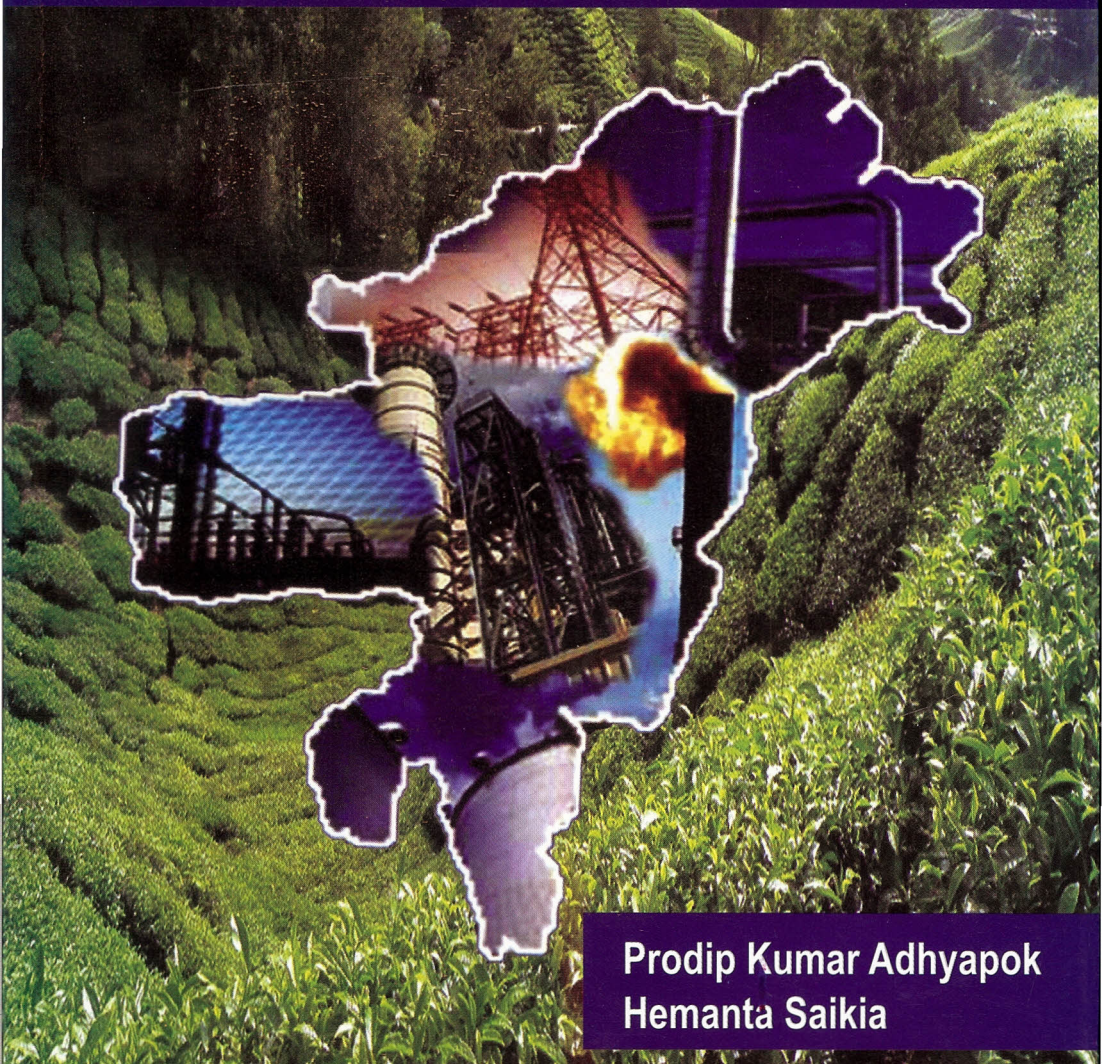
Economic Development of North East India



Prodip Kumar Adhyapok
Hemanta Saikia

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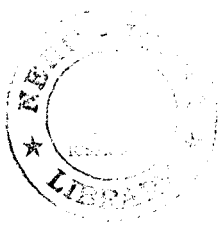


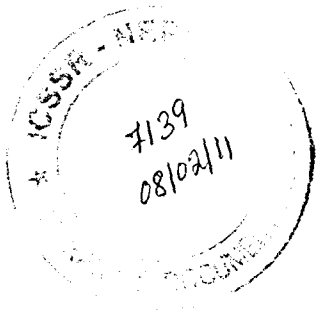
Economic Development of North East India

Authors

Dr. Prodip Kumar Adhyapok
M.A., LL.B., A.E.S., Ph.D.
Associate Professor
Department of Economics
Cotton College
Guwahati, Assam

Hemanta Saikia
M.A., M.Phil
Assistant Professor
Department of Economics
H.P.B. Girls' College
Golaghat, Assam

SSDN Publishers & Distributors
5A, Sahni Mansion, Ansari Road, Daryaganj, New Delhi - 110002
Ph: 011-47520102, 9871115366, E-mail ssdn.katla@gmail.com



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Preface

The economic development is not a homogenous process rather it is an outcome of the shared effect of socio economic as well as and human pointers of a country. From the days of classical economists to the recent it is a general belief that development is bound to be undemocratic because it does not take place in every ingredient of a nation simultaneously. Since all the countries or regions of a country are not unified on the part of both physical and human resources, so discrepancy in the process of growth and development is widely visible in present globalised world especially in developing countries. But these evils are more acute and dangerous for developing economies for instance India due to its devastating nature of backwardness. This unevenness got more intensified especially after independence when the national Government started its planned development programmes through five year plans since 1951. In the early phases of India's planned economic development efforts were mainly confined to sectoral economic development with greater emphasis on raising the per capita income of the people. As a result, certain areas went ahead leaving others lagging behind and thereby creating disparity among the different states in India. In this regard the economic situation of the North Eastern states is remained backward. While most other states in India are gradually moving away from their traditional agriculture-based economy toward market-based economy, Assam is still heavily dependent on the agricultural sector. Compared to most other states in India, Assam is considered a less developed state, which represents a depressing the economic condition of the state. It is one of the seven states in North- East India, covers an area of 78438 sq. km and 26638 thousand of people with an average density of 340 people per sq.km of area as against the average of 324 for the country as a whole. The demographical composition of

the state makes it most distinct in the county. The geographical setting of the region makes it essentially inward looking while the abundant resources like its soil, fossil, fuels, minerals and water resources bestow it with immense developmental potential. The agents of growth-land labour and capital derive their base strength from these resources. Yet the state has remained one of the most backward areas of the country. After Independence efforts have been made by the Planning Commission, Government of India, and Government of the respective state and North Eastern Council (since 1971) for upbringing the forces of modernization and development of the state. While much change and development is witnessed in the state, it still lags behind the rest of the country. Based on a set of indicators covering per capita income, share of industry, agriculture and tertiary sectors to state domestic product, cropping intensity, transportation facilities etc, it is known that the state lags behind at least by 30 per cent of the rest of the country. The state is marked by ethnic plurality, primitive agriculture, illiteracy, poverty, unemployment, primitive agriculture, low industrial development and low level of infra-structural development all acting and interacting to make it a stagnant backward economy. This state of affairs continues to be true despite the fact that terms of State Domestic Products (SDP) has exhibited better performance in the last decade.

Water is one of the crucial natural resource that is used as an enhancing input in agriculture as in the Indian countryside, no single factor makes more of a difference between prosperity and despair than water. In many dry regions of the world irrigation generate an element of stability in agriculture by supplying necessary water and helps in replacing low valued crops by higher one. It is seen that areas with good and controlled water supplies are fertile and productive; those without are barren or subject to the instability of the monsoons. Irrigation systems have transformed the backdrop, extending agriculture into more areas, with higher intensity and yields. Particularly in a country that has seen major natural disasters, irrigation has been a major means of achieving food safety from ancient times. Yet these same irrigation systems that have provided prosperity and protection against famines are now

under increasing pressure in Assam. Extending irrigation through large system is increasingly expensive, while the demand for water is rising due to urbanization, industrialization, and the need to feed a growing population. This places stronger demands on the existing water control systems. Yet water supplies in those systems are unreliable due to mismanagement of surface irrigation systems, falling water tables and unreliable power sources for groundwater, and limited scope to expand irrigated cultivation from watershed management. Thus, even the existing productive base is threatened, and meeting expanded water requirements of a billion people in Assam calls for major reforms in the water sector. In this study, we focus on minor irrigation, especially the Shallow Tube well systems and provide groundwater recharge for even more cultivation. The problems are complex, and finding solutions will require multifaceted approaches, ranging from the macro to the micro. Irrigation is not just a technical system of water delivery, but a socioeconomic system as well. Moreover, because of its importance to local livelihoods and national food security, it is also a highly political issue. Therefore, multidimensional analysis is required. This calls for the involvement of not only researchers from different disciplines, but also policymakers, practitioners and farmers.

Agriculture is the backbone of the economy of Assam. But it is chronically affected by flood from a long period of time. Apart from flood the growth and productivity of agricultural sector is far from satisfactory and is one of the lowest as compared to other states of India. All these distinctiveness of agriculture in Assam directs towards the question of sustainability of agricultural growth and the state of the economy. In this book an endeavor has been made to develop alternative strategy, minor irrigation as one for supporting the agricultural economy. This book furnishes prime importance on the minor irrigation as a vital ingredient in increasing the growth of agricultural sector in flood affected areas. Therefore despite the immense damage caused by the natural calamities like flood or drought, the off-putting effects of such disasters on the agriculture of Assam can be minimized by following appropriate alternative agricultural practices where minor

irrigation can be an alternative of them. Irrigation plays a tremendous role in agriculture in increasing both production and productivity. The present work in this regard is an attempt to study the role and effectiveness of irrigation on developing agricultural scenario in North East India especially in flood affected areas of Assam which is being an indispensable input in such areas.

We request our colleagues in the teaching profession, research scholars and all others who are interested in the studying the minor irrigation as well as the problems of the irrigation sector of Assam to send their suggestions and constructive criticism for further improvement of the book. The intimation of errors and serious misprints will be mostly gratefully received and duly incorporated in the subsequent edition.

Prodip Kumar Adhyapok
Hemanta Saikia

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Prodip Kumar Adhyapok
Hemanta Saikia

Contents

List of Symbols, Abbreviations and Nomenclature

STW	Shallow Tube-Well
kg/ha	Kilogram/ Hectare.
km	Kilometer.
mm	Millimeter.
SKY	Samridha Krisak Ydjana.
SFDA.	Small farmer Development Agency.
NABARD	National Bank for Agriculture and Rural Development.
CCA	Cultivable Command Area
M.I	Minor Irrigation.
Gvt	Government.
%	Percentage.
HYV	High yielding variety.
Ahu	A variety of rice.
Shali	Summer Rice
Boro	Winter Rice
N	North
E	East.
sq mile	Square Mile.
Chaparis	The river island formed of sands.
Chars	The river in sandy areas.
max	Maximum.
C	Celsius.
GDP	Gross Domestic Product.
$	Dollar.
m	Meter.
Japi	Headgear.
Muga Silk	A kind of Cloth.
Beels	Natureally developed water-logging shallow area.
RBA	Rastriya Barh Ayog.
ARIASP	Agricultural Services Project
NLCP	Lapsable Central Pool.
RPS	River Pumping System
AIBP	Accelerated Irrigation Benefit Programme.
NLCP	Non-Lapsable Central Pool.
ARIASP	Assam Rural Infrastructure and Agricultural Services Project.
RIDF	Rural Infrastructure Development Fund.

CHAPTER 1

Introduction

The North Eastern Region comprising eight States occupying about 8% of the geographical area of the country and accounts for about 4% of India's total population. The region represents a inimitable socio cultural framework and faces different problems even though it is endowed with vast natural resources. The people of the region even, remain poor amidst abundance. Government of India have been aware of the need to bring the region at par with the most developed states in the country through the development of infrastructure, generation of employment and alleviation of poverty in the rural areas to bring about the desired socio economic development of the region. In order to impart a definite thrust to the development of the region, the Government of India have taken various measures over the years including earmarking of 10% of the budget allocation for the North Eastern States and Sikkim. However the region continues to be underdeveloped inspite of intensive efforts made since independence for its overall development. There are virtually no organized sector

employments opportunities in the region even though in several states, there is very high literacy rate and in some it is amongst the highest in the country. The region possesses considerable potential for industrial, agricultural and economic growth which has not been adequately realized.

Assam, the rich, green land with dense forests is the gateway to the north eastern part of India. The mighty Brahmaputra River that has its origins in Tibet charts its majestic course through the state. The state of Assam covers an area of 78,438 km and consists of two valleys viz. the "Brahmaputra valley" and "Borak Valley". This mystic land of perpetual blue hills and beautiful rivers is renowned for its tea, rich flora and fauna. The economy of Assam is continued to be predominantly agrarian in the sense that dependence of rural labour force on agriculture and allied activities was nearly 69% as per the population census 2001 and this sector contributes about 38% to the net state domestic product at current prices during 2006-2007. The cultivable area as a percentage of total area during 2002-03 is 41.11% as compared to 46.90% in all India average level. The net sown area excluding all plantation crops being 249 lakh hectares which is 32% of the total geographical area of the state. But inspite of its remarkable dominance in the state economy, the average annual growth rate in agricultural gross state domestic product (at 1993-94 prices) in Assam during 2000-01 to 2004-05 is only 1.31% as compared to 2% in all India level. The average food grain yield during 2000 to 2003 of Assam is 1448(kg/ha) as compared to 1768 all India level. The production of Paddy, one of the main crop of the state economy is only 5.9 quintal/per bigha during 2005-2006. The average yield of paddy is only 3-4 ha/bigha where as it's potentials more than 10 ha/bigha due to faulty water management practices. So the agricultural sector of Assam continues to be under developed as compare to rest of Indian states. Among the non economic constraints the recurrence of flood and erosion continues to be the burning problems for agricultural sector of Assam. The Brahmaputra and Borak are the two main rivers, which cause major problems during the monsoon periods almost every year in the shape of floods and bank erosions affecting rural agricultural sector of Assam

and bring miseries to the people. The major flood that occurred in the state were in the years 1954, 1962, 1972, 1977, 1988, 1998, 2002, 2004, 2006, 2007 and 2008 too; though the flood of less magnitude occurs almost every year. Assam thus accounts for 94% of total flood prone areas of the country and as a result of which it has not been able to achieve the desired progress and prosperity inspite of having vast natural resources.

In Assam net irrigated area as percentage of net area sown is only 6.23% in 2006 as compared to 35.41% in all India average level. But the bulk of the food grains production is found to be in flood prone areas where in dry seasons the farmers produce multiple crops say, vegetable, pulses, sugarcane, onion etc. On the other hand the overall irrigation development in the state is 25% as against the 50% to 90% in case of other states of India. Although attempts are made at micro level to increase production and productivity in agriculture by adopting modern technology in the form of improve seeds and fertilizer, but nothing substantial has been achieved in the region. Low increase in production and low yield in the region may be attributed to the low cropping intensity; low fertilizer consumption and lack of initiative in bringing more area under better seeds. So for sustainable development of agricultural sector, availability of irrigation facility is undoubtedly the most important prerequisite in the development of agricultural sector of such flood damage areas to meet the rising demand for food and to provide employment to the growing population. The modernization of agricultural practices vis-a-vis increase in the productivity of crops cannot be visualized in absence of assured irrigation facilities. The importance of irrigation development bears special significance in the context of efforts towards economic development of the state. It is now a general agreement that flood is the major constrains in the economy of Assam especially agricultural sector. No doubt it is the biggest challenge in front of Assam now and in future; but at the same time one should also note that it has the potentiality to produce multiple crops with the use of HYV seeds if it is backed by adequate minor irrigation facility since natural fertility of flood prone areas is higher as compared to other areas.

Water is one of the most imperative natural resources that is used not only for direct purposes but also used as an input in the process of production in different sectors of the economy. Efficient use of water resource is the basic for the survival of the ever increasing population of the country. In addition to the fact of its being a fundamental input, it works as an enhancing input in agriculture when it is shared with other inputs of production such as improved seeds and fertilizer. Apart from these, irrigation helps replacing low-valued crops by high-valued ones which ultimately results in enrichment of the implication of agricultural production. The concept of multiple cropping has received much more importance particularly after the Green Revolution started in Indian agriculture during the mid 1960s. It has played a fabulous role in agriculture in increasing both production and productivity and developing the economic status of farmers. It helps in bringing wasteland under crops and in raising greater quantities of the same crop on the same plot. In arid and semi-arid climate conditions, the timing and amount of rainfall are not adequate to meet the moisture requirement of the crops. Therefore supplementing irrigation is essential to raise the crops, necessary to meet the need of food for growing population. Scientific irrigation provides the best insure against weather induced fluctuation. Most prominently, irrigation generates an element of stability in agriculture by partially setting free it from the monsoon. Thus irrigation primarily ends the uncertainty in crop production. and consequently increases the crop yields even without any increase in the, use of other farm resources, lowers risks and uncertainties in productions, encourages extensive use of modem inputs, makes possible to grow crops all the year round and hence expands land vertically.

Assam falls in the heavy rainfall zone for which irrigation has not given importance during the past decades. Now it has been recognized that due to lack of irrigation, agriculture in, Assam is, yet to make the technical step forward. The traditional system of farming was mainly accountable for cultivation of single crop. So the state Government does not feel much about the need of irrigation in enhancing crop production by multiple cropping technologies. Despite of its vast potentiality in food

production, the State has been running with deficit in food grain production. The State has been facing with the problem of irregularity of monsoon and problem of floods due to fluctuating rainfall. As against the expected average rainfall of almost 1172.2mm in 2006, the actual rainfall in the state between Jun to August has been only 787.50 mm. So at the same time Assam also face drought like situation due to shortage of rainfall every year. The state is highly reliant on natural moisture and rainfall for growing varieties of crops leading to high degree of instability in agricultural production. Though rainfall is high in the region its distribution over time and space is far from regular. The variations in the pattern of rainfall and its uncertainty in the region may be judged from the observations of recorded rainfall of Assam over a period of 10 years. Under such situation, the necessity of, irrigation facilities to stabilize crop production are being felt. Only recently due importance has been given to creation of irrigation potential in Assam. The unpredictable nature of rainfall makes kharif crops susceptible to the twin problems of flood and drought, thereby adversely affecting agricultural production and productivity. As a result it has become necessary to enlarge the area under and output of Rabi crops which requires sufficient and guaranteed irrigation water. **Table: 1.1** reveals that the seasonal variations in rainfall in Assam are wide from one place to another and from place to place. Delay in pre-monsoon showers and delay in monsoon not only lead to series of dislocations but also cause great damage to the crops. Thus, if the agricultural production is to be improved and cropping intensity is to be raised, irrigation would be one of the most key components. The traditional 'Ahu' crop grown in the period from March to August has been advanced to February with the introduction of HYV seeds and February being a dry month, agriculture during this period is badly in need of irrigation.

In case of created potential also, there exists a vast gap between capacity created and capacity utilized. As per the data, out of a total of 27 06,000 hectares net sown areas of Assam only 20 19% are irrigated in 1997-98. On the utilization front also, out of a created potential of 5, 03,993 hectare under government sector in 2000-7001; only 1, 14,731 hectare was

Table 1.1: District Wise and Season Wise Rainfall in Assam

District	Winter Season December 2004 to February 2005		Summer Season March 2004 to May 2005	
	Normal	Actual	Normal	Actual
1. Dhubri	33.3	7.1	624.0	928.0
2. KoKrajhar	33.3	22.0	624.0	853.6
3. Bongaigaon	33.3	11.6	624.0	1039.2
4. Goalpara	33.3	13.0	624.0	600.2
5. Barpeta	45.7	33.2	554.5	506.0
6. Nalbari	45.7	59.6	554.5	636.3
7. Kamrup	45.7	20.9	554.5	421.7
8. Darrang	57.3	51.0	520.6	617.4
9. Sonitpur	57.3	36.2	520.6	659.6
10. Lakhampur	103.8	141.7	583.7	491.3
11. Dhamaji	103.8	243.9	583.7	901.5
12. Morigaon	57.7	36.8	400.2	334.2
13. Nagaon	57.7	65.7	400.2	507.5
14. Golaghat	97.4	87.8	590.7	743.9
15. Jorhat	97.4	87.4	590.7	738.6
16. Sibsagar	97.4	160.2	590.7	644.8
17. Dibrugarh	103.8	149.3	583.7	702.5
18. Tinsukia	103.8	126.1	583.7	1177.2
19. Karbi-Anglong	69.1	36.9	920.3	325.6
20. N.C.Hills	69.1	30.9	920.3	323.6
21. Karimganj	72.9	80.7	961.8	1688.4
22. Hailakandi	72.9	38.9	961.8	1154.3
23. Cachar	72.9	88.1	961.8	710.3
State Average	66.2	70.8	648.9	726.3

Source: Statistical Hand Book Assam 2006; Directorate Of Economics and Statistics Government Of Assam

utilized thereby putting the utilization percentage at as low as 22.76. (M.K.Dutta,2007).

All groundwater and surface water schemes having cultivable command area up to 2000 hectares individually are classified as minor irrigation schemes. Minor Irrigation Schemes are labour intensive, provide employment to rural population and check their migration to urban areas. They also help in raising the standards of living of rural population and bring them above the poverty line. Such schemes are quick budding and the benefit from the schemes starts flowing with a very small gestation period. Generally, the schemes are installed in a maximum of two to three years. Ground water development forms the major part of the minor irrigation programme and includes construction of dug wells, dug-cum-bore wells, filter points, private shallow tube wells and deep public tube wells. Among these Shallow Tube-Wells is the easiest way of irrigation in flood damage areas which can be privately owned in the backward areas. Shallow tube-well consists of a bore hole built into ground with the purpose of tapping ground water from porous zones. In sedimentary formations depth of a shallow tube well does not exceed 60-70 meters. Success and popularity of the scheme depends on how cheap they are. In shallow water table areas, bamboo frames are also used. Sometimes steel pipe casing are replaced by pipes constructed by rapping bituminized gunny bags over the bamboo frame. The tube wells are generally operated for 6 to 8 hours during irrigation season and give yield of 100-300 cubic meters per day, which is roughly 2 to 3 times that of a dug well. It is cheaper as compared to other means of irrigation facilities. In Assam flood damage areas, shallow tube-wells frequently found engaging watering multiple crop fields during the dry seasons. Like other leading states in India, the programmes for development of irrigation in Assam has been launched under two heads, viz-Major & Medium Irrigation and Minor Irrigation. While the Irrigation Schemes are classified as major, medium and minor, they are categorized as surface flow, surface lift (for major / medium and minor) and ground water lift (for minor only). At present three Departments, viz. Irrigation, Agriculture and Panchayat & Rural Development are associated with

development of irrigation facilities in the State. While the Irrigation Department, being the Nodal Department for development of irrigation in the State executes and maintains Major, Medium and Minor Irrigation Schemes. So this study will mainly consider shallow tube- well irrigation which can easily installed and uninstalled at the time of flood in flood affected areas. There is 16273 hectares of area were irrigated under minor irrigation scheme till 2003-04 in Golaghat district. According to Minor Irrigation Census 2003, only 6 blocks and 1081 village are irrigated under 495 shallow tube-well schemes.

BACKGROUND

Flood is seemed to be the major hindrances in the Socio-Economic development of Assam and until now Government unable to solve this natural problem is continued to be a common phenomenon every year. This research seeks to find out the real picture of the agricultural constraints, socio economic status of the farmers and the hidden reality of insufficiency of irrigation facility in agricultural sector of Assam mainly on the places where flood occurs every year. It also tries to find out the alternative strategies of developing agriculture sector of Assam assuming flood will continues to flow out every.

Irrigation works as an augmenting input in agriculture when it is combined with other inputs of production such as improved seeds and fertilizer. Thus it has a tremendous role to play in agriculture in increasing both production and productivity. Information on irrigation in Assam and in all other States in the region is very much confusing. According to Goswami, the data on irrigation in Assam is most unreliable and the erratic in nature of irrigation statistics, might be due to some misunderstanding (Goswami, 1998). Basic Statistics of North Eastern Region, 1992 published by the North Eastern Council, Shillong indicated that about 22% of the net area sown in the region was irrigated. The present work in this regard is an attempt to study the role and effectiveness of minor irrigation especially shallow tube-well system on the flood damage area of Assam in developing agricultural scenario which is being an indispensable input.

A substantial amount of economic research on agriculture and irrigation has been done in other states of India specially Kerala, Uttar Pradesh, and Maharastra etc. But with best of our knowledge, in Assam a little research on the role of minor irrigation in flood damaged areas is still has not been carried out. This study highlights the real picture of agriculture in the eve of flood in Assam and the ultimate finding may help the policy makers and planners to take up the alternative farming technique for the enlistment of agriculture sector. Though Assam possesses relatively more irrigated area yet it is lagging much behind Manipur, Nagaland and Meghalaya etc in some of the North Eastern state respect of percentage of net irrigated area to net sown area. Besides, the percentage of net irrigated area to the net sown area has significantly declined from 26.6 percent in 1958 to 22.1% in 1989. Whatever irrigation facilities exist in the States are mostly in the form of very minor irrigation. Thus, it can be said that the creation of irrigational facilities is not up to the mark. There exists enough scope to increase the production and productivity of food grains and other crops by putting greater stress on the creation of irrigation facilities, optimal combination of various agricultural inputs such as irrigation, cropping intensity, and improved seeds and fertilizers. Fortunately the region is endowed with enough although erratic rainfall and a snow-fed gigantic river system like the Brahmaputra and its tributaries. There is, thus, enough scope for both water harvesting and river-based irrigation system. In short, one should not allow vast water resources of the region to be drained into the sea along with valuable top soil. Instead every effort must be made to utilize these for productive purposes. According to Das (1984), this low utilization is basically due to the fact that the aspect of 'Command Area Development', which includes construction of field channels, consolidation of holdings, land leveling and shaping and other infrastructural development had not been planned earlier. M. P. Bezbaruah (Bezbaruah, 1994) attributes the problem of under utilization partly to inadequate planning and lack of coordination among various agencies responsible for implementation of irrigation programmes of the state. He, however, is of the view that without a comprehensive study on

the subject it is difficult to point out all the factors responsible for low utilization rate of irrigation potential created. However, the scenario of irrigation in the state is paradoxical. The state can boast of a huge amount of surface as well as ground water resources but these are yet to be fully exploited. The studies carried out on the subject so far as although not sufficient to comprehensively cover all the aspects of the problem, even though they have pointed out a number of interesting factors such as low net irrigated area.

The limitations of the above studies in this context that these studies are basically studies on agriculture in the state in general and therefore, have not adequately analyzed the problems of the irrigation sector especially in the context of flood problem. There are, however, a few studies which have specifically taken up the issues of irrigation and problem of flood damage agricultural sector, including prevalence of mono cropping system among large farmers, resource constraints among small and large farmers, slow development of irrigation distribution network, lack of training and extension programmes to the farmers, non-availability of infrastructure facilities like quality seed and fertilizer in time, institution credit etc. The findings of all these studies are very interesting. But these can a lot to be generalized as the factors for low Shallow tube-well irrigation potential created for the state as a whole since these studies are specific to either a project or a location only.

Looking at the all studies made till now on irrigation and Shallow tube-well irrigation in Assam it has found one major restraint and none of these studies considers flood problem when considering irrigation provision or related aspect. No irrigation agency is found to consider the provision of minor irrigation specially STWs in flood damage areas in winter dry seasons where they can cultivate multiple cropping in the light of irrigation system and can follow an alternative cropping pattern. So the present study will try to consider potentiality of STWs irrigation in flood damage areas.

Objectives of Study

The following are the main objectives of our study:

- To assess the extent of flood damage in concerned area.

- To examine the importance and impact of irrigation on cropping pattern, farmer's income, productivity and employment on flood damage areas.
- To analyze the socio economic impact of irrigation on the farmers.
- Analyze the prospect of alternative farming techniques in the context of shallow tube-well irrigation.

Hypothesis

The following hypothesis will be taken for during the course of the study:

- Flood affects the production of all crops.
- Introduction of irrigation brings significant productivity and cropping intensity improvement in flood damage areas.
- Inadequate Government agricultural infrastructure especially irrigation, institutional provision of credit is the main cause of low agricultural production.
- Illiteracy is the main problem behind the seasonal unemployment in flood affected areas.

Methodology

Research Methodology is a way to systematically solve the research problem. The present study is being carried out with following tactic.

Location of Study

Among the states of Assam, Golaghat district is considered to important one from agricultural point of view in the sense that production and productivity of agriculture is seemed to be one of highest in the state and flood also seemed to be occurring in the district every year. So for the above mention study Golaghat district is considered for sample study purpose.

Population or universe is the aggregate or totality of elementary units, such as about which information is desired. For the present study purpose the population will be four agriculture development officer circles (ADO) where flood is seemed to be occurring every year and agricultural production of the Golaghat district is mostly comes from these places.

Data Collection Method

The collected dataset are classified generally in to primary and secondary data. The primary data are those which are collected afresh and for the first time and thus original in character. On the other hand secondary data are those which have already been collected by some one else and which have been passed through the statistical process. This research is based on the both primary and secondary data. The secondary data will be used to study the macro economic study purpose only and to analyze the historical perspective of research. Secondary data is collected from the publications of various organizations viz. Irrigation Department, Govt. of Assam publications, Department of Agriculture, Directorate of Economics and Statistics, Research Publications of individual and institutional etc.

Sample Selection

A sample is a part of whole i.e. a sample is a group of items selected from the population for the purpose of getting information about the characteristics of the items of that population. The method by which a representative sample can be obtained from a population is called sampling technique.

The primary data will be collected by undertaking field study for investing the role of STWs irrigation in flood damage areas. For present study the sample survey will be conducted following multi stage sampling or cluster sampling method of probability sampling (Random sampling). Multistage sampling technique involves several methods of random sampling. In this study one agriculture development officer circle (ADO circle) of Golaghat district is randomly selected out of around three main agriculture development officer circles. From this circle, three villages namely Balidowar, Jaraguri, and Khakandaguri are selected randomly and 10% households with a total of 108 respondents are being also selected randomly from each of the villages for this study purpose. There is two set of schedules namely household schedule and village schedule are prepared for collecting primary data. Household schedule will be collected from sample households and village schedule is collected from

agriculture development officer circle or village head or school teacher or any other educated people to study the over all status of the farmers and the village. Information on the general background and farming methods and other details relating to cultivation of each farm household in the sample have been colleted by interviewing a senior member (usually the head of the household) of the farm family. For carrying out these interviews and for recording the collected information, a standard schedule of question was used .This schedule was finalized after a number of pre test in the field.

Analysis of Collected Data

Data thus collected is processed and tabulated and then analyzed using statistical and econometrics tools. For the comparison of various series of data of flood affected areas and other areas average, ratios, percentage etc are used. Graphical techniques to represent the above calculation are also presented.

Hypothesis Testing Method

In the process of hypothesis testing quantitative techniques are used. For testing the first hypothesis Regression analysis is conducted between the variables namely flood damage with the production level of multiple crops. To test the 2nd hypothesis, pared't' test is conducted with production and cropping intensity level before implementation of shallow tube-well with production level and cropping intensity after implementation of shallow tube-well in flood affected areas. To test the 3rd hypothesis Chi square test is being conducted to analyze the adequacy of shallow tube-well and institutional provision of credit in flood affected areas. Lastly again to test the last hypothesis regression analysis is carried out between the variables such as number of people engaged in agriculture to total family members with shallow tube- well irrigation and implementation of modern technology. This study also tries to apply several other relevant Statistical methods to focus the hidden reality. Lastly a production function of type Cobb Douglas is strived to construct.

Review of Literature

Review of the literature is must needed aspect in any research work which provides the base foundation. For any scientific investigation past experience strengthens the base of the researcher for future investigation. Therefore, review of literature is a prerequisite for any scientific investigation. In this section, keeping the objectives of the present study in view, a brief review of the relevant literature assembled from both published and unpublished reports has been made under the following sub head:

- Impact of irrigation on agricultural production, cropping pattern and employment
- Under utilization of irrigation in Assam.
- Flood, water resource and agricultural sector of Assam.

Irrigation and Agricultural Sector

The transfer from dependence on rain water to irrigation makes it possible to extend crops through out the whole year. This has led to widespread changes in cropping pattern. Many literatures have shown the consequence of irrigation on the cropping patterns.

Gadgil's. (1948) effort of evaluating economic effects of irrigation with orientation to Godavari and Pravara canal tosses light on many direct and indirect, benefits of irrigation. According to him provision of irrigation facility to the people has enabled them to have a greater cropping pattern, superior productivity and farm income etc.

According to Clark (1970) it is, always valuable to focus irrigation water on the highest valued crops. However, over watering not only fails to give any additional yield but also demolish the land, unsuitable for cultivation as was practical in large areas of west Pakistan. Choudhury (1971) observes the importance of shallow tube-wells which can irrigate nearly 10 acres of land and it was especially related to Nadia District of West Bengal.

The Directorate of Programme Evaluation of the Govt. of Assam (1975) studied the impact of the Jamunna Irrigation Project, Assam and found that paddy yield rate was increased

by 47.3 percent in benefited villages. Agro-Economic Research Center, Jorhat (1975) carried out a study on the impact of Mayong Irrigation Project in Nagaon, Assam on cropping pattern and establish that there was a shift to cultivation of traditional and HYV paddy, from mustered, Pulses and wheat in Rabi season as a result of, irrigation facilities where cropping intensity increases from 109 percent to 126 percent.

In Assam to appraise the impact of irrigation on yield, cropping pattern and employment scenario in the economy some amount of research were conducted. In 1975 a study to assess the Impact of Mayong Lift Irrigation Project in Nagaon on the cropping pattern was conducted. They found the positive impact of irrigation project in encouraging the farmers to raise paddy and jute in the karif season, mustard, pulses, wheat and some other minor crops in the Rabi season. With the introduction of irrigation there was a change in the crops grown in the area. The traditional Rabi crops were being replaced by both traditional, HYV paddies. There was considerable increase in the production due the adoption of irrigation and HYV paddy seeds and the per hectare average yield of paddy increased from 15.6 quintals to 21.3 quintals. Saikia & Bora (1975) in a study of a village of Jorhat district found that yield increased to 2268 Kg per hectare in irrigated field in 1974 from 1843 Kg per hectare in 1972 under rained condition.

Srinavas and Mukunda (1980) have undertook a study on the significant impact of irrigation on cropping pattern and found that as a result irrigation, in Kharif season, income of poor crops were substituted by income bright crops while in Rabi season there was a marked shift in area from inferior cereal crops to superior cereals and the high yielding varieties of paddy, maize and wheat occupied dominant places in the cropping patterns.The Central Task Force (1980) also emphasized the need for irrigation and technological mobilization for the development of agriculture in the North Eastern region.

Kalgra (1981) investigated the water management programme in Sambalpur district of Orissa. He has showed that during Rabi season 72.14 percent of total area cultivated was under HYV seeds in areas with assured irrigation facilities

as compared to 53.97 per cent in the non- irrigated villages in the kharif season also the irrigated areas had 4.67 per cent area under HYV seeds as compared to 1.13 per cent in the non irrigated areas.

Mehra (1981) in his structural analysis of agricultural sector of Assam states that rainfall extremely low in winter season and very erratic in summer season which echoed the need of irrigation. Before independence irrigation was being provided in those states where famine is occurred. But due to the notion that Assam falls in the heavy rainfall region, irrigation is not practiced.

Satpathy (1984) suggested that the benefit of irrigation on agricultural production had been positive in Orissa. There exists a significant impact of irrigation on the development of farm economy and he examined the suitability of the important policies persuaded for irrigation development for the period of 1951-1981 in the state. He concluded that even though irrigation expansion had not been able to appreciably push up the net sown area in Orissa, the 'acreage effect' of irrigation had been significant with the increase in the index of crop intensity, resulting from double and multiple cropping. The "crop pattern effect" had been favorable in the state and crop substitution had taken place in both kharif and Rabi seasons. The shift of cropping pattern from local variety crops to high yielding variety crops had resulted in a rise in yield rate. The author also Pointe out that the expansion of irrigation had increased the level of on-farm development.

Jha (1984) conducted a study on the evaluation of minor irrigation works and found significant change in the cropping patterns, cropping intensity and yield rate of crops. The cropping intensity increased from 126 % to 164% of which Cereals wheat and paddy are to the extent of 50.90% and 189.10% respectively. This study also showed that low remunerative, crops are replaced by high remunerative crops in respective seasons and the area under nonfood crop decreased by 38.78 percent.

Phukan (1985) made a comprehensive study on the impact of deep tube well irrigation of crop production in Jorhat District of Assam and established that there was limited use of the

irrigation potential by the farmers. Only 55% of the potential created by the deep tube wells under study were utilized. Phukan (1986) undertook a similar study on the impact of deep tube well on crop production in Kamrup district of Assam to examine the impact of irrigation on cropping pattern, crop intensity, and yield rates of irrigated crops and adoption of improved inputs due to introduction of irrigation. But the impact of irrigation on crop production was not found to be encouraging. The cropping pattern of the beneficiary sample had shown no significant changes over the non-beneficiary farmers. The intensity of cropping increased only.

Sawant (1986) also had discussed the impact of irrigation on agriculture and observes that irrigation not only enhanced yield rates of agriculture but also induced farmers to adopt modern technology thereby raising the capacity of land considerably. It also imparted stability in yields per hectare and thereby reduced fluctuation in production levels and they are mostly needed in the case of a state like, Tamil, Nadu.

Alagh (1987) is concerned with the elasticity of intensity of cropping with irrigation now approaching zero in some states. Rao et al (1988) concerned with the verification of a mild increase in the impact of irrigation on cropping intensity. Sai (1990) found that in Punjab-Haryana region the impact of Irrigation on Intensify of cropping during the post-HYV period was lower than that in the pre-HYV period.

Roy (1988) carried out a study in Nadia District (West Bengal) and found a change in cropping pattern due to shallow tube well irrigation. The study showed that low yielding crops were replaced by high yielding crops.

On irrigation in Indian agricultural development, comprehensive study was made by Dhawan (1988); according to which, a broad irrigation programme in low and medium rainfall states would appreciatively assist in reaching the goals of maximizing agricultural growth and stability in output. He also pointed out that investments in irrigation in high rainfall regions are bound to have low returns. The protective role of irrigation during drought has also been appraised by him and found that no single state of India has achieved commendable success in drought like situation of its agriculture through

irrigation. The study also examined the impact of irrigation on crop yields with different forms of irrigation. It observed that irrigated yield was highest on farms watered by private tube wells, as compared to on those of tanks, canal irrigation. In low and medium rainfall states of the country, the construction of surface irrigation has tremendously contributed to the quantum of ground water and, hence, to the establishment of privately owned tube wells. The conservative view of superiority of ground water over surface irrigation conveniently overlooks the fact that the later is a necessary praise for the development of the former. Impact of irrigation on intensity of cropping is the central topic of many, of the available irrigation literatures.

Pawar & Chndrakanth (1989) started a study on the relationship between irrigation and agriculture in upper Krishna Basin of Maharastra. He observed that irrigation in association with mechanical and bio-chemical inputs had influenced the land use in the region. The net sown area had also increased and overall the study area had 66.82% of land under cultivation. Even though the entire cropping pattern seems to be governed by agro-climatic conditions, irrigation had played a prominent role by changing the nature and extent of cropping, pattern.

Gangwar and Vanden (1989) examine the impact of Shallow tube well irrigation on farm economy of the Punjab where there was an increase in employment of human labour by 58 percent on the small farms and 65 per cent on the large farms. Mohmamed (1990) in his research studied on the impact of tube well irrigation on farm economy in Bangladesh showed that as a result of irrigation there was a great change in cropping pattern and productivity. In a study relating to Punjab, Singh (1991) observed that the use of irrigation stimulated the farmers to demand hired labour but this demand diverse across farms in large farms and the demand for hired labour tended to decrease.

Baldev (1991), found a significant change in cropping patterns, as a result of irrigation facilities in Bhiwani of Hariyana. The study showed that rice was replaced by wheat and bajra had been replaced by high yielding varieties. Basic Statistics of North Eastern Region, 1992 published by the North Eastern Council, Shillong indicated that about 22 percent of the net

area sown in the region was irrigated and found that it is the main constraints of agriculture in the region.

Dhawan and Dutta (1992) have made a study on the measurement aspects of the impact of irrigation on intensity of cropping. Multiple regression technique was used to undertake cross-sectional and time series analysis of impact of irrigation on intensity of cropping. The study exposed a definite evidence of the close relationship between irrigation development and the rise in intensity of cropping at the all India level.

Saikia and Bora (1993) examined the impact of irrigation project in Nagaon District of Assam and establish that irrigation had considerable impact on cropping patterns. The introduction of irrigation facilities on the Rabi crops like wheat, mustered, pulses etc, had been replaced by both traditional and HYV paddy.

Gogoi (1993) studied the Impact of Irrigation on agricultural development in Kamrup district of Assam. She has also made a comparative study between the farmers benefited by irrigation schemes and those deprived from these facilities. The author found a positive impact of irrigation on the agricultural development in the district.

Chatterjee (1995) conducted a study on Small farmer Development Agency (SFDA), Raibareli and found that as a result of development of irrigation facilities in the form of installing electric tube wells, there is a net return of Rs 297 to each rupees of investment. He also (1995) carried a research on a number of aspects of irrigation in the state of West Bengal. He has observed that irrigation had bestowed its benefits on net sown area, cropping intensity and crop yields among which intensity of cropping marked maximum response. With look upon to crop yields, irrigation played a vital role by augmenting the use of HYV seeds and fertilizers. This requires comprehensive planning with equal emphasis being given to surface and ground water resources. The author suggested more emphasis on ground water irrigation.

Narayanamoorthy (1996) showed that human and bullock labour employment were more on irrigated than on no irrigated farms. The supplementary employment created on irrigated

farms was due to the more careful use of fertilizers, manures, pesticides etc where irrigation itself required extra labour. Vaidhynathan (1996) also studied the impact of investment well irrigation and ground water depletion in Bangalore district and found that cropping intensity in the irrigated farm was 209.52 percent as Compared to 100 percent in non-irrigated farms.

According to Nayak and Bhattacharjee (1996), there has not been any significant increase in the production in Assam and virtually no improvement in the average yield of food grains has been possible even after the introduction of modern technology of production. However, there exists enough scope to increase the production and productivity of food grains and other crops by putting greater emphasis on the creation of irrigation facilities and through achievement of optimal combination of various agricultural inputs such as irrigation, cropping intensity, and improved seeds and fertilizers.

According to Goswami (1998), the data on irrigation in Assam is mostly unreliable and the chaotic nature of irrigation statistics is due to some misunderstanding. Similarly, Bhawan (2000) analyzed the development perspective of the tube-well irrigation, the factors behind the disparity of distribution of STWs and the cost benefit analysis. In conclusion he states that in Indo-Gangotic plains of Uttar Pradesh, Punjab, Harayana, Bihar and West Bengal the farmers have the option to exploit the ground water either through Dug well or STWs.

Roy and Bezbaruah in "Agricultural Growth and Regional Economic Development" (2002) study the agriculture status of "Borak Valley" in Assam and state that the poor status of agriculture infrastructure, especially irrigation, extension service and institutional credit is primary responsible for slow pace of agriculture development in the region.

According to Economic Survey 2002-03 the economic development of Assam is mainly dependent on the development of agriculture and irrigation is the main infrastructure for development of this vital sector. The modernization of agricultural practices vis-a-vis increase in productivity of crops cannot be conceived in absence of assured irrigation facilities. The importance of irrigation

development in a State like Assam therefore, needs special emphasis. The most discouraging aspect of irrigation development in the State is the decreasing trend of utilization of created potential from the government irrigation schemes.

Assam Agro Economic Research Centre carried out a study during, the year 2004. The study revealed that the cropping pattern adopted by the beneficiary farmers (with STW irrigation) and, non beneficiary farmers (without STW irrigation) did not exhibit much difference. The local variety of rice had been substantially replaced by high yielding varieties. After STW irrigation farmers were interested in summer rice cultivation. It was reported that rice alone occupied 18-19 percent of gross cultivated area in the beneficiary holdings. Out of the total rice area 80.5 per cent were irrigated and of the total area under rice 90.52 percent were under HYV of rice. The cropping intensity in the irrigated holdings was found to be 182.00 per cent where as it was 143.00 per cent in the non-irrigated area.

Bansil (2004) observed state wise ultimate irrigation potential and creation till 2001-02 and its impact on cropping pattern. According to this study irrigation potential in Assam 2870 thousand hectares in 2001-02 and potential created till 1996-97 is only 818 thousand hectares. A report published in Nepal showed that the Project (2005). 'Community Groundwater Irrigation Sector Project or STW irrigation programme was a grand success in Nepal. It was carried out in 12 districts in the area of Eastern and Central Region of Nepal with the time frame, of March 1999 to January 2006. The report revealed that cropping intensity was found to be increased by 50 per cent.

According to Dutta (2007) With the shifting of focus from large farmers in Green Revolution areas in northwest India to small and marginal farmers in east India for sustaining the production of rice, states like Assam, where potentials for exploiting the existing technology are yet largely untapped, have received greater attention from the government in recent years. A major constraint in exploiting such potentials in the state is paucity of irrigation. While investment for expanding the irrigation capacity is needed, it is equally important to put necessary institutions in place to ensure that the installed capacity is effectively utilized.

Under Utilization of Irrigation Potential

Creating irrigation potential by the major irrigation projects is a costly affair which requires massive amount of investment to create irrigation potential on a hectare of land. But inspite of massive public investment on the schemes, utilization of irrigation potential is found to be very low, leaving a wide gap between potential created and its utilization which is marked in the case of major and medium irrigation. Interestingly questions relating to irrigation potential did not receive much attention till 1980. However a number of economists including Niranjan Pant, K. P. Alanisami, A. K. Mitra, Robert Wade, Rbbert Chambers, etc. have undertaken some independent studies on the subject. Assam Agricultural Commission set up in 1975 which emphasized the importance of irrigation for agricultural development through improved technology and inputs. The Central Task Force (1980) also emphasized the need for irrigation. In a assemble publication by the Indian Society of Agricultural Economics Bombay & The Institute for Social and Economic Change Banglore (1976) on the utilization of irrigation have found that one of the major defects of the existing data on the irrigation is lack of uniformity in the concepts and definitions and classifications of irrigation resource. Gogoi K. (1989) suggested that Assam is one of the states of India, which has not been able to make much headway its irrigation development. According to him all the data of total irrigation area are cannot taken to be correct.

Flood, Water Resource and Agricultural Sector

Nayak and Bhattachrjee (1999) studied the use of water resources of North East India for agricultural production. He study reveals that there exists a high correlation between net irrigated area with the total cropped area under HYV, fertilizer consumption and food grain production for which a proportionate increase in irrigation facilities must be need aspect for implementing modern farming practices.

Banjee (2005) had explored one of the channels through which disaster affects the poor by analyzing the effect of flood disaster on the wage of the agricultural workers in Bangladesh

where he found negative impact of flood damage and wage formation in Bangladesh. These works along with some other relevant journals and magazines will be dealt with during this course of study.

Historical Perspective

From the time of independence the main strategy that followed by Assam Government to boost up the agriculture sector and the development of seed, fertilizers and multiple cropping projects where they failed to terminate the flow of flood water during each monsoon season which destroy mainly the 'Shali' rice each year along with the other miseries to the state. By the side of this view, irrigation in the state gets a little attention and the central focus is on the flood along with the other restraint of agriculture.

Irrigation as a prime factor for growth of agricultural production due emphasis had therefore also been taken during the British period. From the passage of time agricultural commission of 1975, to the P.C. Goswami every prominent people try to present attention to lack of irrigation facilities in the state during the winter dry season, but till this time the State unable to get any improvement in irrigation facilities. Main question behind the every peasant of flood prone areas is how to survive in the face of flood especially the agriculture. From the time 1950-51 the have hearted every flood and every year where Government some times even helpless. The traditional 'Shali' rice grown in the summer season in the flood prone areas is growing in from the time of memory. So to get rid of such a situation and to grow more crops with the multiple cropping especially the shallow tube-well irrigation can be the best method of irrigation.

The Department of Agriculture, Assam had taken up some irrigation projects as early as 1942-43 along with the launching of the 'Grow More Food Programme' for rising food production in the State. These were mostly minor irrigation projects. These projects were executed in the form of either flood protection measures or drainage schemes to reclaim waterlogged areas. The Power Pump Irrigation Scheme was initiated in the State in 1947-1948 with the objective of extending the cultivation of

winter rice during the winter season in the few flood-affected areas of the State. During the Fourth and Fifth five year Plan period some electric Lift Irrigation Projects were also installed. The revolutionary studies of these projects have indicated that most of these projects have not been successful in enhancing agricultural productions for a number of, reasons. From 1998-99, the State has been operating 'Samridha Krisak Ydjana' (SKY), which was meant to cover 18 districts of Brahmaputra, and Barak Valley with, the installation of one lakh STWs by March 2001. The success of the STW irrigation provided under the World Bank assisted project had undoubtedly brought about a refreshing change in rural areas of Assam, as 38,729 STWs and 5,114 low lift pumps were installed during 1998-1999. During 1999-2000, the State Government had been able to install 30,000 STWs under the SKY with loan assistance from the NABARD while 70,000 more such Tube Wells have been sanctioned. Another 15,000 STWs under the World Bank assisted programme were also being installed. The primary objective of the scheme was to boost agricultural production, especially during the Rabi season and thereby creating additional employment opportunities and providing income generation system. The success of the shallow tube-well irrigation scheme implemented in the State under the SKY, stated by prominent Agricultural Scientist M.S. Swaminathan during his visit to the State in the year 2000 stated that Assam has shown the entry of a minor irrigation lead '*Green Revolution*'. Planning Commission has already suggested it as ideal for adoption in the states. Under this scheme more than 18,000 STWs have been already installed in 'Central Brahmaputra Valley Zone' of Assam. This type of irrigation facility would not only bring about a breakthrough in the production of rice but also change the cropping patterns of the flood prone zone to a considerable extent.

Theoretical Framework

Irrigation

Irrigation is defined as, the process of artificially applying water over crops. Irrigation is a process, other than natural

precipitation, which supplies water to crops, grass or any other cultivated plants. According to Clark, it is the application of water by human agency, to assist the growth of crops and grass. In other words, the, term 'irrigation' does not include the other objects for which man stores and controls the flow of water that is to say the provision of navigable channels and also for getting rid of unwanted water, flood measures and in the draining of swamps and waterlogged land. For Jha, irrigation includes all operations or practices in artificially supplying water to the soil for growing crops, it means by which water is conveyed to arid areas from rivers reservoirs or wells to increase the fertility of land. The HYV fertilizer technology based strategy for agricultural growth through increase in crop yield and cropping intensity, however depends critically on irrigation.

Dhawan (1988) pointed out that irrigation increases crop output through a rise in proportion of net sown area of a holding and gross cropped area and cropping intensity. Apart from these, irrigation helps replacing low-valued crops by high-valued ones, which ultimately results in enhancement of the value of agricultural production. Empirical evidences have shown that the percentage of area under dry season crops has gone up significantly in Assam as a result of irrigation. So the significance of flood prone crops has also gone down considerably. The increasing use of HYV for enhancing agricultural output has also necessitated the expansion of irrigation network.

Irrigation Water and Irrigated Area

Irrigation water is the quantity of water artificially applied in the process of irrigation and does not include precipitation. The irrigated area does not thus take into account the depth or i.e. frequency of watering.

Net and Gross Irrigated Area

Irrigated area can be classified as the net irrigated area and gross irrigated area, The net irrigated area is the area irrigated during an agricultural year of the succeeding year counting the area only once even if two or more crops are irrigated in

different seasons in the same land. Gross irrigated area is the total irrigated area under various crops during the year counting the area irrigated under more than one crop during he same year as many as the number of crops grown, crops sown mixed being taken as one crop. Thus, the area irrigated more than once, can be obtained by deducting the net irrigated area, from the gross irrigated area.

Irrigation Ratios and Intensity of Cropping

The crop irrigation ratio is the ratio of area irrigated under the crop to the total area under the same crop expressed as percentage. The net irrigation ratio is the ratio of net area irrigated to the net sown area in a year expressed as a percentage. while the, gross irrigation ratio is the corresponding ratio between the gross area irrigated and the gross cropped area in a year, The intensity of integrated cropping is the ratio of gross area irrigated to the net area irrigated expressed as a percentage, while the intensity of irrigation is the sum total of the area irrigated under different crops in a year expressed as a percentage of cultivable command area of a project.

Cropping Pattern and Cropping Intensity

Cropping pattern denotes the number of different crops raised per unit of land in different sequence per unit of time. Cropping pattern means both the time and space sequence of crops. Thus the term cropping pattern is used in a more comprehensive sense. When we talk in terms of cropping' pattern for a farmer it will mean even cropping scheme and crop Intensity best suited for the farm.

Irrigation Potential Created and Potential Utilized

According to Planning Commission, irrigation potential is the gross area that can be irrigated from a project in a design year (1st July to 3rd June) of the succeeding year for the projected cropping pattern and assumed water allowance on, its full development. The gross irrigated area will be the aggregate of the areas irrigated in different cropping seasons, the areas

under the seasonal and potential crops being conducted only once in a year. An area if actually irrigated during the irrigation year is smaller than, the, area proposed to be irrigated potential created then there is a case of under utilization.

Cultivable Command Area (CCA)

Cultivable Command Area means the area which can be irrigated from a scheme and is fit for cultivation.

Gross Irrigated Area

The area irrigated under various crops during a year, counting the area irrigated under more than one crop during the same year as many times as the number of crops grown and irrigated.

Minor Irrigation (M.I.) Scheme

A scheme having Cultivable Command Area up to 2,000 hectares individually is classified as minor irrigation scheme.

Medium Irrigation Scheme

A scheme having Cultivable Command Area more than 2,000 hectares and up to 10,000 hectares individually is a medium irrigation scheme.

Major Irrigation Scheme

A scheme having Cultivable Command Area more than 10,000 hectares is major irrigation scheme.

Dug-Well

It covers ordinary open wells of varying dimension dug or sunk from the ground surface into water bearing stratum to extract water for irrigation purposes. These are broadly masonry wells, kuchcha wells and dug-cum-bore wells. All such schemes are of private nature belonging to individual cultivator.

Shallow Tube-Well

It consists of a bore hole built into ground with the purpose of tapping ground water from porous zones. In sedimentary formations depth of a shallow tube well does not exceed 60-70 meters. These tube wells are either cavity tube-wells or strainer tube-wells. These are usually drilled by percussion method using hand boring sets and sometimes percussion rigs. Success and popularity of the scheme depends on how cheap they are. Coir structures formed by binding coir strings over an iron frame are being used as strainer. In shallow water table areas, bamboo frames 'borewell' are also used. Sometimes steel pipe casing are replaced by pipes constructed by rapping bituminized gunny bags over the bamboo frame. These are called bore wells, in which bore-hole is stable without a lining in the bottom portion and a tube is inserted only in the upper zone. The tube wells are generally operated for 6 to 8 hours during irrigation season and give yield of 100-300 cubic meters per day, which is roughly 2 to 3 times that of a dug well.

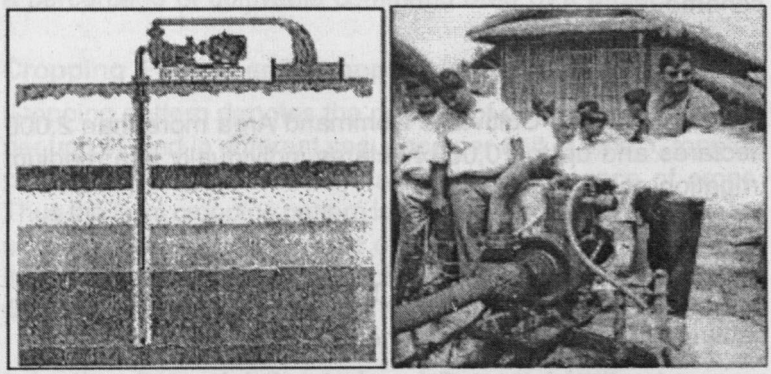

Fig. 1.1: Shallow Tube-Well Irrigation System

Deep Tube Wells

It usually extends to the depth of 100 meter and more and is designed to give a discharge of 100 to 200 cubic meters per hour. The deep tube well is drilled by rotary percussion or rotary cum percussion rigs. These tube wells operate round

the clock during the irrigation season, depending upon the availability of power. Their annual out put is roughly 15 times that of an average shallow tube well and are usually constructed as public scheme which are owned and operated by government departments or corporations.

Surface Flow Irrigation Scheme

These schemes use rainwater for irrigation purposes either by storing it or by diverting it from a stream, nala or river. Some times, permanent diversions are constructed for utilizing the flowing water of a stream or river. Temporary diversions are also constructed in many areas which are usually washed away during the rainy season. The small storage tanks are called ponds or bundhis which are mostly community owned. The command areas of such schemes are 20 hectares or less. The large storage tanks whose command varies from 20 to 2000 hectares are generally constructed by government departments or local bodies. These are the biggest items of surface minor irrigation works.

Storage Schemes

Storage schemes include tanks and reservoirs which impound water of streams and rivers for irrigation purposes. After wells, tanks occupy a very important place under the minor irrigation programme. They provide nearly two-third of the total irrigation from minor sources in the states of Andhra Pradesh, Karnataka, Kerala, Maharashtra, Orissa and Tamilnadu. With undulating topography and rocky sub-strata are eminently suitable for tank irrigation. Besides, there exists scope for further construction of tanks in many areas. A large number of existing tanks in southern States have gone into disuse due to long neglect of repairs. Renovation of these tanks so as to restore the lost irrigation potential is being accorded priority under the minor irrigation programme. The essential features of these schemes are (i) a bund or a dam which is generally of earth, but is also sometimes partly or fully masonry, (ii) anicut and feeder channels to divert water from adjoining catchments, (iii) a waste weir to dispose of surplus flood water, (iv) sluice or

sluices to let out water for irrigation, and (v) conveyance and distribution system. The size of the storage is determined by the run-off expected on the basis of dependable monsoon rainfall in the catchments and by the fact whether the rainfall and cropping pattern would permit more than one filling of the tank. The best and direct method to calculate the runoff would be to gauge the stream flow at the proposed site for a number of years. However, as the observed data over a long number of years is normally not available, the run-off is computed on the basis of empirical formula found applicable from past experience for the region. When tanks are constructed in a series by bounding up the same valley at several points, some spill-over yield from the bonded catchments is also accounted for. In the gross storage provided some percentage provision is allowed for dead storage to be consumed by silting in course of time.

Surface Lift Irrigation Scheme

In regions where the topography does not permit direct flow irrigation from rivers and streams, water has to be lifted into the irrigation channels. These works are similar to diversion schemes, but in addition pumps are installed and pump houses constructed. These schemes, being costly in operation, are feasible only in areas where (i) gravity flow irrigation is not possible (ii) there is keen demand for irrigation and cultivators are enthusiastic, (iii) water is available in the streams for at least about 200 days in a year, and (iv) Cheap electric power is available. Installation of diesel operated pump sets for lifting water makes the operation and maintenance cost of these schemes exorbitantly high. However, for lifting small order of discharge by individual cultivators, portable diesel engine pump sets are feasible as they provide greater flexibility and mobility for installation at different points of the water source or sources. In some areas Solar Pumps are also used for lifting water.

Drip Irrigation System

Drip irrigation system delivers water to the crop using a network of mainlines, sub-mains and lateral lines with emission points spaced along their lengths. Each dripper/emitter, orifice supplies a measured, precisely controlled uniform application

of water, nutrients, and other required growth substances directly into the root zone of the plant.

Plan of the Book

This book is organized in fifteen chapters. Chapter one is mostly based on research methodology, theoretical framework of the study. First part considers background, objectives of the study. A brief review of the literature is also presented in this chapter. Further some important concepts mostly of the Agricultural fields are depicted in the last part of the chapter. The second and third chapters are designed to analyze the present status of the economy of Assam and North east India. Based on the survey of available literature, fourth chapter of the book is designed to understand the nature of the problem or topic i.e. floods damage. But before going to that first an introduction to the study area is presented considering secondary data. Further in the latter part effect of flood on various fields are carried out such as agricultural production, productivity, employment pattern etc. The chapter five to ten are considered as the key chapters of the book as it covers the main theme of the study. All details of the effectiveness of irrigation are conducted in these chapters and it is a long one. First a detail of the sample villages is presented and then sample dataset are analyzed using both graphical and econometric tools. The effectiveness of irrigation on improvement of cropping pattern, production, productivity, income, employment etc is analyzed. Lastly, the role of irrigation on developing socio- economic status of the farmers is also explored out. Last chapter is the concluding chapter is deal with the summary of findings, conclusion, and suggestions.

About the Book

The North East India is referred to a region comprises of the eight States of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. However, the pace of development of North Eastern Region (NER) varies around the states with respect to their resource endowments, level of industrialization as well as infrastructural development. The economy of the region is still primarily agrarian but has full potential to be exploited in the form of vast unexploited resource base available in the region. Despite being rich in natural resources, development in the region has lagged behind the rest of the country. Although agriculture is the backbone of the economy of NER, but it is chronically affected by floods and other natural disasters especially in Assam. Apart from floods the growth and productivity of agricultural sector is far from satisfactory and is much lower as compared to other states of India. All these individualities of agriculture in the region direct towards the need for sustainability of agricultural growth and economy. In this book an endeavor has been made to develop an alternative strategy where minor irrigation as one for supporting the agricultural economy. This book furnishes prime focus on the minor irrigation as a vital ingredient in increasing the growth of agricultural sector in flood affected areas which can be an appropriate alternative agricultural practice.

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Prodip Kumar Adhyapok Associate Professor in the Department of the Economics, Cotton College, Guwahati, Assam has three decades of teaching and research experience and has guided many research project and Ph.D. and M. Phil scholars. As a prolific writer, he has published numerous papers and articles in reputed journals and periodicals. He has also attended many national and international seminar and conferences.

Hemanta Saikia Assistant professor in the department of Economics, Hemo Prova Borbora Girls' College, Golaghat, Assam has a gleaming academic background. He has completed his Bachelor Degree from Dibrugarh University with first class first position in 2005. He has also awarded UGC Junior Research Fellowship in 2008. As an author, he has published around twenty research papers in many reputed national and international Journals

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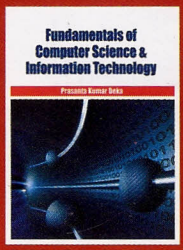

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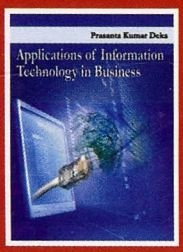

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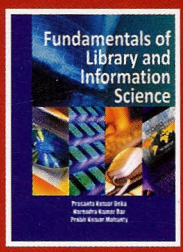

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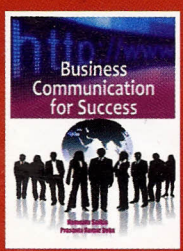

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