DIFFUSION AND DISTRIBUTIONAL PATTERNS OF HIGH YIELDING VARIETIES OF RICE IN THE LOWER BRAHMAPUTRA VALLEY

By

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This is to certify that the thesis submitted by Sri Rangadhar Sahu for the degree of Doctor of Philosophy(Ph.D.) at the department of Geography, North-Eastern Hill University, Shillong, Meghalaya entitled "Diffusion and Distributional patterns of High Yielding Varieties of Rice in the Lower Brahmaputra Valley" is a bonafide study of the author to the best of our knowledge and believes. This study may now be placed before the examiners for evaluation.

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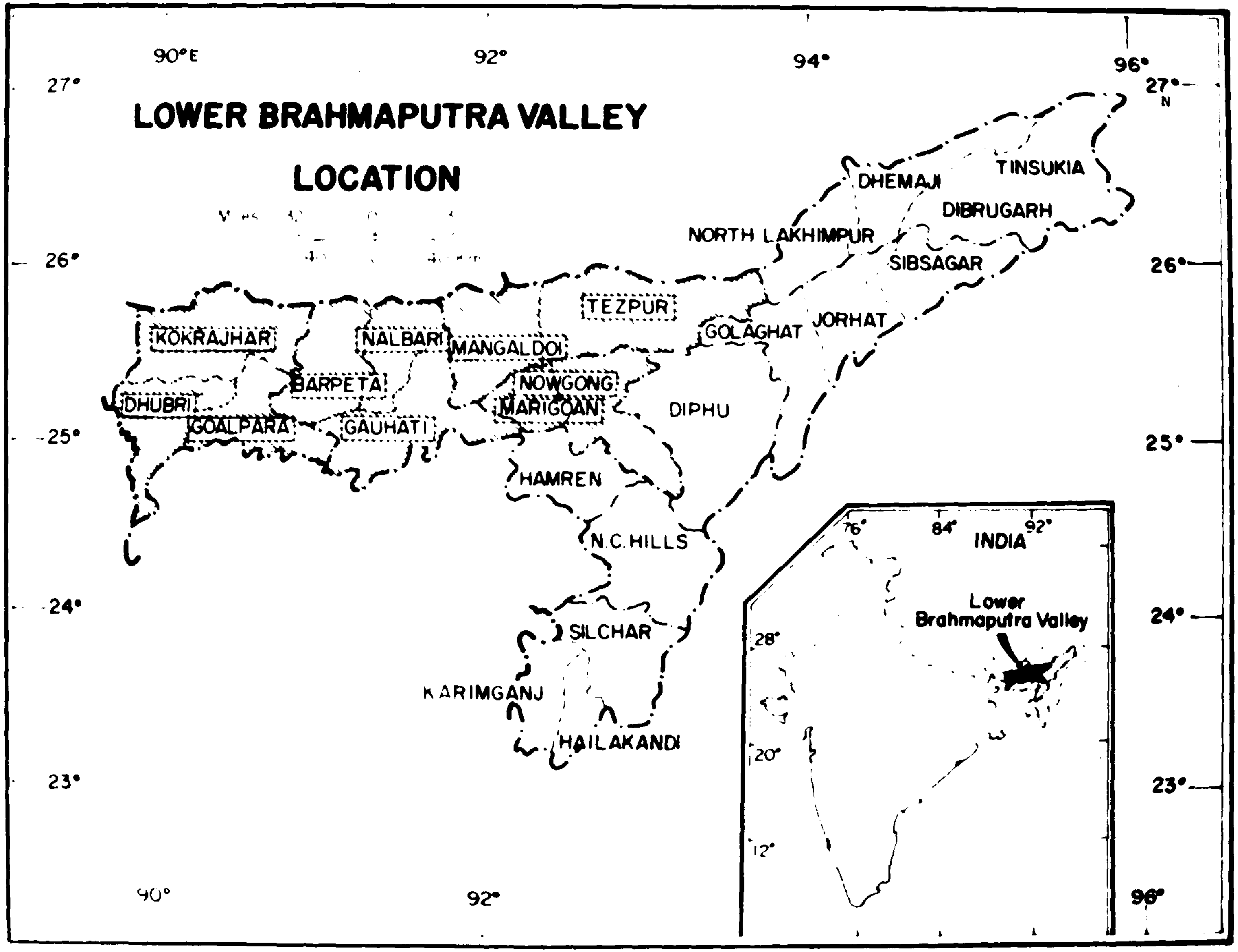
LOWER BRAHMAPUTRA VALLEY
LOCATION
90°E
92°
94°
96°
27°
26°
25°
24°
23°
27° N
90°
TINSUKIA
DHEMAJI
DIBRUGARH
NORTH LAKHIMPUR
SIBSAGAR
TEZPUR
JORHAT
GOLAGHAT
KOKRAJHAR
NALBARI
MANGALDOI
BARPETA
NOWGONG
DHUBRI
MARIGOAN
DIPHU
GOALPARA
GAUHATI
HAMREN
N.C.HILLS
SILCHAR
KARIMGANJ
HAILAKANDI
INDIA
76°
84°
92°
28°
20°
12°
Lower Brahmaputra Valley

Fig.1

INTRODUCTION

During the last couple of decades the global agriculture has undergone dramatic transformation. This transformation in the agricultural scenario even from a subsistence peasant farming to its modern and technically advanced counterpart in many areas is largely due to a pressing need of food grains specifically to eradicate the problem of hunger, under nutrition and malnutrition. The tremendous pressure exerted by population growth on arable land and the growing demand for food and agricultural raw materials are some of the pressing problems of the present day world. While doing extensive farming, man has already pushed the frontier of arable land to the limit and hence agricultural production can only be raised by intensification, multiplication and diversification of crops by adopting new agricultural technology and practices. In recent years, production of cereals has gone up in the developing countries nontheless, the numerous qualitative targets are miles ahead to be achieved.

One of the most spectacular aspects of technological revolution in agriculture is the introduction of High Yielding Varieties of crops which have since the outset conspicuously transformed the agrarian phenomena in most of the developing countries of south and south-east Asia. In so far as the introduction of HYV seeds during early sixtees go, the post introduction phase highlights a discouraging productivity pattern of the new crops specifically rice in terms of both absolute and relative figures. A fundamental question arises as to what precisely has been the role of the new seeds in minimising the long standing social problems ? The answer is obviously disheartening, for, the introduction of HYV programme with an advent of a technological breakthrough has failed to a large extent to bring down the hunger, malnutrition under nutrition and social inequality to minimum in the country. The percapita output has not appreciably increased. It has simply helped to maintain the existing levels of production per capita alongside the nutrition level in many states and union territories confronting an acute problem of population growth. The new varieties have thus resulted in a change in cropping structure, their rotation, methods and agricultural operations. Consequent upon, the advanced technology has quickened the formation of a commercial agriculture. The subsistence peasant farming is therefore in the process of being destroyed with the advent of this new techlology.[1] This, as an attribute can be singled out so as to identify its wide spread effect such as growth of wage labour, formation of a stratum of agricultural labourers, rise of large farmers in terms of social importance and emergence of a new

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1. K.Griffin(1973) The Political Economy of Agrarian Change. Macmillan, Oxford, pp.46-82, 171-194.

class of rural elites. In turn it has brought about a polarisation of social classes creating greater disparities in the income of the rural people which have in the long run led to many social tensions.

The social class structure, relation, alignment and status have drastically changed with a corresponding change in the income distribution. These features in rural India are largely due to the introduction of HYV crops which have substituted the human labour with a high level of farm mechanisation. It has however, ultimately generated a vast potential of human labour surplus in agricultural sector thereby substantially widening the gulf of economic inequality, regional disparity and increasing the problem of unemployment.

There has been an interaction between the modern agriculture and industry, the former depending on the latter for a variety of chemical and mechanical inputs. The subsidies issued by most governments in case of essential inputs indicate the capital intensive nature of agriculture. This is on the other hand, an impetus to innovation diffusion in agricultural sector. Inefficient too, this kind of agriculture will not provide adequate requirements for a sound living thereby opening an outlet of labour flow from rural to urban areas showing a rise in unproductive employment as a negative symbol of social and economic development.

The above discussion mostly reflects the social and economic repurcussions of the introduction of High Yielding varieties of food crops in India.

Without going into the details of merits and shortcomings of the HYV it would be worthwhile to study and analyse the diffusion pattern of the new varieties of rice in a micro region of the Lower Brahmaputra valley which has tremendous renewable resource base and enormous agricultural potential.

The study is aimed to enquire into the diffusion, distributional and dispositional patterns of High Yielding Varieties of rice. Barring the basic objective as regards an assessment of the existing picture of the extent and levels of diffusion of the HYV rice in the area under study, several consequent issues and their solutions have simultaniously been explored. The issues thus raised incorporate as to how, why and to what extent the diffusion has been reflected in the several holding strata of the rural peasantry. What have been the absolute and relative gain in terms of output ? Whether the crop is neutral to scale or dependent on a varietyof socio-economic and physical input factors ?

Before drawing up the details, it will be worthwhile to discuss about the conceptual frame work of a diffusion of innovation of any natural or social phenomenon, upon which the study is based.

The relative existence of phenomena over space has always formed an exciting study for both the social and natural scientists. For an analyst(s) however, it is the spatial/behavioural aspects of such phenomena that stands as the primary concern. This relationship between man on the one hand and space and time on the other, if studied in the spatio-temporal dimension (particularly with reference to HYV of rice) brings out the dynamics of the spatial pattern of diffusion.

There is a growing literature concerning the effectiveness and implementation of High Yielding Varieties programmes. These have been carried out by various organisations, but what seems to be lacking is, how far such programmes have really succeeded . and whether they have encouraging results particularly the support of the peasantry ? These are in addition to the socio-cultural variables that really influence the psychological and effectiveness of such programmes in the rural landscape.

There are a variety of phenomena whose scientific study of diffusion is yet to be attempted. The diffusion of new technological innovation study in agricultural sector draws special attention to raise and improve the standard of living in a society which is predominantly agricultural in character. Agriculture being the backbone of a country's economy is also as the basic sector, an indicator of the overall socio-economic development. The modernisation of an agrarian society i.e. the technological change from the contemporary to modern can be brought about only when the orthodox ideas, conservatism and superstitions, of the rural lot are absolutely wiped out by means of adequate scientific education and training. The advanced technology employed in agricultural sector can also help to accelerate the production and productivity of field crops to a considerable extent.

The main objective of the present study is to find out the pattern and extent to which the adoption of High Yielding Varieties of rice has been diffused among the farmers of the Lower Brahmaputra Valley. Secondly, it seeks an answer as to the distribution of output of the HYV revolution in the country side vis-a-vis the distribution of factor markets. Thirdly an attempt has been made to distinguish, identify and trace out the factors which infact constrain and encourage their way of acceptance. Viewed objectively, the problem is an enquiry as to why some cultivators introduce latest agricultural innovations such as the application of chemical fertilizers or advanced machineries, HYV of crops and so on while others living in the same community do not. The answer is as simple as, the farmers may be knowledgeable, socially powerful and having interaction[2] with the technologically and educationally advanced communities of the society. The immediate neighbours may be lacking these qualities and hence fail to accept the modern agricultural practices. Thirdly the study examines the choice of the farmer as an individual among more than one option open to him as regards the introudction of modern innovation in his farm[3] under the presumption that the infrastructural facilties (credit, extension services, communication and transport and market) are available, the non-availability of which might restrain the adoption.

Despite a variety of reasons often some casual inferences are also made as to the exposure of the farmer to radio and other communication media. This will of course lead us to the limitation of data and adequate informations. Other media such as extension services from the personnels of the Department of Agriculture are also to be examined and analysed so as to draw inferences in view of their importance and effectiveness in helping the spread of diffusion of a new innovation i.e. the High Yielding cultivation of rice.

Fourthly the carriers and the barriers in the process of diffusion of HYV rice will be identified. With a view

2. Fligel, Sen et.al (1968), Agricultural Innovations among Indian Farmers, NICD, Hyderabad pp.1-10.

3. Ibid., pp.1-10

to analysing the diffusion pattern of HYV rice adoption in the various strata of the cultivating households according to their socio-economic standing, the farmer's social setting has been given due importance. For a better understanding, the social characteristics, such as age, formal education, literacy, nonfarm employment of the farmer, family size, agrarian relation (land tenancy such as lease in and lease out of land etc.) religious.beliefs, position in the social ladder (such as caste) have been analysed and given deep insight as regards their role in pulling and pushing a new agricultural innovation i.e. High Yielding Varieties of rice.

In addition to the above features in the farmers social setting, the most vital spectrum of the problem is the farm structure in terms of holdings. This aspect gives rise to some fundamental questions. Is it the farm size (net) which stands as the limiting factor in adopting a new technique of cultivation specifically the HYV of crops? Is the adoption of HYV rice labour intensive ? Is the HYV cultivation scale neutral ? The main aim of raising these questions is therefore to enquire into the nature or characteristics of the farm setting in general and the various strata of holding in particular.

Fragmentation of the cultivated land is also taken into account to determine its influence on the farmers decision in adopting HYV crops. Meaning thereby, quite often the large holdings are so much broken up and fragmented due to the corresponding split up of extended and large families that it poses a psychological problem for the cultivation as to whether he should adopt the same or not.[4] Because there is a fear that small and fragmented fields will stand uneconomic specially in the investment of costly inputs.

Other than these existing situations arround the farmer himself and his farm, the organisational facilities such as credit through cooperatives and banks etc. extension services, the essential inputs (water,fertilizer, machineries) are also to be discussed. These of course have direct impact upon the farming society to have free choice of crops for better production. However, this will enable a researcher to know that within an existing environmental setting what circumstances/can encourage the new agricultural innovations especially the adoption of HYV rice as well as modern methods and practices in a particular agrarian society.

In fact, the size of the farm holding plays vital role as the core issue in the spread of HYV rice and when the latter gets magnified numerous social and agro-economic

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4. See Fligel, Sen et.all.Op.cit.P. 34

problems crop up. The analysis will, therefore be followed by the biasness of the spread of HYV rice cultivation towards a particular direction/holding size.

While analysing the socio-economic obstacles in the diffusion of HYV rice, one gets tempted to know as to what agro-climatic environment a region under study comes within. What is the average impact of the environment on the productivity of HYV rice which is an indirect impetus to the farming inhabitants. Hence the purpose of the study is also to assess and evaluate and to measure the impact of the physical surrounding in terms of the principal parameters. This specific attempt has great socio-economic relevance not only because rice is the leading crop of the area under study but also because the HYVs are not very successful over the greater parts of the country probably due to the uncontrolled supply of water to the crop.

Study Area

The present study is confined to the districts of Goalpara, Kamrup and Nowgong of the Lower Brahmaputra Valley. As a climatic region Brahmaputra Valley is unique in itself. It records over 400 cm. of rain fall annually. The soil is highly fertile being formed by the fluvial deposits of Brahmaputra and its tributaries. The agroclimatic conditions have made the valley an area of monoculture of rice in which more than 70 percent of the gross cropped area is devoted to this crop.

Lower Brahmaputra Valley has been selected as an area of study primarily because of its distinct socio-economic and cultural character (as compared to the rest of the Valley). Reasons are many, but suffice it to say that the influx of immigrants has contributed significantly to the complexity of agricultural land scape. The study contends that the elements of the distribution of phenomena are known and concern itself with the problem connected with the process of diffusion of HYV rice.

The problem of the diffusion of HYV rice and its distribution pattern in social and economic context in the region can also be considered as a spatial phenomenon[5] whose diffusion process will highlight the various physiographic, socio-economic and cultural barriers. Since this sort of study will involve data and information in a time series and there are numerous limitations in procuring them, the study about the spatial diffusion of a new crop in a region is a cumbersome task. The economic pattern of diffusion and distribution of the cultivation of High Yielding Varieties as reflected in the rural farms of

5. From the point of view of the typologies of spatial diffusion, two important aspects arise. Firstly, anything that moves over space is carried by some agent or the other secondly, the rate of movement varies because

this area has been the focus of the study because of its physiographic and socio-economic personality.

Hypotheses

In the present work the following points and hypotheses will be tested:

1. What is the extent of distributional pattern and disposition of the High Yielding Varieties in the Lower Brahmaputra Valley.
2. Whether the physical attributes of the region are conducive for the diffusion and spread of the HYV of rice in the area of study.
3. Whether the socio-cultural, economic and institutional attributes are creating barriers in the diffusion of HYV of rice in the region.
4. The major carriers and barriers of the HYV of rice will be identified.
5. It will be tested if the farm size and their fragmentation are the limiting factors in the spread of HYV of rice or whether the HYVs are neutral to the scale and labour intensive.
6. Whether the Lower Brahmaputra Valley has adquate organisational facilities for the adoption of HYV of rice.

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of extranious factors acting on the direction of the way of diffusion. The most exciting part of the problem of diffusion is the study of both 'carriers' and 'barriers'. For detailed discussion on spatial diffusion see Adams, Abler and Gould, 1971, The Spatial Organisation, Newjersey, pp.389-450.

7. Whether the small farmers and landless labour have been deprived of the benefits of new seeds of rice because of the growing inequality in the distributional pattern of land and output.

8. Whether the farmers of the Lower Brahmaputra Valley are moving from the subsistence towards the market oriented economy.

Plan and Design of the Study.

Data Base

The entire study is based on both the primary and the secondary data and information. The first few chapters are primarily based on the secondary sources. The reports and Field data on the yield estimation survey of High Yielding Varieties of rice conducted by the Directorate of Agriculture, Government of Assam have been procured. Other relevant data on agro-climatic parameters were obtained from the different government sources which include the records of the India meteorological Department, Soil Testing Laboratory of the Government of Assam. In addition to these, the author conducted field survey in the area under review to obtain first hand information and data about soil conditions, agricultural practices, levels and dynamics of production and the performance of HYV of rice. A field to field survey in the sample villages of Goalpara and Kamrup districts was conducted in the form of structured questionnaires. The schedules were designed at the village and household levels. The basic informations were collected and plotted on the village maps.

The field and on-the-spot collection of data by a direct interview with the farmers of the Lower Brahmaputra Valley(such as the districts of Goalpara and Kamrup) have been executed in the following fashion.

Questionnaire Construction

A set of questions basically to know the attitude of the farmers towards the practice of cultivation of High Yielding Varieties of rice alongwith several other circumstances of the farmers socio-economic setting were framed. The sub-sections of the questions were split up into the following areas of investigation.

(i) Social setting

The social setting of the farmers to adopt a new innovation relies on a variety of conditions as to how educated a farmer is, what position he occupies in the social ladder concerning the caste, religion etc., how extended and large a family he lives in, and how financially strong/stable he is, as reflected in his daily or monthly consumption or income. These aspects have been enquired and investigated through simple and comprehensible questions.

(ii) **Holding Size**

The land holding size of the farmers im terms of area operated, area owned, fragmentation of fields, pattern of land utilization-season wise and crop wise, cropping pattern concerning the number of crops raised in various seasons, formation of the fields, levels of productivity of the field crops with special reference to High Yielding and local traditional paddy have been probed into through a set of questions framed for the purpose.

(iii) Consumption Levels of Inputs

The information concerning the advanced economic inputs such as fertilizer, pesticide, irrigation, tractor, diesel pump, weeder, sprayer, and the level of their use have been tapped from individual farmers through direct interview. The response of each of the farmers has been filled up against the respective question asked. A specific column has been devoted to record the expenses incurred in terms of money for the cultivation of different crops in general and the cultivation of High Yielding and traditional varieties of paddy in particular for the final assessment of these two crops.

(iv) Missellanious

A few questions in the schedule have been designed to collect information about the benefits of the cultivation of High Yielding crops specifically paddy, for noting down the dissatisfication caused due to any attribute, and about physical conditions of the agricultural land .

Criteria of Sample Study

Generally for a standard study dealing with socio-economic aspect about 10 to 15 percent of the universe is taken as the sample. But looking at the time, finance and several socio-cultural constraints only eight sample villages were selected. Even in the case of these eight villages the author confronted many problems in the procurement of village maps - showing the field boundries and in filling up the questionnaires, mainly because of the political instability and the problem of foreigners. All the village maps except a few therefore, could not be procured because of such situation in Assam.

In fact the socio-political instability and foreigners issue, were the serious impediments for a smooth field work. All the time the villagers remained curious to know whether the incoming stranger is a government agent, politician, missionary worker, a social reformer or simply a research worker. During the period 1980-81 when the field work was conducted there was a strong 'local vs. outsider' and 'Bengali vs. Assamese' feeling and therefore a very few villages cuold be covered up by the author.

It has, however, been attempted to meet as many farmers as possible in each of the selected villages to know the prevailing socio-economic condition of the people and their attitude towards the HYV of crops and paddy in particular.

About 80 (eighty) questionnaires were completed from the selected villages representing the innovators, non-adopters and immitators, marginal, small, medium and large farmers. It is hoped that a generalisation on the basis of the sample taken can give a satisfactory and sufficiently reliable picture of the diffusion of HYV rice in the area of study. The sample farmers adopting HYV rice in their farms have therefore been taken into consideration.

Plan of Work and Methodology

The study planned and designed within an environmental-cum-socio-economic frame work begins with an assessment of the physiographic background of the region. The agricultural operations being implicit phenomena within the agro-climatic set up of the Brahmaputra Valley, various climatic indices have been prepared for a better understanding of the area in terms of environmental conditions.

In third chapter an attempt has been made to delimit the areal concentration of rice in the Brahmaputra Valley to determine the relative position of the

Lower Brahmaputra Valley. For the determination of the areal dominance of rice in the different component areal units of Brahmaputra Valley the"location quotient method" has been applied. This study is a part of the work done by the author in his unpublished M.Phil. dessertation.

Chapter four is primarily an attempt to find out as to how effective the environmental determinants (such as temperature, rainfall, humidity, nutrient index, soil texture index and pH index) are in explaining the productivity variation of High Yielding varieties in space. For this purpose, the multiple and stepwise regression analysis have been adopted as the tool to measure the composite effect of these variables on the yield per hectare. The inter-relationships of the variables have been tested through bivariate correlation coefficients. The analysis of residuals have been suggestive of the predominance of favourable and adverse environmental factors of lower and higher yield per unit area respectively. The stepwise regression model has helped in discovering the contribution of every individual variable in explaining the productivity variation. It also explains as to how the parameters get changed when the new variables are added in rotation. The changes in the value of R^2(i.e. the coefficient of determination) show the percent variation in each step. It also suggests whether a new variable is worth considering or not thereby helping to keep a watch over the

the changes in the values of regression coefficients and their standard errors. The variables selected are:

(i) Soil nutrient index

(ii) Soil texture index

(iii) pH index

(iv) Rainfall in mm.

(v) Temperature in oC

(vi) Percentage of relative humidity

(vii) Yield of HYVs of rice per hectare

After having established a cause and effect relationship between the environmental parameters and per hectare yield, a map of yield per hectare super-imposed by temperature rain fall and humidity has been presented to show how the yield varies with the corresponding variation of the climatic elements.

The fifth chapter studies and analyses the inter and intra-farm and intra-holding characteristics of the sample farm households. The discussion has been highlighted and made conceivable by the presentation of frequency Tables. Various measures of central tendency and dispersion have been adopted as the media of explanation. It has also been explored that how the High Yielding culture of rice is reflected in different strata of rural households. The inter-relationships of the landuse characteristics have been measured using pearson's correlation coefficients with the test of significance.

In the light of the above discussion,concentrating on the problems and prospects of landuse in the study area, the social setting of the farm households has been assessed and evaluated in the sixth chapter. The bivariate relationships have been found out between the yield and the social variables and among the social variables as well. The variables include family size, religion, age of the cultivator, formal education, number of working members and number of fragmented fields.

The seventh chapter embodies the socio-economic and cultural factors involved in the process of diffusion of new exotic varieties seeds and the pattern of inequality in the distribution of land, output of HYV rice, the profitability in the adoption of HYV rice in relation to indigenous varieties has also been emphasised as far as the various categories of farmers(i.e. small, medium and large farmers) are concerned. The first part of the chapter focusses attention on the identification of the principal component factors which posses a substantial decriptive power from the above two sets of variables taken into account. Factor analysis has therefore been adopted as the tool of analysis. This technique helps in describing economically the sets of variables and also helps in locating the hidden dimensions (components) which account for the statistical relationship between them.

The relative significance of the variables has been determined from the factor loadings which are infact the correlation coefficient of the principal components (such as first, second and third etc.) with each of the variables of any particular set. The factor loadings above 0.5 have been considered as significant. The percentage variation a particular component explains has been calculated by dividing each eigen value above unit by the number of variables and multiplying by 100. The total percentage variation is determined by taking each such eigen value (generally more than unity) into consideration.

The second part of the chapter encompasses an analytical presentation of the inequality in the distribution pattern of net cultivated land, area under HYV rice and output of HYV rice among the various strata of sample farm households. The analysis has been supported through a discussion on Lorenz-Curve which shows the extent of its deviation from the line of equal distribution or the egalitarian line. The concentration indices have been worked out using the formula for Gini's coefficient to show as to how unequal and biased the distribution is. The study of inequality is followed by a subsequent discussion which primarily concentrates on the extent of cultivation and the distributional pattern of area and output among the various strata of farm households. It highlights the extent of cultivation of HYV rice in terms of percentage share of the same to the total operational holding and the level of output per unit area achieved by the different categories of farmers such as marginal,small, low medium, medium, moderately large and large.

The third part is an attempt to analyse the profitability of HYV rice with the help of some quantitative measures so as to assess the problems and the prospects of the cultivation of HYV rice in the area of study. The measures of profitability in the study incorporate the yield in kg.per hectare, Gross return in kg. per hectares net return in Rupees per hectare, net return per unit of output and incremental net return (as percentage of incremental cost). Prior to working out the measures of profitability, an attempt has been made in the third section of the chapter to examine the pattern of distribution of the material inputs in terms of the level of consumption among the sample households. The discussion also highlights whether there has been a technological change in the rural sector or the contemporary traditional technology is still in operation taking the case of the use of input levels for either the varieties of rice-HYV and traditional in money terms.

Inferences and conclusions have been drawn in the concluding chapter to assess the cause of non-adoption of HYV rice in the area under study. Some important suggestions have been made as to why a conducive atmosphere cannot be created for a better yield of HYV rice per unit area, so that a large section of farmers will be attracted thereby accelerating the process for a speedy diffusion of the High Yielding varieties of rice in the Lower Brahmaputra Valley. It has also been suggested that the diffusion of these new varieties will boost the total volume of production to a new high and will bring about a positive change in the agricultural landscape of the region on the one hand and in the agricultural income on the other on which the level of standard of living of the rural population almost exclusively depends.

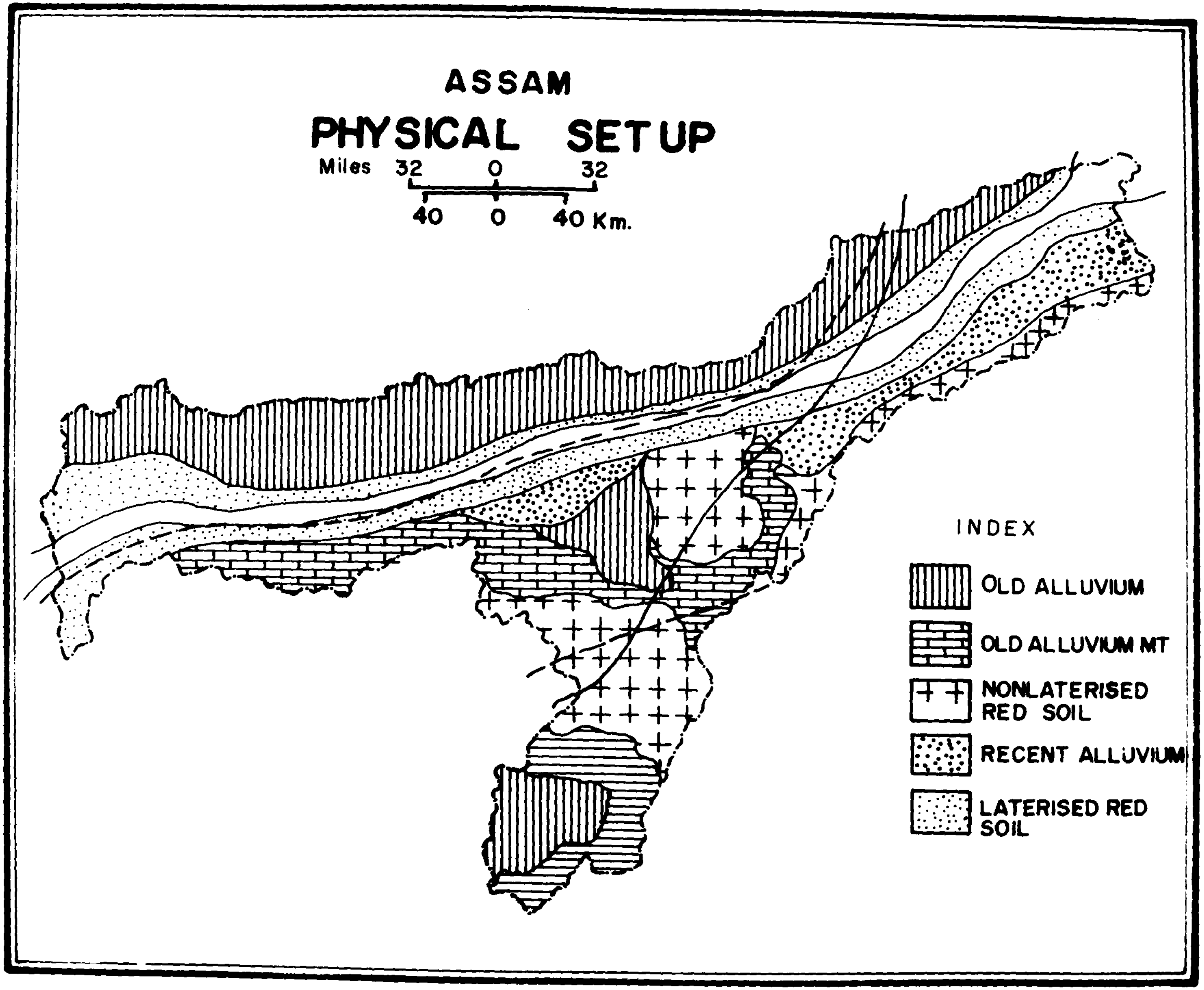
PHYSICAL SET-UP

The area selected for study is the Lower Brahmaputra valley. But since there are very few meteorological stations (recording temperature and relative humidity) the whole of the valley of Assam has been taken into consideration. Moreover, the Lower Brahmaputra Valley is very monotonous and therefore the physiography and drainage of the whole valley have been discussed. The Valley of Brahmaputra, situated between 25°44' to 27°55'N and 89°41'E to 96°2' E is a well defined area with peculiar physical and socio-economic characteristics. It is surrounded by the Eastern Himalayas, Patkai, Naga Hills in the east, the Garo-Khasi-Jaintia and the Mikir Hills in the South. The valley of Brahmaputra of which the area of study is a part extends from the eastern most tip of the upper Assam to the west of Dhubri on the border of Bangladesh. It covers an area of about 56,274 sq.km. and consists of the administrative districts of Lakhimpur, Dibrugarh, Sibsagar, Nowgong, Darrang, Kamrup and Goalpara. (Fig. 1). The area under review consists of the Kamrup, Goalpara and Nowgong districts.

Physiography

The Brahmaputra valley is the result of the aggradational work of the Brahmaputra river and its numerous tributaries. The valley has an imperceptive slope from Sadiya in the North East to Dhubri in the west. The contour of 150 metres separates it from the surrounding areas and its general level varies from 130 metres in the east to 30 metres in the west with a fall of 12 cm per km. The valley is predominantly built up of alluvium of 1500 metres thickness upon a trough formed during the Himalayan uplift. On the other hand, it is very well defined by the boundary fault in the North and the Naga thrust in the south. The slope of the valley seems to be steep in the Northern margin, having an immediate fall from the Arunachal Himalayas, but in the south, the valley has a gentle fall from southern hill ranges.

In the Upper Assam the valley is substantially wide in average ranging between 80 to 100 km. But in the middle part it has narrowed down to 55 km. because of the projection of the granite-gneissic rocks of the Mikir Hills. It again goes on widening towards west and the plain of Kapili joins the main valley. However, it further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OLD ALLUVIUM MT
NONLATERISED RED SOIL
RECENT ALLUVIUM
LATERISED RED SOIL

Fig. 2

narrows down to 65 km in an average while running between the Shillong Plateau and Bhutan Himalaya. In Gauhati area, the river flows very close to the Shillong plateau and it has been noticed that a substantial part of the plateau has been detached and granite hillocks projections have come up in its northern bank. From this point the valley starts widening till it merges with the plain of Bengal.

There is a spectacular difference between the Northern and Southern bank of the river. Numerous tributaries in the form of channels and streams are seen in its Northern back forming alluvial fans on the way. Extensive marshy tracts with the wet soil have been formed by the alluvial debris of the tributaries giving rise to dense forest cover.

The southern section of the valley is less wide and the tributaries are very large in the south-east. An important physical characteristic of the Brahmaputra is that the river is considerably broadened only because of its low gradient resulting into numerous river islands.

Drainage

The Brahmaputra and its hundreds of tributaries play a vital role in the drainage system of the region. The prospect and development of agriculture in the valley largely depends on the optimum utilization of the water potential of the Brahmaputra.

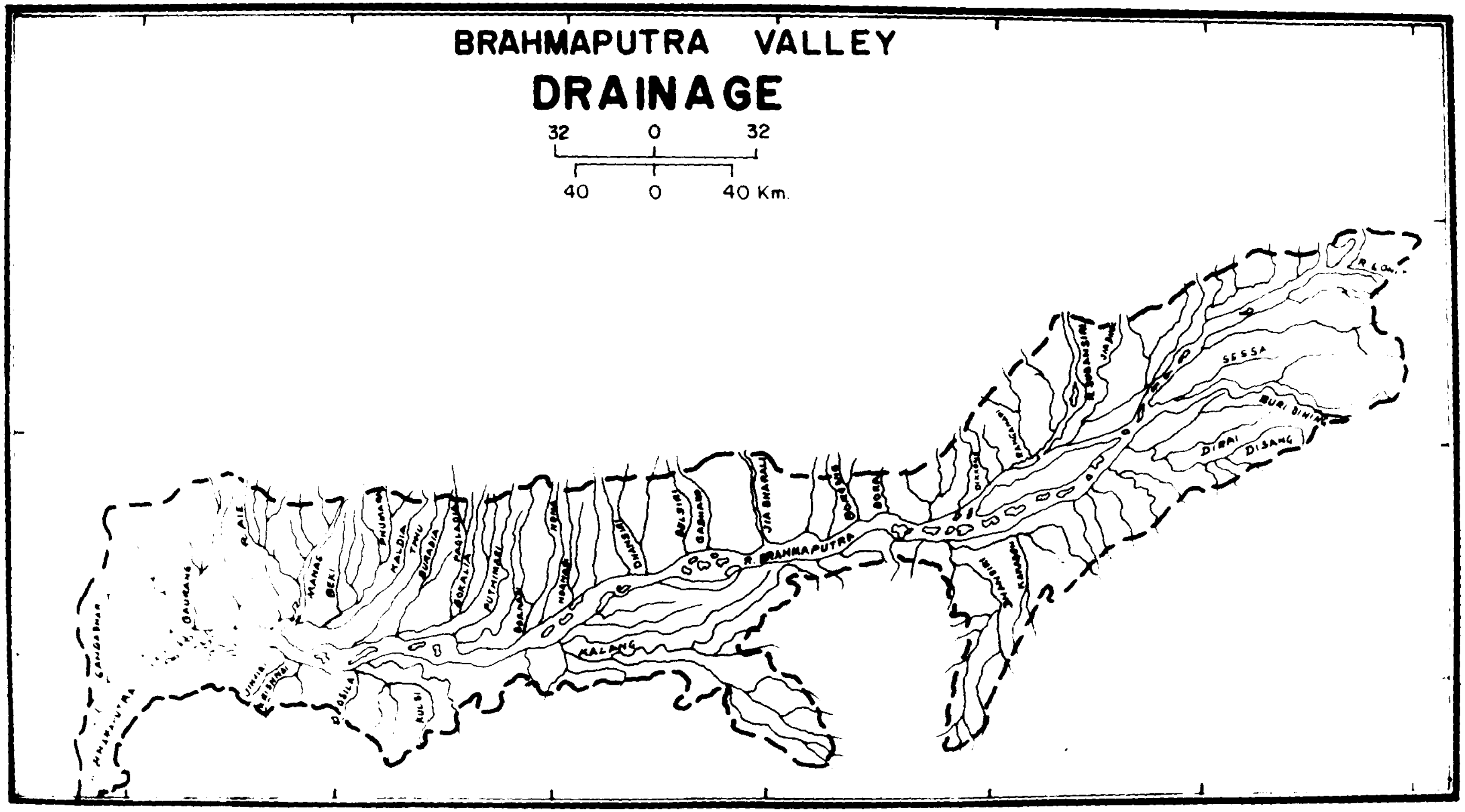
The mighty Brahmaputra owes its origin to Kailash range at an altitude of about 5150 metres. The upper course of the river lies in Tibet where it is called Tsangpo. While flowing through the Siang Division of Arunachal Pradesh it is known as Dihang. Near Sadiya it joins with Dibang from North and Lohit from east and from this point the waters of these three rivers makes the Brahmaputra. The river flows between sandy banks and it has got numerous divergent channels which afterwards rejoin the mainstream. It carries heavy silt and sometimes with a little barrier, it creates almond shaped banks which may be washed away or left out to form big char. Most of the places in the valley are endangered by the erosional activity of the Brahmaputra during floods. Dibrugarh being situated on the sandy banks of the river is susceptible to erosion every year during floods. But Tejpur, Gauhati, Goalpara and Dhubri are less prone to erosion because they are situated on the outcrop of hard and resistant rocks. The river takes turn immediately after Dhubri round the spur of the Garo Hills.

Then it flows through the plains of Bangladesh, gets confluenced with Padma, a branch of the Ganga and finally merges into the Bay of Bengal.

The major tributaries of the Brahmaputra include the Subansiri, Bhareli, Dhansiri, Barnadi, Pagladia and the Sankosh on the right bank and the Lohit, Dihang, Noa-Dihing, Burhi-Dihing, Disang, Dikhow, Shanji, Dhansiri, Kapili, Digaru, Kulsi, Singra, Jiniram, Dudhnoi and the Krishnai on the left bank (Fig.3). A good number of these tributaries are rivers having substantial catchment areas.

Left bank tributaries such as the Lohit, the Dihang, the Burli-Dihing, the Dhansiri and the Kapili are seasonal monsoon streams and have less meandering course. But Dhansiri is quite meandering. A few of these tributaries however, navigable throughout the year. In the valley during the rainy season floods and deluges are frequent which result into heavy damage of life and property.

This is because of the tremendous volume of water and heavy silt discharged by the river which shallows the bed of river. Moreover, heavy rain water is supplemented by the melting of snow in the Himalayas. The river gets chocked up, and active erosion starts on the



BRAHMAPUTRA VALLEY
DRAINAGE
32 0 32
40 0 40 Km.
R. BRAHMAPUTRA
JIA BHARALI
SESSA
BURI DIHING
DISANG
KALANG
MANAS
BEKI
R. AIE

Fig.3

bank, thereby filling the river beds which loose the water holding capacity. This sort of conditions make the river swell, thus resulting into innundation. Since the river valley lies in the seismic zone, earthquakes are frequent which enable the river in shifting its course. Heavy discharge of water by the Brahmaputra thus affects its tributaries in their water profile. Hence floods have become common feature almost all the tributaries of Brahmaputra resulting into damage of crops, life and property.

Climate

The climate of the Brahmaputra valley is essentially monsoonic. The climate of the valley is characterised by a rythemic change in the wind direction. Its climate is mainly governed by the following five factors:

i) the Orography,
ii) the alternating pressure cells of North East India and the Bay of Bengal,
iii) the predominance of maritime tropical airmass,
iv) the local mountain and valley winds,
v) the periodic western disturbances.

The high and lofty mountains in the North create barriers in the path of the cold airmass blowing from

Tibetan plateau to the valley. Moreover, the Himalayan ranges provide suitable conditions for the occurence of orographic rainfall. These mountains also check warm moist south-west monsoon airmass. The east ward moving upper air troughs called the western disturbance and the local phenomena such as mountain and valley winds have considerable impact on the climate and weather of the valley.

The mountain and valley winds start moderating the temperature conditions so that heat waves in the valley are hardly experienced in summer. Fogs, thunderstorms and dust raising winds also come under the local weather conditions. Winter mornings are very foggy in the valley and prolongs for a period of 60 to 70 days. At some places in the southern part fog persists from 90 to 100 days. The existence of fogs is due to availability of moisture evaporated from river beds and from marshy and swampy areas of the valley.

Seasons

On the basis of temperature variation, rainfall and winds four well defined seasons are observed in the valley :

1. Winter season - December to February
2. Summer or Premonsoon season - March to May
3. Monsoon season - June to September
4. Retreating Monsoon - October and November

The winter season starts from December and ends in February. The main characteristic phenomena of this season are cool weather, frequent morning fog, average monthly temperature above 12.8°C, Mean rainfall amounting to an average 11.4 cm. January is the coldest month.

The summer season begins from March and lasts till May. The season is characterised by a rise in temperature, increase in amount and frequency of rainfall with the advance of the season, decrease in diurnal range of temperature. The total average rainfall during the season is recorded as 51.87 cm with an average temperature of 23°C and average diurnal range of about 6.1°C.

Monsoon season in the valley starts from June and ends in September. The low pressure through created in the valley draws in the monsoon currents. The seasonal characteristics include high humidity, weak surface winds, cloudy sky and very sultry weather due to high humidity. The mean temperature during the season increases to 27.17°C with a diurnal range of over 6°C. August seems to be the hottest month of the year and falls in this season. The total rainfall is very high with number of rainy days 18 - 20 in June, July and August and about 14 days in September.

The season of retreating monsoon covers the period of October and November. The season is characterised by a sudden retreat of monsoon when the monsoon weakens towards the end of September, fall of temperature, and appearance of morning mist and fog. The diurnal range of temperature starts increasing and varies from 2.8°C to 5.6°C Winds in this season blow from the north. The average rainfall in this season is about 15.2cm with rainy days varying between 7 to 9 in October and 1 to 3 days in November.

Summing up the whole climatic phenomena in the valley in general it could be concluded thatthough there prevails a homogeneous climate in the valley, nevertheless there is considerable heterogenity in climatic conditions within and between different parts of the valley, in terms of variations in rainfall, range of temperature, and other phenomena like fog and mist. There is a spectacular difference between the eastern and western part of the valley so far as rainfall and temperature are concerned.

The eastern part gets very high amount of rainfall, and has a low range of temperature whereas the western part experiences less rainfall and a higher range of temperature. At the same time the middle portion of the valley seems to be having a rain shadow position and many climatic phenomena different from east and west.

Since the present study is confined to the Lower Brahmaputra valley, an analysis of the spatial distribution of temperature, rainfall and relative humidity has been done for the area in question for the years of 1977-78 for which the data for the HYV of rice was collected. These three variables - temperature, rainfall and relative humidity have a close bearing on the productivity of new seeds of rice and therefore, the climatic study has been related to the productivity of HYV rice in accordance with the time duration in which transplantation and harvest of HYV rice are finished.

There are also a few more studies on the significance of some important weather elements as far as the growth production and productivity of rice are concerned. It is because, climatic factors, such as, temperature, sunlight and rainfall are the major determinants of the growth and yield of rice. Such factors directly affect the physiological process involved in grain production e.g. vegetative growth, development of spikelets and grainfilling. Indirectly the grain yield is affected by them through incidence of plant diseases and insects.[1]

Rainfall effectiveness

(i) Total and Mean Monthly rainfall :

Much of the arable land available for agriculture lie on either side of the river Brahmaputra where though rainfall does not vary so much round the year, but gets concentrated only during the Kharif season with the arrival of monsoon, thereby causing water logging condition which occasionally results into serious damage to the crop. Therefore it is unpracticable to generalize the pattern of annual and monthly rainfall. The rainfall effectiveness is studied in terms of patterns of the intensity of rainfall on the monthly or weekly basis.

At a glance to the 30 years normals of monthly rainfall total and annual mean for 6 major meteorological stations such as Dibrugarh, Sibsagar, Tezpur, Gauhati, Nowgong and Dhubri, plotted in Fig.4 it is distinct that the rainfall based on thirty years varies from east to west direction, between 2759.4mm and 1043.9 as the highest and lowest for Dibrugarh and Nowgong respectively. Nowgong

1. IRRI Research Paper Series No.20 (1978),p.3.

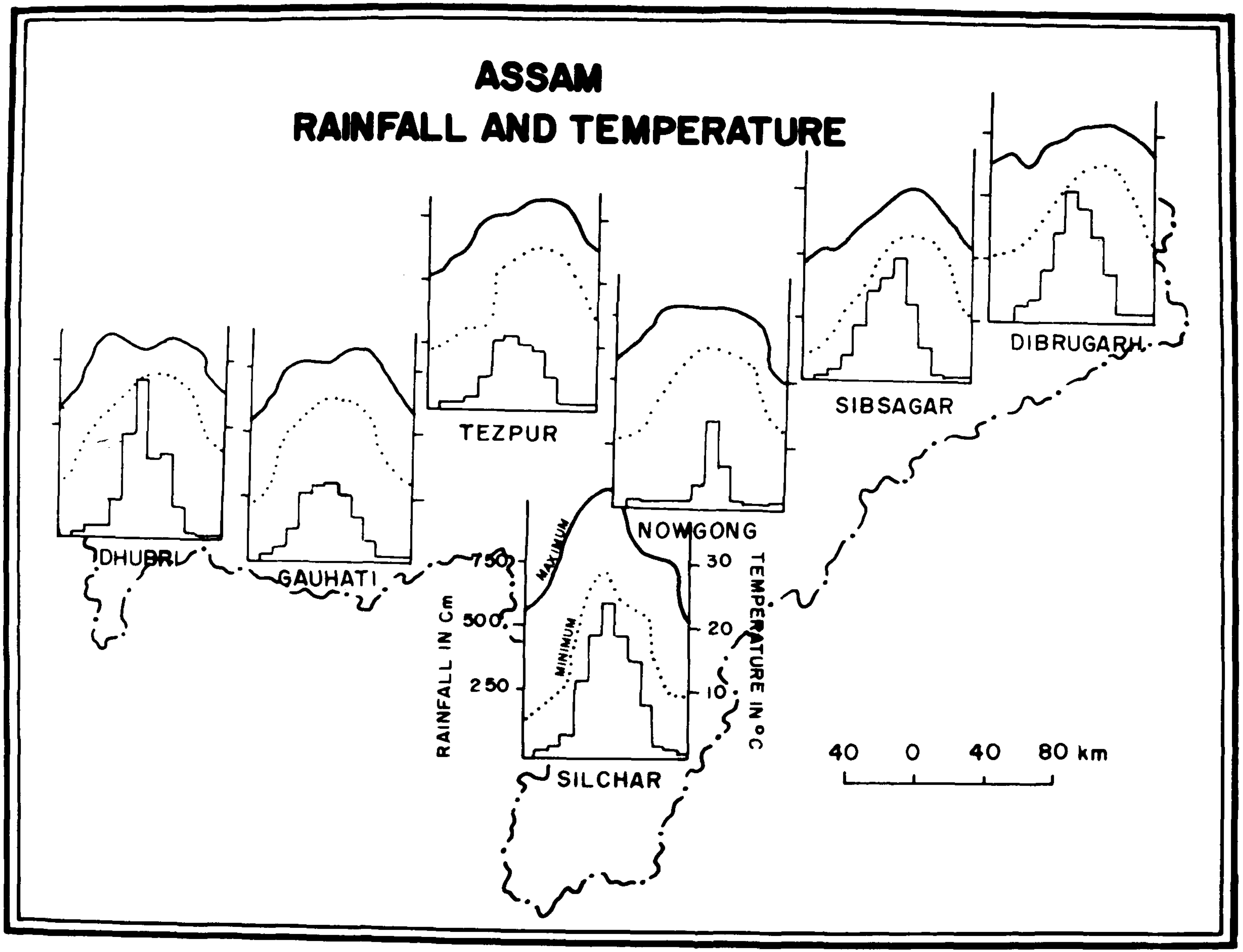

ASSAM
RAINFALL AND TEMPERATURE
DHUBRI
GAUHATI
TEZPUR
NOWGONG
SIBSAGAR
DIBRUGARH
SILCHAR
MAXIMUM
MINIMUM
RAINFALL IN Cm
750
500
250
TEMPERATURE IN °C
30
20
10
40 0 40 80 km

Fig. 4

being situated midway between Dibrugarh and Dhubri gets the least rainfall and from this point it starts increasing east ward again.

Sixty to 70 per cent of the average annual rainfall is recorded during the month of June to September. Nowgong being an exception where above 90 per cent of the total annual rainfall is recorded during June to September though the total monsoon rainfall is relatively lower than all other stations in the valley. In terms of percentage, Dhubri has the second highest i.e. (68.46 per cent) rainfall during monsoon season whereas Dibrugarh with 64.86 per cent comes next to Dhubri.

Intensity

From the agricultural point of view it is the timely distribution of rainfall which is more important and not the seasonal average. In fact, heavy rainfall in one week followed by long intervals of dry weather may affect the HYV of rice adversely.

The precipitation and the number of rainy days may be sufficient to meet the requirements of different crop production in general and HYV rice in particular, but successful harvest is noticed only when the rainfall is timely and well distributed over the rice growing period.

So the concentration of rainfall over few months decreases its usefulness. In 1977 it so happened that the transplantation of HYV rice was carried on without rain because of the late arrival of monsoon in many blocks of the lower Brahmaputra valley.

It would be worthwhile if the intensity of rainfall is studied for the selected station of the whole valley which explains the intensity per 24 hour period. The intensity of rainfall is calculated with the help of the following formula:

$$I = \frac{\text{Total monthly rainfall}}{\text{No. of rainy days}}$$

Table - II.1 shows the station-wise monthly intensity of rainfall.

It will be seen from Table-II.1 that in Dibrugarh, June and January have the highest and the lowest intensity of rainfall being 26.09 and 9.69 mm per rainy day respectively. But in Sibsagar the highest intensity was observed in the month of April. Tejpur experiences high intensity of rain in July and low in December. As evident from the Fig.5 Gauhati shows the maximum intensity of rainfall in the month of August and minimum in the months of January. Dhubri lying in the lowest part of the valley has the highest intensity of rain in June and lowest in February

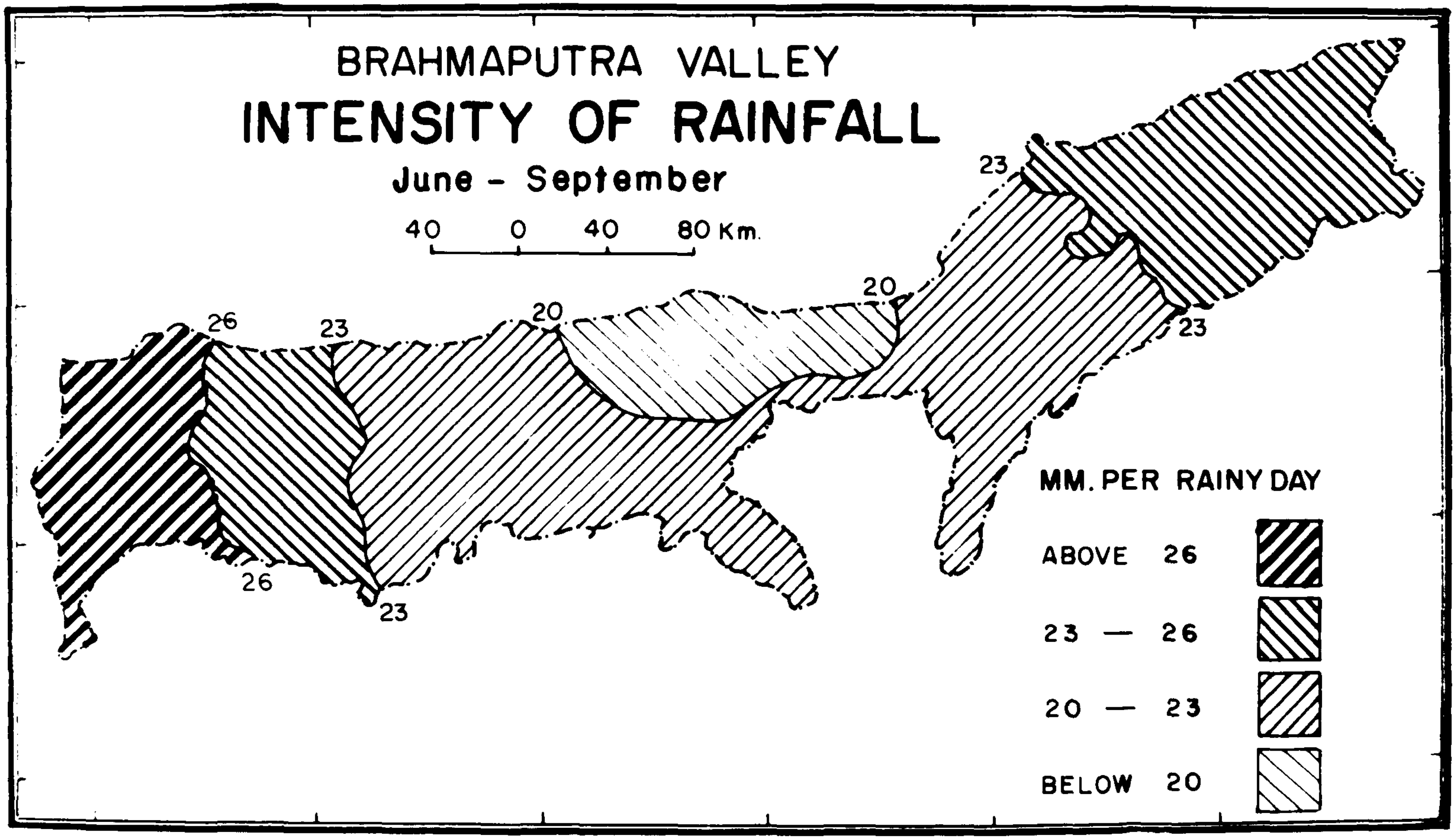

BRAHMAPUTRA VALLEY
INTENSITY OF RAINFALL
June - September
40 0 40 80 Km.
26
23
20
20
23
23
26
23
MM. PER RAINY DAY
ABOVE 26
23 — 26
20 — 23
BELOW 20

Fig. 5

TABLE - II.1

Intensity of Rainfall (1931 - '60)

Stations	M O N T H S											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Spt	Oct	Nov	Dec.	Mean Annual
Dibrugarh	9.69	9.81	12.48	17.11	21.86	26.09	25.57	23.15	22.47	20.46	11.38	10.62	20.95
Sibsagar	9.28	9.49	11.97	24.24	21.75	21.12	24.06	21.63	20.53	15.57	12.54	12.19	19.91
Tezpur	9.44	9.78	11.52	14.44	18.22	17.46	20.63	20.03	19.36	18.97	12.58	9.2	17.99
Gauhati	9.5	10.17	12.71	15.17	18.12	20.1	21.23	23.07	20.00	18.77	7.67	10.00	18.84
Dhubri	14.00	12	16.18	19.52	25.52	35.21	28.18	21.69	29.07	25.02	16.88	12	26.47
Silchar	13.27	13.97	14.48	25.2	28.19	28.28	22.58	22.31	23.21	24.35	23.16	13.8	23.89
Nowgong	11.5	11.79	8.4	0.77	9.71	18.08	20.58	23.04	21.1	16.33	20.00	11.4	20.63

Source: Calculated by author

and December. So the highest rainfall intensity throughout the valley from east to west is observed in the months of June, April, July, August, and June and August for the stations such as Dibrugarh, Sibsagar, Tejpur, Gauhati, Dhubri and Nowgong respectively. Similarly lowest intensity of rainfall at most of the rainfall recording stations is seen in the month of January and December for Tejpur and December and February for Dhubri.

So far as the intensity of rainfall in the monsoon reasons is concerned, Dhubri has the highest intensity during this season whereas Tejpur has the lowest.

Rain Factor

Another meteorological quantification has been done with the help of the formula rain factor which is an index to express a relationship between precipitation and temperature to have an idea about the climatic aridity of the valley. On the other hand it also helps in delimiting the climatic region. Since the number of stations are few, a general discussion over this index could be given. The index has been calculated as :

$$\text{Rain factor} = \frac{\text{Annual precipitation in mm}}{\text{Mean annual temperature in } ^{o}C}$$

The following Table No.II.2 presents the station-wise rain-factor indices.

TABLE - II.2

Stations	YEARS					
	1973	1974	1975	1976	1977	Average
Dhubri	90.5	80.22	59.67	90.49	135.48	91.27
Gauhati	65.52	82.61	62.19	67.33	106.06	76.74
Rangia	24.2	44.44	71.00	71.80	51.39	52.56
Tangla	58.88	90.02	61.17	82.0	91.15	76.64
Majbat	19.13	47.26	78.93	80.3	108.08	66.74
Tejpur	5.93	77.23	-	51.41	87.21	52.95
Gohpur	-	-	-	103.75	66.46	85.11
Chaparmukh	-	74.63	115.02	127.07	153.56	117.57
Lumding	-	40.06	41.85	56.87	62.58	50.34
Dibrugarh	97.77	124.7	105.08	82.94	140.91	110.68
Digboi	-	33.01	-	43.07	63.19	46.42
N.Lakhimpur	100.87	81.35	129.54	110.63	141.65	112.8
Silchar	114.98	98.14	89.82	151.66	133.71	117.66
Haflong	86.95	23.04	86.69	70.00	60.01	65.54

Source: Same as Table II.I

As evident from the Table the 5-years average rainfactor from 1973-77, varies between 46.42 to as high as 117.57 for Digboi and Chaparmukh respectively. The second and third highest indices are found out for North Lakhimpur and Dibrugarh. Such low index which shows high aridity in Digboi and its surrounding region may be attributed to high temperature range and low rainfall. Moreover Lumding is also having comparatively lower index i.e. 50.34 and is situated on in the south east of Nowgong and North of Mikir Hills which is otherwise interpreted as the rain shadow area having rainfall comparatively lower than all other stations in both lower and upper Brahmaputra valley. Hence, crop risk in this area is considerable. In order to raise successful crops irrigation is felt essential in this part of the valley.

In Upper Brahmaputra, North Lakhimpur, Chaparmukh and Dibrugarh have fairly high indices which show low aridity in these parts. So water surplus in these areas are more prominent than deficit. On the other hand these areas experience high amount of rain fall with low mean daily temperature range. A rational management of water resources in this part of the valley will help in bringing high productivity for all crops and particularly rice.

Switching over to the lower part of the valley, the indices appear to be relatively lower than the stations in upper Assam. In this area although rainfall, total, monsoonal and mean monthly are not very less, but the daily temperature range is very high, thereby causing considerable evaporation from water bodies. Though the mean annual rainfall of Dhubri, being situated in the western most tip of the valley, is more or less same as that of Dibrugarh, there is a substantial difference between the rainfactor index i.e. 91.27 for Dhubri and 110.68 for Dibrugarh. Its all because of the temperature variation between the upper and lower part of the valley. Rangia and Tejpur in Kamrup and Darrang districts respectively experience acute aridity the indices nearing 50.0. In the lower part of the valley comprising the districts of Goalpara, Kamrup, Nowgong and Darrang, the index ranges between 50.34 to 91.27 for Lumding and Dhubri respectively. Hence its distinct that as one proceeds towards the western part of the valley the index goes on increasing, indicating less and less aridity in the region. Gauhati, being situated midway experiences a moderate index which can be interpreted as not very arid and very wet climate.

In the year 1977, for which the highly weather sensitive high yielding varieties of rice have been studied in the lower Brahmaputra valley , it is observed that the rainfactor index has a significant variation between 51.39 to 135.48 for the stations Rangia and Dhubri respectively — since higher is the index, lower is the aridity and vice versa, aridity decreases from east to west.

Air Humidity

Apart from temperature and amount of rainfall the relative humidity has also a close bearing on the output of High Yielding Varieties of rice. The valley experiences a very humid climate, the mean annual relative air humidity exceeding 70 per cent in each of the Rainfall recording stations excepting Nowgong, whose mean annual relative humidity comes out to be 55 per cent only. The data relates to 30 years average for each month from 1931 to 1960. In the upper part of the valley, Dibrugarh and Sibsagar have more than 80 per cent relative humidity in air. However, in the lower Assam valley the same has a range between 76 to 78 per cent. So far as the relative humidity is concerned there appears not much variation between lower Upper Brahmaputra Valley. But the slight variation in the lower valley is due to high temperature range in its air.

Coming to the relative humidity in the monsoon season, it is observed that more than 80 per cent humidity is experienced in every part of the valley excepting Nowgong where even in June the air humidity is 49 per cent. The highest relative humidity is recorded in August being 81 per cent while in June and September it is about 75 per cent. Dhubri being situated in the lowest tip of the valley has the highest relative humidity in its surrounding air. On the contrary, it is the most humid part of the valley where percentage of relative humidity exceeds 85 per cent and in June average air humidity is 87 per cent.

Dibrugarh has a very uniform percentage of air relative humidity in wet monsoon months. An average 85 per cent is observed in each month starting from June to September. Winter months in the valley also appear to be humid, the air humidity ranging between 60 to 80 per cent. But Nowgong and its surrounding air seem to be relatively dry, the lowest humidity being 27 per cent in April. Even February and March show 49 and 34 per cent humidity in the air respectively.

It has therefore been observed in most places that rice gives satisfactory yield in the areas having less humid atmosphere. Hence higher relative humidity affects the crop yield adverse. Murata and Togari[2] arrived at the conclusion that the daily air relative humidity is negatively correlated with the rice yields. It could be because, the rainfall and the cloudy weather decrease the amount of Solar radiation thereby increasing the relative humidity. So that the grain yield gets reduced specially when there is rainfall during reproductive stage.

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2. Murata and Togari (1972). An Analysis of the affect of climatic factors upon the productivity of rice at different localities in Japan, Proceedings of Crop Science Societies, Japan, 14(4), pp.372-387.

In view of the above analysis it is observed that either part of the valley seem to be having very humid surrounding which sometimes stands erronious for rice crop. However, Nowgong and its immediate surrounding have very low relative humidity which is rather conducive for crop growth. The variation of temperature and rainfall has been shown in Fig.

Table-II.3 presents the monthly average relative humidity in percentage for six raingauge stations in the valley. The data relates to 30 years average from 1931 to 1960.

Temperature

As evident from the 30 years normals of the above said stations, the mean annual temperature varies between as low as 23.2 to as high as 25.35 for Dibrugarh and Nowgong respectively. There is a spectacular difference in the range of temperature during the Kharif and rabi seasons of the year. Stations falling in the lower part of the valley show a higher range of temperature than the upper, which is normally more than 24^{o}C. Hence because of high range of temperature during the ripening stage the sensitive high yielding varieties of rice crops may be more prone to failure and low yield.

TABLE - II.3

Relative Humidity in Percentage

Stations	MONTHS												Mean Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt.	Oct	Nov	Dec	
Dibrugarh	83	78	71	74	81	85	85	85	85	82	80	84	81
Sibsagar	85	80	74	76	80	82	82	83	86	86	86	86	82
Tejpur	78	70	62	66	89	83	84	84	84	81	79	81	78
Gauhati	78	68	61	65	77	82	82	82	83	81	81	81	76
Dhubri	75	66	67	65	81	87	86	86	86	80	78	78	77
Nowgong	61	49	34	27	28	49	78	81	75	59	55	61	55

Source: Same as Table II·I

Matsu Shima and Manaka[3] hence, are of opinion that 22°C is the optimum temperature for ripening stage of rice and temperature higher than 25°C adversely affects ripening of rice grains. There are on the contrary critical high and low temperature normally below 20°C and above 30°C in different phases of rice growth.[4] It has also been found that temperature and yield rate are positively correlated. De Datta and Zarati[5] failed to find out the negative influence of temperature on the yield of Indian varieties sown every month during the year at IRRI. It is because, higher the temperature higher is the solar radiation which is associated with higher yield. In the present study it will however, be discussed in the chapter IV as to whether temperature is positively or negatively related with the yield of HYV of rice in the lower Brahmaputra valley region.

The efficiency index for temperature for different temperature recording station in the Brahmaputra valley has been calculated with the help of the following formula:

$$I = \frac{T - 32}{4} \quad \text{Where } T = \text{mean monthly temperature in } {}^{\circ}F$$

divised by C.W.Thornthwaite

3. S. Matsushima and T. Manaka (1957). Analysis of developmental factors determining Yield and Yield prediction in low land rice, Proceedings of Crops Science Society, Japan, 25, pp.203-206.
4. S.K. De Datta and P.M. Zarati (1970). Bio-Meteorological problems in developing countries. Environmental conditions affecting the growth characteristics, nitrogen response and grain yield of tropical rice. Bio-Meteorology, 4, pp.71-89.
5. Central Rice Research Institute Bulletin,(1977),p.2.

The range of variation for each station has been given below:

TABLE-II.4

Stations	Range of Variations			Months
Dibrugarh	14.29	-	18.91	(December - August)
Sibsagar	13.75	-	19.40	(January - July)
Tejpur	14.29	-	19.31	(January - July)
Gauhati	14.27	-	19.45	(January - August)
Dhubri	14.20	-	19.15	(January - August)
Nowgong	13.60	-	21.94	(January - May)
Silchar	14.77	-	19.20	(January - July)

Source: Same as Table-II.1

From the above table it is vivid that January is the coldest month in most of the places of the valley when the efficiency of temperature has a variation between 13.6 to 14.29°F for Nowgong and Tejpur respectively. But December seems to be coldest in Dibrugarh having less temperature efficiency.

So far as the hotest months are concerned when air temperature is recorded to be efficient, July and August are most common in most of the places excepting Nowgong where May records the most efficient air temperature.

Since most of the agricultural crops need efficient air temperature and solar radiation for their photosynthesis process within a certain range, temperature efficiency determines the prodyctivity to a greater extent. So the favourable and unfavourabke climatic regions are sorted out on the basis of precipitation and temperature efficiency indices which on the other hand more relate to humid character rather than thermal. The temperature efficiency of the region under study reveals that temperature is not a constraint in the cultivation of the HYV of rice as in each of the twelve months, the temperature is adequate for the determination growth and development of the crop. Rainfall and availability of irrigation are thus the major factors which hamper its growth especially during the winter season.

Precipitation Efficiency

This is a quantitative index showing the effieiency of precipitation or the precipitation effectiveness in each month for the different meteorological stations of the area. The index has been devised by C.W. Thornthwate for climatic classification based on humidity rather than on thermal character. Thermal Efficiency 'I' is applied to subdivide these. Hence

$$i = 11.5 \left(\frac{P}{T - 10}\right)^{10/9}$$

P = Monthly Mean pt. in inches

T = Monthly mean temperature.

The indices help in distinguishing the major climatic regions based on humidity rather than on thermal character. Thermal efficiency 'I' index could be used to subdivide these macro regions. In case of Brahmaputra valley, the stations selected are Dibrugarh, Sibsagar, Tejpur, Gauhati, Dhubri and Nowgong covering almost the entire valley from east to west.

At a glance to the monthly indices (Table-II.5) it can be observed that the efficiency index for drier months such as November, December, January, February and March is more than that for the wet monsoon and premonsoon months. The Table-II.5 presents the twelve months indices for each station.

It will be seen from Table-II.5 that the indices for most of the meteorological stations the indices start increasing from August-September to December-January and then show a decreasing trend from February to June-July and then again go on increasing. Hence it could be infered that, higher is the index lower is the precipitation efficiency for that month and vice versa.

In order to have a comparative study of the efficiency indices, the mean annual efficiency index

TABLE - II.5

Stations	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean Annual
	MONTHS												
Dibrugarh	1.3	1.3	1.3	1.16	1.16	1.04	1.04	1.04	1.04	1.16	1.3	1.3	1.16
Sibsagar	1.3	1.16	1.1	1.04	1.0	.95	0.94	1.15	0.95	1.00	1.01	1.21.	1.05
Tejpur	.88	.84	.78	.63	.72	.7	.69	.69	.70	.73	.8	.86	.75
Gauhati	.75	.72	.66	.63	.60	.59	.58	.58	.58	6.1	.67	.73	.64
Dhubri	1.2	1.16	1.05	.98	1.1	.98	.97	.96	.97	1.0	1.1	1.19	1.04
Nowgong	.48	.45	.46	.44	.32	.32	.35	.36	.36	.38	.44	.48	.38
Silchar	1.56	1.51	1.38	1.32	1.29	1.26	1.25	1.28	1.26	1.3	1.4	1.52	1.36

Source: Same as Table II-1

could be taken into consideration starting from the upper Brahmaputra valley till lower, it is observed that the average monthly efficiency index is the highest for Dibrugarh and lowest for Nowgong. So from generalization point of view, the stations recording higher rainfall, have higher indices than that of the stations recording lower rainfall.

However, the month to month change of the index shows that, the months in the monsoon period when the intensity of rainfall is high, have comparatively lower indices than the months in the winter season for a particular station.

Therefore, Nowgong lying midway between the upper and lower portion of the valley could be taken as the dries and part having higher variability of rainfall, low intensity and low precipitation efficiency. From this point again every climatic index shows positive trend towards the lowest part of the valley. Gauhati and Tejpur being situated on the either bank of the river have also relatively lower precipitation efficiency and the highest efficiency is observed in Dhubri lying at the western most tip of the valley.

Taking each and every point of the aforesaid discussion, it could be said that agriculturally the lower Brahmaputra Valley is not very unfavourable from the rainfall point of view. The rainfall is fairly reliable especially in the month of July and August. The risk to crop however remains in the months of July and September in which the variability of rainfall is higher at all the rainfall recording stations. In fact it is the excessive rainfall which damages the crop in the rainy season.

Soil

In addition to climatic factors, soil parameters play a vital role in the success and failure of rice productivity. Ryu et al[6] arrived at the conclusion that alluvial plains of Korea, with moderate drainage responded better yield than poorly drained soil. In local valley areas it was observed that the productivity was quite higher in imperfectly drained soils than that of moderate. Even within the same type of soil series productivity comes out to be different because of differences in chemical properties of surface soil. As far as the soil water relationship is concerned it has been observed that the close association between soil and water determine the potentiality of the area for better production. In semiaquatic conditions, rice cultivation

6. Ryu, et al (1971), Studies on the relationship between productivity of paddy soils and their chemical and physical properties in Korea. Res. Rep. office Rural Development (Korea) 14 (Plant Environment), pp.1-16.

needs a heavy soil the absence of which will lead to percolation of irrigation water at an ease and faster rate. This is because, rice plants generally demand more water which depends on the conditions of the soil.[7]

Therefore in the areas where paddy is grown dominantly are found to be enriched with more than 70 per cent of the finer particles and clay plus silt in their soils.[8]

Ramiah (1954) is of opinion that there are two important reasons for the wide disparity of rice yields. First the low water supply in certain areas and second, because of the variation in soil conditions.[9]

The valley of Brahmaputra is formed by the alluvial deposits in which alluvial soils have been deposited by the Brahmaputra and its over fifty significant tributaries. Soils of Assam, can be classified into the following major categories among which the first three cover the entire valley of Brahmaputra and the last one is found only in the hill districts. The areal distribution of these soils is given in Fig.2.

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7. D.H. Grist (1955), <u>Rice</u>, 2nd ed. London, Longmans.

8. <u>Ibid.</u>, pp.20-25.

9. <u>Ibid.</u>, pp.20-25.

i. New alluvial soil
ii. Old alluvial soil
iii. Lateritic soil
iv. Red soil.

The new alluvial soils are confined in the low lying tracts of the flood plains of the river in which new silts are deposited almost every year. These soils are sandy loams or silt loams having less acidic contents and thus suitable for the cultivation of rice Jute, pulses, mustard potato and vegetables. These soils are enriched with available phosphate potash and exchangeable calcium.[10]

The old alluvial soils are found at relatively elevated tracts which are free from floods. These soils are more acidic in nature. The pH value being less than that of the greater parts of the valley are covered by the old alluvial soils. These soils lack in available phosphate with low or medium potash content and texturally vary from sandy to clayey loam with high to low content of nitrogen. These soils are favourable for rice, sugar cane, fruits and vegetables but not conducive for the cultivation of pulses and mustard.

Laterite soils are found in limited areas in the valley. These are considerably leached poorly contained with

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10. R.L. Singh, 1971 *India-A Regional Geography*, Varanasi, p.313.

plant nutrients, thus agriculturally less useful. An important feature of the soil types in the valley is that, the northern fringe in the lower part of the valley covering the district of Goalpara, Kamrup and parts of Darrang constitutes of coarse alluvium formed by the debris which have been deposited by the streams in the tarain tracts. On the other hand, red loam and extensive laterite soils are exclusively found in the hill districts. soils of the Brahmaputra valley in general have higher ingradients of nitrogen, phosphorous and pottassium content.[11]

Considering soil as one of the major agro-climatic factors for the growth and yield of any food or non-food crop in general and for high yielding varieties of rice in particular, a thorough and detailed discussion on this parameter has been devoted for the lower Brahmaputra Valley where community development blocks have been taken as the unit area of study (Chapter-IV). The discussion relates to the major soil nutrients, soil texture and reaction whose impact in the subsequent chapter has been studied in relation to the productivity of the highly sensitive varieties of High Yielding rice.

Since adequate scientific data is not alluvial

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11. R.L. Singh, Op.cit., pp.313-314.

for the soils of the valley, the present point of discussion is based mainly on the work done by the Regional Soil Survey Division of the Government of Assam. The information about the texture, structure, pH values, soil nutrients such as nitrogen, phosphorous and potassium were obtained from the Soil Testing Laboratory, Gauhati and Jorhat. The texture and soil nutrients have a close bearing on the growth, development and out-turns of different crops. Therefore, in Chapter-IV, a systematic study of the soil texture, soil nutrients and climatic parameters has been attempted. Their relationships with the performance of rice, especially high yielding varieties have been established in Chapter-IV.

RICE-CULTIVATION-CONCENTRATION AND PRODUCTIVITY PATTERNS

Rice-Seasons and Cultivation Techniques

The methods and techniques of cultivation of different crops vary from each other. Rice, the staple food crop in India is grown in different seasons with varying agricultural practices. Its sowing, growth and harvest can however, be seen all through the year. In the Brahmaputra Valley, three crops of rice in an agricultural year are grown. The rice seasons include Sali and Bao, Ahu and Boro of which Sali and Ahu are the most important crops.

Sali and Bao

This is mainly called Sali or winter paddy season. During this season paddy is grown along with capsularies jute in low lands. It is usually grown through transplantation in the rainy season during the months of July and August. The transplantation is carried out in puddled condition with standing water in the field. Seedlings are raised in highly manured nurseries. Before transplantation takes place, the field is ploughed and puddled 4 to 6 times depending on the nature of the soil and the available labour and cattle energy. After having ploughed the field is pulverised with bamboo ladder. The seedlings raised in the nursery are transplanted in bunches with standing water in the field. Transplantation is mostly done by female labour and the entire operation is labour intensive. After a month and half from the date of completion of transplantation, the farmers apply available quantity of fertilizer. Sali crop flourishes during the rainy season and is harvested in the months of November and December. Bao is grown in deep water flooded and low lying areas in March and April. The crop is generally grown with the help of broadcast method, after having ploughed the dried fields atleast 4 to 5 times. Before the Bao land gets flooded, weeding operation is carried on in large scale. Bao paddy grows in water level upto 4 to 5 inches. After the flood water recedes from the Bao field, the plants settle on the land and start fillering. Harvesting for Bao crop is done during the months of December and January.

Another shallow water paddy locally 'Asra' is cultivated like Bao paddy and is harvested in November and December.

Sali and Bao are considered as the principal crops during winter. These two crops occupy about 57 percent of the total cropped area and the 72 percent of the total area under rice in the state.

ii - <u>Ahu</u>

Ahu is cultivated during autumn season. The broadcast varieties are sown in well prepared fields in

March-April only. Weeding becomes essential for broadcast Ahu paddy. It is harvested in June and July. Transplanted Ahu is grown in irregated field. During March-April seeds are sown in well manured nurseries. When the seedlings come up, after 4 to 5 weeks these are transplanted in puddled fields.

During the field work the author was confirmed that Ahu if transplanted gives higher yields than if broadcast. This fact is also proved by secondary data and information. Ahu is followed by Sali rice and is grown in particular types of lands. Importance of this crop has been felt over years after the HYVs have been in operation.

iii- Boro

The paddy grown during rabi season (i.e. during December and January) is called Boro. It is cultivated in marshy land. Boro is usually called a summer season crop and hence requires adequate and timely irrigation. For Boro, seeds are raised in nurseries in the months of November and December followed by the transplantations of seedlings in well puddled fields in December and January. Boro rice is harvested during April and May and is widely cultivated in Goalpara and Nowgong districts of the Brahmaputra Valley.

It can however, be concluded in the light of the above discussion that Ahu and Sali rice crops are the most important and principal crops in the Brahmaputra Valley.

Ahu, Sali and Boro are widely grown in the lower portion of the valley and in subdivision level the area under these crops exceeds 60 percent of the gross cropped area (Fig.6). Kokrajhar, being one of the western most subdivision of the Brahmaputra Valley is an exception where more than 80 percent of the cropped land are covered by Ahu, Sali and Boro paddy crops. In hectarage Kokrajhar stands second to Korimganj.

It is worthwhile to discuss in brief the irrigation potential in the state of Assam as a primary indicator for successful and effective implementation of High Yielding rice cultivation programme. The subdivisionwise area under irrigation as evident from the Table presented below appears to be highly variable with a range of area in hectares between 0.310 to 30.20 percent for Dhemaji and Kokrajhar respectively during 1974-75 to 1975-76.

TABLE III.1

Class groups in percentage	Frequency	Degree	Cummulative percentage
Less than 5	10	Very low	10
5 - 10	4	Low	14
10 - 15	3	Low medium	17
15 - 20	1	Medium	18
20 - 25	2	High	20
25 and above	2	Very high	22

Source: Calculated by author.

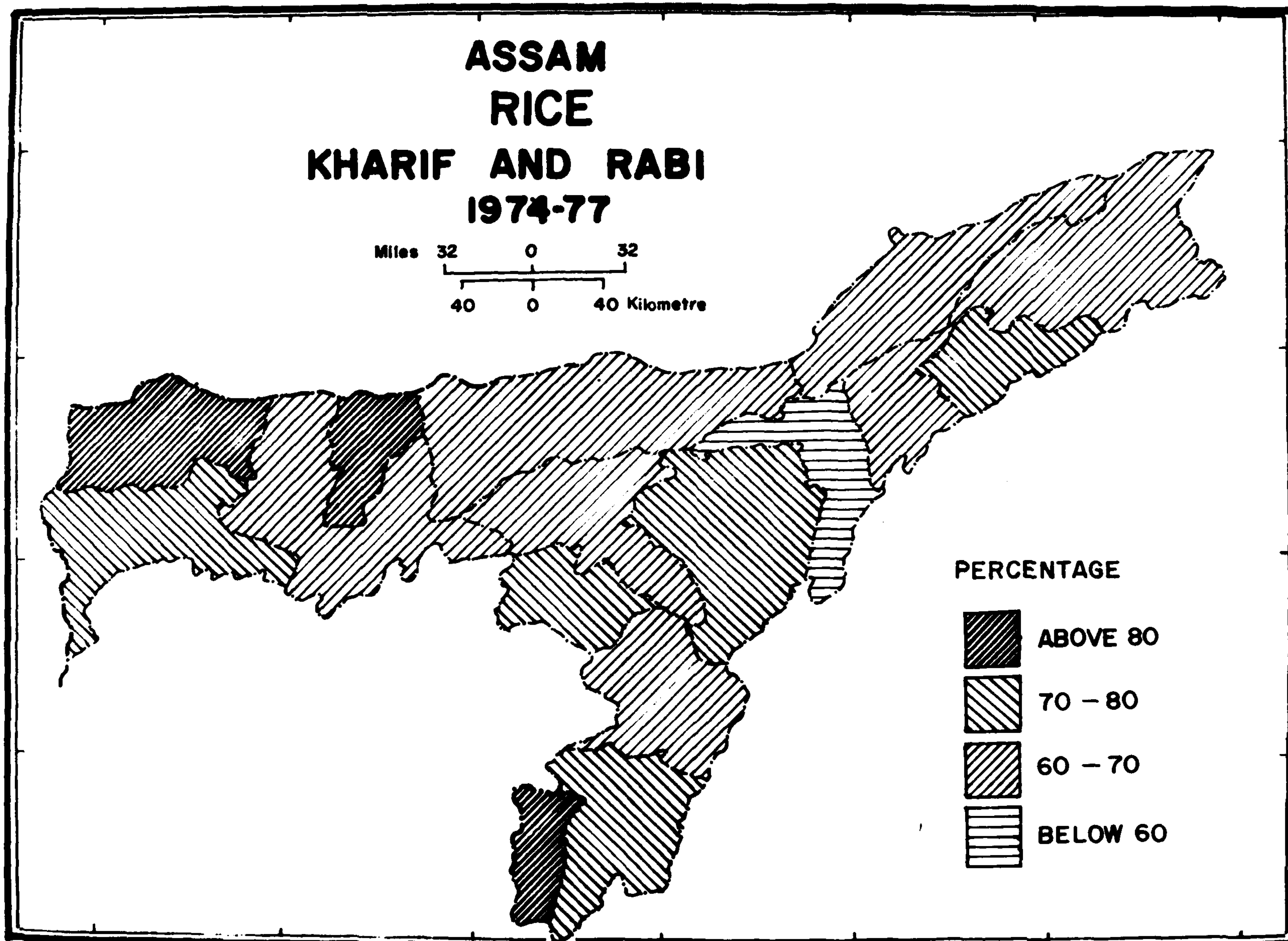
ASSAM
RICE
KHARIF AND RABI
1974-77
Miles 32 0 32
40 0 40 Kilometre
PERCENTAGE
ABOVE 80
70 - 80
60 - 70
BELOW 60

Fig. 6

It will be seen from Table III.1 that a large number of arealunits exhibit very low percentage of area under irrigation. The units are 10 of the 22 and consist of Dhubri, Goalpara, Jorhat, Dibrugarh, Tinsukia, North Lakhimpur, Dhemaji, Silchar, Karimganj and District Karbi-Anglong. These account for only 12.54 percent of the total area irrigated. There are four subdivisions which fall within the category of 5 to 10 percent accounting for 13.24 percent area under irrigation out of the total irrigated area. So the total number of subdivisions coming within the low potentiality of irrigation are 14 and together account for 25.78 percent of the total irrigated areas in the state of Assam. There are four subdivisions which posses medium irrigation potential, between 10 to 20 percent areas to the net cropp land being irrigated. The subdivisions consist of Nalbari, Nowgong, Marigaon and Gauhati having 30.64 percent of the total irrigated land . The rest four subdivisions (Mongaldai, N.C. Hills, Kokrajhar and Tezpur) are under the high and very high categories of area under irrigation having together a share of 44.56 percent of the total irrigated land in the state. Kokrajhar and Tezpur however, seem to be highly equipped with irrigation potential having more than 30 percent of their net cropped area under irrigation. These two have a share to the tune of 29.56 percent of irrigated land. Having a look at the subdivisions exclusively situated in the lower portion of the Valley, it is interesting to note that Dhubri being located at the western tip and also being positioned at the high rainfall zone of the valley is one of the most Poorly irrigated areal unit followed by Goalpara. The rest of the units in the valley do have areas under irrigation ranging between 8.75 to 30.20 percent of the net cropped area for Barpeta and Kokrajhar respectively. The areal units in the lower valley alone possess irrigated net cropped land to the tune of 38.03 percent to that of the state as a whole.

To sumup, the Lower Brahmaputra Valley though receives high rainfall has also an appreciable irrigation potential as compared to the rest of the Valley. If this advantage along with rainfed conditions are properly utilised with high management skill then the High Yielding Varieties programme can be implemented successfully.

The consistency of the distribution of area under traditional and the High Yielding Varieties of rice and the area under irrigation needs special mention for, it shows how variable the distribution is on the space. The relative variability of the distribution can be explained in terms of coefficient of variation. The analysis of the measures of dispersion of the data in terms of mean, coefficient of variation and standard deviation is presented below.

The coefficient of variation of the distribution of areas under rice seasonwise shows that Rabi appears to

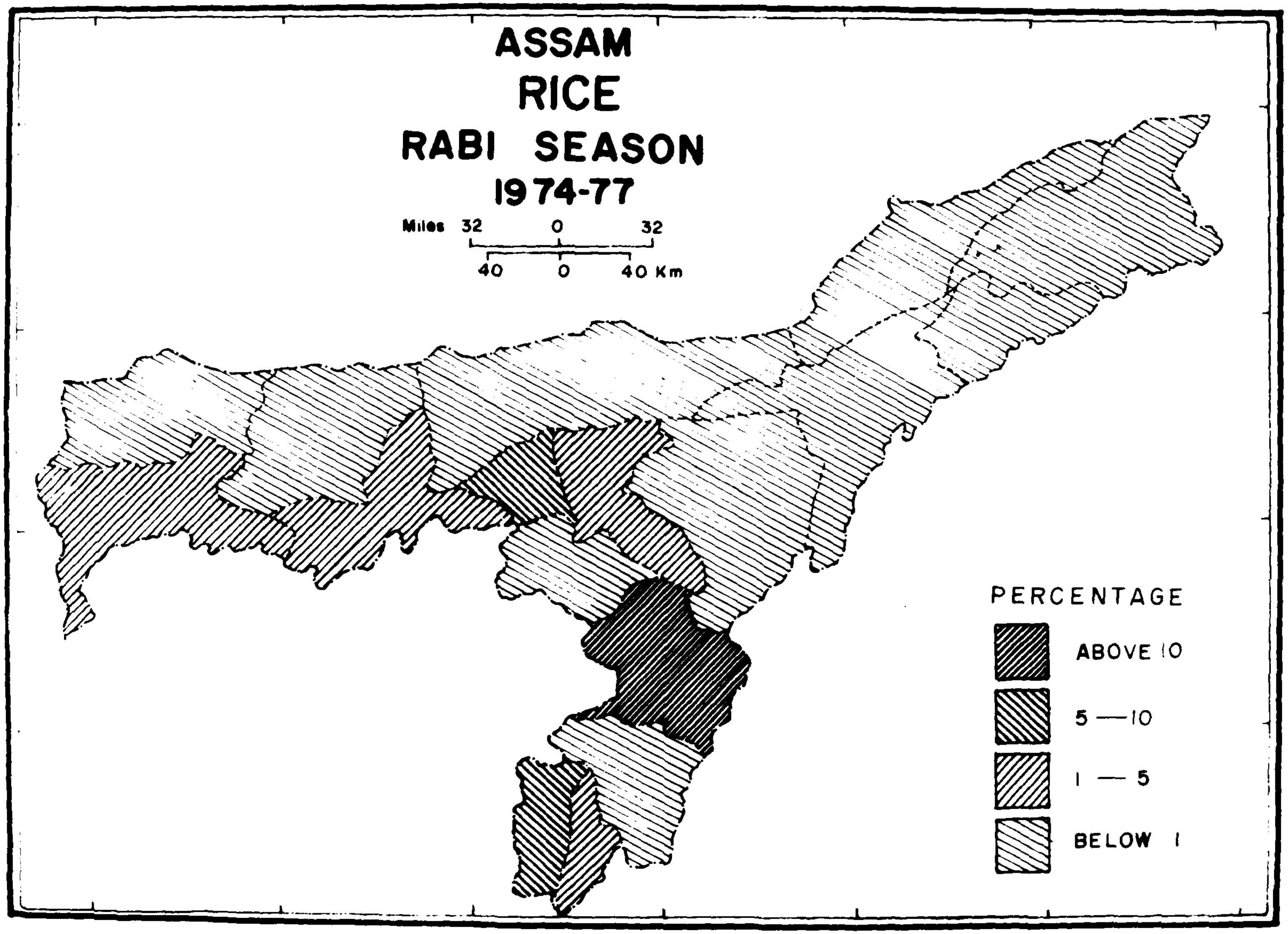
ASSAM
RICE
RABI SEASON
1974-77
Miles 32 0 32
40 0 40 Km
PERCENTAGE
ABOVE 10
5 — 10
1 — 5
BELOW 1

Fig. 7

be the most variable so far as the cultivation of rice is concerned (Fig.7). The distribution is highly inconsistent as evident from the relative variability in terms of percentage(i.e. 218.41 percent). In this case the standard deviation exceeds mean. However, the distribution of area under rice in Kharif season (Fig.8). is highly consistent and less variable than Rabi season, the coefficient of variation being 12.63%. The inconsistency in the distribution of area between Kharif season and during an agricultural year as a whole does not reflect any striking variation.

Accordingly, the variability in the distribution of HYV of rice in terms of percentage to gross cropped area in the component area units also appears to be more than that of the traditional varieties. The coefficients of variation for HYV and traditional varieties are 38.41 and 11.19 percent respectively. The distribution in case of HYV of rice is more variable than the traditional rice.

Coming over to the distribution of areas under irrigation it is noticed that the relative variability in terms of coefficient of variation is 94.57 percent which indicates a high variability in the distribution thereby showing a similar inconsistency in the distribution of areas under irrigation. In this case the standard deviation tends towards mean.

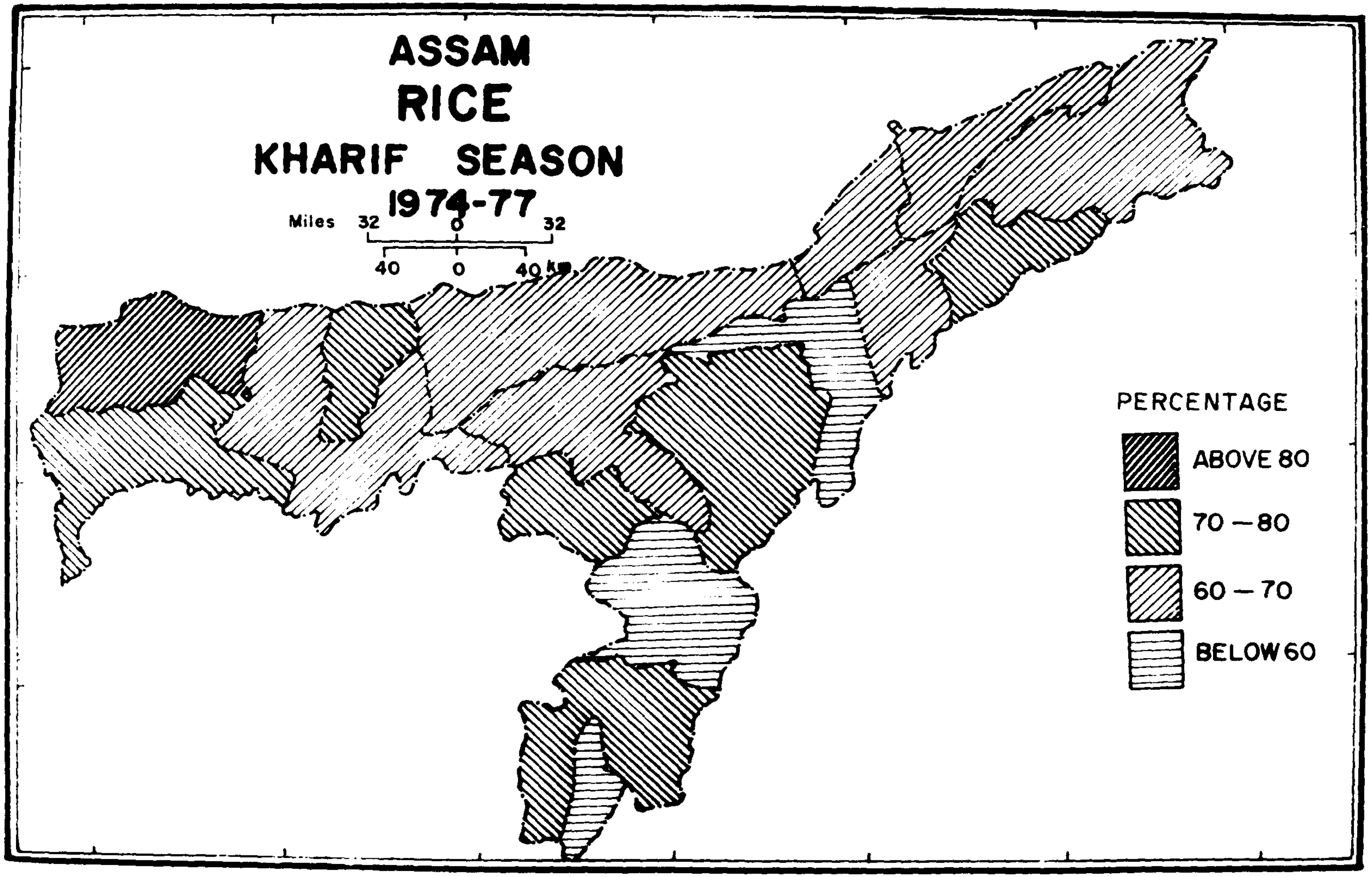
ASSAM
RICE
KHARIF SEASON
1974-77
Miles 32 0 32
40 0 40 km
PERCENTAGE
ABOVE 80
70 — 80
60 — 70
BELOW 60

Fig. 8

Areal Concentration of Rice

Agricultural landscape of a region is well conceived of when its areal dominance of different crops is identified with the help of some standard statistical techniques. The simple delineation of an area into a wheat or cotton region may be useful in knowing the areas of wheat or cotton cultivation but it does not identify the degree of their density of cultivation in a given space and time. The study of concentration of crops therefore, has a great relevance in understanding the agricultural mosaic of a region and finally in the agricultural land use planning at macro and micro level. The main objective of such an attempt is to study and analyse the cropping patterns of an area on a regional basis with a view to bring out their area concentration.[1] Since the introduction of new High Yielding Varieties of crops can be relatively easier in the region where its traditional culture is dominated, the study of spatial concentration of a particular crop is of immense help and most vital to the planners, agricultural scientists and administrators for policy formulations in the implementation of new innovations of agricultural programmes. This study has great socio-economic significance for, it suggests how effectively the innovation of advanced technology (such as HYV of rice in the present case)

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1. Majid Husain(1970) 'Patterns of crop concentration in Uttar Pradesh, Geographical Review of India, Vol.32, pp. 85-109.

can be implemented for its speedy diffusion and acceptance among the farmers. A high concentration index always indicates higher potentiality of agricultural resources. And it is probable that High Yielding Varieties of Crops can be most favourably and easily grown in the areas of high concentration of these crops.

In the present chapter, an attempt has therefore, been made to analyse first the distributional pattern of the area under rice in Assam with special reference to Brahmaputra Valley in order to find out its area concentrations and second to have a discussion over the cropping pattern and productivity of HYV of rice in the area.

Data pertaining to the above study was obtained from the basic agricultural statistics for the years 1974-75 to 1976-77 published by the Directorate of Agriculture, Government of Assam, The data relates to the sub-division level. The study encompases the whole of Assam so as to highlight the relative significance of the Lower Brahmaputra Valley a micro region under investigation.

In order to have an average picture of the area devoted to rice in Assam, 3 years data (i.e. 1974 to 1977) have been taken into account with the intension that the 3 years average would minimise the vagaries of weather on the area of rice cultivation. The density pattern of area under High Yielding Varieties of rice has been shown with a 2 years average(i.e. 1975 to 1977) because of non-availability of data for 1974. The total potentiality created in the state for irrigation upto 1977 has been taken into consideration. The discussion on cropping pattern and productivity of rice is primarily based on the information and statistics collected from the Directorate of Agriculture, Government of Assam and the Agro-Economic Research Centre, Jorhat.

With a view to showing the density pattern of rice cultivation in Assam with special reference to Brahmaputra Valley, a seasonwise break up of the area under rice has been presented. So far as the High Yielding Varieties are concerned, the total area under the same has been shown as percentage to gross cropped area. The regional dominance of rice has been determined firstly, by comparing the sown area in proportion and secondly, by relating the crop density in each of the component areal unit of the province to the corresponding density of the province as a whole. Hence, for the purpose, the Location Quotient method has been applied. The Location Quotient or the index of concentration of crop has been worked out in the way as given below.

I = Index of concentration of crop

$$\frac{\text{Area of crop 'X' in a component areal unit}}{\text{Area of all crops in the component areal unit.}} \div \frac{\text{Area of crop 'X' in the entire region}}{\text{Area of all crops in the entire region.}}$$

If the index value is greater than unity the component areal unit accounts for a share greater than it would have had if the distribution were uniform in the entire region of the particular crop under study.[2]

The percentage values for the density of area under rice in all the component areal units that show concentration have been put in descending order. The index has been made by dividing the descending array into 5 equal parts to distinguish the very high, high, medium, low and very low concentration with the help of index scale. The concentration of rice as the first ranking crop in every unit has been plotted in figure 9.

After having identified the areas of less and more concentration of rice, an attempt has been made to enquire as to whether there is any space relationship within the variables such as concentration indices of rice as a whole and HYV of rice and the extent of area irrigated. The inter-relationships have been shown with the help of bivariate correlation coefficients.

A glance at figure 6 reveals that rice is the dominant and principal food crop in all the component areal units of the area under study and irrespective of subdivision, district and state it has a substantial percentage share

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1. M. Husain, Op.cit., p.170

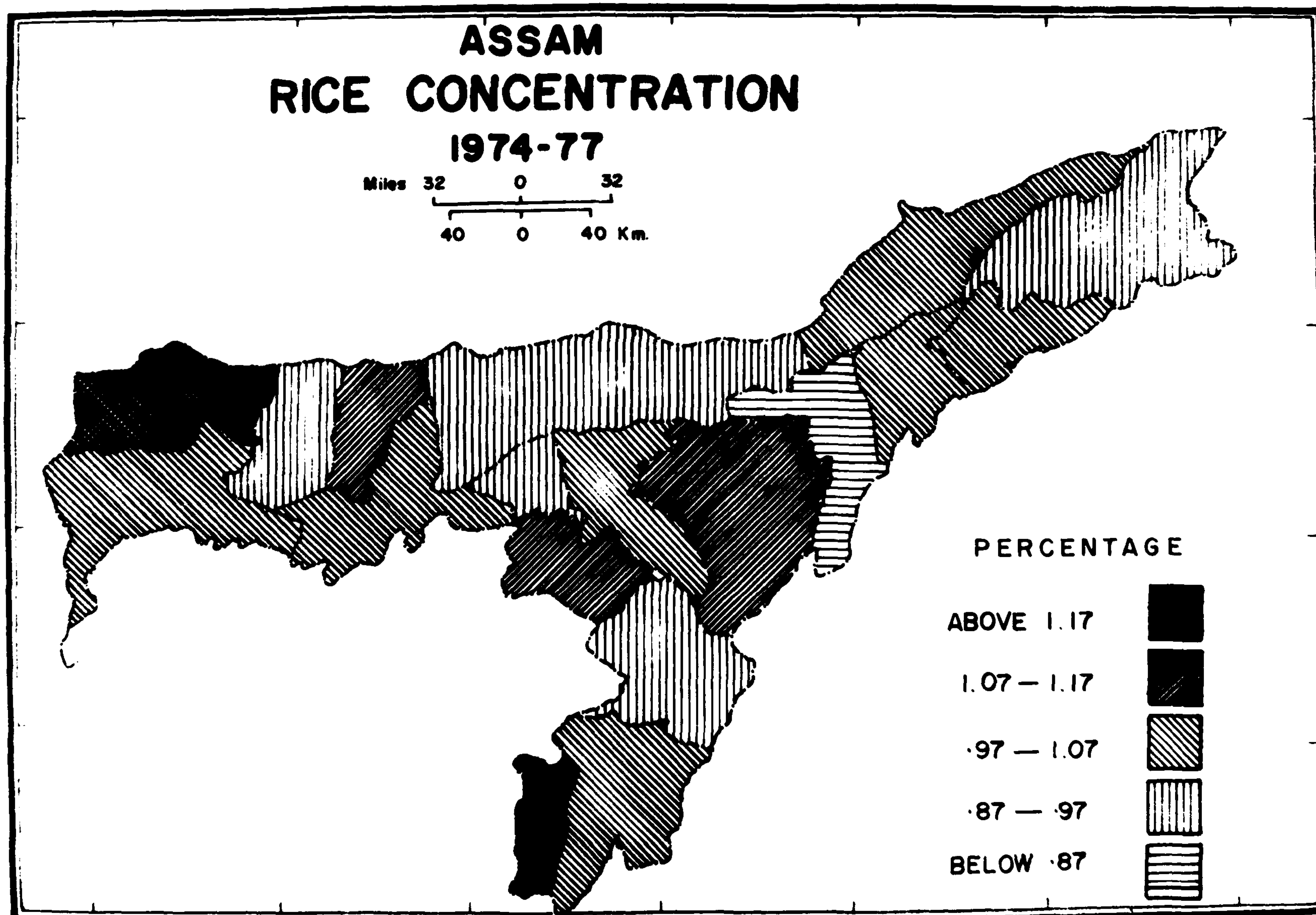
ASSAM
RICE CONCENTRATION
1974-77
Miles 32 0 32
40 0 40 Km.
PERCENTAGE
ABOVE 1.17
1.07 — 1.17
·97 — 1.07
·87 — ·97
BELOW ·87

Fig. 9

which invariably exceeds more than fifty percent in each unit . The percentage of rice being significantly high, the whole of Assam can be delineated as an area of monoculture. The minimum and maximum area varies between 552 to 85.14 percent for the subdivisions of Golaghat and Karimgang respectively.

Since rice possesess a major share of area under cultivation in each area unit, it ranks second to none of the agricultural field crops in the whole of Assam. The percentage share to gross cropped area of the different crops other than rice is invariably below 50 percent in each areal unit.

The following Table shows the frequency distribution of the indices of concentration of area under rice

TABLE III.2

Class group of the indices of concentration	Degree of concentration	Frequency	Cummulative frequency
<0.87	Very low	1	1
0.87 - 0.97	Low	7	8
0.97 - 1.07	Medium	10	18
0.107 - 1.17	High	2	20
1.17	Very high	2	22

Source: Same as Table III.1

It will be seen from the Table No.III.2 that the indices of concentration vary between as low as 0.784 in

Golaghat to as high as 1.20 in Karimganj. The reason for such a low concentration of area under rice in Golaghat may be attributed to less areas put under rice, and low irrigation potential.Karimganj having high areal concentration of rice seems to be an exception because the area despite a low irrigation potential has the highest density of rice cultivation as compared to the rest of the subdivisions in Assam.

As per the arrangement of the index values in a descending order of magnitude with the different distinguishing parts of the array, maximum number of subdivisions are observed within the medium degree of concentration with a range between 0.97 to 1.07. The subdivisions constitute of Goalpara,Dhubri, Gauhati, Nowgong, Jorhat, Sibsagar, North Lakhimpur, Dhemaji, Silchar and Hailakandi. The reasons attributable to such a uniform tendency in the concentration of area are better irrigation facilties, favourable climatic conditions and a host of other socio-economic conditions which remain to be enquired into.

However, very high concentration of area under rice is noticed in the subdivisions of Kokrajhar and Karimganj the index values exceeding 1.17. Similarly high areal concentration of rice is observed in the subdivisions of Nalbari and KarbiAnglong district with a variation in index values between 1.07 to 1.17.

As many as seven subdivisions show low concentration having index values between 0.87 to 0.97. The subdivisions include Barpeta, Tezpur, Mangaldoi, Marigaon, Tinsukia, Dibrugarh and North Cachar.

From the discussion initiated about the concentration of rice areal in the entire state of Assam, it is infered that the areal units comprising a substantial part of the Lower Brahmaputra Valley come within medium , high and very high categories indicating better agricultural poetntial.

It will be worthwhile to present a similar interpretation as regards the concentration of areas under High Yielding Varieties of rice in the state of Assam. An identical pattern emerges as regards the concentration pattern of High Yielding rice cultivation in Assam with special reference to the Lower Brahmaputra Valley. As many as 10 subdivisions fall within medium category of concentration indices (i.e. between 0.80 to 1.20). The subdivisions comprise of Kokrajhar, Nalbari, Gauhati, Morigaon, Golaghat, Tezpur, Dibrugarh, North Lakhimpur, Dhemaji and district KarbiAnglong following the pattern of distribution of areas under irrigation. There are 6 subdivisions which have the range of concentration indices between 1.20 to 1.60. The subdivisions are Goalpara, Nowgong, Jorhat,Sibsagar, Tinsukia and Hailakandi. Only two subdivisions indicate very high concentration indices such as Silchar and Karimganj. In the Lower Brahmaputra Valley except Barpeta and Dhubri all others have medium and high concentration indices. Such discouraging situation in these areas is primarilly due to the adverse agro-climatic conditions.

The relationship as revealed by the correlation coefficients between the concentration indices and area under irrigation shows interesting findings. Area under irrigation and the indices of concentration of rice as a whole are negatively correlated. The correlation coefficient between the former and the latter is -0.136. Meaning thereby, the concentration indices increase with the corresponding decrease in the percentage of area irrigated. It can be infered that the areas having high concentration of rice cultication posses low irrigation potential. It may be because of an assured rainfall all through the year. In a similar fashion, the area under irrigation and the concentration of HYV of rice have a negative correlation following the fact that areas having high concentration of HYVs cultivation have low irrigation potential. The correlation coefficient ($r=-0.430$) is significant at 1 and 5 percent levels.

The concentration of rice as a whole and that of the High Yielding Varieties are positively correlated and the correlation coefficient is statistically significant at 5 percent level . This relationship shows that the concentration of rice areas under HYVs increases with a corresponding increas in the areas under rice as a whole.

Productivity Pattern

So far as the level of output of rice in Assam is concerned, it can be observed from Appendices Table-4 that the output has shown an increasing trend. From about 12.76 lakh tonnes in 1950-51, the production has gone upto about 22.50 lakh tonnes in 1975-76. Thus there has been a net increase of 9.70 lakh tonnes during the past 25 years. The simple annual growth rate,linear growth rate and compound growth rates are 3 percent, 1.58 pereent and 2.3 percent respectively.[3]

Fluctuations in the out turn from year to year in terms of percentage rate of change in index numbers (see Appendices-Table-5) in Assam show that the same has fluctuated between 18.55 percent to -10.44 percent. The average rate of change during the period 1950-51 to 1975-76 is found to be 1.83 percent per annum (Appendices-Table-6). The annual rate of increase in index number is noticeably high during the

3. Adhoc Study No.38, Agricultural Development in Assam (1950-51 - 1975-76). Published by AERC for N.E.India, AAU, Jorhat, 1975, PP.26-156

period 1966-67 to 1968-69. The index number for area has gone upto 105.28 in 1968-69 from 96.91 in 1965-66 (Appendices-Table-4) The yield rate also appears to have changed from year to year.[4]

The average yield rate is about 964 kg per hectare. The linear growth rate of productivity comes out to be only 0.61 percent.[5] (Appendices-Table-7). Better yield rate depends on favourable agro-climatic and socio-economic factors. Absence of floods and timely rains stand favourable for rice productivity. The average production of rice during 8 years out of 26 years(from 1950-51 upto 1975-76) was 1000 kg.per hectare. During 1966-67 the yield rate dropped below 900 kg. per hectare. Production of rice increased by 60.5 percent against the area which increased by 68.74 percent over the plan periods. Thus the increase in production is mainly due to increase in area.[6]

Because of little or no control over floods and drought and because there is little use of irrigation and

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4. Adhoc study No.38,Op.cit., pp.26-156
5. Ibid. pp.2--156
6. Evaluation Report No.76. Quick Evaluation study of the Impact of Agricultural schemes taken up under the plans on production and adoption of improved method of cultivation in the state. Evaluation and Monitering,Planning and Development Department, Govt.of Assam.April, 1979 p.27

power inputs in agriculture there is relatively slower growth of agricultural production trend compared to all India.[7]

Introduction of HYV in Assam

During the ad-hoc annual plans(1966-67 to 1968-69) for the first time a few quick maturing High Yielding Varieties were introduced in the state such as Tichung, Manohar Sali, I.R.8, Mexican Variety of wheat etc. At the end of the ad-hoc plan period, strategy adopted for increasing agricultural production was on quick maturing programme, such as extensive use of High Yielding Variety of seeds.[8]

The introduction of short duration of HYV of rice which are less photosensitive has created such type of situations that three rice crops in a year can be successfully grown in a field provided proper irrigation facilities are available. The incentive for a change in agricultural sector, such as taking up HYV programme, bringing institutional changes undertaking lift irrigation schemes came during the period 1966-67 to 1968-69, though the successive plan periods put more stress in accelerating

7. Evaluation Report No.76.Opcit.P.27

8. Ibid P.7

these plans and programmes. As for instance, a pilot project for lift irrigation with power was undertaken for the first time at Mayang in Nowgong district.[9] The states IV Five year plan (1969-70 to 1973-74) aimed at production of food grains at higher rate than the populationgrowth. The strategy adopted to bring about accelerated progress in production was to increase the area under High Yielding Variety substantially and to strengthen the extension services to push adoption of improved method of cultivation and package of practices by cultivators, conversion of traditional paddy monoculture system into multiple cropping. Large scale demonstration in compact blocks was organised with HYV to popularize the cultivation of the same.[10]

The achievement at the end of the IV Five year plan period in the case of HYV programme in the state of Assam was spectacular. Area under High Yielding Variety rose from 8.4 thousand hectares in 1969-70 to 40 thousand in 1973-74. Consumption of fertilizer rose only to 8.6 thousand tonnes of nitrogen(N), 3.5 thousand tonnes of phosphate (P_2O_2) and 2.84 thousand tonnes of Potash(K_2O_2).[11]

9.Evaluation Report No.26. Op.cit.,p.7

10.Ibid.pp.7-8

11.Ibid p.9

Though more area was brought under High Yielding programme but the overall impact on production was not satisfactory to the desired level. This is mainly because of the non-package practice of cultivation without fertilizer and irrigation. These basic facilities for High Yielding Variety cultivation were also not adequate such as irrigation and fertilizer. During the Five year plan period (1974-75 to 1977 -81) irrigation was given due importance. In certain areas, two rice crops were found to be cultivated.particularly where irrigation was provided.

However, the introduction of HYV began in Assam in 1966-67 at a smaller scale but consequently started getting momentum. Only 13.1 percent of the area is reported to have been covered by HYV of rice by the end of 1972-73. The main constraints of adoption of HYV of rice by the farmers are nonavailability of timely irrigation, seeds fertilizers and insecticides. During the IV Five year plan, the strategy of agricultural development in the state was based on the programme of High Yielding Varieties with package practices, thereby getting all possible supports from rapid development of irrigation, efficient supply of inputs through agro-industries corporation and speeding up the proper educational programmes along with research and extension. There was also high level concensus over multiple cropping keeping the intention of increasing the cropping intensity[12]. For this, special programmes in Rabi season were organised.

Area Occupied by HYV Rice

Information available on the area under HYVs from 1969-79 to 1975-76 and from 1976-77 to 1978-79 as total area under HYV rice for the districts of Assam show that only 13 percent of the total area under rice have been covered by HYVs by the end of 1972-73, this coverage continued till 1975-76. On the contrary, the area under HYVs has increased more than twice from 1969-70 to 1971-72. The districts of Cachar, North Lakhimpur and Sibsagar have achieved practical success as compared to all other district. Districtwise coverage under HYVs is presented in Table III.3 for the period of 1969-70 to 1972-73 and for 1975-76, 1976-77, and 1978-79.

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12. Ad-hoc study No.38, op.cit.,pp.26-156.

TABLE III.3

Area under HYV of rice in thousand hectares

Districts	Years						
	1969-70	1970-71	1971-72	1972-73	1975-76	1976-77	1978-79
Goalpara	10.68(3.1)	11.57(3.5)	14.75(4.3)	24.96(7.1)	39.08(10.32)	55.210(14.59)	108.849(28.96)
Kamrup	16.00(3.7)	18.32(4.2)	27.73(5.5)	41.01(8.9)	44.42(9.29)	59.957(12.55)	83.291(17.81)
Darrang	8.7(8.6)	10.49(5.9)	15.02(6.2)	14.68(5.9)	32.98(11.74)	33.793(12.03)	49.534(18.7)
Nowgong	8.8(4.1)	10.86(4.0)	14.02(6.9)	18.27(8.1)	35.28(13.42)	53.433(20.22)	98.756(37.12)
Sibsagar	29.41(1.2)	31.49(12.5)	33.54(13.8)	45.46(19.7)	46.91(18.33)	54.446(20.18)	65.371(24.3)
Lakhimpur	11.83(5.2)	16.01(16.9)	24.03(13.8)	27.39(24.2)	14.68(12.85)	23.143(19.34)	37.645(27.12)
Dibrugarh			9.46(-)	14.7 (10.9)	25.74(18.88)	27.968(19.63)	29.177(23.13)
Cachar	18.84(5.8)	28.62(14.1)	39.41(2.0)	45.28(23.2)	41.39(18.97)	61.576(28.23)	47.245(21.75)
Mikir Hills	2.59(4.4)	5.5 (5.7)	39.51(6.3)	40.0(37.1)	7.0 (7.94)	22.177(20.67)	26.366(25.51)
N.C.Hills	-	-	-	-	12.0(0.88)	.950(7.25)	2.000(15.98)
Total	99.85(5.1)	108.63(6.3)	271.75(13.1)	213.46 (10.8)	287.6(13.08)	392.653(17.18)	548.234(24.48)

Source: Adhoc study No.38, AERC, Jorhat.

It will be seen from Table III.3 that in 1969-70 about 3 to 12 percent of the rice cropped area was under HYVs. Since then it has shown a continuous upward trend. In 1975-76 the area under HYV of rice varies between 0.88 to 18.88 percent of the total rice area for the districts of NC Hills and Dibrugarh respectively. District Kamrup has 9.29 percent of its rice area under HYVs followed by Goalpara 10.32 percent. Both of these districts constitute the major portion of the Lower Brahmaputra Valley. In other districts of Assam specially in Nowgong, Sibsagar, Dibrugarh and Cachar the High Yielding rice cultivation has appreciably diffused covering 13.42, 18.33,18.88 and 18.317 percent of the total rice area respectively. During the period 1976-77 to 1978-79, the coverage under HYV of rice has almost doubled in some cases such as Goalpara (from 14.59 to 28.96 percent), and N.C. Hills (from 7.25 in 1976-77 to 15.98 in 1978-79). However, in case of Cachar the area under HYV has decreased during this period from 28.23 to 21.75 percent. In all other cases the coverage under HYV rice has increased appreciably (such as Kamrup, Darrang, Sibsagar,Lakhimpur and Dibrugarh) As a result the HYVs have greatly replaced the indigenous varieties within a short span of period i.e. about 10 years.

Performance of HYV of Rice

According to a report on performance of HYV rice in Assam for which trials were conducted in Titabar Rice

Research Station, the recommended varieties such as Jaya, Pusa 2-21, Pusa 2-103, Jagannath and Manohar Sali cultivated in Kharif and Rabi seasons gave the following results seasonwise

TABLE III.4

Variety	Average yield in kg/ha	Seasons of the trial	
Jaya	8111	Rabi	1971
Pusa-2-21	6427	Rabi	
Pusa 2-103	7023	Rabi	
Jagannath	3385	Kharif	1972
Manohar Sali	3141	Kharif	

Source: Same as Table-III·3

It will beeseen from the above Table that Jaya variety sown during the winter season gage the highest yiedd i.e.8111 kg. per hectare. From the agro-climatic point of view it is interesting to note that rice sown in Rabi and grown with controlled irrigation gave higher returns than that of the Kharif rice. A comparison of the Kharif and Rabi rice shows that the per hectare yield of rice in Rabi season is more than double in case of all the three varieties mentioned in the Table III.4 . Thus inspite of applying N,P and K fertilizers at the rate of 50:25:25 and 100:50:50 per hectare, Kharif productivity appears to be very low. As a matter of fact, the HYVs perform better when there is adequate and controlled water supply in time according to need.[13]

The Assam Agricultural University Jorhat is doing Commendable work to educate the ruralites about the HYV by providing them the extension services. The university selected three intensive districts for the demonstration and extension purposes. The following Table presents the yield of HYVs in the district of Kamrup and Sibsagar lying in the lower and upper Brahmaputra Valley and Cachar lying south of N.C.Hills a hill district of Assam.

TABLE III.5

Districts	Year	Crops	Maximum yields in kg./ha
Sibsagar	1972-73	Jaya(Paddy)	8989
	1973-74	Jaya(Paddy)	6323
Kamrup	1972-73	Jaya(Paddy)	7333
	1973-74	Pusa 2-21(Paddy)	7076
Cachar	1972-73	IR-8(Paddy)	9345
	1973-74	IR-8(Paddy)	7092

Source: Ad-hoc Study No.38,Agricultural Development in Assam(1950-51 to 1975-76) AERC.Jorhat.

It will be seen from the Table III.5 that the maximum yield for Jaya HYV of rice varies between 6323

13. See also Reports of the A.A.U.,1972-74 and 1974-75.

to 8989kg. per hectare during the period 1972-74 in the plain districts of Assam(such as Sibsagar and Kamrup). The performance of IR-8 seems encouraging in Cachar, the yield varying between 7092 to 9345 kg per hectare. The reason may be attributed to the old alluvium soil and several other socio-economic measures taken for better performance of HYV rice in these districts.

Productivity of HYV Rice

The average yields of rice for the years 1950-51,1960-61, 1970-71,1973-74,1974-75, 1975-76,1976-77 are 855,968,1022, 994,985,1037,955 kg. per hectare of cultivated land in Assam respectively. It is distinct that the average yield in kg per hectare for ten years interval shows an increasing trend till 1970-71. But this increasein a ten years interval is highly unsatisfactory and discouraging. Reasons of such performances of rice productivity in Assam are many, but when viewed from different angles, it is clear that the effect of Green Revolution in Assam predominantly a rice growing state seems to be negligible as reflected in the productivity of its staple crop-rice. From 1970-71 onwards the yield rate has started declining till 1974-75 (i.e. 985 kg./ha). In 1975-76 it again went up to 1057 kg./ha. However, in 1976-77 the yield rate further declined up to 955 kg. per hectare. Such fluctuations in the yield rate may be attributed to the variable weather conditions in the state. So far as the productivity of High Yielding Varieties of rice is concerned a separate state level data are not available. The yield rate determined by the sample studies can be a measured to asses the performance of HYV of rice cultivation in the state.

In a sample farm study in Nowgong district from 1969-70 to 1971-72 on 100 samples, the following picture in terms of yields of local and HYV of rice emerges.

TABLE III.6

Crops	Average yield in kg./ha (Local Rice)	Average yield in kg./ha (HYV Rice)
Sali paddy	1658	3105
Ahu Paddy	1227	2398
Bao Paddy	1584	-

Source Ad-hoc study No.38, Agricultural Development in Assam(1950-51 to 1975-76) p-156

Table III.6 reveals that the performance of HYVs as compared to local traditional varieties seems to be satisfactory since the mean yield of HYV paddy is more than double the local Ahu and sali paddy. The data for 1968-69 is presented in Table III.7.

TABLE III.7

Seasons	Average yield in quintal/ha.
<u>HYV Paddy</u>	
i - Sali	19.1
ii - Ahu	14.05
iii - Boro	23.42
<u>Local Paddy</u>	
i - Sali	9.16
ii - Ahu	6.52

Source: Same as Table-III·6

A glance at the Table III.7 shows that the yield in either cases of HYV and local paddy in Sali Season comes out to be eoncouraging and better than Ahu season. Here rainfall may be a major attribute for such variation in yield. Greater variability in rainfall during Ahu season and back of irrigation facilities, stand as major impediments for higher and better productivity of HYV of rice in the Brahmaputra Valley region. However, yield in Boro season for HYV paddy seems to be the best amongst the seasons. The average yield for Boro HYV paddy in Sibsagar district is 23.42 quintal per hectare as against Sali i.e. 14.05 and 19.01 quintals per hectare respectively.

Yield estimation survey in the Mayang Irrigation Scheme also shows that even the local traditional Varieties of paddy give appreciably higher yield because of controlled water supply. The following Table presents the output of local and HYV paddies in the Mayang command area in 1968-69 in Nowgong district. The Table is based on the data and information collected from Agro-economic Research Centre for N.E. India, Jorhat.

TABLE III.8

Average yield of Paddy in Sample Households
1968-69
N = 100

Variety and Season	Average yield in quintal/ha.
1. Local Paddy	
Sali(Winter transplanted)	20.8
Ahu(Augumn)	14.1
Boro(Summer)	23.0
Bao(Broadcast deep water)	6.9
2. HYV Paddy	
Sali (Winter transplanted)	37.8
Ahu(Autumn)	25.7
Boro(Summer)	33.4

Source: Same as Table III·6

The author was informed by the farmers of the area under study and the Agro-Economic Research Centre, Jorhat that the short duration HYV paddy is grown in the areas having adequate irrigation facilities during the Ahu season. The traditional indigenous varieties are cultivated mainly in the Ahu and Sali seasons both in plain, and low lying marshy and flooded lands (such as Bao and Boro crops). Hence, three crops a year can easily be grown in the Brahmaputra Valley region without much difficulty.

Package Programme in HYV Rice Cultivation

So as to achieve better and higher output per unit area in the cultivation of High yielding Varieties of Rice, the package programme play the most vital role in both the farmers field and the farm level management. Package practice of cultivation can be defined as a systematic and scientific method of cultivation of any agricultural field crop with the application of advanced agricultural inputs such as chemical fertilizers, pesticides, insecticides, adequate irrigation facilities and upto date farm machineries etc. The impact of farious systems of cultivation (such as Package, Non-package and partial package) has been ovserved very significant in the farm level as well as in the fields of the farmers in Assam in the Brahmaputra Valley. The following discussion throws light on the pattern of yield of HYV rice per hectare of cultivated land in relation to the different package practices. The data concerning the per hectare yield have been obtained from the assessment survey of the Ahu and Sali (HYV) rice programme during 1977-78 undertaken by the

Directorate of Agriculture, Government of Assam[14] for the districts of Goalpara, Kamrup and Nowgong of the lower Brahmaputra Valley. The survey is based on the yield obtained from the individual (sample farms of the community Development Blocks).

Ahu (HYV) Rice

The estimate of average yield rates of early and regular Ahu exhibits significant variation in per hectare yield with various package programmes. The Tables presenting the yield rates have been put in the Appendices-Table-10.

A glance at the Table reveals that the average yield rate of the regular Ahu rice with full package practice is better than that of early Ahu rice. It is observed that the effect of fertilizer and irrigations seem to be prominent in early and regular Ahu respectively. It can however, be infered that the application of fertilizer in paddy is effective only under ideal weather conditions and proper water management in dry weather.

The per hectare yield of early Ahu with full package of inputs varies between as low as 1385 to as high as 3523 kg per hectare for the subdivisions of Dhubri and Mangaldai respectively. There appears to be an increasing trend in the yield rate from west to east direction for both early and

14. See the reports published by the Directorate of Agriculture, Government of Assam on the yield estimation Survey of the Ahu and Sali HYV rice programme during 1977-78.

regular · Ahu HYV of rice. In case of regular Ahu with full package, Dhubri has the lowest yield in kg. per hectare (i.e. 1691 kg/ha.) whereas the highest yield has been obtained from Nalbari subdivision(i.e. 3329 kg/ha.) (App-Table-9)

Comparing the yield rates of full, partial and non-package programmes, the variation comes out to be very striking in either cases of Ahu HYV of rice. Yield obtained from the partial package of early Ahu HYV of rice has a range between 1421 to 2203 Kg. per hectare for Dhubri and Nalbari respectively. Generally the partial package refers to the application of a single agricultural input leaving aside the other associated inputs. Here the average performance of the HYV cultivation in terms of yield in partial package has been taken into consideration with the rotation of each single agricultural input. Thus the yield obtained from the partial package and full package programmes does not indicate any striking variation. However, the variation between the yield responses due to full and partial package where a single agricultural input operates) seems to be significant for both early and regular Ahu(HYV) rice in the Lower Brahmaputra Valley.

The variation in yield between full package and non-package appears to be very significant in both the cases of Ahu HYV rice. The per hectare yield of HYV early

Ahu rice with nonpackage programme varies between 1303 Kg. to 1974 Kg. as the lowest and highest for the subdivisions of Dhubri and Nalbari respectively. Similar picture emerges also when the pattern of yield of the regular Ahu HYV of rice is analysed. Dhubri with nonpackage programme for regular Ahu HYV of rice has shown the poorest response in the yield rate (i.e.785 Kg. per hectare of cultivated land) Such, poor performance of HYV in the Lower Brahmaputra Valley in general and the subdivision of Dhubri in particular can be attributed to undesired and excessive rainfall, lack of controlled irrigation system and several other socio-economic and environmental factors.

The Sali HYV of rice production also indicates the similar impact of different package practices with the same geographical variation in yield rate from west to east direction of the Lower Brahmaputra Valley. But a comparative study between the yield rates of Sali and Ahu (HYV) rice shows that the yield obtained during the Sali season is more in Kg. per hectare than that of the Ahu season.

GEOGRAPHICAL CONDITIONS REQUIRED FOR HYV OF RICE

As will be discussed and analysed in this subsequent Chapters, the cultivation of HYV of rice is progressively getting popularity among the marginal and small farmers of the region. This may be because the High Yielding Varities of rice are neutral to scale and give higher output per unit area. The study made both in the farm management and farmers field reveal that the average yield per hectare of HYVs is almost the double to that of the yield of indigenous varieties. The experimental expectations of yield of HYV is however, never commonly found in the region excepting for a few farmers. Conditions both environmental and socio-economic responsible for such poor yield therefore, need to be investigated. The HYV cultivation is supposed to be undertaken in a very controlled agro-physical set-up because of the sensitivity of these plants. An urgent need is therefore, felt to predict the yield of HYV rice in the prevailing physical and socio-economic condition with the help of precise and careful mathematical models. After having assessed the existing environmental set up of the region, it is also imperative to make an attempt with a view to ascertaining the yield variations explained by a set of major physical parameters using the aforesaid quantitative models.

The data and reports on soil parameters such as soil nutrient, soil texture and soil p^H values have been procured from the analysis records of the Soil Testing Laboratory, Government of Assam. So far as the climatic elements (such as temperature, rainfall and relative humidity) are concerned, the data have been collected from the records of India Meteorological Department and the Directorate of Agrdculture, Government of Assam. The data on yield of HYV of rice have been gathered from the primary field records of the yield estimation survey of Sali rice conducted by the Directorate of Agriculture, Government of Assam for the year 1977-78. The survey was in fact, based on a crop cutting experiment conducted in many sample villages of the area under study.

For the present study the following variables have been chosen with an objective of finding out the inter-correlations between them on the one hand and the effect of agro-climatic variables on the per hectare yield of High Yielding Varieties of rice and local traditional varieties on the other. The varkables are :

i) Soil Nutrient Index
ii) Soil Texture Index
iii) Soil p^H Index
iv) Rainfall in mm.
v) Temperature in ^oC
vi) Relative humidity
vii) Yield of HYV rice per hectare in Kg.

The variables have been prepared in the following fashion.

For a final soil nutrient index composite indices have been prepared on the basis of the individual soil nutrient index such as Nitrogen, Phosphorous and Potassium by giving them different weightages as per their importance for the plant growth. The weightages used here for Nitrogen, Phosphorous and Potassium are 1.5, 1 and 1 respectively. Since Nitrogen has been proved to be the most essential or the key element for better yield of any kind of plant and especially rice, the same has been given weightage as 1.5. The importance of the primary soil nutrients will be discussed subsequently. After having given the said weightages, the total scores for each nutrient have been summed up for each component areal unit (i.e. Community Development Blocks in the present case) to find out the final soil nutrient index.

The index for every individual nutrient such as organic Carbon, phosphorous and Potassium in the Soil is calculated in accordance with the following standard formula.

$$\text{Nutrient Index (NI)} = \frac{\text{Percentage of Soil Samples Coming under low Category} \; \text{XI} + \text{Percentage of Soil Samples Coming under Medium Category} \; \text{X2} + \text{Percentage of Soil Samples Coming under High Category} \; \text{X3}}{100}$$

After having calculated the indices for each nutrient, the same are categorised with the help of the following standard class groups with a view to identifying the low, medium and high proportion of nutrients in the Soil.

Class Groups	Degree of Proportion
1.67	Low
1.67 to 2.33	Medium
2.33	High

The laboratory method for the categorization low medium and high content of each of the soil nutrients such as Nitrogen, Phosphorous and Potassium after chemical analysis is as follows :

Organic Carbon (percentage)		Phosphorous (lb/acre)		Potassium (lb/acre)	
Class Groups	Degree of proportion	Class Groups	Degree of proportion	Class Groups	Degree of proportion
$\angle$ 0.5	Low	$\angle$ 20	Low	$\angle$ 125	Low
0.5 - 0.75	Medium	20 - 50	Medium	125 - 300	Medium
$>$ 0.75	High	$>$ 50	High	$>$ 300	High

The above methods are followed by the Soil Testing Laboratories of Government of Assam.

In a similar manner, the indices for soil texture have been prepared from the laboratory data which are available in terms of percentages of soil samples under light medium and heavy categories. The final indices were prepared by giving weightages to such as 1, 2 and 3 to light, medium and heavy soils respectively. The scores were finally summed up and were divided by 100 to get the soil texture index for each unit area under study. The formula for working out indices of soil texture is as follows :

$$\text{Soil Texture Index} = \frac{\begin{array}{l}\text{Percentage}\\ \text{of Soils}\\ \text{under light}\\ \text{category}\end{array} X1 + \begin{array}{l}\text{Percentage}\\ \text{of Soils}\\ \text{under Med-}\\ \text{ium cate-}\\ \text{gory}\end{array} X2 + \begin{array}{l}\text{Percentage}\\ \text{of Soils}\\ \text{under hea-}\\ \text{vy cate-}\\ \text{gory}\end{array} X3}{100}$$

The indices for soil p^H values obtained (from the Soil Testing Laboratory) in the form of percentages of Soil Samples under Normal, Acidic and Alkaline groups have been calculated by assigning various weightages. The weightages are 3, 2 and 1 for normal, acidic and alkaline groups of Soils respectively. The final indices have been prepared by dividing the weighted sum of percentages of soils under the aforesaid categories by 100 for each component areal unit. The indices for soil p^H values are calculated according to the following formula:

$$\text{Soil } p^H \text{ Index} = \frac{\begin{pmatrix}\text{Percentage of Soil Samples under Normal Category}\end{pmatrix} \times 3 + \begin{pmatrix}\text{Percentage of Soil Samples under Acidic Category}\end{pmatrix} \times 2 + \begin{pmatrix}\text{Percentage of Soil Samples under Alkaline Category}\end{pmatrix} \times 1}{100}$$

The climatic parameters have been considered for the year 1977-78 only. Since the transplantation and harvest of early Ahu and Sali rice of High Yielding Varieties range between May to December, the average monthly rainfall, temperature and relative humidity have been taken into account only for this period of time. The isohyte, isotherm and per hectare yield of HYV rice for 1977-78 have been superimposed in Fig.12. Another limitation in using these parameters is that the average monthly values of climatic variables from May to November have been assumed as same for the surrounding component areal units (Community Development Blocks in the present case) for a particular rainfall recording station, because such data is not available for all the areal units. In the plotting of these climatic variables, interpolation technique has been applied to discern the approximate temperature, rainfall and relative humidity conditions of the different blocks.

The last variable i.e. theyeild of HYV rice per hectare has been prepared on the basis of the observed yeild rate in 25 square metre plots. The yield per hectare has been worked out taking the average figures of two experimental plots of each village in the Sample. Finally the average figure for each areal unit has been calculated taking the Mean of the number of observations. (Sample villages in the present case).

The subsequent phase of the study has been devoted to a detailed analytical discussion as regards the spatial dimension of the variables specifically the soil parameters in the entire area under review. Since an elaborate discussion on the space variations of the climatic elements has been presented in Chapter-II for the Brahmaputra valley as a whole the same have not been discussed in the present chapter because of limitations of data for micro regional units such as Community Development Blocks. The analysis on the Spatial variations of Soil parameters such as nitrogen, phosphorous, potassium, soil texture, and soil pH values have been presented in terms of frequency distribution, statistical measures of central tendencies and dispersions.

After having analysed the spatial pattern of the variations of soil characteristics, an attempt has been made to establish a multivariate relationship between the per hectare productivity of HYV rice and the soil and a number of climatic determinants as explanatory variables in the Lower Brahmaputra valley. The yield has been predicted with the help of multivariabe linear regression analysis and a comparative study of the explanatory power of the variables has been presented on the basis of coefficient of determination (R^2) in a stepwise linear regression model where every additional variable contributes its own explanation on productivity of the particular crop. The multivariate linear regression model is given by the following equation.

If a linear relationship exists between a dependent variable Y and K independent variables such as X_1, X_2 - - - X_k and an error term U, then the relationship between a set of such values can be written as :

$$Yi^1 = \alpha + \beta_1 X_i + \beta_2 X_{2i} + \cdot \cdot \cdot \cdot \cdot + \beta_k X_{ki} + Ui$$

Where i = 1, 2, ... N

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1. See for detailed discussion on general linear model. J. Johnston (1972), Econometric Methods, McGraw Hill Kogakusha Ltd. Tokyo, pp.121-168.

The real values of β coefficients could not be obtained because of the error term which is unknown. There are several limitations too, in the data to determine the error term. However, the β coefficients can be estimated with the help of principle of least squares. Hence it has been assumed that the Mean of the error term is zero. Each error term is independent of itself and their variance is also constant. The presumption follows that the independent variables are not related with each other.

After having found out the regression coefficients and the intercept of the regression equation i.e. the statistical constant, the linear estimations of the yield rate have been ascertained for each component areal unit. And then the residuals have been calculated by substracting the estimated yield rates from the observed ones for every unit area taken into consideration in the model.

It has been presumed that there is a substantial difference in yield rate between the local traditional varieties and High Yielding varieties and within the High Yielding varieties also the productivity differs as per the different systems of cultivation practiced and the input levels in the form of package, non-package and partial package. Here the average performance of HYV rice in terms of productivity in terms of Kg. per hectare obtained from the said practices of cultivation and for either the seasons (such as Ahu and Sali) has been taken into account. Therefore, the regression analysis has been applied for three kinds of performance of rice in separate taking the unit area for the first two models as sub-divisions and the last one at the level of blocks in order to have a comparative picture of the impact of Soil, temperature and rainfall variables on the per hectare productivity.

Finally the stepwise regression analysis has been applied for the High Yielding Varieties in particular with the set objective to know the impact of each additional variable in rotation in explaining the over all variations in productivity.

Since some transformation in the boundaries of the Community Development Blocks was in progress and the author could not succeed in obtaining a map showing the blockwise picture, the figures relating to the per hectare yeild have been shown on the approximate location of the blocks. Hence for the purpose, the thematic maps concerning the Soil nutrient indices have been prepared with the help of proportionate circles (Fig.10,11). The composite picture of the yield, soil and climatic variables have been shown in a map for 33 blocks under study by superimposing soil and climatic variables on yield.

Spatial Variations of Soil Characteristics

Before going into the details of the Spatial Variations of the Soil characteristics in the study area it will be worthwhile to discuss in brief the significance of soil Nutrients for the plant growth and particularly for the rice plants.

The plants collect 13 out of 16 elements essential for their growth from the soil. The rest three carbon, hydrogen and oxygen come from water and from carbon dioxide (CO_2) present in the air. The 13 elements are categorised in three groups given below, each further consisting of 3, 3 and 7 elements respectively.[2]

1. Primary	- Nitrogen (N) Phosphorous (P) and Potassium (K).
2. Secondary	- Calcium (Ca) Magnesium (Mg) and Sulphur (S)
3. Micro Nutrients	- Boron (B), Copper(CU) Iron(Fe) Manganese (mn) Molybdenum (Mo) Zn (Zn) and Chlorine.

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2. Agricultural Guide Book, Department of Agriculture, Assam, 1975-76, p.118.

Generally plants require primary and secondary elements in substantial quanities where as the micro nutrients are needed proportionately in negligible amount. The availability and proportion of plant nutrients affect favourably or adversely the germination, growth and development of crops. Their influence has been ascertained on the HYV rice in the area selected for study.

Nitrogen

Nitrogen has been proved to be the most essential or the key element for better yield of any kind of plant and specially rice. Plants need nitrogen because it promotes rapid growth of the plant, gives dark green colour to the plants, increases yields of leaf, improves quality of leaf crops, increases protein content of food and feed crops, feeds soil micro-organism during decomposition and finally increases flowering and fruiting. Specially the rice plants mainly rely on nitrogen for the decomposition of organic materails under an aerobic conditions. At the early stages of growth, rice plants take up nitrogen in the form of ammonia.

Researchers and agricultural Scientists in India have drawn the conclusion on the basis of experiments that, rice under varied circumstances gives a sharp response to the application of nitrogen. Sethi (1940) finds no example concerning the failure of nitrogen in giving immediate response. On the contrary, an excessive amount of nitrogen results in undesired number of tiller formation for which the yield of grain is affected by mutual shading of the tillers. Excessive nitrogen also causes various kinds of cryptogamic diseases, loding and unfavourable effect on milling quality and quantity. It has been further noticed that, at the early stage of growth, a paddy plant gives a positive response to ammoniacal nitrate, rather than nitrate nitrogen. But in the late stages of growth nitrate nitrogen has been found to be very effective.[3]

Phosphorous

Since the plant receives considerable amount of phosphates from the soil, there is no way to increase phosphate in the soil excepting the practical application of it which when applied responses readily. Insufficient amount of phosphate is available in solution, or suspension state in irrigation water. Phosphate manuring in the paddy field helps increase the grain yield rather than straw. Sircar and Sen (1941) conclude that phosphorous deficiency leads to reduced height and less number of tillering. They are also of opinion that the nitrogen

3. D.H. Grist (1955) Rice, London, p.247.

intake of rice plants heavily depends on the concentration of phosphates. Hence, phosphorous is not only helpful in early stages of growth but also helps in the later stages of development. Phosphate and Potash help grow the plant roots in relation to tops while nitrogen increases the growth of tops (Sato, 1938).[4] The following are the five main functions[5] of the phosphate.

i. It stimulates early root function and growth.

ii. It gives rapid or vigorous start to plants.

iii. It hastens maturity.

iv. It stimulates flowering and seedling.

v. It gives resistance to seed and hay crops.

Potassium

The soils of predominantly rice grown areas are supposed to have potassium adequately because of their heavy nature. In general it does not affect the yield, but in light soils, if it is applied gives sharp response. On the other hand, when potash is used along with nitrogen and phosphate, gives higher yields. Potassium is available in less quantity in soil than phosphorous, nevertheless soil retains it to a greater extent.[6]

4. D.H. Grist, Op.cit., p.247.
5. Agricultural Guide Book, Department of Agriculture, Assam, Op.cit., p.119.
6. D.H. Grist, Op.cit., p.248.

Coming over to the secondary elements without which the plant nutrition remains incomplete, it could be said that calcium, magnesium and sulphur are in no way unimportant for plant growth. Moreover, excess of these elements also gives adverse effect on growth, thereby causing less yield especially of the grain crops.

The prevailing agro-climatic conditions in the Lower Brahmaputra Valley consisting of Kamrup, Goalpara, and Nowgong districts under study show significant variations at a micro level analysis. Agricultural as well as Community Development Blocks as the component areal units in the present study could be sorted out on the basis of the quality of the soil and atmospheric parameters favourable for boosting up the crop productivity. A composite picture of the inherent soil nutrients such as organic carbon, phospherous and potassium in the soils of the area have been plotted in Fig.10 .

The soil fertility status of various community development blocks, in terms of organic carbon, available phosphorous and potassium content reveals that the nutrient index for organic carbon varies from 1.7 to 2.95 in the block Manikpur and Kokrajhar respectively. Out of 43 samples

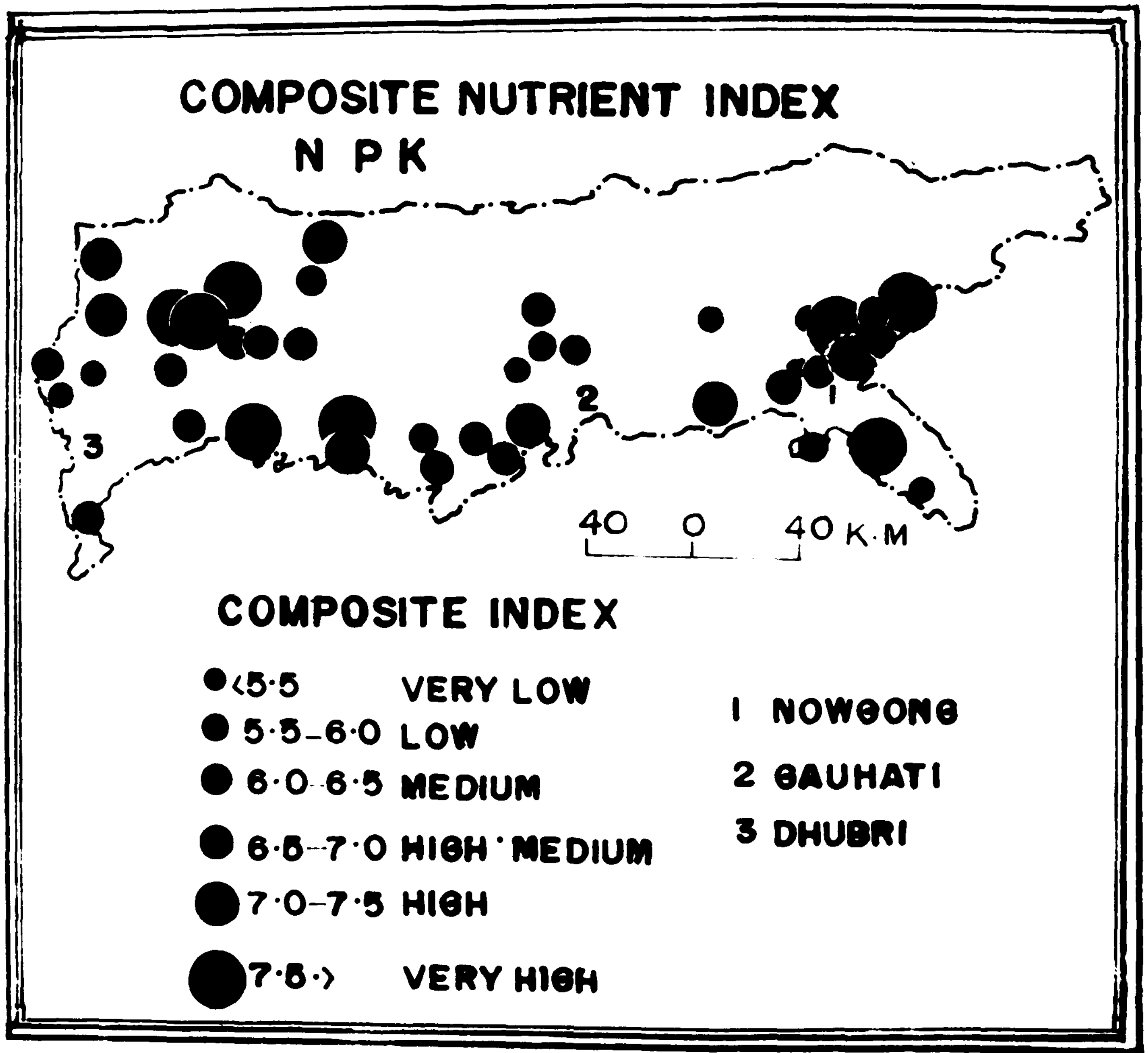
COMPOSITE NUTRIENT INDEX
N P K
1
2
3
40 0 40 K.M
COMPOSITE INDEX
<5·5 VERY LOW
5·5–6·0 LOW
6·0–6·5 MEDIUM
6·5–7·0 HIGH MEDIUM
7·0–7·5 HIGH
7·5·> VERY HIGH
1 NOWGONG
2 GAUHATI
3 DHUBRI

Fig. 10

blocks under investigation only 19 blocks fall under the higher nitrogen content group and the rest 24 come under Medium category. Switching over to available Potassium (K 20) content in the soils of the said number of blocks it is noticed that only one block has higher proportion of potassium available in the soil. As per the laboratory analysis of the soil samples, the soils of 12 blocks show a medium level of potassium nutrient index and as many as 30 blocks are poorly contained with potassium which is an essential inherent element of the soil for any kind of plant nutrition in its vegetative and growth period.

So far as the content of available phospherous in the soil is concerned, a spectacular variation between blocks is noticeable. The nutrient index for phosphorous content of the soil range between 1.08 to 2.69 in the blocks of Gauripur and Khagarijan respectively as the lowest and highest indices. It is interesting to note that not even a single block has higher phosphorous content. And moreover, 33 and 10 blocks respectively come under the medium and low categories of phosphorous content.

The overall nutrient index taking organic carbon(N), Phosphorous (P_2O5) and Potassium together, reveals that the spatial variation of the indices is not that significant. According to the importance or significance of the above said nutrients different weightages such as 1.5 , 1 and 1 have been given to nitrogen, phosphorous and potassium respectively. After having found out the composite indices of these three principal soil nutrients it is noticed that the compositie indices varies between as low as 5.335 to as high as 7.87 in the blocks of Bhurbandha and South Salmara respectively. A vivid picture emerges out of the following frequency Table concerning the fertility status of the 43 blocks.

TABLE - IV.1

Class group (N1)	Frequency	Cumulative Frequency	Categories
< 5.5	1	1	Very low
5.5 - 6.0	6	7	Low
6.0 - 6.5	8	15	Medium
6.5 - 7	12	27	High medium
7.0 - 7.5	7	34	High
> 7.5	9	43	Very high

Source: calculated by author

Having a look at the frequency Table-IV.1 prepared for the overall soil nutrient index it is observed that only one block comes under the very low category soil so far as the nitrogen, Phosphorous and Potassium ingradients are concerned. The block is Bhurbandha of the Mangaldoi subdivision in Darrang District. This block has a strewn topography leached by the fluvial action of the numerous tributaries of the Brahmaputra. As many as 6 blocks are having poorly fertile soil the index of which varies between 5.5 to 6.0. The blocks are Hazo, Gauripur, Golakganj, Lanka, Juria, and Loharighat among which Golakganj ranks first the index being 5.92 and Lanka has the lowest index value i.e. 5.615 particularly in this group.

Coming over to the medium fertility group of the soil, it is observed that 8 blocks are falling under this category. The blocks are Chamoria, Karara, Kamalpur, Manikpur, Rupahi, Kathiatoli, Kapili and Lawkhowa. Chamoria and Kapili have indices 6.06 and 6.455 as the lowest and highest respectively. Having look at the high medium fertility group of the soil, the index of which comes under the class group 6.5 to 7.0, it is clear that the maximum number of blocks i.e. 12 namely Chhaygaon, Rampur, Rangia, Boko, Lakhipur, Srijangram, Boitamari, Bilasipara, Chapar, Mankachar, Agomoni and Mayang are in this group.

Out of these Agomoni and Rampur have the indices of 6.585 and 6.97 as the lowest and highest values respectively.

So far as the high nutrient index group is concerned, 7 blocks are falling in this group; the blocks being Rani, Dimoria, Dudhnoi, Kachhugaon, Gossaiggaon, Borobazar and Khagarijan of which Rani has the lowest index i.e. 7.03 and Dudhnoi has the highest i.e. 7.26.

Switching over to the last class group of the nutrient index within which the soils of as many as 9 blocks having very high nutrient and fertility fall. The blocks are Balijana, Matia, Dotoma, Sidlichirang, South Salmora, Batadraba, Kaliabar, Kokrajhar and Jugijan. Out of these, Dotoma and south Salmora are having indices 7.505 and 7.87 respectively as the lowest and highest. Taking all the blocks together into consideration south Salmara also ranks first in soil fertility index in terms of organic carbon available phosphorous and potassium.

Soil texture is of prime importance for rice crop. From the information collected regarding the quality of soil in terms of its texture it is noticed in each and every block of Kamrup and Goalpara that the texture of a substantial percentage of samples collected by the soil survey Unit, Government of Assam, is of medium category. However, the percentage of sample in this category invariably exceeds 90 per cent for all the blocks. And the percentage of light or heavy soils is very insignificant if not, sometimes nil also.

The texture of soils of Lower Assam has been categorised as per the following gradation.

Texture	Gradation
Sandy, Sandy Loam	Light
Loam, Loamy sandy	Medium
Clay	Heavy

But there are few blocks which need special mention such as Rampur, Dimoria, Chamoria, Hajo, Balijana, Dudkandi, Dotoma, Kokrajhar and Manikpur where the soils are predominantly loamy and loamy sandy in nature for which the percentage exceeds 99 per cent. In case of Rampur, Dimoria and Dudhnoi as per the soil analysis data hundred per cent of the samples falls in the medium category of the textural classification. On the other hand, there is hardly any variation of soil texture of these particular blocks.

Coming over to the blocks of Nowgong and Darrang the soil texture variation appears to be significant as compared to that of Kamrup and Goalpara. As per the laboratory analysis report it is seen at the first sight that the soils in these blocks are found in different types such as sandy, sandyloam, loamy, loamy sandy and clayey silt. But soils of most of the blocks constitute of sandy and sandy loam in a higher proportion which come in light textural classification than loamy, loamy sandy and clayey. The percentages of sandy and sandy loamy soils vary between 14.0 as the lowest and 88 as the highest per cent for the blocks of Jugijan and Lawkhowa respectively.

In order to have a better understanding about the percentage variation of the light soils of all the blocks taking together into consideration the following frequency Table has been attempted.

TABLE - IV.2

Percentage/Class group of samples	Frequency	Cumulative frequency
< 5	25	25
5 - 20	1	26
20 - 35	0	26
35 - 50	1	27
50 - 65	2	29
> 65 +	14	43
TOTAL	43	

Source: Same as Table-IV.1

Table-VI.2 shows that the percentage of sandy and sandy loam soil sample being categorised as the light textured soil is less than 5 per cent in maximum number of blocks i.e. 25 coming under the western most tip of the Brahmaputra valley constituting of Kamrup and Goalpara districts. Only one block has percentage of light soil between 5 to 20 per cent. The block is Lawkhowa of Nowgong district and 14 per cent of its soil is of sandy loam texture.

In the 20 to 35 per cent group, not a single block is observed. Between 35 to 50 per cent only one block namely Rupahi has 46 per cent of its soils as sandy and sandy loamy. In two blocks namely Mayang and Loharighat the soil is sandy loam. This soil covers about 50 to 60 per cent of their total area. It may also be noticed from the frequency Table-IV.2 that in 16 blocks the soil is light sandy.

Hence from the above analysis of the light textured soil of different blocks, it is very distinct that the texture keeps on changing in a west to east direction of the lower Brahmaputra valley. The soil being clayey in the west and sandy loam to sandy in the east.

It would also be worthwhile if the space variation of the medium and heavy textured soils are discussed in a similar analytical framework. The frequency Table-IV.3 reveals the comprehensive picture of the loam and sandy loam soils of the 43 sample blocks.

TABLE - IV.3

Percentage class group of samples	Frequency	Cumulative Frequency
< 20	6	6
20 - 40	6	12
40 - 60	1	13
60 - 80	0	13
> 80	30	43
TOTAL	43	

Source: Same as Table-IV.1

The frequency distribution Table reveals that the percentage of soil sample goes on increasing with an increasing number of blocks so far as loam and loamy sandy textured soils are concerned. As many as 6 blocks show percentage less than 20. These blocks are situated in Nowgong and Mangaldoi subdivisions.

Between 20 to 40 per cent category of the percentage of soil samples having a medium category, another 6 blocks are coming and they are from Nowgong and Mangaldoi sub-divisions. The blocks are Loharighat, Kapili, Kaliabar, Lanka, Mayang and Khagarijan. But the soils of only one block are having an appreciable proportion of loam and loamy sandy texture. The block is Jugijan which has 48 per cent of its soils loamy and loamy sandy. No block comes under the percentage class group of soils between 60 to 80. But it is interesting to note that as many as 30 blocks have a higher percentage between 80 per cent and above, of their soil loam and loamy sandy in texture.

Clayey or clay silt soils are found in a good number of blocks in Nowgong subdivision. The percentages vary between 45 to 35 as the lowest and highest respectively for the blocks of Rangia and (Rupahi and Kapili) respectively. Since there is a sharp textural difference between the blocks of Kamrup and Goalpara taken together and that of Nowgong and Darrang it is needless to discuss every soil type in detail.

From the textural variation of soils between blocks, it could be infered that while the blocks coming under Goalpara and Kamrup districts have predominantly loamy and sandy loam, a substantial number of blocks of Nowgong and Darrang districts are covered by sandy and sandy loamy soils. But Clayey or heavy soils are almost absent in Kamrup and Goalpara districts.

The texture index prepared for the three categories of soil also indicate a remarkable variation between blocks. As per the importance of these categories for crop growth and productivity and specially for rice plant, clayey or heavy soil has been given more weightage than sandy, sandy loamy, loam and loamy sandy. After giving weightages such as 3, 2 and 1 to Heavy, Medium and light soils respectively a weighted sum of the percentages of samples in different categories has been prepared and divided by 100 in order to find out texture index for each block.

Having a look at the different indices prepared and shown in Fig. 11 . for different blocks, it is noticed that the indices range between 1.05 to 3.00 for the blocks of Jugijan and Chaparmukh respectively. Higher the index better the soil texture. The Table-IV.4 reveals the composite picture of the quality of soil in terms of light, medium and heavy texture.

TABLE - IV.4

Class	Frequency	Cumulative frequency
<1.5	11	11
1.5 - 2.0	15	26
2.0 - 2.5	8	34
2.5+	9	43

Source: same as Table-IV.1

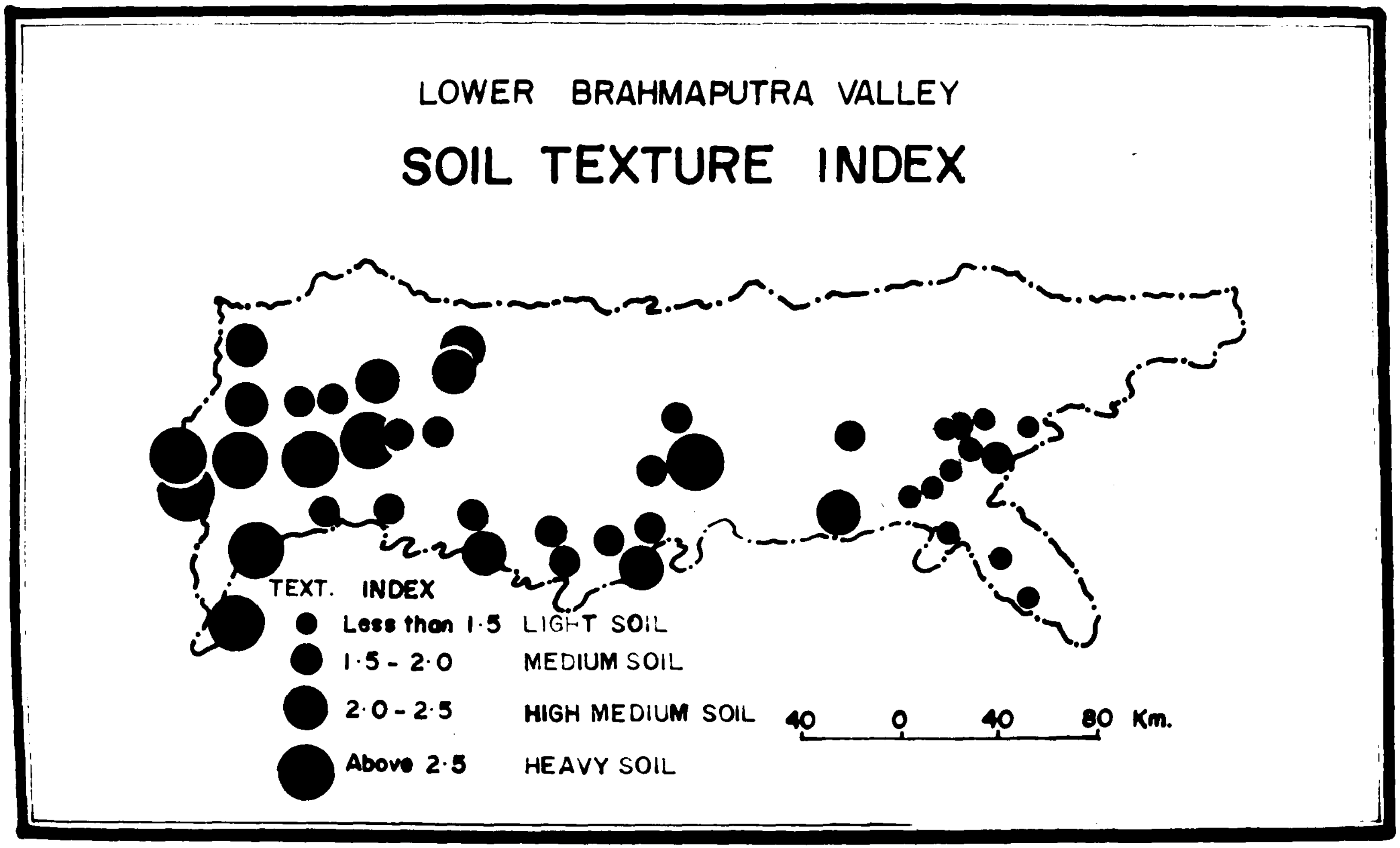
LOWER BRAHMAPUTRA VALLEY
SOIL TEXTURE INDEX
TEXT. INDEX
Less than 1·5 LIGHT SOIL
1·5 - 2·0 MEDIUM SOIL
2·0 - 2·5 HIGH MEDIUM SOIL
Above 2·5 HEAVY SOIL
40 0 40 80 Km.

Fig. 11

There are 11 blocks in which the indices are less than 1.5 and all these blocks lie in Nowgong and Mangaldoi subdivisions. Hence, the soils are the poorest in terms of texture which is unfavourable for rice crop, because it has low moisture retaining capacity. As many as 15 blocks are having the index value between (Table IV.4) 1.5 to 2.0 and the blocks are exclusively from Goalpara and Kamrup districts. In comparison to Nowgong,these blocks are better in soil texture. In 2.0 to 2.5 index value group there are 8 blocks namely, Dimoria, Rampur, Dudhndi, Sidlichirang, Manikpur, Kachugaon, Gossaigaon and Borobazar. There are 9 blocks covered by the best texture soil. The names of the blocks falling in the category of over 2.5 are Karara, Kamalpur, Gauripur, Bilasipara, Chapar, S. Salmora, Agomoni and Golokganj.

Soil Reaction p^H value

The presence of water in the soil is a significant determinant of soil aeration its fertility and suitability for different crops. Various forms of water are present in the soil that exhibit a complex relationship. The proportion of exchangeable bases in the soil is a soil is obtained by the process of measuring concentration of hydrogen ions. It is assumed that the proportion of other ions which can be held by the clay humns complex depends on the space left by hydrogen "ions". The proportion of freehydrogen ion in the soil solution is measured and stated as pH values.

Soils vary in pH from about 4, for strongly acid soils to about 10 for alkaline soils that contain free sodium carbonate. The pH range for most agricultural soils is 5 to 8.5 pH. 7 is the neutral value. Value below pH 7 indicate an acidic soil and value above pH 7 indices an alkalinity.

TABLE -IV.5

pH Value Index

Under pH 4.5	Very high acidity
4.5 - 5.0	High acidity
5.0 - 5.5	Moderate to high acidity
5.5 - 6.0	Moderate acidity
6.0 - 7.0	Slightly acidity
7.0	Neutrality
7.0 - 7.5	Slight alkalinity
7.5 +	Strong alkalinity

Source: Agricultural Geography by Majid Husain, P.40.

The information collected on the soil reaction in terms of pH values, shows that the variation is not that remarkable. According to the percentages of soil sample in acidic, neutral and alkalinity range a pH index has been prepared giving different weightages to different range. The weightages are 3, 2, 1 for acidic, neutral and alkalinity respectively as per the favourability for rice crop.[7]

7. Agricultural Guide book, Department of Agriculture, Assam, Op.cit., p.103.

The indices vary from as low as 1.988 to as high as 3 for the blocks of South Salmora and (Kokrajhar, Sidlichirag and Chamoria 3 for each) respectively. Hence, higher is the index better the growth and productivity of crops. The frequency Table IV.6 shows the index wise group of blocks.

TABLE - IV.6

Class group	Frequency	Cumulative frequency
< 2.0	2	2
2.0 - 2.25	8	10
2.25 - 2.50	0	10
2.50 - 2.75	2	12
> 2.75	31	43

Source: Same as Table-IV.1

Table-IV.6 shows that there are maximum number of blocks i.e. 31 whose index values exceed 2.75. Only two blocks have their index values less than 2.0. The blocks are Batadraba and South Salmora one each in Nowgong and Dhubri subdivision respectively. 8 blocks show their index between 2.0 to 2.25. The blocks are Kurara, Kamalpur, Gauripur, Bilasipara, Chapar, Mankachar, Agomoni and Golakganj. Between 2.5 to 2.75 there are another two blocks such as Baligana and Boitamari. Hence soil reaction does not show a significant variation. But it is observed that the blocks which come under Nowgong subdivision have poor nutrient index poor texture index though pH index does not show unfavourability.

The mean, standard deviation and co-efficient of variation gives the following explanation for Nutrient index, Texture index and pH index. The standard deviation mean and co-efficient of variation for nutrient index are .672, 6.76 and 9.94 respectively. The coefficient of variation shows that the nutrient indices do not vary significantly the variation being 9.94 per cent.

Similarly the standard deviation and mean co-efficient of variation for Texture are 0.578, 1.995 and 28.998 respectively. The coefficient of variation of texture as compared to N1 is significant. So there is a significant variation of the textural quality of soils between blocks.

Coming over the pH index it is observed that the variation is less as compared to Texture but more as compared to nutrient index. The coefficient of variation for pH index is 14.1078 per cent and mean and standard deviation are 2.685 and 0.378 respectively.

As a whole it could be concluded that the variation in soil properties in general is not very remarkable excepting soil texture which needs special mention for its west to east change.

Multivariate Regression Analysis

The regression analysis concerning the impact of agro-climatic variables on productivity of rice in general and the HYV of rice in particular breaks up from sub-division to block level as follows :

Regression Analysis for

Sub-division-wise performance of traditional varieties of rice	Sub-division-wise and block wise performance of HYV rice

Having a look at the results obtained from the Multiple regression analysis for the sub-divisions namely, Dhubri, Goalpara, Gauhati, Kokrajhar, Morigaon and Nowgong it is noticed that the average productivity of the local traditional varieties of rice comes out to be 858.833 kg per hectare. The mean values for soil nutrient index, texture index, pH index, rainfall, temperature and relative humidity are 6.473, 1.96, 2.701, 171.472, 24.58 and 84.173 respectively. The matrix of inter-correlation that emerges out of the bivariate relationship between all these variables including the per hectare productivity has been presented in Table-IV.7.

TABLE - IV.7

Matrix of Inter Correlation

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7
(x_1) Soil Nutrient Index	1	0.181	0.057	0.755	0.095	0.454	-0.082
(x_2) Soil Texture Index		1	-0.773	0.048	-0.538	0.089	-0.824
(x_3) Soil pH			1	0.312	0.196	-0.078	0.417
(x_4) Rainfall in mm				1	-0.36	0.337	-0.131
(x_5) Temperature in ^oC					1	-0.229	0.51
(x_6) Relative humidity						1	0.37
(x_7) Yield of HYV of rice in kg per hectare							1

Coming over to the question of significant and insignificant values of correlation coefficient, it will be seen that the above properties could always be compared with the tabulated 't' values[8] after having found out the same with the help of the following formula.

$$t = \pm \sqrt{\frac{n-2}{1-r^2}} \text{ for } n-2 \text{ d.f}$$

where r = Correlation coefficient

n = No. of observation

Since the number of observations are less, most of the correlation coefficients are coming insignificant at either the diredtions such as positive and negative at 5 per cent and 1 per cent level of significance. Postive correlation is found between soil nutrient index and texture index and rainfall between pH index and rainfall, temperature and yield and finally between relative humidity and yield.

Among all the above positively correlated variables none of the pairs is found having a positive and significant correlation coefficient at 5 per cent and 1 per cent level of significance. But at 10 per cent level nutrient index and rainfall have a significant relationship,

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8. Tabulated 't' values at $\frac{0.05}{2.78}$ $\frac{0.01}{4.6}$ $\frac{0.05}{.791}$ $\frac{0.01}{2.13}$

for which the correlation coefficient is 0.755. The reason is attributed to the terrain condition where water logging persists and on the other hand the water helps increase the process of decomposition of the organic materials in the soil. very insignificant or no correlation exists between nutrient index and soil pH and air temperature, between texture index and rainfall and humidity since the coefficients of correlations are less than 0.1 i.e. approaching 0.0. All other positively correlated variables are although, having the coefficients more than 0.1 nevertheless they are not significant so far as the different levels of significance are concerned. The reason might be due to less number of observations and could be proved when our number of observations is fairly higher in case of block level study than the present case.

A few negative coefficients of correlations are also observed in the study. The paired variables being negatively correlated consist of soil nutrient index and yield rate, texture and pH index, texture index and temperature, texture and yield pH and humidity, rainfall and temperature, rainfall and yield and finally temperature and humidity. But the negative correlation between nutrient index and yield rate seems to be very insignificant as evident from the 'r' value which is less than -0.1. Though these two variables have a negative trend in relationship still it could be infered that there seems to be no relationship between them. Similar relationship have negative trend but the r values approaching 0, is observed between pH and humidity. Excepting these two paired variables, all other are having fairly negative correlation coefficients among which texture index and pH index do have significant correlation at 10 per cent level of significance. The correlation coefficient between soil texture and air temperature also shows a negative trend which is insignificant at 1, 5 and 10 per cent levels. But very high negative correlation is observed between soil texture and per hectare yield which is also significant both at 5 per cent and 1 per cent levels. This could be attributed to the medium textured soil which is not very much favourable for a better yield and could be, the variable is not independent of itself. Hence as the index goes on increasing, the yield rate goes on decreasing. These types of soils have a low moisture, retaining capacity and the cation exchange capacity determined by pH values is not that effective. Because of low moisture and hence less amount of nutrition the yield could be affected. The yield rate shows a negative relationship with rainfall and texture index but with pH index it is positive and insignificant. It is also positively correlated with temperature and humidity. However, the relationship is insignificant at 1, 5 and 10 per cent levels.

In the case of traditional varieties of rice, the climatic parametrs which have been considered, include the mean monthly rainfall for the period 1974-1977, average monthly daily temperature for 1931 to 1960 and relative humidity from 1974 to 1977. But for sub-divisionwise performance of High Yielding Varieties, mean monthly climatic parameters from May to November have been taken into consideration for the year 1977-78 only, since the experimental study of Sali (HYV) rice was conducted for the same year. The matrix of inter-correlation between the variables and the regression coefficient are given in Table IV.8

It will be seen from Table-IV.8 that the correlation coefficients between soil nutrient index and texture index, rainfall, temperature humidity and per hectare yield, between texture index and rainfall temperature and humidity between rainfall and temperature and humidity, and between temperature and humidity are positive. Among these

TABLE - IV.8

Matrix of Inter Correlation

Varibles	X_1	X_2	X_3	X_4	X_5	X_6	X_7
(x_1) Soil Nutrient Index	1	0.27	0.041	0.176	0.476	0.576	0.388
(x_2) Soil Texture Index		1	-0.77	0.84	0.717	0.478	0.065
(x_3) Soil pH Index			1	0.60	-0.237	-0.175	-0.238
(x_4) Rainfall in mm.				1	0.83	0.68	-0.427
(x_5) Temperature in ^{o}C					1	0.879	-0.34
(x_6) Relative Humidity						1	-0.276
(x_7) Yield of HYV of rice per hectare in kg.							1
Regression Coefficients	468.0	513.36	-744.6	-1.51	-12.75	4.99	

posititively correlated paired variables, the correlation coefficients between soil texture and rainfall, rainfall and temperature, and temperature and humidity are significant both at 1 per cent and 5 per cent levels of significance. All other pairs are having positive correlations but at a very low levels of significance. There are eight such pairs of variables i.e. texture index and pH index, pH index and rainfall, pH and temperature, pH and humidity, pH and yield, rainfall and yield, temperature and yield and humidity and yield which are having negative correlationship between them. Among them texture index and pH are having very high negative correlation coefficient and significant at 10 per cent level of significance.

Coming to the estimated value of the per hectare productivity of HYV ($\hat{Y}$) in the subdivisions of Dhubri, Goalpara, Gauhati, Kokrajhar, Marigaon and Nowgong, one observes that the observed productivity in the said subdivisions is more or less the same as the estimated hence the basic residuals for each areal unit approaches zero. Here the residuals as meaningful indicators suggest that at the subdivision level, the positive factors are more relatively significant than the negative, showing the productivity to be equal to or slightly less than the average yield per hectare.

It could be more meaningful in explaining the impact of positive and negative factors on the per hectare productivity of rice, if the subdivisions are further disaggregated into micro order units. In the present case community development blocks have been taken as the areal units of study (Fig.12).

For a micro level study concerning the impact of agro-climatic environment on the productivity of High Yielding Varieties of rice in the lower Brahmaputra valley, all the 33 community development blocks have been taken into consideration. The set of variables taken for the sub-division wise analysis have been retained for the blockwise study. Since the central theme of the present study is to predict the dependent variable in terms of several independent factors, stress has been given to the relationships between the dependent variable of yield and several independent variables like soil nutrient index, texture index, pH index, rainfall, temperature etc..

The average values of the variables are 6.795 (Soil nutrient index) 1.795 (Texture index), 2.776 (pH index), 400.305 (Rainfall), 26.33 (Temperature, 86.79 (Relative humidity) and 3418.121 (Yield per hectare).

Here, the per hectare productivity of HYV rice

LOWER BRAHMAPUTRA VALLEY

PEFORMANCE OF HYV OF RICE

(RAINFALL, TEMPERATURE & YIELD PER HECTARE)

MAY TO NOV. 1977

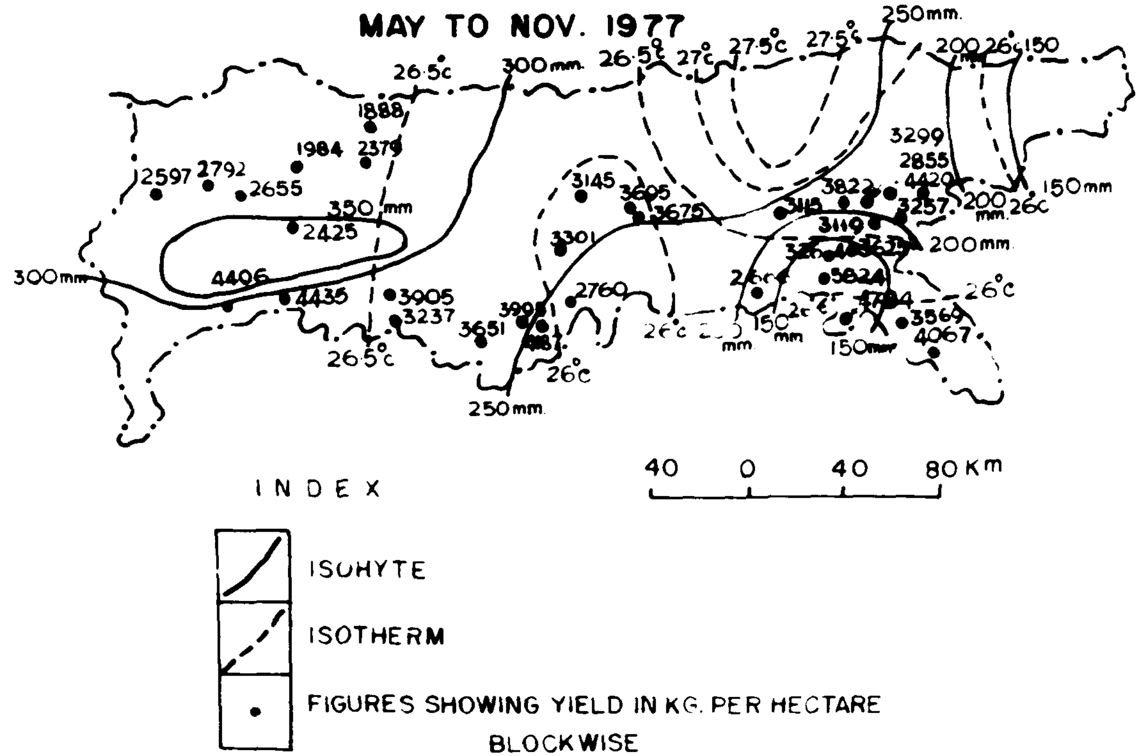

Fig. 12

has been calculated as the average of the package and non-package system of cultivation. In package practice, HYV rice is grown with the help of controlled water supply, application of fertilizers, pesticides and insedticides. So the yields obtained with package programme and without it have been averaged out in order to see the influence of soil and climatic parameters. Table IV.9 presents the matrix of inter-correlation of the variables and the regression coefficients.

At a glance to the correlation Matrix it is vivid that the individual physical variables have all got negative relationship with the yield and that too there seems to be no relationship between the index of soil reaction or pH and yield the correlation co-efficient being 0.090. So far as the relationship between all other variables and the yield is concerned, rainfall and yield have negative and significant relationship. The reason might be attributed to undesired amount of rainfall which adversely affect the yield, since HYV of rice needs a very controlled and timely irrigation. The correlation co-efficient is tested to be significant both at 5 per cent and 1 per cent level of significance. The relationship between temperature and yield is also found to be very

TABLE - IV.9

Matrix of Inter-correlation

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7
(x_1) Soil Nutrient Index	1.00	0.087	0.083	0.428	0.558	0.261	-0.155
(x_2) Soil Texture Index		1.00	-0.2	0.388	0.343	-0.248	-0.207
(x_3) Soil pH Index			1.00	0.237	0.197	0.208	-0.090
(x_4) Rain-fall in mm				1.00	0.740	0.382	-0.387
(x_5) Temperature in ^{o}C					1.00	0.409	-0.501
(x_6) Relative Humidity						1.00	-0.219
(x_7) Yield of HYV of rice per hectare in kg.							1.00
Regression Coefficient	240.63	13.34	126.65	-1.36	-2671.03	-12.99	

significant both at 5 per cent and 1 per cent levels of significance in a negative direction. Meaning thereby there is an adverse effect on the per hectare yield of HYV if the air temperature rises beyond 25°C which has been discussed in the introductory chapters (chap-II)./ Therefore, the air temperature stands as an unfavourable factor for the growth of HYV rice plants in the valley. Though the correlation coefficient between the atmospheric relative humidity and the yield is found negative and -0.219, it is significant only at 50 per cent and insignificant at all other levels the relationship is insignificant. The reason could be, the prolonged persistence of higher percentage of humidity in the air which is sometimes unfavourable for rice growth. Soil nutrient index and yield are also negatively correlated, it is significant at 50 per cent level. The reason is that the process of decomposition of organic materials, available phosphorous and pottassium in water logged areas are more prominent and undesired for high yielding varieties growth, thereby negatively affecting the grain yield. Soil texture is also negatively correlated with the grainyield of NYV rice. The soil texture is found to be medium in category which is sandy loam and loamy in a very wider scale. This sort of soils do not have moisture retaining capacity for natural nutrition development process and would have been favourable for better yield of the plants had it been clayey soil widely. The 'r' value is insignificant at all other excepting the 50 per cent level.

Results of the correlation coefficient between the soil and climatic variables show that, positive correlation exists between almost all the pairs of the six variables excepting the pairs nutrient index and pH and texture which have, though got negative and positive trend respectively in their relationship, still, there seems to be no relationship as evident from the 'r' value, approaching zero. But significant positive correlation exists between nutrient index and rainfall only at 5 per cent level of significance between nutrient index and temperature at both 5 per cent and 1 per cent level, between texture index and temperature at 10 per cent level, between rainfall and temperature at 5 per cent and 1 per cent level, between rainfall and relative humidity at 10 per cent level and finally between temperature and humidity at 2 per cent level. So the reasons for such relationship are obvious for the above paired variables.

Switching over to the estimated values of the dependent variable i.e. yield, prominent differences are marked when compared with the observed yield per hectare. It is further noticed that the estimated yield rates for a good number of blocks are more than that of the observed. Therefore, clear picture emerges when the basic residuals are calculated in order to sort out the areas having positive as well as negative residuals for a better explanation of the favourable and adverse impact of the physical determinants on yield estimation.

Basic residuals are the difference between the observed and the estimated values of the dependent variables and may be either positive or negative values. So $(Y-\hat{Y}))$ gives the basic residual, where Y is the observed value and $\hat{Y}$ is the estimated value. Since the residual maps are very useful in formulating hypothesis, under certain circumstances, the spatial pattern of these residuals helps compare other spatial pattern of phenomena with it provided they occur in obsolute values.

The residuals calculated reveal that the positive basic residuals vary between 1.085 and 1658.79 for the blocks of Kamalpur and Mayang as the lowest and highest respectively. Similarly the negative residuals have a variation between -105.34 and -1188.37 for the blocks of Dadhndi and Sidli respectively. Negative residuals as evident from Table - 13 in the appendices are more in number than the positive. As many as 20 blocks have negative residual and that of the rest 13 have positive. Out of 13 blocks having positive residuals 8 and 3 come within medium and high class group respectively. The rest 2 have very high positive residuals which exceed two times the standard error of estimates.

The standard error of the estimates[9] has been used here in classifying the residuals in different categories. With the presumption that the distribution of residuals is normal and using the properties of normal distribution the residuals have been divided into six categories as:

0 to 1 standard error of estimate

+ 1 SE to + 2 S.E.

+ 2 S.E. and above

0 to -1 S.E.

-1 S.E. to - 2 S.E.

-2 S.E. and less than that.

when the residuals show more than 2 S.E., they should be dropped out of the analysis, since some serious abnormality might be there in the observations.

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9. Standard error of estimates

$$= \sqrt{\frac{\Sigma(Y - \hat{Y})^2}{n - 1}}$$

The following frequency tables present the different categories of basic residuals.

TABIE - IV.10

Frequency table showing positive and negative Residuals

Class Group	Frequency	Categories
0 - 742.16	8	Medium positive
742.16 -1484.32	3	High positive
1484.32 +	2	Very High Positive
Total	13	

Source: Same as Table-IV.1

TABLE - IV.11

Class Group	Frequency	Categories
0 - -742.16	16	Medium negative
-742.16 - -1484.32	4	High Negative
-1484.32	0	Very high negative
Total	20	

Source: Same as Table-IV.1

From the above Tables it is distinct that the role of positive factors which generally determine more than the average per hectare productivity is less significant than the negative. In the lower Brahmaputra Valley negative factors dominate thereby causing lower yield in kg. per hectare for the High Yielding varieties of rice. In the frequency Table-IV.11 showing the blocks of negative residuals it is noticed that four blocks are coming under the high negative residual group. As many as 16 blocks are within the medium negative group. The names of all the blocks having positive and negative residuals have been mentioned in Table- 13in Appendices

Stepwise Regression Analysis:

While attempting a multiple regression analysis, it is useful to know how the parameters change in adding the new variables one after another. This statistical procedure is known as step-wise regression analysis and is helpful in several ways.

It highlights the contribution of an added variables in explaining the dependent variable with the help of the changing R^2 i.e. the coefficient of determination in every step. It tells whether the new variable is worth considering in the model or not. It also helps in knowing the changes in the values of regression coefficients.

In order to explain the productivity of High Yielding varieties of rice in lower Brahmaputra Valley the variables chosen are same as in the multiple regression analysis.

The results of the stepwise regression analysis are given below:

TABLE - IV.12

Variables	Regression Coefficients	R^2	R^2x100	Increase in R^2
Step 1				
X_1	-187.92	0.020	2	-
Step 2				
X_1	-167.16	0.025	2.5	0.005
X_2	-373.20			
Step 3				
X_1	-179.12			
X_2	-428.42	0.028	2.8	0.003
X_3	-340.94			
Step 4				
X_1	1.01	0.030	3	0.002
X_2	-146.61			
X_3	- 51.68			
X_4	- 1.06			
Step 5				
X_1	164.55	0.070	7	0.04
X_2	31.18			
X_3	27.74			
X_4	- 3.14			
X_5	-2620.81			
Step 6				
X_1	240.63	0.12	12	0.05
X_2	- 13.34			
X_3	126.65			
X_4	- 1.36			
X_5	-2671.03			
X_6	- 12.99			

Source: Calculated by author.

A glance at the above Table-IV.12 reveals that the soil variables such as nutrient index, texture index, and pH index and rainfall together explain only 3 per cent of variation in the productivity of HYV rice. Out of this proportion, nutrient index alone explains 2 per cent as evident from the R^2 value mentioned in the above table. Therefore the contribution of soil texture, pH and rainfall appears to be very insignificant in explaining the dependent variables The value of R^2 is obsèrved to have gone up to 0.07 in the fifth step of the analysis where temperature has been taken as an added variable. Hence a net increase of 0.04 in R^2 is because of the additional variable temperature. Switching over to the 6th step of the analysis, it is noted that the explanatory power of all the variables has reached only 0.12, when the last variable air relative humidity was added. In the sixth step, there has been an increasing of 0.05 in R^2 i.e. 5 per cent. However it can be concluded that the variables appear to be inefficient in explaining the variations of productivity of HYV rice in lower Brahmaputra valley. Out of the above variables only few of them should be chosen for best fit in the model. Moreover these selected variables would give better explanation.

LAND TENURE, FARM SIZE, LAND USE AND PRODUCTIVITY

LAND TENURE

Before going into details of the farm size and the pattern of land use in the Lower Brahmaputra Valley it will be worthwhile to draw up the history of the land problems and the related tenurial systems in the Brahmaputra Valley in a nutshell. The tenurial systems of land in Assam[1] date back to the annexation of Assam by British in 1826 prior to which Assam was under Ahom dynasty[2] right from the third decade of the thirteenth century. In Assam because of a high pressure of population on land, several legislative measures in connection with the problems of land reforms have been enacted since 1947 so as to abolish the existence of intermediaries, to eliminate the fear of insecurity of tenancy, to consolidate the uneconomic fragmented holdings and to distribute the surplus land among the landless cultivators and the labourers and so on.

During the British period, Zamindari and Rayatwari were the two principal tenurial practices in

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1. For details of land systems and land reforms see N.C.Dutta,(1968), Land Problems and Land Reforms in Assam, Delhi, pp.10-35. See also, H.N.Banerjee,(1944) A Brief Survey of Assam Land Revenue System, Calcutta.

2. For detailed history of Assam see Edward Gait,(1926) History of Assam, Calcutta.

greater part of the Brahmaputra Valley. In addition to these, Lakhiraj and Nisf-khiraj were two common tenures in Assam. Prior to 1947, there were a few tenancy acts which were legislated for Goalpara (the Goalpara tenancy act, 1929) Sylhet (the Sylhet tenancy act, 1936) and Assam in general (the Assam tenancy act, 1935). The legislative measures taken since 1947 in Assam incorporate abolition of intermediaries, protection of share croppers, ceiling on holdings and consolidation of holdings. The Zamindari system in Assam came to an end after independence with the Assam State Aquisition of Zamindari Act,1951.[3] It was enacted to abolish the intermediaries from the state with a few relaxations. The relaxations include retaining of homesteads, buildings as residence, lands up to 400 bighas for the proprietors and 150 bighas for tenure holders and gardens and orchards. Compensatory provisions were also made for the intermediaries for the acquired states. The religious and charitable institutions were abolished by another act called the Assam State Acquisition of lands belonging to religious or charitable institutions of public nature act, 1959.[4] Necessary compensation was

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3. N.C.Dutta, op.cit., pp.36-52
4. Ibid., pp.114-118

also given under this act. In 1948, the interest of the share croppers was protected and regulated by the Assam Adhiars protection and regulation act[5], 1948. By this act, the share of the landlord was fixed subject to his contribution of plough cattle. In the light of above contribution, his share was to be one fourth. If he did not contribute plough cattle his share was fixed as one fifth.

From the sample survey undertaken by the author to study the diffusion and distributional patterns of High Yielding Varieties of rice among the farmers of the Lower Brahmaputra Valley, it is noticed that the aforesaid legislative measures concerning the land consolidation, the land ceiling and the protection of share croppers enacted since then, do not have much impact on Assam's countryside. A direct interview with the farmers reveals the fact that effective legislative measures should be enacted to consolidate the scattered pieces of agricultural land. It is because, the scattered plots of land are highly uneconomic and pose numerous related problems to go in for the adoption of new innovations and modern inputs like irrigation and tractors. According to the respondents in the sample villages of the study area, tiny fragments of land stand as impediments to

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5. N.C.Dutta, op.cit.,pp. 58-73

introduce improved practices in their land. The small and marginal farmers who posses less than a hectare of cultivated land are strongly feeling the paucity of land under their possession. They, on the other hand, suggest that the land ceiling measures be enacted effectively and the surplus land be distributed among the landless labourers and the farmers having less land for cultivation.

As many as 40 sample households have been taken into consideration to study the diffusion and distributional pattern of High Yielding varieties of rice cultivation within their existing socio-economic and cultural milieu. After having discussed the prevailing situation of land tenure in brief in the sample villages, the distributional pattern of land holdings by farm size and the pattern of land utilization among the farm households have been analysed. Finally, an attempt has been made to study the intercorrelations between the land use variables. The relationship between each of the land use variables and the productigity of rice both HYV and local varieties has also been highlighted in course of discussion.

Land Tenure Systems in the Sample Farms:

Since the sample farm households are pre-eminently agricultural, it will be noteworthy if the land holdings as per the tenurial status of the respondents are brought to light. The tenurial status of the sample farms can be broadly classified into the following categories:

i) Owner cultivator renting out or leasing out part of land.

ii) Owner cultivator cultivating all the land.

iii) Cultivator partly owning and partly getting leased in.

iv) Cultivator partly owning and partly share cropping.

v) Cultivator both getting leased in and share cropping.

vi) Cultivator both leasing out and share cropping.

In view of the aboge tenurial classification of the farm households, it is noticed that the cultivator partly leasing out the land are three out of forty or 7.5 percent and the leased out land varies between 0.203 hectare to 1.35 hectares respectively for ketakibari and together ketekibari and Balijana (Figs.13,14). All these cultivators have leased out partly their land on fixed kind rent which varies between 459.66 kg per hectare to 552.95 kg per hectare of rice for ketekibari and together for

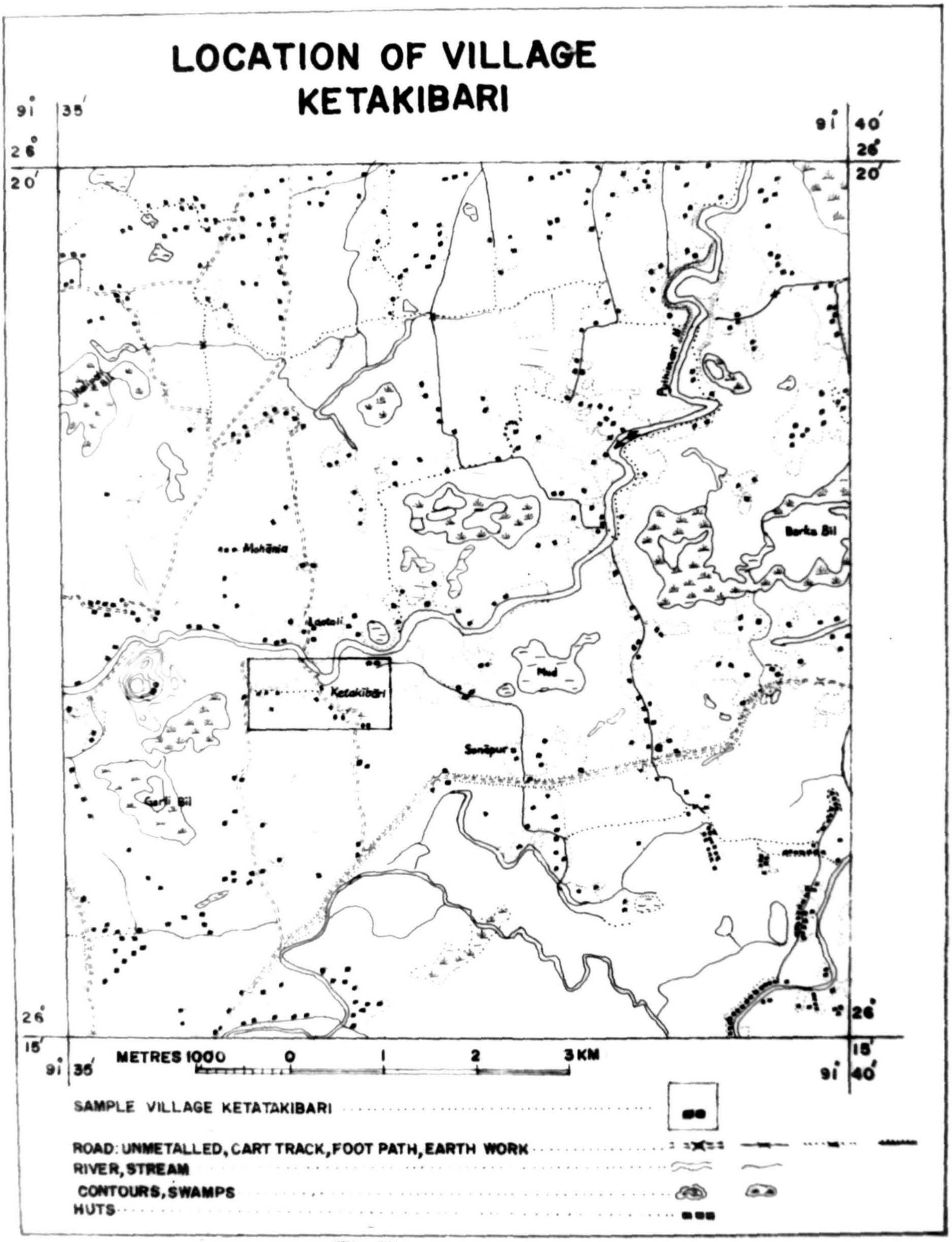
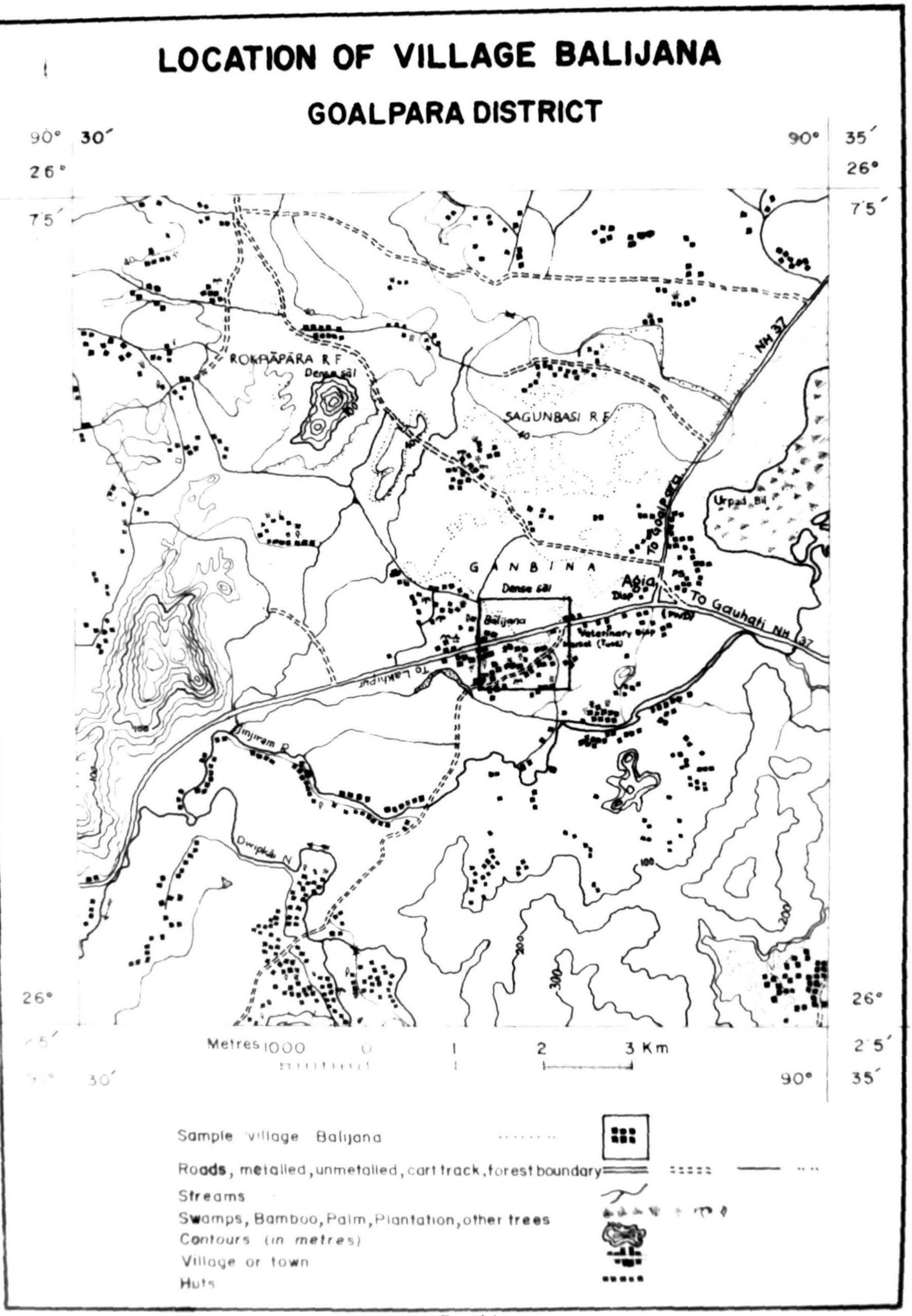

LOCATION OF VILLAGE
KETAKIBARI
Mohānia
Ketakibāri
Sonāpur
Garli Bil
Barka Bil
METRES 1000 0 1 2 3 KM
SAMPLE VILLAGE KETATAKIBARI
ROAD: UNMETALLED, CART TRACK, FOOT PATH, EARTH WORK
RIVER, STREAM
CONTOURS, SWAMPS
HUTS

Fig.13



LOCATION OF VILLAGE BALIJANA
GOALPARA DISTRICT
90° 30′
90° 35′
26°
7′5′
ROKHAPARA R F
Dense sal
SAGUNBASI R F
NH 37
To Goalpara
Urpad Bil
G A N B I N A
Agia
Dense sal
Balijana
To Gauhati NH 37
Veterinary Disp
To Lakhipur
Jinjiram R
Dwipka N
100
200
300
Metres 1000 0 1 2 3 Km
Sample village Balijana
Roads, metalled, unmetalled, cart track, forest boundary
Streams
Swamps, Bamboo, Palm, Plantation, other trees
Contours (in metres)
Village or town
Huts

Fig. 14

(Ketakibari, Ketakibari and Balijana) respectively. The total operational holding of these farmers ranges between as low as 2.03 hectares to as high as 3.38 hectares for Ketekibari and Balijana respectively.

So far as the second category of tenure for the present sample farm households is concerned, it is noticed that 50 percent or 20 out of 40 farmers are owner as well as cultivator of their land. The total operational holding of their land has a range of variation between 0.675 hectare to 6.48 hectares respectively for Jhagrapara and Khara both belonging to Goalpara district.

The third category of farmers i.e. cultivators partly owning and partly getting leased in are 6 or 15.0 percent of the sample whose leased in land ranges between 0.135 hectare to 0.81 hectare for the villages Shilapani and Balijana respectively. Their operational holding has a range of variation between as low as 1.147 hectares to as high as 4.793 hectares in case of two cultivating households of the village Shilapani of the south western part of the Goalpara district (Fig.15). These households have got part of their total operational holding leased in for a fixed cash rent which varies between Rs.1851.85 to Rs.5925.93 per hectare for the sample villages Balijana and Shilapani respectively

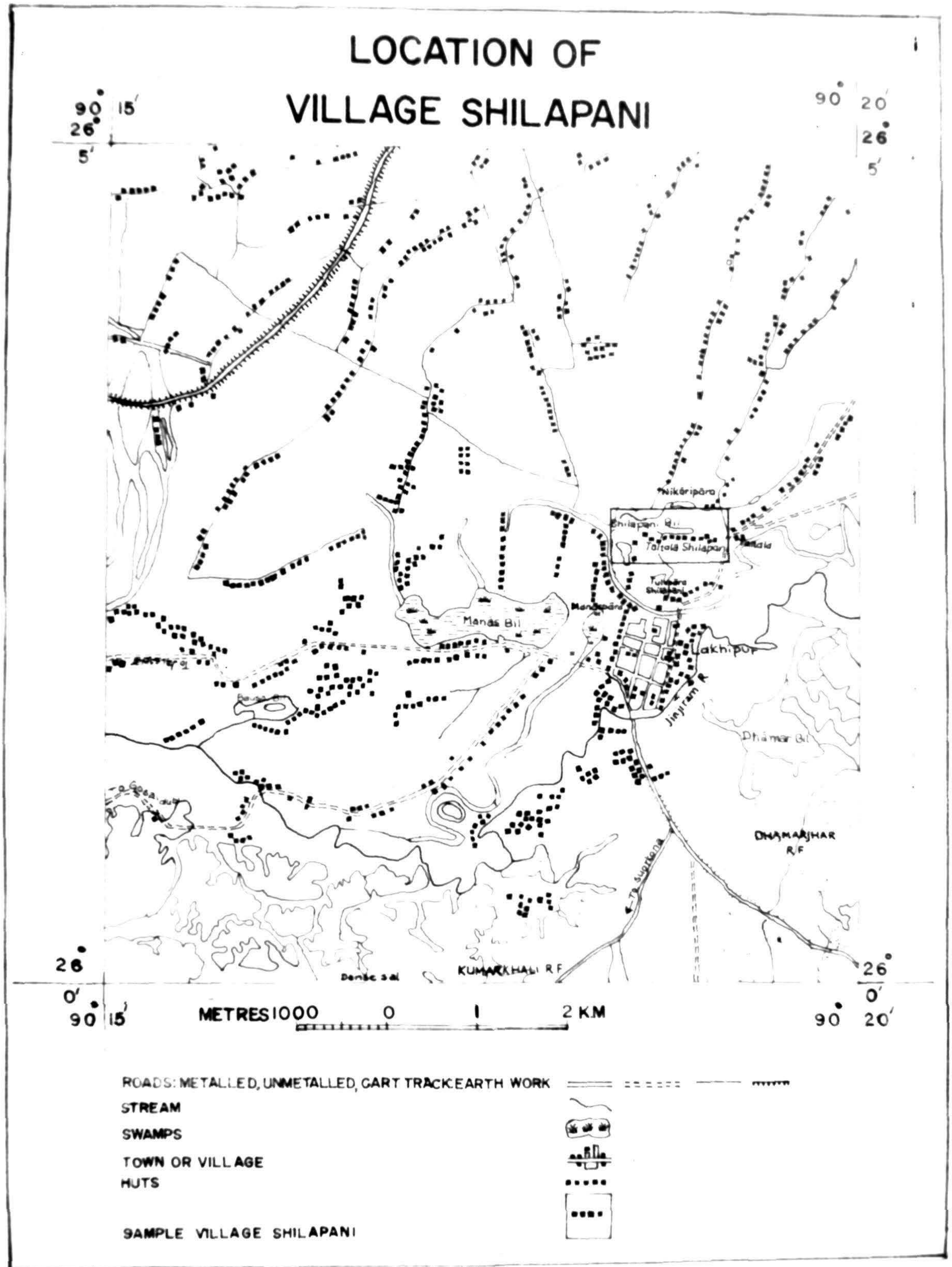

LOCATION OF
VILLAGE SHILAPANI
90° 15'
26°
5'
90° 20'
26°
5'
Nikeripara
Shilapani Bil
Tatola Shilapani
Manas Bil
Lakhipur
Jinjiram R.
Dhamar Bil
DHAMARJHAR
R/F
KUMARKHALI R.F.
26°
0'
90° 15'
26°
0'
90° 20'
METRES 1000
0
1
2 KM
ROADS: METALLED, UNMETALLED, CART TRACK, EARTH WORK
STREAM
SWAMPS
TOWN OR VILLAGE
HUTS
SAMPLE VILLAGE SHILAPANI

Fig 15

(Fig 14 and 15). Both these villages are from Goalpara district.

The fourth category of farmers in the sample who are partly owning and partly share cropping the owner's land are nine or 22.5 percent of the sample. The land for share cropping varies between 0.135 hectare to 0.945 hectare for Ketekibari and Balijana respectively. The total operational holding of these farmers has a variation range between 0.864 hectare to 4.922 hectares respectively for Ketakibari and Gog(Fig 13 and 16) all belonging to Kamrup district.

The fifth and sixth categories of farmers are one each who have both got leased in and share cropped and leased out and share cropped respectively. These households belong to Ketakibari and Khara of Kamrup and Goalpara districts respectively. The cultivator from village Khara who owns 4.658 hectares has got leased in 0.81 hectare and share crops 1.485 hectares simultaniously. He has total operational holding up to 6.953 hectares. The other from Ketakibari both share cropping (i.e. 0.338 ha.) and leasing out (i.e. 0.135 ha.) has a total operational holding only 1.418 ha. of cultivated land.

Table V.1 presents the respondents classified according to the tenurial status and type of family.

LOCATION OF VILLAGE GOG

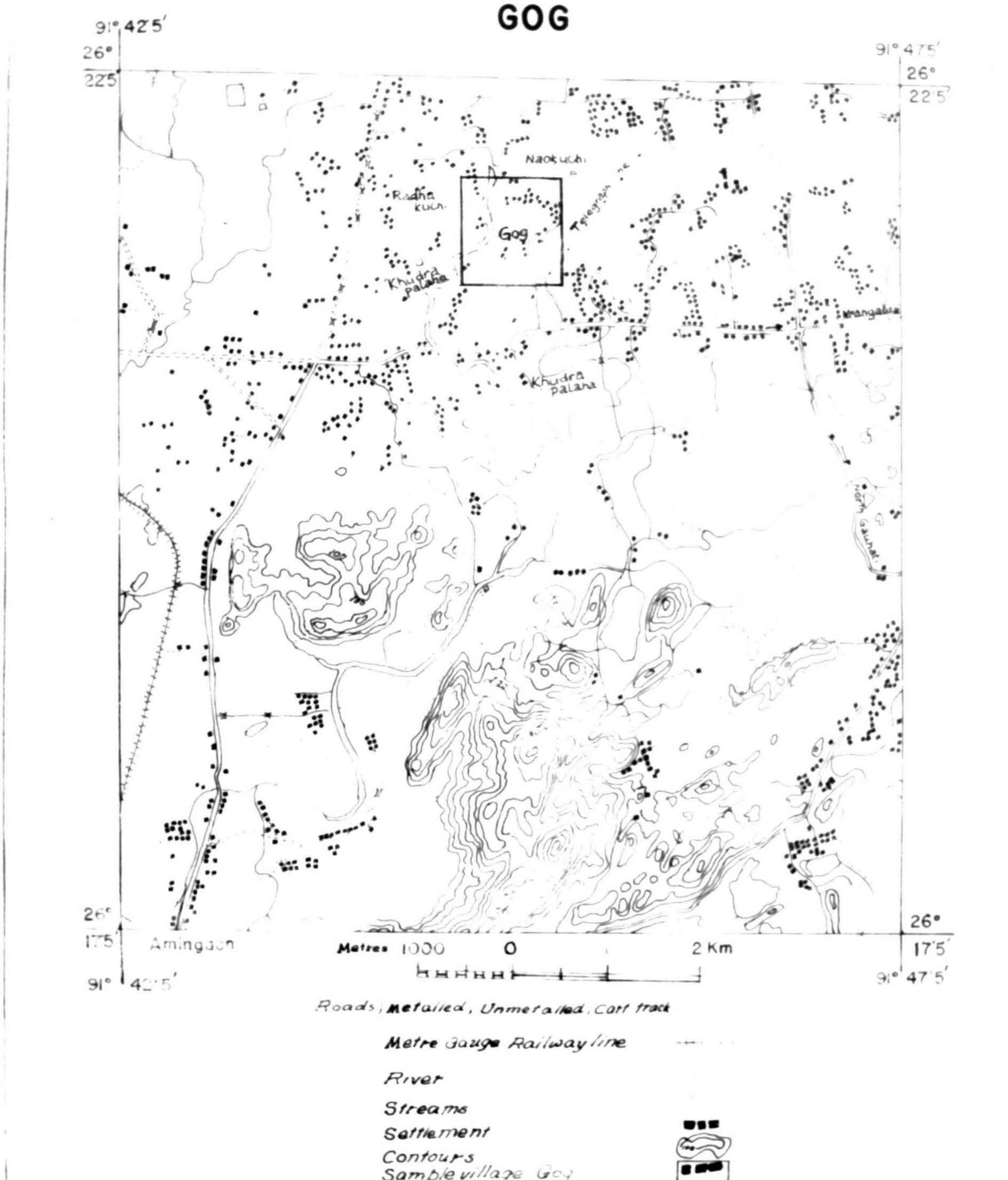


Fig. 16

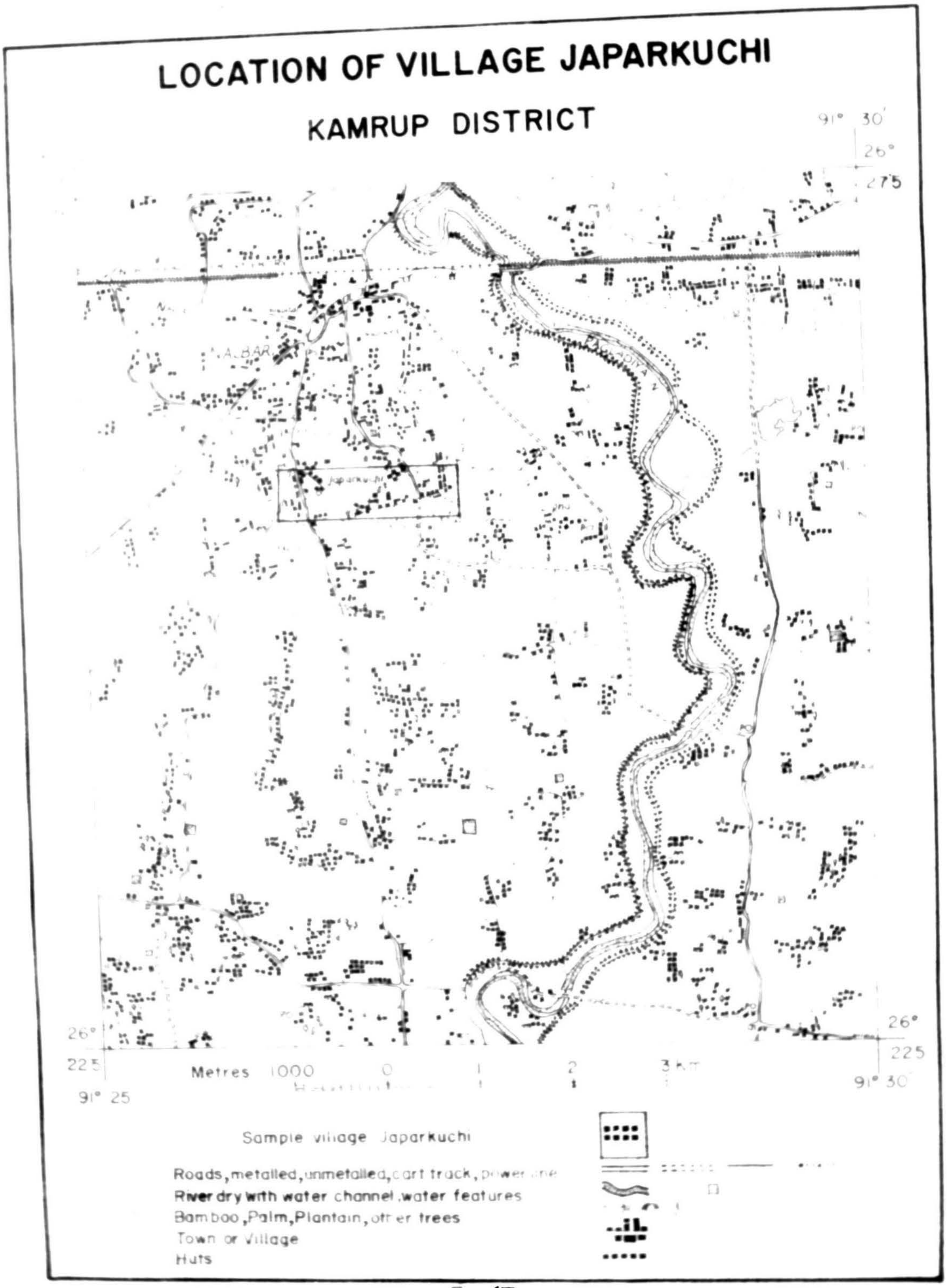

LOCATION OF VILLAGE JAPARKUCHI
KAMRUP DISTRICT
91° 30'
26°
275
Japarkuchi
26°
225
Metres 1000 0 1 2 3 km
91° 25
91° 30'
Sample village Japarkuchi
Roads, metalled, unmetalled, cart track, power line
River dry with water channel, water features
Bamboo, Palm, Plantain, other trees
Town or Village
Huts

Fig. 17

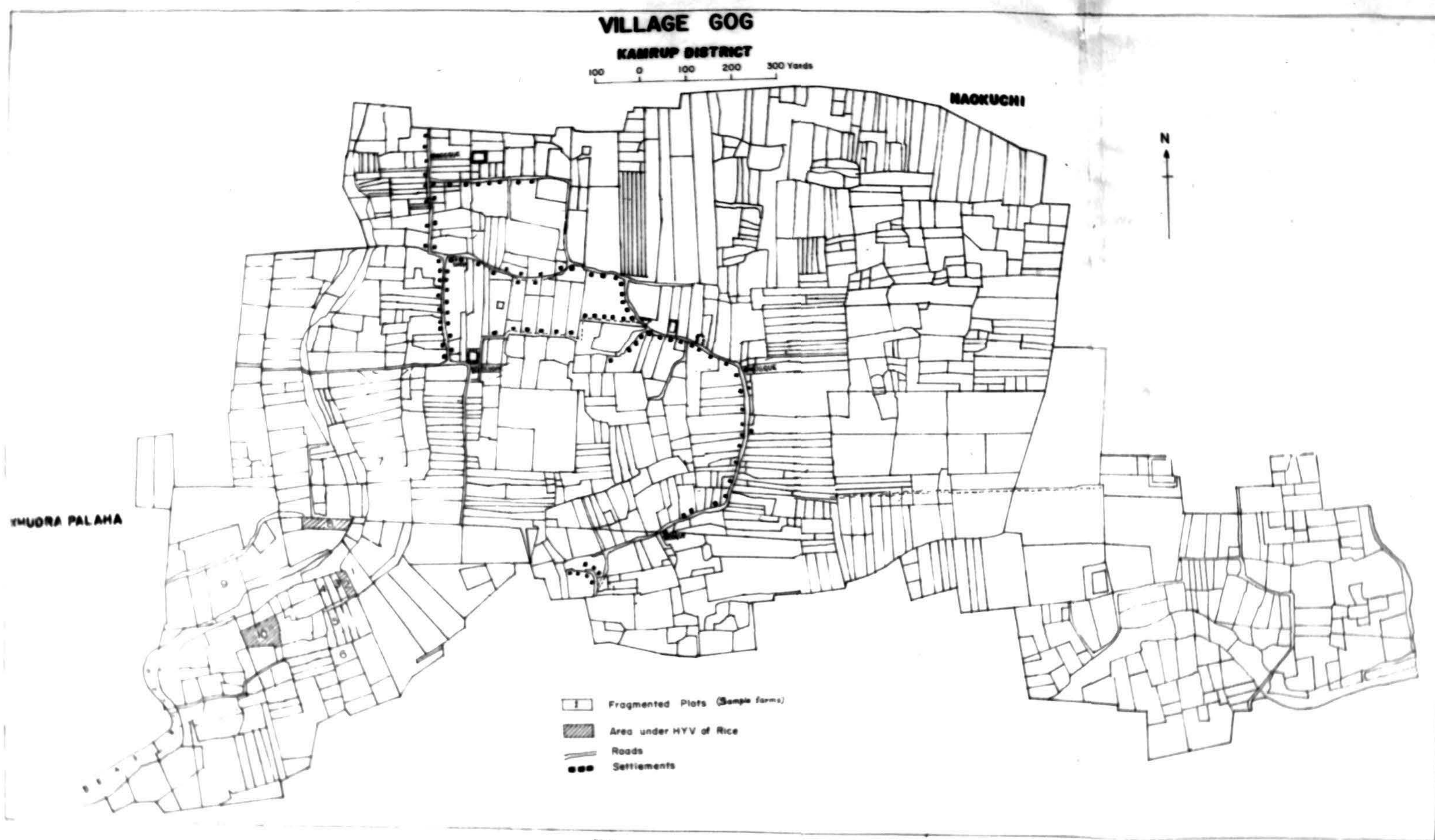

VILLAGE GOG
KAMRUP DISTRICT
100 0 100 200 300 Yards
NAOKUCHI
N
HUDRA PALAHA
Fragmented Plots (Sample farms)
Area under HYV of Rice
Roads
Settlements

Fig.18

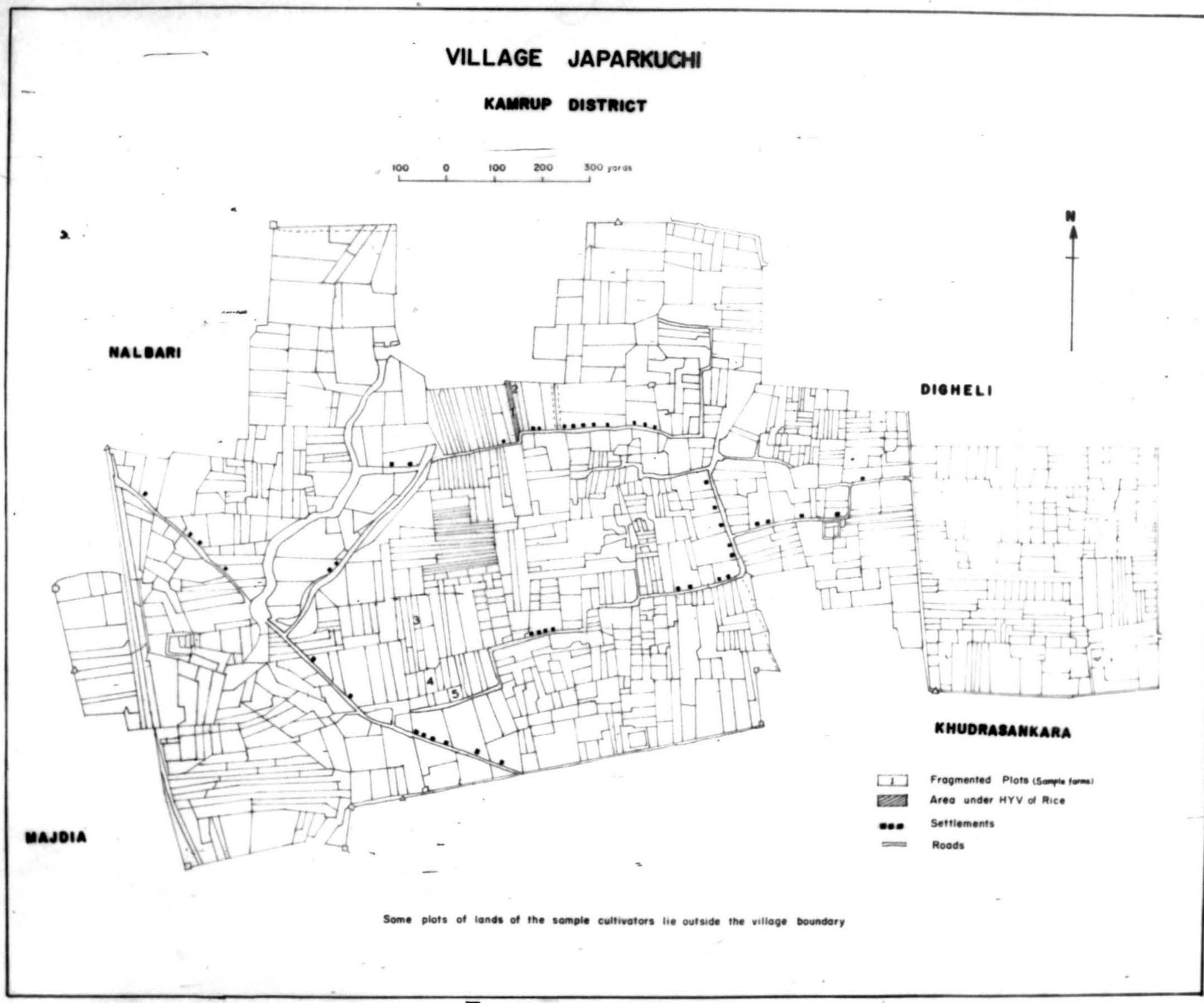

VILLAGE JAPARKUCHI
KAMRUP DISTRICT
100 0 100 200 300 yards
N
NALBARI
DIGHELI
KHUDRASANKARA
MAJDIA
Fragmented Plots (Sample farms)
Area under HYV of Rice
Settlements
Roads
Some plots of lands of the sample cultivators lie outside the village boundary

Fig.19

TABLE -V.1

Respondents classified according to the tenurial status and type of family.

Categories of tenurial status	Family type		Total
	Joint	Nuclear	
i) Owner cultivator renting out or leasing out part of land.	1	2	3
ii) Owner cultivator cultivator cultivating all the land.	1	19	20
iii) Cultivator partly owning and partly getting leased in.	-	6	6
iv) Cultivator partly owning and partly share cropping.	2	7	9
v) Cultivator both getting leased in and share cropping.	-	1	1
vi) Cultivator both leasing out and share cropping.	-	1	1
Total	4	36	40

Source: Calculated by author

It will be seen from the above table that 90 percent or 36 farmers belonging to different tenurial status have nuclear families and the rest 10 percent have joint families.

FARM SIZE.

The sample survey conducted during the field work projects some of the most interesting agrarian features in the Lower Brahmaputra Valley for, it has formed through ages spectacular traditional and social values. The size of land holding, the productivity of agricultural land and the pattern of land utilization have been basically conditioned by a variety of socio-economic and cultural factors especially the tenant-owner relationships. The present analysis highlights the stratification of the farm households adopting High Yielding Varieties of rice, as per their cultivable land holding and the basis of such stratification.

Before focussing attention on the stratification of the farm households it will be a meaningful attempt to have a comparative study between the distribution of area under High Yielding Varieties of rice and that of the local traditional varieties. This will lead to formulate the hypotheses as to whether the farm size i.e. the net operational holding is the constraint to the adoption of HYV practice or the farmers are inclined towards the cultivation of local traditional varieties of crops because of less risk and the better environmental adaptability of these crops. Such hypotheses will help in explaining the fact that whether the benefits accruing from the introduction of new agricultural innovations like HYV crops have gone to the large farmers thereby widening the disparity between the small and large farmers. The entire study basically being an evaluative one, also aims at finding out the extent to which the introduction of High Yielding varieties of rice along with the complementary farm inputs in this study area has been actually adopted by the different categories of farmers and with what results. The study further enquires to specify, locate and identify the causes of its non-adoption. The above issues have been explored in the subsequent chapters.

It is clear from the data and information gathered during the sample survey of the farm households that out of the entire sample consisting of 80 households 50 percent are yet to adopt new innovation such as the HYV of rice. The remaining half though, have adopted it, nevertheless it will not be correct to classify them as the real adopters for, their adoption seems to be in an experimental level. The area devoted to HYV of rice varies between as low as 0.068 hectare to as high as 2.025 hectares for two different villages of the extreme tips of the Lower Brahmaputra Valley. Excepting a handful of farmers who have been practising this new innovation with adequate instructional guidelines, all others can be put under the nomenclature as imitators or followers.

A glance at the Table-V·2 entitled "Distribution of area under HYV or rice" exposes typical characteristics of the land size of HYV rice which on the other hand reflects the attitude, motive and psychology of the farmers towards these crops. And the causes of such discouraged feeling towards HYV rice culture in lower Assam Valley need thorough investigation.

TABLE V.2

Frequency Distribution of Area under HYV rice.

Categories of Aria (in ha.)	Frequency	Degree	Percent to total adopters.
Less than 0.1	2	Very low	5
0.1 - 0.50	25	low	62.5
0.50 - 1.00	9	Medium	22.5
1.00 - 1.50	3	High medium	7.5
1.50 - 2.00	-	High	-
2.00 and above	1	Very High	2.5
	40		100.00

Source: Same as Table-V-1

It will be seen from the above Table that an overwhelming majority of the entire sample of farm households which on the contrary, constitute 90 percent of the sample and have put less than 1 hectare of cultivable land under HYV rice irrespective of their net area under cultivation. Amongst the 40 adopters of HYV rice culture 36 fall within the garb of the above situation. There are only 4 farmers or 10 percent of the entire sample to whom we can say as progressive whose area under HYV rice exceeds 1 hectare. It is interesting to note that out of the total sample households there is only one farmer from Ketakibari, infrastructurally a progressive village(Fig.20) who devoted 2.025 hectares of his arable land to the HYV of rice. The average area under HYV of rice comes out to be 0.464 hectare with a standard deviation of 0.416 which shows a coefficient of variation i.e 89.66 percent. Meaning thereby the distribution of area under HYV rice among the farm households seems more inconsistent ascompared to total rice.

The above picture, which emerges out of the distributional pattern of area under HYV rice among the innovators and imitators will be more factual and meaningful if the householdwise net area under cultivation i.e. the total operational holding is analysed in the light of the area put to HYV rice. This will in turn, explain whether farm size is the only limiting factor for the introduction of HYV of rice, and hence goes in favour of the large farmers who can take risk.

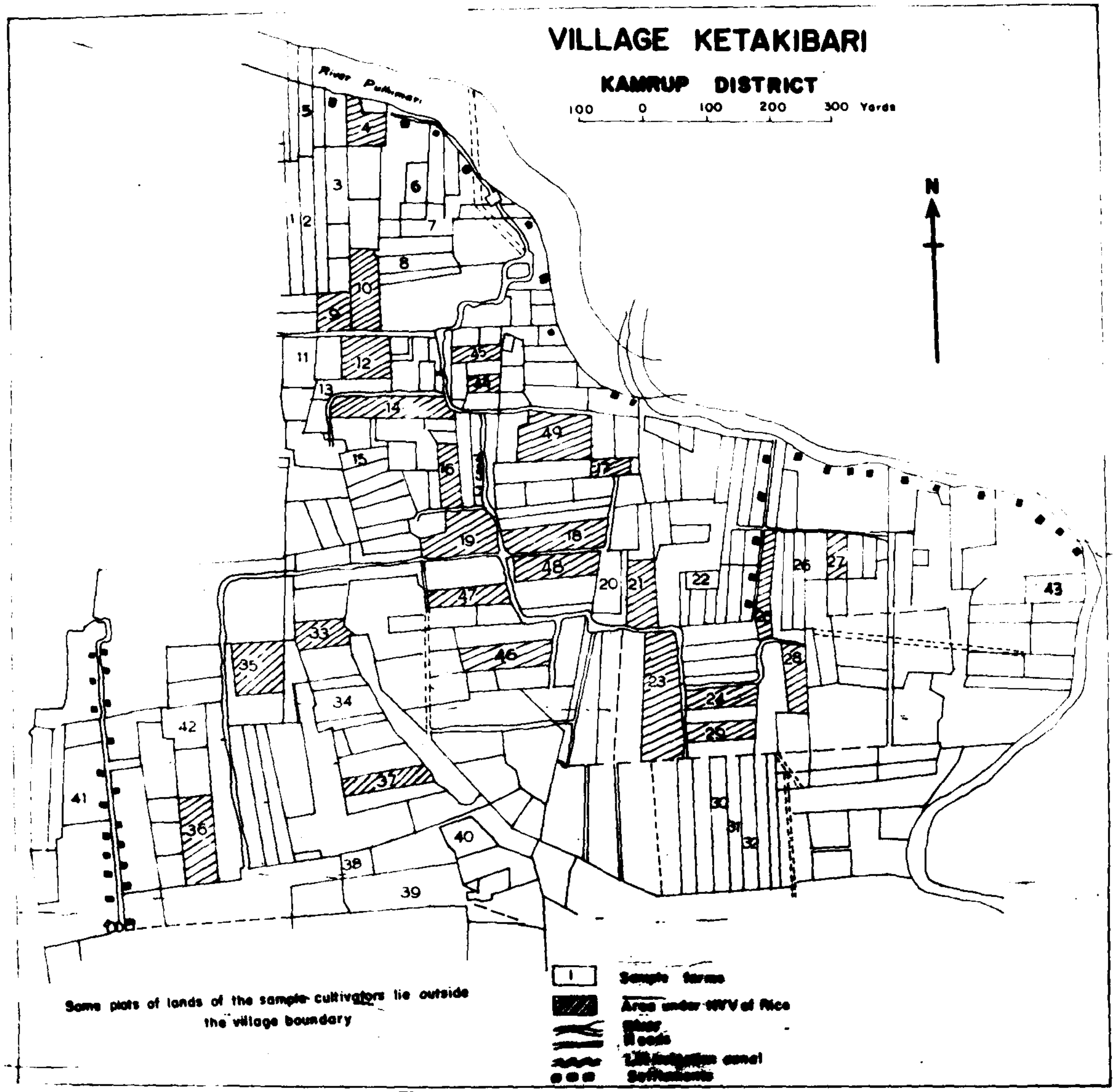

VILLAGE KETAKIBARI
KAMRUP DISTRICT
100 0 100 200 300 Yards
N
River Pulumari
Some plots of lands of the sample cultivators lie outside the village boundary
Sample farms
Area under HYV of Rice

Fig.20

Because there are chances of the crop failure due to unpredictable circumstances.

Table-V.2 exhibits that the maximum number of farmers (i.e.25 out of the 40 constituting of 62.5 percent) have between 0.1 to 0.5 hectares of land devoted to High Yielding Varieties of rice and are in the category of low degree of cultivation of High Yielding Varieties. But it may so happen that although these farmers devote low percentage of area under cultivation because they want to avert risk, but their land holding might be much more higher than that of the remaining farmers. Only two farm-households coming within the very low category of area under HYV have devoted land under this crop which is even less than 0.1 hectare. In the category of 1.5 to 2.00 hectares of land under the HYV of rice, there is however, not even a single household in the sample.

As far as the distribution of area under local traditional varieties of rice such as Ahu and Sali are concerned, the following picture emerges. The figures presented in Table-V.3 show the frequency distribution of area under local traditional varieties.

TABLE - V.3

Frequency distribution of area under local traditional varieties of rice.

Size groups (in ha.)	Frequency	Degree	Cummulative frequency.	Percentage	Cummulative percentage.
Less than 1	2	Very low	2	5	5
1 - 3.35	23	Low	25	57.5	62.5
3.35- 4.70	7	Medium	32	17.5	80.0
4.70- 6.05	5	High medium	37	12.5	92.5
6.05- 7.40	2	High	39	5	97.5
7.40 and above	1	Very High	40	2.5	100.0

Source: Same as Table V-1

As compared to the distribution of area under High Yielding Varieties of rice, the area devoted to local traditional varieties varies between 0.945 hectare to 7.695 hectares of arable land as the lowest and highest for the villages Ketekibari and Khara respectively. It will be seen from the Table -V.3 that the area devoted to local rice for a majority of households(i.e. 23 out of 40 or 57.5 percent) comes within the size group of 1.to 3.5 hectares and hence can be put under low category of cultivation of local rice. There are only two households (i.e.5 percent of the sample) whose area under local Ahu and Sali rice is less than a hectare of cultivated land.

One household has however, devoted land under local rice exceeding 7.4 hectares as the very high size.

It is clear from the distribution pattern of local rice that a substantial percentage of households(i.e. 62.5 percent) or 27 out of 40 sample households come within the low category of area under local rice. The area varies between less than 1.00 to 3.35 hectares. The medium categories of households comprising of 30 percent of the entire sample have a size group which varies between 3.35 to 6.05 hectares. Only 7.5 percent of sample farms have area under local traditional varities varying between 6.05 to 7.4 hectares and above in the size categories. The average area under local rice is 3.132 hectares with a standard deviation 1.65 and coefficient of variation 52.9 percent. The distribution seems to be inconsistent.

Farm Size Classification of Operational Holdings.

Switching over to the total cultivated farm size of the farm households adopting High Yielding Varieties of rice it is noticed that there is a significant variation between the operated land holding of small, marginal, medium and large farmers as evident from the classification of farmers in relation to their holding size. Table V.4 presents the distribution of holding size of the farm households.who have adopted the HYV of rice in their farms.

TABLE V.4

Frequency Distribution of Operational Holdings

Holding size (in ha.)	Frequency	Cummulative Frequency	Degree	Percentage	Cummulative percentage
Less than 1.00	3	3	Very low	7.5	7.5
1.00 - 2.25	14	17	Low	35.0	42.5
2.25 - 3.50	13	30	Medium	32.5	75.0
3.50 - 4.75	5	35	High medium	12.5	87.5
4.75 - 6.00	3	38	High	7.5	95.0
6.00 and above	2	40	Very high	5.0	100.0

Source: Same as Table-V.1

It will be seen from the above Table that there appears a positive skew distribution (Fig.23) of holding sizes among the farmers. The maximum number of households come within 1 to 2.25 hectares of cultivable land. The holding size varies between as low as 0.675 hectare to as high as 6.953 hectares for Jhagrapara and Khara respectively (Figs.21,22). The lowest number of farm households are noticed within the class group of 6 hectares and above and hence have maximum operational net area under cultivation. If the holding size is arranged in an ascending array and split up into 6 categories such as very low, low, medium, high medium, high and very high operational holding, then the respective percentage shares of distributions of households within each category are 7.5, 35.0, 32.5, 7.5 and 5.0 . The percentage of households within medium category of net operational holding is the highest (i.e. 45 percent) followed by low (i.e. 42.5 percent). Only 12.5 percent of the households fall within the high category of net arable land.

A pertinent question in view of the categorization of farmers as small, medium and large arises. The issue appears to be one of the most controversial and ambiguous characteristics of agrarian social scene. The question is, who are the farmers to be designated as small, medium and large respectively ? What criteria should be adopted to identify them as small, medium and large ? Are they to be stratified as regards their size of holding, or the cut-off line is to be drawn at the point to identify the small farmers where the gross farm income is just enough to meet the cost of cultivation and incur consumption expenditure comparable to the standard of living of an average rural household. Let us examine how a minimum farm business income of an average Indian farm family for a standard living can be a criterion to determine the holding size below which small and marginal farmers can be identified.

According to Khusro[6] on the income unit of land, the farm inputs are generally not purchased from the market

6. A.M. Khusro,(1973) Economics of Land Reform and Farm Size in India, Delhi, p.62.

in case of a large number of farm households but supplied by the farm family invariably. If the cost of these inputs are substracted from the crop output, then the net profits come out to be very insignificant or often negative. The inputs also include the rent of land, interest on fixed capital, and imputed value of family labour. "But since, for a large majority of cases, the return to family labour, the interest on fixed capital and the rent on land accrue to farmer himself, a meaningful concept of farm business income can be had by adding together the value of family labour, interest on fixed capital, rental value and net profits if any"[7].

In the light of the above discussion on the farm business income what should be the average farm size in order to have the minimum income for an Indian farm household ? With most of the family farm inputs, the income is supposed to be Rs1200/- per year "which according to the Planning Commission, a family holding ought to provide"[8]. Computing the Planning Commission's income unit for adequate farm business income empirically for Andhra Pradesh, West Bengal Punjab and Uttar Pradesh against 1954-55 data, Khusro is again of opinion that the average acreage necessary for securing that income with current techniques etc., would seem to be about 15, though this

7. A.M.Khusro, op.cit., p.62

8. Ibid.,p.64.

figure varies between 10 to 20 for Uttar Pradesh and Andhra Pradesh together and Punjab respectively.[9] The reason for such a big variation for Punjab(i.e. 20 acres to have Rs.1200/- as farm business income) is attributed to under estimation in the report.

The above average figure might serve the purpose of statistics but to be programatic, a cut-off line below which the farmers should be called small farmers will always vary in a spatial dimension as it varies in case of Uttar Pradesh, Punjab, Andhra Pradesh and West Bengal to achieve a fixed income.

According to the field study report of the Reserve Bank of India the family holding can be defined"as a holding that would yield adequate income to maintain an average farm family at the nutritionally desirable level of living. Cultivators with a holding less than such a size may be considered to be the small farmers. This method of stratification is liable to be criticised since the determination of the size of family holding itself may call for a detailed enquiry."[10]

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9. A.M.Khusro, op.cit.,p.67

10. The Small Farmers(1967-69) A Field Study,Reserve Bank of India, Bombay, 1977 pp.3-6.

Such queries encompass the type of farming, the size of farm business, cropping pattern, irrigation facilities, use of inputs, fertility status of land, economic status of the farm households, climatic conditions and a host of others.

On the other hand, the concept of an economic holding has been defined and used by the Congress Agrarian Reforms Committee[11], 1951. But it has been spelled out in detail by the Hyderabad Agrarian Reforms Committee, 1949 which says that an economic holding in a normal year may give a cultivator a surplus, after having met all the necessary expenses, just enough for a good standard of living for the family with a minimum comfort as per the Indian standard and without being obliged to debts.[12] In later stage, the nomenclature of an economic holding has been replaced by "family holding" by the Planning Commission which according to local conditions and the existing conditions of technique decided a net income from agriculture for a family of average size to be Rs.1200/- per annum.[13] Now the question arises, should we call the farmers as small having a holding size which is just below the

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11. A.M.Khusro,op.cit., p.41

12. Ibid., P.41

    See also for a detailed discussion (a) Report of the Congress Agrarian Reforms Committee,AICC(1951) p.8. (b) Report of the Hyderabad Agrarian Reforms Committee (1949).

13. A.M. Khusro, op.cit.,p.41

size for earning the above yearly income according to the Planning Commission. The answer is obviously negative, since this size will differ from place to place to achieve this income. So a small farmer at one place may be called as the large at the other.

Even an intermediate holding called the basic holding[14] has been invented by the Agrarian Reforms Committee which is below the size of an economic holding and does not provide a reasonable standard of living to the cultivator. The farmers having a basic holding or even below this would need a subsidy or rehabilitation treatment. Therefore, the basic holding and the holding size below it may also be called as the holdings to identify the small and marginal farmers. These sizes will also vary spatially as per the socio-economic and physical conditions.

In the light of the above comments on the economic holding, family holding or basic holding, which fulfill only some not all the forms such as work unit, plough unit or income unit,[15] one can say that in India no serious attempt has been made to define those limits of holding size in different soil-crop complexes, other than

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14. See for detailed discussion, A.M.Khusro, op.cit.p.42 on basic holding.

15. See for detailed discussion, Ibid.pp.44-62 on economic holding, family holding and basic holding.

a few exceptional cases. Hence it is wise to adopt acreage as the satisfactory measure of farm size to identify marginal, small, medium and large farmers in different places as per the local factors.

Khusro while discussing on the relationship between input and output, farm size and farm efficiency, is of opinion that "farm size can be defined either in terms of a single input, say acreage, or in terms of output; and farm efficiency either in terms of output per unit of a single input, acreage, or as output per unit of cost of all inputs"[16]. There are many advantages and disadvantages of the above sets of definitions. Khusro[17] is again of opinion that the merit of acreage as farm size is that it can be seen by everyone and thus cannot be concealed. On the contrary, it constitutes of both good and bad, dry and wet. Hence a standardisation method is imperative which on the other hand has to be arbitrary.

Output, on the other hand, is no doubt a more general measure of size than acreage and hence there is great temptation to use it[18]. This seems to be an unsatisfactory measure since it takes into account the high and low income yielding crops without their differential

16. A.M.Khusro, op.cit. p.105
17. Ibid., p.106
18. Ibid., p.106

values.[19] There are so many other difficulties involved in this measure such as price fluctuations etc. Thus, incomparability between farms increases if size were to be measured in terms of value of output.[20] There is thus,no single satisfactory measure of farm size[21] at least to identify small, medium and large farmers according to their holding sizes.

In a country like India which is highly characterised by its socio-economic and physical diversity, small, medium and large farmers cannot be identified in terms of fixed and constant acreages everywhere. In a particular socio-economic and environmental set up, the farmers should be stratified heirarchically in terms of acreage. So, acreage should be a standard measure of farm size. A certain farm size constituting of a certain acreages at one place to identify a group of farmers (as for instance small, medium and large) may not be necessarily same at the other. On the other way round, a standard farm size at one place may be equivalent to a few times more or a few times less than that of its

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19. A.M. Khusro, op.cit., p.106
20. Ibid.,p.106
21. Ibid., p.107

standard counter part at the other if the physioo-socio-economic considerations[22] are taken into account. A large farmer having a substantial acreage of land may be considered as a small farmer because the land productivity is too low to cater to the need of the farm household and the vice-versa. The gross farm income at the prevailing market price as a basis for determining the limit of farm size in order to identify the small farmers can also be ruled out because it makes the size distribution of farm holdings such non-uniform that it becomes difficult even to find out a standard unit for stratification. As for instance all the cultivators at one place may be considered as small farmers irrespective of their holding size.

The Reserve Bank of India's field study on small farmer is thus liable to be criticised since they have in the long run, resolved to adopt the gross farm income[23] or the value of gross produce as the basis of classification of farmers.

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22. The field study report of the Reserve Bank of India (op.cit.p.6) shows that ". . . Comparability between villages (developed/undeveloped) and districts is vitiated by the fact that a small farmer in a developed village may correspond to a medium or large in an underdeveloped village."

23. According to the field study report(ibid.p.6) "Once it is decided to accept gross farm income as the most appropriate measure of size of farms for the stratification of farmers, the question arises as to where the

In the light of the above arguments which pinpoint the socio-economic and physical complexities as the constraints to a distinct and unambiguous economic stratification of the farmers, the arbitrary method on the basis of net operational holding be accepted as reasonable because it is not bound to any scale and thus scale free. Another alternative to it to maintain uniformity in different strata is that the farm holdings may be arranged in ascending or discending order. Having arranged the holdings, the median, first and third quartile may be determined to divide the array into just four equal parts to identify marginal, small, medium and large farmers.

It may be recalled here that the holding size includes only land under plough[24] other than the current fallow irrespective of whether it is leased in, share-cropped or owned.

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cut-off line should be drawn to identify the small farmers. The line was drawn at the point where the gross farm income was at the most sufficient to enable the farmer to meet his cost of cultivation and incur consumption expenditure comparable to the standard of living of an average rural household . . ."

24. Biplab Dasgupta,(1977), The New Agrarian Technology and India, Calcutta, p.301 The author shows that the basis of identifying a small farmer in the Kollegal taluk of Mysore was the land under cultivation or plough but not land under ownership.

As far as the above methods are concerned the cut-off point will vary from place to place according to the operated holding. It further implies that however unproductive a land is, if taken care of physically and economically, will yield better production. Hence,holding size is independent of itself. It does not depend on production. The total or gross production may however, depend on holding size. In the present case to stratify the sample farm households into small, medium and large, the arbitrary method has been adopted and its application been tested through empirical findings. Presuming the area under study as a homogenious physiographic unit where the physical parameters do not vary much , the arbitrary method of stratifying the farmers heirarchically as small, medium and large would be the most suitable method rather than adopting the gross farm income in terms of output as the basis of their stratification.

The households adopting HYV cultivation of rice have been examined in terms of their farm size, so as to understand which broader categories they are generally considered in. Table V.5 presents the classification of the farm households in broad categories.of holding size.

TABLE V.5

Classification of sample households by holding size

Holding size(in ha.)	Category	Frequency	Cummulative Frequency	Percentage	Cummulative percentage.
Less than 1.00	Marginal	3	3	7.5	7.5
1.00 - 2.25	Small	14	17	35.0	42.5
2.25 - 4.75	Medium	18	35	45.0	87.5
4.75 and above	Large	5	40	12.5	100.0

Source: Same as Table-V.1

It will be seen from the above table that out of the 40 farm households adopting HYV practice, majority households i.e. 18 or 45 percent of the entire sample do fall within the medium category and hence can be designated as medium farmers. The holding size of these farmers varies between as low as 2.25 to as high as 4.75 hectares of arable land. Marginal farmers have been defined as those who own or occupy or have got leased in or do share-cropping less than a hectare of cultivable land in the socio-economic setting of the rural Lower Assam. The small farmers come in the next rung of the ladder to marginal in the heirarchy and form substantial part of the whole i.e. 35.0 percent. The small and marginal farmers in the sample together account for 42.5 percent of the entire sample. As a matter of fact, the medium farmers form the largest single group (i.e. 45 percent of the sample) comprising 18 out of 40 households followed by the small i.e. 35 percent. The marginal farmers account for 7.5 percent of the sample or 3 out of 40 households. A substantially low percentage of farm households in the sample (i.e. 5 out of 40 or 12.5 percent) who have introduced HYV rice in their farms do come within the large category. Their farm size exceeds 4.75 hectares of cultivable land.

In view of the above analysis it can be concluded that small and medium[25] farmers dominate in the study area accounting for 80 percent of the sample. According to the analysis it can also be said that a higher proportion of net operational holding is concentrated within the marginal, small and medium farmers. The relative concentration will however be analysed in chapter VII.

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25. A report on the High Yielding Varieties Programme in India, ICAR, New Delhi(1979-80) shows that medium farmers dominate in the rural areas in Assam.

LAND USE

It will not perhaps be exaggerated if the Brahmaputra Valley of Assam is called the "rice bowl" of the North-Eastern India where rice is predominantly grown and put under cultivation in component areal units invariably exceeding 60 percent of the gross cropped area. Besides, the introduction of High Yielding Varieties of rice in the valley has brought about a change in the crop-cycle by raising the cropping intensity to a new high. In an area of monoculture of rice, it will be note worthy to throw light on the land use pattern, so as to understand how the new exotic and short duration varieties of rice have helped the farmers to go in for more than two crops a year. For the purpose 40 sample farm households have been chosen at random from 8 different villages of the Lower part of the Brahmaputra Valley.

Gross Cropped Area

Gross Cropped area is an indicator of cropping intensity of an area. Gross cropped area increases with a corresponding increase in the area sown more than once. Switching over to an analysis of a statistical frequency distribution of the gross cropped area of the farm households adopting the cultivation of the High Yielding Varieties of rice, it is interesting to note that the minimum and the maximum gross areas vary between 1.283 and 9.315 hectares for the sample farmers from the villages Jhagarapara and Khara respectively. These villages are located (Figs.21,22) in the western part of the study area. The following Table depicts the frequency distribution of gross cropped area among the sample farm households.

TABLE V.6

Frequency Distribution of Gross cropped Area

Size Categories (in ha.)	Frequency of househods	Extent of gross area	Cummulative frequency	Percentage	Cummulative percentage.
Less than 2.5	6	Very less	6	15	15.0
2.5 - 4.0	11	Less	17	27.5	42.5
4.0 - 5.5	11	Medium	28	27.5	70.0
5.5 - 7.0	6	High medium	34	15.0	85.0
7.0 - 8.5	4	High	38	10.0	95.0
8.5 and above	2	Very high	40	5.0	100.0

Source: Same as Table-V.1

It will be seen from the above Table that the frequencies of farm households show a sharp increase from 6 to 11 with the corresponding increase in the size class of gross cropped area and thereafter the frequencies start falling gently downward with the parallel increase in the size classes. However, the distribution when plotted on

LOCATION OF SAMPLE VILLAGES KHERAJ DAOBHANGI AND JHAGARAPARA

GOALPARA DISTRICT

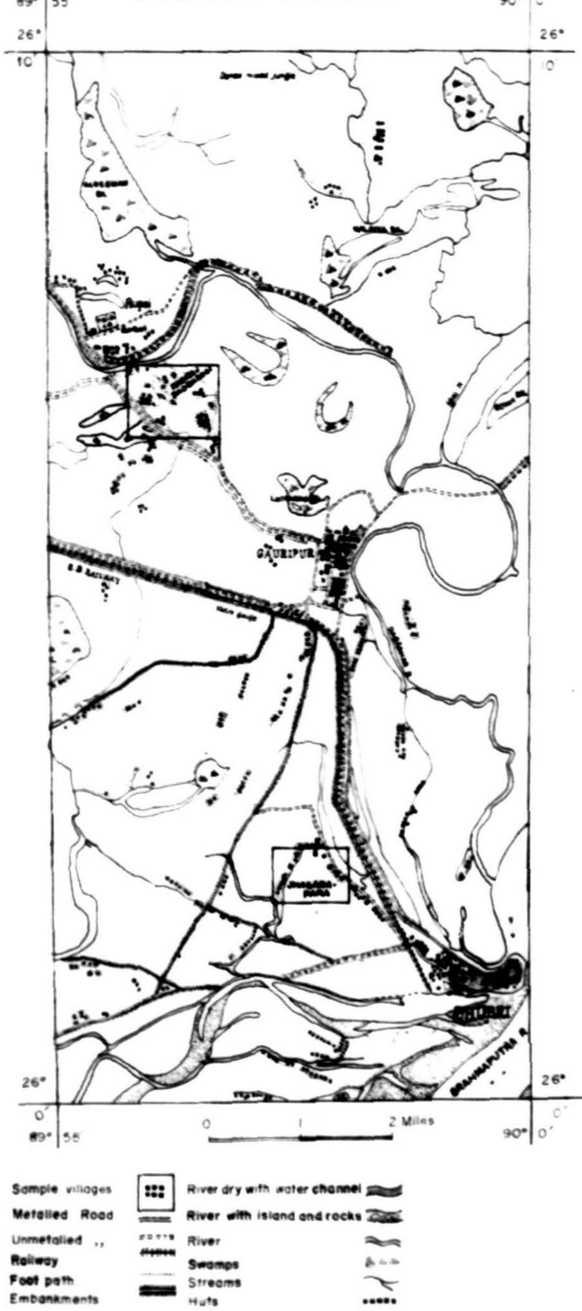

Fig 21

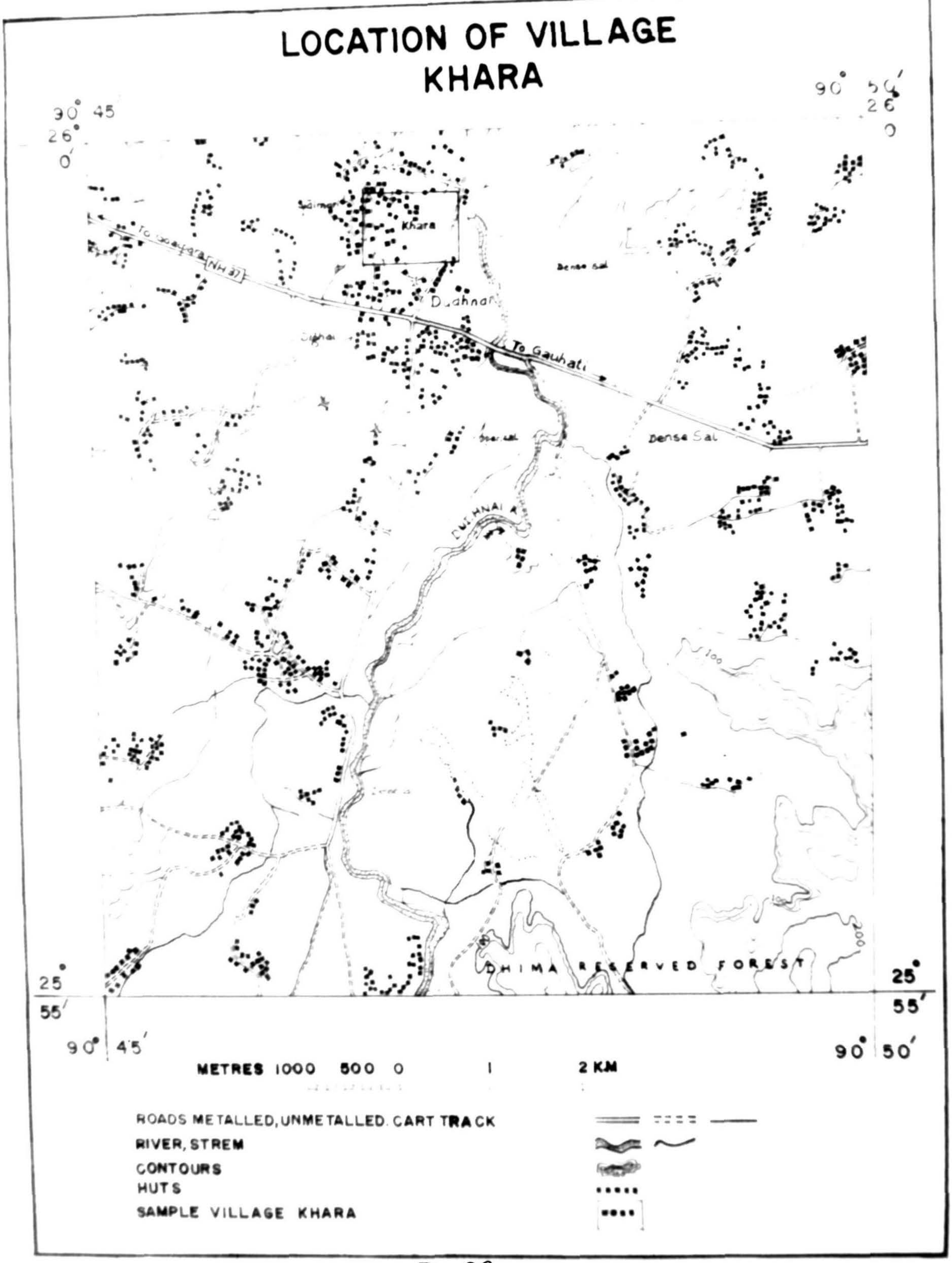
LOCATION OF VILLAGE
KHARA
90° 45′
26° 0′
90° 50′
26° 0′
Khara
To Goalpara
NH 37
Dense Sal
To Gauhati
DUDHNAI R.
DHIMA RESERVED FOREST
100
200
25° 55′
90° 45′
25° 55′
90° 50′
METRES 1000 500 0 1 2 KM
ROADS METALLED, UNMETALLED, CART TRACK
RIVER, STREM
CONTOURS
HUTS
SAMPLE VILLAGE KHARA

Fig. 22

a two dimensional graph presents on almost symmetrical picture. The modal class groups of the gross cropped area i.e. between 2.5 to 4.0 and 4.0 to 5.5 hectares of cultivated land have the highest number of farm households (i.e. 11 and 11 each) constituting together 55 percent of the entire spectrum of sample adopting High Yielding Varieties of rice culture. The highest size group of the gross area sown has the lowest number of households i.e. 2 which account for only 5 percent. Next to the modal groups having the maximum frequencies are 5.5 to 7.0 and less than 2.5 hectares categories which account for 6 households or 15 percent each.

It will also be seen from Table V.4 that the intensive nature of cultivation of land is well manifested as the size category of the gross cropped area increases with the decrease in the frequency of households. If the categories in Table V.6 are framed according to the gross area put to cultivation, as very less intensive, less intensive, medium intensive, high medium intensive, high intensive and very high intensive, then the first four categories showing less and medium intensive cultivation will account for a substantial percentage share of households (i.e. 85.00 percent of the sample). Similarly the high intensive group will account for only 15 percent. The intensive nature of cultivation can be well conceived from the inter-correlation between the net area sown, area sown more than once and the gross cropped area. This will be discussed in the later part of the present chapter. What emerges from the above analysis is, the less and medium or moderately intensive nature of cultivationamong the farmers of the Lower Brahmaputra Valley which consist of 85 percent of the entire sample households adopting HYV rice cultivation. There are very few households i.e. only 6 or 15 percent which cultivate their land intensively. However, 2 households have put their land to intensive use whose gross cropped area exceeds 8.5 hectares or 11.93 percent of the net cropped area. These farm households belong to the village, Khara of Dudhnoi block of Goalpara district and are plain tribes called Bodo Kachari. So as to have a broad understanding about the nature of cultivation, it can be infered that the land is very less intensively cultivated. Because 42.50 percent of households come within the category of gross cropped area which varies between less than 2.5 to 4.0 hectares of arable land. They seem to have cultivated their land less intensively. The next lot of farmers (42.50 percent) belong to the category varying between 4.0 to 7.0 hectares of gross cropped area. They are said to have cultivated their land medium or moderate intensively. The third lot of farmers (i.e. 15 percent) seem to be practising relatively higher intensive cultivation whose gross area sown exceeds 7.0 hectares of arable land. The above discussion throws light on the intensity of land use as evident from the gross area put to cultivation. The picture which however be more distinct when the intensity of cropping is discussed in the later part of this chapter.

In order to understand the consistency in the distribution of the gross cropped area, it will be worthwhile to analyse the different statistical measures of central tendencies of the data under review. The average gross cropped area in the sample households comes out to be 4.593 hectares of the cultivated land. The standard deviation of the gross area sown amongst the sample households is 2.026 . From the above measures, the consistency of the distribution of the gross area sown can be best explained with the help of the coefficient of variation in terms of percentage which on the other hand, is a measure of relative disprsion of the distribution of data in relation to its central value. The coefficient of variation in this case comesout to be 44.390 percent. It shows that the distribution of gross area sown is though not highly variable and inconsistent neverthless it shows a moderate inconsistency.

Double Cropped Area

Coming over to the distributional pattern of the area sown more than once in the sample farm households, the following picture emerges. The area sown more than once ranges between as low as 0.067 ha. to as high as 4.185 ha. in the village Jhagarapara of Goalpara district and Ketakibari of Kamrup district respectively. The following Table gives a comprehensive picture of the distribution of area under double cropping among the sample farm households under study.

TABLE V.7

Frequency Distribution of Double cropped Area

Size groups of area(in ha.)	Degree of distribution.	Frequency	Cummulative frequency	Percentate	Cummulative percentage
Less than 0.75	Very low	6	6	15.0	15
0.75 - 1.50	Low	14	20	35.0	50
1.50 - 2.25	Low moderate	8	28	20.00	70
2.25 - 3.00	Moderate	10	38	25.0	95
3.00 - 3.75	High	1	39	2.5	97.5
3.75 and above	Very high	1	40	2.5	100

Source: Same as Table-V-1

It will be seen from the Table presented above that the overall picture as to the distribution of area sown more than once among the farm households introducing HYV of rice seems to be positively skewed and bimodal (Fig.23). Maximum households (i.e.14) lie within the size group of 0.75 to 1.50 hectares constituting 35 percent of the sample. The least number of households lie within the class groups of 3.to 3.75 hectares and above, the percentage share being 5.00 percent. These farmers utilize their land as intensively as possible round the year. The next highest number of

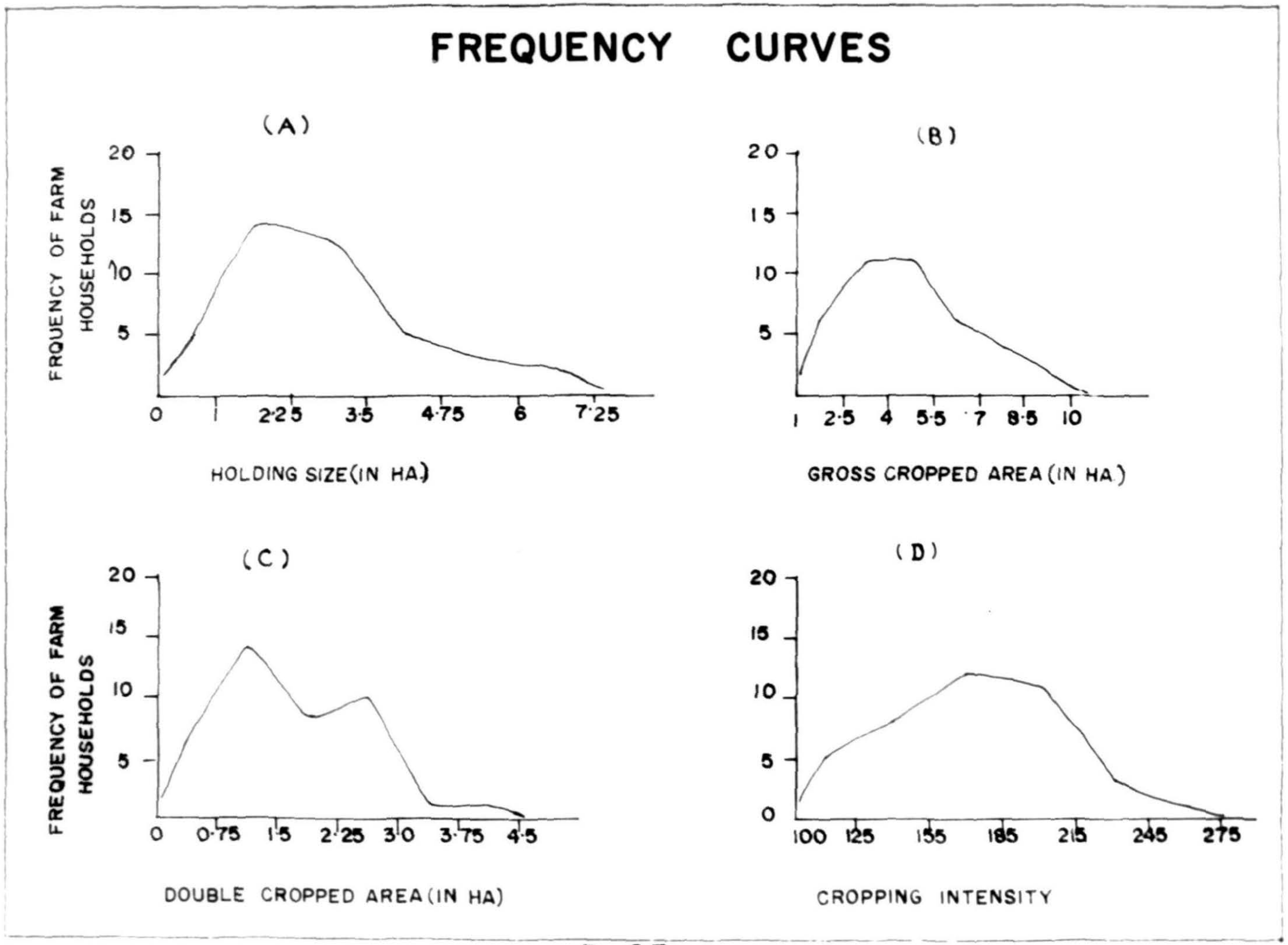
FREQUENCY CURVES
(A)
FREQUENCY OF FARM HOUSEHOLDS
20
15
10
5
0
1
2·25
3·5
4·75
6
7·25
HOLDING SIZE (IN HA)
(B)
20
15
10
5
1
2·5
4
5·5
7
8·5
10
GROSS CROPPED AREA (IN HA)
(C)
FREQUENCY OF FARM HOUSEHOLDS
20
15
10
5
0
0·75
1·5
2·25
3·0
3·75
4·5
DOUBLE CROPPED AREA (IN HA)
(D)
20
15
10
5
0
100
125
155
185
215
245
275
CROPPING INTENSITY

Fig. 23

households i.e. 10 out of 40 or 25 percent of the entire sample come within the size group of 2.25to 3.00 hectares. The maximum number of households are concentrated within two size classes (0.75 to 1.50 and 2.25 to 3.00 hectares) which comprise of 60 percent of the sample.

However, the nature of intensification of land use is well marked in each size group of the distribution. The land belonging to only one household is highly intensive, as he grows not only paddy crops but devotes his land to other cereals and mustards in the winter season, while the other farmer's agriculture is not much diversified and consequently they could not intensify their cropping structure. On the contrary, maximum number of farmers put their land into cultivation for minimum number of times. As a result, the land rotation on crop priority seems to be very low, thereby indicating the predominance of a few field crops suitable for the land in the existing climatic and socio-economic environ. The moderately intensified cultivation is noticed in ten farm households(i.e.25 percent of the entire spectrum of sample) ranking second in the distribution heirarchy. Eventhough the detailed classification as regards the intensive land use goes the way as very less, less,less medium, medium, high and very high, nevertheless the entire distribution can be classified into 3 broad categories. These include intensity of low, medium and high area under double cropping. The following Table clarifies the same.

TABLE V.8

Farm households classified according to the size of land under double cropping

Size class (in ha.)	Degree of distribution	No.of farm households (Frequency)	Cummulative frequency	percentage	Cummulative percentage.
Less than 1.5	Low	20	20	50.0	50.0
1.5 - 3.0	Medium	18	38	45.0	95.0
3.0 and above	High	2	40	5.0	100.0

Source : Same as Table-V·1

What is evident therefore from the above analysis is that a large number of farmers put their land into crop raising as minimum as possible comprising of 95 percent of the total farm households in the sample. So within the range of 1.5 hectares and less double cropped area indicating less intensification of landuse highest number of households fall. The range between 1.5 to 3.0 hectares of land which indicates moderate intensification of landuse has the next higher number of farms i.e. 18 followed by 24. The third category showing high intensification has the least number of farms i.e. 2 followed by 18.

As a very common principle of rural agricultural land use which advocates that higher is the area sown more than once higher is the intensification of the crop land use,it can be infered in the present context that the agricultural land in the lower Brahmaputra Valley is not very intensively cultivated or the land is not kept continuously under cultivation, the nature being moderate, followed by largely less intensive as evident from the sample households adopting High Yielding Varieties of rice.

The analysis will be more meaningful if the important measures of central tendencies distributed statistically as well as the relative measures of disprsion are discussed in particular reference and context. Though the mean cropped area sown more than once is 1.718 hectares, the standard deviation in the distribution has a tendency of closeness towards the mean thereby reflecting a corresponding closeness of the degree of inconsistency in the distribution pattern of the double cropped area. The standard deviation being 0.865 in relation to mean, the coefficient of variation exceeds 50 percent i.e.50.35.

The standard deviation and the coefficient of variation do not explain significant difference as compared to the gross cropped area. However the coefficient of variation of the gross cropped area being smaller i.e. 46.695 shows a more consistent distribution than that of the area sown more than once.

Cropping Intensity

With reference to the earlier debate in view of the intensity of land use in the farms of the sample households, here a more illustrious and conceivable view can be brought to light in terms of land use efficiency. Singh defines the land use efficiency as "the extent to which the net area sown is cropped or resown. The total cropped area(gross area sown) as a percentage to net area sown gives a measure of land use efficiency which really means the intensity of cropping.[26]" Reshaping more comprehensive the above definition, it can be explained that, the intensity of cropping gives an idea as to the number of crops raised on a field all through an agricultural year. Growing a single crop in the field for the whole year refers to an index of cropping intensity which is 100 percent. Similarly if two crops are grown in a particular agricultural year then the index of intensity will mean 200 percent. Meaning thereby the higher the index of cropping intensity, the higher the land use efficiency.

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26. Jasbir Singh, (1971), Agricultural Atlas of India - A geographical Analysis, Kurukshetra, p.139

So far as the present study is concerned in regard to the efficiency of land use among the sample farm households the cropping intensity has a range of variation between 104.72 to 275.0 as the lowest and highest indices for Ketekibari lying in the eastern part of the study area and Kheraj Daobhangi a western village of the same respectively.

The following Table shows the frequency distribution of the indices of cropping intensity in the farms of the sample households.

TABLE V.9

Frequency distribution of the indices of cropping intensity

Class groups of indices	Frequency	Degree of efficiency	Cummulative frequency	Percent	Cummulative percent
Less than 125	5	Very low	5	12.5	12.5
125 - 155	8	Low	13	20.0	32.5
155 - 185	12	Medium	25	30.0	62.5
185 - 215	11	High medium	36	27.5	90.0
215 - 245	3	High	39	7.5	97.5
245 and above	1	Very high	40	2.5	100.0

Source: Same as Table-V-1

It will be seen from the above Table that the distribution of indices of intensity of cropping when plotted on a graph will give a negatively skewed picture (Fig 23). The vertical scale i.e. frequency of households exhibits a moderately sharp increase over the horizontal scale i.e. class groups of indices.from 5 to 12, then falls gently to 11 and thereafter a sharp decrease in frequency is observed. Meaning thereby, the curve is tilted towards right hand side, characterising the distribution of as negatively skewed. It is apparent from the column depicting the degree of efficiency against the class groups of indices of cropping intensity that maximum frequencies in terms of households (i.e. 12 out of 40 or 30 percent of the entire sample) have a medium degree of agricultural efficiency. The indices of cropping intensity of these households vary between 155 to 185. It implies that though these farmers utilize their land more than once in an agricultural year for different crop raising, nontheless a part of the net cropped area remains unutilized or may be left fallow irrespective of the number of crops grown, since the intensity cropping indices vary between 155 to 185 which are less than 200 were they utilizing their entire operational holding at least twice a year, the cropping intensity would have been 200. So it is obvious that though the High Yielding Varieties of rice have been adopted and introduced by them but the extent of land use for these particular crops seems to be very low. And it further implies that these households achieving medium degree of efficiency in their agricultural operation have never spared their entire operational holding for HYV rice other than the local rice as evident from the gross area sown which has a closeness towards the area under local traditional varieties.

The next group of farmers comprising 27.5 percent of the sample (i.e. 11 out of 40) posses the high medium degree of agricultural efficiency whose indices of cropping intensity ranges between 185 to 215. These farmers appear to have used their entire net cropped area more or less twice a year. Though the fact that whether the HYV rice crops have covered maximum total net operational holding at least once a year, remains hidden, still a generalized explanation can be attempted through the correlationship between the intensity of cropping and the area under HYV rice. A positive significant coefficient of correlation will establish the fact that the area under HYV rice increases with the corresponding increase in the intensity of cropping. This will be discussed in the subsequent sections of this chapter.

Then the high medium degree of agricultural efficiency is followed by the low which account for 20 percent (i.e. 8 out of 40) farm households; the indices of cropping intensity of these households vary between as low as 125 to as high as 155. These group of farmers seem to be poor in terms of land utilization since substantial part of the net cropped land has not been put to cultivation even twice a year. Since the area under traditional varieties of rice approaches the gross area sown, in most cases of the sample households it can be said that these households devote very low percentage of their net holding to HYV rice cultivation and are in the experimental level in regard to the High Yielding culture.

The farmers having low degree of agricultural efficiency are followed by very low group consisting of 12.5 percent (or 5 out of 40) of the total sample. The indices of intensity vary between 125 and less. These farmers are in the lowest rung of the ladder in terms of land use.

Then comes the group of farmers having the high degree of agricultural efficiency accounting for a mere 7.5 percent (i.e. 8 out of 40) of the entire sample. The cropping intensity in case of these farmers varies between 215 to 245. Their net operational holding is put to cultivation even more than twice a year. Whether the area under HYV rice of these households increases with the increase in the gross area sown or the intensity of cropping will be discussed in the next section of this chapter.

However, only one farmer in the sample is noticed to be in the highest rung of the ladder in terms of agricultural efficiency. The cropping intensity index of this farmer is 275. It is clear that the farmer has put the net cropped area under cultivation at least more than two and a half time . Irrespective of the fact that the farmer has achieved the highest degree of agricultural efficiency, but it is observed that the area under HYV of rice in an agricultural year of this farmer is only 0.135 hectare which is a discouraging figure.

What emerges from the above analysis is that a substantial percentage of the sample households (i.e. 57.5 percent) come within medium degree of agricultural efficiency whose cropping intensity has an arbitrary range of variation between 155 to 215. The next 32.5 percent of the sample households are having a low degree of agricultural efficiency, the indices of intensity of cropping varying between even less than 125(i.e.104.72) to 155. The farmers having the high degree of efficiency in agriculture account for only 10 percent of the entire sample with a variation range of the intensity of cropping

215 to 245 and above. It can be infered from the above analysis that the farmers of the Lower Brahmaputra Valley are not very efficient in utilizing the agricultural land. Though,there is an ample scope of resource utilization in the study area, nevertheless, the area is lagging far behind in terms of mechanised farming through the introduction of modern farm innovations as compared to the other agriculturally developed parts of the country. Diffusion of the HYV of crops specifically is still to gather momentum in this area. Because HYV of rice crops needing a short duration for growth and harvest can raise the cropping intensity substantially if adopted extensively. But the above analysis shows that a large number of households do not utilize their land as intensively as possible. Hence, the indices of cropping intensity for these households are usually below 200.

The average index for the sample households comes out to be 171.99 which is an appreciable figure. The standard deviation in the distribution of indices of cropping intensity is 36.48. In regard to the consistency of the distribution, one can say that the distribution is not very inconsistent as evident from the coefficient of variation which is only 21.21 percent.

Inter-correlations between the Land use Correlates

While explaining the frequency distribution of the land use characteristics of the farming households questions arise as to

(i) Whether the farmers devoting more or little area under High Yielding Varieties of rice have proportionately adequate or scanty operational holding, gross cropped area, double cropped area or not

(ii) Whether the inter-relationships between the land use variables are significant or not.

A meaningful and comprehensive conclusion can be drawn concerning the above problems with the help of an analysis of inter-correlations between the land use variables.The correlation matrix presented in Table V.10 will help explain the degree of relationship between the land use variables. Such variables incorporate area under local traditional varieties of rice, area under HYV of rice, net cropped area, gross area sown, double cropped area, yield per hectare of cultivated land of local and High Yielding varieties of rice and intensity of cropping etc.

Matrix of Inter-correlations

Variables		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	Area under local rice	1.000	-0.061	0.855	0.912	0.625	-0.224	0.026	0.048
X_2	Area under HYV of rice		1.000	0.193	0.150	0.017	-0.135	0.481	0.446
X_3	Net cropped area			1.000	0.916	0.385	-0.495	0.356	0.357
X_4	Gross cropped area				1.000	0.722	-0.158	0.282	0.342
X_5	Double cropped area					1.000	0.490	0.397	0.174
X_6	Indices of cropping intensity						1.000	-0.288	-0.157
X_7	Yield per hectare (Local rice)							1.000	0.823
X_8	Yield per hectare(HYV of rice)								1.000

Table V.10 entitled "Matrix of Inter-correlations" reveals that most of the bivariate relationships are positive except a few which show negative relationships. The paired variables being negatively correlated are area under local rice and indices of cropping intensity (r=-0.224, insignificant at 1,2,5 and 10 percent levels), area under HYV of rice and indices of cropping intensity (r=-0.135, insignificant at 1,2,5 and 10 percent levels), net cropped area and indices of cropping intensity(r=-0.495, significant at all the levels of significance) and gross cropped area and indices of cropping intensity(r=-0.158, insignificant at all the levels).

The negative correlation between the area under local varieties of rice and the intensity of cropping irrespective of being insignificant is suggestive of the fact that the crop rotation in the sample farms seems to be poor. Because, once the entire land is devoted to mostly local rice, the index of cropping intensity becomes 100 and the rest of the times a substantial portion of the cultivable land is left fallow or uncultivable for which the index hardly exceeds 100. Had there been a multiplication tendency in land use among the farmers by bringing the land under cultivation with a variety of crops as many times as possible over the year, the cropping intensity could have had an increasing trend. Hence, the cropping intensity is a dependent phenomenon on the number of times a particular plot of land is brought under cultivation in an agricultural year. It would have increased with a corresponding increase in the area under local rice (in lieu of decrease as found in the present case) had the latter been cultivated for more number of times with the adoption of the short duration High Yielding Varieties. The negative relationship between the above variables further suggests that the increasing trend in the area under local rice is attributed to a similar trend in the net area under cultivation which will be discussed subsequently. It however, does not help increase the cropping intensity because of lack of double and multiple cropping. Suffice it to say that higher is the intensity of cropping, higher is the efficiency of landuse. The negative correlation between the area under HYV of rice and the indices of cropping intensity reveals a similar situation. Because, the area under the new varieties of rice crops seems to be an insignificant addition to the gross area sown which is an indicator of higher cropping intensity. On the other hand, the negative and significant relationship between the net cropped area and the indices of cropping intensity reveals the fact that the former increases with the decrease in the latter.

It is distinct that the net area is not efficiently brought under cultivation in terms of double and multiple cropping. The insignificant negative relationship between the gross area sown and the indices of cropping intensity reveals an identical situation in which the cropping intensity decreases as the gross cropped area goes on increasing. It is because, the increase in grass cropped area is largely due to a similar increase in the net area sown which will be discussed subsequently. Since, double and multiple cropping is not practised efficiently the gross cropped area does not help increase the cropping intensity. It further implies that the farmers having bigger farm size are relatively more inefficient in utilizing their land.

The paired variables being positively related include area under local rice and net cropped area ($r = 0.855$, significant at all the levels), area under local rice and gross cropped area($r=0.912$, significant at all the levels), area under local rice and double cropped area ($r = 0.625$, significant at all the levels), area under HYV of rice and net cropped area ($r = 0.193$, insignificant at all the levels), area under HYV of rice and gross cropped area ($r = 0.15$, insignificant at all the levels), area under HYV of rice and double cropped area ($r = 0.017$, insignificant at all the levels), net cropped area and gross cropped area (r=0.916, significant at all the levels), net cropped area and double cropped area (r = 0.385, significant at all the levels except at one percent), gross cropped area and double cropped area (r = 0.722, significant at all the levels) and double cropped area and indices of cropping intensity (r = 0.49, significant at all the levels except at one percent).

The high positive and significant relationship between area under local rice and net cropped area shows that area under local traditional varieties of rice increases vigorously with the corresponding increase in the net cropped area. It implies that the farmers are too much inclined towards these traditional crops for which a substantial or even the entire net holding is brought under cultivation during the respective seasons round the year. It may be because, the local traditional rice crops are easily adaptable to the environment and are much more reliable than the new exotic varieties. A better diffusion of the new varieties can hence be expected only, when the farmers extensively grow these crops. Of course, going in for a hundred percent High Yielding culture is confronted with a number of socio-economic and physical resistances, but the same can be overcome provided the farmers are met with the basic infrastructures needed for such advanced innovations in agriculture. Conversely, the various methods of scientific cultivation need to be brought home to the cultivators through adequate training and persuation.

Because of the fact that a gross negligence towards the cultivation of High Yielding Varieties of rice is noticed in almost all the sample farms, the area under a few important local rice crops (Ahu and Sali) becomes a substantive addition to the gross area sown all through an agricultural year. This fact is supplemented by high positive and significant relationships between the area under local rice and the gross cropped area and between the area under local rice and the area sown more than once or the double cropped area. Since local rice is grown at least twice a year (some times more in some places[27]) it is obvious that the area under double cropping is mostly the consequence of the cultivation of local rice irrespective of the area under a few miscellanious crops. Double cropping therefore, increases proportionately with the increase in the area devoted to local rice.

An insignificant and positive relationship between the area under HYV of rice and the net holding in operation

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27. In some places of the study area, Boro and Bao rice are grown. Boro is grown in low lying areas with stagnant and standing water such as Dhubri and Lakhipur blocks.(See chapter III).

shows that the area under HYV of rice increases within the net holding or the farm size. The question arises as to why the relationship between these two variables is insignificant where as the same is significant in case of the local varieties of rice. Oneecan say that farm size is never a factor for the cultivation of HYV of rice. It is the psychology of the cultivators who adopt it. In the present case, the large farmers bring relatively more area under High Yielding Varieties than their smaller counterparts. Had the areas been brought under cultivation of the High Yielding Varieties of rice in large scale in conformity with the farm size or covering the entire net operational holding or a substantive part of it, the relationship between these two factors would have been significantly positive. The diffusion of HYV of rice culture hence, could wide spread if the farmers adopt these varieties in large scale and grow extensively irrespective of the farm size. The positive and insignificant relationship between the area under HYV of rice and the gross cropped area indicates that the increase in gross cropped area is not largely due to the area under HYV of rice. On the contrary, the area under HYV of rice does not add to the gross area significantly. Though, there is a positive trend of relationship between these two variables, but the relationship being highly insignificant shows that the gross area is not dependent on the area under HYV of rice to a large extent. The relationship could tend to be significant if there is a steady increase in the area under HYV of rice through double and multiple cropping which will result in a similar increase in the gross cropped area during the agricultural year. Viewed more objectively, the farmers in the study area have a greater propensity towards the local rice crops than the High Yielding Varieties.

The next pair of variables constituting of the area under HYV of rice and the double cropped area, are the most insignificantly and positively correlated ($r = 0.017$). The correlation coefficient shows that the relationship between the variables tends to be zero. Hence it can be said that the area under HYV of rice and the double cropped area do not have any relationship with each other. This is because, the contribution of area under HYV of rice to the area under double cropping is considerably low. It implies that double cropping is not practised as far as the area under High Yielding Varieties are concerned.

The high positive and significant relationship between the net area sown and the gross cropped area suggests that the gross cropped area entirely depends on the total operational holding or the net area sown. It may not be because the increase in gross cropped area is due to the cropping multiplicity in the present case. It is largely because of a relative increase in the net cropped area. The increase in gross area hence depends on the number of times the net area or a part of it is brought under cultivation. It is irrespective of what particular crop is sown whether it is local rice or HYV of rice is any other field crop. Since two principal local rice crops such as Ahu and Sali in the in the study area dominate the agricultural land scape, in many cases the gross area becomes double the net area sown if the latter is brought under cultivation entirely. Therefore, the gross cropped area increases with a corresponding increase in the net area sown. In view of this analysis it can be said that if the farmers are provided with more cultivated area the number of field crops in one calendar year can be raised with short duration varieties resulting in a less intensive subsistence agriculture. This will in turn facilitate the farmers to maintain the fertility status of the soil at its existing level. And this needs a large scale reclanation of unculturable waste, land under forest and area left fallow as well as barren. By adopting these methods the total volume of foodgrains can also be raised to meet the requirements demanded by the growing population.

The next pair of variables consisting of the net area sown and the area under double cropping shows a positive and significant relationship (insignificant at one percent). Since double cropping to a great extent depends on the net holding under cultivation, it can be suggested that for a scientific utilization of land the net area cropped by the individual farmers be raised to a standard size which will suffice to the need of more and more double cropping so as to accelerate the growth of agricultural production.

It can be seen from Table V.10 that area sown more than once possess a high positive and signifincant relationship with the gross area sown. It implies that in the case of Lower Brahmaputra Valley as the gross area under cultivation increases, there is a corresponding increase in the area under double cropping. In order to bring more area under double and multiple cropping, irrigation provisions especially the lift irrigation needs to be adequately developed. So that it will be a real asset for the farmers to go in for the adoption of the High Yielding Varieties of rice which can be grown during the year even more than once because of the short duration maturity of these varieties.

The last pair of variables such as the area under double cropping and the indices of cropping intensity show a positive and significant relationship at all the levels except at one percent of statistical significance . It can be infered that higher is the double cropping higher is the agricultural efficiency. Hence, double cropping is one of the most important factors for raising the efficiency of agriculture in any region. In the area under study, since double cropping is only due to the local rice crops, adequate facilities in terms of infrastructure should be provided to the farmers in order to raise the efficiency of crop land use. Scientific agriculture should be introduced through adoption of new farm innovations. Because, scientific and mechanised agriculture helps in economising time, in saving man hour and also ultimately in rasing the farm efficiency.

PRODUCTIVITY

HYV Rice.

The yield of High Yielding Varieties of rice for the sample households varies between as low as 6.22 quintals per hectare in Kharaj Daobhangi of Goalpara district to as high as 110.59 quintals per hectare in Gog of Kamrup district. Table V.ii presents the frequency distribution of yield of HYV of rice in quintals per hectare among the households.

TABLE V.11

Frequency Distribution of Yields in quintals per hectare of HYV of Rice

Class groups of yield (in quintals/ha.)	Level of yield	Frequency of farm households	Cummulative frequency.	Percentage	Cummulative percentage
Less than 10	Very low	4	4	10.0	10.0
10 - 20	Low	11	15	27.5	37.5
20 - 30	Low moderate	13	18	32.5	70.0
30 - 40	Moderate	8	36	20.0	90.0
40 - 50	Moderately high	1	37	2.5	92.5
50 - 60	High	2	39	5.0	97.5
60 and above	Very high	1	40	2.5	100.0

Source: Same as Table-V.1

It will be seen from Table V.11 that the level of yield of HYV of rice for as much as 70.0 percent of the households is below 30 quintals per hectare. A large number of households (60 percent) have achieved the level of yield ranging between 10 to 30 quintals per hectare. The levels of yield classified into various categories include very low, low moderate, moderate, moderately high, high and very high. There are four households (i.e. 10 percent of the sample) who have got very low yields. The yield for these households is less than 10 quintals per hectare, the lowest yield calculated being 6.22 quintals for the cultivator in Kheraj Daobhangi of Goalpara district. Only one household has got the highest return (i.e.110.59 quintals per hectare) which is obviously an exception. The farmer is from village Gog of Kamrup district. Such an achievement of the farmer according to him is attributed to his scientific method of cultivation. As far as the utilization of the available resources are concerned he has followed all necessary instructions that he received from the technical personnels of the department of agriculture. Mention may be made here that the farmer was a trainee in the agricultural demonstration training centre at Kahikuchi of Kamrup district in 1970 which was primarily organised to impart instructions to the progressive farmers on scientific agriculture. The largest number of households (i.e. 13 out of 40 (32.5 percent) fall within the class group of yield varying between 20 to 30 quintals per hectare. These farmers can hence, be designated as the low moderate group in terms of yield. The second largest number of households (i.e.11 out of 40) which form 27.5 percent of the sample lie within the productivity range of 10 to 20 quintals per hectare and can be said to have achieved a low level of productivity per unit area. The moderate group comprises of 8 households (20 percent of the sample) who have reached the level of yield which exceeds 30 quintals and is below 40 quintals per hectare. Other than the farmer coming within the category of very high level of yield, there are only two households (5.0 percent) whose yield exceeds 50 quintals per hectare and can be called as the high productive farmers.

In view of the above analysis it can be said that the level of productivity of HYV of rice is though not very high in the study area, nevertheless, the overall picture as regards the productivity of HYV of rice seems to be appreciable. It is noticeable that more than 50 percent of the sample farmers get moderate return varying between 20 to 50 quintals per hectare. The poor performance of the low productive farmers consisting of as much as 27.5 percent of the sample may be attributed to the infrastructural facilities in the area as well as the socio-economic con ditions of the farmers which have mainly deprived them of using the modern farm inputs such as fertilizers, pesticides, and other farm machineries and so on. The average return appears to be encouraging which is 26.09 quintals per hectare. The relative advantage of the cultivation of HYV of rice will however, be more conceivably discussed in chapter V.11 . As far as the consistency in the distribution pattern of yield of HYV of rice is concerned it is observed that the distribution of yield is highly inconsistent because, the variability is enormous as evident from the coefficient of variation i.e. 69.45 percent. The standard deviation comes out to be 18.125.

Local Rice

The situation appears to be more grave when one looks at the productivity levels of the local traditional varieties of rice of the sample farmers. The yield per hectare of the local Ahu and Sali rice varies between 5.18 quintals to 52.66 quintals for the farmers from Jhagarapara and Gog respectively. Table V.12 presents the frequency distribution of the yield of local rice in quintals per hectare.

TABLE V.12

Class groups of yield (in quintals/ha.)	Frequency of farm households	Level of yield	cummulative frequency	Percentage	cummulative percentage.
Less than 8	6	Very low	6	15	15
8 - 16	22	Low	28	55	70.0
16 - 24	8	Low moderate	36	20	90.0
24 - 32	1	Moderate	37	2.5	92.5
32 - 40	1	Moderately high	38	2.5	95.0
40 - 48	1	High	39	2.5	97.5
48 and above	1	Very high	40	2.5	100.0

Source: same as Table-V.1

It will be seen from Table V.12 that 70 percent of the sample farmers produce spectacularly lower yield which is less than 16 quintal per hectare. The low moderate group comprises of another 20 percent of the sample farmers, the yield per hectare coming within the category of 16 to 24 quintals. The moderate, moderately high, high and very high levels of yield have been achieved by one farmer each respectively. These farmers come within the categories of yield in quintals per hectare varying between 24 to 32, 32 to 40, 40 to 48 and 48 and above. It is again noteworthy to go through the above table that the level of yield for a maximum number of farmers i.e. 22 out of 40 (55.0 percent) is low. The yield level of these farmers come within the frequency class group i.e. 8 to 16 quintals. The next 15 percent farmers produce even less than 8 quintals a hectare. Only 20 percent farmers have reached an optimistic level of yield which falls within the class group of 16 to 24 quintals per hectare.

The average yield of local rice is 15.375 quintals per hectare. The distribution of the yield of local rice appears to be highly variable and inconsistent as evident from the coefficient of variation i.e. 66.07 percent. The standard deviation in the distribution is 10.16.

The analysis of the pattern of yield of both HYV and local rice suggests that the introduction of High Yielding Varieties of rice by the sample farmers has been a comparative advantage over the local rice in terms of yield and total volume of production as well. Though numerous socio-economic and cultural factors stand as constraints in achieving further optimism in the yield level, nevertheless these can be eliminated by improving the economic conditions of the farmers to a desirable extent. When majority of the farmers are at the subsistence level, spread of new innovations among them will be a strenous task unless their social and economic conditions are improved. So far as the Lower Brahmaputra Valley is concerned, what is more important is, to pay attention to the infrastructural development of the region for achieving the goal of higher productivity in agriculture. Farm size as one of the most important factors of production should be brought to its standard size in the region which will accelerate the process of diffusion of new innovations such as the introduction of HYV of rice in the present case. Because, such a size will be economic for the use of modern farm inputs like chemical fertilizers, pesticides and farm machineries etc.

Land use Correlates and Productivity

HYV Rice

Coming over to the impact of land use on the yield level of HYV of rice the following picture emerges. It will be seen from the Table V.10 that the area under HYV of rice is positively related with yield per hectare (r = 0.446, and significant at all the levels of significance) the relationship of other variables with yield include net cropped area and yield of HYV rice (r =0.357, significant at 10 and 5 percent levels only), gross cropped area and yield of HYV rice (r = 0.342, significant at 10 and 5 percent levels only), double cropped area and yield of HYV rice(r = 0.174, insignificant at all the levels) indices of cropping intensity and yield of HYV rice (r = -0.157 insignificant at all the levels) and yield of local rice and that of the HYV rice.

The area under HYV of rice having a positive and significant relationship with the yield indicates that area deveted to this crop is one of the vital factors which governs the yield level. Since, HYV of rice cultivation involves more human labour because of lack of farm mechanisation in the study area and hence labour intensive, larger farm size reduces the labour cost by the introduction of indivisibles such as tractors, threshers and wheelers etc. Other material inputs such as chemical fertilizers, pesticides and insecticides etc. can also be economically used in case of large farms. Hence, smaller farms being highly uneconomic will incur relatively more expenses than the larger ones. In view of the above facts, it can be said that the yield of HYV of rice increases with the corresponding increase in the area under the crop.

The positive and significant relationship between net cropped area and yield of HYV of rice at 5 and 10 percent levels of significance highlights the fact that the farmers possessing more land are enabled to go in for the introduction of HYV rice. It implies that land, labour and capital are the three basic requirements for the adoption of High Yielding rice in the farm. It may be recalled here that the insignificance of the relationship between these two variables at 1 and 2 percent levels may be attributed to inconsistency in the data and sampling.

Gross area sown and the yield per hectare of cultivable land having a positive and significant relationship at 10 and 5 percent levels indicates that adequate gross area devoted to HYV rice results in better output in terms of total volume of production which raises the per hectare yield. So it is obvious that as the gross cropped area increases, there is a proportionate increase in the yield of the HYV rice.

The double cropped area also depicts a similar picture showing a positive relationship with the yield. However, the relationship is insignificant at all the levels.

The last pair of variables but one i.e. the indices of cropping intensity and the yield of HYV rice shows an insignificant and negative relationship among each other. It is vivid that in the sample farms, as the cropping intensity goes on increasing, the yield goes on simultaniously decreasing. Meaning thereby, the farmers are not that much interested in bringing more area under HYV rice which could raise the intensity index thereby raising the productivity. Hence, the negative relation in the present study is a discouraging scene.

The relationship between the last pair of variables (positive and significant at all the levels) is suggestive that as the productivity of HYV rice among the farmers in the sample goes on increasing, there is a proportionate increase in that of the local rice. It further implies that the farmers adopting HYV rice take equal care of the local traditional varieties of rice which gives in the long run better yield per unit area.

Local Rice

In order to have an understanding as to the influence of the land use characteristics on the pattern of yield of rice in the Lower Brahmaputra Valley, it will be a meaningful attempt to bring a comparison between the local and HYV of rice.

It will be seen from Table V.10 that the relationship between the area under local rice and the yield per hectare does not emerge a distinct picture since the same is insignificant at all the levels though the trend is positive. The correlation coefficient approaches zero ($r = 0.026$) and reflects as if the variables do not have any relation with each other. This fact seems unlike and unusual and explains that the yields are variable without any conformity with the area under cultivation. The reason can either be attributed to the inconsistency in the sampling distribution or the traditional technology employed in the production process or variable weather, and environmental conditions. Sometiemes it may so happen that larger farms owing to low fertility status of the soil get low return per unit area. Hence, the study needs further investigation and research.

However, it is observed that the area under HYV rice increases with the corresponding increase in the yield level of local rice having a positive and significant correlation (r = 0.481, significant at all the levels.). It is vivid that the farmers adopting HYV culture pay equal attention or more to the local rice.

The yield of local rice is positively related (r = 0.356, significant at 5 and 10 percent levels) with the net cropped area. As the farm size increases, the per hectare yield increases in proportion. The reason could be, the productivity increases with the increase in farm size because large farms stand viable for the economis use of modern farm inputs.

Similarly the gross cropped area shows a positive relationship with the yield of local rice but insignificant at all the levels of significance except at 10 percent (i.e. r = 0.282). It shows that yield of local rice increases with a corresponding increase in the gross area.

Double cropped area and the yield of local rice per hectare are positively related, the relationship being significant at 10,5 and 2 percent levels (r = 0.397). It can be said that yield of local rice increases with the increase in the area under double cropping.

The last pair of variables constituting the indices of cropping intensity and the yield of local rice present a negative and significant relationship at 10 percent level only. It explains that the yield as a dependent phenomenon decreases with a corresponding increase in the cropping intensity. Though the net operational holding of the farmers are the real addition to the gross acreage, by double cropping, but the yield of local rice does not increase at par. The reason could be attributed to the traditional technology involved in the cultivation of local rice.

From the above comparative analysis of the relationship between the land use and the yield levels of HYV and local rice, one can arrive at the conclusion that the adoption of HYV rice in the valley is gradually bringing about a technological change in agriculture. It appears that the traditional method of cultivation is being replaced by its modern counterpart which is evident from the analysis of productivity pattern of local and HYV rice. Under the traditional technology the relationship between the farm size and output is supposed to be negative as studied by the eminent agro-economists[28] but in the present case the relationship comes out to be positive and also statistically significant at 5 and 10 percent levels. "The latest evidence shows that the inverse relationship between farm size and output per acre found under traditional technology no longer holds true with the adoption of new technology.[29]"

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28. See C.H. Hanumantha Rao(1975) Technological Change and distribution of Gains in Indian Agriculture, Delhi, pp.142-144.

29. Ibid p.142

SOCIO-ECONOMIC SETTING

So as to have a broad understanding of the pattern of diffusion and distribution of HYV of rice among the farmers of the Lower Brahmaputra Valley, it is necessary to discuss the social, economic and cultural profiles of the farming community. It is because, the new innovations in agriculture concerning the introduction of High Yielding Verieties of crops etc. may produce different types of impacts depending upon the differences in the economic and socio-cultural characteristics of the Community. Ceteris paribus, the responses of people to new ideas or innovations are basically conditioned by their culture[1]. Meaning thereby, the success of the introduction of new innovations is to a greater extent, determined by the absence of inbuilt cultural resistances. If the technological innovations are capable of bringing socio-cultural changes and new needs are generated in the people where such changes are welcome by them, it is imperative to have a prima-facie understanding of their socio-economic and cultural life. The present chapter is an attempt to analyse the socio-economic and cultural profile of the sample farm households under study with a view to understanding some of their existing characteristics.

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1. C. Rajagopalan; and Jaspal Singh,(1971) Adoption of Agricultural Innovations, Delhi p.13.

Education

Formal education plays a key role in communication of new ideas, information and therefore, helps in the diffusion of innovations. Education is generally believed to be helpful in elimination of superstitions and widens the mental horizon of a person and thereby prepares or predisposses him to be receptive to new ideas[2]. Nevertheless, it depends upon the quality of education. Quite often, mere literacy helps a person to be influenced by new ideas and enables him to read newspapers and other periodicals and also to keep his farm and household accounts.

Amongst the 40 farm households adopting HYV rice cultivation, it will be seen from Table VI.1 that 6 cultivators are illiterates and 5 are highly educated. The educated and illiterates have been given different weightage for the purpose of composite index. The scores have been calculated by assigning different weightage to the different level of education such as Primary, Middle English,Higher Secondary, Intermediate, Graduation and above. The weightage assigned to the various levels of education are presented in Table VI.1

2. C.Rajagopalan and Jaspal Singh, op.cit.p.19

TABLE VI. 1

Weightage assigned to different levels of education

Levels of Education	Weightage
Illiterate	0
Primary (Lower)	1
Primary (Upper)	1.25
Middle English	1.50
Higher Secondary	3
Intermediate	3.5
University Education	5.5

Source: Prepared by author

The picture that emerges out of the arbitrary classification of the educational levels attained by the farmers in the sample exhibits that maximum number of cultivators in the Lower Brahmaputra Valley fall within the low and medium categories of educational status. The number of cultivators are 16 and 13 in low and medium categories respectively. The percentage of highly educated farmers receiving college education and more is 12.5 percent. The percentages of low and, medium educated farmers come out to be 40 and 32.5 percent respectively constituting together 29 of the 40 farm households in the sample. The rest 15 percent of the sample (or 6 out of 40) being completely illiterates have no educational status. The following frequency table reveals the above analysis

TABLE VI.2

Frequency Table showing the educational status of the farmers

Class groups of scores of educational level	Frequency	Educational level	Commulative Frequency	Pertage
Less than 1	6	Illitrate	6	15
1 - 2.5	16	Low	22	40
2.5- 4.0	13	Medium	35	32.5
4.0- and above	5	High	40	12.5

Source: Calculated by author

The analysis will be more meaningful when educational levels of the farmers are correlated with other socio-economic cultural and demographic correlates. In the present case only heads of the households have been taken into consideration. Their educational level has however been assessed. It may be recalled here that low and medium categories of scores refer to the level of upper primary and intermediate in the education ladder.

Education being a positive source of knowledge exposes a person to new ideas and makes easier for him to understand the modern techniques involved in scientific agriculture. The hypothesis to be tested in the later part of this chapter is that an educated farmer will always have better output per unit area than the illiterate and relatively lower educated farmers. Bhati concludes that technical knowledge is itself an important input. An investigation on the importance of technical knowledge among farmers in a new paddy settlement on the west coast of Malay peninsula shows that the farmer who keeps up with modern ideas will have a better income than a neighbour who is in all other way equally endowed but without up-to-date technical education. This indicates that technical knowledge is a real ecomomic source[3]. Hence technical knowledge can be achieved through proper education and training.

Age

Age of the head household or the principal cultivator in the farm family seems to have had considerable bearing on the adoption of new innovations such as up to date methods and techniques in agriculture. The hypothesis that the younger generation will be more enterprising and receptive to new innovations in agriculture than that of their older counterparts can also be examined in case of

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3. U.N.Bhati (1975), Technical knowledge as a determinant of farmers income. Economic theory and Practice in the Asian setting vol.3, The Economics of Agriculture (ed.) New Delhi, p.45.

the Lower Brahmaputra Valley. It will be worthwhile if the age of the sample farmers is stratified into frequency classes so as to determine in which category of age, the cultivators are maximum in number. The following table presents the frequency distribution of the age of the sample cultivators adopting High Yielding Varieties of rice in their farm.

TABLE VI.3

Frequency distribution of the age of the sample cultivators

Class groups	Frequency	Cummulative Frequency	Percentage	Cummu-lative percen-tage.
Less than 30	3	3	7.5	7.5
30 - 45	16	19	40.0	47.5
45 - 60	9	28	22.5	70.0
60 - 75	9	37	22.5	92.5
75 and above	3	40	7.5	100.0

Source: Same as Table-VI.2

It will be seen from the above table that the age of the cultivators varies between 24 and 85 in the villages Jhagarapara of the Dhubri subdivision and ketokibari of the Gauhati subdivision respectively. These villages however lie in the either extremes of the Lower Brahmaputra Valley. There are only 3 cultivators whose age is below 30 years and constitute of 7.5 percent of the total sample. Of these

3 cultivators, 2 are again from the Goalpara subdivision lying in the south bank of the Brahmaputra. A substantial percentage of the farmers i.e. 40 percent are found within the age group 30 to 45. They are 16 out of the 40 sample cultivators. As the class groups of age go on increasing the number of cultivators in the respective age groups show a decreasing trend. The age groups such as 45 to 60 and 60 to 75 have 9 cultivators each. However, the oldest age group of farmers are only 3 in number. There are 3 youngest farmers also who are below 30 years of age. If below 45 years is presumed as the age group in which farmers are supposed to be enterprising then it is noticed that 19 out of the 40 sample farmers belong to this group constituting of 47.5 percent of the entire group of farmers. These farmers are fairly distributed among the sample villages. The following table depicts the village wise number of farmers below 45 years of age.

TABLE VI.4

Villages	No.of farmers
Jhagarapara	4
Balijana	4
Ketokibari	4
Shilapani	3
Khara	2
Gog	-
Kheraj Daobhangi	1
Japar Kachi	1
Total	19

Source: Same as Table-VI.2

It will be seen from the above Table that most of the farmers below 45 years of age are from the western part of the area under study i.e. 15 of the 19 farmers.

The older generation between the age group of 45 to 75 and above constitutes of 52.5 percent i.e. 21 of the 40 sample cultivators. The villagewise distribution of the farmers belonging to older generation in terms of age is presented below

TABLE VI.5

Villages	No.of farmers
Jhagarapara	4
Balijana	2
Ketokibari	5
Shilapani	2
Khara	11
Gog	1
Kheraj Daobhangi	6
Japerkuchi	-
	21

Source: Same as Table-VI·2

The distribution again appears to have been biased against the western part of the Lower Brahmaputra Valley

The villages lying in the extreme parts of the region under study have a large number of farmers in the age group (i.e. 45 to 75 and above), the number being 15 of the 21 classified as the old farmers (i.e. 71.40 percent).

It is infered from the above analysis that in the Lower Brahmaputra Valley (specifically the western tip of the valley) the younger generation is making a satisfactory head way as compared to their older counterpart in adopting the new varieties of rice in their farm. This fact can be substantiated and supplemented as well, when the productivity of HYV rice in terms of yield in kg. per hectare is correlated with the age. This will lead us to know whether the younger farmers are ahead of the older ones in terms of productivity. This will be discussed in the later part of this chapter.

Family Size -

In an agrarian society like India family and family size play important role. It is noticed that Indian rural families are fast disintegrating from joint to nuclear characteristic Rajagopalan and Singh[4] are of opinion that the traditional Indian society is characterised by its joint families which no longer exist at present.

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4. C. Rajgopalan and Jaspal Singh, Op.cit., p. 18

This feature from India's rural society has disappeared because of the advant of the industrialisation and urbanisation. In the present case the nuclear families predominate in the area under study. Of the entire sample 90 percent farm households have a nuclear strucrure(i.e. 36 of the 40 farm households) There are only 4 households which are structurally joint. These families belong to the villages Ketakibari and Japarkuchi of the eastern part of the study area the number being 2 and 1 respectively. Another family which is said to be joint is from Kheraj Daobhanji of the western part of the study area.

Switching over to the size of the family it is noticed be that small families are more numerous than the larger ones for, the family is determined by its type. Family size also has its own economic implication. In the sample under study the size of family varies from as low as 2 to as high as 23 for the villages Khara and Jhagarapara respectively. Both the villages however lie in the eastern part of the Lower Brahmaputra Valley. Table No.VI.6 presents the frequency distribution of family size in the sample villages.

TABLE VI.6

Class groups of family size	Frequency	Degree of size	Cummula-tive Frequency	Percentage
Less than 4	2	Very low	2	5.00
4 - 8	11	Low	13	27.5
8 - 12	20	Medium	33	50.00
12 - 16	5	High Medium	38	12.5
16 - 20	1	High	39	2.5
20 and above	1	Very high	40	2.5

Source: Calculated by author

It will be seen from Table VI.6 that as per the categorization of the sizes as very low, low, medium, high medium, high and very high, medium sized families predominate in the sample. Of the 40 families under study 20 come within the size group of 8 to 12 members, constituting 50 percent of the entire sample. Medium is followed by low family size between 4 to 8 members and account for 27.5 percent of the entire sample households. There are 5 families which come within the high medium group of size and account for 12.5 percent of the entire sample. However, the high size group of families are 2 only, one each in high and very high group respectively accounting for 5 percent of the sample. Similarly the very low group of family size contains 2 families accounting for again 5 percent of the sample. To sum up the medium sized families in the sample are many (i.e. 25 of the 40 and 62.5 percent). This is again followed by low sized group of families accounting for 32.5 percent of the sample (i.e. 13 of 40 families). The large sized families are however very few (i.e. 2 of 40 families under study accounting for 5 percent of the sample)

The villagewise distribution of family size of the sample households is presented in Table VI.7, below

TABLE VI.7

Villages	Sizes: Less than 4	4-8	8-12	12-16	16-20	20+	Total
Jhagarapara	-	3	3	-	1	1	8
Balijana	1	3	2	-	-	-	6
Ketokibari	-	2	4	3	-	-	9
Shilapani	-	1	4	-	-	-	5
Khara	1	1	-	1	-	-	3
Gog	-	-	1	-	-	-	1
Kheraj Daobhangi	-	1	6	-	-	-	7
Japar kuchi	-	-	-	1	-	-	1
Total							40

Source: Same as Table-VI.2

The respondents have been classified as per the various size groups of family in the respective sample villages. It will be seen from the above Table that the village Jhagarapara has the low, medium, high and very high sizes of families. All the large sized families are found in this village only. The reason might be attributed to the muslim culture and tradition since the village is mostly populated by muslims. On the other hand, all the respondents adopting and practicing HYV of rice cultivation in this village are muslims. In most of the villages in the sample medium size of families dominate, the members varying between 8 to 16. Rajagopalan and Singh[5] are of opinion that the size of family is generally related to the type of family which is proved to be opposite in the present study, the nuclear families having more members than the joint.

It will be also noteworthy if the size of family is related to the productivity pattern of HYV rice.

Religion

Religious belief has been a perpetual phenomenon in a traditional society specifically India. The significance of religion in life of the people ....can be demonstrated by illustrating how religious beliefs and values condition social and economic behaviour.[6] Though the religious beliefs

5. C. Rajagopalan and Jaspal Singh, Op.cit., P.10
6. Ibid. p.14.

and their impact upon the agricultural practice have not been the concern of the present study nevertheless on the basis of the direct interview with the people of the area under study it can be said that there are numerous beliefs and superstitions connected with the agricultural practice. Right from the preparation of the land for a crop to be grown till its harvest there are specific days of the week and time for their execution. Hindus are more inclined to these beliefs thanthe muslims in the area under study.

The sample farm households of the Lower Brahmaputra Valley under study constitute of mainly Hindus and Muslims. Of the 40 farm households the Hindus and Muslims families are 18 and 22 respectively. The following table presents the respondents classified into their respective religion villagewise in the sample.

TABLE VI. 8

Sample villages	Religion		
	Hindu	Muslim	Total
Jhagarapara	-	8	8
Balijana	6	-	6
Ketokibari	2	7	9
Shilapani	1	4	5
Khara	3	-	3
Gog	-	1	1
Kheraj Daobhangi	5	2	7
Japerkuchi	1	-	1
Total	18	22	40

Source: Same as Table-VI2

It will be seen from the above table that the respondents from the village Jhagarapara are all Muslims whereas the same are all Hindus in the village Balijana. Ketakibari and Kheraj Daobhangi lying in the east and west of the study have mixed samples consisting of both Hindus and Muslims. It has also been found out that Muslims seem to be more Progressive in adopting the new innovation than the Hindus which is evident from the relation between religion and productivity of HYV rice in the sample villages. The yield per unit area comes out to be more in case of Muslims than that of Hindus.

Caste

Caste and profession still go together in Indian rural society. Casteism and hierarchy of caste have posed such problems that these have almost been a threat to the National development programmes as well as to the emotional integration of the people. The prepounderance of various castegroups is strongly felt when the problem is viewed in a spatial context. Generally the higher caste people in the society enjoy all the accessibilities within their reach. Though the diversity in occupation has undermined the occupational base of the caste to some extent specifically in the areas having a touch of modernisation, nevertheless in many remote rural areas it has retained its position and has direct linkage with occupation.

The case in the Lower Brahmaputra Valley is no way less. Unlike other areas of India, Brahmaputra Valley has however no sharp distinction between various caste groups except Brahmins.

Of the 40 sample farm households as the adopters of HYV rice cultivation in the area under study 45 percent (i.e.18) are Hindus and are of different castes such as Rajbangshi, Jogi, Kalita, Fisherman (Keut), Baidya, Kaystha and Saloi. Among these 3 farm households belong to Kachari tribe from the village Khara of Goalpara district. The original occupation or the profession of the aforesaid caste groups are said to be fast disappearing because of the creation and openings of new jobs and opportunities in many facets. On the other hand, the traditional occupation is time consuming and labour intensive and hence have been substituted by the modern scientffic technology. Though it does not necessarily mean that the lower caste farmers will have less opportunities and access to the social privileges such as getting the necessary facilities for technological innovations in agriculture (HYV rice and the advanced inputs in the present case). But their positions in the society has made them such that they are bound to lag behind.

The following Table presents the villagewise caste groups of farmers of the study area.

TABLE VI.9

Villages	Castes								
	Kachari tribe	Raj bangshi	Jogi	Kalita	Keut	Baidya	Kayastha	Saloi	Total
Jhagarapara	-	-	-	-	-	-	-	-	-
Balijana	-	1	4	1	-	-	-	-	6
Ketokibari	-	-	-	2	-	-	-	-	2
Shilapani	-	-	-	-	1	-	-	-	1
Khara	3	-	-	-	-	-	-	-	3
Gog	-	-	-	-	-	-	-	-	-
Kheraj Daobhangi	-	2	-	-	-	-	1	2	5
Japarkuchi	-	-	-	-	-	-	-	-	-
Total	3	3	4	3	1	1	2	1	18

Source: Same as Table-VI.2

It will be seen from the above table that there are 4 house holds who are jogi by caste but cultivation has been their main occupation. Kalita, Rajbangshi and Kachari tribe are 3 each in the sample. Kachari tribes seem to be the progressive cultivators in the valley of Brahmaputra and have enough land at their disposal. The perhectare return of these tribes is also appreciable and better than other caste farmers. Being scheduled as tribes they get better facilities in agriculture from government agencies. Keut, Baidya and Saloi are one each in the sample and are considered as low castes in Assam. Two of these farmers belong to Shilapani and Kheraj Daobhangi of the western Lower Brahmaputra Valley who are Keut and Baidya by castes respectively. The other one is from the eastern part of the study area and is saloi by caste. There two farmers who are Kaysthas and are also from western part of the study area.

Though the farmers in the sample are of different castes but agriculture is their main occupation primarily due to the favourable environmental set-up of the area they live in. Brahmaputra Valley as a unique area specifically for agriculture has been an advantage for the people of different castes to take up cultivation as their occupation down the ages.

Working members

Family labour is considered to be an important economic input specifically for small and subsistence farmers. Though according to many authors it is difficult to measure this input reasonably, nevertheless there is unanimity among the researchers that farm family labour is a positive explanatory variable of productivity. Apart from the family labour's relevance to small farmers, technological changes so far as they facilitate an increase in cropping intensity or multiple cropping, might lead to a more intensive utilization of the services of the family farm worker or permanent farm servant and hence to a more even distribution of work put in by them during the year.[7] The present study however, does not specify and measure the efficiency of family labour categorically since it is a cumbersome task. But the total human labour cost in money terms (both family and hired labour) has been calculated per unit cropped area of HYV rice in the sample farms.

A recent study[8] on the marginal value productivity of human labour for Uttar Pradesh and Punjab, shows that the marginal value productivity of human labour is positive all along and generally above the wage rate. This phenomenon

7. C.H.H.Rao, Op.Cit.,p.119

8. See G.R.Saini (1979), Farm Size, Resource Use Efficiency and Income Distribution, Delhi, PP.55,61,86.

assumes added significance when the bulk of the labour is contributed by the farm family itself. One of the findings again suggests that the marginal value productivity of family labour especially of the small farmers corresponds to market wage rate vis-a-vis a general expectation on small farms where the former is much below the wage rate, the labour being supplied by the farm family itself with the intention of maximizing the returns per unit area rather than at equating the value of the marginal product with an imputed wage rate.

The significance of family labour is well understood from the above discussion. The labour cost in general per hectare of cultivated land is the highest in the present study. Except a few households with relatively bigger farmsize, all others in the sample are either medium or small farmers where family labour is a positive input factor. The relative significance of the perhectare labour cost for the cultivation of HYV rice in case of small, medium and large farmers has been discussed by simple comparison. Switching over to the full time adult working members of each of the farm households Table VI.10 emerges

TABLE VI.10

Class group	Frequency	Degree of Frequency	Cummulative Frequency
Less than 3	19	Low	19
3 - 5	10	Medium	29
5 and above	3	High	32

Source: Same as Table-VI·2

It will be seen from the above table that of the 40 s sample farm households 32 or 80 percent have adult working members who work in the field for 8 hours and their number varies between 1 to 6. The rest 8 households have no working member from the family and hence rely upon the hired labour or permanent, hired for the agricultural operations over the year. There are 19 farmers (i.e. 59.38 percent) who have less than 3 adult working members and can be called as the low category of households in terms of family labour. The medium category of households (i.e. 10 out of 32 or 31.25 percent) have working members varying between 3 to 5. Rest of the households i.e. 3 out of 32 or 9.38 percent have more than 5 adult working members and come within the high category in term of family labour. The relationship between productivity per hectare of cropped land and the number of working members in the family will be discussed in the next subsection of this chapter which will throw light on the allocation efficiency of family workers in terms of productivity of HYV rice in each farm households. The following table presents the villagewise classification of respondents according to the number of working members in the family.

TABLE VI.11

Classification of Respondents According to Working Members

Villages	Categories of working members			
	less than 3	3-5	5 and above	Total
Jhagarapara	1	3	1	5
Balijana	2	3	-	5
Ketokibari	6	1	-	7
Shilapani	4	1	-	5
Khara	-	-	1	1
Gog	-	-	1	1
Kheraj Daobhangi	5	2	-	7
Japarkuchi	1	-	-	1
Total	19	10	3	32

Source: Same as Table-VI.2

Spatially the households having working members less than 3 varies between 1 to 6 for Jhagarapara and Japarkuchi and Ketekibari respectively. Next to Ketekibari is Kheraj Daobhangi which has 5 households having working members less than 3. Between 3 to 5 working members, the households are distributed as 3,3,1,1 and 2 respectively for Jhagarapara, Balijana, Ketakibari, Shilapani and Kheraj Daobhanji. There are 3 households having more than 5 family fulltime working members one each in the sample villages Jhagarapara, Khara and Gog respectively.

Permanent Farm Labour.

While discussing the socio-economic profile of the sample farm households it is imperative to throw light on the types of labour used for different farm operations. Whether the cultivators wholly depend on the hired seasonal labour or the family labour or they partly depend on hired and family labour and partly on the permanent farm labour at their disposal who work in the farm at different operations all through the year with a fixed payment in cash or kind. So far as the present study for 40 farm households is concerned it is noticed that 12 households (30 percent) do not have permanent labour. The rest have permanent farm workers varying between 1 to 4 in number. The following table presents the frequency distribution of the permanent farm labours in the sample households of the Lower Brahmaputra Valley.

TABLE VI.12

Class groups	Frequency	Cummulative Frequency
1 - 2	11	11
2 - 3	15	·26
3 and above	2	28

Source: Same as Table VI·2

It will be seen from table VI.12 that maximum number of households i.e. 15 out of 28 or 53.57 percent have permanent farm labours between 2 to 3 followed by 11 households or 39.29 percent of the total, having less than 2 farm labours. Only two households are noticed to have kept 3 or more number of permanent labour.

The permanent farm labours are generally paid a fixed amount in the end of an agricultural year by the tenants. Food and clothes are given by them excluding the salary. The yearly salary varies between as low as 360 to as high as 800 per annum per labour. The distribution of salary over the year by different tenants is given below.

TABLE VI.13

Class groups	Frequency	Cummulative Frequency
Less than 400	2	2
400 to 500	4	6
500 - 600	4	10
600 - 700	13	23
700 and above	5	28

Source: Same as Table-VI-2

It will be seen from Table VI.13 that maximum number of households (i.e. 13 out of 28 or 46.43 percent) pay as salary to their permanent labour between Rs.600 to 700 per annum followed by 5 households who pay more than Rs.700/- per annum. There are 4 households each whose payment varies between Rs.400/- to 500 and Rs.500/- to 600/- respectively. Only 2 households pay less than Rs.400/- a year to their permanent labour.

The villagewise classification of the respondents according to the number of permanent farm labour is presented below

TABLE VI.14

Sample Villages	Permanent farm labours			
	1 to 2	2 to 3	3 and above	Total
Jhagarapara	1	2	1	4
Balijana	1	4	-	5
Ketokibari	3	5	-	8
Shilapani	2	1	-	3
Khara	-	1	1	2
Gog	-	-	-	-
Kheraj Daobhangi	3	2	-	5
Japarkuchi	1	-	-	1
Total	11	15	2	28

Source: Same as Table VI.2

The avive table reveals that Ketakibari has the maximum number of households(i.e.5) having permanent farm labours between 2 to 3, followed by Balijana with 4 households. Jhagarapara and Khara have one household each having more than 3 permanent labours.

It will be also noteworthy to classffy the respondents villagewise as per their range of payment as salary in money terms to their permanent farm workers.

TABIE VI.15

Sample Villages	Salary in Rupees					
	Less than Rs.400/-	400-500	500-600	600-700	700	Total
Jhagarapara	1	-	1	2	-	4
Balijana	1	-	-	3	1	5
Ketakibari	-	-	3	2	3	8
Shilapani	-	1	-	1	1	3
Khara	-	-	-	2	-	2
Gog	-	-	-	-	-	-
Kheraj Daobhangi	-	3	-	2	-	5
Japarkuchi	-	-	-	1	-	1
Total	3	4	4	13	5	28

Source: Same as Table-VI-2

It will be seen from the above table that a majority farmers (13 out of 28) pay between Rs.600 to 700 per year to their permanent labours. The distribution of the households as per their share in the sample in the sample villages is observed as 2,3,2,1,2,2 and 1 respectively for Jhagarapara, Balijana, Ketakibari, Shilapani, Khara, Kheraj and Japarkuchi. Out of the 5 households paying more than Rs.700/- per annum 3 belong to Ketakibare. This could be because of the diversity of the farm operations in this particular village where farm mechanisation is making a headway. Other two households of this village also pay between Rs.600 to Rs.700/- to their permanent farm labour.

Draught Animals

In a society predominantly agricultural in nature. the farm households are characterised by certain features such as agricultural implements draught animals etc. In traditional farm households draught animals are considered as the major assets and the economic resource as well. These animals are needed for various agricultural operations such as plogghing the land for cultivation, meeting the needs of carriage and so on. It will be worthwhile to discuss the possession of draught animals specially bullocks of the sample farm households in the Lower Brahmaputra Valley as the area of study. The following table shows the distribution of number of bullocks and buffallows possessed by the farmers for their agricultural operations.

TABLE VI.16

Class groups	Frequency	Cummulative Frequency
Less than 3	26	26
3 - 5	9	35
5 - 7	4	39
7 and above	1	40

Source: Same as Table- VI.2

It can be seen from the table No.VI.16 that a majority of the farm households have less than 3 animals at their disposals. They constitute 26 of the 40 farm households or 65 percent of the entire sample. The number of animals varies between 2 to 8. Nine households have draught animals varying between 3 to 5 and constitute of 22.5 percent of the entire sample. There are 4 households (i.e. 10 percent of the sample) who posses draught animals between 5 to 7. However, only one household has more than 7 animals at its disposal of which 2 are buffallows, 6 are bullocks and three calf.

Fragmentation

Fragmentation in Indias agricultural scene seems to have occupied a pivotal position as a serious problem amongst many others. Cultivated land often gets divided owing to the death of the head of the family or to the breaking up of an extended family among the dissenting brothers. Irrigated agriculture is highly associated with fragmentation. Lands of different qualities therefore come under a single ownership. But sometimes commercialised and larger farms are less susceptible to be more fragmented. Roy and Fligel et al[9] are of the view that fragmentation index is related

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9. Prodipto Roy,C. Fligel,et.al(1968) Agricultural inno-vations among Indian farmers, NICD, Hyderabad, p.34

negatively[10] with the value of agricultural products raised and also with commercialisation index.

In case of Brahmaputra Valley of Assam this problem has been long standing. Land holdings in Assam and specifically in the Valley are fragmented into small pieces which stand as obstacles for the farmers to go in for the introduction of new innovations in the farms such as HYV rice and other food and non-food crops. The surveys of rural economic conditions conducted by the government of Assam during the period 1948-49 revealed that the great majority of the holdings are in scattered fragments and a large number of households have fragments of the holdings outside their villages.[11] Datta is also of view that 81.70 percent of the holdings are fragmented and the average number of fragments per holding is 3.6. The average number of fragments per holding for Goalpara district has also come out to be 3.2.[12]

So far as the present study is concerned the problem of fragmentation in case of the sample households in two districts such as Goalpara and Kamrup is equally serious

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10. Prodipto Roy C. Fligel,et.al., Op.cit. p. 34. The authors have found out r=21 for fragmentation index and value of agricultural products raised and r =-.39 between the farmer and the commercialisation index.

11. N.C.Dutta, Land Problems and Land returns in Assam,Delhi, op.cit., p.101

12. Ibid. p.101

and needs urgent attention for its consolidation. The number of fragmented fields irrespective of the size of holdings for the sample households varies between as low as 2 to as high as 12. However, the agricultural land of one households has not been split up into tiny pieces.

The following table reveals the condition of fragmentation in case of the sample households under study.

TABLE VI.17
Distribution of the number of fragmented fields

Class groups of No. of gragments	Frequency	Degree	Cummulative frequency
Less than 2	1	Very lwo	1
2 - 4	8	Low	9
4 - 6	14	Medium	23
6 - 8	8	High medium	31
8 - 10	3	High	34
10 and above	6	Very high	40

Source: Same as Table-VI·2

It will be seen from the above table that the households coming under low, medium and high categories of fragmentation are 9,22, and 9 respectively. The percentage distributions for the above categories such as low, medium and high are 22.5, 55 and 22.5 percent respectively. Of the low fragmentation category, one household falls within the very low group i.e. less than 2 is in fact derived of fragmentation. Maximum number of households i.e. 14 of the 40 sample farm households constituting 35 percent of the entire sample come within the medium category of fragmentation the number of fields varying between 4 to 6. High medium, high and very high categories of households in term of fragmented fields are 8,3 and 6 respectively whose number of fields varies between 6 to 8, 8 to 10 and 10 above with a percentage share 20 percent, 7.5 percent and 15 percent respectively. It can be infered from the above analysis that considerable number of households i.e. 77.5 percent of the entire sample are of medium and high categories in terms of their fragmented agricultural land. The relationship between the number of fragmented fields and the levels of productivity will be meaningful attempt to study how fragmentation is a social/economic hindrance for resource use and also for achieving higher level of crop productivity especially HYV rice in the Lower Brahmaputra Valley.

Off-farm Occupation

While discussing the diffusion and distributional pattern of the HYV rice in the study area (i.e. the Lower Brahmaputra Valley) it becomes necessary to highlight the occupational status of the sample farm households other than cultivation. Because, it throws light on the financial capability of the farmers to go in for the cultivation of HYV rice which is capital intensive in nature. Of the 40 households under study 23 or (57.5 percent) have family members at least one or more who is/are engaged in different activities within or outside the village. The occupations include teachership, government services (such as forester, clerkship, medical jobs(such as Asst.Professor, registrar,) construction works, business and so on. The total number of people engaged in different activities is 34. The household-wise number of members engaged in off farm occupation is given in the Appendix Table 18. The Table presented in the Appendix Table 18 reveals that the village Jhagarapara in the western part of the study area has 6 out of 8 households or 75 percent who have members at least one or, more being engaged in off farm occupations such as teachership, job in the forest department, construction work, government services, business and so on. Balijana has 4 households out of 6 being engaged in occupations other than cultivation. The family members from Balijana having off farm occupation are one from each household. Ketakibari another eastern sample village of the study area has 7 out of 9 households or 77.77 percent have family members who are having off farm occupations such as teachership, clerkship, medical jobs, business, and contractor etc. The maximum number of members having this kind of occupation is 4 and minimum is 1. Khara, a sample village has two households out of 3, one member each of which is engaged as teacher. Kheraj Daobhangi a sample village in the western part of the area under study has as many as 3 households out of 7 or 72.84 percent who have members 3, 1 and 1 each being engaged in different off farm jobs such as clerk, doctor, government service and business. Shilapani is the ohly sample village which does not have any household having jobs other than cultivation.

Indebtedness and Sources of Finance:

Here, an attempt has been amade to ascertain how many cultivators in the sample of 40 are resorted to borrowing in the preceeding agricultural seasons. The informations and data collected at household level reveal that as many as 7 or 17.5 percent cultivators have borrowed money either from money lenders, or financial agencies. It has also been conformed from the individual farmers while having personal interview with them that even if most of the respondents are not indebted or have not borrowed money from any sources, nevertheless their financial situation is not very favourable to go in for the adoption of scientific technology in their farm. Becuase of higher interest many of them have not dared to be in debt irrespective of their financial position. Specifically the money lenders are the principal sources of finance in need.

Of the seven cultivators who are yet to pay off their debt 4 have borrowed money from the village money lenders with 10 percent interest. The following table presents the villagewise borrowing in rupees from different sources

TABLE VI.18

Villages	Sources of finance			
	Money lender	Irrigation Dept.	Tribal Development Corporation	Co-op. bank
Jhagarapara	-	-(1)	-	-(1)
Balijana	-	-	-	-
Ketakibari	Rs.2000/-(1)*	-	-	-
Shilapani	Rs. 500/-(2)	-	-	-
Khara	-	-	-	-
Gog	-	-	-	-
Kheraj	-	-	-	-
Japarkuchi	-	-	-	-

*Figures in the bracket indicate the number of farmers

Source: Same as Table-VI.2

So far as the interest is concerned, the tribal development corpporation is said to have fixed the same to the tune of Rs.6/- per 100. It is infered from the above analysis that the government agencies appear to be very ineffective in terms financial help to the farmers which have created a grave concern among them. Table VI.20 reveals that the distribution of households in terms of indebtedness is very uneven. Sample cultivators in as many as 4 out of 8 villages have not lent money from none of the sources mentioned in the Table VI.20. In Shilapani 3 out of 5 cultivators adopting HYV rice cultivation are in debt to the tune of Rs.200/-, Rs.500/- and Rs.500/- respectively. All of them have borrowed from the money lender. One cultivater from Jhagarapara has borrowed from the irrigation department for buying diesel pump. In Ketakibari also one cultivator has borrowed from money lender to the tune of Rs.2000/- with an interest rate of 10 percent.

Possession and use of advanced agricultural implements

So far as the possession and use of advanced agricultural implements among the sample households are concerned it is noticed that of the 40 households 9 households or 22.5 percent own advanced implements such as dieselpump, sprays, weeder, thresher and duster etc. Of the entire sample 23 out of 40 or 57.5 percent have used these implements in different agricultural operations. Excepting the 9 households who both own and use these implements the rest 14 or 35 percent of the entire sample do not own any implement but have only used by getting them hired for free of cost from the CD blocks. 17 cultivators or 42.5 percent of the total sample have neither owned nor have they ever used the advanced implements in the varioas operations of cultivation.

The cultivators only using, both using and owning, and neither using nor owning the above advanced agricultural implements have been listed in the Appendix-Table19. Of the 8 sample villages under study the cultivators of the village Ketakibari introducing HYV rice in their farms are noticed to have used a variety of implements such as weeder, thresher sprayer and lift irrigation etc. Because of the provision of lift irrigation in this village a substantial share of the cultivators have also intreoduced HYV rice cultivaton in their farms. The cultivators of the village Jhagarapara widely use diesel pump and most of the sample cultivators own also to meet the need of the irrigation of HYV rice. A few cultivators (i.e. 3 of the 7) use diesel pump, sprayer and weeder for the better cultivation of HYV rice. Only one cultivator in this village both own and use weeder, sprayer duster and diesel pump for HYV rice cultivation.

Marketable Surplus(Rice)

So far as the marketable surplus of rice in the area is concerned it is mostly consumed in the family and sold in small quantity to clear, debt, land revenue and to fulfil other needs. In the sample farm households only 16 out of 4 or 40% of the cultivators have surplus. The rest 24culti-vators or 60 percent of the entire sample either do not have any surplus living at the subsistence level or they depend on the market at the time of deficit. It has also been confirmed that a substantial number of farmers having no surplus buy rice along with other essential commodities such as oil, sugar, dal and jute etc from the market for rest of the season in an agricultural year. Surplus of total rice in kg. among the surplus cultivators varies between as low as 111.97 kg to as high as 4478.9 kg . for the villages shilapani and Ketakibari respectively. The lowest and the highest surplus cultivators are from either extremes of the study area such as western and eastern respectively. The following table presents the frequency distribution of surplus rice in kg.

TABLE VI.19

Class groups of rice in kg.	Frequency	Degree	Cummulative Frequency
Less than 800 kg	8	Very low	8
800 - 1600kg	2	Low	10
1600 - 2400 kg	3	Medium	13
2400 - 3200 kg	1	High medium	14
3200 - 4000 kg	1	High	15
4000 and above	1	Very high	16

Source- Same as Table-VI.2

It will be seen from the above Table that 50 percent (8 of the 16) surplus farmers in rice production, are of very low category in terms of surplus which varies between as low as 111.97 to less than 800 kg. Two households fall within the low category of surplus, the amount varying between 800 to 1600 kg. Medium and high medium categories of farmers in terms of rice surplus account for 7.5 and 2.5 percent or (3 and 1) of the entire set of surplus generating farmers. The ranges of surplus for the said categories are between 1600 to 2400 kg. and 2400 kg to 3200 kg respectively However, the high and very high categories of farmers constitute only 1 each (or 2.5 percent each) of the 16 surplus farmers whose surplus varies between 3200 kg to 4000 kg and 4000 kg and above respectively.

So far as the surplus from the HYV rice is concerned only 7 of 16 households or 43.75 percent of the surplus group of farmers generate surplus from the High yielding varieties of rice. The quantity of surplus rice from HYV varies between as low as 111.97 kg to as high as 4478.9 kg for the village Ketakibari. It may be recalled here that the highest surplus cultivator from Ketakibari has been specializing in HYV rice only because of the farmers inclination towards mechanisation of his farm. On the other hand the village is also equipped with lift irrigation facilities for agriculture. Most of the sample farmers of this village have achieved higher productivity per hectare because of a high dessemination of technical knowledge among them. The most important point is that 6 out of 7 or 85 percent surplus farmers of HYV rice are from this village. The above mentioned farmer achieving the highest surplus of HYV rice also belongs to relatively higher caste (i.e. Kalita) in the caste hierarchy of Assam.

What appears from the above discussion is that most of the representative farmers adopting HYV cultivation of rice are still below subsistence level. The improvement of the economic conditions of this sizable lot of farmers needs urgent attention of the government.

Nearest Market Centres

In an agricultural economy, market centres of daily, weekly, and permanent transactions play vital role for buying and selling the agricultural commodities. Once the landuse theorist von-then-neu explained that the type of land use[15] will vary with the distance from the market. In the present sample of 40 households taken from 8 different villages of the Lower Brahmaputra Valley where rice is the dominant crop it is noticed that the sample villages are either located nearest to a market[14] or the markets have developed of their own to meet the need of buying and selling the agricultural commodities produced in the nearby villages. The villages and the nearest markets with distance are presented in Table VI.22

15. M. Husain(1979) Agricultural Geography Delhi,p.159

14. Ibid.,P.159-164. For detailed discussion on market and landuse relation in von-thunen's model.

TABLE VI.20

Villages	Nearest Market	Distance (Approx) in K.M.
Jhagarapara	Dhubri	2.5 Kms
Balijana	Balijana	0.5 Kms
Ketakibari	Borombol	1.5 Kms
Shilapani	Lakhipur	2.0 Kms
Khara	Dhdhnoi	2.0 Kms
Gog	Baihata	4.0 Kms
Kheraj Daobhangi	Gouripur	3.5 Kms
Japarkuchi	Nalbari	2.0 Kms

Source: Same as Table-VI.2

It can be seen from the Table VI.22 that Balijana has the closest distance (i.e. 0.5 kms) from its market Balijana which is a weekly market. Ketakibari from its nearest market Boromboi is located approximately 1.5 Kms away. The market meets twice a week. Next to Ketakibari in terms of nearest market distance are Shilapani, Khara and Japarkuchi being located approximately 2.0 Kms away from their respective markets such as Lakhipur, DDudhnoi and Nalbari. Lakhipur and Dudhnoi are small towns and serve the purpose of daily marketing. Nalbari is a medium town and the sub-divisional headquarter. Then comes Jhagarapara in terms of distance. This village is arround 2.5 Kms away from its market Dhubri, which is a big urban and commercial town and serves the purpose of all kinds of business transactions such as agricultural, industrial etc. Kheraj Daobhangi another sample village is situated approximately 3.5 Kms from its nearest market Gowripur which is a small town and close to which daily and weekly markets are located. Gog, a sample village in the eastern part of the study area is arround 4.00 Kms away from its nearest market Baihata Charali which is a permanent and daily market for the nearby villages. It has developed at the meeting point of two national highways near the village Baihata.

It can be infered from the above analysis that the sample villages enjoy a good network of markets for disposing of and purchasing their agricultural commodities. But most of the villages lack the facilities of technical consultancy and other advanced know how such as HYV cultivation etc which are basically available in relatively bigger urban centres.

Communications

The acceptance and introduction of any technical innovations becomes successful only when the innovators are said to have made up their mind through others influence, and pursuation through personal trial, through instructions from the concerned technical agencies and so on. Finally the success of a particular innovation gets diffused among the fellow beings in such a way that it brings about altogether a social change. This change is reflected in many ways such as the attitude and outlook of the people etc. Hence the socio-cultural characteristics and the nature of the innovations are partly and equally responsible for the successful adoption failure in adoption of an innovation.

The most vital aspect of getting the innovation diffused over a social plain is to disseminate the knowledge about the innovation. The spread or the diffusion of knowledge will be possible through several media such as personal contact, public demonstration, media of mass communications including radio, newspapers, documentary film shows and so on. Personal contact will be easily carried on in compact areas. But in the areas of scattered population mass media are the only channels to educate, persuade and convince the people. Hence personal contact also cannot result in desired success unless the people are comprehensively brought home to. Care and attention is also to be taken towards more traditional society in which close personal contact and negative attitude of the community count much without the prior consent of the community as a whole to accept a new innovation. The different media are also supposed to be effective so as to have a positive impact on the physical, social and psychological aspects of the community.

Since the present investigation encompasses the study as to how effectively the diffusion of a new technological innovation called the exotic varieties of High Yielding rice has occured in the countryside of the Lower Brahmaputra Valley, the assessment of the role of a group of communication media draws urgent attention. For the purpose 40 cultivating households as a representative sample from eight such villages have been taken into review. The first sources of communication concerning the benefit of the cultivation of HYV rice in the sample villages as responded by the cultivators can be sorted out as follows.

i- Village Level Worker

Of the 40 respondents to have introduced HYV rice cultivation 8 or 20 percent of them are noticed to have been informed about the High Yielding Varities of crops in general and rice in particular by the village level worker. Maximum of these cultivators are from the village Ketakibari (i.e. 6 out of 8 or 5 percent) alone. The rest 2 or 25 percent are 1 each from Jhagarapara and Kheraj Daobhangi, the western villages of the study area. Though these cultivators received only information about the benefit of growing HYV crops in terms of higher productivity, from the village level worker but the other relevant technical informations about the HYV cultivation were received by them from the agriculture specialists of the community Development Blocks. Because the village level worker is as good as a laymen in these respects.

ii- Personnels of the Community Development Blocks

Community Development Blocks play decisive role in the area under study in disseminating knowledge about the scientific and advanced agricultural practice. In the present sample of cultivators majority from almost all the villages (i.e. 21 out of 40 or 52.5 percent) appear to be in contact with community development block so far as the cultivation of HYV crops is concerned. 21 cultivators have received information and technical knowledge from the blocks agricultural officer. Many of them are said to have personaly met the block officials. Except the cultivators of Ketakibari under study all others from rest of the villages have got both informations and know how from the block. But the sample cultivators from Ketakibari seem to be more progressive in terms of farm mechanisation the know how of which has mostly been dictated by the block officials.

Direct Observation from Own Village.

A few cultivators from the sample which account for 6 out 40 or 15 percent of the entire sample have been confirmed by personal interview that they have introduced the HYV rice in their farm by direct observation from other progressive cultivators of their respective villages. These cultivators are one each from the villages Jhagarapara, Balijana, Ketakibari and Kheraj Daobhangi respectively. The sample cultivator fromJaparkuchi village of Nalbari subdivision is said to have been informed of the

The following Table shows the villagewise classification of respondents in terms of various communication media from which the farmers have been aware of the HYV rice cultivation as well as the technical know how involved in it.

TABLE VI.21

Villagewise classification of the respondents according to different communication/information madia

Villages	The media of information							
	Village level workers	Personals of CD blocks	Panchayat office	Samavay Samaty	Observation from village	Observation from outside the village	Radio and News papers	Total
Jhagarapara	1	5	-	-	1	-1	-	8
Balijana	-	4	-	-	2	-	-	6
Ketakibari	6	2	-	-	1	-	-	9
Shilapani	-	4	1	-	-	-	-	5
Khara	-	3	-	-	-	-	-	3
Gog	-	1	-	-	-	-	-	1
Kheraj	1	3	-	1	1	-	-	6
Japarkuchi	-	-	-	-	1 (Village head)	-	-	1

Source: Same as Table VI·2

The above table shows the number of respondents and their sources of information about the High Yielding culture.

HYV cultivation from the village headman.

Other Sources

Other sources in the present case include Samavay Samity and Panchayat Samity. Two from among the sample cultivators have responded on the question of first source of information about the adoption of HYV rice that Samavay Samity and Panchayat Samity have been the source of their information of HYV rice introduction. Because these varieties give higher Yield per unit area. But the other technical informations about the HYV culture has been received by the specialists of agriculture in the Community Development Blocks. These cultivators are one each from Jhagarapara and Kheraj Daobhangi villages respectively.

However, not a single respondent received the idea of HYV culture from the discussion over the mass media such as radio and Newspapers. Though a few of the sample farmers have listened to radio it has however, been tough for their understanding.

In the light of the above discussion it can be infered that the communication media in spreading the news of benefit of the HYV culture have been ineffective for a better understanding of their technical innovation among a majority of poor and uneducated farmers more and effective extension services through personal contact and via mass media are some of the pressing needs to achieve speedy diffusion among them.

Major Socio-Economic and Cultural Correlates and Inter-correlations among them

In the present sample study productivity of HYV rice has been considered as an indicator to understand as to how enthusiastically a farmer has adopted a new technological innovation with the existing socio-economic and cultural environment arround him. It can also be hypothesised that better productivity in terms of yield in Kg. per hectare is the outcome of a better organisation and utilization of farm resources. It also suggests that the farmer has a better socio-economic and cultural background which has helped him achieve this goal. Apart from the purely economic inputs the socio-cultural factors play a vital role not only in achieving higher productivity but also in adopting a new innovation as for example introduction of HYV rice. The adoption of this innovation will fast spread among the cultivators provided it does not receive any socio-cultural resistance. Of course, the farmers have to be pursuaded and convinced via different media, but an educated farmer will understand and adopt it faster than his uneducated and illitrate counterpart. A young enterprising energetic and educated farmer will be paying more attention towards scientific farming by introducing new innovation.

The present discussion is an attempt to assess the major socio-economic and cultural correlates of productivity of HYV rice. It also finds out the inter-relationship among these socio-economic and cultural variables. In view of the above discussion it can also be examined that whether higher productivity is associated with positive socio-economic and cultural correlates or not. The following socio-Economic and cultural factors have been taken into consideration.

i - Holding Size
ii - Education
iii - Age
iv - Family Size
v - Religion
vi.- No.of working members
vii - No.of Fragmented fields
viii - Yield of High Yielding Varieties of rice.

Inter-Correlation

A farmer's social status and importance is sometimes well conceived of from his holding size. It will be worthwhile if the holding size as a social variable is correlated education, age, family size religion, family working members and the fragmentation of agricultural land. So far as the sample households in the present study is concerned it is interesting to note that holding size is positively related with the above variables. Meaning there by, the holding sizes increases with the corresponding increase in education, age of the farmer, family size, religion, working members of the family, fragmentation of the cultivated fields etc. However, religion as a cultural factor has been quantified by assigning scores such as 1.5 to Hindu and 1.25 to Muslims under the hypothesis that Hindus are socially in a more advantagious position than Muslims.

But the relationship appears to be highly insignificant (r=0.021) with education age (r=0.196), family size (r=0.251), religion (r=0.173) number of working members (r=0.236). However, the size of holding and the number of fragmented fields are significantly correlated (r=0.417)at 1,5 and 10 percent levels. Coming over to the educational of the farmers, it is noticed that the former is negatively correlated with age(r=-0.353), family size (r=-383), number of working members (r=-0.37) and number of fragmented fields (r=-0.156). But with religion the relationship is positive (r=0.164). As the level of education increases the age of the farmers decreases and same is the case with family size, number of working members in the family and the number of fragmented agricultural fields. It is obvious that young farmers are more educated than the older ones.

In small families, it is financially easier to get education. In educated families also members working in the field will be less as evident from the above correlation analysis. Since level of education and number of fragmented fields in the sample households are negatively correlated it can be infered that educated families are not in favour of spliting up their cultivated lands. Education and religion being positively related, it can be said according to the quantitative grading of religion that Hindus among the sample households are more educated than the Muslims. So far as the statistical significance of the relationship is concerned it is observed that education and age are significantly related at 5 and 10 percent levels of significance. The relationship between education and family size is significant at all the levels except 1 percent. With religion it is insignificant at 1,2, 5 and 10 percent levels. With number of working members, it is significant at 2,5 and 10 percent levels. But at 1 percent level it is insignificant. With number of fragmented fields the relationship of education is also insignificant at all the levels.

Age of the farmers is positively related with family size (r=0.558), number of working members (r=511), number of fragmented fields (r=0.214) but it has insignificant regative relation with religion. The relationship is highly significant for family size at all the levels, for number of working members at all the levels except the number of fragmented fields which is insignificantly related at all the levels.

Family size is positively related with number of working members and number of fragmented fields, the relationship being significant at all the legels for number of working members and at 2,5 and 10 percent levels for number of fragmented fields. As the family size increases, the working members also increase simultaniously. Fragmented number of fields also increase with the corresponding increase in family size.

But family size is negatively related with religion, the relationship being insignificant. However it implies that family size increases with decrease in religion or the vice versa. According to the scores assigned to the religion, Hindus have small family size than Muslims under study.

Religion is positively and insignificantly related with number of working members and number of fragmented fields. But number of working members in the sample households is positively related with the number of fragmented fields the relationship being insignificant at all the levels.

The following table presents the matrix of intercorrelation between the socio-cultural variables of the sample households under study.

TABLE VI.24

socio-cultural Variables*							
X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
1	0.021	0.196	0.251	0.173	0.236	0.417	0.357
	1	-0.353	-0.383	0.164	-0. 37	-0.156	-0.011
		1	0.558	-0.055	0.511	0.214	0.068
			1	-0.259	0.422	0.345	0.019
				1	0.004	0.039	-0.216
					1	0.184	0.236
						1	0.161
							1

*X_1 = Holding size

X_2 = Education

X_3 = Age

X_4 = Family Size

X_5 = Religion

X_6 = Number of working members

X_7 = Number of fragmented fields

X8 = Yield of High Yielding Varieties of rice.

Socio-Cultural Correlates and Productivity

Since the productivity is the resultant of a series of socio-economic and physical factors, it will be meaningful if a relationship is established between the productivity of HYV rice and its socio-cultural correlates. In the present case an attempt has been made to know as to how socio-cultural factors influence the productivity and what is the degree of their relationship with the same. So far as the sample farm households are concerned it is noticed that holding size has a positive relation with productivity of HYV rice (r=0.357), the relation being significant only at 5 and 10 percent levels. Education and productivity are negatively and insignificantly correlated (r= -0.011) Family size and age are also related insignificantly and positively with productivity (r=0.019 and r = 0.068 respectively). Religion and productivity are insignificantly and negatively related (r=0.216). Productivity is again related with number of working members in the farm families and the number of fragmented fields positively the relationship being significant at 10 percent level for workigg members (r= 0.236) and insignificant at all the levels for number of fragmented fields (r=0.161).

It can be infered from the above analysis that the socio-cultural variables cannot be considered as good explanatory variables of the variation of productivity of HYV rice. The impact seems to be insignificant on the yield pattern of HYV rice in the study area.

BARRIERS IN THE DIFFUSION AND RELATIVE PROFITABILITY OF HYVs RICE - AN INTER-HOLDING ANALYSIS

The process of socio-economic transformation, with the advent of modern technology in recent times, has been a global phenomenon. Though this change can be put forth as a visual expression and can be compared with the violent tidal waves in the ocean having few focal origins, but there appears to be a dearth of theoretic, as well as methodological view points to enquire into the structure of this change. The change specifically in the rural communities also can be of many underlying dimensions, such as agricultural, industrial and so on. At present, however, there does not exist a field of study which analyses the economic and social processes that are transforming village communities in the developing world, and relates village to national development.[1]

There are, infact, some basic hindrances which are supposed to be highlighted while studying the details of micro level development. The three most important can be discussed with much insight. First, the communities going through the process of socio-economic change are in number and different from each other. A primary survey though, can be undertaken to study the

1. Irma Adelman and George Dalton,(1971) A factor analysis of modernisation in village India, Economic Development and Social Change, The Modernisation of Village Communities.(ed.) New York, p.492.

process for specific communities, but the findings and the conclusions cannot be generalized to other villages because of a wide range of variations. Second, the field information on the socio-economic structure seem to be inadequate and the accuracy also, dubious. Third, the lack of theoretical models for studying the sequential change and development at the village level has also posed problems for a theoretically persuasive and amenable policy for implementation.

Social scientists of various disciplines are concerned with the introduction of innovations and highlight in their studies, different aspects of the transformation process. They have also, arrived at the conclusion that the policies in connection with the modernisation of the social life are met with numerous disparate and mutually interacting forces. Development planners who must devise policies to apply at the village level therefore, have no knowledge of the functional relationships among variables of the kind available to planners working on macro-economic development.[2]

The actual results of economic development in India have fallen, short of the planners' objectivies and the peoples aspirations. The view is widely held that the plan programmes have themselves been responsible for the widening

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2. Irma Adelman and George Dalton, op.cit. p.493

of inter- and even intra-regional disparities in various socio-economic fields[3]. Social and economic inequalities are reflected, not only in interpersonal and intergroup differentials, but also in inter-regional inequalities. However, the problem of inter-regional imbalances has two aspects, intra-regional and inter-regional imbalances in economic development both of which have received attention in each of the successive Indian Five Year Plans of development[4]. In fact, balanced growth of all the regions, disprsal of industries and the extension of benefits of progress to the backward regions have all along been major objectives of planned economic development of the country[5].

But, irrespective of the plan objectives and the consequent programmes, in which minimisation of the inter-regional inequalities is one of the many concurrent issues, the inequality has started widening because of the fact that the already developed and other metropolitan regions

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3. S. Prakash, and A.C.Mohapatra,(1980) Economic development in the state of Madhya Pradesh, India - A study of inter-temporal and intra-regional variations, Third World Planning review, Vol.2, No.1,p.91.

4. Ibid. p.91

5. Ibid. p.92

have still been the points of gravitation in terms of new investments and enterprises in both private and public sectors. The backward and underdeveloped regions have been conciously bypassed, thereby being a concern for the social scientists to find out alternatives for such widening disparity in development in a spartial dimension. Therefore, it may be stressed here that in an economically underdeveloped and backward region, the new innovations in either the sectors of economy such as agricultural and industrialwill be a difficult task unless adequate infrastructural facilities are developed and the economic conditions of the people are improved as observed in the developed metropolitan regions of the country. The reason as to why the investment still increases in industries is that the latter yields more than average returns on investment. But the activities such as agriculture, irrigation, animal husbandry, dairying, fishing, education, water suply, cottage industry etc. generally, give less than average return on investment.[6] But, these are supposed to spread the socio-economic development and the agricultural infrastructures become the basis of the diffusion of new innovations in the farms. It is obvious from the above discussion that the inequalities and the plan design have been made inter-related for the development itself.

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6. S. Prakash and A.C. Mohapatra, op.cit.p.92

The seeds of HYV have been made available to the farmers in different regions of the country, but at the same time, the necessary input facilities such as supply of fertilizer, irrigation facilities and other infrastructural necessities have not been ensured in all the regions, thereby posing the problem of package practice.

The problems in the plan implementation and the inequalities in the spatial dimension of the economic development, therefore, remain unexplored, unless studied in a theoretic framework. It draws urgent attention of the researchers to analyse and explain the economic inequalities in terms of cost and benefits to the economy. It is also imperative to discuss whether they stand as the real accelerators or the impediments in the changing process of economic growth. The most important aspect of studying inequalities is to explain them through the underlying factors that lie behind them as a result of which the functional relationship between the variables can be found out for a suitable policy implementation. Once the existing inequalities are known through statistical estimation, even for macro-regions, it will be easier to come down to micro-analysis such as a village.

In the present chapter, an attempt has been made to explain the principal factors that lie behind the agricultural development of the Lower Brahmaputra Valley in general and the diffusion and distributional pattern of High Yielding Varieties of rice, a new technological innovation in the agricultural farms in particular, keeping in view the existing socio-economic conditions of the peasantry. It has been felt imperative to explain the prevalent inequalities in the distribution pattern of factors of productions, such as area, inputs and yield among the many cultivating households of the area under study. For the purpose, some sample households have been taken into consideration. The relative gains from the adoption of HYV rice have been discussed with the help of an analysis explaining the unequal distribution of area and yield and the concentration of the same in a few particular strata of the sample households. The cost and benefit acrued from the introduction of HYVs in terms of unit area and unit production has been calculated, whether the HYV cultivation of rice will be a successful innovation with the socio-economic and infrastructural background of the area under study.

It is obvious that many socio-economic and cultural forces are visualized when a new innovation starts getting acceptance among the farmers, but of several factors at work, an attempt has been made to isolate the few that are most important by factor analysis. Suggestions and the policy uses of the factors have been explored subsequently. However, the basic objective of the factor analysis is to reduce a large number of variables to a few factors which explain maximum variance in terms of percentage in the structural system of the factors.

As far as the present exercise is concerned, the first point of discussion focusses attention on the analysis of the component factors the objective of which is to group the variables into a few clusters of factors, according to the closeness of the linear relationship between them. The study is primarily based on the field data procured during the sample household survey of eight different villages of the Lower Brahmaputra Valley of Assam. It had been intended prior to the survey conducted to gather comparable information from the cultivating households on the structure and performance of village communities in regard to their reactions towards the introduction of new skills, technology and the High Yielding crops in the agricultural farms. Of a variety of information collected through direct interview with 40 farmers adopting HYV rice in their farms, few specified sets of variables have been chosen for factor analysis. The sets of variables pertain to various socio-cultural variables indicating the social background of the farmers and variables concerning the land use characteristics of the farmers. Each set constitute of seven, and four variables respectively for socio-cultural characteristics and land use characteristics. In order to have a comparative study between the High

Yielding and the local traditional varieties of rice in terms of the clusters of variables being closely inter-correlated the land use variables have been taken into account. The analysis concerning the comparative study has thereafter, been broken up into two parts for the above varieties of rice separately. The sets of variables concerning the land use characteristics are presented below.

Set I HYV of Rice	Set II Local Rice
i - Area under HYV rice	i - Area under local rice
ii - Net cropped area	ii - Net cropped area
iii - Gross cropped area	iii - Gross cropped area
iv - Double cropped area	iv - Double cropped area.

Finally the underlying dimensions or the factors involved in the socio-economic and cultural characteristics of the farmers have been analysed in terms of clusters of variables being significantly and linearly interrelated. The set of such variables chosen for the study is presented below

Set III Socio-economic and cultural variables

i - Holding size
ii - Education
iii - Age
iv - Family size
v - Religion
vi - Number of working members
vii - Number of fragmented fields

Several variables have however, been discarded from the study of factor analysis because of the fact that the variables lack systematic association with the included variables, that the data concerning these variables are inadequate, sometimes misleading and underreported. Such variables include, indebtedness, caste, communication media, etc. The caste structure[7] of Assam was felt so confusing and indistinct that this variable was deleted from the analysis of component factors. That too, the entire sample constitutes of both Hindus and Muslims around 50 percent each. If caste would have been taken into consideration, then the muslim households were supposed to be deleted because they do not belong to any caste stratum. As far as indebtedness, cooperative facilities, and the communication media about the first source of knowledge of HYV rice cultivation are concerned, the data was inadequate in case of the first two variables and third one was not considered because it did not have much impact on the adoption and yield pattern of HYV rice as reported by the individual farmers. Even if, the farmers were aware of the benefits of HYV cultivation at the first hand information but the adoption depended on the availability of adequate resources and operational

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7. Mention may be made here that the Vaishnabite movement in Assam has led to intermixing of castes in a great way which is unimaginable elswhere in the country.

capital. On the other hand, the variable seems to have lacked systematic association with the other included variables. The same is the case with many other variables which have been discarded.

Switching over to the variables included in the analysis, the importance and the method of quantification of the same were presented in the following fashion.

Of the three sets of variables taken into account for the analysis of principal factors, two are concerned with agriculture and third one relates to the socio-economic and cultural background of the farm households who have been practising High Yielding cultivation of rice in their farms.

Before going into the details of the variables, it may be pointed out that the area under study i.e. the Lower Brahmaputra Valley being agriculturally one of the most suitable areas of the country, has hardly undergone any significant charge in the agricultural sector during the last two decades, inspite of the much talked about Green Revolution. The production process and the practice in agriculture in this area have remained as traditional as it is observed even today. It is still, a debtable issue whether the plan implementation programmes have structurally failed which could be mostly attributed to the poor infrastructural development or the socio-economic and cultural factors of the farmers, which have impeded the policies of agricultural development in the region. Farm mechanisation, through technological innovations is yet to be achieved in this area, even though it is a common phenomenon in the region like Punjab, Haryana, Western U.P. etc. The cultivation of HYV of rice has though,already made head way in other parts of the country, but the process of its diffusion is still to gather momentum in the Lower Brahmaputra Valley region the reasons of which are numerous and mostly relate to socio-economic and cultural factors. It will be an interesting study to throw light on those factors which inhibit the adoption of these variaties by the farmers. It will be worthwhile also to discuss the nature and importance of the variables chosen for the study.

A - Land use

Land being one of the most crucial factors of agricultural development,is also considered to have played the keyrole in the adoption of new innovations such as the HYV of rice in specific and the farm mechanisation in general. The net area sown or the amount of land determines as to how effectively and intensively it can be brought under plough during an agricultural year. In order to maximise the farm income there should be a viable unit of land in which investments on different heads such as advanced inputs, indivisibles like tractor, threshers,weeders etc. do not stand uneconomic in the production process. For this purpose, three principal land use characteristics such as net area sown, gross cropped area and the area sown more than once during an agricultural year have been chosen for the analysis of component factors. Besides these, area under High Yielding Varieties of rice per household has been included as a variable which can be considered as one step towards the farm modernisation or advanced practice in agriculture. In order to have a comparative study between the High Yielding culture of rice and its traditional counterpart, area under traditional varieties of rice has been included alongwith the above mentioned land use variables to form a separate block for the analysis of principal component factors explaining maximum variance in relation to a particular factor.

i - Net area sown

The actual area under cultivation(net area under plough) of the individual farmers has been chosen for the analysis. Net area amongst the sample households varies between 0.675 hectares to 6.953 hectare with an average figure 2.815 hectares per household. This variable as a limiting factor for the introduction of High Yielding Varieties of rice and for the economic utilization of farm resources and its relation with the other land use characteristics has however been highlighted in the preceeding chapter.

ii - Gross Cropped Area

This indicator shows how the net area shown is inflated during an agricultural by double and multiple cropping of different field crops. The actual figures of the gross area sown have been taken into account for all the cultivating households in the sample. The gross area varies between as low a figure as 1.283 hectares to that of its high counterpart i.e. 9.315 hectares with an average gross acreage 4.594 hectares per household.

iii - Double Cropped Area

The area sown more than once indicates the double cropped area. It suggests that more is the double cropped area higher is the intensity of cropping. It is the absolute difference between the gross and the net acreage under cultivation. It ranges between 0.067 hectare to 2.835 hectares with an average fivure 1.779 hectares for the sample households.

iv - Area under HYV of Rice

The actual figures of the area under HYV rice for the sample households have been taken into consideration for the analysis. It has a range between 0.068 hectares to 2.025 hectares with an average area 0.464 hectare. Its relation with the other land use variables has been discussed in the preceeding chapter.

v - Area under Local Rice

The area devoted to only local traditional varieties of rice such as Ahu and Sali has been considered for the factor analysis in this chapter. This indicator varies between 0.945 hectares to 7.95 hectares with an average area 3.132 hectares per sample household.

B - Socio-Cultural Variables

Socio-cultural characteristics form the basis of the diffusion of modern innovations in agricultural sector. A variety of studies on such characteristics of the farmers show that new innovations have mostly been adopted by young, educated, higher caste and large farmers.[8] According to Bose, Rahim and others the large farmers generally adopt innovations much earlier than small farmers.[9] Education of

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8. For detailed discussions on diffusion of innovations and characteristics of farmers see: Everett.M.Rogers,(1962) Diffusion of innovations, Free press of Glencoe, New York.

9. Santipriya, Bose(1961) Characteristics of farmers who adopt agricultural practices in Indian villages, Rural Sociology, Vol.26,pp.138-145, S.A. Rahim(1961) Diffusion and Adoption of Agricultural Practices - A study in a Village in East Pakistan, Pakistan Academy of Rural Development, Commilla, East Pakistan.

farm people regarded as an investment in human resources is believed to contribute to farm productivity and differential rate of diffusion of technological change among farms.[10] Educational consciousness as a cultural aspect of the farmers though sometimes difficult to measure, plays significant role in accepting scientific and innovative ideas. Prospective of a farmers exact knowledge on a particular aspect of an innovation such as HYV of rice, slightly more than the formal education also helps a lot to come to know about modern use of things through interaction with educated mass, and different communication media. Saini is of opinion that education of farm people however, becomes a more important in the process of diffusion of technological change i.e. a transition from a traditional to a new agriculture.[11] Freeman arrived at the conclusion from a study of three North Indian villages that families in the upper economic status adopted recommended agricultural practices to a larger extent than families in lower economic status.[12] A number of similar studies

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10. G.R. Saini(1979) Farm size, Resource use Efficiency and Income Distribution, Delhi, p.33.

11. Ibid., p.34

12. Charles Freeman(1961) Economic Status and Adoption of New Agricultural and Home Practices. A Study of Three Villages in R.N.Saxena,(ed) Sociology and Social Problems in India, Asia Publishing House, Bombay.

completed as yet, indicate that the literate farmers are more innovative than illiterate ones.[13] According to Rahudker young farmers are more receptive to new practices than older ones.[14] Singh concludes that farm size and caste groups are highly related to the level of modernisation.[15] He further emphasises that the mean modernisation index rises with a rise in farm size. It has the same relationship with the caste hierarchy i.e. the mean modernisation index rises with the rise in the social hierarchy.[16] So far as the educational level of farm operator is concerned the mean modernisation level rises with the level of education up to junior high school.[17] Singh is again of opinion that there is a critical minimum level of education which is necessary to facilitate the adoption of new technology after which education appears to play a very minor role.[18]

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13. R. Ramachandran(1975) Spatial Diffusion of Innovations in Rural India, Mysore, p.121.

14. W.B.Rahudker,(1962) Farmers Characteristics associated with the adoption and diffusion of improved farm practices, Indian Journal of Agricultural Economics, Vol.17.

15. Srinath Singh(1976) Modernisation of Agriculture- A Case Study in Eastern Uttar Pradesh, Delhi,p.151

16. Ibid., p.151

17. Ibid., p.151

18. Ibid., p.151

In the present study seven socio-economic and cultural variables have been chosen to throw light on the principal factors involved in the diffusion process of the adoption of HYV rice by 40 farm households selected from 8 different villages of the Lower Brahmaputra Valley. The above views have been substantiated through a factor analysis to confirm as to how the factors explains maximum variance showing linear associations of the variables. The following are the variables selected for the analysis.

Holding Size

Holding size as a variable for the analysis shows the social status of the farmer in terms of agricultural land. The variable is related with so many socio-economic characteristics of the farmers. In so far as holding size determines the socio-economic hierarchy of the farmers, it has a variation between 0.675 hectare to 6.953 hectares for the villages Jhagarapara and Khara of the sample villages under study. The average size of holding for the sample households is 2.81 hectares with a standard deviation 1.52 and coefficient of variation 54.09 percent which on the other hand indicates that the distribution is inconsistent though not highly variable.

Education

This variable has been quantified in terms of weightages assigned to different strata of educational level attained by the farmers such as primary,middle, highersecondary, college and more. This has been explained and analysed more conceivably in the preceeding chapter. The variable being an indicator of socio-economic consciousness appears to be related with numerous aspects of modern life. It makes the farmers more receptive to scientific ideas and innovations such as introduction of HYV crops and modern farm equipments. The indices of educational level varies between 0.5 to 4.5 for the villages (Jhagarapara, Ketekibari, Shilapari, Kheraj) (Jhagrapara,Balijana, Katekibari,Khara) respectively. The average index for the sample as a whole is 2.1which indicates a qualitative level between middle english and higher secondary standard of the farmers in terms of education. The standard deviation is 1.33 with a coefficient of variation 63.33 showing the educational status of the cultivators highly inconsistent and variable in relation to holding size. There six farmers amongst the 40 sample who are completely illiterate and have therefore been assigned 0.5 as the weightage because even if they are illiterate the working experience as cultivators also counts in agricultural aspects.

Age

It can be presumed that age of the cultivators is one of the prime factors as to why young farmers are more interested in modernisation of their farms than the older ones. The variable is also related with educational level, family, size etc. Age of the farmers in the present sample of 40 farmers varies between as low as 24 to as high as 85 with an average age 49.2o. The standard deviation in the age distribution is 15.21 and the coefficient of variation is 30.91 percent. The distribution also appears to be less inconsistent in relation to education and holding size.

Family Size

This variable included in the analysis of factors has its own association with mostly age, education, holding size, working members and so on. Large families with sufficient holding are more prone to modern innovations such as introduction of HYV of rice etc. with other associated aspects of cultivation. Family size in the present sample varies between 2 to 23 for the sample villages Khara and Jhagarapara respectively. The average family size is 8.95 with standard deviation in the distribution 3.78 and coefficient of variation 42.23 percent showing the former less variable than holding size and educational level.

Religion

Religion as a cultural variable also plays important role in the diffusion and acceptance of new innovations in the agricultural farms being simultaniously related with many other aspects such as the family size, education, working members, fragmentation of the cultivated land and so on. This variable has been quantified with the help of weightages to have been assigned to different religious groups of farmers - in the present case - mostly hindus and muslims. The religion index varies between 1.25 to 1.5 for two groups of religion such as muslims and hindus respectively. All other statistical measures of central tendencies and disprson are not likely to make any positive sense in this case.

Working members

This variable for the farm households is associated linearly with many socio-cultural aspects of farmers living such as age, family size, holding size, education and so on. Working members for the farm holds vary between 1 to 5 with mean, standard deviation and coeficient of variation 1.88, 1.54 and 81.92 percent respectively. The distribution seems to be highly inconsistent and variable.

Fragmented Fields

Fragmentation of agricultural land is a socio-economic consequence which has been causing concern for the researchers. The variable is related with several social phenomena such as disintegration of large families having further chain reaction of economic set up of the farm households. Fragmented plots for the sample households vary between 2 to 12 for Jhagrapara and Khara respectively. The average number of fragmented fields is 5.7 with standard deviation and coefficient of variation, 1.54 and 27.02 percent respectively. However, the distribution is relatively less inconsistent and less variable also.

The statistical technique

Statistical technique is of immense help for analysing precisely a particular research problem irrespective of its nature and characteristics. As far as the socio-economic problem is concerned, there are various kinds of methods and techniques which are applied in accordance with the aim and objective of the problems. So as to probe into the factors involved in the socio-economic transformation, change or any such characteristics there of factor analysis[19] is considered to be the most authentic, suitable and viable method to conceive of such

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19. See:(a) Harman,H.H., Modern Factor Analysis, Chicago, 1960.

(b) Thurstone,(1961) Multiple Factor Analysis,Chicago,

(c) Adelman and C.T. Morris(1967) Society,Politics and Economic Development, Balsimore, kind of situations. The technique is not based on any kind of preexisting theory.

In so far as the technique is applicable it takes into account a mass of diverse data of socio-economic characteristics and is not concerned with the sensitivity of the scale chosen for the quantitative specification of the variables. It helps in eliminating many difficulties involved in the study of mkcrodevelopment. The technique helps use an analysis of variance to group variables into a few clusters as per the closeness of the former in a linear relationship. The clusters or the factors that are extracted from a diverse set of variables on the basis of a mathematical principle can be characterised as follows:

(a) The variables having been significantly, linearly and closely related are clustered within a single factor or component.

(b) The variables within a single factor are mostly independent of that of the other factors.

(c) The extracted factors explain together the total variance to a maximum limit being considered successively.

(d) The factors are independent of themselves being uncorrelated with each other.

The number of factors should be such that the last one must explain at least 5 percent variance. More over the factor analysis does not show any cause and effect relationship. Its objective is to extract the underlying dimensions or regularities from as mass of data and information in which a number of variables are comprised of. Each factor constitutes of variables which are again mutually interdependent. In the present case the results of the factor analysis have been interpreted. The variables pertain to land use and socio cultural characteristics. Table VII.1 and VII.2 substantiate the significance of the influence of the factors on the variables. The factor loadings of a specified factor indicate the correlation between each observed variable with that particular factor.

After having analysed the principal factors, the scores are calculated to examine the position of each observation along these dimensions or components. These scores are the weighted sum of the variables of each observation. The elements of each eigen vector are used as weights to work out the factor scores of each successive factor analysis.

After having found out the correlation matrices for the sets of variables chosen for the study such as land use and socio-cultural, the eigen roots and vectors have been calculated.[20] The eigen roots considered normally more than unity have been used to estimate the vectors of factor loadings. The factor loadings have been found out by multiplying each eigen vector (N_k) by the square root of their corresponding eigen values($\lambda i \ldots \lambda k$) i.e. $Nik\sqrt{\lambda i}$.

Since, the analysis relates to both High Yielding and the local traditional varieties of rice, specifically for the land use variables and the socio-cultural variables have been analysed separately the following Table present the eigen roots, their proportion of variation explained and the factor loadings corresponding to the largest roots.

TABLE VII.1

Land use variables (HYV)	Eigen roots	Prop of variation explained	Factor loadings *	
			Factor 1	Factor 2
Area(HYV) X_1	2.41	60.25	0.2325	-0.9445
Net cropped area X_2	1.003	25.08	0.8866	-0.0901
Gross Cropped area X_3	0.585	14.63	0.992	0.0668
Double Cropped area X_4	0.0001	0.0003	0.758	0.3087

*Factor loadings more than 0.5 have been considered as significant.

20. Computer programme on Factor Analysis has been done by the Computer Centre, Survey of India, Shillong(See Appendix-Table-24).

It will be seen from Table VII.1 that the two largest eigen roots being greater than unity (i.e. 2.41 and 1.003) have been selected for the analysis of their corresponding factors. These two eigen roots explain together 85.33 percent of the total variation.

Factor I

As far as the first factor is concerned, the land use characteristics have their highest loadings for net cropped area(0.8866), the gross cropped area (0.992) and the double cropped area(0.758). All these variables are positively loaded on factor I which suggests an efficient land utilization in terms of double and multiple cropping. Even though factor I suggests an efficient land utilization for the sample households in the study area nevertheless, it is imperative to examine as to whether the efficiency of land use is characterised by the introduction of advanced farm innovations such as the new exotic varieties of rice crops in the present case which help in raising the cropping multiplicity for an effective land utilization. On the other hand, Table VIII.1 shows that the area under HYV of rice does not have significant linear association with the variables as were said above. It however, forms a seperate factor being negatively loaded on the same. It can hence be said that the land use efficiency as suggested by factor I may be because of large scale cultivation of local rice crops. This will be discussed in the subsequent part of the discussion.

Net cropped area and gross cropped area are the basic indicators of raising the efficiency of agriculture in the rural areas. Bringing more number of crops under cultivation increases the gross acreage thereby making the crop cycle efficient. It is noticeable from the clusters of variables in factor I that the net cropped area increases with the increase in gross acreage under different crops increases simultaniously. As a result, the area under double cropping also increases with the corresponding increase in the gross cropped area. What emerges from factor 1 is that in the country side of the Lower Brahmaputra Valley there is a greater scope of intensifying the land use pattern. The cropping intensity of the area can be raised tremendously since the variables relating to land use appear to be having very close relation among themselves. The size of holding stands as one of the major limiting factors, as to why the farmers are not eager to go in for multiple cropping alongwith the hybrid variaties of crop raising. Larger is the holding size, larger is the area under double cropping and the more is the gross acreage during an agricultural year. It is further suggestive that the farmers though try to maximise the land use operation, but it is the size of net operated land which is the real constraint to achieve the goal. If there could be a redistribution of land with the effective implementation of land ceiling act, the small and marginal farmers could benefit to a greater extent . The whole situation concerning the efficient land use system of the rural lower Assam, reveals that the prospect of cropping multiplicity appears to be optimistic. Double cropping could be appreciably raised by farm modernisation and introduction of short duration high yielding crops such as HYV of rice, rice being the stapple crop of the area.

Factor II

The second factor involved in the land use characteristic pattern of the sample households adopting High Yielding Varieties of rice reveals the fact that this factor is heavily and negatively loaded on the area under High Yielding Varieties of rice. This factor explains alone 25.08 percent of the total variation as evident from the corresponding charecteristic root i.e. 1.003. Factor II as an independent phenomenon in the land use pattern shows a poor performance of land use specifically for the recently introduced exotic varieties of rice. The distribution of area under HYV rice appears to be highly inconsistent and variable. The factor indicates that the high differential courage of area under HYV rice may probably be attributed to the lack of infrastructural facilities and many socio-economic condition of the farmers. Less imigination potential has probably impeded the adoption of HYV rice with more acreage alongwith the many disincentives such as the uniform distribution of advanced inputs, availability of cooperative finance and so on. Hence it can be infered that the diffusion of HYV of rice cultivation is yet to receive full momentum in the area under study. The farmers can be said at the experiment level of the High Yielding cultivation of rice

Local Rice

Switching over to the analysis of the factors in relation to the above four land use variables for the local traditional varieties of rice, the following picture emerges. The Table presented below shows the number of variables, the eigen roots, their proportion of variation explained and the factor loadings of the corresponding largest eigen root.

TABLE VII.2

Variables	Eigen roots	Proportion of variation explained.	Factor loadings*
Area under local rice (X_1)	3.247	81.18	0.9504
Net cropped area(X_2)	0.633	15.83	0.8946
Gross Cropped area(X_3)	0.199	4.98	0.9900
Double cropped area(X_4)	0.0001	0.003	0.7416

* Factor loadings more than 0.5 have been considered significent.

It will be seen from the above Table that amongst the 4 eigen roots only one is the largest of all(i.e. 3.247) which alone explains 81.18 percent of the total variation in the land use pattern of the sample households in relating to the area under local traditional varieties of rice. It is obvious from the above table that a single factor emerges in the traditional local rice culture of the rural Lower Brahmaputra Valley. The factor is positively and heavily loaded on the area under local rice, net cropped area, gross area sown and the area under double cropping. The variables being grouped to be called a single factor are highly and linearly associated with each other. The underlying dimension or the regularity noticed in this factor is that it represents the traditional nature of rice cultivation in Lower Brahmaputra Valley area. Meaning thereby, rice being predominantly grown during the year in different seasons, the land use characteristics mostly relate to the local rice. Probably, different local varieties of rice such as Ahu, Sali, Bao and Boro are grown which decidedly increase the gross acreage as well as the area under double cropping. The factor reveals that larger is the area under local rice, larger is the gross acreage and that of the area under double cropping. Similarly the net cropped area is positively associated with area under local rice, gross cropped area and the area under double cropping. The local variety of rice being less risky seems to be prefered by the farmers. It however does not need much sophistication in the farming technique. These crops are highly resistant to pests and insects and hence, risk averting. It can be infered that the local varieties of rice have probably a significant position in the agricultural mosaic of the rural lower Brahmaputra valley, being responsible for higher cropping intensity. Rice being grown even more than twice in many places of the area under study occupies a pivotal position in the crop cycle. It further shows that in this traditional rice culture area new innovations such as exotic HYV of rice can be successfully grown with fast diffusion alongwith economic incentives to the farmers and adequate infrastructural facilities.

Socio-Cultural Variables

Factor I

The social characteristics having their highest loadings in factor I are educational level of the farmers, age of the farmers, family size, number of working members in the farmers household, and the number of fragmented agricultural land. All the loadings except the educational level are positive and show high correlation with factor I. This factor depicts the farming households as highly tradition bound and orthodux. Age of the farmers and their educational level indicate that old farmers are less educated than the younger ones. As the age of the farmers increases, the family sizd increases correspondingly. Larger families have more number of fragmented cultivated land and the number of working members specifically for agricultural purposes increase with the correspinding increase in the family size. Conversely, the educational level of the farmers coming from the large families is relatively poorer than the small nuclear ones. The above analysis can be more substantiated with the help of the following Table which shows the variables, the eigen roots and their proportion of variation explained and the factor loadings of the largest eigen roots.

TABIE VII.3

Variables	Eigen roots	Proportion of variation explained	Factor loadings	
			1	2
Holding size(X_1)	2.61	37.29	0.452	0.6809
Education(X_2)	1.355	19.36	-0.5978	0.3747
Age(X_3)	0.938	13.4	0.7679	0.1056
Family size(X_4)	0.686	9.8	0.805	-0.1601
Religion(X_5)	0.597	7.96	-0.1523	0.689
No.of fragmented fields(X_7)	0.369	5.27	0.5281	0.4756

*Factor loadings more than 0.5 have been considered significant.

It will be seen from the Table VII.3 that the two largest eigen roots (i.e.2.61 and 1.355) explain 37.29 and 19.36 percent variation respectively. The corresponding vectors of factor loadings of these eigen roots indicate a group of 5 variables which make a cluster or factor as is already discussed. Educational level of the farmers having negative loading suggests that the differences of education among the cultivation appears to be high and can be attributed to the fact that the old farmers in larger familes have chosen cultivation as their occupation since long time back when facilities for education were inadequate fragmentation of the cultivated land being an universal phenomenon in Indian agrarian scene is noticed in the society which is highly tradition bound and educationally backward. According to the facts revealed by the factor I, one can infer that in the rural areas of the lower Brahmaputra Valley the farming society is rested to the so called socio-cultural tradition. Unless the educational conciousness is raised with other socio-economic improvement, the diffusion of modern innovations such as the introduction of HYV of rice, advanced farm machineries will be a difficult task.

Factor II

The second factor explains 19.36 percent of the total variations in the socio-cultural variables. This factor is positively and heavily loaded on the holding size of the farmers and the religious groups. These two variables form a cluster and indicate close association among themselves. Higher indices for the Hindus show that the increasing trend of the holding size is towards the Hindu community. Holding size has the second highest loading in factor I and suggests that holding increases with the family size, number of working members, number of fragmented fields and age but decreases with the increase in educational level. Factor II represents the biasness of farm holding against religion.

Measure of Inequality and the Pattern of Diffusion of HYV Rice.

Adoption of HYV of rice has raised the total output of cereals but simultaneously it has created many inter-regional and intra-regional inequalities. This happened because, the inputs have not been available to all the farmers at the required leved. In the present chapter it has been attempted to ascertain the yield pattern of HYV of rice with respect to the farm size which can be meaningfully undertaken in the present day context for a major rice producing area i.e. the Lower Brahmaputra Valley. The adoption of HYV of rice crops in the rice producing areas is a post green revolution phenomenon. The reason for the adoption of these exotic varieties of rice crops in these areas are many and mostly attributed to the high return per unit area. But the question is whether the various sections of the farming community have equally been benefited from the introduction of this technological innovation in terms of productivity. The second question is, whether the inequalities in the distribution pattern of yield among the different strata of the peasantry within the same region have grown as a result of the diffusion of these crops. Thirdly, whether the HYV of rice crops are farm size biassed. Meaning thereby, the adoption of HYV of rice crops is concentrated only within a few categories of farmers in terms of area and number of farm households hierarchically.

The diffusion pattern of HYV or rice cultivation in the Lower Brahmaputra Valley area can therefore, be revealed when one throws light on the different sections of farming community such as marginal, small, medium and large farmers to know as to which categories of the farmers have adopted the HYV of rice cultivation in a large scale.

One of the most interesting aspects of the study is that the contribution of the small farmers towards the declining trend of inequalities in production resulting from the unequal distribution of land among the farming households can be assessed judiciously. This is due to the fact that the productivity per unit of land in case of small farmers is generally higher because of abundance of family labour input in traditional agriculture. Their intensity of cultivation is also high in relation to the large farmers.

It is a general feeling that the large farmers exploit the situation more successfully than their small counterparts as far as the adoption of new technology is concerned. This is because they have better access to capital and can make its use more rational due to favourable farm size. They have also better risk and uncertainity bearing capacity. However, the small farmers are affected adversely because of less access to capital, investment and fragmentation of holdings. The very requirement of capital to carry out new agriculture has tilted the balance against the small farmers with limited access to capital and in favour of the big farmers who have not only relatively easy access to it (capital) but can also make its more rational use because of the favourable farm size. At the same time the greater risk and uncertainity bearing capacity of the big farmers puts them in a more advantagious position to exploit the new opportunities.[21] In the light of the above situation in Indianagriculture, it can be examined in the present case that whether the big farmers (according to the present classification for Lower Brahmaputra Valley) take more risk in going in for HYV cultivation in terms of area under HYV of rice.

In order to test the above hypotheses, a study as to the measure of inequality in the distributional patterns of area and production of HYV of rice has been undertaken in the present case. For the purpose, Lorenz curves have been drawn to explain the inequality pattern of farm holding, area under HYV of rice, and the production of HYV of rice as far as the different sections of farmers i.e. marginal, small, medium and large farmers are concerned. Gini's coefficients have been calculated to highlight the concentration of a certain variable in a

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21.G.R. Saini, op.cit.,p.125

particular size class. So as to draw the Lorenz curves, First, the farm households have been arranged in the ascending order according to their farm size. Second, the ascending array of the farm households have been divided into 10 equal parts as per farm size starting from the lowest 10 percent households. Third, the cummulative percentage figures of farm households, land (net area under cultivation), area under HYV of rice and output have been derived.

Table VII.4 shows the cummulative percentages of farm households, total land under cultivation, output of HYV of rice, area under HYV of rice in the respective ten percent household categories.

TABLE VII.4

Cummulative percentage of farm households	Cummulative Percentage of		
	Net area under cultivation (Land)	Output of HYV of rice	Area under HYV of rice
10	3.41	4.79	7.64
20	8.57	7.12	11.28
30	14.21	12.24	20.01
40	21.09	23.88	30.19
50	29.24	31.91	38.18
60	38.59	43.40	53.09
70	49.68	54.67	65.09
80	62.87	63.16	74.54
90	78.66	79.22	86.18
100	100.00	100.00	100.00

Source: Calculated by author

An analysis of Table VII.4 reveals that the inequality in the distribution pattern of output of HYV of rice with respect to farm size (net area under cultivation) appears to be relatively less than that of the area under HYV of rice (Fig.24). The curve for output runs almost parallel to the egalitarian line well, beyond 62.87 percent of the net area as against 80 percent of the households. The output curve inter secting the egalitarian line twice below 20 percent of the net area indicates that the output appears to be having a tendency of being equally distributed at 6 and 18 percent of the net area approximately as distinct from the Lorenz curve (Fig.24). It is intersting to note that more than 50 percent (i.e.54.67 percent) of the output appears to have been concentrated within approximately 50 percent of the net area under cultivation (i.e. 49.68 percent) which belongs to 70 percent of the total households from the bottom. Hence, the rest 30 percent of the households own around 50 percent of the net area(50.32 percent) and 45.33 percent of the total output. These farmers come in the upper ladder of the land holding and can hence be designated as big farmers.

The area under HYV of rice is found to be having more inequality in the distribution pattern as compared to the output with respect to the net area under cultivation.

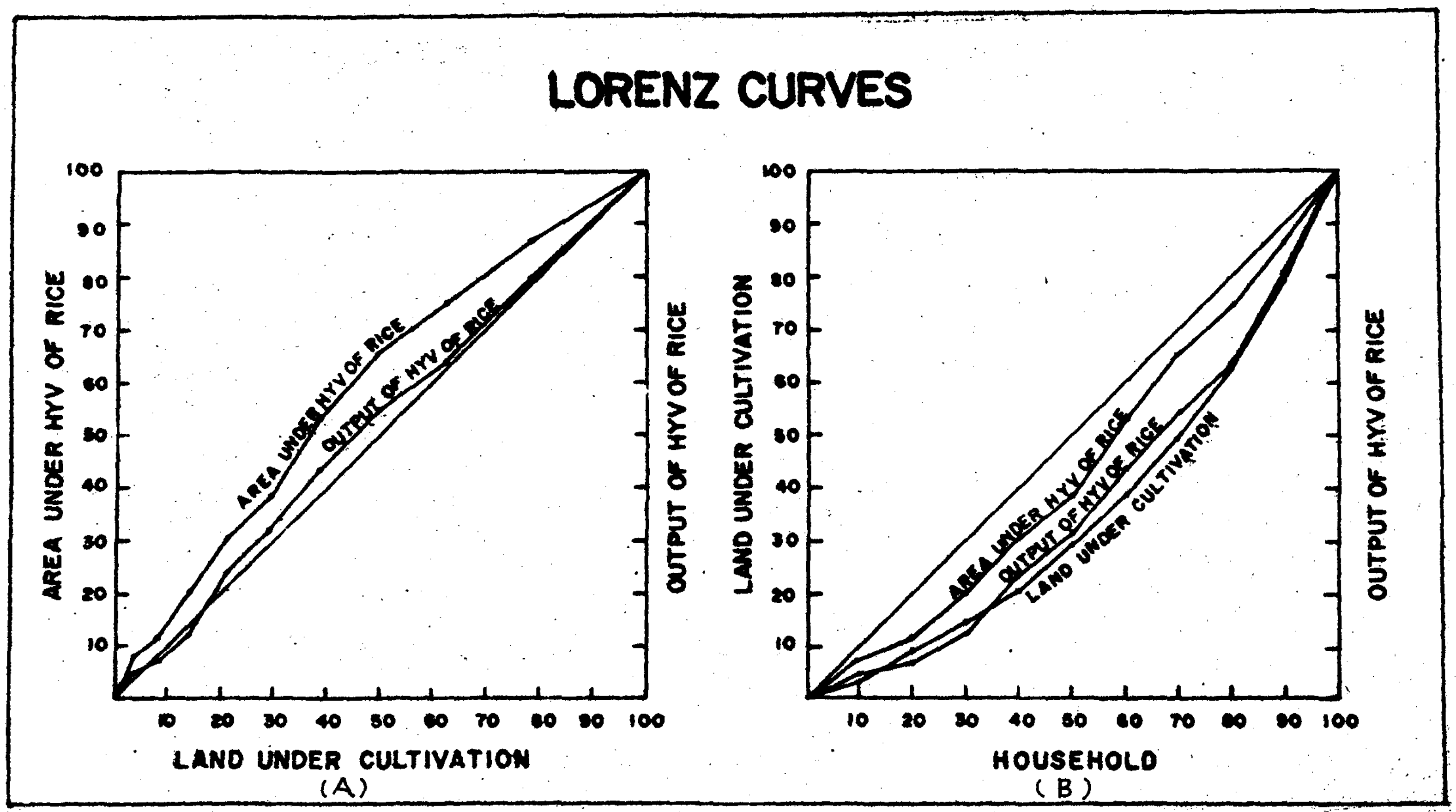
LORENZ CURVES
AREA UNDER HYV OF RICE
OUTPUT OF HYV OF RICE
AREA UNDER HYV OF RICE
OUTPUT OF HYV OF RICE
LAND UNDER CULTIVATION
(A)
LAND UNDER CULTIVATION
OUTPUT OF H.Y.V OF RICE
AREA UNDER HYV OF RICE
OUTPUT OF HYV OF RICE
LAND UNDER CULTIVATION
HOUSEHOLD
(B)

Fig. 24

In a similar fashion as discribed above, around 65 percent of the total area under HYV of rice(65.09 percent) is found to have been concentrated within approximately 50 percent (49.68 percent) of the net area owned by 70 percent of the households under study from bottom. The above findings expose the fact that in the Lower Brahmaputra Valley small and medium farmers dominate being affected by the paucity of net cultivated land and other economic accessibilities which have resulted in low coverage of HYV of rice.

The Gini's coefficients of concentration for output of HYV of rice and area under HYV of rice are found to be 0.034 and 0.172 respectively. It can be infered that the former is less unequal than the latter with respect to the net area under cultivation.

The distribution of the above attributes in relation to the share of the farm households indicates an identical situation. It is found that as much as around 50 percent (ie. 50.32 percent) of the net cropped land is concentrated within a few farm households i.e. 30 percent of the entire sample. Of the three attributes such as area under HYV of rice, output of HYV of rice and the net cropped land, the most unequal is the distribution of the net cropped land in relation to the share of the farm households. This has the maximum deviation from the line of equal distribution as compared to the area under HYV of rice and the output of HYV of rice. The classification of the farmers as small, medium and large, assuming successively from bottom the respective shares as 30, 40 and 30 percent each shows that a substantial share of cultivated land and the output of HYV of rice (i.e. 50.32 and 45.33 percents respectively) appears to have been concentrated within the top 30 percent of the farm households i.e. the large farmers.. Then, comes the mediumfarmers who constitute about 40 percent of the households next to the small from bottom. These farmers also have an appreciable share of land (i.e. 35.47 percent) and output of HYV of rice (i.e.42.43 percent). The small farmers are however, lagging considerably behind in terms of cultivated land and output of HYV of rice (the shares being a meagre 14.21 and 12.24 percents respectively).As far as the share of area under HYV of rice is concerned, the medium farmers do posses the highest share of area under HYV of rice (i.e. 45.08 percent)followed by the large farmers(i.e. 34.91 percent) and the small farmers(i.e. 20.01 percent). The small and the medium farmers together have a share of the same to the tune of 65.09 percent. It can however, be concluded from the above analysis that the large farmers accounting for a meagre share of the total households are found to be the leading cultivators in terms of net operational holding and output of HYV of rice.

The Gini's coefficients of the aforesaid attributes show that there is higher inequality of net operational holding amongst the farm households, the coefficient being 0.287. Then, comes the output of HYV of rice which has a similar trend of inequality in the distribution pattern with the Gini's coefficient of concentration i.e.0.254. From the lorenz curve it is found that the distribution of output and net operational holding at 15 and 34 percent households appears to be equal since both the curves have intersected each other at these points (Fig.24B). It implies that between 15 and 34 percent households output of HYV of rice is more unequally distributed than the net operational holding. The Gini's concentrationratio (0.118) for area under HYV of rice shows that the inequality in the distribution pattern of area under HYV of rice is low as compared to output of HYV of rice and the net operational holding.

What emerges from the analysis of inequality in terms of classifying the farm households in an ascending array is that, a greater concentration of output in the upper 30 percent of the households might lead to a situation where the adoption of this new technological innovation in the diffusion process will be confined to the big farmers as is already observed, thereby creating a commercial and monopoly agriculture. A uniform spread of this new technology can hence be accelerated, provided the farm size and the factor markets are imperatively equalized. In order to maintain the productive capacity of land at an equal and maximum possible level artifical measures need to be evolved, so that there is minimum disparity in the productive capacity of agricultural land. The inequality in the distribution pattern of area under HYV of rice, output of HYV of rice can also be reduced to minimum because of equal access to factors of productions and minimum variation in the productive capacity of arable land.

HYV of Rice - Extent of Gultivation and the Distributional Pattern of Area and Output among the Various Strata of Farm Households.

It will be interesting to highlight the extent of cultivation of HYV of rice in terms of percentage share to the total operational holding and the level of output per unit area achieved by the different categories of farmers such as marginal, small, low medium, medium, moderately large and large. The following Table illustrates as to how much area is devoted to HYV of rice and what is the output per unit area achieved by each category of farmers.

TABLE VII.5

Holding size (in ha.)	Category of farmers and percentage area	Output (in kg)	Total Area (HYVs) in ha.)	Operational holding (in ha.)	Percentage share of area(HYVs)	Out put per unit area
1.00	Marginal (7.5)	2426.07	1.283	2.484	51.65	1890.94
1.00	Small (35.0)	16198.67	5.266	23.410	22.49	3076.09
1.25-3.50	Low medium (32.5)	17840.98	6.481	36.781	17.62	2752.81
3.50-4.75	Medium (12.5)	6345.11	2.430	20.659	11.59	2611.16
4.75-6.00	Moderately large (7.5)	18102.24	2.835	15.52	18.27	6385.27
6.007	Large (5.0)	671.84	0.270	13.433	2.09	2488.29
All farmers	100.00	61584.91	18.565	112.587	16.49	3317.26
Mean			3.09	18.77	20.61	3534.09
S.D			2.09	10.45	16.10	1505.26
C.V			67.73	55.66	78.13	42.59

Source: Same as Table-VII·4

It will be seen from Table VII.5 that the cultivation of HYV of rice appears to have been diffused to a considerable extent among the marginal farmers having net area under cultivation less than a hectare of arable land. These farmers devote more than half of their net operational holding (i.e. 51.65 percent) to HYV of rice in the sample villages of Lower Brahmaputra Valley. It implies that the marginal farmers are more inclined to the adoption of HYV of rice. As far as the coverage of area under HYVs rice practice is concerned it seems that the marginal farmers in the sample villages cultivate High Yielding varieties of rice in a large scale. The share of these farmers is however too low in relation to farmers in the upper strata in terms of farm size. The reason of such appreciable coverage may be attributed to the fact that the High Yielding Varieties of rice when grown gives relatively better yield than the local varieties of rice irrespective of environmental conditions. This situation has been substantiated in the preceeding Chapter (i.e. Chapter IV). Another reason is that the small and marginal farmers do take risk in the Lower Brahmaputra Valley region to go in for the cultivation of HYV of rice as far as the water availability is concerned. The area being less vulnerable to drought conditions and being situated in the high rainfall zone of the country, stands favourable for the cultivation of rice. Though the area does lack much irrigation potential for controlled water system for the cultivation of HYV of rice, nevertheless, water being a prerequisite for the HYV of rice does not pose much problem for the farmers because of assured rainfall apecifically during June to October. Since small and marginal farmers are not economically better off, for investment on irrigation they usually depend on rainwater for the HYV of rice cultivation.

As far as the output per unit area is concerned, the marginal farmers are in the lowest level i.e. 1890.94 kg per hectare. The reason may be attributed to poor capital investment which seems to be far from reality in case of these farmers in the area under study. The actual investment in money terms (i.e. actual cost) per hectare of cultivated land will be discussed in the subsequent section of this chapter.

The categories of farmers, holding size, area under HYVs and output of HYVs per unit area in the sample villages have been given in Table VII.6.

TABLE VII.6

Categories of farmers	Holding size (in ha.)	Percentage of farm households	Total output in each cagetory (in kg)	Total area under HYV of rice in each category (in ha.)	Total operational holding in each category (in ha.)	Percentage share of area under HYV of rice to total holding	output per unit area under HYV of rice (in kg/ha.)
Small	<2.25	42.5	18624.76	6.549	25.894	25.29	2843.91
Medium	2.25-4.75	45.00	24186.09	8.911	57.74	15.43	2714.18
Large	4.757	12.5	18774.08	3.105	28.953	10.72	6046.65
All farmers		100.00	61584.93	18.565	112.587	16.49	3317.26

Source: Same as Table-VII·4

It will bee seen from Table VII.6 that the small farmers have devoted a substantial share of their cultivated land to HYV of rice whereas the large farmers in the present case have not taken that risk. In terms of output however, the picture is just the reverse for the highest output per unit area has been achieved by the large farmers. It is interesting to note that the small farmers are also more efficient than their medium counterparts in terms of output per unit area as evident from the above Table VII.6

Inputs

Besides the intense utilization and the quality of land, availability and the application of inputs such new seeds, water, fertilizers, new agricultural implements, pesticides and insecticides and both the human and animal labour are some of the important factors upon which the acceptance, adoption, diffusion and the performance of the High Yielding Varieties of rice cultivation depend. These factors moreover, determine the overall agricultural development of a region. Investment in land and the bulk of agricultural inputs are on the other hand, dependent upon the availability of resources for investment but the lack of finance stands as the major bottleneck for an overwhelming majority of farmers to go in for modern innovations in their farms. Unless our rural areas are agriculturally prosperous which is reflected by the income accrued from this sector, it will remain a myth to attain a healthy and sound economy. The area under cultivation and its productivity are therefore, two most vital aspects upon which the overall prosperitydepends. Substantiating the above points one can say that higher productivity is an indicator of advanced and mechanised agriculture where capital for investment plays a vital role. The number of such inputs and their method of quantification have been presented in the following fashion for the HYV rice.

Seed

The amount of seed in terms of money spent per hectare of cultivated land has been calculated for the purpose of the analysis. It will be seen from the Appendix – that such amount varies from Rs.46.91 to Rs.370.17 for the villages Ketekibari and Shilapani respectively. The average amount spent per hectare land devoted to HYV rice is Rs.117.44 with standard deviation 60.24 and coefficient of variation 51.29 percent. It does not necessarily mean that higher amount spent on HYV seeds will yield better productivity. Better productivity is rather dependent on the quality of the seed which is beyond the scope of the present study and involves more technical investigation.

Manure

Local manure plays an important role in the higher productivity of HYV rice. For the present analysis this input has been calculated in terms of money spent per hectare of land devoted to HYV rice. Expenditure of manure varies from Rs.55.56 to Rs.555.56 for the villages Shilapani and Khara respectively with mean, standard deviation and coefficient of variation Rs.199.29, Rs.160.45 and Rs.80.51 percent respectively.

Fertilizer

Chemical fertilizer being one of the most important inputs for higher productivity of HYV of rice has been calculated in money terms spent per hectare of land devoted to HYV rice. Amount of rupees spent on fertilizer varies between Rs.73.96 to Rs.555.56 per hectare for HYV rice with mean, standard deviation and coefficient of variation Rs.219.82, 136.01 and 61.87 percent respectively. Of the 40 households under study two have not invested money on fertilizer.

Pesticides and Insecticides

The expenditure incurred on this input has a range between Rs.4.23 to Rs.209.88 per hectare of cultivated land for HYV rice with mean.standard deviation and coefficient of variation Rs.31.88, 45.56 and 142.91 percent. The distribution in the expenditure of this input appears to be highly variable for which standard deviation exceeds mean and shows higher inconsistency in the consumption pattern of insecticides and pesticides. Of the 40 sample households 16 or 40 percent are noticed not to have spent money on this input.

Human Labour

The actual labour cost calculated per hectare of area under HYV of rice varies from Rs.488.88 to Rs.1626.03 for the villages (Jhagarapara, Ketakibari, Shilapani and Kheraj Daobhanji) and Balijana respectively. Such a large variation of labour cost is due to the fact that the labour cost in reality refers to the actual cost of labour excluding the man days given by the permanent labour incurred for a hectare of land devoted to HYV of rice right from the land preparation till the harvest and the cost of the permanent labour distributed over the gross acreage under HYV of rice. The expenses incurred for the fooding[1] of the permanent labour during an agricultural year have been included with the annual salary of the same. The average labour cost estimated is Rs.809.67 with standard deviation 323.95 and coefficient of variation 37.95 percent. The distribution seems to be less in consistent as evident from the coefficient of variation.

Animal Labour

The cost of animal labour includes the cost of the animal and the wages incurred from the preparation of the land till the thrashing of the crop at the prevailing market wage rates. Such cost varies between Rs.339.79 to Rs.1351.26 for the villages Ketakibari and Jhagarapara respectively. Such a wide variation in the animal labour cost is also attributed to a yearly average cost of a draught animal distributed over the gross

1. The expenses for fooding of an adult permanent labour have been fixed in money terms as Rs.900/- per annum in the rural areas of the Lower Brahmaputra Valley. A permanent adult labour who is employed without food is paid Rs.1500/- per annum as salary of which Rs.600/- from the real salary in cash.

acreage which is considered as the part of the investment in agriculture. It has been presumed according to the expectation of the farmers that a pair of bullocks of sound physique renders service for all kinds of agricultural operations for at least a ten years period. Hence, the yearly investment on draught animal has been calculated on the basis of this account. The average cost of animal labour (as an imput) comes out to be Rs.647.51 per hectare.

Irrigation Charges

Irrigation as one of the most vital inputs for the new varieties of rice has hardly been given importance by the sample farm households. Of the entire sample under review as much as 50 percent have not invested money on irrigation. For rest of the farmers, the expenditure varies between as low at Rs.83.33 per hectare to as high as Rs.370.37 for the villages Kheraj Daobhangi and Ketakibari respectively. Ketakibari is the only village in which all the sample farmers have invested on irrigation. This is because, the village is provided with the facility of lift irrigation for which farm mechanisation has made considerable headway in this village. The average expenditure on irrigation for the sample as a whole is Rs.114.03 with standard deviation 127.51 and coefficient of variation 111.82 percent. The distribution of expenses appears to be highly variable for which standard deviation exceeds mean.

Agricultural Loan

In the entire sample only 10 percent (4 out of 40) farmers are observed to be indebted to either financial agencies or money lenders for loan for cultivation. The amount as a partial investment on agriculture varies between Rs.57.19 to Rs.111.03 for Ketakibari and Shilapani respectively per hectare of cultivated land.

Expenditure on implements in rupees per hectare varies between Rs.45.31 to Rs.336.67 for Kheraj Daobhangi and Ketakibari villages in the sample respectively. The total amount spent on different implements has been distributed over the area under rice only. It has been confirmed during the interview hours with the farmers that expenditure on implements mostly refers to the cultivation of rice only since the former is the stapple food crop and more than 60 percent of the area is devoted to this crop. The expenditure is also same for the HYV of rice as it is for the local varieties of rice such as Ahu and Sali. The average expense incurred for implements per hectare for HYV rice is Rs.169.14 with a standard deveation 68.87 and coefficient of variation 40.72 percent. Coefficient of variation indicates that the distribution of this variable seems to be less inconsistent.

Profitability of HYV of Rice in Terms of Cost of Inputs and Return in Money Terms.

Coming over to the total cost of inputs for the sample households it is noticed that (AppendixTable-22) the same varies between as low as Rs.1610.13 to as high as Rs.3801.31 for the villages Kheraj Daobhangi of Goalpara district and Ketakibari of Kamrup district respectively per hectare of land devoted to HYV of rice. The average cost for the sample households as a whole comes out to be Rs.2380.71. Table VII.7 illustrates the comparative figures on both HYV and local rica as regards the average yield in kilograms per hectare, gross return per hectare of gross cultivated land, net return per hectare of land (unit of land) in money terms. Cost per unit of land (i.e. hectare here), net return per quintal and kilogram of HYV and local rice and incremental net return over incremental cost.

TABLE VII.7

Average Yield, Cost and Return

	HYV Rice	Local rice	Excess of HYV rice
1. Yield in Kgs. per hectare	2609.64	1537.56	1072.88 (69 .73 percent)
2. Gross return in Rs. per hectare	3297.95	1939.74	1358.21 (70.02 percent
3. Net return in Rs. per hectare	917.24	44.51	872.73
4. Cost in Rs.per hectare	2380.71	895.23	485.48 (25. 62 percent)
5. Net return per quintal	35.15	2.09	32.25
6. Net return per kilogram	0.35	0.029	0.321
7. $\Delta NR / \Delta C$			1.797 (179.77 percent)

Source: Same as Table-VII.4

Having worked out the yield, cost and return of HYV of rice for the sample farm households as a whole, it will be worthwhile to examine the profitability of HYV rice cultivation in relation to the local varieties of rice.

It is distinct that the cost of productions of HYV of rice is substantially high and is higher than that of the traditional local varieties. The adoption of new varieties in the diffusion process could be much more profitable provided the output per unit area is high in order to neutralize the higher production cost. In the present case the output per unit area however, does not seem to be as evident from the Table VII.7

With a view to assessing the profitability of HYV of rice, the following measures have been worked out to infer as to the problems and prospects of the cultivation of the HYV of rice in the lower part of the Brahmaputra Valley (exclusively Goalpara and Kamrup districts).

i - Yield in kilograms per hectare

The yield of either the varieties of rice has been calculated by dividing the total area under the crop with the total production. The yield for individual farmer and the average yield for the sample as a whole has been calculated.

ii - Gross return in Rs.per hectare

The yield per hectare has been converted into money terms by multiplying the prevailing nearest market price of the village per quintal of rice of both the varieties with the yield. As far as the local varieties are concerned the average price for Ahu and Sali rice has been taken into consideration.

Hence Gross return (GR) = Price per unit of out (P/O) X yield per unit of land(O/L)

iii - Net return in Rs.per hectare

Net return (NR/L) per unit of land (i.e. hectare here) has been calculated by substracting the cost per unit of land(C/L) from the gross return per unit of land (GR). Hence Net return (NR/L) - Cost per unit of land (C/L).

Cost in the present case includes both variable cost and the depreciation value of the fixed inputs. Here the depreciation value of bullocks for ploughing as a part of the investment in an agricultural year has been considered. Since the cost of the bullock varies between Rs.1,000/- to Rs.3,000/- and more an average value of Rs,2,000/- per bullock has considered in the present analysis of cost and profitability, of HYV of rice. As per the experience of the farmers, a pair of bullocks renders services for at least a 10 years period. Hence, the yearly investment per bullock has been taken as Rs.200/-. Apart from this fixed amount., a cash expenditure of Rs.600/- a year for food and forage of the bullock has been included leaving aside the other animal feeds which are made available from the farmers field such as the forage of the paddy and other cereal and pulses. The animal labour in terms of wage also includes as a part of the animal labour cost during the preperation of the land and the harvest of the crops.

iv - Net return per unit of output(NR/O)

This as a measure of profitability has been worked out by dividing the net return per unit of land with the yield per unit of land or taking the proportion between the net return per unit of land and the yield per unit of land.

$$\text{Hence } NR/O = \frac{NR/L}{O/L} = \frac{\text{Net return per unit of land}}{\text{Yield per unit of land}}$$

V-Incremental Net return (as percentage of incremental cost)

Incremental net return has been worked out by substracting the net return traditional variety from that of the High Yielding.

Hence incremental net return ($\triangle NR$) = Net return from HYV $(NR/L)h$ - Net return from traditional variely$(NR/L)^t$.

Similarly inceemental cost ($\triangle C$) = Cost of production of HYV $(C/L)h$ - cost of production of traditional variety $(C/L)^t$

The percentage of incremental net return to that of the cost suggests as to how the investment of an extre amount in buying inputs can raise the net return.

Besides the above measures of profitability of HYV of rice, the cost per unit of output (C/O) will be a good measure of efficiency of the new technology i.e.HYV or rice.

It will be seen from Table VII.7 that the average yield of HYV of rice is though not substantially high, still it is higher than that of the traditional varieties of the farm households. The excess yield of HYV of rice comes out to be 1072.08 kg. per hectare. Similarly the excess of gross return of HYV of rice over the local varieties is Rs.1358.21, the gross return of HYV of rice and traditional varieties being Rs.3297.95 and 1939.74 per hectare. The yield and gross return as excess for HYV of rice are 69.73 and 70.02 percents respectively.

The net return (NR/L) comes out to be substantially high for HYV rice as compared to local traditional varieties the difference being Rs.872.73 in favour of HYV of rice.

Switching over to the cost per unit of output (C/O), the new varieties exhibit a higher cost for producing just one unit of output. The excess cost per hectare of land of HYV rice over that of the traditional is Rs.485.48 or 25.62 percent.

Coming over to the ΔNR/ΔC(ratio of the incremental net return to the incremental cost), it is noticed that the HYV of rice brings an additional net return (Table VII.7) of Rs.872.73 on the investment of an extra cost of Rs.485.48. Putting it more precisely, one unit of extra cost will bring 1.797 units of an additional net return. On the other way round, 79.77 percent extra net return is achieved in case of High Yielding Varieties of rice over the local varieties. Hence, the above ratio seems to be quite encouraging in case of the farmers of the Lower Brahmaputra Valley, signifying the fact that the cultivation of HYV of rice has better prospect over a longer time period.

It is vivid from the above study that the adoption of HYV or rice is capital intensive and a unit increase in the cost as investment increases the net return quite substantially. In the case of the present sample households of the study area, this increase in the net return is registered more than 75 percent over the incremental cost.

It will be seen from Table VII, 7 that the net return per unit of output i.e. the net return per quintal and kilogram of HYV of rice comes out to be substantially higher than that of the traditional variety. When HYV of rice gives a net return per quintal and kilogram Rs.35.15 and Rs.0.35 respectively, the traditional variety gives as low as a net return Rs.2.9 and 0.029 respectively for the above units of output. It is distinct that the cultivation of HYV of rice is much more remunerative than that of the traditional variety when considered for the sample households as a whole. The excesses of net return in case of HYV of rice are Rs.32.25 and Rs.0.32 per quintal and kilogram respectively . In spite of the fact that the price for both the varieties do not differ and the new variety is more efficient in terms of cost of inputs, the output in money terms and the net return come out to be highly encouraging in general rather than for the specific and individual farmers.

It can, hence, be infered that the cultivation of HYV of rice in the country side of the Lower Brahmaputra Valley look more profitable than that of its traditional counterpart. On can also say that if the modern inputs could be made available to the farmers at more reasonable prices and the fixed inputs such as the farm machineries etc. were made available to the farmers at subsidised rates, then probably the HYV cultivation of rice could transform the entire agricultural landscape of the study area by substituting the traditional varieties of rice. This situation could lead to a wide spread diffusion of the cultivation of HYV of rice among all the sections of farming community such as low, medium and large.

CHAPTER - VIII

CONCLUSION

The present work is an attempt to study the diffusion pattern and performance of the High Yielding Varieties of rice in the various size of land holdings in the Lower Brahmaputra Valley. The objective of the study has been to ascertain the influence of the physico-socio-economic factors on the spread of High Yielding Varieties of rice. The input cost, return and profitability have been investigated with the set goal of determining the measure of inequality and the carriers and barriers of the exotic varieties of rice in the area under study.

The agricultural Mosaic of the region reveals that rice is the dominant crop occupying at least 60 per cent of the gross cropped area in each of the component areal units, excepting Golaghat sub-division in which only 52 per cent of the total cropped area is under rice cultivation. In some of the sub-divisions, rice is sown over 80 per cent of the total cropped area, nevertheless, there are significant variations in the concentration and the distributional pattern of rice in the lower part of the Brahmaputra Valley. Cultivation of two to three crops of rice in a year is a common practice, but it dominates the agricultural land scape mainly in the Kharif season. A large number of areal units are, however, poorly irrigated and, it has been determined that higher concentration of rice areas possess a low irrigation potential. High Yielding Varieties of rice seen to be grown mainly in the areas of high concentration of rice.

So far as the correlation coefficients between the agro-climatic variables in the region are concerned, it has been ascertained that significant positive correlation exists between soil nutrient index and rainfall at 2 per cent level of significance. Nutrient index and temperature are also found to be highly and positively correlated at 1 per cent level of significance. Soil texture and temperature are positively related and the relation is significant at 10 per cent level. The most significant and high positive correlation exists between rainfall and temperature, rainfall and humidity and temperature and humidity, the significance levels being 1, 5 and 2 per cent respectively. It has also been ascertained that, though the negative correlation exists between soil texture and p^H values and soil texture and humidity but the relationship comes out to be insignificant at all the levels.

The correlation coefficient between every individual independent variable and the dependent variable (i.e. the productivity of HYV of rice) reveals that the relationship between the per hectare yield of HYV of rice and the physical indicators in the Lower Brahmaputra Valley is negative in every case. Moreover, insignificant negative correlations exist between yield and soil nutrients, yield and soil pH (tending to no correlation) and yield and relative humidity. All the above paired variables have correlation coefficients which are insigificant at all the levels.

Significant negative correlation however does exist between rainfall and yield of HYV of rice at 5 per cent levels of significance. In a similar manner temperature and per hectare yield are also highly and negatively correlated at 1 per cent level. Taking all the variables together into consideration the multiple correlation coefficient comes out to be positive but insignificant at all the levels.

Out of the analysis concerning the sub-division wise per hectare yield of traditional and HYV of rice and the agro-climatic determinants an interesting picture emerges out. In the case of traditional varieties, there seems to be no correlation between the soil nutrient index and the per hectare yield. Conversely, there is high negative correlation between per hectare yield and soil texture and significant at 1 per cent level. Soil pH and yield of local varieties of rice show a positive correlation, but the relationship is insignificant at all the levels.

With the help of multiple regression analysis, the per hectare yield of every community development block has been predicted. The estimated yields per hectare in many cases show an increasing trend rather than a real decrease. The residual analysis throws light on the fact that in the area under study, the negative residuals are more dominant than positive because of the unfavourable soil and climatic conditions for the growth of HYV of rice.

The stepwise regression analysis enables to express the change in the explanatory power of the independent variables in explaining that of the dependent with the help of the every additional variable in the model. It has been concluded that as the variables are added one by one in the model the explanatory power of the variables starts increasing. The increase is however observed to be very low. All the six variables together explain only 12 per cent variation in the yield.

In order to examine the spread and level of diffusion of the HYV of rice in the different parts of the study area and the various size of holdings some typical villages and sample households were selected. The sample study reveals that 50 per cent of the farmers are yet to adopt the cultivation of HYVs. The rest have adopted the same, but it is vivid from their farm size and the area under HYV of rice that they are still at the experimental level. The area devoted to HYV of rice varies between as low as 0.068 hectare to as high as 2.025 hectares for two different villages situated at the extreme tips of the Lower Brahmaputra Valley (Figs.21,13). An overwhelming majority of the sample farm households constituting 90 per cent have put less than one hectare of cultivated land under HYV of rice irrespective of their net area under cultivation.

An analysis of the frequency distribution of net area under cultivation or the holding size which is under plough only reveals that 42.5 per cent of the households possess small holding - varying between less than one to

2.25 hectares. The medium holding farmers consist of 45 per cent of the sample, the holding size varying between 2.25 to 4.75 hectares. The rest 12.5 per cent with a holding size between 4.75 to 6 hectares may be called as the large farmers.

On the basis of the size of holding the farmers in the sample villages have been classified as marginal, small medium and large whose net area under cultivation varies between less than 1.00 hectare, 1 to 2.25 hectares, 2.25 to 4.75 hectares and 4.75 hectares and above respectively. In accordance with the above classifications, the percentage share of the aforesaid categories of farmers are 7.5, 35.0, 45.0 and 12.5 per cent respectively. The small and medium farmers are, however, dominant among the sample households. The large farmers are very few in number. Inference can be made from the above analysis that, in the Lower Brahmaputra Valley, the operated net holding appears to have been concentrated in marginal, medium and small categories of farmers accounting for 87.5 per cent of the sample. The same view concerning the dominance of small and medium farmers in Assam is also expressed by the ICAR report on the HYV programme in India (1979-80) with reference to Assam. In the subsequent discussion on the pattern of inequality of land, it has been found that the relative concentration of land is high among the large farmers.

The gross cropped area as an indicator of higher cropping intensity has a range of variation between 1.283 to 9.315 hectares for the villages located in the western part of the area under study. (Figs.21,22) The intensive nature of cultivation of land is well manifested as the size category of the gross cropped area increases with the decrease in the frequency of households. The frequency distribution of the gross cropped area shows that a sizeable number of households (i.e. 85 per cent) have little or moderate intensity of land use while high intensive of agriculture is found in only 15 per cent of the sample households. The gross cropped area of these 15 per cent farmers varies between 7.0 to 8.5 hectares and above. The final analysis reveals that the arable land is very less intensively cultivated in the Lower Brahmaputra valley.

The area sown more than once ranges between as low as 0.067 hectares to as high as 4.185 hectares for the villages Jhagarapara and Ketakibari of Goalpara and Kamrup districts respectively. (Fig. 21 and 13). A substantial share of the households i.e. 35 per cent of the sample comes within the low size group of area sown more than once varying between 0.75 to 1.50 hectares. The distribution being of bimodal and skew, the second highest share of households accounting for 25 per cent comes within the size group of moderate degree in area put to double cropping. High degree of double cropping is noticed only in 5 per cent of the sample, the area varying between 3.00 to 3.75 hectares and above. As a whole, it appears that 50 per cent of the sample households practise double cropping in a low degree (i.e. less than 0.75 to 1.50 hectares). The next 45 per cent do have moderate degree of double cropping. What is evident is that a large number of farmers i.e. 95 per cent of the sample households devote very little area to double and multiple cropping. The agricultural land use hence in the study area is not very intensively cultivated.

The lowest and highest index of cropping intensity varies between 104.72 to 275.0 in Ketakibari an eastern village and Kheraj Deobhangi a western village respectively. From among the entire sample, 32.50, 57.50 and 10.00 per cent households have low, medium and high degree of efficiency in crop raising. Only one household has, however, very high degree of cropping intensity the index being 275. The first 62.5 per cent of the households coming within the categories of very low, low, medium, degree of efficiency in terms of land use indicate that though the High Yielding Varieites of rice have been adopted by them but the extent of landuse for three crops seems to be very low the index of cropping intensity being less than 200. Even, the household haveing highest degree of cropping intensity the intensity index being 275, is however, noticed to have devoted only 0.135 hectare of land to HYV of rice. This analysis high lights that the farmers of the Lower Brahmaputra Valley are not very efficient in land utilization, inspite of the conducive agro-climatic setting and the introduction of the short duration High Yielding Varieties of rice. The diffusion of HYV rice crops is, therefore yet to gather momentum in this area and largely depends on the farmers enthusiasm to go in for the adoption of these crops which can quicken the crop cycle in an agricultural year.

With reference to the question posed as to whether the farmers devoting more or little area to this HYV of rice have proportionately adequate or scanty operational holding, gross cropped area, and double cropped area, whether the inter-relationships between the different aspects of landuse are significant or not, the following results have been ascertained. The study of inter correlations between the landuse variables indicates that excepting a few, most of the pairs of variables are positively correlated. The paired variables having positive and significant relations between each other comprise of area under traditional varieties of rice and net ctopped area (r = 0.855, significant at all the levels), area under traditional varieties and gross cropped area (r = 0.912, significant at all the levels), area under traditional varieties of rice and double cropped area (r = 0.625 significant at all the levels), net cropped area and gross cropped area (r = 0.916, significant at all the levels), net cropped area and double cropped area (r = 0.385, significant at all the levels except at one percent), gross cropped area and double cropped area (r = 0.722, significant at all the levels, and finally the double cropped area and the indices of cropping intensity (r = 0.490, significant at all the levels, except at one per cent).

The high and significant positive correlation between the area under traditional rice and net cropped area is indicative at a vigorous increase in the area under local varieties with the increase in the net cropped area. It implies that the farmers are so much inclined towards these traditional crops, most probably, because of their high reliability and environmental adaptibility that a substantial or even the entire net holding is brought under cultivation during the respective seasons of Ahu and Sali round the year. The widespread diffusion of the new exotic varieties of rice can thus, be expected only when the farmers go in the reverse way.

The high positive and significant relationship between the net area sown and the gross cropped area suggests that the gross cropped area, to a large extent depends on the total operational holding (i.e. the net area sown) which by double and multiple cropping helps to increase the gross cropped area. Hence, as the net area sown increases, there is a corresponding increase in the gross cropped area. It further suggests that a sbbstantial net area sown facilitates the farmers to achieve through cropping multiplication, an appreciable gross acreage. In order to achieve this goal, the short duration High Yielding varieties of rice crops should be extensively grown, so that there will be a faster multiplication of the crop cycle in terms of number of times.

From among the paired variables being negatively correlated, one pair shows negative and significant relationship between themselves. The variables are, net cropped area and the indices of cropping intensity. It is obvious that the net area is not efficiently brought under cultivation thereby decreasing the cropping intensity. It therefore results in a conseuqnet decrease in double cropping multiplicity and gross acreage.

An insignificant positive relationship between the area under HYV of rice and the net area sown indicates that farm size is never a factor for the cultivation of HYV of rice. Farmers psychology and attitude, on the contrary, play an important role in the adoption of new innovations in agriculture. On the other hand, the area devoted to the local varieties of rice is highly, positively and significantly related with the farm size (i.e. the net operational holding or net area sown). This is because, higher reliability is attached to the local varieties than that of its High Yielding counterparts. Hence, HYV rice culture is never farm size biassed. It, by and large, depends on the farmer's progressive attitude, skill and self-interest which can be given further impetus through adequate scientific education, training and pursuation.

The productivity of HYV of rice is found to be having positive and significant relationship with the area under HYV of rice (r = 0.446, significant at all the levels), with the gross cropped area (r = 0.342, significant at 5 and 10 per cent levels), with the net cropped area (r = 0.357, significant at 5 and 10 per cent levels) and with the productivity of local rice (r = 0.823, significant at all the levels. With the indices of cropping intensity, the relationship is however, negative but insignificant.

Substantiating the above analysis one can say that larger areas under HYV of rice become economic for the application of modern farm inputs which, obviously, will raise the productivity. Meaning thereby, larger is the area under HYV of rice higher is the productivity level. Since the relationship between the area under HYV of rice and the net cropped area tends to be positive, farmers having bigger farm size seem to have been tempted to devote relatively more area under the former. It is distinct therefore that, bigger the farm size, higher the productivity as evident from their being positively correlated.

As far as the socio-economic profile of the farmers selected for study is concerned, most of the farmers possess low and medium educational status, the percentages being 40.00 and 32.50 per cent respectively while 15 per cent of the farmers are illiterate. The rest 12.50 per cent farmers have attained higher educational status i.e. College and university education. The young farmers below 30 years of age are only about 7.00 per cent and therefore the adventurous nature is missing in the sample households and villages.

Family-size as a social indicator behind the adoption of modern innovations varies between 2 to 23 in case of the sample households. Small families are more numerous than the larger ones. The percentage shares in different size categories such as verylow, low, medium, high medium, high and very high are 5, 27.5, 50, 12.5, 2.5 and 2.5 respectively. This analysis makes the study distinct that the households having medium family size (i.e. between 8 to 16 members) dominate which account for 62.50 per cent in the entire sample followed by the small families (the members varying between less than 4 to 8) constituting of as much as 32.50 per cent of the sample. Large families are only 5.00 per cent of the sample. The medium and large families are mostly Muslims who belong to the western villages of the area of study.

Religious beliefs and religion in particular as socio-cultural factors often determine the social and economic behaviour of the farming community to accept new ideas. As per the direct interview with the farmers of different religious, the Hindus are observed to be more inclined towards the religious beliefs in agriculture than that of the Muslims. The sample households constitute mainly of Hindus and Muslims accounting for 45.00 and 55.00 per cent respectively.

As much as 80 per cent households in the sample do have adult working members who work in the field for about 8 hours in general and their number varies between 1 to 6. Rest of the households do not have working members and hence rely on the hired labour for all kinds of agricultural operations. From among the households having working members, 59.38 per cent have less than 3 adult working members and do come in the low category in terms of family labour. The medium category of households in family labour constitutes of 31.25 per cent and do have adult working members varying between 3 to 5. The rest 9.38 per cent of the households have more than 5 members who devote full time in agriculture.

As much as 30.00 per cent farm households do not have permanent farm labour. The rest have permanent farm workers between 1 to 4 in number. Maximum households (i.e. 53.57 per cent) have permanent labour between 2 to 3 followed by next 39.29 per cent having less than 2 farm labours. As substantial share of the households (i.e. 46.43 per cent) pay salary to their permanent labour between Rs.600/- to Rs.700/- per annum. Next to this group i.e. 17.85 per cent households pay more than Rs.700/- as salary to their permanent farm workers. The salaries are, however, excluding the fooding and clothing which are provided by the farm households.

A majority of the households (i.e. 65 per cent) are noticed to have possessed draught animals on whom the field operations largely depend, less than 3. The next higher group of farmers having draught animals between 3 to 5 and constitute of 22.5 per cent of the sample. Only 10 per cent of the households have between 5 to 7 draught animals while only one household possesses more than 7 draught animals.

Fragmentation of agricultural land as a social problem is no way a less in the Lower Brahmaputra valley. As much as 55 per cent of the sample households have fragmented fields varying between 4 to 8. Low and high fragmentation of cultivable land is observed in 22.5 per cent of the households each, the number of fragments varying between less than 2 to 4 and 8 to 10 and above respectively.

Other than cultivation, as much as 57.50 per cent sample farm households have members at least one or more being engaged in off farm occupations which include teaching, government services business and construction works. As far as indebtedness of the farmers and the sources of finance of the farm households are concerned, it is found that 17.5 per cent of the farmers are resorted to indebtedness either to money lenders or other financial agencies. The rest of the farmers are still not financially sound. Of the entire sample, 22.5 per cent households both own and have used the different advanced agricultural implements. As much as 35 per cent of the farmers have only used these implements. The rest 42.5 per cene neither own nor do they use these implements such as diesel pump, sprayer, weeder, thrasher and duster etc.. The most advanced in regard to these implements is the village Ketekibari (Fig. 20) of Kamrup district being provided with lift irrigation facilities.

The agricultural production in the farm households is mostly consumed and sold in small quantity to clear up debts, land revenue, and to fulfil other needs. About 60 per cent households are not left with any surplus, rather they depend on the market at the time of deficit.

The inter-relationships between the socio-cultural variables reveal interesting findings. The number of fragmented fields increases with the increase in the size of holdings. Educational levels of the farmers increase with the decrease in age, signifying the fact that, the young farmers are more educated than the older ones. Education also increases with the decrease in family size. It indicates that farmers coming from smaller families are more educated than that of their bigger counter parts. As the educational level of the farmers increases, there is a corresponding decrease in the number of working adult members in the family. Educated families hence, have less number of working members who work in the field. The agricultural fields of the educated families are less fragmented the relationship between the former and the latter being insignificant. This tendency is, on the other hand, a healthy sign in the country side of the Lower Brahmaputra Valley. Education seems to have spread more among the Hindus than the Muslims, though the relationship of education with religion is insignificant statistically at all the levels. This tendency might lead to serious consequences in the agricultural development in the area. Since Muslims appear to be good cultivators in terms of productivity as compared to Hindus, the agriculture will be more traditional if education does not spread among the Muslims. The productivity increases with a corresponding increase in the number of working members in the family, the relationship being significant at 5 and 10 per cent levels. On the contrary, a negative and insignificant correlation exists between family size and religion highlighting the fact that Muslims have bigger family size than the Hindus (according to the weightage given to different religious). In accordance with the above situation, one can arrive at the conclusion that Muslim cultivators are making headway in terms of productivity which can be possibly attributed to larger family size. It may be because larger family size serves the purpose of intensive utilization family labour. Since family size and number of working members are positively and significantly correlated, it can be rightly said that Muslim families have adequate number of working members because of larger families, thereby increasing the productivity level.

Factor analysis of the land use variables highlights the fact that traditional technology still prevails in the area. Local varieties of rice occupy a pivotal position in the land use system. While the area devoted to HYV of rice forms a separate factor being negatively loaded on the same, the local varieties of rice go along with the other land use variables, such as gross cropped area, double cropping and net cropped area and make a cluster projecting linear relation with each other. The efficiency of land use can straight way be attributed to the extensive cultivation of local varieties rice. The analysis shows a poor performance of landuse for the new exotic varieties of rice which reflects a negative attitude of the farmers towards these crops.

Factor analysis of socio-cultural variables throws light on the social background of the farmers. While, on the one hand, factor I depicts the farming households as highly tradition bound and orthodox in terms of larger families, high fragmentation of agricultural land, and low educational status; on the other, factor II represents the biassness of farm holding towards the Hindus.

The measures of inequality in the distribution of HYV of rice reveal that more than 50 per cent of the output appears to have been concentrated within 50 per cent of the net area under cultivation, belonging to as much as 70 per cent households from bottom. The inequality in the distribution pattern of output appears to be relatively less than that of the area under HYV of rice for which the output curve runs almost parallel to the egalitarian line beyond 62.87 per cent of the net area (Fig.24). At 6 and 18 per cent levels land and output seem to have been equally distributed between which share of output is less than than of the land. As much as 65.09 per cent of the total area under HYV of rice is found concentrated within 49.68 per cent of the net area owned by 70 per cent of the households from the bottom. The Gini's coefficients show that the distribution of output of HYV of rice is less unequal than that of the area under HYV of rice with respect to the net area, the coefficients being 0.034 and 0.172 respectively.

The share of the farm attributes as against the households show that land is most unequally distributed followed by the output of HYV of rice and the area under HYV of rice. Much of the land and output concentration (i.e. 50.32 and 45.33 per cent each) is spectacularly and relatively high within the top 30 per cent i.e. the big farmers. The shares of the same for the bottom 30 per cent farmers are as low as 14.21 and 12.24 per cent each. The share of the land devoted to HYV of rice for the farmers in the top and bottom strata of 30 per cent each include 34.91 and 20.01 per cent respectively. The middle

40 per cent farmers posses a substantially high share of area under HYVs (i.e. 45.08 per cent) and do have encouraging shares of output and cultivated land. Land and output with an equal share each are available to 15 and 34 per cent households as evident from the inter-section of both these curves at these points. The Gini's coefficents for land, output and area under HYV of rice indicating relatively high and low concentration in sequence incorporate 0.287, 0.254 and 0.118 respectively.

The study of inequality indicates that a relatively greater concentration of output and land is visible among the large farmers than that of the area under HYVs. This tendency might lead to a situation of monopoly agriculture in the diffusion process. What emerges from the analysis is that the area under study is dominated by small and medium farmers with highly unequal distribution of land, output and area under HYV of rice. If this process continues then it may result into serious social disparity and tensions. Hence it is high time to bring equality in the society with equal access to social opportunities. To achieve this goal, the redistribution of land among the small and medium farmers needs urgent attention. By virtue of it, a uniform spread of the new technology, specifically HYV of rice can take place irrespective of holdings such as small, medium and large which will have a real reflection of farmer's interest and enthusiasm in the adoption of new innovations in agriculture.

It has also been found that the marginal farmers having net operational holding less than one hectare of cultivated land are relatively more inclined towards the HYV of rice culture than that of the other categories of farmers, their share being more than 50 per cent of the net holding followed by small (22.49 per cent), moderately large (18.27 per cent) low medium (17.62 per cent), medium (11.59 per cent) and the large farmers (2.01 per cent).

Such an extensive and widespread cultivation of High Yielding rice among the marginal farmers may be attributed to the reason that the exotic new varieties of crops give relatively better production than that of the local varieties. This has been illustrated in Chapter-IV. The coverage of HYV of rice in case of the small farmers is also appreciable and encouraging. It is clear that the small and marginal educated farmers do take risk to go in for the High Yielding Culture as far as the water availability is concerned. Lower Brahmaputra valley being less vulnerable to draught conditions owing to its location in the high rainfall zone of the country stands favourable for the cultivation of rice. Though the area does lack adequate irrigation potential for controlled water system specifically for the new varieties of rice. Nevertheless, water does not pose much problem for the farmers because of assured rainfall during June to October. On the other hand, the rainfall variability in the whole of Brahmaputra valley is less than 20 per cent. Apart from the above reasons, there are still many other factors which remain unexplored as to why the small and marginal farmers have much propensity towards HYV culture.

The case is just reverse with the large farmers in the study area who appear to be indifferent towards High Yielding Culture as evident from their area coverage. It may be because, these farmers try to avert risk due to crop failure and may be because the infrastructural facilities are inadequate and the High Yielding culture is capital intensive and labour substituting for which farm mechanisation is imperative. But what apparently is visualised in the area that other than the lack of farm mechanisation in terms of advanced machineries and technical skill, specifically in case of the big farmers, human labour may be a serious impediment in the process of adoption of HYV rice which does not suffice to their need because of bigger farm size even though, there is a relative increase in working members with that of the holding size. Since small farmers largely depend on family labour as has been observed in other areas of the country, this may also be a reason as to why small and medium farmers in the present case are more interested and able in adopting HYV of rice apart from the reasons cited above. In the absence of mechanisation in agriculture in the study area, it will not perhaps be exaggerated if said that the High Yielding cultivation in the study area is more characterised by its labour intensive nature than that of its labour substitutive through mechanisation by capital investment. This is because, productivity of HYV of rice as an indicator of enthusiastic agriculture increases with the increase in the number of working members in the family which has been pointed out in the preceding discussions. The medium farmers also seem to be progressive in regard to the coverage of land under HYV of rice and output level also as compared to their bigger counterpart.

The output per unit area (i.e. hectare) reveals that the marginal farmers come in the lowest rung of the ladder (i.e. 1890.94 kg/ha), the reason of which may be attributed to poor capital investment which is on the other hand, not available easily to these farmers. The moderately large farmers are the most progressive in terms of output (i.e. 6385.27 kg/ha). Though the reasons are obvious, but it needs further investigation. The large farmers appear to be lagging behind in this regard the productivity in their case being 2488.9 kg per hectare. The small farmers deserve mention because they rank second to the moderately large group in terms of output i.e. 3076.09 kg per hectare. Encouraging output in case of the moderately large and small farmers may by and large be due to family labour and the farmers progressive attitude towards modern agriculture. It further implies that the farm-size of moderately large group of farmers stands viable and economic for the adoption of HYV of rice unlike the small farmers whose agriculture may be because of efficient utilization of family labour. The average output for all the categories of farmers comes out to be 3534.09 kg per hectare of cultivated land.

It can be concluded in the light of the above discussion that if the farmers are split into just three strata as small medium and large, then the small farmers have considerably made headway in terms of coverage of area under HYV of rice, lagging behind in output level, where as the picture seems to be reverse in the case of the large farmers. The medium farmers appear to have shown an encouraging performance in terms of coverage of area under HYV of rice and output per unit area. The small farmers are, still ahead in terms of output as compared to their medium counterpart.

The picture that emerges from the above discussion is that the size of HYV practice does not have significant positive relation with the size of holding in the sense that the size of HYV plots remains constant irrespective of holding size i.e. small, medium and large. This may be largely due to lack of mechanisation and concentration of use of labour, particularly the family labour. The HYV package practice is thus scale neutral and perhaps more favourable to smaller holdings.

The diffusion of HYV culture is therefore, appreciable among the small and medium holding farmers whose social and economic standing needs a thorough investigation within a more rational, pragmatic and comprehensible framework. The large farmers are, however, still to be attracted towards this modern farm innovation. The reasons are though numerous, nevertheless, it can be said that the area suffers from the inadequacy or paucity of infrastructural facilities fbr farm mechanisation as well as the human labour. Moreover, scientific training and education is felt imperative as prerequisite to motivate the big farmers for the adoption of new innovations such as HYV of rice.

In order to have a pragmatic approach to the cost benefit analysis of the adoption of HYV of rice human and animal labour have been given due importance in terms of real cost incurred on the same. The total cost owing to these two inputs include the yearly salary paid to the permanent labour and that of the investment on drought animals as parts of total cost. These inclusions have led to minimum exaggeration in working out cost figures. The total cost for the farm households per hectare individually shows that as much as 62.5 per cent of the farmers have more or less benefitted from the HYV of rice cultivation, the total cost being less than the gross return per hectare. Mention may be made of the sample farmers of Ketekibari who have all, except one benefitted from the High Yielding rice cultivation. This may be largely because of efficient resource utilization that is accessible to the farmers within their reach. The average cost and return (gross) per hectare have been calculated as Rs.2380.71 and Rs.3287.95 respectively for the entire sample.

The measures of profitability of HYV of rice vis-a-vis the local varieties such as gross return in rupees per hectare, net return in rupees per hectare, net return per unit of output and incremental net return as percentage to incremental cost have highlighted the following results.

The yield and gross return as excess for HYV of rice as compared to local rice are 69.73 and 70.02 per cent respectively. The new varieties incur a higher cost for producing just one unit of output than the local rice. The excess cost for HYV of rice over that of the local varieties is 25.62 per cent. The incremental net return of HYV of rice as percentage to incremental cost over the local varieties of rice is 79.77 per cent. It implies that one unit of extra cost will bring 1.79 i.e. 1.80 units of an additional net return of High Yielding rice. This ratio appears to be highly encouraging and suggests that the adoption of HY+V of rice has got better prospect over a longer time period.

Having examined as to how much the farmer gets after the deduction of all the costs for every quintal or kilogram of crops, it is found that the net return per unit of output (i.e. per quintal or kilogram) are Rs.35.15 and Rs.0.35 per quintal and kilogram of HYV of rice. In case of local varieties, the same are substantially low i.e. Rs.2.9

and Rs.0.029 respectively per quintal and kilogram of crops. It is vivid that the HYV of rice is much more remunerative than that of the local varieties in terms of net return in the study area.

Although there are speculations on the diffusion, spread and performance of HYV of rice in the Lower Brahmaputra valley the study reveals that the region is lagging behind in the productivity of rice. On the basis of the multivariate analysis made in the present venture the author ascertained that the region has the ecological set up conducive for the cultivation of HYV of rice and their diffusion has therefore a great scope. In order to obtain the desired results more research, however, is to be done both in the agro-climatic set up and cultural milieu of the region on the one hand and the physiology of the new varieties of rice on the other.

The following suggestions in the opinion of the author will go a long way in popularising the HYV and in raising their productivity in the highly fertile and extensively cultivated tract of the Lower Brahmaputra valley.

The High Yielding variety rice crops are highly sensitive to the weather elements specially at the flowering and grain formation periods. The absence of an adequate meteorological information keeps the former in guessing the weather conditions. Installation of more Meteorological and rainfall recording stations is therefore, a pre-requisite for the success of HYV of rice : Such climatic data will help in making timely and more realistic weather forecast enabling the farmers to adjust and regularise their agricultural operations accordingly. A similar point is observed about the properties of soils. The soil regional laboratories have got enough data but the information needs to be plotted on large scale maps and explained to the respective farmers so that they may apply the deficient components of soil nutrients in the right proportions.

The soil analysis shows that the humus contents in the soil of Nowgong and Kamrup are deficient. With the help of more fertilizers and manures, the fertility and productivity of these districts can appreciably increase the productivity of rice in the region.

From the study made, the author arrived at the result that it is not the total amount of rainfall but its timely distribution over the different phases of crop growth which determines the total output. The chemical fertilizers which are costly inputs cannot be used with confidence by the farmers specially in the Ahu rice crop during the winter season when the weather is clear, cool and rainless. The winter rice crops in the region could be ideally grown if provisions for controlled irrigation through canals, tanks, wells and tube wells could be made.

Apart from financial aspects, the extension machinery should be most extensive and efficient. The optimum use of inputs can be made only if proper supervision to the cultivators is available, which depends on the type of extension machinery evolved and the personnel employed. There should be a perfect coordination between farmers, extension agent farm supervisors technologists, researchers, planners and administrators. Any slackness in the coordination specially the research and diffusion of innovations may further retard the progress towards the adoption of HYVs in the region.

The process of diffusion of HYV of rice can be quickened by a vigorous and wide spread campaign through the nook and corners of the country-side about the benefits of the advanced agriculture.

Since the landuse pattern in the country-side of the Lower Brahmaputra Valley has been explored to be the most inefficient in terms of cropping intensity, the author is of the opinion that the cropping multiplicity be accelerated by introducing the exotic short duration crops. This will generate a vast surplus of production and the surplus work force can get employment during the off season.

Based on a hypothetical view right from the inception of this study as to whether the modern enterprises in agriculture are confronted with socio-cultural and economic resistance of the farming community at the initial level the following suggestions for the farmers of the Lower Brahmaputra Valley area might probably generate positive repurcussions if acted upon with an objective view of policy implementation. It has been concluded that a large section of the sample farmers have achieved at least formal education or more in the area under study. So an effective implementation of High Yielding Varieties programme is supposed to envisage the linkage of production inputs with technical know-how and skill of the farmers through a planned and organised training programme supported by Farm Radio Broadcast and functional literacy as has been included in the set objective of farmers training and education in India by the farm information unit, Directorate of Extension, Ministry of Agriculture and Irrigation, New Delhi.

The family size of the farm households being of largely low and medium suggests that a greater proportion of human labour for all kinds of agricultural operations may be hired because of small families which probably may not be catering to the need of adequate labour. This needs further investigation. This is supplemented by a subsequent finding that from among a large number of households having adult working members for agricultural operations, maximum families lack an adequate number of the same, thereby relying on permanent hired labour or seasonal or either. A curiosity or inquisitiveness arises as to despite an extensive traditional technology prevailed which in general human labour intensive the area in deficient of labour. The question arises where the hired labour is to be procured from?[18] Is it that the area experiences a floating seasonal labours hail from outside of its jurisdiction? The author is of opinion that if the outside influx of labour perpetuates in the area more than desired and the floating labour tries to settle down in search of employment, then it might accentuate further social tensions in the long run which is already spearheading with speed and vigour.

There are obvious reasons as regards the non-availability of hired labour within the region. It is because, every farmer has more or less some land at his disposal. Moreover the landless labourers in the area under study may be proportionately very few. On the other hand, the inequality in the distribution of cultivated land among the farmers is not very alarming as compared to other areas of the country. This kind of situation in the area has, probably, resulted into a considerable shortage of human labour specifically during the cropping seasons. The author, therefore, has a strong conviction in this regard and is tempted to suggest that the introduction and breakthrough of new tools and implements be used in the area which can solve the problem of inadequacy of labour.

It may be proposed here in the case of the religious dichotomy linked with production relations in the area that Muslims being the progressive cultivators in the area should be paid extra-attention by protecting their interests in terms of socio-economic accessibilities to the factor markets for the introduction of new innovations in agriculture without social deprivation and discrimination.

Some of the very acute problems in the agrarian scene of the Lower Brahmaputra Valley area include land fragmentation, less employment opportunities, during the off farm seasons, poor organisation of social institutions such as credit facilities, low level of application of advanced mechineries and less generation of surplus in production absence of larger commercial centres and low level of communication facilities which have almost retarded the diffusion of new innovations in agriculture specifically the High Yielding Varieties programme. The role of Community Development Blocks has, however, been commendable as regards the extension services in bringing the illiterate farmers home to the inherent benefit of the agricultural innovations. After having examined, the situation is not very satisfactory in the agricultural scene. The author extends suggestion that a transformation from the traditional to its modern counterpart can only be brought about in the agriculture of the rural areas of the Lower Brahmaputra valley through an organised and systematic execution of agricultural policy, so that the trial on the diffusion of any updated innovations in the area will be a greater success. And this needs a perfect coordination between the cultivators, administrators researchers, other committed agencies and the communication media. How this co-ordination could be achieved, needs more research and investigation.

TABLE -1

Response of the rice plant to varying temperature at different growth stages.

Growth stage	Critical temperature(°C)			References
	Low	High	Optimum	
Germination	16-19	45	18-40	Change and vergara (1971):Nishlyama (1976)
Seedling emergence and establishment	12-35	35	25-30	Nishiyama(1976)
Rooting	16	35	25-28	Nishiyama(1976)
Leaf elongation	7-12	45	31	Nishiyama(1976)
Tillering	9-16	333	25-31	Nishiyama(1976)
Initiation of Panicle Primordia	15	-	-	Owen(1969,1972a, b)
Panicle differentiation	15-20	30	-	Nishiyama(1976): Satake(1969)
Anthesis	22	35-36	30-33	Poggendorft(1932); Kusanagi and Washio (1974);Sato et al (1973);Tanaka and wada(1955); vergara et al (1970)
Ripening	12-18	30	20-29	Nishiyama(1976); Yoshida and Parao (1976)

Source - IRRI Rsearch paper Series, No.20,July 1978 pp.6.

TABLE - 2

Total Monthly Rainfall (1931-60)
(in mm)

Stations	Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.
Dibrugarh	34.9	60.8	99.8	203.6	356.3	514	516.5	417.7	341.5
Sibsagar	29.7	46.5	94.6	218.2	361.1	390.8	476.3	400.2	301.8
Tejpur	15.1	22.5	55.3	148.7	306.1	296.8	336.3	312.8	236.2
Gauhati	11.4	18.3	53.4	125.9	273.6	293.4	301.5	263.0	190.0
Dhubri	11.2	19.2	45.3	154.2	418.5	644.3	447.7	305.3	331.4
Nowgong	2.3	16.5	8.4	2.3	6.8	90.4	341.6	341.0	168.8
Silchar	14.6	44.7	97	312.5	493.3	605.2	546.5	475.3	378.4

Source: Calculated by author

Contd.....

Contd......

Stations	October	November	December	Mean monthly rainfall in mm.	Mean annual rainfall in mm.	Monsoon rainfall Percentage in mm (June - Sept.)
Dibrugarh	165.7	27.3	22.3	229.95	2759.4	64.86
Sibsagar	135.5	30.1	19.5	208.69	2504.3	62.66
Tejpur	132.8	22.6	9.2	157.86	1894.4	62.40
Gauhati	90.1	11.5	5.0	139.43	1673.2	62.63
Dhubri	135.1	11.8	1.2	210.43	2525.2	68.46
Nowgong	29.4	10.0	5.7	86.99	1043.9	90.22
Silchar	207.0	44.0	6.9	268.78	3225.4	62.18

TABLE - 3

Lower Brahmaputra Valley - Mean Monthly Temperature 1977

Stations	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.
Dhubri	17.00	20.35	25.1	23.4	25.7	26.75	28.2	28.7	28.65
Gauhati	16.05	19.65	23.75	23.1	25.25	26.95	28.75	28.45	28.45
Rangia	16.5	19.9	23.75	22.55	25.2	26.55	28.75	28.8	28.0
Majbat	16.4	18.3	22.5	22.55	25.25	26.65	29.2	28.4	28.2
Tezpur	17.95	21.2	25.25	24.5	25.35	27.15	29.6	28.95	29.25
Gohpur	14.55	18.2	20.0	21.85	24.15	26.15	28.4	27.3	29.8
Lumding	16.	18.95	23.85	23.6	25.35	27	28.95	28.85	24.4

Source: Directorate of Agriculture, Govt. of Assam.

Contd....

Contd.........

Stations	Oct.	Nov.	Dec.	Mean annual	Average monthly Temperature in °C (May to Nov,)
Dhubri	25.05	23.1	-	24.72	26.59
Gauhati	24.4	22.0	18.2	23.75	26.32
Rangia	24.05	22.25	18.85	23.76	26.22
Majbat	24.3	21.2	17.85	23.4	27.60
Tezpur	25.55	21.45	18.45	24.55	26.75
Gohpur	23.6	19.65	16.65	22.36	25.43
Lumding	24.40	21.35	18.6	23.44	25.75

TABLE - 4

Area, Production and Average Yield of Rice in Assam, 1950-51 to 1975-76 with Index Numbers

Base= 1952-53=100)

Year	Area		Production		A.Yield	
	Hectares	Index	In Lakh Tonnes	Index	Kg/Ha	Index
1950-51	1492020	80.43	12.75	82.62	855	102.76
1951-52	1783589	96.15	14.12	91.50	793	95.31
1952-53	1854937	100.00	15.44	100.00	832	100.00
1953-54	1573906	84.85	15.18	98.33	965	115.98
1954-55	1560723	84.14	15.66	101.46	1004	120.67
1955-56	1600827	86.30	15.40	99.79	963	115.74
1956-57	1601940	86.36	16.17	104.78	1010	121.39
1957-58	1593556	85.99	15.37	99.57	965	115.98
1958-59	1690242	91.12	15.89	102.97	941	113.10
1959-60	1696502	91.46	16.67	107.99	983	118.15
1960-61	1716154	92.52	16.33	105.76	968	116.34
1961-62	175593	94.62	16,48	106.74	985	118.39
1962-63	1777520	95.83	14.76	95.60	956	102.88
1963-64	1754979	94.61	17.54	113.62	1015	121.99
1964-65	1779168	95.92	17.88	115.84	1021	122.71
1965-66	1797546	96.91	17.13	110.96	968	116.34
1966-67	1851815	99.83	16.32	105.72	895	107.57
1967-68	1886831	101.72	17.87	115.76	957	115.02
1968-69	1952790	105.28	19.89	128.85	1035	124.40
1969-70	1967598	106.07	19.67	127.42	916	110.09
1970-71	1968370	106.12	19.80	128.22	1022	122.83
1971-72	1967530	106.07	19.08	123.58	985	118.39
1972-73	2068770	111.53	21.77	140.99	1052	126.44
1973-74	2077820	112.02	20.66	133.81	994	119.47
1974-75	2057500	110.92	19.83	128.47	960	115.39
1975-76	2199053	118.55	22.49	145.69	1038	124.76

Source:(1)Estimates of Area and Production of Principal Crops in India, 1950-51 to 1964-65,Directorate of Economics & Statistics, Ministry of Agriculture. Government of India.

(2)Directorate of Economics & Statistics, Government of Assam.

TABLE - 5

Annual percentage variation over preceding Years in the Index Numbers of Output of Rice in Assam, 1950-51 to 1975-76

Year	Percentage in Index Numbers Rice
1950-51	-
1951-52	+ 1.07
1952-53	+ 0.93
1953-54	- 1.67
1954-55	+ 3.18
1955-56	- 1.64
1956-57	+ 5.00
1957-58	- 4.97
1958-59	+ 3.41
1959-60	+ 4.88
1960-61	- 2.06
1961-62	+ 0.93
1962-63	-10.44
1963-64	+18.55
1964-65	+ 1.95
1965-66	- 4.21
1966-67	- 4.72
1967-68	+ 9.50
1968-69	+11.30
1969-70	- 1.11
1970-71	+ 0.66
1971-72	- 3.65
1972-73	+14.09
1973-74	- 5.09
1974-75	- 5.09
1975-76	+13.41

Source: Same as Table-4 (2)

TABLE - 6

Average of Annual Rate of Increase or Decrease in Index Numbers (by periods)

Year			Rice
1951-52	to	1955-56	+ 0.37
1956-57	to	1960-61	+ 1.25
1952-52	to	1960-61	+ 0.81
1961-62	to	1965-66	+ 1.42
1966-67	to	1968-69	+ 5.36
1969-70	to	1975-76	+ 2.05
1950 -51	to	1975-76	+ 1.83

Source : Same as Table-4 (2)

TABLE - 7

Annual Linear Growth Rate in Production and Productivity of Rice in Assam 1950-51 to 1965-76

Crops	Annual Linear Growth rates of	
	Production	Productivity
Rice	+1.58	+0.61

Source: Same as Table-4 (2)

TABLE - 8

Lower Brahmaputra Valley - Total Monthly Rainfall, 1977 in mm.

Stations	Total	Mean Annual	Monthly Mean (M to N)
Kampur	1294.7	107.89	147.24
Gohpur	1098.2	91.51	29.60
Majbat	2509.9	209.16	288.28
Barpeta	2323.9	193.66	300.15
Gauhati	2209	184.09	246.57
Tejpur	2141	178.4	239.8
Kokrajhar	2804.7	233.73	338.38
Bilasipara	1548.8	1290.06	1814.4
Dhubri	3349	279.08	199.57
Lumding	-	-	171.5

Source: Same as Table-3

TABLE - 9

Yield-rate of Regular Ahu(HYV) in kg/ha

The figures within bracket indicate number of experiment

Sub-division	Full-package	Partial package			Non-package	Pooled
		Fertilizer alone	Irrigation alone	combined		
1. Dhubri	1691(8)	1412(5)	1019(5)	1216(10)	785(2)	1363(2)
2. Kokrajhar	2426(7)	-	1846(10)	1846(10)	1032(4)	1884(21)
3. Goalpara	-	1868(10)	1666(2)	1834(12)	1738(27)	1767(39)
4. Gauhati	2414(21)	2377(3)	2087(17)	2130(20)	1681(32)	2015(73)
5. Nalbari	3329(3)	2685(1)	2007(1)	2082(9)	1937(11)	2175(23)
6. Barpeta	-	2426(6)	-	2426(6)	1512(8)	1903(14)
7. Nowgong	2539(32)	2123(5)	1975(12)	2019(17)	1258(16)	2088(65)
8. Marigaon	2470(8)	2280(1)	2249(6)	2253(7)	1398(5)	2126(20)
9. Mangaldoi	2870(11)	-	2233(11)	2233(11)	1750(5)	2403(27)
10. Diphu	-	-	2502(4)	2502(4)	2306(8)	2371(12)
11. Hamren	-	-	-	-	2389(3)	2389(3)

Source: Same as Table-3

TABLE - 10

Yield-rate of early Ahu (HYV) in kg/ha

(The figures within bracket indicate number of experiment)

Subdivisions	Full package	Partial package			Non-package	Pooled
		Fertilizer alone	Irrigation along	combined		
1. Dhubri	1385(8)	-	1421(5)	1421(5)	1303(2)	1386(15)
2. Kokrajhar	2231(12)	-	1810(5)	1810(5)	-	2107(17)
3. Goalpara	-	1922(2)	-	1922(2)	-	1922(2)
4. Gauhati	2339(13)	-	1955(18)	1955(18)	1536(8)	1997(39)
5. Nalbari	2254(3)	2238(2)	2089(6)	2203(8)	1974(4)	2152(15)
6. Barpeta	2736(4)	2184(6)	-	2184(6)	1472(7)	2021(17)
7. Nowgong	2080(13)	1915(2)	1546(4)	1667(6)	1373(8)	1779(27)
8. Marigaon	2085(8)	2183(1)	1977(4)	2018(5)	-	2058(13)
9. Mangaldoi	3523(5)	-	1790(20)	1790(10)	-	2367(15)
10. Diphu	-	-	3511(2)	3511(2)	2215(4)	2647(6)
11. Hamren	-	-	-	-	2710(3)	2710(3)
Average	2232(66)	2110(13)	1905(54)	1954(67)	1696(36)	2008(169)

Source: Same as Table-3

TABLE - 10

Soil Nutirent Index

Blocks	Nutrient Index Nitrogen (N)	Nutrient Index Phosphorous (P)	Nutrient Index Potassium (K)
Chhaygaon	2.28 M	1.64L	1.76 M
Rani	2.48 H	1.58L	1.73 M
Rampur	2.24 M	1.69L	2.16 M
Dimoria	2.00 M	1.91M	2.23 M
Chamaria	2.10 M	1.42L	1.49 L
Rangia	2.13 M	1.81M	1.7 M
Karara	1.93 M	1.62L	1.65 L
Kamalpur	2.07 M	1.83M	1.51 L
Hazo	2.13 M	1.54L	1.13 L
Boko	2.51 H	1.64L	1.51 L
Lakhipur	2.24 H	1.69M	1.45 L
Balijana	2.44 H	1.86M	2.1 M
Dudhnoi	2.54 H	1.73M	1.72 M
Madia	2.68 H	1.62L	1.98 M
Srijangram	2.36 H	1.92M	1.33 L
Boitamari	2.42 H	1.78M	1.5 L
Dotma	2.49 H	2.13M	1.64 L
Kokrajhar	2.95 H	2.06M	1.11 L
Sidlichirang	2.51 H	2.28M	1.74 M
Manikpur	1.7 M	2.12M	1.43 L
Kachhugaon	2.4 H	2.14M	1.48 L
Gossaigaon	2.4 H	2.14M	1.48 L
Borobazar	2.4 H	2.14M	1.48 L
Garipur	1.87 M	1.08L	1.95 M
Bilasipara	2.29 M	1.76M	1.43 L
Chapar	2.29 M	2.03M	1.5 L
S.Salmora	3.20 H	1.96M	1.11 L
Manakchar	2.29 M	1.76M	1.43 L
Agomoni	2.11 M	2.05M	1.37 L
Golakgunge	1.98 M	1.69M	1.26 L
Khagarijan	2.35 H	2.69M	1.01 L
Jugijan	2.4 H	1.67L	2.37 H
Rupali	2.02 M	2.05M	1.30 L
Lanka	1.95 M	1.62M	1.07 L
Batadraba	2.64 H	2.08M	1.78 M
Juria	2.06 M	1.8 M	1.00 L
Kalibar	2.37 H	2.21M	1.84 M
Kathiatoli	2.14 M	1.89M	1.18 L
Kapili	2.35 H	1.78M	1.15 L
Lawkhowa	1.77 M	2.3 M	1.29 L
Loharight	1.9 M	1.78M	1.07 L
Bhurbandha	1.73 M	1.73L	1.01 L
Mayang	2.31 M	2.17M	1.20 L

M = Medium
L = Low
H = High

Source: Soil Testing laborotory, Govt. of Assam, Gauhati

TABLE - 11

Subdivision wise Performance of HYV Trials Conducted After and Before 30th June 1977-78

Name of Subdivisions	Yield in kg/ha. after 30th June(Transplantation)	Yield in kg/ha. before 30th June	Average yield in kg/ha	Nutrient index	Texture index	pH Index	Mean monthly rainfall in mm. (Nov. to June)	Temp. in oC	Relative humidity in %	Estimated yield (y)	Basic residual (Y - Y
Dhubri	2136	1864	2000	6.632	2.956	2.022	1237.675	26.49	88.21	1999.975	.0247
Goalpara	816	1772	1994	6.117	1.967	2.884	784.133	26.47	87.56	1293.971	.0286
Gauhati	2560	2618	2589	6.611	2.16	2.67	246.56	26.27	85.13	2588.966	.0338
Kokrajhar	1852	-	1852	7.235	2.003	2.996	720 .481	26.49	88.25	1851.97	.0299
Marigaon	2286	1360	1823	6.035	1.315	2.805	219. 268	26.07	83.92	1822.967	.033
Nowgong	2304	2149	2227	6.709	1.362	2.829	175. 187	26.25	87.48	2226.964	.036
Regression coefficients				468.002	513.364	-744.6	-1.516	-12.753	4.993		
Intercept of the regression equation			657.973								

Source: Calculated by author

TABLE - 12

SUBDIVISION VISE PERFORMANCE OF TRADITIONAL VARIETIES 1974-77

Name of the subdivision	Yield in kg/ha after 30th June (Transplantation)	Yield in kg/ha before 30th June	Average yield in kg/ha.	Nutrient index	Texture index	ph Index	Mean monthly rain-fall in mm. (1974-77)	Temp °C average (1931-60)	Relative Humidity in percentage	Estimated yiels (Y)	Basic residual (Y - Y)
Dhubri			829	6.632	2.956	2.022	158.19	24.35	85.33	829.093	.093
Goalpara			860	6.117	1.967	2.884	129.88	24.35	85.00	860.072	.072
Gauhati			810	6.1110	2.16	2.67	139.69	24.6	81.00	810.081	.081
Kokrajhar			845	7.235	2.003	2.996	297.49	24.35	85.16	845.197	.197
Marigaon			905	6.035	1.315	2.805	168.44	24.48	84.33	905.101	.101
Nowgong			904	6.709	1.362	2.829	135.143	25.35	84.22	912.440	8.44
Regression coefficients				-4.307	-74.659	-48.474	-0.025	8.16	11.949		
Intercept of the regression equation			-38.302								

Source: Same as Table-11

TABLE - 13

Agro-climatic variables and yield of HYV rice

Name of the Blocks	Nutrient Index	Texture Index	pH Index	Rainfall in mm.	Temperature in ^{o}C	Humidity in %	Yield in Kg./ha (Pack+ Non pack.) Average(y)	Estimated Yield(y)	Y - Y	Category
1	2	3	4	5	6	7	8	9	10	11
Chhaygaon	6.82	1.997	2.834	246.56	26.27	87.14	3995	3609.38	+391.62	Medium positive
Rani	7.03	1.994	2.722	246.56	26.29	85.52	2760	3613.39	-853.39	High negative
Rampur	6.97	2.0	2.879	246.56	26.29	85.52	4187	3618.76	+568.24	Medium positive
Dimoria	7.14	2.0	2.763	246.56	26.29	85.52	2666	3644.97	-978.97	High negative
Rangia	6.705	1.99	2.865	246.56	26.22	81.42	3145	3793.59	-648.59	Medium negative
Karara	6.165	2.944	2.03	246.56	26.29	85.52	3695	3304.92	+390.08	Medium
Kamalpur	6.445	2.797	2.006	246.56	26.19	82.78	3675	3673.91	+1.08	Medium positive
Hajo	5.865	1.99	2.796	246.56	26.23	85.23	3301	3506.51	-205.51	Medium negative
Boko	6.915	1.995	2.803	246.56	26.32	87.14	3651	3494.79	+156.21	Medium positive
Lakhipur	6.5	1.97	2.943	784.133	26.48	88.64	4406	2893.03	+1512.96	Very high positive
Balijana	7.62	1.993	2.706	784.133	26.49	87.39	4435	3121.74	+1313.26	Highpositive
Dudhudi	7.26	2.0	2.787	784.133	26.38	87.14	3237	3342.34	- 105.34	Medium negative
Matia	7.62	1.989	2.835	784.133	26.49	87.39	3905	3138.13	+ 766.87	High positive
Boitamari	6.91	1.881	2.713	784.133	26.49	87.39	2425	2953.27	- 528.27	Medium negative
Dotoma	7.505	1.991	2.996	784.133	26.49	87.39	2792	3130.83	- 338.83	Medium negative
Kokrajhar	7.595	1.997	3.00	784.133	26.49	89.39	2655	3126.93	- 471.93	Mediumnegative
Sidli	7.685	2.018	3.00	784.133	26.49	89.39	1984	3172.37	-1188.37	Highnegative
Manikpur	6.1	2.006	2.988	784.133	26.49	87.39	2379	2791.53	- 412.53	Mediumnegative
Gossaigaon	7.22	2.003	2.996	784.133	26.49	89.39	2597	3036.10	- 439.10	Mediumnegative
Borobazar	7.22	2.003	2.996	784.133	26.49	87.39	1888	3062.08	-1174.08	High negative

Source : Calculated by author

Contd.......

1	2	3	4	5	6	7	8	9	10	11
Khagarijan	7.225	1.34	2.95	175.187	26.28	88.18	3119	3699.78	-580.78	Medium negative
Jugijan	7.64	1.05	2.95	175.187	26.28	88.18	3569	3803.52	-234.51	Medium negative
Rupali	6.38	1.89	2.94	175.187	26.28	88.18	3257	3491.64	-234.64	Medium negative
Lanka	5.615	2.24	2.83	203.13	25.85	88.99	4067	4432.73	-365.73	Medium negative
Batadraba	7.82	1.21	1.195	175.187	26.28	88.18	3299	3622.41	-323.41	Medium negative
Juria	5.89	1.27	2.95	175.187	26.28	88.18	3822	3379.48	+442.52	Medium positive
Kaliabar	7.605	1.37	2.93	175.187	26.28	83.92	4420	3843.63	+576.37	Medium positive
Kathiatoli	6.218	1.32	2.99	147.243	26.28	88.18	4784	3466.60	+1317.39	High positive
Kapili	6.455	1.39	2.92	175.187	26.28	88.18	3625	3510.03	+114.96	Medium positive
Kawkhowa	6.245	1.19	2.92	175.187	26.28	88.18	2855	3462.17	-607.17	Medium negative
Loharighat	5.7	1.78	2.76	175.187	26.32	83.92	3115	3251.38	-136.38	Medium negative
Bhurbandha	5.335	1.17	2.86	219.268	26.07	83.92	3264	3846.13	-582.13	Very high pstv.
Mayang	6.735	1.46	2.75	219.268	26.07	83.92	5824	4165.21	+1658.79	
Regression	240.63	13.349	126.659	-136	-2671.032	-12.991.				

TABLE - 14

Land Tenurial Status of the Sample Farm Households

Name of the Village/Block	Sl.No.	AREA Owned (in ha.)	Leased in (in ha.)	Leased out (in ha.)	Share cropped (in ha.)	Total
1	2	3	4	5	6	7
Jhagarapara/	1	4.05	-	-	-	4.05
Dharmsala	2	0.54	-	-	0.405	0.945
	3	1.62	-	-	-	1.62
	4	0.675	-	-	-	0.675
	5	1.215	-	-	0.27	1.485
	6	4.05	-	-	-	4.05
	7	4.151	-	-	-	4.151
	8	1.62	-	-	-	1.62
Balijana/	9	3.375	-	1.35	-	3.375
Balijana	10	0.54	-	-	0.945	1.485
	11	1.89	-	-	-	1.89
	12	3.375	-	-	-	3.375
	13	1.215	-	-	0.54	1.755
	14	3.443	0.81	-	-	4.253
Ketakibari/Hajo	15	1.944	-	-	0.135	2.079
	16	2.97	-	1.35	-	2.97
	17	2.025	-	0.203	-	2.025
	18	2.16	-	-	-	2.16
	19	5.535	-	-	-	5.535
	20	0.594	-	-	0.27	0.864

Source: Same as Table-13

Contd...........

1	2	3	4	5	6	7
	21	1.08	-	0.135	0.338	1.418
	22	2.997	0.27	-	-	2.267
	23	1.485	-	-	-	1.485
Shilapani/	24	2.295	-	-	-	2.295
Lakhipur	25	2.936	0.135	-	-	3.071
	26	4.793	0.27	-	-	5.063
	27	1.147	0.203	-	-	1.35
	28	2.295	-	-	0.135	2.43
Khara/	29	3.173	-	-	-	3.173
Dhudhnoi	30	6.48	-	-	-	6.48
	31	4.658	0.81	-	1.485	6.953
	32	4.112	-	-	0.81	4.922
Kheraj Daobh-	33	4.455	-	-	-	4.455
angi/Golakganj	34	2.16	0.27	-	-	2.43
	35	2.7	-	-	-	2.7
	36	1.418	-	-	-	1.418
	37	2.97	-	-	-	2.97
	38	2.43	-	-	-	2.43
	39	1.62	-	-	-	1.62
Japarkuchi/ Digheli	40	1.755	-	-	0.54	2.295

TABLE -15

Land Use Variables and Productivity of HYVs and Local Rice

Village/ Block	Sl.No.	Area under HYV rice (in ha.)	Area under Local Rice (in ha)	Net Area Sown (in ha.)	Gross cropped area (in ha.)	Double cropped area (in ha.)	Index of cropping intensity	Yield of HYV Rice in kg/ha.	Yield of Local Rice in kg./ha.
1	2	3	4	5	6	7	8	9	10
Jhagarapara/ Dharmsala	1	0.135	5.400	4.050	7.088	2.038	175.012	1382.370	898.546
	2	0.675	1.08	0.945	1.755	0.810	185.714	1935.333	1228.666
	3	0.270	2.16	1.62	2.97	1.35	183.333	1382.370	518.388
	4	0.270	0.675	0.675	1.283	0.608	190.074	1382.370	663.541
	5	0.405	1.485	1.485	2.97	1.485	200.000	2303.975	904.835
	6	0.675	6.750	4.050	8.235	4.185	2003.333	3317.704	221.804
	7	0.135	5.535	4.151	6.885	2.734	165.863	2764.740	842.914
	8	0.405	2.16	1.62	3.375	1.755	208.333	921.580	760.310
Balijana/ Balijana	9	0.675	3.375	3.375	4.050	0.675	120.000	3317.703	1935.32
	10	0.068	1.89	1.485	2.282	0.797	153.[illegible]70	1372.206	1224.392
	11	0.135	2.295	1.89	2.835	0.945	150.000	829 .427	1431.146
	12	0.270	3.915	3.375	4.590	1.215	136.000	2073.555	1382.378
	13	0.405	1.35	1.755	2.228	0.473	126.951	1382.370	2488.281
	14	0.405	4.725	4.253	6.615	2.362	155.537	1382.370	1737.848
Ketakibari/ Hajo	15	0.405	2.835	2.079	3.375	1.296	162.337	2211.802	18561.335
	16	1.080	3.24	2.97	4.995	2.025	168.181	3455.944	1497.577
	17	0.945	1.62	2.025	3.848	1.823	190.024	5924.476	4607.926
	18	0.945	2.16	2.16	3.713	1.553	171.898	4147.133	1537.898
	19	2.025	3.375	5.535	6.777	1.242	122.439	5529.511	3981.25
	20	0.338	1.485	0.864	2.012	1.148	132.870	2208.529	1382.384

Source: Same as Table-13

Contd........

1	2	3 U	4	5	6	7	8	9	10
	21	0.135	0.945	1.418	1.485	0.067	104.724	2211.777	1224.392
	22	0.608	3.51	3.267	5.319	2.052	162.809	3314.984	1244.14
	23	0.810	2.025	1.485	4.32	2.835	234.146	2764.753	829 .427
Shilapani/	24	0.270	2.835	2.295	4.995	2.700	217.643	2211.815	1843.171
Lakhipur	25	0.270	4.725	3.071	6.210	3.139	202.214	3073.555	1105.90
	26	0.270	5.130	5.063	7.493	3.430.	147.995	3455.963	2182.702
	27	0.135	1.620	1.350	2.835	1.485	210.00	3870.666	1267.185
	28	0.203	3.915	2.430	4.928	2.498	202.798	2022.512	953.364
Khara/Dhdhnoi	29	0.270	2.700	3.173	3.915	0.742	123.384	2350.037	1382.377
	30	0.135	7.695	6.480	9.315	2.835	143.75	3317.704	1552.143
	31	0.135	6.615	6.953	8.640	1.687	124.262	1658.888	1184.895
Gog/Khara.	32	0.540	2.835	4.922	7.425	2.503	150.853	11059.018	5266.201
Kheraj Daobha-	33	1.080	4.32	4.455	5.603	1.148	125.768	2764.759	1658.863
ngi/Golakganj	34	0.270	2.835	2.43	4.455	2.025	183.33	622. 074	605 .615
	35	0.945	2.565	2.70 0	4.185	1.485	155.000	1935.333	1731.610
	36	0.068	1.890	1.418	2.565	1.147	180.888	1646.618	533.201
	37	1.350	2.970	2.970	5.603	2.633	188.653	3455.948	1193.872
	38	0.135	2.835	2.430	2.780	1.350	155.555	2488.296	987.415
	39	0.135	2.160	1.620	4.455	2.835	275.000	1244.148	794.866
Japarkuchi/ Digheli	40	0.135	3.645	2.295	4.347	2.052	189.411	691.185	819.188

TABLE - 16

Communication Media for Cultivation of HYV Rice

Village/ Block	Sl. No.	Communication media
Jhagara-para/Dharmsala	1	C.D.Block
	2	Own observation
	3	C.D.Block
	4	VLW
	5	C.D.Block
	6	C.D.Block
	7	Own Village
	8	C.D.Block
Balijana/ Balijana	9	C.D.Block
	10	Own.Village
	11	C.D.Block
	12	C.D.Block
	13	C.D.Block
	14	Own village
	15	VLW
	16	VLW
	17	Own Village
	18	VLW
	19	VLW
	20	VLW
	21	VLW
	22	C.D.Block
	23	C.D.Block
Shilapani/Lakhipur	24	C.D.Block
	25	C.D.Block
	26	C.D.Block
	27	G.Panchayat
	28	C.D.Block
Khara/ Dudhnoi	29	C.D.Block
	30	C.D.Block
	31	C.D.Block
Gog/Karara.Kheraj/Golakganj	32	C.D.Block
	33	Cooperative
	34	C.D.Block
	35	VLW
	36	Own Village
	37	C.D.Block
	38	C.D.Block
	39	Own Village
Japarkuchi/Digheli	40	Village Head

N =
VLW= Village level worker

TABLE - 17

Family Type, Religion and Caste of the Sample Farm Households

Family Type	Religion	Caste
N	M	-
NN	M	-
N	M	-
N	M	-
N	M	-
N	M	-
N	M	-
N	M	-
N	H	Rajbanshi
N	H	Jogi
N	H	Jogi
N	H	Jogi
N	H	Jogi
N	H	Kalita
J	M	-
N	H	Kalita
J	M	-
N	H	Kalita
N	M	
N	M	-
N	M	-
N	M	-
N	M	-
N	H	Fisher man
N	M	-
N	M	-
N	M	-
N	M	-
N	H	Kachari Tribe
N	H	Kachari Tribe
N	N	Kachari Tribe
N	M	-
J	H	Baidya
N	H	Rajbangshi
N	H	Rajbangshi
N	M	-
N	H	Kayastha
N	H	Kayastha
N	M	-
J	H	Saloi

N= Nuclear
J= Joint
H= Hindu
M= Muslim

Source: Same as Table-13

TABLE - 18

Number of Family Members engaged in Off Farm Occupations in Sample Farm Households

Village/ Block	Sl No.	OFF FARM OCCUPATIONS: Teaching	Forest service	Construction work	Govt. Clerical Job/other services	Medical job (Doctor)	Engineer	Business	Total
1	2	3	4	5	6	7	8	9	10
Jhagarapara/ Dharmsala	1	1	1	-	-	-	-	-	2
	2	1	-	-	-	-	-	-	1
	3	-	-	-	-	-	-	-	-
	4	-	-	-	1	-	-	-	1
	5	-	-	1	-	-	-	-	1
	6	-	-	-	1	-	-	1	2
	7	-	-	-	-	-	-	-	-
	8	-	-	-	1	-	-	-	1
Balijana/Balijana	9	-	-	-	-	-	-	1	1
	10	-	-	-	-	-	-	-	-
	11	1	-	-	-	-	-	-	1
	12	-	-	-	1	-	-	-	1
	13	1	-	-	-	-	-	-	1
	14	-	-	-	-	-	-	-	-
Ketakibari/ Hajo	15	1	-	1	2	-	-	-	4
	16	-	-	-	-	2	-	-	2
	17	-	-	-	2	-	-	-	2
	18	-	-	-	1	-	-	-	1
	19	-	-	1	-	-	-	1	2
	20	-	-	-	-	-	-	-	-

Source: Same as Table-13

Contd...........

1	2	3	4	5	6	7	8	9	10
	21	-	-	-	-	-	-	-	-
	22	1	-	-	-	-	1	-	2
	23	-	-	-	1	-	-	-	1
Shilapani/ Lakhipur	24	-	-	-	-	-	-	-	-
	25	-	-	-	-	-	-	-	-
	26	-	-	-	-	-	-	-	-
	27	-	-	-	-	-	-	-	-
	28	-	-	-	-	-	-	-	-
Khara/Dudhnoi	29	1	-	-	-	-	-	-	1
	30	1	-	-	-	-	-	-	1
	31	-	-	-	-	-	-	-	-
Gog/Karara	32	-	-	-	-	-	-	-	-
	33	-	-	-	2	1	-	-	3
Kheraj/Daobhangi/ Golakganj	34	-	-	-	-	-	-	-	-
	35	-	-	-	-	-	-	-	-
	36	-	-	-	-	-	-	1	1
	37	-	-	-	1	-	-	-	1
	38	-	-	-	-	-	-	-	-
	39	-	-	-	-	-	-	-	-
Japarkuchi/ Digheli	40	-	-	-	1	-	-	-	1

TABLE - 19

Economic Organization of the Sample Farm Households

Name of the Village/ Block	Sl.No.	Advanced farm Implements						No.of Bullocks	No.of Permanent labour	Rate of payment of salary to the permanent Labour in Rs. per annum.
		Diesel pump	Tractor	Sprayer	Thresher	Duster	Weeder			
1	2	3	4	5	6	7	8	9	10	11
Jhagarapara/ Dharmsala	1	N	N	N	N	N	N	4	2	600
	2	N	N	U	N	N	N	2	-	-
	3	N	N	N	N	N	N	2	-	-
	4	O	N	N	N	N	N	2	1	300
	5	UU	N	N	N	N	N	2	-	-
	6	O	N	N	N	N	N	4	3	600
	7	N	N	N	N	N	N	3	2	500
	8	O	N	N	N	N	N	2	-	-
Balijana/ Balijana	9	O	N	N	N	N	N	2	1	700
	10	N	N	N	N	N	N	2	2	600
	11	N	N	N	N	N	N	2	2	600
	12	N	U	U	N	N	N	2	2	600
	13	N	N	N	N	N	N	2	-	-
	14	N	N	N	N	N	N	3	2	350
Ketakibari/ Hajo	15	N	N	U	N	N	N	2	2	700
	16	N	N	U	N	N	N	2	2	700
	17	N	N	U	N	N	N	2	1	600
	18	N	N	O	N	N	O	2	2	500
	19	N	N	U	O	N	N	2	2	800
	20	N	N	O	N	N	N	2	-	-

Source: Same as Table-13

) O = Owned and used
U = Only used by getting hired
N = Neither used nore owned

Contd..............

1	2	3	4	5	6	7	8	9	10	11
	21	N	N	U	N	N	N	2	1	500
	22	N	N	U	N	N	N	4	2	500
	23	N	N	N	N	N	N	2	1	600
Shilapani/	24	N	N	N	N	N	N	4	-	-
Lakhipur	25	N	N	N	N	N	N	6	2	400
	26	N	N	N	N	N	N	6	1	700
	27	N	N	N	N	N	N	2	1	600
	28	N	N	U	N	N	N	5	-	-
Khara/Dudhnoi	29	N	N	N	N	N	N	4	2	600
	30	N	N	N	N	N	N	8	4	600
	31	U	N	U	N	N	N	6	-	-
Gog/Karara	32	O	N	N	N	N	N	3	-	-
Kheraj Daobhangi/	33	O	N	O	N	O	O	3	2	450
Golakganj	34	U	N	N	N	N	N	2	1	600
	35	N	N	U	N	N	U	2	2	600
	36	N	N	N	N	N	N	2	-	-
	37	N	N	N	N	N	N	2	1	400
	38	N	N	N	N	N	N	2	1	400
Japarkuchi/	39	N	N	N	N	N	N	2	-	-
Digheli	40	N	N	N	N	N	N	2	1	600

O = Owned and used
U = Only used by getting hired
N = Neither used nore owned.

TABIE- 20

Marketable Surplus of HYV and Local Rice
(in Kg/ha.)

Village/ Block	Sl.No.	HYV Rice	Local Rice	Total
Jhagarapara/	1	-	-	-
Dharmsala	2	-	-	-
	3	-	-	-
	4	-	-	-
	5	-	-	-
	6	-	-	-
	7	-	-	-
	8	-	-	-
Balijana/	9	-	-	-
Balijana	10	-	-	-
	11	-	-	-
	12	-	1866.21	1866.21
	13	-	-	-
	14	-	-	-
Ketakibari/	15	-	-	-
Hajo	16	4478.9	-	4478.9
	17	-	-	-
	18	485.22	-	485.22
	19	1492.97	559.86	2052.83
	20	-	-	-
	21	111.97	149.30	261.27
	22	746.48	373.24	1119.73
	23	559.86	-	559.86
Shilapani/	24	-	559.86	559.86
Lakhipur	25	-	-	-
	26	-	746.48	746.48
	27	-	-	-
	28	-	111.97	111.97
Khara/Dudhnoi	29	-	933.11	933.11
	30	-	3732.42	3732.42
	31	-	2239.43	2239.42
Gog/Karara	32	-	2985.94	2985.94
Kheraj/Golak-	33	149 .3	223.95	373.24
ganj.	34	-	-	-
	35	-	-	-
	36	-	-	-
	37	-	-	-
	38	-	-	-
	39	-	-	-
Japarkuchi/ Digheli	40	-	186.62	186.62

Source: Same as Table-13

TABLE - 21

Social Variables

Name of the Village/ Block	Sl.No. of house holds	Holding size (in ha.)	Education	Age	Family Size	Religion	No.of working members	No.of Frag-mented fields
1	2	3	4	5	6	7	8	9
Jhagarapara/ Dharmsala	1	4.050	0.5	60	16	1.25	5	7
	2	0.945	3.0	35	8	1.25	1	3
	3	1.620	3.0	60	8	1.25	3	3
	4	0.675	3.0	41	8	1.25	0	2
	5	1.485	1.25	60	7	1.25	3	3
	6	4.050	1.25	40	8	1.25	0	6
	7	4.151	1.00	85	23	1.25	3	5
	8	1.620	4.50	38	6	1.25	0	7
Balijana/ Balijana	9	3.375	3.5	30	5	1.50	0	3
	10	1.485	1.50	42	8	1.50	4	4
	11	1.890	4.50	50	7	1.50	3	5
	12	3.375	3.00	29	6	1.50	2	4
	13	1.755	1.50	26	3	1.50	1	3
	14	4.253	1.50	50	9	1.50	3	6
Ketakibari/ Hajo	15	2.089	3.00	60	14	1.25	0	11
	16	2.97	4.50	64	11	1.50	2	8
	17	2.025	3.00	33	9	1.25	3	5
	18	2.160	3.00	43	5	1.50	0	4
	19	5.535	3.00	50	12	1.25	2	5
	20	0.864	0.50	50	8	1.25	1	7
	21	1.418	1.50	24	10	1.25	2	5

Source: Same as Table-13

Contd.......

1	2	3	4	5	6	7	8	9
	22	3.267	1.00	60	12	1.25	1	8
	23	1.485	3.00	42	5	1.25	1	3
Shilapani/	24	2.295	1.00	83	11	1.50	3	5
Lakhipur	25	3.071	3.00	44	9	1.25	1	10
	26	5.063	1.00	48	8	1.25	1	11
	27	1.350	0.50	40	7	1.25	1	4
	28	2.430	1.00	42	10	1.25	2	7
Khara/Dudhnoi	29	3.173	4.50	31	4	1.50	0	4
	30	6.480	4.50	42	2	1.50	0	6
	31	6.953	1.00	65	14	1.50	5	12
Gog/Karara	32	4.922	1.00	61	10	1.25	6	10
Kheraj Daobha-	33	4.455	3.00	54	11	1.25	2	0
ngi/Golakganj	34	2.430	0.50	50	9	1.50	1	8
	35	2.700	3.00	51	9	1.50	3	10
	36	1.418	0.50	83	9	1.25	4	4
	37	2.970	1.00	54	9	1.50	2	6
	38	2.430	0.50	73	7	1.50	2	4
	39	1.620	1.50	38	8	1.25	1	3
Japarkuchi/ Digheli	40	2.295	1.00	37	14	1.50	1	7

TABLE-22

Cost of Inputs and Total Return in Rupees per hectare of Cultivated Land(HYVs of Rice)

Name of the Village/ Block	Sl. no. of house-holds	Seed	Manure	Ferti-lizer	Pesti-cides & insecti-cides	Human labour	Animal labour	Irri-gation charges	Agricultural Imple-ments	Agri.loan and interest	Total cost of in-puts.	Total return
1	2	3	4	5	6	7	8	9	10	11	12	13
Jhagarapara/ Dharmsala	1	148.15	222.22	370.37	51.85	793.65	555.20	0	105.85	0	2247.29	1796.6
	2	130.37	66.66	444.44	44.44	518 .52	1015.38	0	182.34	0	2402.15	2515.5
	3	166.66	166.66	111.11	0	488 .88	642.42	148.15	101.00	0	1824.88	1796.6
	4	185.19	111.11	370.37	0	1161. 01	1351.26	370.37	77.96	0	3627.27	1796.6
	5	204.94	148.15	493.83	37.04	518. 52	642.42	0	101.00	0	2145.9	2915.2
	6	167.41	111.11	222.22	0	798. 30	492.29	106.66	121.44	0	2020.04	4313.4
	7	111.11	333.33	185.19	0	777. 42	452.28	0	116.22	0	1975.55	3594.5
	8	185.19	111.11	123.46	61.73	518. 52	577.77	0	96.29	0	1674.07	1198.6
Balijana/ Balinana	9	185.19	148.15	148.15	37.04	824. 69	498.76	0	172.83	0	2014.81	4081.14
	10	191.18	441.18	0	0	1626. 03	804.99	0	130.58	0	3193.96	1687.56
	11	185.19	555.55	111.11	88.88	1369. 31	668.07	0	176.37	0	3154.48	1019.67
	12	185.19	555.55	170.37	166.66	1024. 33	452.28	0	130.70	0	2885.08	2557.02
	13	185.19	555.55	155.55	12.35	518. 52	821.99	0	112.22	0	2361.37	1699.86
	14	185.19	185.19	283.95	209.88	748. 67	466.51	0	113.38	0	2192.77	1699.86

Source: Same as Table-13

Contd.....

1	2	3	4	5	6	7	8	9	10	11	12	13
Ketakibari/ Hajo	15	130.86	93.83	123.46	39.51	1318.89	577.77	222.22	211.63	0	2718.17	2720.76
	16	92.59	0	231.48	681.52	1011.01	424.02	370.37	141.36	0	2339.75	4250.88
	17	296.30	63.49	132.28	4.23	889.49	519.55	148.15	139.47	57.19.	2180.15	7286.52
	18	74.07	158.73	158.73	15.87	1124.95	534.68	296.30	295.82	0	2659.15	5100.81
	19	278.02	92.84	133.33	8.89	972 .07	339.79	222.22	206.70	0	225 .86	8601.9
	20	186.39	133.14	73.96	0	488 .88	899.13	221.89	277.78	0	228.17	2717.07
	21	185.19	59.26	379.37	74.07	1372.39	1181.14	222 .22	336.67	0	3801.31	2720.76
	22	185.86	87.17	328.95	36.18	897.16	705.32	279. 61	131.50	0	2651.75	4077.45
	23	46 .91	277.78	246.91	0	776.85	474 .07	333.33	115.74	0	2271.59	3400.95
Shilapani/ Lakhipur	24	185.19	111.11	103.70	0	488.88	744.34	0	200.19	110011	1943.52	2720.76
	25	277.78	277.78	118.52	29.63	789.42	876.65	0	241.56	0	2611.34	2551.02
	26	140.74	55 .56	185.19	0	643.18	744.34	0	200.19	0	1969.2	4250.88
	27	370.17	111.11	555.56	7.41	929.10	668.07	0	105.78	77.63	2824.83	4761.33
	28	177.34	369.46	167.49	29.56	488.88	915.47	0	161.92	111.33	2421.45	2488.29
Khara/ Dudhnoi	29	185.19	166.67	0	37.04	1077.39	921.07	0	255.41	0	2642.77	2890.5
	30	281.48	111.11	407.41	22.22	777.45	1019.00	222.22	128.81	0	29697	4081.14

Continued.....

1	2	3	4	5	6	7	8	9	10	11	12	13
	31	185.19	555.56	185.19	74.07	518.52	474.07	266.67	138.89	0	2398.16	2040.57
og/Karara	32	129.63	416.67	118.58	81.48	518.52	426.93	222.22	134.67	0	2048.7	15040.24
heraj	33	166.67	55.56	370.37	0	852.67	523.08	83.33	45.31	0	2096.99	3594.5
aobhangi/ olakganj	34	148.15	166.67	11.11	0	736.70	462.85	0	179.56	0	1805.04	808 .6
	35	111.11	63.49	317.46	0	1087.59	486.02	158.73	167.26	0	2391.66	2515.5
	36	191.18	0	0	0	459.26	727.48	0	232.21	0	161 .13	2141.1
	37	203.70	55.56	222.22	0	661.67	389.29	222.22	160.64	0	1915.3	4492.8
	38	133.33	222.22	259.26	0	773.55	526.98	222.22	317.48	0	2455.04	3230.4
	39	148.15	333.33	148.15	37.04	488 .88	426.85	0	224.44	0	1806.84	1617.2
aparkuchi/ igheli	40	170.37	222.22	333.33	0	745.07	471.77	222.22	276.07	0	2441.05	939 .76

TABLE-23

Cost of Inputs and Total Return in Rupees per hectare of Cultivated Land(Local Rice)

Name of the Village/ Block	Sl.No of house holds	Seed	Manure	Fertilizer	Pesticides insecticides	Human labour	Animal labour	Irrigation charges	Agricultural implements	Agri.loan and interests	Total cost of inputs	Total return
1	2	3	4	5	6	7	8	9	10	11	12	13
Jhagarapara/ Dhafmsala	1	150.00	36.11	0	0	712.52	584.83	0	105.82	0	1589.28	1168.7
	2	125.93	69.44	74.07	0	481 .48	1045.01	0	182.34	0	1978.27	1662.7
	3	153.24	62.50	0	0	451.85	672.05	0	101.01	0	1440.65	673 .4
	4	139.26	88.89	96.3	0	1101.75	138.89	207.41	77.97	0	3092.47	863.2
	5	130.64	80.81	0	0	481 .48	672.05	0	67.33	0	143 .31	1176.5
	6	137.04	55.56	0	0	783.49	521.92	0	121.43	0	1619.44	2875.6
	7	142.73	54.20	0	0	725.20	481.92	0	116.20	0	1520.25	1095.9
	8	139.81	60.19	43.98	18.06	481.48	607.4	0	96.30	0	1447.22	988.00
Balijana/ Balijana	9	133.33	29.63	59.26	0	795.06	528.39	0	172.84	0	1718.51	2380.05
	10	142.86	79.36	0	0	1633.44	834.62	0	131 .49	0	2821.77	1791.2
	11	141.98	130.72	43.57	0	1376.72	697.70	0	176. 37	0	2566.26	1760.13
	12	141.00	76.63	11.49	0	957.3	607.4	0	130. 72	0	1924.54	1699.86
	13	142222	333.33	74.07	0	481.48	851.62	0	112. 23	0	1994.95	3060.24
	14	146.03	19.05	31.75	0	696.45	496.14	0	113.38	0	1502.8	2137.74
Ketakibari/ Hajo	15	184.13	52.91	0	0	1251.86	471.95	74.07	211.64	0	2246.56	2282.88
	16	156.79	0	42.59	33.64	959.16	453.65	222.22	117.07	0	1985.12	1842.54
	17	156.17	64.81	38.89	0	789.86	549.18	86.42	129.95	57.58	1872.86	5667.84
	18	170.83	0	0	3.7	1043.6	564.31	0	311.03	0	2093.47	1891.74
	19	185.19	10[illegible].22	29.63	0	864.83	[illegible]60.42	88.89	206.7	0	1846.88	4869.63

Source: Same as Table-13

Contd..........

1	2	3	4	5	6	7	8	9	10	11	12	13
	20	158.92	0	0	0	451.85	928.76	0	292.34	0	1831.87	1699.86
	21	149.21	31.75	105.82	7.41	1357.58	1210.77	126.98	331.41	0	3320.93	1505.92
	22	245.30	42.74	0	1.71	844.44	734.95	139.6	131.6	0	2140.34	1530.12
	23	154.07	26.17	0	0	732.41	503.70	82.96	115.74	0	1615.05	1020.9
Shilapani/	24	158.73	15.87	0	0	466.67	773.97	0	200.2	0	1615.44	2266.89
Lakhipur	25	165.93	12.7	52.9	0	781.83	756.28	0	241.57	0	2011.21	1360.38
	26	136.45	35.09	38.99	0	613.55	773.97	0	200.2	0	1798.25	2685.09
	27	175.93	37.04	0	0	929.1	697.7	0	105.81	0	1945.58	1558.41
	28	219.16	38.31	0	6.13	481.48	945.1	0	162.35	0	1852.53	1172.19
Khara/	29	165.56	38.89	0	0	108580	950.70	0	255.43	0	2495.38	1796.6
Dudhnoi	30	153.09	3 .9	0	0	784.86	648.63	62.38	128.82	0	1781.68	1908.96
	31	151.93	15.87	0	0	466.67	503.70	0	13 .89	0	1277.06	1457.55
Gog/Karara	32	157.67	238.1	118.52	81.48	481.48	456.56	0	134.68	0	1668.49	7161.76
Kheraj Daobha-	33	149.31	31.25	46.3	0	815. 26	561.71	6.94	446.23	0	2057.00	2156.70
ngi/Golakganj	34	161.2	42.33	0	0	736. 70	492.48	0	179.57	0	1612.28	787.8
	35	191.81	46.78	0	0	1035.37	515.65	0	167.26	0	1956.87	2130.36
	36	134.39	0	0	0	451 .85	757.11	0	233.92	0	1577.27	692 .9
	37	153.87	55.56	0	0	632.04	418.92	0	160.64	0	1421.03	1552.2
	38	127.69	42.33	70.55	0	743.92	556.61	0	317.46	0	1858.87	1283.1
	39	141.67	90.28	0	0	481.48	492.48	0	224.47	0	143.39	1033.5
Japarkuchi/ Digheli	40	155.28	20.58	0	0	730.23	501.4	164.61	276.05	0	1848.15	1113.84

TABLE - 24

COMPUTER RESULTS

Landuse Variables		Socio-Cultural Variables
HYV rice	Local rice	
Exce Ver ≠ 1.1 ORDER OF MATRIX=4 EPS=1.0E=8 NO.VEC=1.0 K.B./FILE = FILE DATAFILE=DATAS-FIL	EXEC Daadjadobi Exec Ver ≠ 1.1 ORDER OF MATRIX=4 EPS=1.0E=8 NO.VEC=1.0 K.B./FILE=DATA4.FIL	A EXEC JACOBI EXEC VER ≠ 1.1 ORDER OF MATRIX=7 EPS=1.0E-8 NO.VEC=FILE DATAFILE=DATAS.FIL
EIGENVALUES	EIGENVALUES	EIGENVALUES
8.24780739639 0.633288704551 0.119205917704 1.97981347836E-04	2.41051164764 1.00354651409 0.585743929941 1.97908324997E-04	2.61027029661 1.35589750889 0.988478482213 0.686222721073 0.557963351732 0.481275661007 0.369891978464
NO.OF ROTATIONS =15	NO.OF ROTATIONS=15	NO.OF ROTATIONS = 62
CORRESPONDINGEIGENVECTORS	CORRESPONDING EIGENVECTORS	CORRESPONDING EIGENVECTORS
EIGENVECTORS OF LAMDA 1	EIGENVECTORS OF LAMDA 1	EIGENVECTORS OF LAMDA 1
0.528835574805 0.497266748434 0.550629997136 0.412762147946	0.15088368008 0.572181692034 0.640152121758 0.489946412778	0.27952562029 0.369328869099 0.474844171641 0.497455736055 0.0948093455906 0.443930347342 0.326281812856

Questionnaire for Agricultural Survey

I Name of the Block:

II Village:

1. Name of the Head of the Family:

2. Age: 3. Sex : M...... F.......

4. Marital Status: Married....Unmarried.... Widow ....
Widower....Divorced.... Seperated....

5. Religion: Hindu .... Muslim .... Christian....
Sikh.... Jain .... Buddhist .... Any Other....

6. Caste: (Do not write Scheduled caste/O.B.C.as the answer).

7. Tribes:(Do not write Scheduled tribe etc. as the answer).

8. Educational Status of the respondent:

9. Type of Educational Insititution(s) attended by the respondent:
(a) (b) (c)

10. Occupation of the respondent

11. Other members staying with the respondent in the household:

1	2	3	4	5	6	7
Relationship with the respondent	Sex	Age	Marital Status	Ed. status	Occupational status	Nature of occupation S P SP

8	9	10	11
If permanent Agl. Non-Agl	Working with the respondent Yes/No	If not does he/she contribute financially in the economy of the respondent	Does he/she eat in the same kitchen with the respondent Yes/No

12 Area under the crop:

Rice HYV	Rice local	Maize	Wheat	Gram	Jute	Sugar cane	Other Miscellenious crops

13 No.of Fields:

No.	Area
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

14. Practice of Cultivation:
Share Cropping   Lease holder   Own field

15. Date of Sowing seasons: Ahu Sali Boro   Date of Harvesting seasons: Ahu Sali Boro

Rice HYV

Rice Local

16. Inputs suplied:
Fertilizer Pesticides Insectcides   Any other inputs.

17. Agricultural Implements:
Tractor Thresher Harvester Others

18. Irrigation Facilities:
Tubewell well Tank   Any other source

19. Irrigation of crops with No. of times:

Rice HYV	Rice Local	Maize	Wheat	Gram	Jute	Sugar cane	Other Miscellenious. Crops

20. No.of times Fertilizers given:

Rice HYV	Rice local	Maize	Wheat	Gram	Sugare cane	Jute	Other Miscellenious crops.

21. Varieties HYV grown:

Rice	Maize	Wheat	Sugar cane	Gram	Jute	Other Miscellenious crops.

22. Approximate Expenditure:

Heads of Expenditure	Rice HYV	Rice local	Wheat	Maize	Gram	Sugar cane	Jute	Other crops.
Seed								
Fertilizer								
Irrigation								
Implements								
Labour								
others								

23. Financial difficulties:

24. Sources of Finance:

Bank	Moneylender	Co-operative Bank	Other sources

25. Total Return in Quantity:

Rice HYV	Rice Local	Wheat	Maize	Gram	Jute	Sugar cane	Other Miscellenious.

26. Surplus(Sale or Purchase):

Rice HYV	Rice Local	Wheat	Maize	Gram	Sugar cane	Jute	Other Miscellenious crops

27. Manpower Utilized:

Rice HYV	Rice Local	Wheat	Maize	Jute	Gram	Sugar cane	Other Miscellenious.

28. First source of Information about Innovations
Agricultural Officer own village Public meeting.

Rice HYV
Wheat "
Maize "
Sugar "
cane
Gram "
Bazra "
Other crops
Thresher
Harvester
Others

29. Dissatisfaction caused if any:
a-
b-
c-
d-
e-
f-
g-

30. No.of fields with Physical characteristics:

Soil	Texture	Level of the field	Any other characteristics.

31. Total production:

Rice HYV	Rice Local	Wheat	Maize	Jute	Gram	Sugar cane	Other Misc-elleni-ous crops

32. Nearest Market Centres in KM:

1-

2-

3-

4-

5-

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1 - Lift Irrigation pump house.

2 - Ploughing by bullocks.

3 - Weeder in operation

4 - Use of sprayer in the paddy field

5 - Lift irrigation canal in the paddy field.

6 - Aijong paddy (H.Y.V.)

7 - Paddy field

8 - Broadcasting method of cultivation

9 - Author in the paddy field (Goalpara district)

10- Crop threshing with the help of bullocks
(Goalpara district)

11 - Author while interviewing the farmers
(Goalpara district)

12 - Bullock-cart in vogue in rural areas of
Lower Brahmaputra Valley.

13 - Boro paddy in low land area

14 - Weekly market centre(Boromboi, Kamrup district).