maintenance cost and other management aspects. Another set of schedule will be designed to gather information from the water users.

- **Sampling design**

A multi-stage sampling technique was followed while selecting the households (A group of persons normally living together and use water resources from irrigation projects.) . In the first stage two districts were selected purposively. From each district one administrative block was selected to cover projects command. Thus, Karunabari Blocks was selected from Lakhimpur districts while Dhemaji Blocks was selected from Dhemaji district. In the third stage the villages which fall under the project command were selected. Finally the sample households were selected from the sample villages considering the relative services covered by the minor projects. Altogether 188 households of all categories were interviewed with the help of a semi-structured household schedule.

2. Observations and Findings

2.1 Significance of Minor Irrigation in Assam

In Assam Minor Irrigation (All surface and ground water schemes with cultivable command area up to 2,000 hactare are classified as Minor Irrigation schemes. These include *inter alia*, *kuhals*, tanks with surplus weirs, canals and sluices, diversion weirs (anicuts), lift irrigation schemes and sub-surface water schemes viz. dug wells, tube-wells, farm ponds, check dams, khadins, snow harvesting structures, etc. In many States/ regions minor) schemes are seem to be more cost effective due to numbers of reasons (phanindragoyari 'scarcity in the midst of plenty: irrigation development for water abundant assam')like:

- Major irrigation projects are costly and, in most cases, beyond the resource capacity of the state's exchequer.
- Due to large initial investment and long gestation period involved, large scale irrigation systems have several limitations in the state.
- Moreover, due to heavy rainfall and frequent floods every year, possibility of large scale irrigation systems being destroyed and causing great loss is obvious.
- Small scale irrigation projects render numbers of services besides water supply to farm land. These includes control of soil erosion, enhance fertility, recharging of ground water level, development of allied sectors, etc.

2.2 Means of Irrigation

Following table (table-2.1) shows the available sources of irrigation in the surveyed area.

Table 2.1: Major source of irrigation in the surveyed villages

Villages	Operated land (Bigha)	Major source of irrigation		
		STW	DTW	Others
Matikhula	218.00		✓	
Bangalmari	229.5		✓	
No-1 Gheyari	250.50	✓		
Tinthengia	387.50	✓		
Karunabari	326.00	✓		
2 No. Bogori	556.00			✓
Source: Field Survey, 2014-15				

Others =Other sources of minor irrigation include ***check bundh, galley control, agribundh, etc.***

The survey reveals that the different sources of minor irrigation services observed in the study areas were Sallow Tube Well (STW) Deep Tube Well (DTW), *NullahBandh (*These are Traditional Knowledge Based water harvesting system. These schemes are seemed to be effective in high land area where ground water harvesting is very difficult. In this system of water harvesting the natural flow of water in very small rivers called Nullah were blocked putting earth, gavels and now a days through swish gate and water is channelized to the crop fields. In the present study the traditional water harvesting system which could provide water up to 500 hectares of land are considered*)*. The first two schemes are based on ground water while the later one bases on surface water that flows through the *Nullah*. It was observed that existing irrigation services in the surveyed areas fail to cover the complete operated area of the region. Therefore a significant portion of the operated land is still cultivated based of rainfall. So far the productivity of rain-fed cultivation is concerned it is found to be the highest in Matikhula village (3.08qntl/bigha) followed by Bangalmari village (2.98 qntl/bigha)

Productivity of Irrigated and Rain-fed Agriculture

Various empirical studies proved that sustained irrigation services induce productivity as well as cropping intensity. The present study also attempts to highlight the role of irrigation as production and supply shifter. Before the observation, let us consider some key characteristics of operational holdings.

Table 2.2: Distribution of operated land according to sources of water

Villages		Operated land (Bigha)	Land under different water sources (bigha)	
			Irrigation	Rain water
Matikhula	N	25	25	25
	Sum	218.00	92.50	125.50
Bangalmari	N	28	28	28
	Sum	229.50	107.50	122.00
Gayari	N	30	30	30
	Sum	250.50	108.50	122.00
Tinthengia	N	35	35	35
	Sum	387.50	195.00	129.50
Karunabori	N	25	25	25
	Sum	326.00	53.00	273.00
2 no. Bogori	N	45	45	45
	Sum	556.00	215.00	341.00
Total	N	188	188	188
	Sum	1967.50	771.50	1113.00
Source: Field Survey, 2014-15				

Bigha is a very common and popular unit of measurement of land in Assam. 7.5 bigha=1hectare.

It is clear from the data presented in Table 2.2 that irrigation services cannot cover all the operated land in the surveyed area. A part of the land is still dependent upon rainfall for operation. It is estimated that out of total operated land of 1967.50 bigha, irrigation service is extended to 771.50 bighas of land only. That is the irrigation service could cover

only 39.21 per cent of the total operated land in the surveyed area.

In order to test the significant differences between the productivity of irrigated and rain-fed agriculture the ANOVA analysis was run through SPSS. Attempt was made to observe the followings:

- Is there significant difference in productivity of irrigated land and rain-fed land?
- Is there significant difference in productivity of irrigated land across the groups (villages)?
- Is there significant difference in productivity of rain-fed land across the groups (villages)?

The experiment reveals that there is significant difference between productivity of irrigated land and rain-fed land. The F value is found to be 48.508 which is highly significant at 0.01 level. Detail is presented in table-2.3.

Table 2.3: ANOVA Analysis between productivity of irrigated land and rain-fed land

Farm productivity	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	314.507	1	314.507	48.508	0.000
Within Groups	2424.859	374	6.484		
Total	2739.366	375			
Source: Self calculated based on field survey data, 2014					

The ANOVA analysis also revealed that farm productivity irrigated agriculture significantly varies across different groups (villages). The F value is found to be 4.810 (table-2.4) which is highly significant at 0.01 level. This difference are due to the fact that some of the surveyed villages have its land under *BODO RICE* cultivation which productivity is very high (varied from 7.33 -10 qntl/bigha)

The differences of productivity under rain-fed agriculture, however, across different groups are not significant. The F value is calculated at 1.648 which is significant at 0.148 level only. The marginal differences in productivity of rain-fed land indicate that the lands belong to different villages, are almost under same soil quality and rainfall characteristics. Thus, a comparative analysis of table 2.3 and table 2.4 establishes that irrigation service induces farm productivity. As a result irrigated land shows a greater productivity than that of rain-fed land.

Table 2.4: ANOVA Analysis of productivity of irrigated and rain-fed land of different villages

		Sum of Squares	Df	Mean Square	F	Sig.
Productivity of irrigated land	Between Groups	265.307	5	53.061	4.810	.000
	Within Groups	2007.572	182	11.031		
	Total	2272.879	187			
Productivity of rain-fed land	Between Groups	6.584	5	1.317	1.648	.149
	Within Groups	145.396	182	.799		
	Total	151.981	187			
Source: Self calculated based on field survey data, 2014-15						

Irrigation ration and Farm productivity

In order to highlight the contribution of irrigation service, the farm productivity and irrigation ratios (Irrigation ratio is calculated dividing total irrigated land by total cropped area) are observed. The result supports the fact that higher the irrigation ratio greater is the productivity. So it is observed that in Tinthengia village where irrigation ratio is comparatively higher (0.65) the productivity is also greater being 4.75 quintal /bigha. Similarly in Karunabari, where irrigation ratio is lower (0.24) in comparison to others, the productivity is also lower being 3.76 quintal/bigha.

Based on the village-wise average value of irrigation ratio and productivity, efforts were made to observe the relationship by fitting a regression equation as well as calculating the value of R square. The Figure 2.1 shows the estimated regression line of productivity on irrigation ratio, estimated equation and the value of R square. The higher value of R square (0.576) signifies that farm productivity is highly dependent upon irrigation ratio.

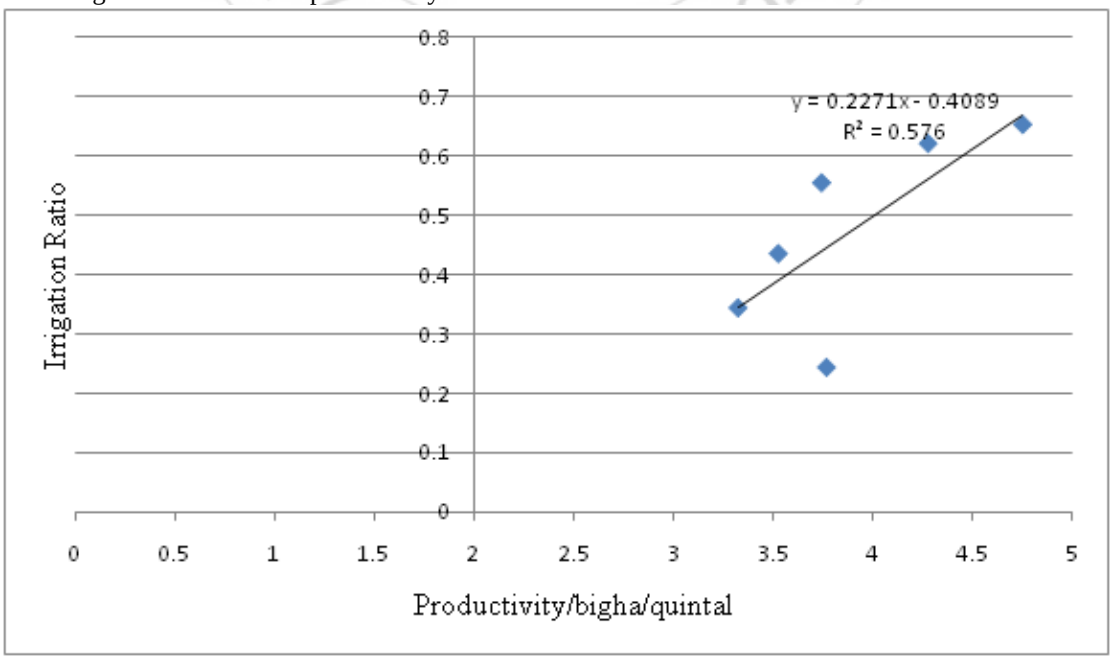

Figure 2.1: Impact of Irrigation ration on Productivity

Source: Field Survey, 2014-15

Contribution of Agriculture to GDP and Employment

An attempt was made to quantify the agricultural contribution (In the present context of study agricultural production is accounted for rice production only. So there is a chance of under estimation of the contribution of agriculture to GDP) to GDP and employment. For that purpose total production of rice is converted into monetary value, multiplying by market price of rice. After that its percentage contribution to GDP is observed. Like-wise, numbers of peoples engaged in agriculture and total work force are calculated separately and then the contribution of agriculture sector to the total work force is observed. Table 2.5 presents this information.

Table 2.5: Share of Agriculture in GDP and Employment

Sl. no	*Villages*	*percentage share of agriculture in GDP*	*percentage share of agriculture in employment*	*Ratio of worker pdn in agri. to non-agri.*
1	Matikhula	67.58	69.99	1:0.48
2	Bangalmari	71.71	74.61	1:0.51
3	No-1 Gheyari	81.96	83.72	1:0.64
4	Tinthengia	78.52	71.44	1:0.68
5	Karunabari	58.24	64.80	1:0.36
6	2 No. Bogori	65.92	69.44	1:0.24
7	Total	68.58	71.52	1: 0.48

Source: Field Survey, 2014-15

Data presented in table 2.5 shows that agriculture plays an important role in contributing to GDP and employment in the surveyed area. Agriculture contribution to GDP is accounted for as much as 68.58 per cent of GDP. It is the Gayari village where the agriculture contribution to GDP is found to the highest being 81.96 per cent and the figure is the lowest in Karunabari village being 58.24per cent. While employment is concerned the overall contribution is found to be 71.52 per cent. The contribution of agriculture to employment is the highest in Gayari village being 83.72per cent followe by Tinthengia village (71.44 percent), It was found to be lowest in Karunabari village being 64.80 per cent. Thus, it is proved that agriculture play a very important role in providing sources of income and employment to the peoples in the surveyed area. However, the ratio of workers production (agriculture workers: non-agriculture workers) shows that agriculture workers are less productive in comparison to that of non-agricultural workers. It may be due to subsistence type of operation system, non-practice of multiple cropping, lack of technological progress, etc. As such agricultural workers productivity is accounted for 0.48 per cent of the non-agricultural workers' productivity.

3. Conclusion and Policy Implication

The existing minor irrigation services are of great importance in livelihood promotion of the peoples living in the project command which is mostly flood affected. Its impacts were observed on human, physical, social, financial and natural assets which determine status of livelihood of the peoples.Though the status of irrigation development in the study region is not much satisfactory yet it can undoubtedly be said that it has induced farm productivity and livelihood assets.

In the surveyed area the irrigation service could covers only 39.18 per cent of the total operated land. The available sources of irrigation were only minor irrigation schemes; particularly Deep Tubewell (DTW), Shallow Tubewell (STW) and other conventional mode of irrigation which includes ***check bundh, galley control, agribundh, etc.*** However, irrigation ratio and cropping intensity are very poor in the surveyed area. Thus the study advocates a strategic policy formulation for a radical increase in cropping intensity, supported by commensurate irrigation facilities along with required (and feasible) increase in productivity levels of foodgrains especially rice and wheat.

References

[1] Angood, C., Chancellor, F., Morrison, J. and Smith, L, Hansip, N., (2002): *'Contribution of Irrigation to Sustaining Rural Livelihoods: Nepal Case Study'. HR Wallingford technical report OD/TN 113,* Wallingford, UK available from http://www.hrwallingford.co.uk/downloads/publications /dlreports/ODTN113.pdf cited on 23rd June 2005.

[2] Arabiyat T. S.; Segarra, E. and J.L. Johnson (2001). Technology Adoption in Agriculture: Implications forGround Water Conservation in the Texas High Plains, *Resources, Conservation and Recycling,* Vol. 32,pp.147-156.

[3] Brabben, T., Angood, C., Skutsch, J., and Smith, L., (2004): 'Irrigation can Sustain Rural Livehoods: Evidence from Bangladesh and Nepal', cited on 24th June 2005 available from http://www.hrwallingford.co.uk/downloads/publications /dlreports/OD151.pdf

[4] Briscoe , J. and R.P.S. Malik (2007) '*Handbook of Water Resources of India'* , Oxford University Press, New Delhi.

[5] Coupal, R.H., and P.N. Wilson (1990), Adoption Water-Conserving Irrigation Technology: The Case of SurgeIrrigation in Arizona, Agricultural Water Management, Vol. 18, pp. 15-28.

[6] Desai, B. M., 2002. Policy Framework for Reorienting Agricultural Development.Presidential Address.Indian Journal of Agricultural Economics. 57 (1), 1-21. 7

[7] DFID (1999).Sustainable livelihoods and poverty elimination.Background briefing, Department for International Development.December 1999, London.

[8] FAO (1996).Agriculture and food security. World Food Summit, November 1996, Rome.

[9] George, P. S. and V. V. Chaukidar (1972), Modernization of Paddy Rice System and Challenges Ahead, IndianJournal of Agricultural Economics, April-June.

[10] Fan, S., Hazel P., and Sukhadeo T., (1999): 'Linkages between Government Spending, Growth, and Poverty in Rural India', *Research Report No 110.* International Food Policy Research Institute: Washington D.C., USA., Washington DC.

[11] Hussain, I., and Hanjra, A.M., (2004): 'Irrigation and Poverty Alleviation: Review of the Empirical Evidence', *Irrigation and Drainage (53)*pp 1-15.

[12] Lipton, M., Litchfield, J., Blackman R., De Zoysa D., Qureshy L and Waddington, H. (2002): 'The Impact of Irrigation on Poverty', *Draft Paper,* Poverty Research Unit at Sussex, University of Sussex, UK

[13] Mellor, J.W., (2001): 'Irrigation, Agriculture and Poverty Reduction: General Relationships and Specific Needs', in Hussain and Biltonen (eds) Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia - Bangladesh, China, India, Indonesia, Pakistan and Vietnam Conference Proceedings, Colombo, 9–10 August 2001, International Water Management Institute, Colombo
[14] NEDFi (North East Development Finance Corporation). 2002. *NER Databank*. NEDFi, Guwahati, India.
[15] Rao, D.M. and R.S. Despande (1986), Agricultural Growth in India – A Review of Experiences and Prospects,Economic and Political Weekly.
[16] Ravallion, M., and Datt .G., (1996):'How Important to India's Poor is the Sectoral Composition of Economic Growth, The World Bank Economic Review 10 (1).
[17] Reba, P., (2003): 'Sectoral Trends in the Water Sector (Technology, Policy and Poverty) in South Asia', Paper presented at South Asia Conference on Technologies for Poverty Reduction, New Delhi, 10 -11 October, 2003, cited on 26th June 2005 Retrieve from http://www.itdg.org/docs/region_south_asia/session1_water.pdf