons/ha)	Total Labour cost (Rs/ha)	Labour Productivity (Rs/person) (2)-(6)/(8)	Capital product (in Rs per Rs 100 (2)-(investment)/6
		Input cost	Transport cost	Total						
Highly accessible	45221	5350	4662	9972	3895	2.00	.78	11132	52980	875
(0-6)	40634	3761	3622	7383	3748	1.91	.96	12866	38422	741
Moderately accessible (6-12)	35506	2500	2333	4833	3356	1.50	1.04	8869	30913	749
	33594	2495	2300	4795	2854	1.90	1.13	7099	27203	928
Accessible (12-18)	28720	3666	3204	6870	2683	3.56	1.39	10804	18731	668
	24543	1873	1142	3015	2374	2.05	1.61	15147	15244	702
Less Accessible (18-24)	19823	1725	1035	2760	2029	2.30	1.69	9855	10529	491
	16891	1495	1520	3015	1861	2.85	1.95	8151	7708	469
Very less accessible (24-30)	12000	1342	1694	3036	1314	4.75	2.05	6205	5213	441
	9245	1125	1262	2387	1089	4.76	2.17	8990	3758	234
Extremely Less accessible (30-36)	7732	1245	1360	2605	947	5.98	2.18	7212	3112	549

N.B.: * Total costs per household is divided by G.C.A to get input cost per hectare of G.C.A.
** Total employment per household is divided by G.C.A. to get labour engagement per hectare of G.C.A.

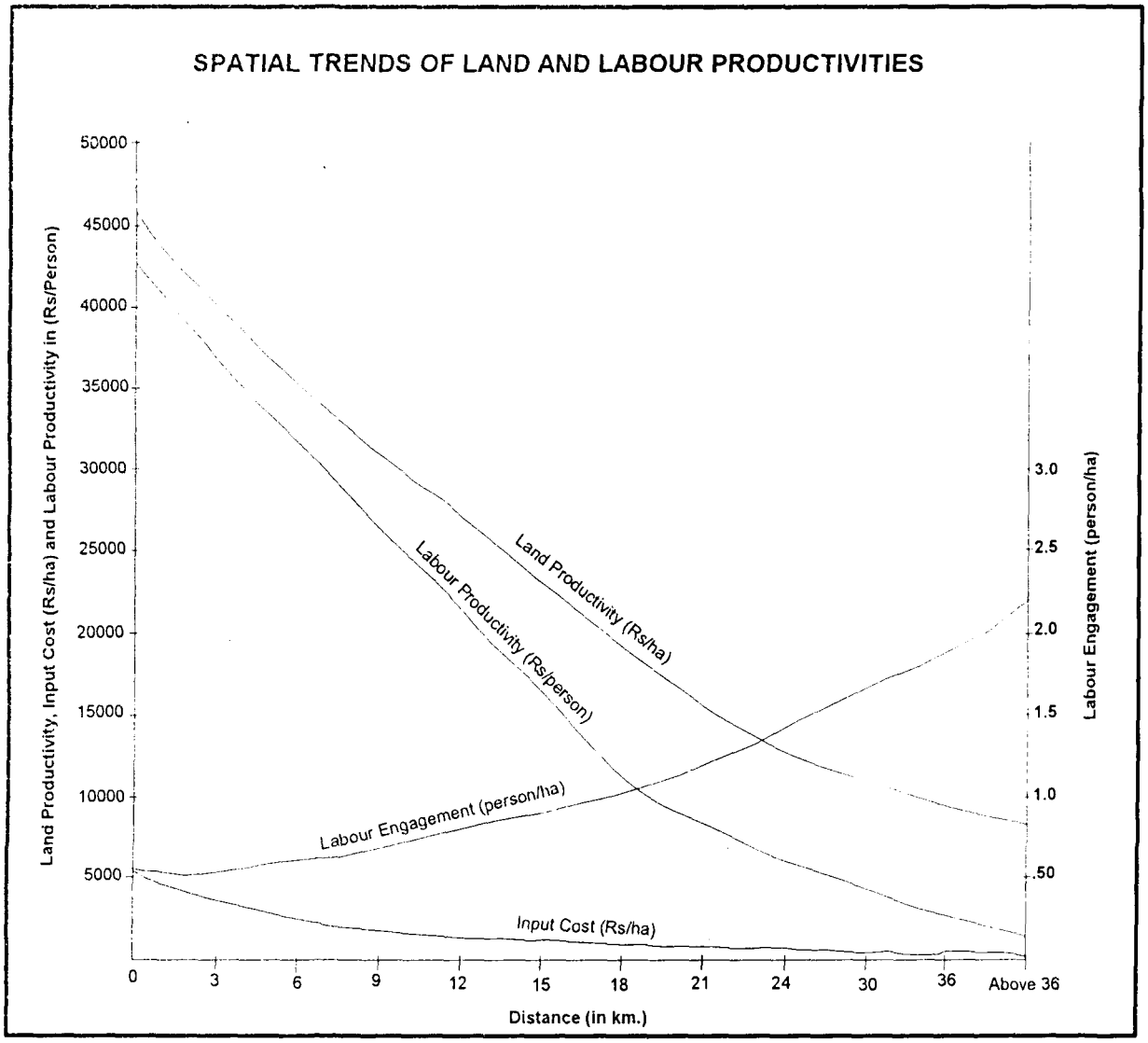

SPATIAL TRENDS OF LAND AND LABOUR PRODUCTIVITIES
Land Productivity, Input Cost (Rs/ha) and Labour Productivity in (Rs/Person)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
Labour Engagement (person/ha)
3.0
2.5
2.0
1.5
1.0
.50
Land Productivity (Rs/ha)
Labour Productivity (Rs/person)
Input Cost (Rs/ha)
0
3
6
9
12
15
18
21
24
30
36
Above 36
Distance (in km.)

Fig. 5.4

5.4 Concluding Remarks:

Spatial variations in agricultural products and productivity which are interpreted and analysed in this Chapter by taking into account four major dimensions of agricultural production, namely, average crop yield, land productivity including production costs show the distance decay pattern.

There is a general observation that the yields of various crops diminish at a constant rate as the distance increase from the market centre. In case of average crop yield it is found 11,289 kg/ha at 0-3 km distance and 8,499 kg/ha in extreme peripheral areas (i.e., 36 km from the market region). As far as land productivity (i.e., the average yield in terms of money) is concerned, it also follows the similar trend in the market region. On account of increasing labour intensity and decreasing the technological input costs from the market centre in the market region, the land, labour and capital productivities decrease curvilinear. The crop-revenue, productivity and costs in the spatial structure would be analysed together in the next Chapter to understand the land rent and the effects of prices and wages on the spatial pattern of agricultural production.

References:

Abdul, M. (1991): *Agricultural Productivity and Regional Development*, Vikash Publications, New Delhi, p-13.

Boserup, E. (1981): *Population and Technology*, Basil Black Well, Oxford.

Dixit, R. S. (1984): *Market Centres and their Spatial Development in the Umland of Kanpur*, Kitabmahal, Allahabad.

Dunn, E. S. (1954): *The Location of Agricultural Production*, University of Florida Press, Gainesville, p. 6,

Garrison, W. L. and D. F. Marble (1957): The Spatial Structure of Agricultural Activities, *Annals of the Association of American Geographers*, Vol. 47, pp.137-44

Gupta, J. P. (2005): Crop Diversification in Panchkula District, Haryana, *Hill Geographer*, Vol. XXI (1&2), pp. 11-23.

Katzman, M. T. (1974): The Von Thunen Paradigm, The Industrial Urban Hypothesis and the Spatial Structure of Agriculture, *American Journal of Agricultural Economies*, Vol.56, pp.683-96.

Kumar, B and Mishra, S. K. (1985): Are Agricultural Markets Location Optimal? A Case Study of Gaya District, Bihar, *Hill Geographer*, Vol. IV (2), pp. 1-8.

Kumar, Binod & Mishra, S. K. (1985): Determinants of Regional Marketed Surplus of Agricultural Commodities: A Case Study of Gaya District, Bihar; North Eastern Hill University, *Journal of Social Sciences and Humanities*, Vol. III (3), pp.22-28

Lal, D. (1974): *Agricultural Growth, Real Wages and the Rural Poor in India*, Mimeo, p. 180.

Mahammad, N. (1981): *Perspective in Agricultural Geography*, Vol.-4,Concept Publishing Co., New Delhi.

Narain, D. (1977): Growth of Productivity in Indian Agriculture, *Indian Journal of Agricultural Economics*, Vol. 32 (2), pp. 20-32.

Shafi, M. (1984): *Agricultural Productivity and Regional Imbalance – A Study of Uttar Pradesh*, Concept Publishing Company, New Delhi.

Singh, K. and Das, D. C. (2000): Pattern of Agricultural Labour Productivity in Lower Brahmaputra Valley, Assam, *North Eastern Geographer*, Vol.31 (1&2), pp. 35-42.

Singh, R. (1999): Towards Optimization of Agricultural Production process, *Journal of Geography* (Gauhati University), pp. 33-53.

Singh, S. and Rahman, R. (1995): Regional Disparities in Agricultural Growth in Assam, *North Eastern Geographer*, Vol.26 (1&2), pp. 24-32.

Chapter-VI

Generalizations and Hypotheses Testing

6.0 Introduction:

In the earlier Chapters, the agricultural production, their economic and social factors, the technological inputs and their patterns including the effect of the prices on the utility of inputs, the wage rates and its effects on labour intensity employed in agricultural practices and so on have been studied. It is also mentioned here that spatial patterns of agricultural productivities (that are related to land, labour and capital) are also visualized decreasing from the market centre in the market region. Initial findings of these two chapters (Chapters-IV and V) are much interesting when it is found that land and labour productivities decrease spatially and capital products are almost constant. On the other hand, total production cost per areal unit, transport cost/unit of area increases in the spatial patterns of agricultural activities. Still two aspects left for further discussion that are:

(a) What is the pattern of land rent and cost per unit of production in its spatial manner in the market region?

(b) How the prices of technological inputs and labour wages if changes at market centre do effect these patterns of production costs as well as land rent in the market regions?

The dimensions relating to these questions are implicitly based on the generalizations of the spatial pattern of agricultural activities as well as of the testing the validity of the hypotheses given in the Chapter-I.

6.1 Spatial Pattern of Rent:

In this Chapter, these two dimensions of agricultural activities are to be analysed by applying the "cause-effect relationship" for the synthesis of the facts and hypotheses testing.

(1) *Spatial Pattern of Land Rent*: It is obvious that land rent is more related to two factors of agricultural production intensity: (a) the cost structure which is input – price-dependent and the productivity and production (revenue) which is dependent on price of the commonly produced and the land rent is the differential factor of these two attributes as described theoretically in Chapter-I. Since revenue decreases gradually in the spatial patterns of market region technological cost is almost equal throughout in the spatial context, the labour costs increases slightly and transport cost increases fast in the peripheral areas. It is obvious that land rent must diminish as distance increases from the market centre (Table-6.1 and Fig. 6.1).

(2) It is interesting to note in this discussion that cost/unit of production also marginally decreases in the spatial pattern. It means that cost increases faster than the decreasing in production. It may be because of two economic factors in the operation of agricultural farms: (a) the fluctuation of market prices of the input commodities used by the farmers. The first factor is the part of testing the validity of the first hypothesis and more related to the changes in the prices of technological inputs subject to the changes in their use (price elasticity to the demand of the inputs) and (b) the freight rate which increases the transport cost

and, consequently, the total costs of the use of input at farms. The second factor is more concerned in the changes in the freight rates which are more related to the means of transport, the conditions of road network and increase in fuel prices. These factors increase the input prices at farm. Effects of such factors on the spatial organization of agricultural activities are tested by using the demand function as suggested in Chapter-I (eqns. 3 and 4).

Table-6.1: Spatial Pattern of Costs and Capital Products

Distance (kms)	Average Yield (kg/ha)	Land Productivity (Rs/ha)	Total Production Cost (input + labour costs) (Rs/ha)	Net Profit (Rs/ha)	Cost Per Units of production (in Rs per 100 kg)	Labour productivity (Rs/person)	Capital products (Rs/Rs)
Very Highly Accessible (0-3)	11289	45221	15027	30194	133	52980	875
Highly Accessible (3-6)	8432	40634	16614	24020	197	38422	741
Accessible (6-9)	7857	35506	12225	23281	155	30913	749
Moderately Accessible (9-12)	8784	33594	9953	23641	113	27203	928
Moderately Less Accessible (12-15)	7038	28720	13487	15233	191	18731	668
Less Accessible (15-18)	7323	24543	17521	7022	239	15244	702
Least Accessible (18-21)	7436	19823	11884	7939	159	10529	491
Extremely Least Accessible (21-24)	7035	16891	10012	6879	142	7708	469
High Extremely Least Accessible (24-30)	9139	12000	7519	4481	82	5213	441
30-36	8199	9245	10079	-834	122	3758	234
36 above	8499	7732	8159	-427	95	3112	549

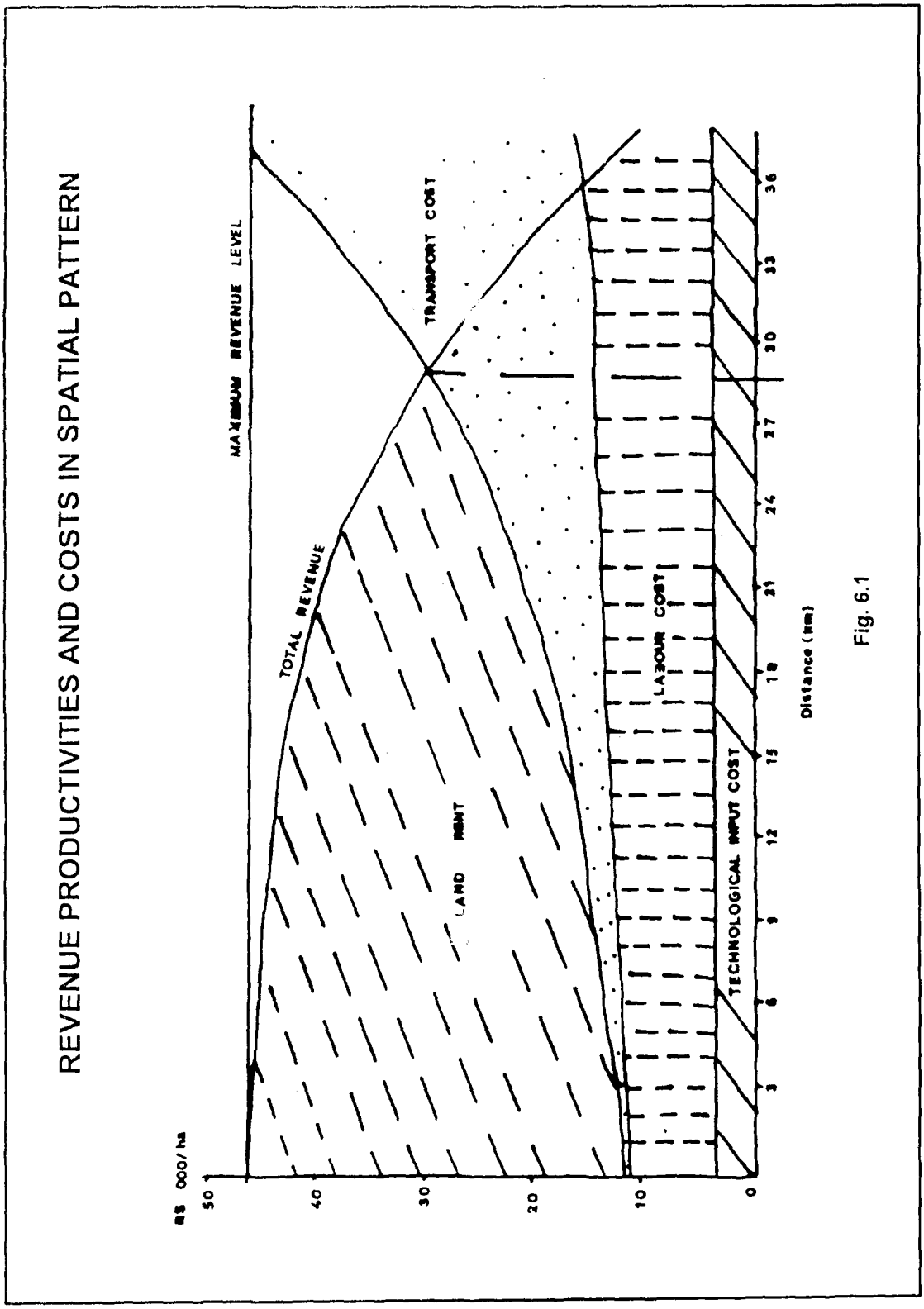

REVENUE PRODUCTIVITIES AND COSTS IN SPATIAL PATTERN
Rs 000/ha
50
40
30
20
10
0
MAXIMUM REVENUE LEVEL
TOTAL REVENUE
TRANSPORT COST
LAND RENT
LABOUR COST
TECHNOLOGICAL INPUT COST
3
6
9
12
15
18
21
24
27
30
33
36
Distance (km)

Fig. 6.1

6.2 Hypotheses Testing:

The validities of the first as well as the second hypotheses are tested by calculating transport costs and used as co-efficient in the spatial system of prices. Since the prices of technological inputs and spatial wage follow linear patterns and the demand of technological inputs as well as labour intensity follow non linear in the spatial system of agricultural production as interpreted earlier in Chapter-V, the effects of input prices and wage rate have been computed by establishing the demand function which is based on 'The variable base and constant power'. It was used by Griffith (1986) for assessing the market demand of various commodities as given below.

$$D(P, s) = Ao\,(Pm + \alpha s)^{-\eta} \quad \ldots \quad \ldots \quad (1)$$

and

$$L(W, s) = Lo\,(Wm - \beta s)^{-q} \quad \ldots \quad \ldots \quad (2)$$

where D and L are demands of technological and labour inputs respectively, Pm and Wm are prices and wages η and q are price and wage elasticises and Ao and Lo are maximum level of factors when their demands are inelastic ($\eta = 0$, $q = 0$) (Singh 2002).

The values of market prices of technological inputs and labour wage (Pm and Wm), the co-efficient related to transport as well as travel costs (α and β) and the maximum values of input demands as well as labour intensity (Ao and Lo) have been used as given in earlier Chapters. The elasticity coefficients, which will help in understanding the effects of sensitivity of the prices of technological inputs and labour wage rates in the spatial organization of agricultural activities are calculated by

transforming the demand of inputs and prices/wages into log scale (Table- 6.2 and 6.3). They would provide the observations for testing the validity of given hypotheses. The following generalizations have been deduced in connection with the given hypotheses,

Table-6.2: Spatial Structure of the Input Costs

Distance from Jorhat (kms)	Mid Values (km)	Total costs (Rs/ha)	Total Transport Cost (Rs/ha)	Total Technology (Rs/ha)	Input Demand (D in Rs)	Log D	(pm + αs)	Log (pm+αs)
Very Highly Accessible (0-3)	1.5	15027	10132	972	4895	3.689	183	2.262
Highly Accessible (3-6)	4.5	16614	11866	1196	4748	3.626	349	2.548
Accessible (6-9)	7.5	12225	8869	1420	3356	3.526	515	2.712
Moderately Accessible (9-12)	10.5	9953	7099	1514	2854	3.455	681	2.833
Moderately Less Accessible (12-15)	13.5	13487	10804	1609	3083	3.488	847	2.927
Less Accessible (15-18)	16.5	17521	10147	2295	7374	3.865	1013	3.005
Least Accessible (18-21)	19.5	11884	9855	2982	3935	3.595	1179	3.075
Extremely Least Accessible (21-24)	22.5	10012	8151	2767	3673	3.565	1345	3.128
High Extremely Least Accessible (24-30)	27.0	7519	5605	2553	3192	3.504	1594	3.202
30-36	33.0	9079	5990	2715	3089	3.489	1926	3.285
36 above	40.0	73591	5212	2877	3607	3.557	2313	

Table-6.3: Spatial Structure of Labour Wages and Labour Costs

Distance from Jorhat (kms)	Mid values (km)	Labour Cost (L in Rs)	Log L	(Wm-βs)	Log (wm-βs)
Very Highly Accessible (0-3)	1.5	10132	3.71	118.125	2.073
Highly Accessible (3-6)	4.5	11866	3.748	114.20	2.057
Accessible (6-9)	7.5	8869	3.777	111.63	2.047
Moderately Accessible (9-12)	11.5	7099	3.851	105.63	2.023
Moderately Less Accessible (12-15)	13.5	10809	4.033	103.22	2.013
Less Accessible (15-18)	16.5	10147	4.006	99.37	1.997
Least Accessible (18-21)	19.5	9855	3.994	95.63	1.980
Extremely Least Accessible (21-24)	22.5	8151	3.911	91.81	1.963
High Extremely Least Accessible (24-30)	27.0	5605	3.97	86.25	1.935
30-36	33	5990	4.003	78.75	1.896
36 above	40	5212	4.074	70.00	1.845

I. The degree of sensitivity (elasticity) of price of the inputs demanded is noted very low, i.e. $\eta = -0.1432$. It means that input prices does not have much effect on the demands of technological inputs. As a result, the costs of technological inputs per areal unit decreases (Fig.-6.2)

II. The degree of sensitivity (elasticity coefficients) of wage rate for the demand of labour input in the special system of agricultural activities is marked very high, i.e. $q = -1.4278$ (Fig.- 6.2). It is much higher than the unity and shows that there is a significant influence of labour wages on the migration of labour to the urban centre (Jorhat Centre).

III. The average rate of transport cost of inputs and marketable surplus is recorded Rs-55.33 for transporting such commodities per quintal per km. On the other

hand, an amount of Rs 1.25 cost of travel of the labor per person per km from rural to market centre in the Jorhat market region is observed. Consequently, there are two reasons to use less inputs in the peripheral areas: (a) the proportional transport cost to the total input cost is very high as shown in Fig.- 6.3 and (b) the low income of the subsistence farmers living in the peripheral areas of the market region. The transport costs may be minimized either by improving the road conditions or by changing the means of transport in the area. However, the close vicinity of market in the market region has fairly good conditions of road with its high intensity. More details on this matter may be interpreted elsewhere.

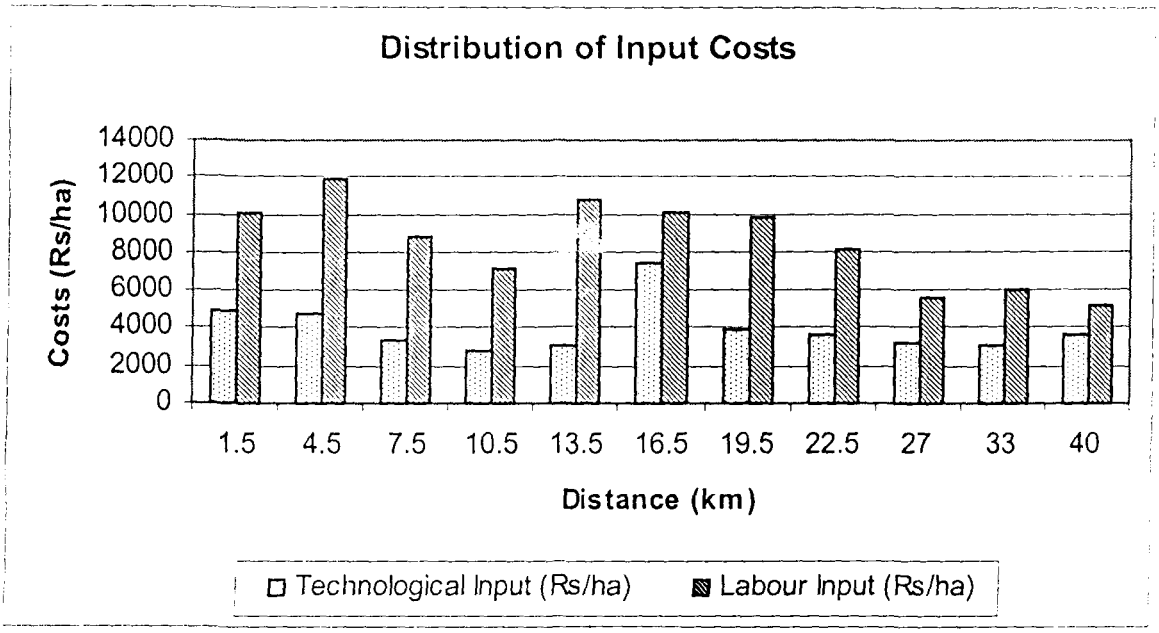


Fig.-6.2: Distribution of Input Costs

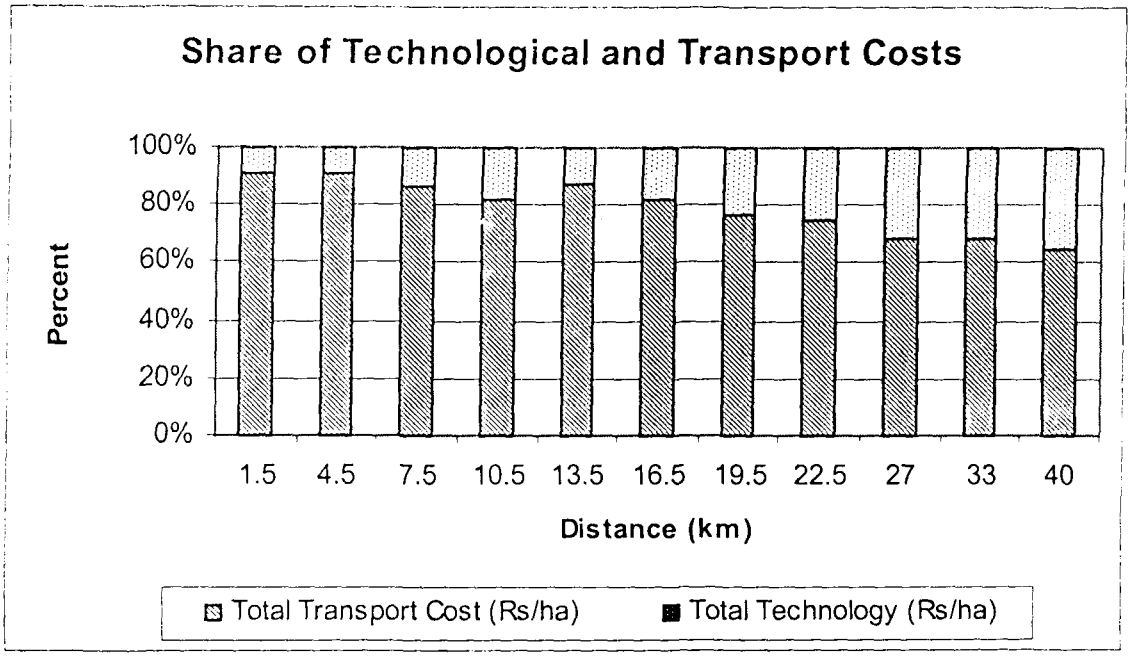


Fig.-6.3: Share of Technological Input and Transport Costs

Observations which have been drawn from the above discussion clearly show that the sensitivity of input prices do effect on input demand in the area. But the degree of their effects are not very significant in the present condition of the development of agricultural activities. On the other hand, the sensitivity of wages changes effectively the optimal limits of the agricultural intensification. Therefore, hypothesis (a) is found valid in the growing conditions of agricultural activities in the district.

Undoubtedly, the intensity of transport network intensifies the agricultural activities and effects the spatial organisation of landuse significantly as given in hypothesis (b). It is because the improved conditions of transport network decreases the transport cost, the technological inputs from market to the nearby areas and also reduces

the travel cost for the labour. Thus, this hypothesis is also valid under the present conditions.

6.3 Initial Findings:

6.3 (a) General Inferences:

Higher concentration of household is noticed in the small size of farmers' family (4-5 persons/family). Contrary to it, very large and large size of families (more than 10 persons) include only 21 percent of the total household. There are many characteristic features of subsistence peasant economy as given by many scientists. However, the some specific observations on the basis of farmers' family size, their landholdings and subsistence levels are drawn.

6.3 (b) Subsistence level of Agriculture and Market Surplus:

Classifying a total number of sample household into five categories on the basis of percentage share of marketed surplus as: Subsistence (0-20% farm product as marketable surplus), Semi-subsistence (20-40%), Dual subsistence (40-60%), Semi-Commercial (60-80%) and Commercial (80-100%), it is found that there is a gradual increase in the cultivated area at farm level by converting waste and forest lands to the NSA. The crop yield also increases marginally over time. It means the processes of expansion and intensification started in the subsistence farming systems in the district. The particular findings are given below:

I. Commercialization in the farming system is positively related with the size of land holdings and family size. Larger families who have bigger size of land

holdings have started producing more marketable surplus (commercial activities) with the employment of the major part of their family labour who are educated and more mobile. Female dominates in the subsistence farm activities. Male adults contribute when there is change in the farming activities from subsistence to commercial.

II. The duration of employment of hired labour increases as farm activities changes from subsistence to commercial. But commercial farm are labour consuming (especially hired labour) in the farms of commercial activities.

III. General land use changes by increasing land under NSA from the plantation and miscellaneous tree crops when farming practices alters from subsistence to commercial. Winder paddy, potato contribute higher share of marketable surplus in then subsistence farming and Bettlenut and vegetables are growing for marketing surplus.

IV. The farmers occupying large size of landholdings practice intensive farming with commercial crops. At such large holding sizes of farms, a large share of land is under paddy crop which is grown as commercial crop because a very small share of total food grains are used for family consumption and remaining share of paddy product is used as marketable surplus. Beetlenut and vegetables are major commercial crops in these commercial farming practiced in the larger land holding sizes.

6.4 Preliminary Deductions:

I. As per the conducted survey and compilation of survey results, it is found that the farmers of the Jorhat city region are applying multiple inputs at their farms. The multiplicity ratio is recorded highest 4.12 for the application of irrigation following 3.89 for others like use of fertilizers, H.Y.V. seeds, pesticides and power tiller. It means a simultaneous adoption of input technology like fertilizer, H.Y.V. seeds, pesticides and power tiller are being used by most of the farmers of the region.

II. Use of inputs at farm level varies spatially. About 50 percent share of the total cost is invested only on four technological inputs, i.e., fertilizers, H.Y.V. seeds, pesticides and water pump (irrigation specially in winter season) at farms located in the close vicinity, while two inputs namely, fertilizer and H.Y.V. seeds account for more than 50 percent share of total input cost invested by the farmers in the outer peripheral areas. It is clear that total cost on the use of technological inputs diminishes as distance increases from the Jorhat market centre

III. Out of a total of 21 crops that include an area of more than 95 percent GCA, the two peripheral zones which are located about 30 km from the market centre are found diversified which include 20 to 21 crops in its cropping pattern. The highly market accessible areas (3-6 km) are also having the significant number of crops with the prevalence of Cauliflower, Brinjal, Tomato, Jika, Ladies finger in its diversified crop pattern. The most accessible areas from the market centre (0-3

km) are dominated by commercial crops in its cropping pattern; only seven out of 21 crops appear in the cropping pattern of this area.

IV. So far as crop yield is concerned, the average crop yield of the district based on collected data recorded highest in summer paddy (8985 kg/ha) within the group of food grain crops. However, the yield rates of the vegetables are remarkably high in the district. For example, Olkabi (Knolkhol) has the highest yield (i.e., 17,621 kg/ha) in the district with the significant variation from 30,000 kg/ha in the close vicinity of market to 5,242 kg/ha in the outer periphery.

V. Spatial margin of input, which was prepared by calculating the average input cost/ha for 30 sample villages and drawing Iso-cost lines, shows that the total input cost (including labour) increases as distance increases from the Jorhat market region. The pattern of Iso-cost lines is influenced by road network.

VI. The same pattern emerges for Iso-transport cost also. However, the spatial margin of transport cost are more smooth in the peripheral areas

VII. There is record decrease in land productivity from Rs. 44,221/ha in the most accessible areas to a minimum of Rs. 7,732/ha in the most remote areas of the market region. Graph shows clearly that is almost decreasing at constant rate of Rs. 1000/ha/km when distance increases from the market.

6.5 Spatial Patterns of Revenue and Labour Productivity:

I. Labour productivity diminishes when distance increases from the town in the market region. It is recorded about Rs.52,000/person in the close vicinity of the

market and lowest as Rs.3,112/person in the peripheral areas of beyond 36 kms. Its pattern shows that it diminishes fast in the close vicinity of the market centre and slower in the peripheral areas. The pattern of decrease is slightly curvilinear rather than linear. The causes of decreasing in labour productivity are obvious that the total labour employment per HH increases by distance from the market centre and, consequently, the intensity of agricultural labour force also increase spatially from 78 persons/sq km to 218 persons/sq km as distance increases from the city. It decreases the productivity in its spatial pattern.

II. The maximum revenue a farmer is achieving at a very close distance from market, say 1.5 km, is calculated maximum (Rs. 45,221/ha). However, it diminishes curvilinear when distance increases from the market centre. On the other hand, total technological input costs are noticed constant in the spatial pattern which is nearly Rs. 3,500/ha.

III. There is a slight increase in labour cost and faster increase in transport cost in the peripheries of the market region. Thus, total input cost increases curve-linearly.

IV. Land rent is considered as differential between the total revenue and the total costs. It (land rent) decreases from Rs 30,000/ha in the close surroundings of the market centre to Rs 3,700/ha in the outer peripheries of the region. This also decreases non-linearly in the market region.

In the end, it may be concluded that commercialization do occur in the growing agricultural economies as exist in the study area. The agricultural production activities

produce marketable surplus which is supplied to and the technological agricultural innovations which are diffused by the centrally located market centre (that is Jorhat town) are the part of the spatial patterns of agricultural land uses. These spatial patterns of agricultural activities follow the non-linear trends of agricultural land rent, labour and capital productivities as well as labour dominated pattern.

References:

Griffith, D. A. (1986): Central Place Structure using Constant Elasticity of Substitution Demand Cones: The Infinite plane, *Economic Geography*, Vol. 62 (1), pp. 74-84.

Singh, S. (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 30(3), pp.229-244.

Bibliography

Abdul, M. (1991): *Agricultural Productivity and Regional Development*, Vikash Publications, New Delhi, p-13.

Amedeo, D & R. G. Golledge (1975): *An Introduction to Scientific Reasoning in Geography*, John Wiley and Sons, Inc., New York, pp. 299-306.

Amedeo, D. and R. G. Golledge (1975): *An Introduction to Scientific Reasoning in Geography*, New York: John Wiley and Sons, Inc., pp. 299-306

Baker, O. E. (1926-1933): Agricultural Regions of North America, *Economic Geography*, Vol. II, pp. 459-493; Vol. III, pp. 50-86, 309-339, 447-465; Vol. IV, pp. 44-73, 399-443; Vol. V., pp. 3639; Vol. VII, pp. 109-153, 325-394; Vol. VIII, 325-377 and Vol. IX, pp. 167-197.

Berry, B. J. L., E. C. Conkling and D. M. Ray (1993): *The Global Economy, Resource Use, Locational Choice and International Trade*, Printice Hall Englawood Cliffs, New Jersey, pp. 253-67.

Berry, B. J. L., E. C. Conkling, D. M. Ray (1993): *The Spatial Organisation of Land use: The Global Economy Resource Use, Locational Choice and International Trade*, Printice Hall, Englo Wood Cliffs, New Jersey.

Bhagabati, A. K. (1990): *Spatial Analysis of Small Scale Agriculture in Assam: A Case Study of Nalbari District*, Unpublished Ph.D. Dissertation, Gauhati University, Guwahati.

Bhalla, G. S. and Tyagi, D. S. (1989): *Patterns in Indian Agricultural Development – A District Level Study*, ISID, New Delhi.

Bharadwaj, O. P. (1956): *Land use and Soil erosion problems of Bias Jalander Doab*, Unpublished Ph. D Thesis, London School of Economics, Delhi University, Delhi, pp 66-72.

Bhatia, S. S. (1965): Patterns of Crop Concentration and Diversification in India, *Economic Geography*, Vol.41, pp. 40-56

Blaike, P. (1971): Spatial Organisation of Agriculture in some North Indian Villages, Part-I, *Transactions*, Institute of British Geographers, Vol. 52, pp. 1-40.

Blaikic, P.M. (1971): Spatial Organisation of Agriculture in Some North Indian Villages, The Institute of British Geographer, *Transaction*, Vol.52 pp.1-40.

Bora, B. (2002): *Population Characteristics & Agricultural Development in Jorhat District, Assam,* Unpublished PhD Thesis submitted to the Department of Geography, North Eastern Hill University, Shillong.

Borah, D. (1983): *Role of Contact Farmers on Transfer of Technology to follower Farmers under T & V System*: AERC for N.E. India, Assam Agricultural University, Jorhat.

Boserup, E. (1981): *Population and Technology*, Basil Black Well, Oxford.

Brookfield, H. C. (1964): Question on the Human Frontier of Geography, *Economic Geography*, Vol.40, pp. 283-303.

Bunge, W. (1962): *Theoretical Geography*, Lund (Sweden): Lund Studies in Geography, Series C, General and Mathematical Geography, University of Lund, Sweden.

Burton, I. (1963): The Quantitative Revolution and Theoretical Geography, *Canadian Geographer*, Vol. VII, pp. 151-62.

Butler, J. B. (1960): *Profit and Purpose Informing (A Study of Farms and Small Holdings in parts of North Riding)*, University of Leeds, Department of Economics, p-68.

Casetti, E. (1972): Spatial Equilibrium Distribution of Agricultural Production and Land Values, *Economic Geography*, Vol. 48, pp. 193-98.

Casetti, E. (1972): Spatial Equilibrium Distribution of Agricultural Production and Land Values, *Economic Geography*, Vol. 48, pp. 193-98.

Chisholm (1979): The Von Thunen - Principle and Agricultural Zonation in Colonial Mexico, *Journal of Historical Geography*, Vol. 3, pp. 123-33.

Chisholm, M. (1962): *Rural Settlement and Land use*, Hutchins on Lib. London, pp. 11-12.

Chouhan, T. S. (1984): Agricultural and Livestock Development in Western Rajasthan: A Case Study of the Malani Region, *The Indian Journal of Geography*, Vol. XIV (1), pp. 68-78.

Chouhan, T. S. (1987): *Agricultural Geography, A Study of Rajasthan State*, Academic Publishers, Jaipur, p. 27.

Chouhan, T. S. (1987): *Agricultural Geography*, Academic Publishing, Jaipur.

Conkling, E. C. (1963): South Wales: A Case Study in Industrial Diversification, *Economic Geography*, Vol. 53, p.221-240

Coppock, J. T. (1964): *An Agricultural Atlas of England and Wales*, London: Faber

Das, H. P. (1970): *Geography of Assam,* National Book Trust, New Delhi.

Das, I. T. and Das, M. M. (1989): Land Use Patter in the Pagladia – Puthimari Basin, *North Eastern Geographer*, Vol.21 (1&2), pp. 9-25.

Das, M. M. (1984): *Peasant Agriculture in Assam, A Structural Synthesis*, Inter India Publications, New Delhi.

Das, M. M. (1984): Peasant Agriculture in Assam, Inter India Publications, New Delhi.

Das, M. M. (1995): *Land Holding Structure: A Problem in Peasant Agriculture in Assam*, Konark Publishers Pvt. Ltd. New Delhi, pp. 37-98.

Das, M. M. and Datta, L. (1986): Landuse and Agriculture in North-East India, *North Eastern Geographer*, Vol. 18, (No. 1&2), pp. 28-48.

Das, M.M. (1984): *Peasant Agriculture in Assam*, Inter India Publications, New Delhi.

Day, R. H. and E. H. Tinney (1969): A Dynamic Von Thunen Model, *Geographical Analysis*, Vol. I, pp. 137-151.

Dayal, E. (1984): Agricultural Productivity in India – A Spatial Analysis, *Annals of the Association of American Geographers*, Vol. 74 (1), pp. 98-123.

Dayal, E. (1984): Agricultural Productivity in India, A Spatial Analysis, *Annals of the Associations of American Geographer*, Vol.74, pp. 98-123.

Deka, N. (1996): *Impact of Agro-Ecological Conditions on Rice Cultivation in Majuli River Island (Assam)*, unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill University, Shillong.

Desai, D. K. (1966): Technological Change and its Diffusions in Agriculture, *Indian Journal of Agricultural Economics*, Vol. XXI, pp. 134-142.

Directorate of Assam (1993): *Field Manual for Rain fed Agriculture in Assam*, Assam Agriculture University, Jorhat (Assam), p. 6.

Dixit, R. S. (1984): *Market Centres and their Spatial Development in the Umland of Kanpur*, Kitabmahal, Allahabad.

Docke's, P. (1969): L'Espace dans la pensee economique du XVIe an XVII e Siecle, Paris, Flammarion.

Dunn, E. S. (1954): *The Location of Agricultural Production*, Gainesville, University of Florida Press, p. 6.

Dunn, E. S. (1954): *The Location of Agricultural Production*, University of Florida Press, Gainesville, p. 6.

Dunn, E. S. (1954): *The Location of Agricultural Production*, University of Florida Press, Gainesville, p. 6,

Engelbrecht, T. H. (1883): *Crop Regions of North America,* c.f. Hussain, M.(1996): *Systematic Agricultural Geography*, Rawat Publications, Jaipur, pp. 17-44.

Estal, R. (1976): *A Modern Geography of United States*, Penguin Books, Middlesex, England.

Ewald, U. (1977): The Von Thunen Principle and Agricultural Zonation in colonial Mexico, *Journal of Historical Geography*, pp. 123-33.

Ewald, U. (1977): The Von Thunen Principle and Agricultural Zonation in Colonial Mexico, *Journal of Historical Geography*, Vol.3, pp.123-33.

Ferber, R. & Verdorm, P. J. (1962): *Research Methods in Economics and Business*, Macmillan Co. New York, pp. 33-34.

Ferber, R. and P. J. Verdoorn, (1962): *Research Methods in Economics and Business*, Macmillan Co, New York, pp. 33-34.

Francisco, S.A.J. and J.K. Routray (1992): *Road Transport and Rural Development – A Case Study of the Philippines*, HSD Research Report-28, AIT, Bangkok, pp. 33-52

Garrison, W. L. and D. F. Marble (1957): The Spatial Structure of Agricultural Activities, *Annals of the Association of American Geographers*, Vol. 47, pp.137-44

Garrison, W. L., & D. F. Marble (1957): The Spatial Structure of Agricultural Activities, *Annals of the Association of American Geographers*, Vol. 47, pp.137-44.

Gazetter of India, Assam State, Sibsagar District (1967), Govt. of Assam, Shillong, pp. 20-21, 31-32, 121 and 236.

Gibbs, J. and Martin, W. (1962): Urbanisation, Technology and the Division of Labour: International Patterns, *American Sociological Review*, Vol.27, pp. 126-140.

Goswami, P. C. (1963): *Economic Development of Assam*, Asia Publishing House, New Delhi.

Government of Assam (1967): *Assam District Gazetteer, Sivasagar District*, Shillong, p.21

Griffith, D. A. (1986): Central Place Structure using Constant Elasticity of Substitution Demand Cones: The Infinite plane, *Economic Geography*, Vol. 62 (1), pp. 74-84.

Grigg D. (1982): *The Dynamics of Agricultural Change, The Historical Experience*,

Grigg, D. (1969): The Geography of Farm Size, A Preliminary Survey, *Economic Geography*, Vol.42, pp.205-235.

Gupta, J. P. (2005): Crop Diversification in Panchkula District, Haryana, *Hill Geographer*, Vol. XXI (1&2), pp. 11-23.

Gupta, J. P. (2005): Crop Diversification in Panchkula District, Haryana, *Hill Geographer*, Vol. XXI (1&2), pp. 11-23.

Hagen, E. E. (1975): *The Economics of Development*, Richard D. Irwin, Inc., London.

Hall, P. (1966): *Von Thunen's Isolated State*, translated by C. M. Warthenberg, Oxford, Pergamon.

Hall, P. (ed) (1966): Von Thunen's Isolated State: An English Edition of Des Isolierte Staat, Pergamon Press, London.

Haloi, K. (1985): Structure and Pattern of Land Holding in Arunachal Pradesh, *Hill Geographer*, Vol.IV (2), pp. 22-31.

Harris, D. R. (1969): Agricultural System Ecosystems and the Origin of Agriculture, In Ucko, P. J. and Dimbleby, G. W. (ed): *The Domestication and Exploitation of Plants and Animals*, Vol. VI, pp. 2-7.

Harvey, D. W. (1966): Theoretical Concepts and the Analysis of Agricultural Land use Pattern in Geography, *Annals of the Association of American Geographers*, Vol. 56, pp. 361-74.

Helburn, N. (1957): The Bases for a Classification of World Agriculture, *Professional Geographer*, Vol. IX, pp. 2-7.

Horvarth, R. J. (1969): Von Thunen's Isolated State and the area around Addis Ababa, Ethiopia, *Annals of the Association of American Geography*, Vol. 19, pp. 308-23.

Husain, M. (1979): *Agricultural Geography*, Inter India Publications, Delhi.

Husain, M. (1979): *Crop Combination in India; A Study*, Concept Publishing Co. New Delhi.

Jonasson, O. (1925-26): Agricultural Regions of Europe, *Economic Geography*, Vol. XII, pp. 227-314, Vol. II, pp. 19-48.

Jones, C. F. (1928-30): Agricultural Regions of South America, quoted from M. Hussain (1996): Systematic *Agricultural Geography*, Rawat Publications, Jaipur and New Delhi, p.24.

Kakati, B. K. (1985): *Impact of Agricultural Innovation on Socio-Economic Structure of Bajali Block*, Unpublished M. Phil Dissertation submitted to the Department of Geography, Gauhati University, Guwahati, pp. 8-13.

Katzman, M. T. (1974): The Von Thunen Paradigm, In the Industrial Urban Hypothesis and Spatial Structure of Agriculture, *American Journal of Agricultural Economics*, Vol.56, pp 683-96.

Katzman, M. T. (1974): The Von Thunen Paradigm, The Industrial Urban Hypothesis and the Spatial Structure of Agricultur. *American Journal of Agricultural Economies*, Vol. 56, pp. 683-96.

Katzman, M. T. (1974): The Von Thunen Paradigm, The Industrial Urban Hypothesis and the Spatial Structure of Agriculture, *American Journal of Agricultural Economics*, Vol.56, pp.683-96.

Kellerman, A. (1983): Economic and Spatial Aspects of Von Thunen's Factor Intensity Theory, *Environment and Planning*, Vol. 15, pp.1521-30.

Khusro, A. M. (1973): *Economics of Land Reform and Farm Size in India*, Macmillan, India.

King, L. J. (1964): *Statistical Analysis in Geography*, Englewood Cliffs Prentice Hall Inc.

Kostriwcki, J. (1968): Agricultural Typology, Agricultural Regionalisation Development, *Geographia Polonica*, Vol. XXVI pp. 265-74.

Kostrowicki, J. (1964): Geographical Typology of Agriculture, Principles and Methods, *Geographia Polonica*, Vol. III, pp. 146

Kothari, C. R. (1990): *Quantitative Techniques*, Vikash Publishing, New Delhi, p. 108.

Kothari, C. R. (1996): *Research Methodology, Methods and Techniques*, Wishawa Publication, New Delhi, p. 35.

Kothari, C. R. (1996): *Research Methodology, Methods and Techniques*, Wishwa Publications, New Delhi, p.35

Kumar, B and Mishra, S. K. (1985): Are Agricultural Markets Location Optimal? A Case Study of Gaya District, Bihar, *Hill Ge[illegible]pher*, Vol. IV (2), pp. 1-8.

Kumar, B. & Mishra, S. K. (1985): Determinants of Regional Marketed Surplus of Agricultural Commodities: A Case Study of Gaya District, Bihar; North Eastern Hill University, *Journal of Social Sciences and Humanities*, Vol. III (3), pp.22-28

Lal, D. (1974): *Agricultural Growth, Real Wages and the Rural Poor in India*, Mimeo, p. 180.

Mahammad, N. (1981): *Perspective in Agricultural Geography*, Vol.-4,Concept Publishing Co., New Delhi.

Marx, K. (1933): *Capital*, Vol. B, Charles Kerr & Co, Chicago,

Marx, K. (1971): *Principle d'une Critique to Economic Politique*, cited from Cavailhes.

Mavi, H. Singh (1963): Crop Concentration and Diversification in Nainital District, U.P. Himalaya, *National Geographical Journal of India*, 33(2), pp.160-167.

Mohammad, N. (ed) (1981): *Perspective in Agricultural Geography*, Vol. V, Concept Publishing Co., New Delhi.

Mohammed, A. (ed) (1978): *Dynamics of India*, Concept Publishing Co., New Delhi.

Mohammed, N. and Amani, K. Z. (1970): Crop Combination in the Trans-Ghaghara Plain, *Graphical Review of India*, Vol. XXXII, pp. 47-59.

Narain, D. (1977): Growth of Productivity in Indian Agriculture, *Indian Journal of Agricultural Economics*, Vol. 32 (2), pp. 20-32.

O' Kelly, Morton. E. and Bryan, D. (1996): *Progress in Human Geography*, Vol.20 (4), pp. 457-475.

O'Kelly, M. E. & D. Bryan (1996): *Agricultural Location Theory: Von Thunen's Contribution to Economic Geography*, Progress in Human Geography, Vol.20 (4), pp. 457-475.

O'Kelly, M. E. (1988): Aggregate Rent and Surplus Measurement in a Von Thunen Model, *Geographical Analysis*, Vol.20, pp. 187-97.

Peet, J. R. (1969): The Spatial Expansion of Commercial Agriculture in the Nineteen Century - A Von Thunen Interpretation, *Economic Geography*, Vol. 45, pp. 283-301.

Peet, J. R. (1969): The Spatial Expansion of Commercial Agriculture in the Nineteen Century: A Von Thunen Interpretation, *Longman Geography*, Vol.45, pp. 283 and 301.

Phukan, P.K. (1992): Role of Growth Centres in Agricultural Development in Golaghat District (Assam), Unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill university, Shillong,

Phukan, U. (1990): *Agricultural Development in Assam*, Mittal Publications, New Delhi.

Phukan, V. (1990): *Agricultural Development in Assam*, Mittal Publications, New Delhi.

Rahman, R. (1994): *Levels of Agricultural Development in Assam*, unpublished M. Phil Dissertation submitted to the Department of Geography, North Eastern Hill University, Shillong.

Rahman, R. and Singh, S. (1992): Changing Patterns of Agricultural Labour Productivity in Assam, *Hill Geographer*, Vol. IX (No.1&2), pp. 25-31.

Saikia, H. (1987): *Size of Holding and Productivity: A Case Study of Nowghon District*, unpublished M. Phil. Dissertation Submitted to the Department of Geography, North Eastern Hill University, Shillong.

Schernz, J. N. (1816): Beschveibung der land Wirtzchaft in Niederelsars Parey, Berlin (Quoted from Geography of Agriculture: Themes in Research, p.1)

Scott, A. J. (1976): Land and Land Rent: An Interpretation Review of the French Literature, *Progress in Geography*, Vol. 9, pp. 101-139.

Shafi, M. (1972): Measurement of Agricultural Productivity of the Great Indian Plains, *The Geographer*, Vol. XIX, pp. 4-13.

Shafi, M. (1984): *Agricultural Productivity and Regional Imbalance, A Study of Uttar Pradesh*, Concept Publishing Co., New Delhi.

Shafi, M. (1984): *Agricultural Productivity and Regional Imbalance – A Study of Uttar Pradesh*, Concept Publishing Company, New Delhi.

Shantz, H. L. (1943): Agricultural Regions of Africa, *Economic Geography*, Vol.16, pp. 1-47, 122-161and.341-389; Vol. 17, pp. 217-249 and 353-379; Vol. 18, pp.229-246; Vol. 19, pp. 77-100 and 217-269.

Sharma, B. (2003): *Changing Pattern of Agricultural Labour Productivity in the Brahmaputra Valley*, M. Phil Dissertation (Submitted to the Department of Geography, North Eastern Hill University, Shillong, pp. 52-103.

Sharma, B. (2003): *Changing Pattern of Agricultural Labour Productivity in Brahmaputra Valley,* Unpublished M. Phil. Dissertation submitted to Department. of Geography, North Eastern Hill University, Shillong.

Sharma, B. L. (1991): *Applied Agricultural Geography*, Rawat Publications, Jaipur.

Shear, James A. (1965): A General Measure of Diversity, *The Professional Geographer*, Vol.17, pp.14-17.

Sidhu, H. S. (1991): *Agricultural Development and Rural Labour, A Case Study of Punjab and Haryana*, Concept Publishing Company, New Delhi.

Simmous, I. G. (1966): *Ecology and Land Use Transaction of the Institute of British Geographers*, Vol. 38, pp. 59-72.

Singh, G. B. (1979): *Transformation of Agriculture*, Vishal Publication, Kurukshetra, pp. 77-79.

Singh, J. (1974): *An Agricultural Geography of Haryana*, Vishal Publications, Kurukshetra.

Singh, J. (1979): A New Technique of Delimiting Agricultural Production Typology in Food Crop Dominated Economy, *Geographila Polonica*, Vol. 40, p.21.

Singh, J. and Dhillon, S. S. (1984): *Agricultural Geography*, New Delhi, Tata McGraw Hill Publishing Company, pp. 175-206.

Singh, J. & Dhillon, S. S. (1984): *Agricultural Geography*, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Singh, J. (1974): *An Agricultural Atlas of India- A Geographical Analysis*, Vishal Publications, Kurukshetra, India.

Singh, J. (1976): An Agricultural Geography of Haryana, Vishal Publication, Kurukshetra.

Singh, J. *et. al.* (1982): *Determinants of Agricultural Productivity, A Sample Study of Operational Holdings for Land Use Planning*, Vishal Publications, Kurukshetra.

Singh, K. and Das, D. C. (2000): Pattern of Agricultural Labour Productivity in Lower Brahmaputra Valley, Assam, *North Eastern Geographer*, Vol.31 (1&2), pp. 35-42.

Singh, L. S. (1998): Role of Growth Centres in agricultural Development in Imphal Valley, Unpublished Ph. D. Thesis submitted to the Department of Geography, North Eastern Hill university, Shillong,

Singh, R. (1999): Towards Optimization of Agricultural Production process, *Journal of Geography* (Gauhati University), pp. 33-53.

Singh, R. L. (ed) (1971): *India: A Regional Geography*, (1st Edition), National Geographical Journal of India, Varanasi, p.306.

Singh, S. (1994): *Agricultural Development in India – A Regional Analysis*, Kaushal Publications, Shillong.

Singh, S. (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 30(3), pp.229-244.

Singh, S. and B. Sharma (2003): Determinants of Crop Intensity in Assam Plain, *The Geographer*, Vol. 50(1), pp. 58-72.

Singh, S. and Rahman, R. (1995): Regional Disparities in Agricultural Growth in Assam, *North Eastern Geographer*, Vol.26 (1&2), pp. 24-32.

Singh, S. (1994): *Agricultural Development in India, A Regional Analysis*, Kaushal Publications, Shillong.

Singh, S. (2002): Optimizing the Spatial Structure of the Agricultural Production Function, *Geographical Analysis*, Vol. 34 (3), pp. 229-244.

Statistical Handbook (1971, 1981, 1995, 1998, 2000, 2001): Directorate of Economics and Statistics, Govt. of Assam, Guwahati.

Stoddart, D. R. (1965): Geography and the Ecological Approach- the Ecosystem as Geographical Principle and Method, *Economic Geography*, Vol. 50, pp. 242-51.

Taher, M. (1975): Regional Basis of Agricultural Planning in the Brahmaputra Valley, *Journal of North East India Geographical Society*, Vol. 8, pp. 122.

Taylor, G. (1930): Agricultural Regions of Australia, *Economic Geography*, Vol. 6, pp. 109-134 and 213-142.

Tewari, A. K. (1965-66): Land Utilization in Jaunsar Bawar, *The Deccan Geographer*, Vol. III, pp. 1-128.

Thoman R. & Corbin Peter B. (1962): *The Geography of Economic Activity*

Timmons, J. F. (1944): Distribution of World Land Resources, *Land Policy Review* (Winter), pp. 8-14.

Tress, R. C. (1939): Unemployment and the Diversification of Industries, *The Manchester School*, Vol.9, pp.140-152.

Vickerman, R. W. (1979): *The Micro-Economic Foundations of Urban & Transport Economics*, Vol. I, pp. 30-59.

Viser, S. (1982): On Agricultural Location Theory, *Geographical Analysis*, Vol.14, pp.167-76.

Visser, S. (1980): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol. 56, pp. 311-19.

Visser, S. (1980): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol.56 (4), pp. 311-319.

Visser, S. (1980-82): Technological Change and the Spatial Structure of Agriculture, *Economic Geography*, Vol. 56, pp.311-19.

Visser, S. (1982): On Agricultural Location Theory, *Geography Analysis*, Vol.14,pp. 167-76.

Von Humboldt, A. (1807*): Land use in Cuba and South America*, c.f. Hussain, M. (1996): *Systematic Agricultural Geography*, Rawat Publications, Jaipur, pp. 17-44.

Von Thunen, J. H. (1826): Der Isolierte Staat in Besiehung auf Landwirtschafts and National Okonomie, Quoted from W. B. Morgan and R. J. C. Munton (1972): *Agricultural Geography*, Methuen and Co, London.

Von Valkenburg, S. (1931-36): Agricultural Region of Asia, *Economic Geography*, Vol. 7 (1931); pp. 217-237, Vol. 8 (1932); pp. 109-133, Vol. 9 (1933); pp. 1-18, 109-135, Vol. 10 (1934); pp. 14-34, Vol. 11 (1935); pp. 227-246, 325-337, & Vol. 12 (1936); pp. 27-44, 231-249.

Walpert, J. (1964): The Decision Process in a Spatial Context, *Annals of The Association of American Geographers*, Vol. 54, pp. 537-58.

Weaver, John C. (1954): Crop Combination Regions in the Middle West, *Geographical Review*, Vol. 44 (2), pp. 537-58.

Whittlesey, D. (1936): Major Agricultural Regions of the Earth, *Annals of the Association of American Geographers*, Vol. 54, pp. 531-58.

Young, A. (1770): The Farmer's farm though the east of England, Vol. 4, Strahan, London

HOUSEHOLD SCHEDULE

1. (a) Name of the village :
   (b) i) Electrified : Yes/no
   ii) Distance from Road :
   iii) Distance from Jorhat City :
   iv) Distance from nearest town :
2. Name of the Head of the Household :
3. Caste :
4. Religion :
5. Demographic Pattern of the Household :

Sl. No.	No. of Persons	Age	Sex	Education	Occupation
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

6. General Landuse:

Total Holding (Size in hectares).

i) Bari land :
ii) N.S.A. :
iii) Area sown more than once :
iv) Waste land :
v) Plantation & Miscellaneous :
vi) Fallow Land :
vii)Total irrigated areas (Hectares) :

7. Area under different crops: (Cropping Areas):

Crops	Area in ha	Yield in Quintal/ha	Domestic Consumption	Market Surplus	Prices	Sources of Selling surplus
Rice Autumn Rice						
Winter Rice						
Summer Rice						
Wheat						
Sugarcane						

Jute						
Coconut						
Pulses						
Potato						
Bettlenut						
Crops:						
Vegetables:						
a) Cabbage						
b) Phulkobi						
c) Olkobi						
d) Brinjal						
e) Raddish						
f) Pattal						
g) Vendi						
h) Jika						
i) Squash						
j) Rangalao						
k) Others						

8. a) Total Fertilizer used :
   b) Mode of cultivation : Bullock plough/Power tiller/Tractor

9.

Labour	No. of persons	Duration (Full time/Half time/Man-days/Wage Rate							
		July to Sept		Oct to Dec		Jan to March		April to June	
		No. of days	Wage rate	No. of days	Wage rate	No. of days	Wage rate	No. of days	Wage rate
Family Labour									
Hired Labour									

10. Agricultural Infrastructure/Technology

Source of Buying	Nature of Availability	Total Annual Cost	Purchased from own money	Received from Govt.
a) Irrigation				
b) Irrigation				
c) H.Y.V. seeds				
d) Power tiller				
e) Cost				
f) Water pump				

/pump set				
g) Plough				
h) Fertilizer				
i) Pesticides				
j) others				

11. Hired Labour

No. of persons	Age	Sex	Literate/illiterate	From where distance	Wage rate per month in Rs.
1					
2					
3					
4					
5					
6					

12. Transport Costs

Mode of transport	July to Sept		Oct to Dec		Jan to March		April to June	
	Fre.	Cost	Fre.	Cost	Fre.	Cost	Fre.	Cost
Rickshaw								
Scooter								
Auto								
Vikram								
Zeep								
Taxi								
Thela								
Cycle								
Bullock cart								
Mini truck								
Truck								
Others								

Name of the Interviewer.