

IMPACT OF MINOR IRRIGATION ON AGRICULTURAL
LANDUSE, CROPPING PATTERN AND CROP
PRODUCTION IN JORHAT DISTRICT (ASSAM) :
A GEOGRAPHICAL ANALYSIS

KAMALA KANTA GOGOI

Dissertation

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT
OF THE DEGREE OF
MASTER OF PHILOSOPHY

To



DEPARTMENT OF GEOGRAPHY
SCHOOL OF HUMAN AND ENVIRONMENTAL SCIENCES
NORTH-EASTERN HILL UNIVERSITY
SHILLONG (INDIA)

NOVEMBER, 1994



DS
631.5870954162
GOG

LIBRARY
Acc: 103046
Acc:
Date: 27-2-98
Class by:
Sub Reading by:
Date:
Prescribed by:



पूर्वोत्तर पर्वतीय विश्वविद्यालय

मयूरभंज परिसर, शिल्लोण - 793014 (मेघालय)

North-Eastern Hill University

Mayurbhanj Complex, Shillong - 793014 (Meghalaya)

Phone :
Grams : NEHU

Dr. B.S. Butola,

Reader, Dept. Of Geography

CERTIFICATE

This is to certify that the dissertation entitled "Impact of Minor Irrigation on Agricultural Landuse, Cropping pattern and crop production in Jorhat District" (Assam): A Geographical analysis, submitted by Shri Kamala Kanta Gogoi, for the Degree of Master of Philosophy in Geography to the Department of Geography, North-Eastern Hill University, is a bonafide study to the best of my knowledge and belief. The researcher has given due acknowledgements to study cited in the dissertation. The study may now be placed before the examiners for the evaluation.

Date:- 10.11.94

R.K. Rai

Head

Department of Geography
North Eastern Hill University
Shillong.

B.S. Butola
(Dr. B.S. Butola)

Supervisor

DEDICATED
TO
MY FATHER

ACKNOWLEDGEMENTS

At the very outset my heartfelt thanks and gratitude go out to my supervisor Dr. B.S. Butola, Reader, Department of Geography, North-Eastern Hill University, Shillong, for his constant encouragement, affectionate advice and painstaking editing of the manuscript.

I owe a deep sense of obligation to Prof. R.K.Rai, Head, Department of Geography, NEHU, Prof. R.Gopalakrishnan, Prof. A.C. Mohapatra and Dr.Surendra Singh. I also grateful to all faculty members who gave me the constructive suggestions at the time of Pre-Submission seminar on this topic.

At different stages in the preparation of my dissertation, I approached the various officers of Jorhat district. I extended my thanks for their assistance for procuring the necessary data.

I must acknowledge the help and encouragement that I received from Mr. M.L.Phukan,Principal, Mr. H.N. Bora, Head,Department of Geography and my colleagues, Dr.A.P.Mahanta, Bimal Bora, Joysankar Hazrika, Dr.Benu Gogoi and Mrs.Menakshi Hazrika of J.B. College, Jorhat for the completion of this work.

I shall be failing if I do not acknowledge

the immense help that I received from my wife Bijaya at various stages of my research work. I cannot rate the constant inspiration of my family members and relatives.

Finally, I wish to thank Mr. P. S. Thomas and Mr. K.V. Mathew for their neat and accurate computer processing of this dissertation and also thanks to all my friends and well-wishers, who helped me in several ways in the pursuit of research work.

Shillong

Kamala Kanta Gogoi
(Kamala Kanta Gogoi)

Date: 10 Nov., 1994.

CONTENTS

	Page No
Acknowledgements	
List of Tables	
List of Figures	
Chapter I Introduction	1-16
Chapter II Physical Setting and Aspects of Agriculture	17-37
Chapter III Agricultural Situation and Landuse Pattern	38-72
Chapter IV Aspects of use of Modern Techniques in Agriculture and its Physico-Social Impact	73-88
Chapter V Database and Methodology	89-96
Chapter VI Irrigation and Agricultural Develop- ment : A Case Study of Selected Micro irrigation Project	97-117
Chapter VII Summary of Main Conclusions and Suggestions	118-128
Bibliography	

LIST OF TABLES

Table No	Title	Page No
2.1	Average monthly rainfall of Jorhat for a period of 10 years (1984-1993)	34
2.2	Maximum and Minimum average monthly temperature of Jorhat District (1984-1993)	34
2.3	Average monthly Relative humidity of Jorhat District (1984-1993)	35
2.4	Monthly Water Balance- Jorhat District	36
3.1	Volume of change in landuse pattern in Jorhat District (1989-90 to 1992-93)	42
3.2	Cropping Intensity of Jorhat District (1992-93)	46
3.3	Crop Combination Analysis- Jorhat	49
3.4	Production & Area of main crops	53
3.5	Production & Area of main crops, Jorhat	53
3.6	Occupational Structure - Jorhat (1971)	57
3.7	No. of Tractors & Power Tillers - Jorhat (1971)	60
3.8	Blockwise No. of Machine tools- Jorhat	61
3.9	Blockwise HYV seeds used in Jorhat	65
3.10	Blockwise Fertilizer consumption (NPK) - Jorhat	67

3.11	Blockwise Pesticides used in Jorhat (1983-84 to 1992- 93)	70
4.1	Irrigation Schemes in Jorhat District	81
4.2	Blockwise sources of Irrigation (1992-93)	84
6.1(B)	Population of Sex and average size of household	99
6.2(A)	Age Sex Ratio	101
6.3(A)	Literacy Level	102
6.1(B)	Landuse Pattern of the household (irrigated villages) according to size group in hectares (1993-94)	104
6.2(B)	Landuse Pattern of the household (unirrigated villages) according to size group in hectares (1993-94)	105
6.3(B)	Selection of the sample landholders	106
6.4(B)	General Landuse Pattern of the sample landholders (irrigated) (1993-94)	107
6.5(B)	General Landuse Pattern of the sample landholders (unirrigated) (1993-94)	108
6.6(B)	Cropping Pattern	113
6.7(B)	Cropping Pattern, Yield and Productivity of sample landholders according to agro-ecological zone (1993-94) Irrigated villages	114
6.8(B)	Cropping Pattern, Yield and Productivity of sample landholders according to agro-ecological zone (1993-94) Unirrigated villages	115

LIST OF FIGURES

Fig.No	Title	Facing Page No
1	Location Map	4
2	Geological Structure - Jorhat District	21
3	Relief features - Jorhat District	23
4	Drainage Pattern - Jorhat District	24
5	Rainfall Temperature graph (1984-1993)	28
6	Hythergraph - Jorhat (1984-1993)	28
7	Climograph - Jorhat (1984 - 1993)	28
8	Rainfall Temperature variations graph - Jorhat	28
9	Water Balance - Jorhat	29
10	Soil Zones - Jorhat District	32
11	Volume of change in Landuse Pattern in Jorhat (1992-93)	43
12	Crop Intensity - Jorhat (1992-93)	47

CHAPTER I
INTRODUCTION

CHAPTER I

INTRODUCTION

Statement of the Problem

The incidence of rainfall in the state of Assam varies between moderate to heavy. Ninety per cent of rainfall generally occurs during the rainy season from the month of May to October. But during this period too, rainfall distribution is not uniform. Seasonal variation in rainfall causes many problems to the predominantly agricultural state. It is particularly so at the time of sowing and harvesting of the crops. Nearly 95 percent of the total geographical area of the state falls under the Brahmaputra and the Barak valley. It is one of the most fertile region of our country. But, due to such variations in the rainfall, the livelihood and means of subsistence of over 91 percent of the total population of the state also remain highly uncertain. Moreover, the large proportion of the work force i.e., 76.7 percent engaged in agriculture also face chronic problems due to the same reasons. Therefore, if the state of Assam has to catch up with the other developed states of the country, it is imperative that agriculture must be given prime importance. It gets enhanced significance due to the rise in population at an alarming rate. Besides this, to keep pace with Tea plantation of Assam, the production of other crops must be raised. The agriculturists in the state have also tried to explore the traditional methods of practicing rotation of crops, double cropping, multiple

cropping, mixed farming and diversification of crops etc. But, the erratic behavior of south West Monsoon in the summer and North East Monsoon in the winter have caused problems to the farmers. It has thus become necessary to consider irrigation as the most effective way of solving these problems. Moreover, from the experience of agriculturally developed regions of the country it has become evidently clear that assured irrigation is the only way for the successful implementation of Green Revolution technology in Agriculture. Phukan¹ indicates that stability in agricultural production and improvement in productivity could be achieved through irrigation.

The state of Assam, too has taken up a good numbers of irrigation project since 1960. But most of the large irrigation projects have remained either highly under utilized or they have become disfunctional. An attempt is being made in the present study to evaluate the role of some of minor irrigation projects in District Jorhat on the development of agriculture with the following objective in mind:

OBJECTIVES:

The main objective of this study is as follows:

1. To identify the irrigated areas under different types of irrigation.

2. To analyse the environmental and institutional problems

related with the development of irrigation.

3. To highlight the interrelationship between existing minor irrigation project and agricultural practices, landuse pattern, cropping pattern etc.

4. To study the impact of irrigation project upon cropping intensity, diversification of crops and rotation of crops.

5. To co-relate crop production and crop productivity with irrigation facilities.

6. To suggest measure for better utilization of irrigation and improvement in agriculture particularly in terms of productivity and labour employment.

STUDY AREA

District Jorhat is situated in the central part of Upper Assam Valley. It extends between $93^{\circ} 35'E$ and $94^{\circ} 97'E$ longitudes and $26^{\circ} 20' N$ and $27^{\circ} 8' N$ latitudes with an area of 2,859 sq.km. The total population of the district is 868,445 (1991 Census), out of which 453,001 are males and 415,444 are females. It is an agriculturally dominated district where 46 per cent of the total geographical area is under cultivation and 46.4 per cent of the total labour force (1991 Census) is employed in it excluding the workers in tea plantation.

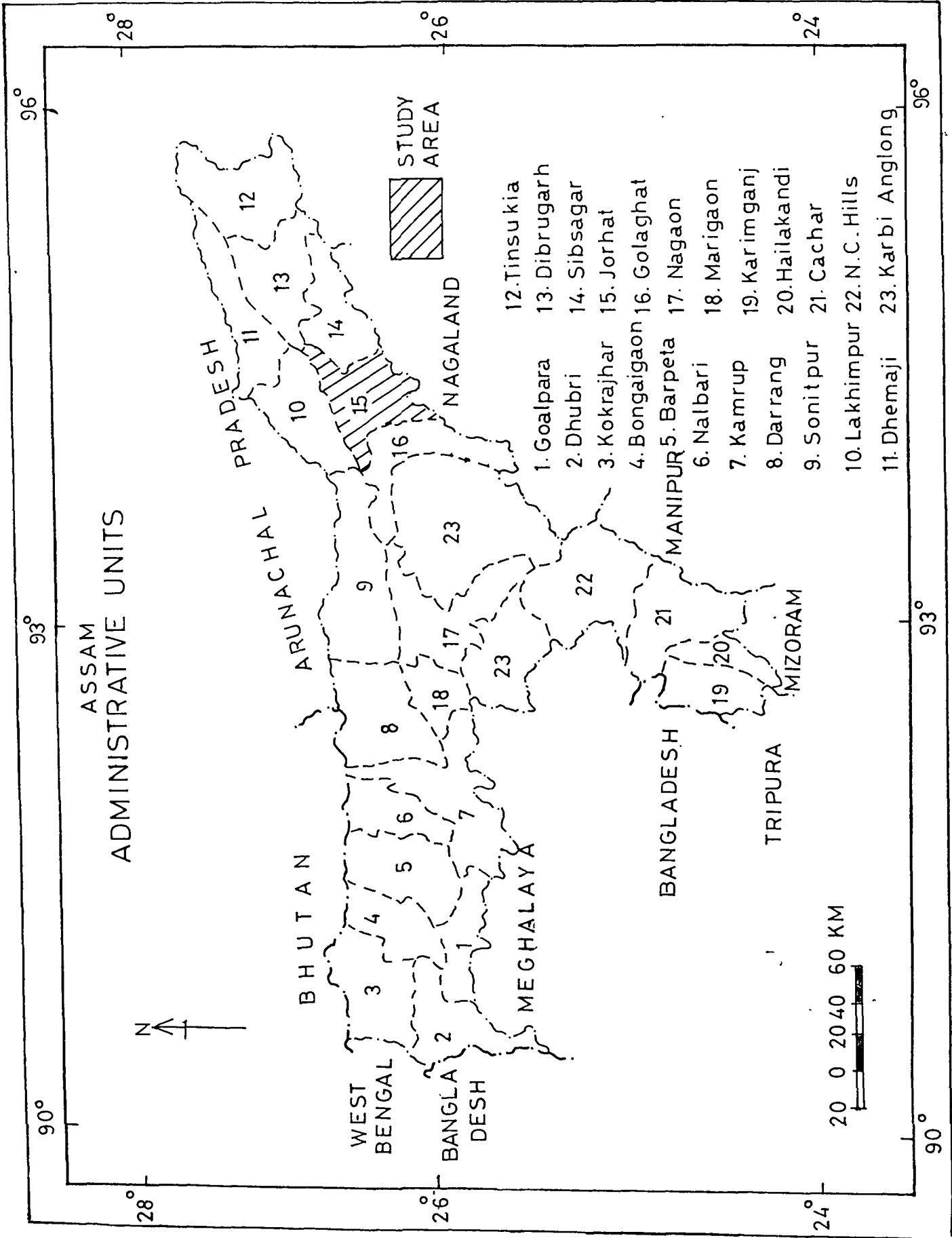


FIG.-1

The State of Assam is not only a geographically large unit but it is cultural activities too. The diversity of nature and culture have also brought in significant change in agricultural practice within the state. In the present study District Jorhat has been taken as a sample. It has world's largest riverine island Majuli with in it. Except some parts of the extremes southern margin near the foothills of Nagapahar, large part of the district is plain one. The district is a fertile land which consist mainly of old alluvium, New alluvium and red laterite soils. Hot and humid climate is predominantly prevailing here. Agriculture occupies the major role in the socio-economic development of the people. Old alluvium soils of the district support the luxuriant growth of tea gardens. The Tocklai Tea experimental Centre and Assam Agricultural University located in the district have taken leading role in the agricultural development of the District as well as in North-Eastern Region of India. It is evident from the above discussion that the study aims to study one of the most significant aspect of the life and environment of the people at a micro level. Paucity of published as well as unpublished materials have been the single largest obstacle in the effort. The researcher is not aware of such study done at such micro level for any district of Assam. Therefore, large part of the study will include maiden attempt in the part of the research. However, what ever little help he has been able

to get from the scantely available published and unpublished documents the researcher feels highly obliged to these contribution and expressed his indebtedness towards them by acknowledging some important aspect of their contribution in the following sections:

REVIEW OF RELEVANT LITERATURE

1. In India the impact of irrigation has been studied by several scholars from past to the present. Most of the studies done by the scholar are at micro level (i.e., village level). Krishna Murthy² has evaluated the influence of Mettur Irrigation Project on agriculture and agro industries in Puttokotai Taluk of Tanjor district of Tamil Nadu in 1956. His findings showed a positive relationship of irrigation and socio-economic status of the people. Humanta Rao³ compared yields in Telengana between partially irrigated and dry farmers. In 1967, Divankar Jha⁴ studied the impact of Tribeni Canal Irrigation project of the Champaran District of Bihar to assess the direct and indirect benefit of the farmers. Another study was conducted by Abdul Azis⁵ in his own village in Kolar District to see the nature of changes in the rural economy and life before and after the introduction of well irrigation. Pandey's⁶ study on impact of irrigation on rural development in Bihar indicated that the overall performance of the irrigated

village is far better than that of the unirrigated villagers. Misra and Vivekananda (1979)⁷ while studying the Tunga Bhadra Dam observed an inverse relationship between size of holding and the area irrigated.

Recently, Vesudeva Rao⁸ compared the impact of Malaparara Canal Irrigation at micro and macro levels in the Nargund Taluk in Karnataka State. His finding showed that family labour participation has come down with the increase of irrigation and small farmers have brought more areas under irrigation. Patel⁹, in his study, "The implementation of minor irrigation schemes in Ajmer District of Rajasthan" indicated that small farmers have benefited due to increase of irrigation which increase cropping intensity and crop productivity. Bhalerao and Mauraya (1985)¹⁰ assessed the importance of labour intensive crops like vegetables ect. to solve the problem under employment and disguised employment in Indian rural areas. In their view, adoption of labour intensive crops not only occupy comparatively less area but also contribute proportionally more employment and more income accrued to the farmers. In Assam, the evaluation of irrigation, is very much limited. Therefore there is an urgent need to look into irrigation so as to make the rural landscape bountiful with different crops which will contribute in the overall economic and sound development of the rural areas.

2. STUDIES RELATED TO IRRIGATION IN ASSAM.

It was thought earlier that irrigation was not necessary in Assam as it falls under humid climatic region regulated through the monsoon. At that time Agricultural fields were more in comparison to population. Now the whole scenario is altered for which artificial irrigation is necessary for the raising of crops. The following are the literatures related to irrigation in Assam :

Sahu (1984)¹¹ showed that rice is the dominant crop of Assam, occupying more than 60 per cent of the total cropped area. His findings revealed that large number of areal units of cropped lands of assam are poorly irrigated, and higher concentration of rice areas possess a low irrigation potential.

Goswami and Gohain (1968)¹² studied the response of farmers to the HYV programme in paddy. Their findings showed that due to the lack of irrigation facilities other inputs for increasing agricultural production cannot be unutilized properly. A study conducted by Phukan (1970)¹³ to examine the nature and extent of double cropping in Sibsagar district of Assam. The study revealed that a small fraction of their cropped lands are under double cropping. The percentage of double cropped area to net sown area varies from 3 percent to 20 percent and the only way to increase the cropping

intensity to provide assured irrigation. Ali Irshad (1975)¹⁴ while studying the impact of Mayang Lift Irrigation of Nagaon District showed that with the introduction of irrigation, the Rabi crops have been replaced by both traditional and HYV paddy in the winter months. It has increased the cropping intensity. Phukan (1985)¹⁵ conducted a study on the impact of Tubewell irrigation on crop production in Jorhat district of Assam. He observed that Ahu paddy (transplanted variety) is the second crop followed by Sali paddy in the irrigated lands. His finding revealed that the use of irrigation was restricted to transplanted Ahu paddy only. The study indicates that the irrigation has increased the production of crops. Goswami, (1987)¹⁶ while studying the impact of Minor Irrigation on agricultural production Hajo Block revealed that irrigation has not only increased the crop production but also standardized the mode of living of farmers.

The foregoing survey of literature shows that the limited number of studies conducted on this particular aspect. Therefore, there is a need to conduct a stimulate study on the nature of interrelationship between minor irrigation and aspect of agriculture at the micro level. For assessing the importance of irrigation in the agricultural development of the district following hypotheses have been tested.

HYPOTHESIS

(1) With the increase in distance from the flood plains, agricultural production and cropping intensity is likely to increase with introduction of irrigation, while village situated nearer to the flood plain are likely to show only but marginal impact of irrigation upon the same.

(2) In a graded society use and benefits from a micro irrigation project are likely to benefit the high income and agriculturally rich section of the society relatively more than poorer section or in other words, micro irrigation project will accelerate the process of social differentiation mostly along the economic lines.

(3) Higher literacy will contribute in increasing the agriculture problem but increase in qualification will lead to higher out migration which will adversely affect the agricultural production in the region with the introduction of irrigation facilities.

(4) Cropping pattern will show marginal changes in the village situated near the flood plain. But it will have the sufficiently high impact in the vilages far from the flood plain.

(5) Introduction of assured irrigation facilities will promote

production of cash crops and subsequently greater modernization of the economy along with increase in the return of Agricultural Wage Labourer. As opposed to the rainfed agriculture will have predominance of cereal crops in the cropping pattern and most of the agricultural operation will be carried by the family labour.

DATABASE AND METHODOLOGY

i) Data Base.

It is evident from the above that the study will rely mostly on the primary data source. However, secondary data source will be used mainly for the following purposes:

a) Secondary Source:

Included here are the published document, reports, books and journals from the Government, semi Government, individual and private agencies some of the secondary data used here are:

a) Agricultural situation in India - Ministry of Agriculture, Govt. of India for Agricultural landuse and Production etc.

b) Statistical Handbook of Assam - Directorate of Economics and Statistics, Govt. of Assam for

General landuse pattern, age and sex ratio and agricultural inputs.

c) District Census Handbook - Economics and statistical Dept. Jorhat for climatic data and classification of worker.

b) Primary Source

It includes collection of data through questionnaire . Two questionnaires were prepared for collecting information.

(i) Village Questionnaire:

Information pertaining to general and agricultural land use pattern were collected.

(ii) Household Questionnaire:

Information regarding agricultural production, prices and inputs were collected.

ii) **Methodology**

For the purpose of collecting information six villages were selected from the three Ecological zones of the district. Out of these, two villages were selected from each ecological zone will be considerate that one village

should have irrigation while the other without it. Thus some of the methodological step involved:

- i) Selection of the District and villages.
- ii) Process of data by using statistical techniques.
- iii) Presentation of data - cartographic techniques:
 - a) Graphs
 - b) Maps
 - c) Composite indices etc.

CHAPTER SCHEMES

(1) Statement of Problem.

Objectives

Study area

Review of Relevant Literature

Hypothesis

Data Base and Methodology

Chapter Scheme

(2) Introduction of Study Region

(a) Location of the District

(b) Physiographic Frame

i) Geology

ii) Relief and Physical Setting

iii) Drainage

(c) Climate

(i) Rainfall

(ii) Temperature

(iii) Humidity

(iv) Evapo-Transpiration

(d) Soils

(e) Vegetation

(3) Agricultural situation and Landuse Pattern.

(4) Aspects of Use of Modern Techniques in Agriculture and its Physico-Social Impacts.

(5) Data base and Methodology

(6) Irrigation and Agricultural Development: A Case Study of Selected Micro Irrigation Projects.

(7) Summary of Main Conclusions and Suggestions.

DATABASE AND METHODOLOGY

(i) **Data base.**

It is evident from the above that the study will rely mostly on the primary data source. However, secondary

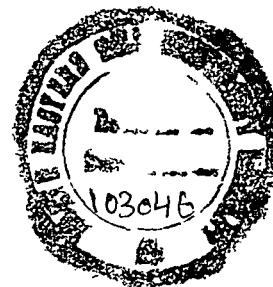
data sources will be used mainly for the following purposes:

a) **Secondary Source:**

Included have are the published documents, reports, books and journals from the Government, semi Government.

REFERENCES.

1. Phukan, U. Agricultural Development in Assam, Mittal Publications, New Delhi, 1990.
2. K. Murthy, Influence of Mettur Irrigation on Agriculture and Agro Industries. Planning Commission, Govt. of India, New Delhi, 1959.
3. Hanumantho Rao C. "Alternative Explanation of the Inverse relation between Farm size and output per acre in India", Indian Economic Review, Vol. I, No. 1966, pp. 1-12.
4. Divankar Jha. Evaluation of the Benefits of Irrigation Tribeni Canal Bihar, Orient Longman, Bombay, 1967, pp. 60-73.
5. Adbdul Aziz. "Irrigation & Economic Change in Karnataka Village" in Thimnath (ed) Rural Development, Chungh Publications, Allahabad, 1979, pp. 256-264.



6. Pandey, M.P. Evaluation of impact of Irrigation on rural Development: A case study of common area, Concept publishing Co., New Delhi, 1979, pp.1-120.
7. Misra, G.P. & Vivekananda, M. Impact of Canal Irrigation in rural areas: Case of study of Bettery District. Himalaya Publishing Co., Bombay, 1979, pp.130-145.
8. Vasudeva Rao, D. Rural Development Through Irrigation. Ashish Publishing Home, New Delhi, 1987, pp.137-144.
9. Patel, A.R. "Irrigation Scheme and Small Farmers", Kurukshetra Vol.XXI.No.21, 1983, pp.7-21.
10. Bhalerao, N.M. and Maurya, R.U. "Employment Generation Through Labour Intensive Crops", Khadi Gramodyog, Vol.XXXII, No.3, December, 1985, p.199.
11. Sahu, R. "Diffusion and Distribution Pattern of HYV of Rice in the Lower Brahmaputra Valley," Unpublished Ph.D. Thesis, NEHU.
12. Goswami P.C. & Gohain, D. "Evaluation of HYV Programme in Paddy: A Case Study in Sibsagar District", Twenty Five Years of Agro-Economic Research in N.E.India, AERC, Jorhat, 1968, p.83.

13. Phukan, U. "A study of Double Cropping in Sibsagar district", in Twenty Five Years in Agro-Economic Research in N.E India, AERC, Jorhat, 1970, p.99.
14. Ali, A.M.M. Irshad, "A Study on the impact of Mayong Lift irrigation project, Ibid. ,1975, p.115.
15. Phukan, U. "A Study of the impact of Deep Tube Well Irrigation on crop production in Jorhat District of Assam, " 1985,p.192.
16. Goswami, B: "Impact of Minor Irrigation on Agricultural Landuse and Cropping Pattern: A Case Study of Hajo Block". Unpublished M.Phil. Dissertation, 1987.

CHAPTER II
PHYSICAL SETTING AND ASPECTS OF
AGRICULTURE

CHAPTER 11

PHYSICAL SETTING AND ASPECTS OF AGRICULTURE

In the age of science and technology nearly every aspect of both nature and society have gone under remarkable changes. Ever increasing translations of scientific knowledge into production technology have not only made new facts available for analysis and study but it has also asked for redefinition of old facts relevant to contemporary needs and requirements. Geography as a discipline lying at the interface of both natural and social sciences have also been influenced by these changes. Apart from the augmentation of new facts it has also accepted and taken up the stupendous task of redefining the existing facts. A few of such facts relevant to the present study have also been considered here with the same spirit and purpose in mind.

i) Location from the point of view of space relation such as accessibility and interaction etc.

ii) Physiography from the point of view of natural aspects such as

a) Geology for economic utilization of minerals and mining resources.

b) Relief, for the purpose of other economic uses particularly agriculture,

c) drainage for the purpose of irrigation, transportation as

well as a destroyer of human cultural space and material life through floods etc.

iii) Climate including all its elements like temperature, rainfall, humidity, evapo-transpiration etc. as an important factor in the growth of plants, animals and human beings.

iv) Soil as the basis of economic existence of agrarian population and,

v) Vegetation for its economic and environmental utilities.

II Location

Location of a place plays a significant role in its development and importance. Areas located near the centers of rapid urbanization and industrialization occupy specific significance in the development than those located far from these. Areas situated near the large water bodies like seas and oceans experience moderate climate while those situated far from these in the interior of the continents have extreme climatic conditions. Location can be seen from four important angles.

i) Relative Location

Jorhat district is located on the South bank of the river Brahmaputra covering an area of 2859.0 sq.km.

It lies by the side of the National Highway No. 37 at a distance of 308 km to the North-East of Guwahati and 134 km South-West of Dibrugarh.

ii) Absolute Location

Jorhat District lies between 93°35'E and 94°37'E longitudes and 26°20'N and 27°8'N latitudes.

iii) Situation

Situated on a flat plain, created by the Brahmaputra and its tributaries, it has an altitude of 50-60 metres above the mean sea level. It shares its border with Lohit Suti, North Lakhimpur on the North, Naga hills in the South, District Sibsagar in the East and in the with District, Golaghat in the west.

iv) Aspects

On the basis of 1991 census, the district has two towns, six urban areas, 792 villages, six development blocks and two sub-divisions namely Jorhat and Majuli.

III Physiographic Frame

In the absence of detail exploration it is difficult to estimate the amount and extent of mineral and fossils fuel deposited in the district. However, on the basis

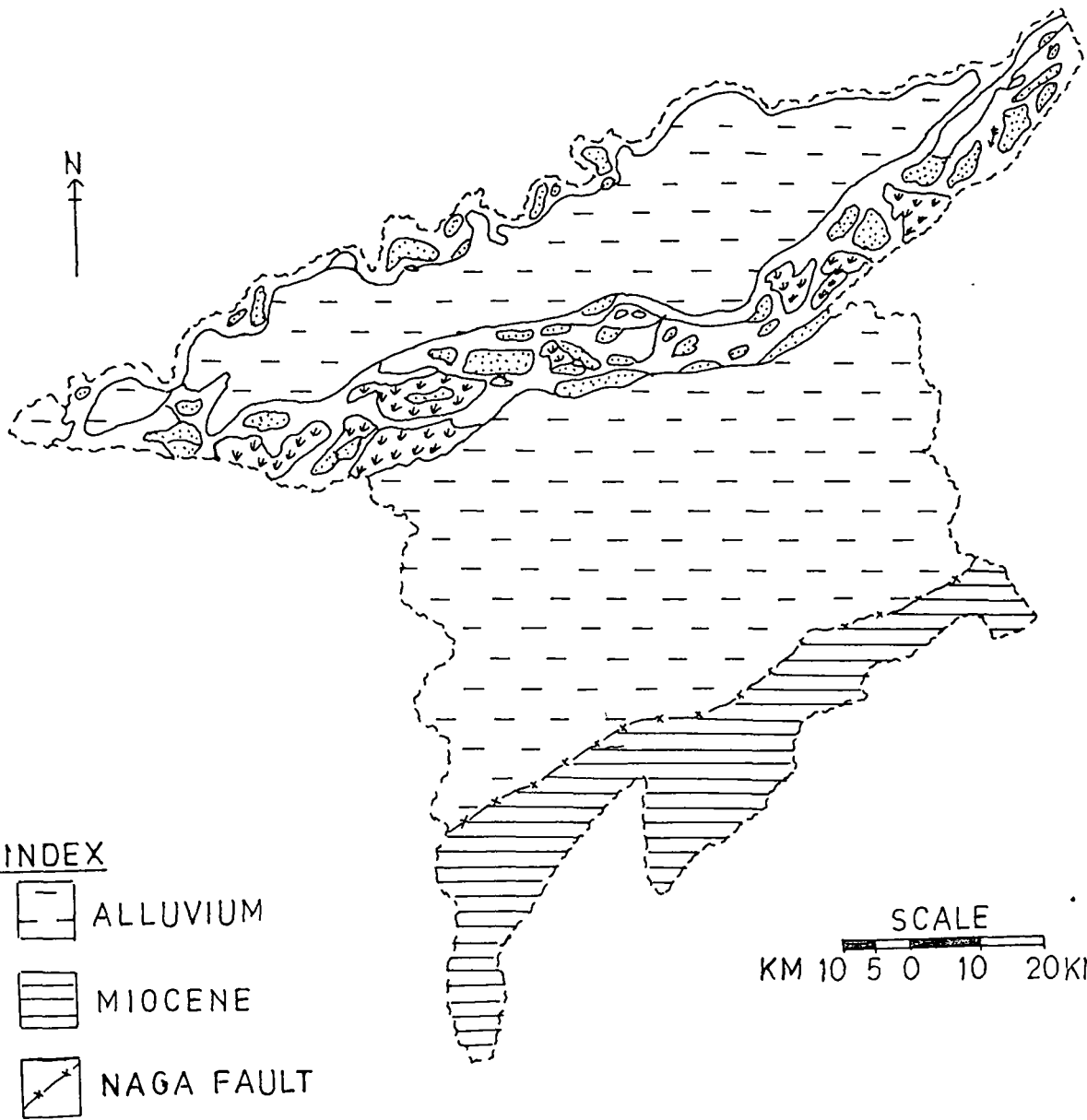
of the geological history of the district and active geomorphological processes in the entire Brahmaputra basin, it can be expected that this district is likely to have significantly high fossils fuel deposits. But, for the time being, geological structure of the district is also important that way it has influenced the relief, drainage and soils of the district.

PHYSIOLOGRAPHIC FRAME

i) Geology

Looking at aspects of geological structure it can be generalized that large parts of the district Jorhat, is covered by the rock formation belonging to Miocene and Pliocene time ie. the recent periods of Tertiary age¹. Due to lack of non-availability of detail geological information at the district level, structural features of the rock formations have been studied on broad basis. Information, given by the Geological Survey of India (Regional Headquarter, Shillong), there are two types of rocks prominently found in district Jorhat. It is also evident from the map (Fig. 2) that the southern part of the district is formed of Namsang series belonging to the Miocene period². Here the rocks are slightly hard, with sandstone, clay and slates as dominated rock types. The soils are eroded and deposited towards the northern and

JORHAT DISTRICT GEOLOGICAL STRUCTURE



Based on Geological Survey of India's Map

FIG.-2

north western parts of the district due to heavy rainfall and undulating topography. Thus leaving behind the red soil which has less humus contents with very low fertility and as a result not very much congenial for agricultural purposes. The rainfactor and abundant supply of water are also responsible for erosion of rock materials and its deposition in the lower parts of the district. On the other hand, central part which lies between the river Brahmaputra in the north and Naga hills in the south is covered by old alluvium soils, deposited during Miocene and Pliocene periods. It is rich in humus contents, and therefore, it can be used for intensive cultivation. The deposition processes of rock formations are still active process in the neighbouring areas of the mighty river Brahmaputra. So, the soils of the extreme northern part of the district are mostly on newly formed alluvium which has more water accumulations and fine sands. The alluvium deposits in the plain area are calculated to be about 1500 metres thick³.

ii) Relief and Physiography

Physiography is one of the dominant parameters of physical environment and its impact on patterns and density of agriculture is immense⁴. With the exception of some undulating surface features in the extreme southern part, the entire district is relatively plain with altitudes varying

150 metres to 200 metres in the southern part and between 50 - 60 metres in the North. These spatial variations in the relief are also shown over the map (Fig. 3). On the basis of local geological features and active geomorphological process the district can be divided into the following three subdivisions.

- a) Northern low-lying areas,
- b) Central fertile plains and
- c) Southern highlands.

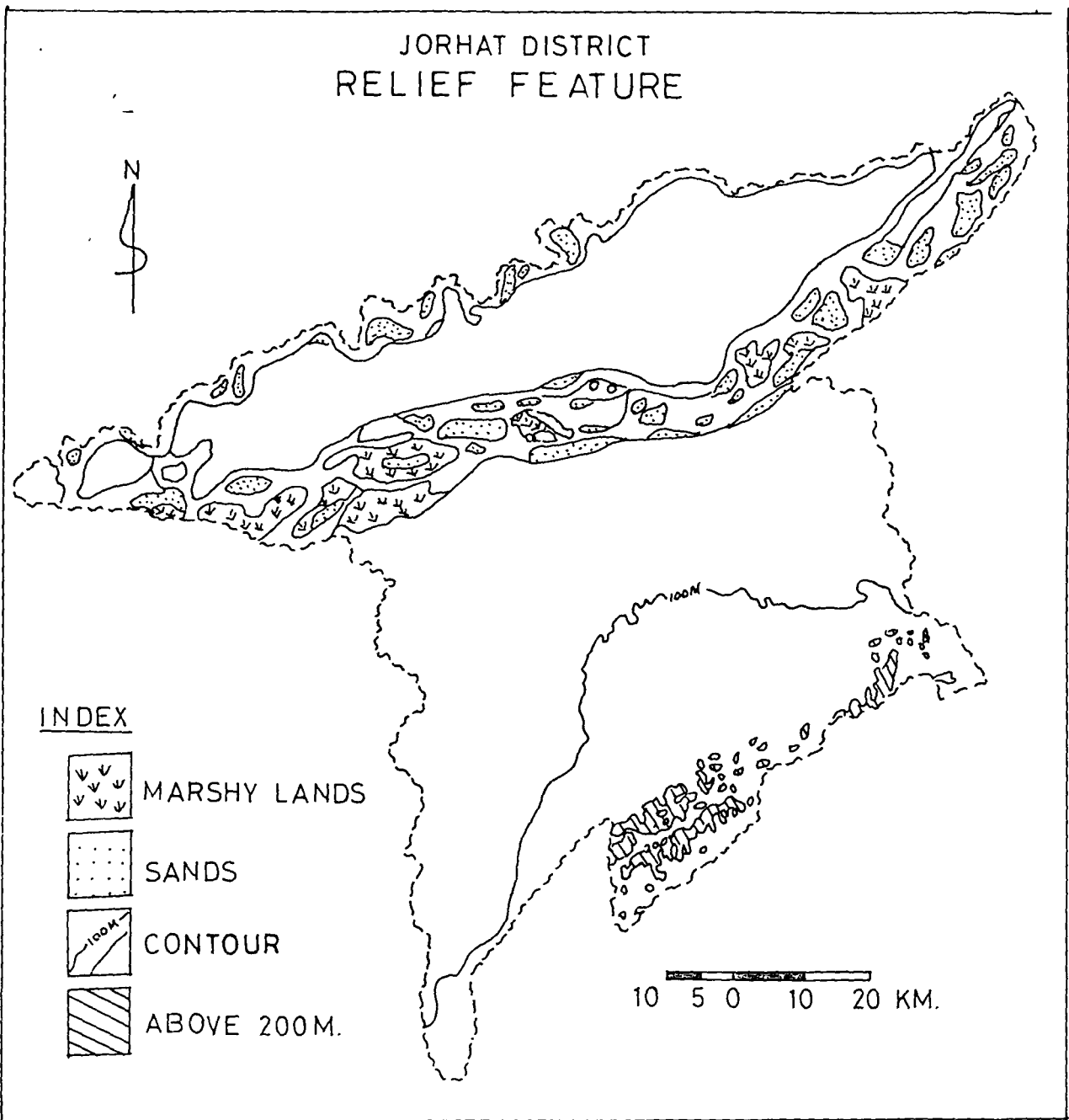
a) Northern Lowlying area:

This area includes the world famous "River Island Majuli"⁵ subdivision and lowlying areas of southern Brahmaputra ie. Northern parts of Dhekargarah block (N-W Block) and Teok Block. These areas are annually inundated by the river Brahmaputra during the time of full south western monsoon. It occupies large number of marshes and swamps which are formed by waterlogged conditions and supports luxuriant fodder grasses like Kher, Nal, Ekara and Khagari.





b) Central fertile Plains:

This is an extensive homogeneous plains of Upper Assam which is formed by the aggradational work of the river Brahmaputra and its tributaries. The area slopes down gradually from south to north and mostly composed of old alluvium soils.

JORHAT DISTRICT RELIEF FEATURE



INDEX

-  MARSHY LANDS
-  SANDS
-  CONTOUR
-  ABOVE 200M.

10 5 0 10 20 KM.

FIG.-3

c) Southern Highlands:

This area lying in the Southern margin occupies nearly 15 percentage of the total area of the district. It is bounded by the long wall of Nagapahar (Naga hills) in the south. Thus the topography here is somewhat undulating due to the presence of the foot hills of Naga hills.

It is also evident from the maps that district Jorhat is dominated by relatively plain topography. The minor local level topographic variations is largely caused by the fluvial action of river Brahmaputra and its tributaries. Thus physiography, relief and drainage make the composite natural environment of the district.

IV Drainage:**i) Surface Water**

District Jorhat is drained by the river Brahmaputra and its tributaries, viz. Jhaugi, Bhogdoi and Kakodonga which originate from Nagahills in the south. All these tributaries meet the mighty river Brahmaputra which crosses the district from east to west and form various confluence (Fig. 4). Most of the areas bordering the southern Brahmaputra are occupied by a vast tract of lowlying swamps and heels. Apart from the several heels and swallow mires, this district does not have any other large water body or lakes. However, mentioned must be made here that a few tanks dug by

JORHAT DISTRICT
DRAINAGE PATTERN



Source Topo-Sheet No. 83 H, I & J

FIG-4

the former Ahom Kings are still in use as source of fresh water for the surrounding areas. Besides these, some "Kuliput" which are dug by the 'Kuli' for construction of embankments in the flood affected lowlying areas are also used for agricultural purposes during the dry months i.e., November to April. Though the water from these 'Kuliputs' needs proper management before it can be used for irrigation.

ii) Ground Water

A sufficient high quantity of water goes inside the surface through surface soil. It is stored and flows below the surface as ground which can be used for irrigation during the dry seasons. District Jorhat is also endowed with large potentialities of ground water resources. Irrigation, based on utilisation of ground water resources, is not only cheap, but also within easy reach of an average peasant. The depth of water table varies from 2 to 4 metres in the district. In the northern parts of the district, ground water level is only 2 metres as this area is a lowlying marshy land. In the southern hilly tract of the district, ground water is not available upto 10 metres, while in the central part of the district water table is found at a depth of between 3 to 5 metres. Apart from these the water table also fluctuates from one season to another in a year. During rainy season, when excessive rainfall occurs, the water table goes up and

during winter, it goes down because of dry climate. The ground water gradient of the district is towards the Brahmaputra river. An important characteristic feature of drainage system, not only in the district Jorhat but also in the entire Brahmaputra valley is its perennial nature which makes water management a multipurpose project in the region including irrigation, navigation, fishing, power generation etc. It is well known that climate is the most determining factor behind the perennial drainage system of the region. Apart from influencing the drainage climate is also important for the growth and diversity of life including flora, fauna and soils of the district. It is therefore important to study climate in more detail.

V Climate:

The location as well as situation of the district discussed in the previous section of this chapter has played significant role in influencing the climate of the region. Being a part of Upper Assam Valley, district Jorhat also falls into the same climatic zone shared by the other areas of upper Brahmaputra valley of Assam. It is characterized by high humid atmosphere, abundant rains and general coolness.

Four seasons are generally prevalent in this district with slight differences in weather condition.

These are as follows:

- 1) The Cold Season ----> December to February
- 2) The Season of severe
thunderstorm ----> March to may
- 3) The South West Monsoon ----> June to the beginning
of October
- 4) The Post Monsoon Season ----> October to November

Temporal variations in the distribution of precipitation, temperature, humidity and evapatranspiration are the main distinguishing feature of these season. *

1) Rainfall:

It is clear from the Table No.I that though the average rainfall of the district does not vary much over different months of the year yet monthly variation are generally common. Records of rainfall in the district is available for one station (Tocklai Tea Experimental Centre, Jorhat) for period ranging from 1984 to 1993 (10 years). The details of the rainfall at this station and for the district as mentioned in Table No.I shows that the average annual rainfall in the district is 2000 mm throughout the zone. About 67 percent of the annual rainfall in the district is received during the monsoon season from June to October. July being the month with the maximum rainfall.

ii) Temperature:

The mean temperature of the district during the month of July ranges between 28.0°C to 28.5°C and in January between 15.5°C to 16.0°C. The mean maximum temperature recorded has been upto 33°C during July and mean minimum falls down to 8° in January⁶.

The cold season starts about the end of November when both day and night temperature begin to drop rapidly. January is the coldest month of the year with mean daily maximum at 21.5°C. Temperature begins to rise from about the beginning of March and by July it attains the highest point, the mean daily maximum temperature being 32.5°C.

The monsoon season is the period of the year with the highest temperatures. Being also the period with high moisture in the air, the weather is often unpleasant with damp heat particularly in between the two spells of rain. With the withdrawal of the south west monsoon by about the second week of October, the weather gradually becomes cooler.

iii) Humidity:

The atmosphere is highly humid throughout the year in the District Jorhat. Table No.2 and 3, give the temperature and relative humidity data for a period of 10 years (1984 - 1993).

It is pertinent to note that for better

JORHAT DISTRICT
RAINFALL - TEMPERATURE GRAPH
(1984-93)

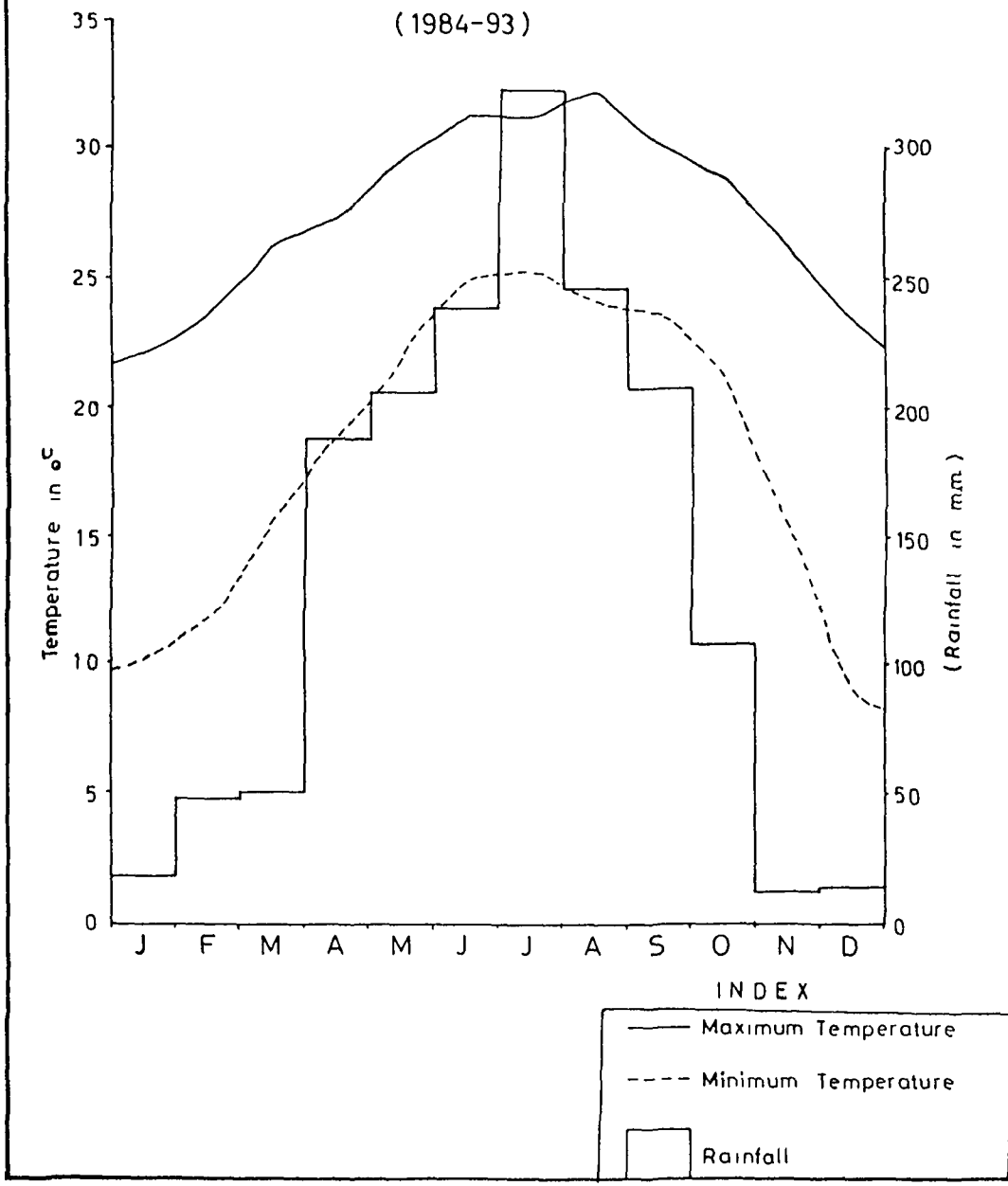


FIG 5

HYTHERGRAPH—JORHAT

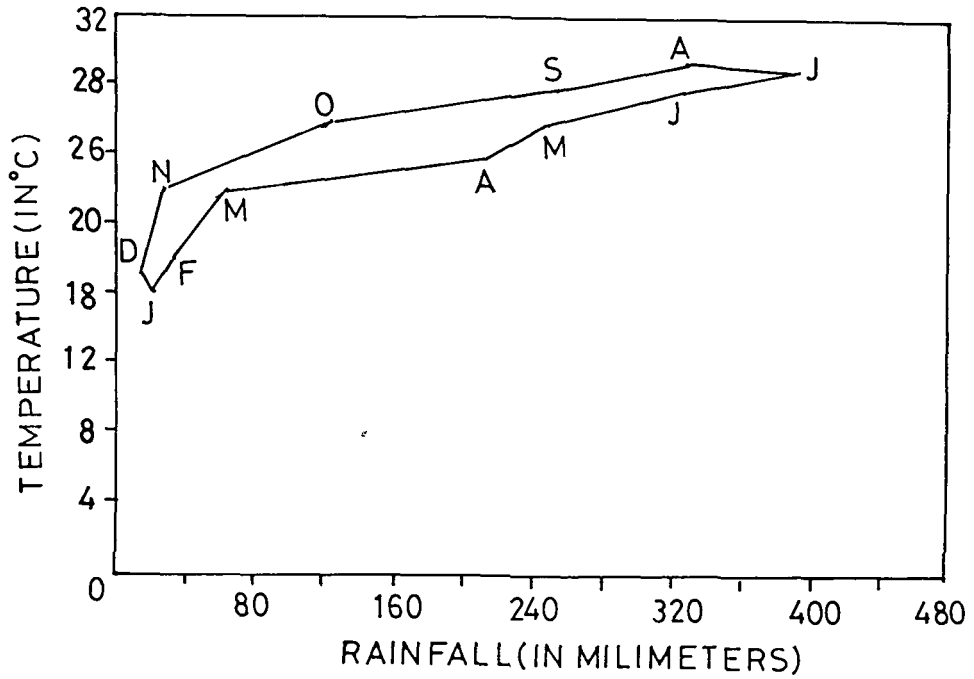


FIG-6 BASED ON 10 YEARS AVERAGE (1984-93)

CLIMOGRAPH—JORHAT

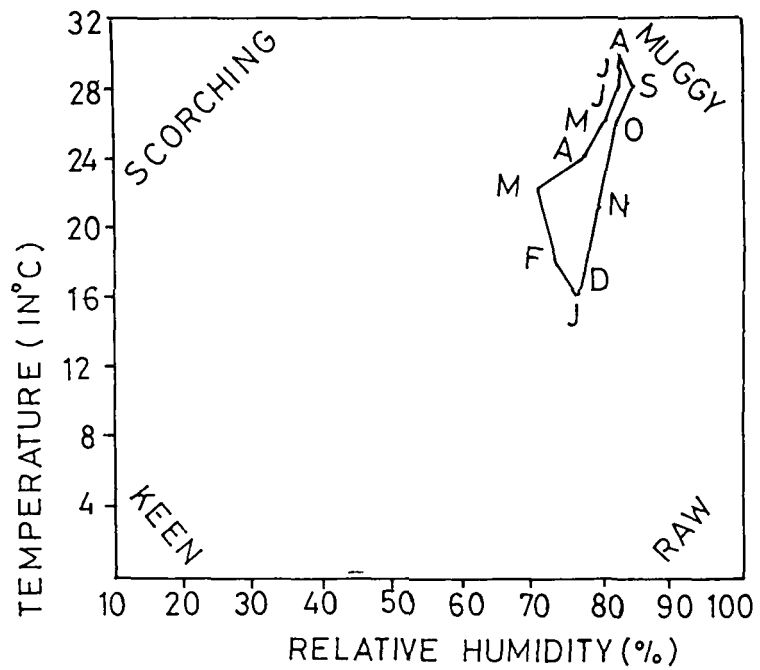
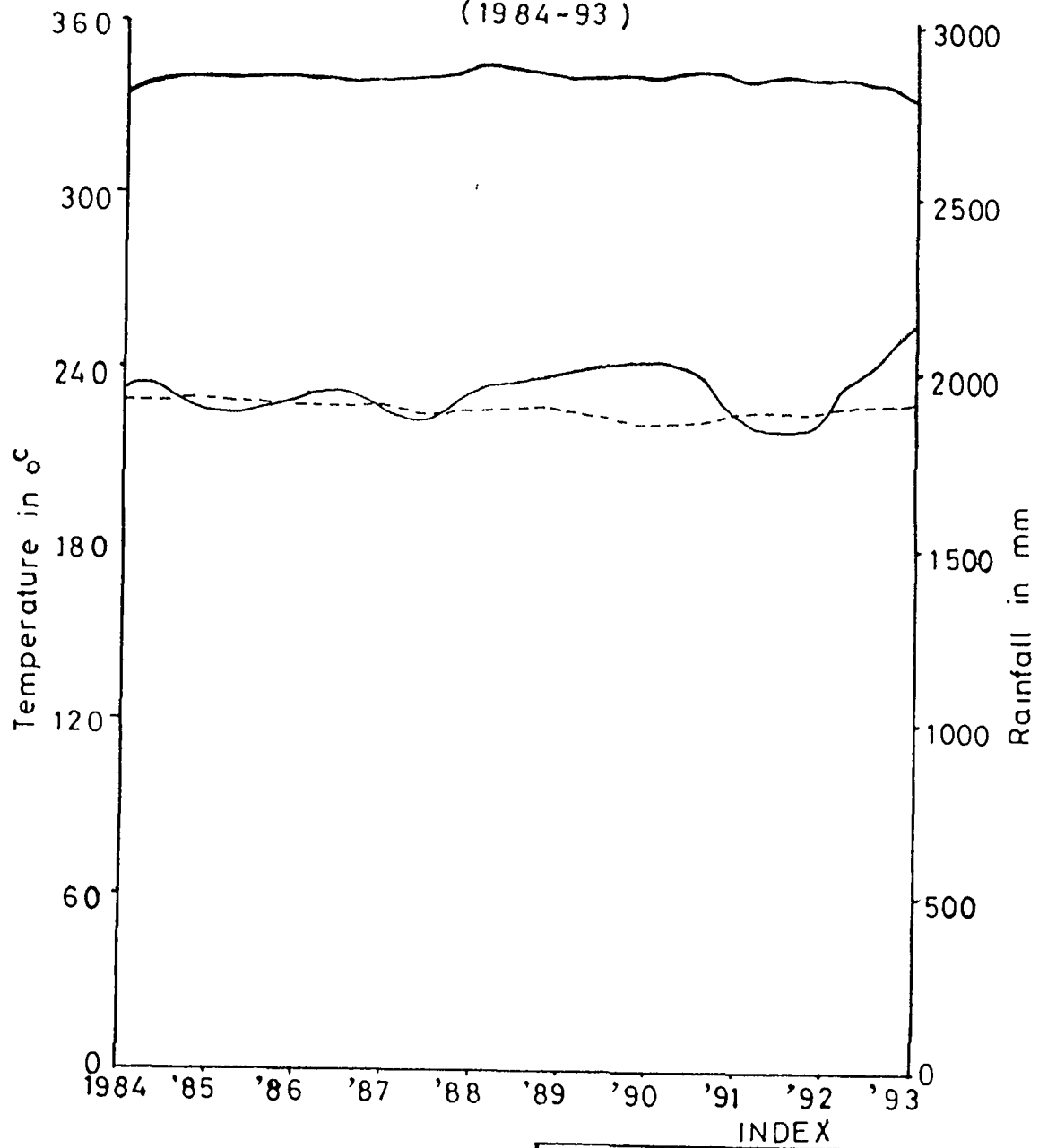


FIG-7 BASED ON 10 YEARS AVERAGE (1984-93)

JORHAT DISTRICT
RAINFALL AND TEMPERATURE VARIATIONS
(1984-93)



— Maximum Temperature
- - - Minimum Temperature
— Rainfall

FIG. 8

understanding of the climatic condition of district Jorhat climatic graphs are needed. Fig. 5, Fig. 6, Fig. 7 and Fig. 8 show Rainfall - Temperature graph, Hythergraph, Climograph and Rainfall Temperature variations graph respectively by using the climatic data. These climatic figures reveal that the summer and the winter seasons are quite distinct in respect of temperature condition and rainfall distribution, thereby facilitating the cultivation of a variety of crops during these two seasons of the year, thus giving a seasonal rhythm to the agricultural activities of the district.

iv) Evapo - Transpiration :

The annual potential evapo-transpiration at Jorhat district is 1,260 mm . Water deficit is estimated to be 30 mm at Jorhat. According to climatic water balance studies, period of moisture deficit in Jorhat is from November to December and extends upto Mid March. The Evapo-Transpiration Ratio measures the Plant nourishment time which is the outcome of -----> AE/PE -----(1)

In Jorhat, Evapo-transpiration ratio is 0.6, 0.7, 0.7 in January, February and March respectively. The Evapo-Transpiration ratio is 1, for other months.

The water-budget approach of the water availability is very much essential for understanding the water

JORHAT DISTRICT WATER - BALANCE

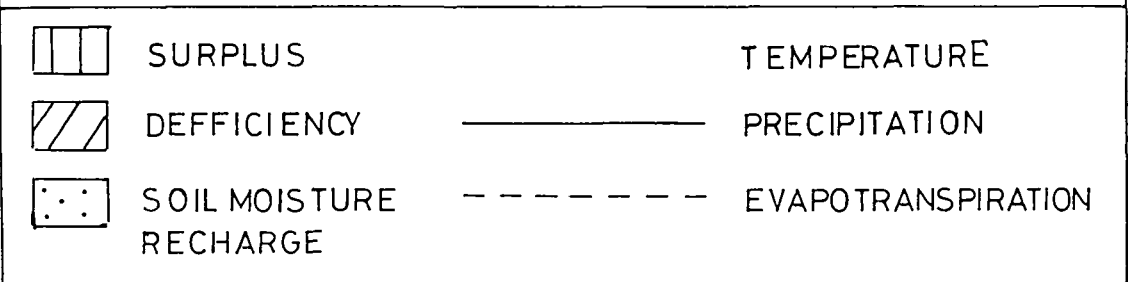
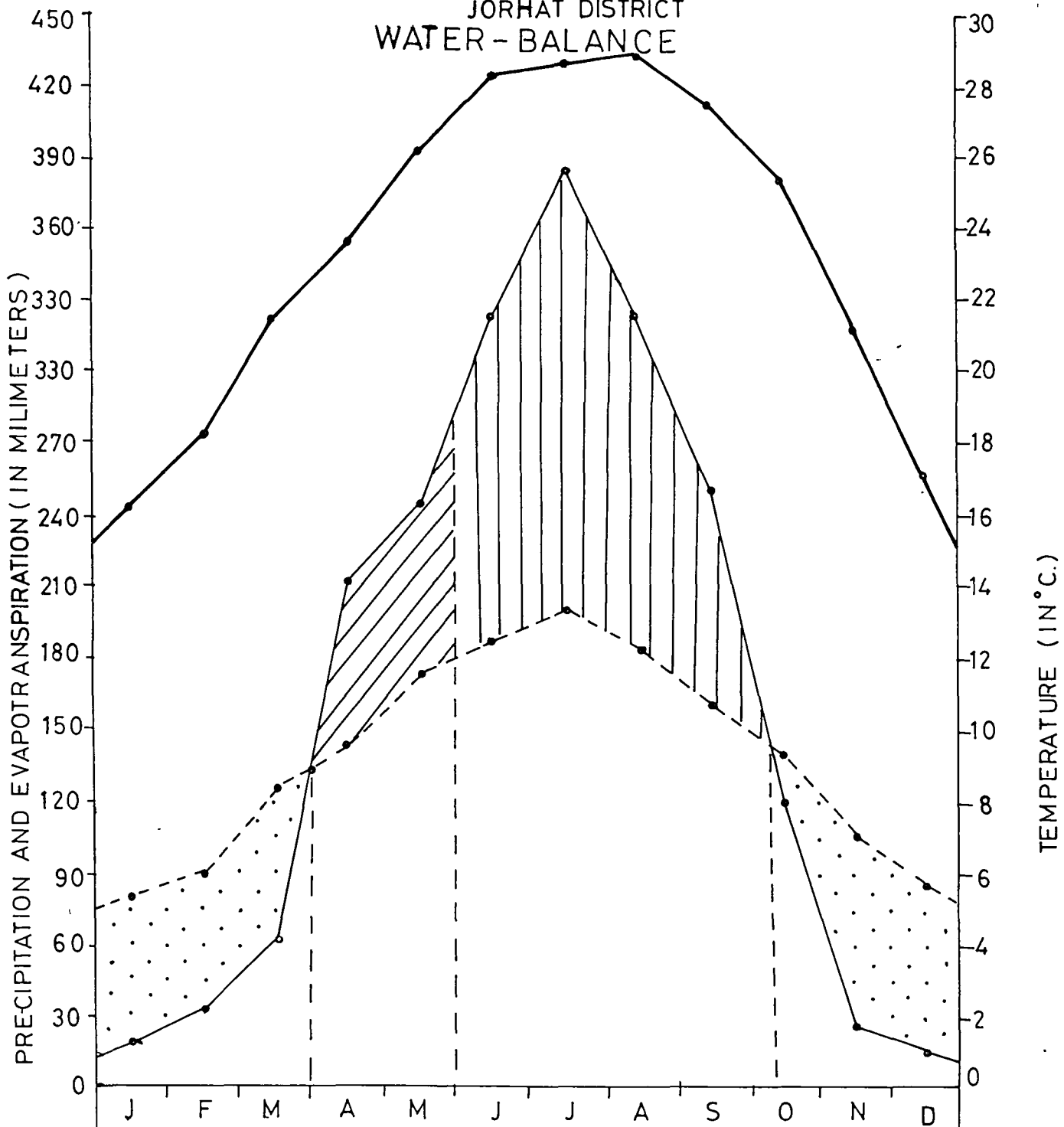


FIG-9

requirements. Using Thornthwaite and Mather formula⁷,

$$PE = 11.5 \left(\frac{P}{t-10} \right)^{10/9} \text{ -----(2)}$$

the quantity of potential evapo-transpiration has been assessed for each of the month and then water balance table has been prepared (Table No. 4). The table indicates that the months of April and May have the water deficiency while the soil recharge period is from October till March (winter season). Therefore, the period from June to October is the best period for Agriculture (Fig. 9).

Climate being the most significant element of the natural environment has both temporal as well as permanent impact upon the environment. Nature and quality of soil, type and density of vegetation are among the permanent impact of climates on the environments. But in its turn soils and vegetation also influence the habitat environment on the one hand and social environment on the other. Thus, soils occupy specific significance of environment that can directly influence particularly agricultural development.

IV Soils:

Soil is the source of meeting practically

all the human needs of foods, clothing and an ever increasing list of other needs. Actually, human beings get nearly all their food requirements from soil and it is estimated that less than one percent of what human beings eat comes from of fish and other water bound organism. Hence, geographical investigation of soil characteristic in agricultural geography is of great significance as geography is a human ecology⁸. It is a prerequisite for all agricultural operations and planning.

On the basis of their occurrence, chief characteristics and suitability for cultivation, the soils of the district can be divided into three types:

- i) New alluvium soils,
- ii) Old alluvium soils and
- iii) Laterite red soils.

i) New alluvium soils:

Three types of soils are mostly found along the northern lowlying flood plain areas of the district. "B" groups are the common series in this part which is characterized by maximum accumulation of materials. The new alluvium soil of the district is composed of sandy loams. It is useful for the cultivation of rice, jute, pulse, mustard, pea, potato and vegetables. The nitrogen percentage and organic matters are also suitably proportional for agricultural

purposes. But acid contents are less. The pH value is normal, i.e., 5.5.

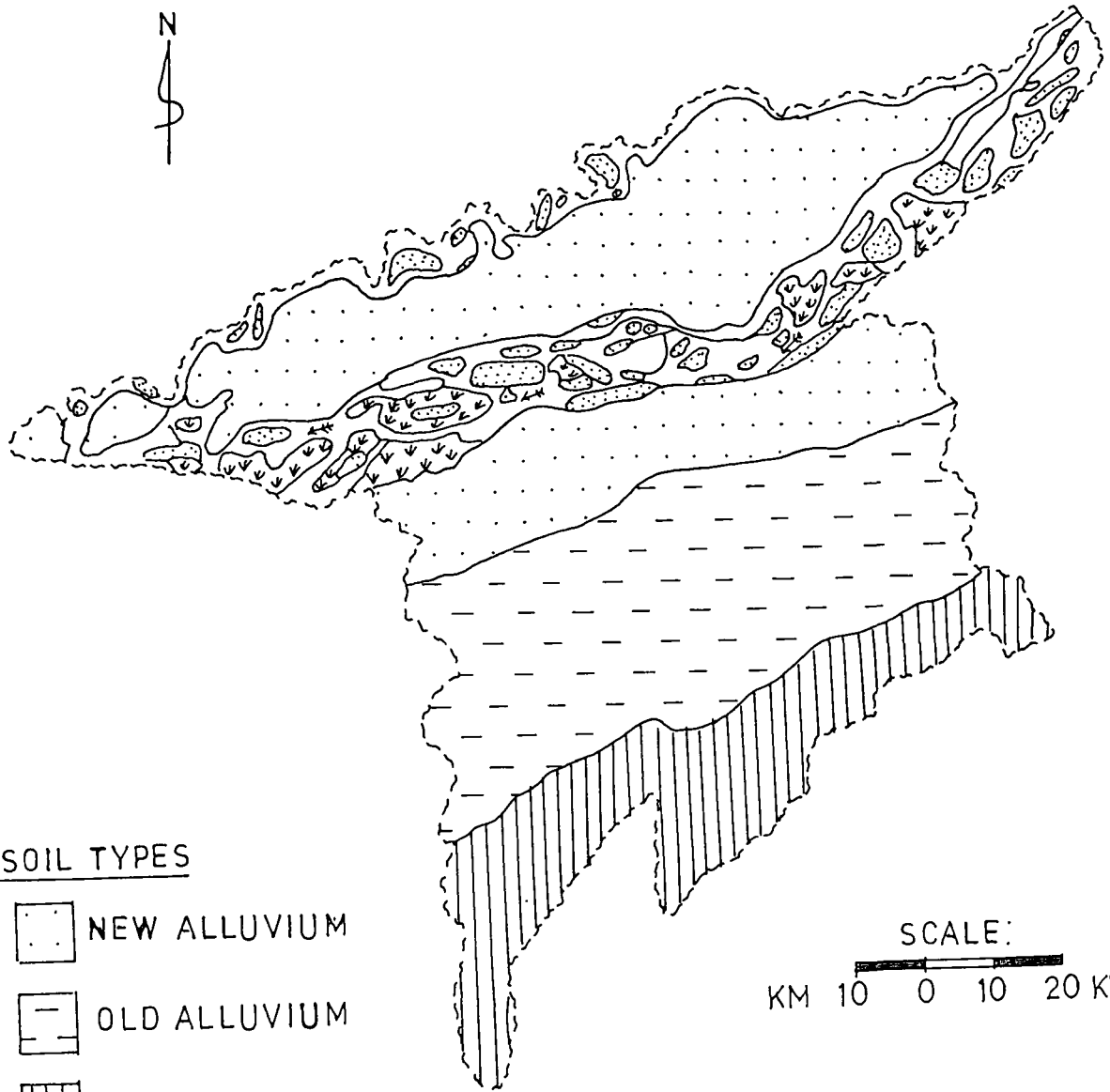
ii) Old Alluvium Soils:

In between new alluvium soils and laterite red soil areas, there lies the wide and most important belt of old alluvium specially in the central part of the district. "O" group of soil is prominent in this zone. These soils result from litter derived from dead plants and organisms. The color is generally yellowish. The texture of the soil varies from sandy to clay loams with different amount of nitrogen content. This zone is relatively less acidic in nature and usually deficient in "available phosphate" with low to medium proportion of potash. The PH value varies from 4.2 to 5.5. It forms the higher grounds and supports numerous tea gardens of the district.

iii) Laterite red soils:

The laterite red soil is confined to the southern margin of the district. In this zone, "A" group of soil is formed, which is mineral horizons and characterized by maximum leaching. The texture varies from sandy to clay to clay loams. Such soil is rich in minerals (specially Fe) and poor in organic contents. It is highly leached and deficient in potash, phosphorus and lime. So, it is less fertile and not much suitable for agricultural purposes, but it support

JORHAT DISTRICT SOIL ZONES



SOIL TYPES



NEW ALLUVIUM

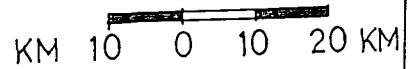


OLD ALLUVIUM



LATERITE RED SOIL

SCALE:



Based on Agricultural Atlas of Assam(1971)A.A.U

FIG-10

luxuriant forest and grass vegetation (Fig. 10).

V Vegetation:

Jorhat district has no distinguishable variety of natural vegetation, as the climatic condition, prevailing in the district is almost same throughout the areas, But the area with its peculiar topography, fertile soils and climatic conditions help the growth of luxuriant vegetation. The district had a total of 10550 hectares of land under forest in 1993. The C.D Blocks situated in the eastern and southern parts of the district occupy the higher area under forest covering 9010 and 1540 hectares respectively. The soil of these blocks, is rich in mineral content. Broadly, vegetation of the district can be classified as follows:

- i) Tropical Evergreen forest
- ii) Miscellaneous forest⁹

i) Tropical evergreen forest:

The south eastern part of the district has best stock of evergreen forest. They include vegetation such as Houong, Nahor, Sam, Amri, Gunseroi, Makai, sopa, etc.

ii) Miscellaneous forest:

This type of forests include riverine and Savannah types of forests in the district which can be seen in the northern and central part of the district. In this category

such species are included whose top canopies are deciduous and the middle and lower canopies are evergreen in character. The most common trees of this type are Bhelu, bamboos such as Keko and Dalo, Koroi, simalu. Various kinds of grass such as Ekara, Nal, Khagari, etc. are grown in low-lying areas, (Riverine tracts).

On the basis of above discussion it can be concluded that the relief and physiography of the district is the result of underlying geological structure and active fluvial geomorphological processes. The river Brahmaputra and its tributaries not only provide the main system of drainage in the district but it also plays its role in creating local physiographic variation. In view of the uncertain characteristics of monsoon rains in the district there exists a *Prima facie* case in favour of irrigation, even in the summer months for assured supply of water to the crops.

TABLE NO: 2.1

Average monthly rainfall of Jorhat for a period of 10 years (1984 - 1993)

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (in mm)	18.70	47.1	48.55	186.01	207.3	239.7	324.6	246.17	206.30	209.25	12.84	13.94

Source: Tocklai Tea Experimental Station, Jorhat.

TABLE NO : 2.2

Maximum and minimum average monthly temperature of Jorhat district (1984 - 1993)

Months	J	F	M	A	M	J	J	A	S	O	N	D
Maximum Temp. °C	22.1	23.74	26.7	27.56	29.54	31.9	31.6	32.21	30.69	29.22	26.76	23.6
Minimum Temp. °C	10.06	12.7	16.57	19.46	22.39	25.04	25.03	24.96	24.46	21.46	15.40	9.59

Source : Tocklai Tea Experimental Centre, Jorhat.

TABLE NO: 2.3

Average monthly Relative Humidity of district Jorhat for a period of 10 years (1984 - 1993).

Months	J	F	M	A	M	J	J	A	S	O	N	D
R.H. %	76.85	76.2	73.2	78.15	80.25	81.4	83.05	81.4	84.2	82.65	77.75	77.0

Source : Tocklai Tea Experimental Centre, Jorhat.

TABLE NO : 2.4

Monthly Water Balance - Jorhat District

(Water holding capacity in alluvium soil of Jorhat District is assumed as 200 mm. All values except T in mm, T & P value are 20 years (1970-1990) average).

	J	F	M	A	M	J	J	A	S	O	N	D
T °C	16.13	18.14	21.58	23.81	26.22	28.37	28.57	28.73	27.73	25.57	21.33	17.20
Unadj PE	3.06	3.44	4.09	4.51	4.97	5.38	5.41	5.44	5.25	4.85	4.04	3.26
PE	83.56	89.78	126.38	144.77	174.45	187.22	193.14	184.42	162.23	142.59	107.87	87.04
P	19.68	32.35	62.41	211.40	246.10	323.50	385.49	324.32	252.18	121.51	26.44	16.53
P-PE	-63.88	-57.43	-63.97	66.63	71.65	136.28	192.35	139.90	89.95	-21.08	-81.43	-70.51
Acc Pot WL	-236.90	-294.33	-358.30	0	0	0	0	0	0	-21.08	-102.51	-173.02
ST	0	0	0	66.63	138.28	200.00	200.00	200.00	200.00	178.92	97.49	26.98
? ST	-26.98	-26.98	-26.98	-66.63	-71.65	-61.75	0	0	0	-21.08	-81.43	-70.51
AE	46.66	59.33	89.39	144.77	174.45	187.22	193.14	184.42	162.23	142.59	107.87	87.04
AE/PE	0.6	0.7	0.7	1	1	1	1	1	1	1	1	1
D	36.90	30.45	36.99	0	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0	0	0	0	0
Ro	0	0	0	0	0	0	0	0	0	0	0	0

T= Monthly average temperature

Unadj PE = Unadjusted Potential Evapo-transpiration.

PE = Potential Evapo-transpiration

P = Mean Monthly average Precipitation. Acc Pot WL = Accumulated Potential Water loss.

ST = Soil Moisture storage.

ST= Change in Soil Moisture storage AE = Actual Evapo-transpiration

D = Moisture Deficit

S = Moisture Surplus

Ro = Water Runoff

Temperature and rainfall data are collected from Regional Tea Research Centre, Tocklai, Jorhat.

REFERENCES

1. Assam District Gazetters (1967), Sibsagar District, Shillong, p-21.
2. Government of Assam (1967), op.cit., p-21.
3. Singh, R.L (ed 1971) India: A Regional Geography. (1st edition), N.G.J.I, Varanasi. p-306.
4. Chouhan T. S. Agricultural Geography. A study of Rajasthan State. Academic Publishers Jaipur -302003, p-27.
- 5 Majuli is the local name of the area which lies between Brahmaputra river and its tributary.
- 6 Field Mannual For Rainfall Agriculture in Assam. Directorate of Research A.A.U. Jorhat: Assam, Page-6
- 7 Thornthwaite and Mather, cited from Maps & Diagrams, by Monkhouse , F.J. & Wilkinson. H.12 (1980) B.I. Publications, New Delhi, p-215.
- 8 Putnam, D.F. 1967. Soils and their geographical significance. In Geography in the twentieth century (ed). Griffith Taylor, London, pp. 221-222.
- 9 Gazettcer of India. Government of Assam (1967), op.cit. p-25.

CHAPTER III
AGRICULTURAL SITUATION
AND
LANDUSE PATTERN

CHAPTER III

AGRICULTURAL SITUATION AND LANDUSE PATTERN

Agriculture is a major occupation as well as an most important source of livelihood for majority of the population in the state of Assam and also in the other states of India. But, the nature of dependence of population on agriculture is significantly different in Assam as compared to the other states of the region as well as of the country. Coexistence of predominantly intensive subsistence wet paddy cultivation with the highly mechanized and commercial tea cultivation on the one hand and subsistence Jhum cultivation on the other are some of the unique features of agriculture in Assam. The uniqueness of agricultural system in the state is the composite result of factor natural, social, economic and historico-political in nature. Some of the important of aspects of agriculture indicating the outcome of the above mentioned multifaceted inter-related factors from the point of present study are:

(a) agricultural landuse as an outcome of interaction between the cultural and environmental,

(b) Cropping intensity, crop-combination and agricultural efficiency as indicators of human adjustment to a given environment for meeting unlimited human needs from limited resource through greater use of ever improving

agricultural technology.

(c) assessment of agricultural resources for meeting demand of food, employment and income in the future.

1 **Agricultural Landuse.**

Land resources play an important role in fostering man's economic social and cultural progress. Among the other use of land resource, its use as a agricultural resource has played a vital role in engaging highest percentage of the inhabitants of the world¹ for their employment and livelihood.

Agricultural landuse in Assam is characterized by a low percentage of cultivable land, predominantly high percentage of total agricultural land under rice, low crop intensity and low yields of crops per unit area. Unlike the developed regions of the world, agricultural landuse in Assam means the cultivation of land for growing crops and leaving insignificantly low percentage of the total cultivable area under other uses like grassland, poultry farming, horticulture, pisciculture and diary farming etc.

It is a common experience that for the overall development of a region, in general and agricultural development in particularly landuse survey at micro-level is of utmost importance². But, ironically enough the sate of

Assam so far lags far behind in proper landuse survey. This is believe to be an important factor in making proper assessment of landuse difficult in the State. However, inspite of the inadequate information available about the landuse pattern in the state it has been observed that in district Jorhat as well as in the state of Assam area under different crops have increased but very slowly during the past two decades. According to an estimate the gross cropped area increased from 1.56 lakh hectares in 1980-81 to 1.75 lakh hectares in 1990-91 in district Jorhat. Moreover, it is also seen that out of the total cropped area, food grain crops occupy about 81 percent thus, leaving only 19 percent area under other crops. The predominance of food crops in the agricultural landuse of the district indicates marginal modernization of agriculture through increasing use of modern production techniques in Jorhat as well as in Assam.

Rice, being major staple food of the people, accounts for nearly 76.5 percent of the total agricultural area in 1992-1993. This is because rice is grown extensively in every block of the district in all the seasons of the year. But, unlike the other agriculturally developed areas of the country rice cultivation in Assam is labour intensive with limited modernization. On the basis of growing reason, three types of rice are grown in the district. These are winter rice (sali and Bao), autumn rice and summer rice.

Among the three types of rice, winter rice is the most important occupying as high as 70.0 percent of the total cropped area (1992-93). The share of autumn rice is only 5.5 percent while summer rice accounts only 1.0 percent of the same.

Besides rice, wheat is another important food crop of the district. Wheat is grown in Rabi (winter) season. But it is observed that the area under wheat has not been increasing significantly during the last decade as it accounts only 1.4 percent of the total cropped area. The area under maize cultivation is also equally insignificantly low in the district. Apart from those pulses and oilseeds are also important food crops in the district occupying an area of 8.5 percent and 3.5 percent of the total cropped area respectively. Oilseeds are an important traditional rabi crops in the district as well as in Assam. Rape and mustard cover the highest share of agricultural land among the oil seeds. The other oil seeds grown in the district are sesamum, linseed and castor etc., but these are not much significant with respect to their area and production.

TABLE 3.1

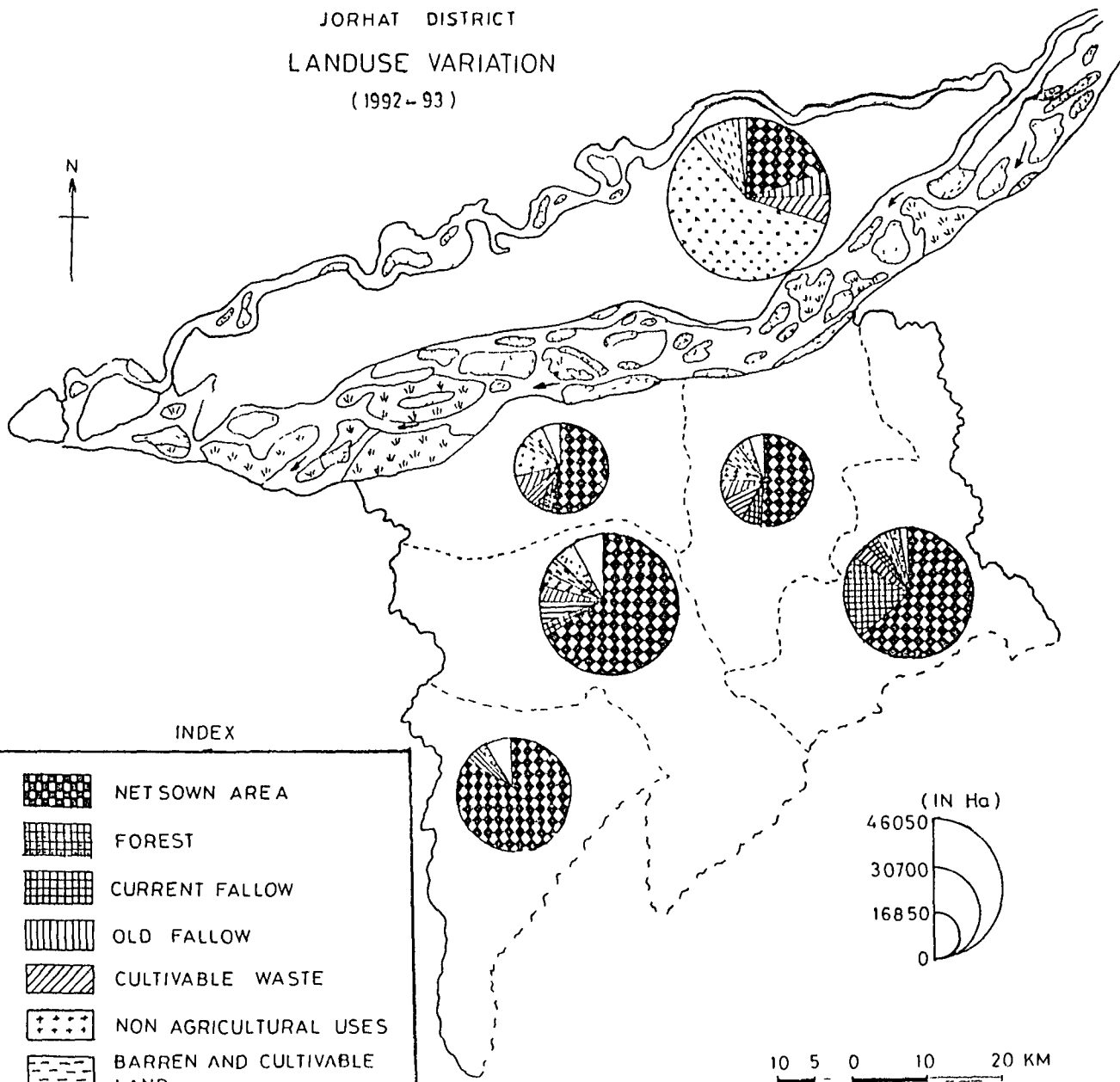
Volume of change in landuse pattern in Jorhat District
(1989 - 90 to 1992 - 93)

(Area in hectares)










SL.No.	Categories	1989-90		1992-93	
		Area	%	Area	%
1.	Geographical Area	304964		304964	
2.	Forest	10534	3.4	10550	3.46
3.	Land put to non agri- cultural use	83874	27.5	84200	27.6
4.	Barren & Uncultivable land	19389	6.3	19387	6.35
5.	Total (3 & 4)	103263	33.8	103587	33.19
6.	Permanent Pastures and other grazing land	6743	2.2	6730	2.2
7.	Land under miscellaneous	10391	3.4	10375	3.4
8.	Cultivable waste land	12126	4.0	12114	3.9
9.	Total (6+7+8)	29260	9.6	22509	7.4
10.	Fallow Land other than Current fallow	7244	2.4	7230	2.4
11.	Current fallow	8874	2.9	8910	2.9
12.	Total (10+11)	16118	5.3	16140	5.3
13.	Net Area sold	146840	48.0	149313	48.9
14.	Area sown more than once	23262	-	24046	-
15.	Total (13+14)	170102	-	173359	-

Source: Block Development Office, Jorhat District.

JORHAT DISTRICT
 LANDUSE VARIATION
 (1992-93)



INDEX

-  NET SOWN AREA
-  FOREST
-  CURRENT FALLOW
-  OLD FALLOW
-  CULTIVABLE WASTE
-  NON AGRICULTURAL USES
-  BARREN AND CULTIVABLE LAND
-  PERMANENT PASTURES AND GRAZING LAND
-  MISC TREE CROPS

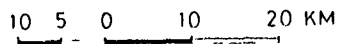
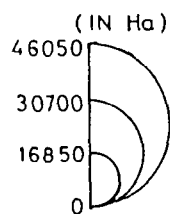


FIG II

Some fiber crops like jute and cotton are also produced in the district. But, their share to the total cropped area is not much significant, i.e., (0.06 percent only). Sugarcane, is another cash crop grow in the district. Its share is also only marginal as it covers only 0.7 percent of the total cropped area.

There are other miscellaneous crops like potato, tobacco, chillies, sweet potato, ginger, cabbage, bringal, tomato, onion, cauliflower, radish, ladys'finger coconut etc. grown in the district. Among these crops, Potato covers an area of approximately 1.5 percent of the total cropped area. Other crops are however, not significant with respect to their area and production. Last but not least important crop grown here is tea. Tea is an important commercial crop of the country and it has specific significant in the economy of the district and state. But it has been dealt separately from the agricultural landuse pattern because of differences in the purpose, scale, labor processes and production relation and also it being tree crop and grown for a longer period (50-60 years) However it is worth mentioning here that the world famous Tocklai tea research centre is also situated within the district.

2 Cropping Intensity

Intensity of cropping gives some indication of the gross cropped area which in its turn

indicates greater control over the processes of agricultural production through the use of appropriate techno-institutional arrangement. Meaning thereby higher the intensity of crop higher will be the landuse efficiency and vice versa. The total cropped area or gross cropped area gives a measure of landuse efficiency which really means the intensity of cropping. ³ It refers to the number of crops grown in the same area in one year.

$$\text{Intensity of Cropping} = (N_j/N_o) \times 100$$

Where, N_j = Total cropped area

N_o = Net sown area

The areas where the intensity of cropping is under 130 percent may be considered agriculturally poor whereas cropping intensity between 130-200 is considered moderate and between 200-300 is higher and above 300 percent is very high.

In case of district Jorhat, it is noticed that almost entire cultivable land has been brought under plough. So there is an urgent need of intensive use of land for better agricultural productivity. It is particularly so, because of mounting pressure of population has not only changed man land ratio adversely but the opportunity of employment had also gone down over the years. Increasing agricultural density, fragmentation of agricultural holdings

are other adverse fall out of the same. It is interesting to note that though in Assam as well as in district Jorhat, the percentage of plain land to the total geographical area is highest in the country but cropping intensity is not as high as it is noticed in other states of the country. An important reason for low agriculture intensity can be the low percentage of irrigated area in the state. In the absence of well developed irrigation system, agriculture here is largely rainfed and percentage of area under H.Y.V. is also not significantly high. Rice being the principal crop in the district is cultivated through traditional methods and by using household inputs including seeds. Though, the agricultural density in the district is relatively higher with 720 person/km², yet most of the peasants do not like to intensify their agriculture as they get their subsistence from the cultivation of winter paddy with minimum problem. Thus winter paddy is extensively grown in the district. As opposed to these cultivation of other paddy is difficult and high risk prone and the farmers prefer to work in plantation during other seasons. So that they can minimise their problems on the one hand and earn to improve their family income.

As regards to intensity of cropping Jorhat district falls under agriculturally weaker area with its cropping intensity being lower than 113 percent. Table 3.2

gives the block wise intensity of cropping of the district.

The blockwise cropping intensity shown in the table reveals that the blocks covering the central parts of the district and the interfluvial plains have intensity level i.e. above 122 per cent. This is due to the existence of fertile soils with favorable moisture availability throughout the year.

TABLE NO: 3.2

Cropping Intensity of Jorhat District (1992-93)

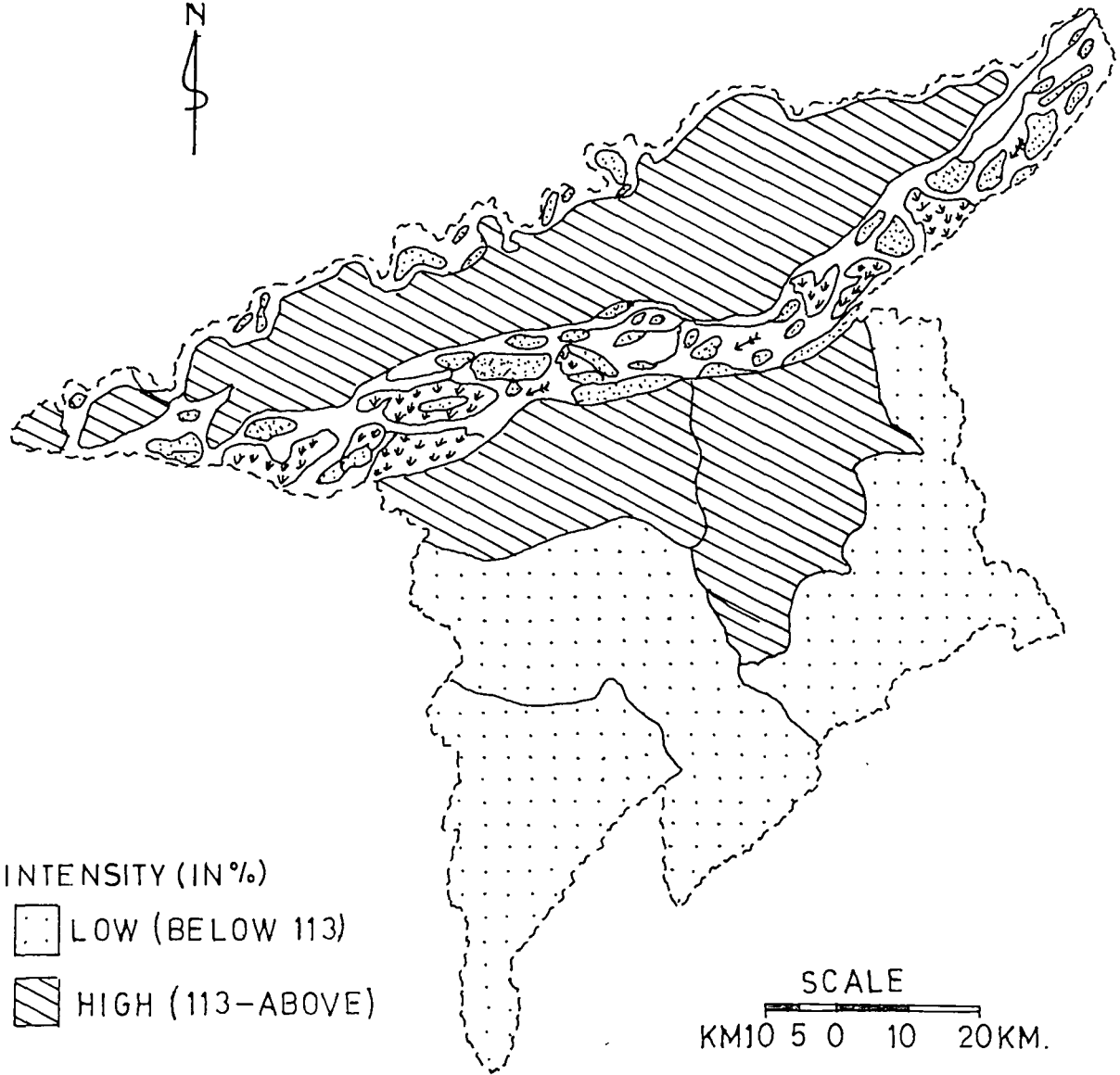
(Area in hectares)

Name of the Block	Gross Cropped Area	Net sown Area	Area sown morethan once	Cropping Intesity
Titabor	31787	30138	1649	105.47
Central Jorhat	19493	15818	3675	123.23
Majuli	31445	25910	5535	121.36
North west Block	21340	17075	4265	124.97
East Jorhat	25606	24552	1054	104.29
Jorhat	33583	30820	2763	108.96
District Total	163254	144313	18941	113.12



Source: Block Development Offices, Jorhat District.

The cultivators of these zones cultivate various rabi crops after the harvesting of the winter crops as


JORHAT
CROP INTENSITY
1992-93



INTENSITY (IN%)

	LOW (BELOW 113)
	HIGH (113-ABOVE)

SCALE



KM 10 5 0 10 20KM.

FIG-12

the soil is very fertile. Moreover, these three blocks have comparatively higher net irrigated areas than the other blocks. Thus, along with high monsoonal rainfall, fertile alluvial soils and developed irrigation facilities have contributed in increasing cropping intensity (Fig.12). On the other hand, the other three blocks viz. Titabor, Jorhat and East Jorhat, situated in the central part and southern part of the district have old alluvium soil with limited soil moisture specially during winter season and have limited dependable irrigation facilities. Therefore, here the cropping intensity is lower (below 113%) than the district average. Thus, the share of current fallow land, in the general landuse categories can be observed higher in these blocks of low cropping intensity.

3 Crop Combination

The study of crop combination provides a basis for agricultural planning. Crops are considered to be the main index of agricultural typology and as such as a region is often named after the principal crops, e.g., ricefield, wheat belt, a coffee belt, etc. Apparently such namings are valid for the areas with a monoculture. But in reality no part of the earth's surface is exclusively monocultural. So, crop combination technique is devised for naming a region after some selected crops on the basis of either their economic importance or hectareage strength.

J.C. Weaver⁴ (1954) was the pioneer in formulating the crop combination technique in geographical research. He used this technique of crop combinations while he studied the complex structure of crop combination regions in the Middle West (the United States). His technique of crop combinations based on the formula of standard deviation, which maybe stated as follows:

$$\text{Standard deviation (s)} = \sqrt{\frac{\sum d^2}{n}}$$

where s is the standard deviation

d is the difference between the actual crop percentages in a given regional unit and the percentages in the theoretical distributions.

n is the number of crops in a given combination.

Among the other geographers who used quantitative crop combination techniques, the names of Doi & Raffinllah⁵ and H.J. Nelson⁶ may be mentioned. In this reasearch work, however Weaver's methods has been used.

TABLE NO: 3.3

Using the Crop Combination of J.C. Weaver, the Crop Combination of Jorhat District is analysed for the year 1992-93.

Crop Combination	Mono Culture			2-Crop combination			3-Crop combination			4-Crop combination			
	1	1	2	1	2	3	1	2	3	4			
Crops	Rice	Rice	Pulses	Rice	Pulses	Oilseeds	Rice	Pulses	Oilseeds	Potato			
Actual Percentages of the total cropped area	76.5	76.5	8.5	76.5	8.5	3.5	76.5	8.5	3.5	1.5			
Theoretical Distribution of crops in %	100	50	50	33.33	33.33	33.33	25	25	25	25			
Deviation of actual percentages from theoretical distribution (d)	23.5	26.5	41.5	43.17	24.83	29.83	51.5	16.5	21.5	23.5			
Deviation square (d ²)	552.25	702.25	1722.25	1863.64	616.52	889.83	2652.25	272.25	462.25	552.25			
Sum of the squared deviation (Ed ²)	555.25	2424.50			3369.99			3939.00					
Sum of the squared deviation divided by number of crops, i.e., variance Ed ² /n	552.25	1212.25			1123.3			984.75					
s = $\frac{Ed^2}{n}$	23.5	34.8			33.51			31.3					

According to Weavers method the percentage area under all the crops is arranged in descending orders. The Crop-ranks explain the land-occupying significance of cropping pattern⁷. The areal variations of crop-significance have been described by using the crop combination method of J.C.Weaver by taking into account the crops which are significant upto the first, 2nd, 3rd and fourth ranks (Table No.3.3). It can be visualized from the table, that, the general cropping patterns of the district enjoys mono-crop culture, paddy is, no doubt the first ranking crop in all the parts of the district except for a few patches located in the southern and south-Eastern parts where tea is the first-ranking crop.

There is much variation regarding in the distribution of second, third and other ranking crop in the combination. This is due to prevailing situation in the related areas which are generally affected by flood and draught etc. For example, in the Northern Lowlying areas of the district, particularly in Majuli sub-division pea, mustard and rabi pulses take second place in the combination though sometimes summer rice takes first position in the cropping pattern. Moreover, it is noticed that Tea (not included in the Table) is the 2nd ranking crop in the villages situated in the southern part of the district. It can be concluded that, cropping patterns of the area is mainly influenced by one crop

i.e., paddy and it is also the first rank crop (mono culture) and second crop is commercial crop like potato, pulses, tea which feed the economy of the farmers of this area.

Agricultural Efficiency

Agricultural efficiency is the function of the combined interplay of a variety of factors including the physical, social, economic and techno-organisational. The combined effect of these factors manifest itself in determining per hectare yields as well as value of production in any given region. The measurement of agricultural productivity is, therefore, necessary to understand as to whether maximum return per unit area of land has been obtained in a particular physio-cultural milieu with the application of human efforts at the existing level of development⁸.

Geographers and agricultural economists have long been interested in determining the agricultural efficiency in different parts of the world and they have desired various methods to measure it. Among these methods, S.S. Bhatia's method (1968)⁹ seems to be of some use to show the agricultural efficiency. According to him, agricultural efficiency may be regarded as the aggregate of various crops expressed though their output per hectare but each crop would contribute proportionately to its share of crop land in the

cropping pattern. The hectare yields of component units may be expressed as percentage of the average hectare yield for the entire region to obtain indices of yield efficiency for each crop. The yield efficiency indices may be weighed by the share of crop land devoted to each of the crops. A weighed average of yield efficiency of all crops would provide an index of agricultural efficiency for the component unit in relation to the entire study area. Bhatia's method of measurement of efficiency of agriculture can be put as follows:

$$E_1, E_2, E_3 = \frac{Y_a}{Y_r} \times 100$$

where E_1, E_2, E_3 etc indicate agricultural efficiency index of the each crops.

Y_a indicates the production of particular crop in the district

 Area under that particular crop in the district

and Y_r indicate production of that particular crop in the state

 Area under that particular crop in the state

Following table gives the agricultural efficiency for Jorhat district based on Bhatien method.

TABLE NO: 3.4

(1991-92)

Assam	Area in hectares	Jorhat	Area in hectares
Rice	2572000	Rice	78560
Pulses	117000	Pulses	8690
Oilseeds	326000	Oilseeds	3900
Potatoes	62000	Potatoes	1200

TABLE NO: 3.5

(1991 - 92)

Assam	Production in tonnes	Jorhat	Production in tonnes
Rice	3197000	Rice	225275
Pulses	54000	Pulses	2875
Oilseeds	183000	Oilseeds	7480
Potatoes	473000	Potatoes	7335

Now, for

$$E_1 \text{ (Rice)} \text{ -----} \rightarrow \begin{array}{r} 225275 \\ \hline 78560 \\ \hline 3197000 \\ \hline 2572000 \end{array} = 2.30 \times 100 = 230$$

$$E_2 \text{ (Pulses)} \text{ -----} \rightarrow \begin{array}{r} 2875 \\ \hline 8690 \\ \hline 54000 \\ \hline 117000 \end{array} = 0.72 \times 100 = 72$$

$$E_3 \text{ (Oilseeds)} \text{ -----} \rightarrow \begin{array}{r} 7480 \\ \hline 3900 \\ \hline 183000 \\ \hline 328000 \end{array} = 3.21 \times 100 = 321$$

$$E_4 \text{ (Potatoes)} \text{ -----} \rightarrow \begin{array}{r} 7335 \\ \hline 1200 \\ \hline 473000 \\ \hline 62000 \end{array} = .79 \times 100 = 79$$

The table reveals that Agricultural efficiency in the district is worth noting as compared to the other districts of Upper Assam Valley. This is because, only one or two crops are grown in the same plot of land during an agricultural year leaving it fallow for few months in of the

year. Thus natural fertility of the soil is restored and yield of crops per hectare increases leading to the increase in Agricultural efficiency.

Agriculture in Assam as well as most part of India is not merely as economic activity. On the contrary it is a way of life and also a symbol of harmonious intention between society and nature. The prosperity of agriculture infact greatly depends upon the favorable aspects of the natural and is directly proportionate to human progress. Therefore, resource utilization both human and natural in agriculture occupies enhanced significance in the planning and development of the State and also in district Jorhat.

5 Agricultural resources:

Resource stands for anything and everything over environment that are useful for satisfying human needs but must be culturally acceptable, economically feasible, technologically accessible at a given point of time. Looking at the resources used in agriculture the following types of resources take part in any agricultural operation.

i) Man as a Resource:

Agriculture so far the major activity of man in which both nature and human beings participate as equals but, under specific circumstances and stages of human

development their role tend to vary. In an underdeveloped country like India the role of nature is more determining and human beings are at the receiving ends. Thus, human beings on their part try to compensate it by increasing the number of labourers in the agricultural operation. Thus, Indian agriculture is said to be labour dominated. According to 1991 census approximately over 60 percent of the total workers were engaged in agriculture in India.

The district census figures of Jorhat explain that the total work force in the district is 28.5 percent to the total population (in 1971)¹⁰. Therefore, nonworking population of the district is extremely higher than the working population (Table 3.6). As a result, depending ratio is higher than (2.5) the State average.

TABLE NO: 3.6

Occupational Structure of Jorhat District (1971)

	Persons	Percentage
1. Total Population	646445	
2. Total workers	183980	28.50
3. Total Non-workers	462465	71.50
4. Agricultural workers (cultivators & agricultural labourer)	85329	46.38
5. Industrial workers*	11515	6.26
6. Workers engaging Tertiary activities**	41647	22.46
7. Others	45489	24.90

N.B. : * It includes household industries, manufacturing and processing, servicing and repairs.

** It includes construction, trade and economic, transport and other services.

Source: District Census Handbook, Sibsagar District, Census of India, 1971, Part- X-B.

The above table indicates that the population of dependents (that include children plus too old persons) reflects the higher degree of manpower potentials that

can be utilized in the future. Furthermore, the percentage of agriculture work force (cultivators plus agricultural labourers) to the total working force is only 46.38 percent which is less than the state average. It shows that the working population engaging in plantations, secondary and tertiary activities are also noticeable. However, the main concentration of work force is employed in agricultural activities.

ii) Capital Resource:

a) Draught Animals:

Agriculture in Jorhat district is more or less a type on mixed farming. Livestock and poultry are part and parcel of a household enterprise. Use of bullocks and buffaloes for ploughing and transport and use of elephant for transportation is a common feature in the district. It is estimated that a standard pair of bullock or a buffalo can manage plough an area of about 2.0 - 2.8 hectare of land per season (subjected to the nature of the soil). During the field observation, it is observed that nearly 80 percent of total agricultural households have their own pair of bullocks for carrying agricultural operations including ploughing and transportation. Elephants are used for pulling log of woods from the forest.

iii) Tractors and Power Tillers

Since agriculture in the district Jorhat is traditional in nature, the use of modern tools and techniques of production are used only to a limited extent. Use of tractor and power tiller is done only in the large farms. Fragmentation of land into smaller holding making it rather difficult to use capital intensive techniques of production. Moreover, the poor socio-economic conditions of the agrarian population is also an important deterrent in this regard. Use of these and many more capital intensive techniques are prevalent only in the tea gardens (which are excluded here) where tractors are used for different purposes. But, it is seen that use of power tiller shows a gradual increase as their number over the year in the district. Highest number of power tiller are used in Titaber Development Block of Jorhat district Table No: 3.7 shows the number of Tractors and Power tillers in the district.

TABLE NO: 3.7

Year	Tractor	Power Tiller
1980 - 81	4	35
1981 - 82	3	25
1982 - 83	4	48
1983 - 84	4	78
1984 - 85	3	36
1986 - 87	2	69
1987 - 88	4	51
1988 - 89	2	61
1989 - 90	1	74
1990 -91	1	92
1991 - 92	2	113
1992 - 93	2	124

Besides these, pumpset, improved plough, sprayer, paddy weiden and rake are also used for agricultural operation.

Table No: 3.8 shows the Blockwise number of Machine Tools acquired during 1992-93.

TABLE NO: 3.8

	Titabor	Central Jorhat	Majuli	N-W Jorhat	East Jorhat	Jorhat	District Total
Tractor	-	-	-	-	-	-	2
Power Tiller	63	7	10	25	7	12	124
Pumpset	32	5	7	8	14	7	73
Improved Plough	45	17	7	20	12	48	149
Sprayer	40	16	2	16	11	20	105
Paddy Weeder	30	2	4	6	5	5	52
Rake (Racker or Bindha*)	34	3	-	3	12	-	52

Source: Assam Agro-Industries Development Corporation Ltd.,

Jorhat District.

Source* : Block Development Offices, Jorhat District.

Apart from these there are some other smaller implements used in agriculture in the district.

iv) Small Implements

Small implements used by peasants can be classified as (i) Traditional and (ii) improved.

'Nangal' is used for tillage operations including puddling for transplantation and the 'Moi' (Bamboo Ladder) is used for leveling and breaking clods. Both these are bullock driven or buffalo driven. The 'Kor' or 'Kodali' (Hoe) is another important associated tillage implement used invariably in small scale cultivation of vegetable etc., and also for bunding the paddy fields. In some areas where inter-cultural is practical, sometimes bullock driven 'Bindha' (Rack) is used for weeding.

Among hand implements, Dolimari (the clod breaker), Kachi (sickle) and 'Dao' are important. Besides, these 'Siprang' for digging, Joboca, the hand rack, and the 'Lahoni' for spreading water and 'Okhan' bamboo stick are also used in various agricultural operations.

v) Bio-Chemical And Technological Resources:

Improvement in the production technology is a prerequisite to economic growth and development. Technological progress in terms of spread of improved seeds,

fertilizers, pesticides, improved implements and machines are of utmost important in agricultural operation. Greater use of modern technology does only increase the per hectare production but also increases the agricultural efficiency.

For a proper development of agriculture in a nation/area, the process of diffusion of agricultural innovations must be accelerated to the extent that the new farm technology is available to cultivators in the form it is most intelligible to them¹¹. The field observation and information collected through the questionnaires also reveal that the district Jorhat too is also making an advance in this direction though very slowly. Some of the important technologies changes taking in the district are :

a) High Yielding variety seeds

In Assam, for the first time, a few quick maturing H.Y.V. were introduced during the adhoc annual plans (1966-67 to 1968-69). Some of the Important H.Y.V. seeds were Monohar Sali, I.R.8, Tichung(Rice) and Mexican variety of wheat etc. At the end of the adhoc plan period, the strategy adopted for enhancing agricultural production was on quick maturing programme such as extensive use of H.Y.V.seeds. With the introduction of H.Y.V. of rice, specially those are relatively less photo sensitive, it was possible to reduce the growing

season for rice and in thus produce three crops in a year from the same field. This was more successful in areas where assured irrigation was possible. In this respect the Assam Agricultural University, Jorhat is doing commendable work by educating the farmers about the H.Y.Vs and also providing the extension services.

According to one report on performance of rice in Assam for which experiments conducted in Titabar Rice Research Station in Jorhat district, it was found that the recommended varieties are Jaya, Pusa 2-21, Pusa 2-103 Jagannath, Pnkaj and Monohar Sali rice varieties are sown in **Kharif** and **Rabi** seasons while Jaya variety is famous for winter season which gives the highest yield.

The Agricultural Department has undertaken the responsibility for arranging supply of H.Y.V. seeds. There seems a gradual increase in the use of HYV seeds of various crops in the district. The farmers of the district are mainly using HYV seeds of rice, wheat, mustard, pulses, Jute etc. Table No. 3.9 shows a record increase in the use of HYVs seeds used during the last ten years, (1983-1984 to 1992-93). In the early 1983, specially in 1983-1984, the use of HYV seeds was only 2.96 kg. per hectare which has been raised upto 9.29 kg/hectare in 1992-93. Blockwise figures of HYV seeds consumption indicate that Majuli which is located in the

TABLE NO: 3.9

Blockwise HYV seeds used in Jorhat District: 1983 - 84 to 1992 - 93

Year	Titabor		Central Jorhat		Majuli		N-W Jorhat		East Jorhat		Jorhat		District Total	
	1	2	1	2	1	2	1	2	1	2	1	2		
1983-84	16521	0.65	13667	0.87	344400	12.78	3320	0.19	4470	0.18	33867	1.10	416245	2.96
1984-85	51901	1.89	2859	0.18	546510	19.99	5403	0.32	6370	0.26	28600	0.93	641643	4.49
1985-86	43156	1.46	4549	0.29	390630	14.07	4592	0.27	6480	0.26	29811	0.97	479218	3.30
1986-87	142261	4.8	5524	0.35	463020	16.39	5050	0.30	12320	0.50	26646	0.87	654821	4.49
1987-88	46292	1.54	3760	0.24	942450	33.24	10692	0.63	11070	0.45	27985	0.91	1042249	7.11
1988-89	25684	0.85	2410	0.15	1168588	45.20	10000	0.59	16262	0.66	15130	0.49	1238054	8.60
1989-90	115091	3.89	2460	0.13	1136168	43.95	8415	0.50	15610	0.64	14300	0.46	1292044	8.48
1990-91	121315	3.95	2470	0.62	1137100	45.00	8620	0.62	15735	0.61	14310	0.67	1299550	8.53
1991-92	120472	4.00	2390	0.70	1200252	46.26	8800	0.60	16293	0.65	15000	0.72	1363207	8.63
1992-93	122427	5.27	2495	0.87	1223000	47.25	8853	0.60	16758	0.72	15422	0.95	1388955	9.49

N.B. : Col.1 refers to total HYV seeds used (in Kg)
Col.2 refers to HYV seeds Kg. per Hectare.

Source: Block Development Offices, Jorhat District.

interfluvial plains of the district is noticeable for extensive use of HYV seeds and its increase has been recorded highest from 12.78 kg/hectare in 1983-84 to 48.65kg/hect. in 1992-93. It may be due to high perceptibility of the farmers and proper extension agricultural services in the area.

b) Fertilizers:

The production of H.Y.V seeds cannot increase, if it is not associated with the use of manures and fertilizers. Higher doses of fertilizer always help crops to growth after fulfilling the basic needs of soil fertility. The following table (Table No.3.10) shows that fertilizer consumption is increasing in the district over these periods. The table reveals that, the total consumption of fertilizers in

TABLE NO: 3.10

Blockwise Fertiliser Consumption (NPK) in Jorhat: 1983-84 to 1992-93

Year	Titabor		Central Jorhat		Majuli		N-W Jorhat		East Jorhat		Jorhat		District Total	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1983-84	161	6.3	113	7.2	22	1.3	116	6.8	2	0.1	208	6.55	622	4.42
1984-85	177	6.4	119	7.6	6	0.4	117	6.9	41	1.7	248	8.05	708	4.96
1985-86	362	12.2	119	7.7	29	1.0	178	10.4	65	2.7	234	7.60	987	6.79
1986-87	209	7.0	132	8.4	31	1.1	261	15.3	114	4.6	225	7.30	972	6.66
1987-88	226	7.5	195	12.4	53	1.9	198	11.6	112	4.6	165	5.36	949	6.48
1988-89	977	32.5	237	15.0	33	1.3	223	13.0	146	6.0	127	4.13	1743	12.10
1989-90	995	33.0	240	15.1	52	1.7	225	13.1	148	6.1	149	5.36	1809	12.72
1990-91	1000	35.2	250	15.5	39	1.1	235	13.5	150	6.12	169	5.79	1843	12.8
1991-92	1062	35.9	252	15.6	46	1.2	239	14.0	155	6.2	225	7.30	1979	11.9
1992-93	1135	36.5	255	17.5	52	1.62	241	15.5	152	6.3	234	7.60	2069	14.17

N.B. : Col.1 refers to total fertilizer consumption in tonnes.

Col.2 refers to fertilizer consumption in Kg/hectare.

Source: Development Offices, Jorhat District.

the district has increased from 622 tonnes 1983-84 to 1979 tonnes 1992-93. On account of rapid increase in the total consumption of fertilizers rather than the increase of the net sown area during the last decade, the tendency of its intensity has also been recorded increasing from 4.42 kg/ha. to 15.10 kg/ha. in the same period. During 1992-93, per hectare consumption is recorded highest in Titabar block (36.5 kg) followed by Central Jorhat (17.5 Kg), N.W.Jorhat (15.5 kg). Though, the fertilizer consumption is very high in Titabar block, but the productivity is low i.e. Rs.882.58 per hectare whereas in Majuli, productivity is high i.e. Rs.1280.76 per hectare. This is due to the location of Majuli in the flood prone region. Apart from the use of chemical fertilizer cowdung is also used by the farmers. It is approximately about 1 quintal/hectare.

c) Use of Pesticides:

The farmers of Jorhat district are serious enough about the control of pests and insects that cause serious damage to the crops. Thus they try to control it by various method including pesticides. The seedling of crops are highly succesptible to pests, disease and infestations by insects. Due to prevalence of humid climate of the area, pests and weeds are the main constrains to get proper yield of the crops, specially of H.Y.Vs which are less resistant.

Therefore, a record increase in the use of pesticides have been noticed during last ten years from 1983-84 to 1992-93. It is noticed that per hundred hectare consumption of pesticides was only 1.86 kg in 1983-84 and it has increased upto 3.50 kg/hectare in 1992-93. Table No. 3.11 shows the intensive use of pesticides in Jorhat district. Then this table also reveals that, Jorhat block is marked for intensive use of pesticides (more than 10 kg/hectare) in 1992-93, while it is recorded less intensive in the Titabar Block (only 2.1 kg/'00 hect). The overall performance of the use of pesticides in the district is not significant.

It can be concluded from the preceding discussion that here is a remarkable variation in the cropping patterns interesting of cropping, crop-combination, agricultural efficiency and bio-chemical technification in the district. It is obvious that, the areas of new alluvial soils having sufficient moisture availability highly significant for paddy cultivation with high crop intensity. While the areas of central allvial plains have little diversified cropping patterns with medium degree of crop intensity. Though these areas enjoy infrastructural facilities like market accessibility and better road connectivity. The southern part of the district, which has hilly terrain is noticeable for tea cultivation. And the central southern parts show greater response in terms of agricultural production to irrigation them

TABLE NO: 3.11

Block wise Pesticides used in Jorhat District 1983-84 to 1992-93.

Year	Titabar		Central Jorhat		Majuli		N-W Jorhat		East Jorhat		Jorhat		District Total	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1983-84	600	2.34	311	1.99	364	1.35	280	1.64	40	0.16	1021	3.31	2616	1.86
1984-85	825	3.00	225	1.45	180	0.66	425	2.49	83	0.34	1230	3.98	2868	2.07
1985-86	175	0.59	161	1.03	355	1.28	92	0.53	146	0.60	1365	4.42	2294	1.57
1986-87	593	2.00	840	5.32	694	2.46	145	0.85	205	0.84	1731	5.62	4208	2.88
1987-88	1515	5.04	101	0.64	2084	7.35	84	0.49	210	0.84	2175	7.06	6169	4.20
1988-89	60	0.19	60	0.38	983	3.80	787	4.62	185	0.75	2840	9.23	4915	3.41
1989-90	250	0.20	55	0.30	508	1.97	450	2.63	152	0.62	3137	10.17	4552	2.98
1990-91	232	0.9	60	0.38	765	2.65	455	2.65	180	0.72	3150	10.20	4742	3.00
1991-92	305	1.6	312	2.00	805	3.00	597	3.12	225	0.92	3170	10.40	5414	3.19
1992-93	350	2.1	225	1.45	1011	3.90	760	4.52	275	1.22	3172	10.41	5793	3.50

N.B: Col. 1 indicates total use of pesticides (in k.g.)

Col. 2 denotes intensity of its use (kg/'00 ha)

Source: Block Development Offices, Jorhat District.

the lowlying area. Last but not least is the increase in the agricultural production is largely due to increasing use of modern production technology agriculture.

REFERENCES

1. N. Mohammad, "Perspective in Agricultural Geography,
Vol. III. Concept Publishing Co. New
Delhi, 1981, p. 159.
2. N. Mahammad, Ibid. p. 165.
3. Singh, Jashbir 1972, a new technique for measuring
agricultural efficiency in Haryana, India. The
Geographers, XIX(1), p. 14.
4. Weaver, J.C. 1954 'Crop-Combination Regions in the Middle
west' The Geographical Review, 44(2) p. 176.
5. Doi, K. 1959, "The Industrial Structure of Japanese
Prefecture" Proceedings I.G.U. regional Conference in
Japan, 1957, cited by Mohammad N., 1975, 'Crop
Combination regions in Ghaghara Rapti Doab', The North
Eastern Geographer, 7(1 & 2)

- Rafiullah, S.M, 1956 "A New Approach to Fundamental Classification of Towns", Geographer, R, Cited by Mohammad, N. ibnid.
6. Nelson, H.J., 1955, 'A Service Classification of American Cities', Economic Geography, 31, pp.189-210.
7. Hussain, M. (1982), Crop Combination in India - A Study, Concept publishing Company, New Delhi, p.34.
8. S. Shafi, M. 1960 Measurement of agricultural Efficiency in Upper Pradesh Economic Geog. Vol. 36(4), pp.296-305.
- Singh J. 1972. A New Technique for measuring agricultural efficiency in Haryana, India, The Geographers, XIX(i), pp.14-27.
9. Bhatia, S.S. 1968. A New Measure of Crop Efficiency in Uttar Pradesh Economic Geography, 43, No. 3, p.248.
10. District Census Hand book, Sibsagar District, Census of India, 1971, Part X-B.
11. Mohammad, N. (1978). Impact of Economic Factors on Diffusion of Agricultural Innovations in Central Trans-Ghagara Plain, Geographical Review of India, Vol. 40, No. 3, p.226..1m0

CHAPTER IV

ASPECTS OF USE OF MODERN
TECHNIQUES IN AGRICULTURE AND
ITS PHYSICO-SOCIAL IMPACTS

CHAPTER - IV

ASPECTS OF USE OF MODERN TECHNIQUES IN AGRICULTURE AND ITS PHYSICO-SOCIAL IMPACTS

Development of Irrigation Facilities And Changing Tenancy Relation

Land tenure system or tenancy is perhaps one aspect which received considerable attention from the government particularly after the Independence. Like other parts of the Upper Assam Valley, share cropping is the principal form of tenancy relation in the district Jorhat. Under the system of sharecropping practiced in the district total produce is divided into two equal share between the tenant and the land lord. This system of share cropping is commonly known as "Adhi" and the share cropper, the 'adhiar'. This is a total violation of the 'Assam Adhiar Protection Act' of 1948, which was to be fully implemented by 1957. It depicted that out of the total production, 1/4th share will go to the land owner if he also supplies plough, cattle and other assistance and his share will be only 1/5th in case he does not provide any other assistance to the sharecropper. Increasing population pressure on land due to absence of adequate alternative source of livelihood has given rise to fierce competitions for land among the tenants for taking land on sharecropping basis even at much inverse term and condition

includes accepting only 50 percent share of the produce. This practice is still persisting inspite of the legal provisions. In some parts of the district, it is also observed that significantly high quantity of the produce usually paddy is to be paid to the land owner under fixed tenancy system.

Apart from the exploitation of the tenants through the Adhi system the tenants are also uncertain about the duration of the occupancy right on the land. In most cases it is renewed annually and the land owner has every right to resume that land after the end of the year. Thus the tenant has no permanent interest in the land, its management and soil fertility. So the productivity level of land is not upto the mark in such situations. Since the tenant has the occupancy right only for a short period he hesitates to make any long term investments and improvement on the land. Along with the 'Adhi System' of share cropping, the system of leasing in and leasing out is also practiced in some parts of the district. Under the lease system of agriculture, the duration of the lease is fixed in advance, thus the tenant try to produce more from the land in the same year by using modern inputs. Thus, double cropping and crop rotation are important feature of such system of agriculture.

The process of leasing out of land arises from various socio-economic factors. Most common among these

are those house hold having alternative sources of income. Fragmentation of holdings due to division of the family resulting into the emergence of uneconomic holdings and scattered fields etc. are other major factor for leasing out the land. An important aspect of agricultural relation in the district is conspicuous absence or non-existence of documentary evidences about share cropping and leasing out/leasing in system. Most often it is done verbally which shows that so far the tenancy relation have not been the principal cause of social tensions in the district. During the field survey, it was observed that most of the rich owner cultivators (big farmers) leased in land from others and they cultivate the field with surplus labourers at low wages rates. These big farmers also use modern techniques and they earn more production from the field. As a result, they become more prosperous and it is expected that with ever sharpening socio-economic differentiation, these farmers have the potentiality of becoming capitalist farmer in the future. Thus it can be foreseen that though the improvement in agriculture is likely to take place through the leasing in/leasing out system, but it also certain that it will be at the cost of sharpening social-economic differentiation and landless in the village. The instances of landlessness are taking place in a dialectically related process of land consolidation in fewer and fewer

hands. It is also observed that the transfer of land from the small and poor peasant is taking place through the 'debt trap' of the money lender cum landlords. Since agriculture in the study area is largely controlled by natural factors then the fluctuation in the agricultural production and economic condition of the people remain strongly correlated. In case of adverse environmental changes including droughts and floods and also recurrent spurious expenditures due to birth, death and sickness does not only adversely affect agricultural production but also forces the smaller farmer to take loan from the money lenders for meeting their requirement. In case of default the land of these small farmers get transferred to the money lenders. Land transfer due to loan default is perhaps the most important reason both for the pauperization of the cultivator and also backwardness of agriculture. Therefore, for the proper agricultural development of the district the role of money lender needs to be minimized. For this purpose modern financial and credit institutions can be of vital significance.

Role of Financial Institutions i.e. Bank and Co-operative credits in the agricultural development.

Availability of capital within acceptable terms and condition is a pre-requisite for using modern inputs in agriculture. Capital can be made available from different Government, semi-government, Co-operatives and private

financial institution. Most often it is observed that the nature of financial institutions also determine the ways for the utilisation of the credits. For example, credit provided by village money lenders and merchants landlords are mostly spent for purchasing necessities other than the modern inputs and draft animals. It is particularly true in case of small peasants. Since the needs of farmers are not only manifold, but most of these are unproductive too. So, they use the money mostly for the repayment of the old debts, build and repair houses, purchase foodstuffs, meet the expenses of marriages, rituals and festivals and spend for medical treatment etc. The net outcome is that they continue to languish in the debt trap generation after. A possible remedy from this lies in the greater role of the alternative source of finance, such as the Government agencies, commercial banks, the co-operatives and progressive control over the role of village money lenders, merchants and land lords. In certain cases, the role of these can be restricted by the help and assistance provided by friends and relatives. But it is unfortunate that even after the four decades of independence and planning the village money lenders is by far the most important credit institution in the district Jorhat. According to a report of the survey conducted by Agro-Economic Research Centre at Namoni Borpomua village¹ in Majuli block of the district Jorhat, it was found that 48 percent of the total loan in the villages were taken from the

professional money lenders and 25 percent from the village merchants. It has specific significance in Assam because the average number of people covered by a bank is much higher as compared to other states of India. It is estimated that the ratio is about 24,000 population per bank in Assam as against 10,000 population per bank in India².

Very recently the Government and Semi Govt. institutions like co-operative banks, state Banks and Lakhimi Gaonwalia Bank have come forward for providing loans to the farmers for agricultural development at the district level. But the experiences have not been much encouraging both for the farmers as well as the financial institutions. Mis-utilization of money by the farmers and delayed in the repayment of loans have created problems to the Banks and the borrowers. And it can be hoped that this is only a phase of adjustment and in future both the parties will be able to reach an economically viable adjustment.

Continuous poverty of the people and non availability of medium and long term investible agricultural loans have serious repercussion on the development of agriculture in the district. Inadequate development of basic agricultural infrastructure like irrigation and marketing facilities are some of the most pronounced by product of capital deficiency in the district.

6 Irrigation Infrastructure.

Water is basic input along with favorable climate and suitable soil condition for agricultural development. Besides, these, use of fertilizer, insecticides, high yielding seed and modern technology are also important for the modernization of agriculture. But, irrigation is the main axis around which revolves the entire operations of agricultural modernization. Though the district Jorhat is endowed with sufficient surface as well as ground water potential, yet, the percentage of irrigated area is extremely low i.e., 1.46 percent to net sown area of the district. This is largely due to the presence of moisture availability in the soil for most of the days in a year. Thus, irrigation is required only for mid winter to summer seasons (December to May). It is also the driest period of the crops year. The need of irrigation have gained greater urgency with the increasing demand for more agricultural production due to increasing population and relatively less dynamic socio-economic system. The history of irrigation in district Jorhat division (Irrigation) started functioning from March 1979, and Irrigation Division, prior to that it was known as Jorhat Ground Water Division with its head quarters at Jorhat.

Since its inception, this division has been dealing with Minor Irrigation, viz. Flow irrigation ,Lift

irrigation from surface sources and deep-Tube wells schemes from Ground Water source. The shallow tube wells and low lift points are operated by a corporation named Minor Irrigation Development Corporation. (M.I.D.C.). Their main objective of participating in field of irrigation is to introduce small shallow Tube wells/low lift points under institutional finance for small farmers etc. The minor schemes of the district are taken up by these division as Government Schemes.

The district has approximately 147640 hectares of land available for cultivation out of that 2065 hectares of land has been brought under irrigation upto June 1993. The following table shows the subdivision wise existing irrigation schemes upto June 1993.

TABLE No. 4.1

Irrigation Schemes in Jorhat District

Types of scheme	Total No. of Schemes		Completed schemes upto June 1993		Potential created upto June 1993 (in hac.)	
	Jorhat	Majuli	Jorhat	Majuli	Jorhat	Majuli
LIS	14	9	7	9	1550	1050
FIS	3	NIL	3	NIL	1596	NIL
DTW	42	NIL	12	NIL	3050	NIL
MDTW	3	9	1	NIL	225	NIL
STW	2	9	2	9	75	2375
CHAR AREA	NIL	6	NIL	6	NIL	2375
TOTAL	64	33	25	24	6496	3875

Source: Executive Engineer, Jorhat Division (Irrigation)

From the table it is clear that the targeted achievements could not be possible, specially in case of Deep Tube Well and Medium deep Tube Well schemes. This is due to the following reasons :

(i) there were no proper motivation on the part of the farmers and the selection of the sites as well as the beneficiaries was not properly planned.

(ii) In some cases tube wells were installed in a place where the land owners of the command area lived far away from the site.

(iii) defective installation caused breakdown of the tube wells.

(iv) recurrent devastating floods in the district had also caused serious damage to the tube wells.

(v) non-availability of some important materials such as cement and other steel materials at the time of needs.

Due to presence of these constrains and barriers, proper implementation of these irrigation schemes and the potential use of water for irrigation has not been brought up to the mark so far. Therefore, private pump sets operations are very much important for irrigation purpose. At present, only the Lift irrigation Schemes (LIS) are functioning satisfactorily in the district. But, sometimes, the power

failure has created problems to the farmers particularly the time of cultivating,transplantation and growing.

Going through the table No. 4.2 Canal irrigation (Government or private), it can be concluded that lift or flow irrigation systems can be considered as one of the best means of watering the field in the district.

The table depicts that pumpset irrigation is more pronounced than canal irrigation in the district. Government canals supply water for irrigation in North West Jorhat and East Jorhat Blocks. In these blocks around 0.7 percent of the net sown area is irrigated by this particular source. In North West Block irrigation provided by private canal is important. More than 3.8 percent to the net irrigated land is watered by this source.Pumpset irrigation particularly in the Majuli block, where ground water table is high and even the marginal and small farmers are using ground water potentials through their pumping sets.

TABLE NO: 4.2

Blockwise Source of Irrigation (1992-93)

Source	Titabar		Central Jorhat		Majuli		N-W Block		East Jorhat		Jorhat		District Total	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Government Canal	210	0.68	55	0.31	-	-	106	0.62	145	0.79	22	0.07	538	0.38
Private Canal	157	0.52	-	-	-	-	600	3.52	-	-	-	-	157	0.11
Pumps	75	0.25	-	-	680	2.62	-	-	-	-	-	-	1355	0.94
Other Sources	-	-	-	-	-	-	-	-	-	-	15	0.03	15	0.03
Total	442	1.45	55	0.31	680	2.62	706	4.24	145	0.79	37	0.10	2065	1.46

N.B. : Col.1 indicates total irrigated area in hectare.

Col.2 refers percentage of net irrigated area to net sown area.

Source: Block Development Offices, Jorhat District.

It was mentioned earlier that lack of capital has caused slow pace of development of agricultural infrastructure in the district, which in its turn has adversely affected the process of agricultural development. Low level of surplus generation in agriculture and subsequently inadequate development of marketing facilities are another bottleneck of agricultural development here.

7 Agricultural Marketing:

Agricultural marketing in the district Jorhat, is carried on by both i.e., the free market and the district controlled market/State controlled market agencies. In the traditional system of free market, the village traders or agents of wholesalers and millers operate in the village and the village market, commonly known as 'hat' or 'bazaar', which is actually a primary market located in the rural areas. Village traders and traders from "Terminal markets"³ also make purchases directly from the producers. The system of free agricultural marketing is predominant in Assam. Though, after the suspension of whole sale traders since November '73, the trade of paddy and rice is carried on by the private agencies and the influence of private traders has decreased to a great extent. Petty traders of rice are, however allowed to carry rice or paddy grains not exceeding 5 quintals. Even then, the

open market plays a dominant role in the supply of rice to the urban and the rural consumers, because of the inadequate quantum of rice supplied by the Govt. through fair price shops and consumers' cooperatives.

Low level of agricultural infrastructure and insufficient use of modern inputs have resulted into low share of agricultural commercialization and industrialization of agriculture. According to one estimate, Assam is one of those backward states of the country which has very weak agro-industrial base (Tea excluded). District Jorhat which is also the centre of Regional Research Laboratory and tea research centre also shows more or less similar pattern.

8 Agricultural Industry:

The agro-processing industries of the district Jorhat are mainly concentrated in the field of processing of food grains. Rice, wheat, pulses and mustard seeds are the main products processed in the district. according to 1990-91 census, there are 82 agro-processing units in the district Jorhat . Hand pounding of rice which was once a common household activity in the rural areas has gradually been replaced by machine milling due to establishment of small rice haullers. These agricultural industries have given employment to a limited number of working population, but nevertheless it

has greatly influenced the economic development of the district.

On the basis of the foregoing discussion it can be concluded that predominance of share cropping and village money lenders with varying terms and conditions mostly unfavourable to cultivators are the two major institutional bottleneck in the modernization and development of agriculture in the district Jorhat. It is more alarming because of the fact that well after over four decades of independence, the modern credit institution and modern market relations have failed to make significant impact in the rural areas. Lack of irrigational infrastructure and conspicuous absence of agro-industrial interdependence continues to hamper the development of agriculture here.

REFERENCES

1. Namoni Borpomua, Village Survey No.15, Agro Economic Research Centre, A.A.U., 1976, p.70.

Das M.M., op.cit. Page.221.

2. Das M.M. (1984) Peasant agriculture in Assam. Inter-India publications, p.222.

Economic Survey of Assam(1985-86).

3. 'Terminal Market' - Usually situated in large urban centres where a part of the produce is sold to the local consumers and the rest is transported to other consuming centres.

CHAPTER V

DATABASE AND METHODOLOGY

CHAPTER - V

DATABASE AND METHODOLOGY

1. Agriculture is well over a few thousand year old economic activity in the Brahmaputra Valley. Over, these centuries it has gone under enormous changes in its technical, institutions and occupational forms and contents. Today, it is perhaps the most complex and multidimensional human activity particularly in the state of Assam. It is so because, the state of Assam experiences an unique combination and coexistence of most advanced as well as most primitive forms of agriculture within one and the same block. It is well known that Assam has the largest number of tea plantations in the country and at the same time it has significantly high proportion of agricultural land under Jhumming or slash and burn cultivation. Correspondingly the type of labourer and technical input as well as the scale and motive of agriculture operations are also diametrically opposite to these agricultural types.

It all amounts to say that study related to different aspects of agricultural in the State of Assam in general and in the study area i.e. district Jorhat in particular is a quite stupendous task. The difficulties in taking such a study have increased mainly due to the role of three major centers of agricultural research and development having their head quarters at Jorhat. These are Toklai tea research Institute, Agriculture University, Jorhat and Regional

Research Laboratories, Jorhat.

For the purpose of present study the aspects of agriculture related to tea plantation have been excluded from the main theme of the research mainly because:

i) tea plantation has failed to establish organic links with the other economic activities of the district and it is mostly an enclave economy.

ii) The nature, source and scale of the techniques, capital and labour used in plantation agriculture is highly dissimilar from that used in other types of agriculture practiced in the district.

iii) Plantation agriculture largely depends upon the physical aspects of the environment such as soil types, slope, rainfall, temperature and drainage etc. and artificial irrigation has only but marginal significance in improving plantation agriculture. As opposed to the modernization of other agricultural types is largely based on assured irrigation.

iv) Plantation agriculture involves long term agriculture operation while other agriculture types are seasonal in nature and these are also different in their motives. Profit maximisation being the sole aim of plantation

agriculture and it is different from maintain minimum living standard in case of other agricultural types.

It is largely due to these reasons that tea plantations have been excluded from the scope of present study. Therefore the study concentrates exclusively on the non-plantation agricultural types in the district.

Non plantation agriculture in district Jorhat displays a synthesis of physical and social aspects. The District has three district agro-climate division in it and for assessing the response of minor irrigation on these aspect of agriculture six villages were selected from the three agro-ecological setting for sample study.

II. Selection of Sample Village.

In all six villages were selected for assessing the impact of minor irrigation on agriculture in the district. The criteria adopted for the selection was the availability/Non-availability of minor irrigation facilities in the villages. Out of the three agro-ecological zones two villages were selected from each zone and out of these two one village was selected from those having irrigation facility while the other without it. For the purpose of this study the following six villages were selected:

Name of village	Agro ecological zone	Nature of irrigation
Nahatia Ujani Khongia	Northern Low lying areas	LIS
Handique gaon Buruk Borua gaon	Central fertile land	D.T.W.
Lalung gaon Lohang Bebejia	Southern High lands	F.I.S.

III. Selection of Sample House Holds

After the selection of these villages ten house holds were selected from each villages on the basis of stratified random sampling. The need to select the samples on the basis of stratified random sapling was due to difference in the nature of land holding. It was thought that at least one house hold must represent different holdings size in the village. Then in all sixty households were surveyed for assessing different aspect of agriculture.

IV. Data Collection

It is evident from the objective and the quarries raised in the study that it will require factual information and data for making an objective assessment. Two information sources of data were used in this study.

i) Secondary data source.

Included here are most of the published report, books and journals from various governments, semi-government organization and individuals. The need of such data was felt in order to :

- a) To obtain the overall view of the prevailing situation,
- b) To make the study dichoronical for the purpose of comparison.
- c) To substantiate the gaps which are likely to remain in the primary source.

Some of the important secondary data used in this study are given below:

Sl. No.;	Source	Publisher and year	Data available
1.	Agricultural situations in India	Ministry of agriculture, Govt. of India, 1992	Area and production of crops, Agricultural farm prices etc.
2.	District census Hand-book of Assam	Directorate of Economics and statistics, Govt. of Assam Guwhati, 1992-93	Area, sex ratio, fertilizer, irrigation, workforce etc.
3.	District census Handbook	Economics and statistical Dept. Jorhat 1992-93	Climatic data, No. of blocks, No. of villages, landuse data etc.
4.	Basic statistics of North Eastern Council	North Eastern Council, 1990	Comparable data
5.	Economics survey of India	Directorate of economics & Statistics, Govt. of Assam 1992	Comparable data
6.	Toposheet No. 83 H.I. & J	Survey of India Dehradun	Geological Map, Relief and Drainage

ii) Primary data source

The nature of the data available through the secondary source show that it is highly inadequate from the point of view of present study. Therefore, most of the information and data was collected through various primary source i.e. personal observation, Photographs, interviews and questionnaire. But for the present study questionnaire method was used more than any other. Two types of questionnaire were prepared for the purpose.

1) Village questionnaire:

Information related to general landuse, soil types, vegetation, workforce, agricultural landuse were collected from the village level revenue office and community development Block office.

2) Household Questionnaire:

Information related to workforce, agricultural input, and output etc was collected at the house hold level.

V. Methodology

Information collected through the method mentioned above was processed and represented by using the following statistical and cartographic technique.

1) Statistical technique

Use of mean standard deviation and analysis of variation was done for the purpose of comparing the performance of agriculture at different level i.e. inter-village, intra-village, village, block and district levels.

ii) Cartographic Technique

Use of Cartographic tool like, graphs Choropleth and bar diagram have been done for showing the climatic and other information in the district.

On the basis of above discussion it can be concluded that data related to minor irrigation and aspects of agriculture for district Jorhat is scantily available through the secondary sources. Therefore, the study is based on the data collected through the primary sources. There are various statistical and cartographic techniques in use among the geographers for processing and representing the data, but, use of simple mean and standard deviation and simple cartographic techniques like chropleth, isopleth and graph is done here mainly due to the number of observations bieng very less than the minimum required i.e. six villages for using any sophisticated technique like correlation, regression and complex Index etc.

CHAPTER VI

IRRIGATION AND AGRICULTURAL
DEVELOPMENT : A CASE STUDY OF
SELECTED MICRO IRRIGATION
PROJECT

CHAPTER -VI

IRRIGATION AND AGRICULTURAL DEVELOPMENT : A CASE STUDY OF SELECTED MICBO IRRIGATION PROJECT.

It is an undisputed fact that agricultural development in India is a function of successful use of irrigation based package technology. In the previous chapters it was discussed that though Assam falls under a humid climate region yet it needs assured irrigation for meeting the moisture requirement of the crops particularly during the months of December to May. It is during these months that the potential evapo-transpiration is much higher than the actual evapo-transpiration. The farmers of the state have responded to this difficulty by introducing artificial irrigation facilities in district Jorhat too. But, it was also discussed that the economic strength of the farmers is most important in utilizing the irrigation facilities in the district. In this chapter an attempt has been made to study the following aspect of irrigation and agricultural development:

- (i) Demographic background of the sample beneficiaries for understanding the relationship between literacy, age and sex structure and use of irrigation facilities.
- ii) Size of land holding and use of irrigation.
- iii) Irrigation and changing cropping pattern,

Part - ADemographic Background of the sample Beneficiaries.

Indian agriculturist is considered to be a house hold enterprise carried through the house hold labour. Joint family system was largely responsible for it, but with the change in production technology and increasing disparities the joint family system are increasingly disappearing and giving place to small nuclear families. Most of such families find it better to leave their traditional occupation and migrate to the urban centers .Thus leaving agriculture operation to be carried by female less efficient work force. The only way to change this pattern is through modernization of agriculture. Change in the sex ratio and house hold size is likely to be an interdependent result of it.

i) Size of the House hold and sex ratio:

The sex-ratio is measured in terms of the number of female per 1000 males. According to United Nations' study, "the classification of population by sex is one of the most important aspect in almost all types of population statistics and at the same time, one of the easiest method to obtain information in a census¹. A balance between the two sexes is essential for a healthy society. In the economic sphere a higher proportion of men signifies a larger number of

workers available for greater production, and a higher proportion of women usually mean fewer workers available for work, thus greater degree of economic dependence from the table No.6.1, it is evident that out of total population of 444, in the 60 sample house hold . 240 are males and 204 are females. So, the number of male are larger as compared to females. But the average size of household is higher which is estimated to be 7.4. It is much higher than the state level which is about 5.5. This indicates that the joint family system is still alive in the district.

TABLE NO: 6.1(A)

Population of sex and average size of household

No. of households	Population			Average size of households
	M	F	Total	
60	240	204	444	7.4

ii) Age and Sex Ratio:

Economies subjected to the interplay of strong pull and push factors are characterized by distorted age and sex-ratio leading to high dependency. Higher number of unproductive population mostly children below the age of 15 years and old over 60 years, handicapped also large section of female always change the population balance. The relative

burden of the economically unproductive of population is conventionally measured in terms of the dependency ratio defined the number of dependents per 1000 worker.

From the table No.6.2 it is clear that out of the total population 444, the number of children below the age group of 0-14 is 134, and the old people above 60 are 23 in number, while the then are 287 person individuals in the productive age group i.e., workers. Thus, the dependency ratio is approximately 54.70.

Literacy Level

Education is one of the most important factors which influences almost all the demographic aspects and also the economic development of a state/nation in various ways. It certainly helps the people to free themselves from the shackles of anachronisms, and opens their minds to different and never aspirations.

The agricultural development of a region largely depends upon the educational status of the people of the region Higher is the number of educated persons, greater is the technification in agriculture. Moreover literacy level leads to diversification of crops, practice of multiple cropping and use of modern inputs etc.

TABLE NO: 6.2(A)

Age Sex Ratio

Age Group	Sex		Sex		Total No.		Dependency Ratio
	M	F	M (%)	F (%)	M	F	
0-14	77	57	32.08	27.94	240	204	
15-59	150	137	62.5	67.15	(54.0)	(45.94)	54.70
60+	13	10	5.41	4.90		100	
Total	240	204	100	100			



The Table No. 6.3 reveals that the educational status of the study area is somewhat improved and encouraging.

TABLE NO: 6.3(A)

Literacy Level

Educational status	Male	Female	Total
1. Illiterate	8.5 (35.4)	124 (60.78)	209 (47.04)
2. L.P. Standard	30 (12.5)	20 (9.80)	50 (11.26)
3. M.E. Standard	35 (14.6)	15 (7.35)	50 (11.26)
4. Metriculate	40 (16.6)	20 (9.8)	60 (13.5)
5. Under-graduate	20 (8.3)	15 (7.35)	35 (7.88)
6. Graduate	15 (6.2)	8 (3.92)	23 (5.18)
7. Post graduate	5 (2.08)	2 (0.98)	7 (1.57)
8. Technical lines	10 (4.16)	-	10 (2.256)
Total	240 (100.00)	240 (100.00)	444 (100.00)

N.B. : Figures within the brackets indicate percentage of column total.

Source : Field Study.

The over all literacy rate among the sample house hold is 47.04 per cent with 60.78 per cent male literacy and 35.4 per cent female literacy. This is much higher than the

state average. It is largely due to changes taking place due to plantations testing and Jorhat agricultural University in the district. It is also noticed that the level of education is by and large evenly distributed among different standard of education including technical education.

(Part - B)

2.Land Holding and Land Use Pattern

In the preceding chapters, all those factors responsible for bringing changes in the cropping pattern, crop production and crop productively have been discussed in detail. In the previous section of this chapter the social background of the sample beneficiaries was discussed. Now it is evident from the forgone discussion that these is- every possibility of balanced development and self sustained growth of agriculture in the district Jorhat. The farmers are aware how to produce more from their agricultural fields, though the fragmentation of holdings and lack of assured irrigation facilities have created problems to the farmers in realizing their full potentials. Once such irrigation facilities are developed then there will be corresponding changes in the cropping pattern, crop output and productivity of crops of the district. This section tries to analyze to responsibility of samples beneficieries in relation to land holding and landuse pattern.

TABLE NO: 6.1(B)

Landuse Pattern of the household (irrigated villages) according to size groups (in hectares) 1993-94.

Size Group	No. of household	Total owned land	Leased out land	Land under own use	Leased in land	Total operational land	Current fallow	N.S.A.	Area sown more than once	S.C.A.
Sl.No. 1	2	3	4	5	6	7	8	9	10	11
< 1.0	2	1.19	-	1.19	2.60	3.79	-	3.79	2.35	6.14
1.00 - 2.50	20	31.82	-	31.82	4.35	36.17	0.22	36.39	12.20	48.59
2.50 - 5.00	8	23.69	1.00	22.69	-	22.69	0.06	22.75	9.70	32.45
5.00 - 7.50	-	-	-	-	-	-	-	-	-	-
7.50 & above	-	-	-	-	-	-	-	-	-	-
Total	30	56.70	1.00	55.70	6.95	60.96	0.28	63.93	24.25	88.18

TABLE NO: 6.2(B)

Landuse Pattern of the household (unirrigated villages) according to size groups (in hectares) 1993-94.

Size Group	No. of household	Total owned land	Leased out land	Land under own use	Leased in land	Total operational land	Current fallow	N.S.A.	Area sown more than once	S.C.A.
< 1.0	7	3.15	-	3.15	0.06	4.21	-	4.2	0.66	4.87
1.00 - 2.50	16	29.86	-	28.86	1.00	30.86	-	30.86	2.32	33.18
2.50 - 5.00	4	15.07	1.36	12.71	-	12.71	0.32	13.03	2.00	15.04
5.00 - 7.50	3	20.87	-	20.87	-	20.87	1.00	21.87	1.00	22.87
7.50 & above	-	-	-	-	-	-	-	-	-	-
Total	30	68.95	1.36	66.59	1.06	68.65	1.32	69.97	5.98	75.95

Source: Field Investigation.

TABLE NO: 6.3(B)

Selection of the Sample Landholders

Name of the sample village	Agro-Ecological zone	Total land of villages	Total land of the sample	Size of the holdings				Total No. of selected land holding
				Marginal < 0-1	Small 1.00-2.50	Medium 2.50-5.00	Large 5.00-7.50 & above	
Code A - Nahatia	Northern lowlying area	174.0 ha.	16.09	1	8	1	0	10
Code B - Ujani Khangia	same	101.0 ha.	13.26	2	7	1	0	10
Code C - Handiqu Gaon	Central Fertile Land	170.0 ha.	22.63	0	7	3	0	10
Code D - Buruk Barna	same	108.0 ha	27.23	1	6	1	2	10
Code E - Lalung Gaon	Southern Highland	273.0 ha	23.64	1	5	4	0	10
Code F - Lohong Bebejia	same	263.0 ha	22.80	4	3	2	1	10
Total - 6		1089.0 ha	125.65	9	36	12	3	60

N.B. : Code A,C,E indicate irrigated villages.

Code B,D,F indicate unirrigated villages.

Source : Field Investigation.

TABLE NO: 6.4 (B)

General Landuse Pattern of the sample land holders (1993-94)

Irrigated Villages (in Hectares)

Agro Ecological zone	Total No. of sample land holders	Total owned land	Leased out land	Land under own use	Land under lease	Total operational holding	Current fallow	Net area sown	Area more than once	6.C.A. intensity (%)	Cropping intensity (%)
Northern low lying area	10	16.09	1.0	15.09	2.02	17.11	0.22	16.89	10.12	27.01	160.27
Central Fertile land	10	22.63	19.18	4.05	23.23	2.02	2.21	21.21	8.33	29.54	139.98
Souther highland	10	23.64	1.05	22.59	1.22	21.37	1.62	19.75	7.75	26.50	134.2

Source: Field Investigation.

TABLE NO: 6.5(B)

Unirrigated villages

(Ujani Khongia, Buruk Borna & Lohong Bebejia)

Agro Ecological zone	Total No. of sample land holders	Total owned land	Leased out land	Land under use	Leased in land	Total operational holding	Current fallow	Net area sown	Area sown more than once	5.C.A. intensity (%)
Northern low lying area	10	13.26	2.26	11.00	1.00	12.00	1.22	11.78	3.22	15.00
Central fertile land	10	27.23	3.02	24.21	1.6	23.61	2.75	20.96	1.09	22.05
Southern highland	10	22.80	4.00	18.80	2.00	20.80	1.60	19.20	1.00	20.20

Source : Field investigation

On the basis of the data collected from the sample villages (see Table No.6.1,2,3,4) it is evident that the implementation of irrigation changed the pattern of operational holdings significantly.

With the availability of assured irrigation it is noticed that agricultural intensity have increased upto 180 per cent and a section of the land owners have started leasing lands to tenants from other villages, thus enjoying high rents. This may also be due to the shortage of family labour in the face of intensification of cultivation . Data on ownership and operational holdings and landuse pattern of the sample beneficiaries are given in Table 6B-1,2,3 & 4.

It is evident from the tables that there are minor changes in the area leased out and leased in. But there is significant change with respect to crop intensity.

The cropped area increased from 63.93hectares to 88.18 hectares, an increase of 37.93 percent within a year. As a result, overall crop intensity increased from 109 percent to 144 percent. But the crop intensity in the lands outside the command area remained static at 109 percent. This means that there is a difference of 35 percent of crop intensity between the irrigated villages and unirrigated villages. The area under current fallow in the irrigated area

is also decreased to unirrigated villages. Thus, even during the field survey it was noticed that the land use pattern have changed significantly among the sample beneficiaries.

2. Cropping Pattern and Diversification of Crops

The benefits derived out of irrigation can be broadly termed as direct and indirect. Direct benefits include the change in cropping pattern, higher intensity of cropping, use of H.Y.V. seeds, investments and the others in the form of trade, health, education, transport and communication links.²

The concept of cropping intensity and its pattern implies high degree of intensity of land use during a given agricultural year. It shows the extent to which the land is being utilized again and again within a given year. Assured irrigation is the single most important infrastructure which enables the farmer to utilize the same plot of land again and again and thereby help in the increase of gross hectareage of the farmers.

The observations on cropping pattern presented in the Table No.6(B), not only reveals out the difference in the intensity of cropping, but also the nature of difference in the cultivation of crops between two situation, one in the villages having irrigation facilities and the other

without any irrigation facilities. It is observed that in the district Jorhat, since rice is the principal food crop, every farmer cultivates this crop. However, it is evident that the farmers those have irrigation facilities have become more forward looking by using H.Y.V seeds and other associated package, while the unirrigated areas, the farmers still cultivate the traditional varieties of seeds. The net result is, that there is a change in the cropping method and this makes the standard of living of the farmers better Field survey shows that about 90 percent farmers use H.Y.V. seeds, mainly IR 8 , Monohar Sb, Pankaj, Pusa(2-21) and Socket by transplanting method with sufficient use of fertilizers. As opposed to the selection in the non-irrigated villages is differ. Broadcasting method of sowing is practiced here. Only 25 percent farmers use H.Y.V seeds without chemical fertilizers, except animal manure. Sali paddy is extensively cultivated in both the situation and it accrue 30 per cent in the irrigated villages and 100 percent in the unirrigated ones. It is so because of the floods the low lying areas are inundated.

The cropped area increased from 63.93 hectares to 88.18 hectares, an increase of 37.93 per-cent within in a year. As a result, overall crop intemsity increased from 109 percent to 144 percent. But the crop

intensity in the lands outside the common area remained the same at 109 percent. This means that there is a difference of 35 percent of crop intensity between the irrigated and unirrigated villages. The area under current fallow in the irrigated area is also decreased by about 1 hectare as compared to unirrigated villages. Thus, even during the field study it was noticed that the land use pattern has changed significantly among the sample beneficiaries. With availability of assured irrigation it is noticed that agricultural intensity increased up to 180 percent. It is noticed that a section of the land owners have started leasing out lands to tenants from other villages, thus enjoying a high rent.

3. Production and Productivity

In general, it can be observed that, there is a positive correlation between irrigation and crop productivity leading ultimately to overall increase in production in the district. Since, there is no up-to-date data on irrigation and productivity therefore field information was collected to assess the aspect. The field data, so collected is used for comparative analysis of both the situations viz. irrigated villages. It reveals that there is a gap between the two situations with respect to yield and productivity of crops. The yield per hectare in the irrigated areas of Autumn and

TABLE NO: 6.6 (B)

Cropping Pattern

Crops	Irrigated			Unirrigated		
	% of farmers farmers used HYV	% of farmers used fertilizers	% of farmers farmers used HYV	% of farmers farmers used HYV	% of farmers used fertilizers	% of farmers used fertilizers
Ahu paddy	100	100	80	25	80	2
Sali	100	62	80	55	100	10
Bao	0	-	-	0	40	-
Potato	25	-	50	75	30	-
Brinjal	52	100	-	-	46	33
Pulses	50	0	-	-	61	-
Mustard	42	50	0	-	46	-
Vegetables	50	60	4	-	62	10

Source : Field Survey.

TABLE NO: 6.7(B)

Cropping Pattern, Yield and productivity of sample land holders according to agro-ecological zones (1993-94).

Irrigated villages

Crops	Northern lowlying area				Central Fertile Land				Southern Highland				District Total			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Autumn paddy	6.91	27.69	16.4	3.25	14.37	55.4	6.5	21.8	39.6	16.66	24.72	37.13				
Winter paddy	14.63	58.63	10.2	18.32	81.02	30.2	19.6	65.74	37.0	42.55	63.15	52.70				
Summer paddy	-	-	-	-	-	-	-	-	-	-	-	-				
Mustard	0.10	0.10	8.2	0.39	1.72	5.4	0.93	3.11	1.2	1.42	2.10	-				
				Rs. 3540.00		Rs. 8855.60		Rs. 14000.00		Rs. 9850.70						
Rabi pulses	0.13	0.52	12.5	-	-	-	0.13	0.44	2.5	0.26	0.38	4.1				
Pea	1.33	5.33	9.7	-	-	-	0.66	2.20	3.20	1.99	2.95	3.3				
Wheat	-	-	-	-	-	-	0.53	1.77	4.5	0.53	0.78	-				
Potato	1.06	4.24	29.2	0.26	1.14	5.5	0.53	1.77	25.5	1.85	2.74	23.0				
Vegetables	0.79	3.16	20.00	0.39	1.72	5.5	0.93	3.11	3.5	2.11	3.13	9.6				

N.B :Col.1 refers Area in hectares,

Col.2 refers aea in Percentage.

Col.3 refers yield in quintals/hectare

Col.4 refers productivity in Rs/hectare for all crops

Source: Field Survey.

winter paddy are 37.13 and 52.7 quintal/hectare whereas in unirrigated areas it is about 20.13 quintals/hectare and 32.7 quintal/hectare respectively. In case of other crops also, there are differentiation. The table No.6.7 and table No. 6.8 shows clearly the yield rate of crops between the two situations. Thus it can be said that 'irrigation' is the most important infrastructure for increasing the crop production if it is utilized in a proper way. The productivity of crops in irrigated villages Rs.9850.70/hectare whereas in unirrigated villages it is Rs.6850,00/hectare. This difference is due to use of modern inputs by the farmers of the both situation.

On the basis of above discussion it can be concluded that the condition of agriculture and the farmers have shown considerable improvement after the introduction of modern production techniques in agriculture. The success of these techniques is exclusively dependents upon the nature of assured irrigation. Thus can be said that introduction of assured irrigation is an imperative for both improving agriculture as well as the standard of living of the people even in the state of Assam.

REFERENCES

- 1 United Nations Census Methods, p.14
- 2 Rao, D. Vasudeva, "Irrigation: A clue for Rural Development",
Kurukshetra, vol. xxxiv, No.11-12, 1986, p.14.

CHAPTER VII

SUMMARY OF MAIN CONCLUSIONS
AND
SUGGESTIONS

CHAPTER VII

SUMMARY OF MAIN CONCLUSIONS AND SUGGESTIONS

I. i) Agriculture is the main occupation of majority of population in Assam. It accounts for highest percentage of human and land resources engaged in it but, it is surprising to note that significantly higher proportion of agriculture in the state depend upon natural factors.

ii) There is a paucity of research materials on the interrelationship between micro-irrigation and agriculture at the district and village level.

II. 1. The location of the district along southern bank of the river Brahmaputra and its spatial links with the other developed town of the state by the National high way has significantly influence the aspects of agriculture in the district including growth of large tea estates in the district.

ii) Geographical structure of the district and active fluvial geomorphological process particularly recurrent flood from river Brahmaputra have induced uncertain in the agricultural developed in the district.

iii) The relatively homogeneous relief features of the district the role of active fluvial geomorphological processes is most significant in creating variation in the relief at the micro

level. The process of erosion being higher and active in the south and deposition in the northern parts of the district.

iv) River Brahmaputra forms the only drainage system of the district. The volume and level of water in the mighty Brahmaputra also influences the ground water table in the district. Areas close to the flood plain have very high water table and the depth of water increases with the distance from the river Brahmaputra.

v) Humid climate with maximum rainfall during the south western Monsoon season i.e. June to October is the specific characteristic feature of climate in district Jorhat. The annual variation of minimum temperature between 15° to 28° C is most favorable for carrying agricultural operation round the year. But, due to temporal variation in the rainfall the district a short but significant dry spell from January - March. It is during this period the difference between potential evapo-transpiration and Actual evapo-transpiration is maximum. It is most crucial for agriculture therefore, irrigation becomes important for carrying agricultural operations without much problems.

vi) Soils of the district are a combined product of local geology, relief, vegetation and climate. These being the important variable in de-marketing the agro-ecological zone of

the district show that New alluvial soils of the north are rich in humus and other organic contents and their pH value is also Normal. As opposed to their the soils in the soilthem part are deficient in organic contents.

vii) Ever green vegetation are the dominant forest type in district Jorhat. But the density of forest cover is proportional to the distance from the river Brahmaputra. It is being highest in the south and minimum in the north. It is largely due to the frequent flood in the northern low lying area.

III i) Agriculture is the major occupation as well as means of livelihood of majority of the population of the district. Therefore, development and modernization of agriculture will have corresponding changes in the employment and livelihood of population in the district.

ii) Paddy is the predominant crop in the district. Paddy is grown in three seasons of a year but, winter paddy is the most significant followed by autumn paddy and summer paddy is grown only in the areas not prone to floods and related natural calamities. Therefore, district Jorhat is a monocultural region if tea is excluded from the agricultural land use. Otherwise Rice and tea account for 1st and second ranking crops in the district.

iii) Cropping intensity in the district is much lower than the

district average. It is mainly due to the forced fallow land on account of frequent floods, and lack of modern techniques of agricultural produces. But it is noticed that agricultural intensity is higher in the Block having assured irrigation facilities.

iv) District Jorhat accounts for very low agricultural efficiency. An important reason behind low agricultural efficiency is the continuation of primitive production techniques, poor economic condition of the farmers and incompetent techniques to combat the adverse environmental impact such as flood etc.

v) Agriculture accounts for highest proportion of natural and human resources employed in it. It accounts for 46 percent of the total land resources and 76 percent of the man power engaged in it.

vi) Draught, Animals like, bullocks and Buffalo are some of the capital resource of agriculture in the district Jorhat. Apart from these traditional capital resources Tractor, and power tiller are also becoming popular in the district. But, because of poor economic condition of the cultivator these are used only, but marginally and use of traditional implements continues to occupy dominant place in the agricultural operations.

vii) Use of modern bio-chemical inputs like HYV seeds, fertilizer and pesticides have registered significant increase in the district, but this has been largely possible in the areas endowed with assured irrigation. Their use is also dependent upon the economic condition of the farmers. Big and rich farmers use more of these modern inputs than the small and marginal farmers.

IV i) Tenancy relation or land tenural system is one of the most intricate aspect of agricultural development and modernization in Assam. Share cropping i.e. "Adhi" system is most prevalent in the state and it is total violation of Assam Adhiar Protection Act of 1948.

ii) Apart from the exploitation the tenants under the share cropping the uncertain duration of land occupancy also creates major obstacles in any permanent improvement of land and soil. As a result the soil fertility decline has become the principal characteristic feature of agriculture backwardness in the district. In some parts of the district it is noticed that fixed duration lease system is also practiced. The system is relatively better and the tenants are motivated to introduce some short term agricultural development techniques including use of biochemical inputs.

iii) House hold having other source of livelihood and income

are the main in leasing out the land followed by fragmentation of land resulting into rise of uneconomic holding.

iv) Most of the farmers those lease in the land are big farmers. They also use modern agriculture production techniques and it is expected that they are also the potential capitalist farmers of the district. But, it will be at the cost of small and marginal farmers which will ultimately join the army of landless wage labourers.

v) Agricultural indebtedness due to natural and human causes another important reason behind land transfer from small farmers to big farmers and money lender etc.

vi) Loan taken from the village money lender mostly for non-productive expenditure is the single most important economic factor that constantly pushes the small farmer into the ever widening debt trap and it is surprising that even after four decades of independence the role of the village money lender is worthnoting and their debt trap continue to persist.

vii) Conspicuous absence of modern Banking and credit institutions have contributed in the consolidation of traditional credit institutions like Money lender and Sahukars in the district. Most of the loan provided by these private institution are consumer in the debt trap. As a result of which the instance of land transfer due to indebtedness still

prevalence in the district.

viii) Artificial irrigation has undoubtedly been accepted as the input in agricultural modernization. But, it is surprising to note that district Jorhat has insufficiently low proportion of area under irrigation. Though, introduction of irrigation is over two decades old in the district yet most of the schemes sponsored by government have failed and only recently private pumpsets have been introduced for this purpose. Relatively higher water table have helped the farmer to dig their own well at relatively lower cost and this mode of irrigation is gaining popularity in the district.

(ix) Village traders and middle men continue to dominate the agricultural market in the district of Jorhat. Their strength is proportional the degree of accessibility and interaction between the rural areas and neighboring market centers.

(x) Low volume of surplus generation and highly backward market relation complement each other in keeping agriculture backward in the district including development agro-based industries.

V. i) Agriculture is one of the earliest and most complex human occupation in the State of Assam. The complex nature of agriculture in the State is the result of co-existence of most primitive and most advanced forms of agriculture in one and the

same district.

ii) Paucity of data and information pertaining to this complex human activity has made it imperative to conduct study at the village and house hold level.

iii) Selection of villages for the purpose of analyzing the impact of irrigation on agriculture occupies specific significance in the study. For this purpose stratified random sampling technique was used.

iv) Use of sophisticated statistical and cartographic tools is most common in the geographical research but use of mean, standard deviation and other simple techniques have been done here mainly because of less samples.

VI. i) Higher dependency ratio shows that the nature of burden on agricultural sector in the district. Existence of joint family system is largely responsible for it and with the introduction of market relation and modernization in agriculture the dependency ratio can be brought down.

ii) With the introduction of assured irrigation facility, agriculture has gained enhanced significance and thus competition for agricultural land has increased with the number of lease, in case being higher in the irrigated villages as compared to unirrigated ones.

iii) As expected irrigation has contributed in increasing the intensity of land use with more than 50 percent in case of irrigated villages. It is experienced as high as 160 percent in the irrigated villages and it is below 118 percent in the irrigated villages. The disaggregated picture of the villages also show that the cases of leased in and leased out land is more in the parts and there is a sharp decrease in the amount of fallow lands with the introduction of irrigation in the same villages.

iv) Winter paddy is the most important crop in the district followed by Autumn paddy. It may be largely because most of the flood plains are also available for the cultivation of winter paddy particularly in the low-lying flood prone areas of the north and in the central fertile plain. It can be corroborated by rapid decline in the area under Autumn paddy which is less than 40 percent in case of the low lying areas of the North and below 20 percent in the central plain.

v) Higher ground water table in the north even low lying areas is an important factor for some degree of crop diversification with peas and potatoes accounting approximately 5 and 4 percent of the total cultivated area. It is less than 1 percent area in the southern high lands and very insignificant in the central fertile plains.

vi) With the introduction of minor irrigation the cropping intensity have increased. But the disaggregated picture shows that it has increased above 49 and 33 percent for the medium holding i.e. between 1-2.5 and 2.5-5 hectare holdings respectively as opposed to only 6 percent in case of holding size below 1 hectare. It proves that irrigation have benefited the medium and large farmers more than the small farmers.

vii) Moreover, it is also evident from the table no. 6. 7 that due to frequent inundation of the low lying areas of the north and occasionally in the central part agricultural operation have become difficult in these areas with low level of productivity per hectare. As opposed to this areas less prone to such natural calamities make agricultural operation possible round the year leading to increase in the per hectare productivity. It is approximately 2 time more in central fusive plain and four times in the southern high lands as compared to the low lying areas of the North . Use of modern irrigation facilities is an important factor for such high productivity per hectare.

viii) The study conducted for six sample villages two each from the three agro-ecological zone also prove that the productivity tends to increase from north to south or from the areas of rainfed agricultural to the areas of assured irrigation. It is estimated to be approximately Rs.10,000;

Rs.7,700 and Rs.3055 in case of villages from southern high land, central ferrule plain and northern low lying areas respectively.

ix) Use of modern agricultural inputs particularly, H.Y.V seed and fertilizer is more in the irrigated villages. It is observed that nearly 90 percent farmers in the irrigated villages use H.Y.V seeds during Ahu paddy season as against 25 percent in the irrigated villages as opposed to 55 percent in the irrigated villages during the sali paddy season. This is somewhat different than the observation made by different scholar suggesting use of H.Y.V. in Brahmaputra valley on a large scale.

BIBLIOGRAPHY

BIBLIOGRAPHY

- Alexander, K.C.: "Agricultural Development and Social Transformation Journal of Rural Development, Vol.4, No.5, 1985, p.565.
- Ali Inshad: A Study on The Impact of Mayong Lift Irrigation Project (Nawgong District, Assam). Agro-Economic Research Center for N.E. India, A.A.U. Jorhat.
- Bhalla, G. S. & Tyagi, D. S.: Patterns in Indian Agricultural Development District Level study
- Bhalero, M.M & Maurya, R.P.: "Employment Generation through Labour Incentive Crops: A simple study" Khadi Gramodyog, Vol. xxxii, No.3, p.199, 1985.
- Bhatia, S.S. (1965) Patterns of Crop-Concentration and Diversification in India, Economic geography, Vol.41, pp.39-56.
- Bhatia, S.S. (1967) A New Approach to Measure Agricultural Efficiency in U.P., Economic Geography. Vol.43 pp.224-260.
- Borthakur, M. (1968) Some Aspects of Weather in the Brahmaputra Valley, Journal, Assam Science Society Vol. II, pp.92-100.

- Bora, M. "agricultural production Processes in Jorhat District(Assam) A Geographical Analysis unpublished M.Phil Dissertation 1991 ,NEHU.
- Das, H.P.(1970) Geography of Assam National Book Trust, New Delhi.
- Das, M.M. (1984), Peasant Agriculture in Assam A structural analysis, Inter India. Publications, New Delhi.
- Das, M. M. & Dutta, L.(1986), regional Variations in Landuse in Agriculture in North-East India, North Eastern Geographer, Vol.18, No.12, pp.28-48.
- Devi Vidyawathi, A.Krishna Mohan, P. "Need reform in Irrigation distribution, a Case study", Journal of Rural Development, Vol.4, No.2, 1985, p.334.
- Directorate of Economic and statistics, Government of Assam, Statistical Hand book of Assam 1990, 1991, 1992, 1993, 1994.
- Directorate of Census Operations, Government of Assam, Provisional Population Totals, Census of India, 1991, series-4.
- Edwin, T. "Irrigation Management in India, "Kurusheetra, Vol.xxx II, No.12, p.13.1984.
- Goswami, B."Impact of Minor Irrigation on agricultural Landuse

and Cropping Pattern: A Case Study of Hajo Block",
Unpublished M.Phil. Dissertation, NEHU, Shillong, 1987.

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

Government of Assam (1967), Assam District Gazettes: Sibsagar
District, Shillong.

Guha, J.L. and Chattoraj, P.R (1980), A New Approach to Economic
Geography: Study of Resources, The World Press
Pvt.Ltd., Calcutta.

Hussain, M. (1982), Crop combination in India -A study, Concept
publishing Company, New Delhi.

Jusawala, M.F. "evaluation of the Benefits of the Nizam sagau
Irrigation Projects" (Osmania University), Hyderabad,
1964.

Mishra, S. A comparative study of the Economics of Minor source
of Irrigation in U.P., (Oxford and IBH publications
Co., Calcutta), 1968.

Mohammad Noor, "Perspective in Agricultural geography, Vol.III;
(Concept publishing Co, New Delhi) 1981.

Monkhouse, f.J and Wilkinson, H.R. (1980), Maps and Diagrams,
B.I. Publications, New Delhi.

- Misra, R.P.(1968), Diffusion of Agricultural Innovations, University of Mysore.
- Patel, A.R., Irrigation schemes and Small Farmers, Kurukshetra, Vol.XXXI, No.21., 1983, p.7.
- Phukan, U., "Agricultural Development in Assam", Mittal Publications, New Delhi, 1990.
- Rao, N.J.V.N. & Ram Reddy R. , "Minor Irrigation and Tribal Development, Kurukshetra, Vol.XXXIV, No.12, P. 31, 1985.
- Rao, Vasudeva.D., Irrigation: A Clue for Rural Development", Kurukshetra, Vol.1.XXXIV, No.11-12, P.141988.
- Rao, Vasudeva, D - Rural Development through Irrigation (Ashish publishing House New Delhi, 1987).
- Shafi, M.(1960), Measurement of Agricultural Efficiency in Uttar Pradesh, Economic Geography, Vol.36, No.4, p.295-305.
- Singh, S.(1984), Technological Transformation in Agriculture, Ariana Publishing House, New Delhi.
- Singh, J. (1976), Agricultural Atlas of India Geographical Analysis Vishal publications, Kurukshetra.

Singh R.L.(ed),1971,India: A Regional Geography,NGJI, Varanasi.

Swant, S.B. and Ganguli, A, (1983), Factors Affecting Agricultural Efficiency in India, National Geographer, Vol.18.No.1,pp.110-118.

Saikia, P.D. and Phukan, V. Twenty Five Years of Agro-Economic Research in N.E.India (1960-85), Assam Agricultural University.

Shanthudu, D. "Impact of Land Reforms, A study", Kurukshetra, Vol.XXXI, No.17, p.12, 1983.

Weaver, J.C.(1954), Crop Combination Regions in the Middle west, Geographical Review, Vol.44, pp.175-2000.

Yadav. G.P. "Credit Needs of Agriculture and Rural Development", Khadi Gramodya, Vol.XXXII, No.8, p.405, 1986.

1980 LIBRARY
Acc. No. 103046
Acc. to Bhatia
Date 27-2-98
Class by
See card no. 103
Enter by
Serialized no.