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MINOR IRRIGATION FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN ASSAM: A CRITICAL REVIEW

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Abstract: In many places, irrigation plays a stabilizing role in agriculture by supplying necessary water and assisting to replace low-valued plants with better alternatives. In an area that experiences frequent floods during the summertime as a result of heavy rains and drought, irrigation enables them to take place. The main focuses of the paper is to assess the economic impact of tube-wells on the farmers, analyze the possibility of alternative farming techniques in view of soil degradation in affected areas. The result revelaed that there is significant difference between the cropping intensity before and after implementation of STW irrigation and STW irrigation leads to a statistically significant cropping intensity improvement in flood affected areas. There is a considerable shift in land area from other crops to HYV crops. The average cropping intensity is much higher 132.66 percent in the irrigated farm while it is only 106.66 percent in the non irrigated farm. The over all analysis regarding the impact of STW irrigation on the cropping intensity in the study area showed that irrigation water helps in expanding the cropping intensity in flood affected area.

Keywords: Irrigation, agriculture, cropping intensity, soil degradation.

Introduction:

Water is one of the crucial natural resources that is used as an enhancing input in agriculture. In many dry regions of the world, irrigation generates an element of stability in agriculture by supplying necessary water and helping to replace low-valued crops with higher ones. In an area where floods frequently characterize the summer season due to heavy downpours and drought-like winter, irrigation is relatively critical as irrigation in such areas is mandatory in only winter seasons. In Assam, the gateway to the northeastern part of India, the mighty 'Brahmaputra River' charts its majestic course through the state, and the state consists of two valleys, viz. the "Brahmaputra valley" and "Borak Valley." Assam's economy mainly depends on agriculture, contributing about 38% (2006-2007) to the NSDP at current prices. Even though this sector is the backbone of the State's economy, the growth rate and productivity are far from satisfactory and one of the lowest compared to other states of India. So the agricultural sector of Assam continues to be underdeveloped compared to the rest of Indian states, where the flood problem is supposed to be the significant reason for the agricultural backwardness of Assam, leading to the question of sustainability of agricultural growth. The Brahmaputra and Borak are the two main rivers, which cause significant problems during the monsoon periods almost every year in the form of floods and soil erosions, affecting Assam's rural agricultural sector and bringing misery to the people. With the increasing intensity of flood in Assam and damages caused to the agricultural sector of Assam continue to increase. In Assam, most minor irrigation is present in shallow tube well irrigation (STW), which is easy to install according to the need of the time. The present work in this regard is an endeavor to study the role and effectiveness of the shallow tube-well system in the flood-damaged area of Assam in developing agricultural scenarios, which is an

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indispensable input in such areas. This paper also seeks an accurate picture of the agricultural constraints and economic status of the farmers in Assam, mainly in flood-damaged areas. The main objectives of the paper are to: assess the extent of flood damage in concerned areas, examine the importance and impact of shallow tube-well on cropping pattern, farmer's income, productivity, and employment in flood-damaged areas, analyze the economic impact of shallow tube-well on the farmers, analyze the prospect of alternative farming techniques in the context of shallow tube-well irrigation.

Methodology:

This study is based on primary and secondary data collected from various sources. The secondary data is used to study the macroeconomic study purpose 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. Primary data are collected following multi-stage sampling in the Golaghat district of Assam. In the first stage, the Dhemaji Development Officer Circle (ADO) of Golaghat district is randomly selected from around three leading agriculture development officer circles. In the second stage of these ADO circles, three villages, namely No1 Joraguri, No.2 Khakand Guri, and Balidowar, are selected randomly, and in 3rd stage, 10% of households are also selected from each of the villages; a total of 108 households. Data thus collected will be processed, tabulated, and then analyzed using statistical and econometrics tools, viz regression analysis, paired t-test, etc.

The villages:

The villages under reference - No.1 Joraguri village is situated in the northwest part of the Golaghat district nearby the west bank of the Brahmaputra river, situated 20 kilometers away from Dergaon town; the Balidowar and No2, Khakand Guri villages, are situated in the west bank of the Brahmaputra river and northern part of the Golaghat district 10 kilometers away from Dergaon town. The 'Gala Bile' is situated on the western side of these villages. In total area, No1 Joraguri is the largest, with 379 hectares kilometers, followed by No.2 Khakand Guri (155 hectares) and Balidowar (376 hectares). Joraguri comprises 236 households, followed by Balidowar (179 households) and No.2 Khakand Guri, with 72 households. The total population in No1 Joraguri is 1418 persons, followed by Balidowar (849 persons) and No.2 Khakand Guri (379 persons).

Analysis:

In Assam, as much as 70 percent of the flood loss is accounted for crop damage. The State ranks 3rd regarding the total land area affected and eighth and ninth, respectively, concerning the population affected and cropped area damaged in all of India. The average area affected by floods during the period 1971-1988 was almost 30 percent higher than the average for the preceding (18 Years) 1953-1970. So far as the effect and damages in agriculture of sample villages are concerned, it is prominent that the summer crops are severely affected. Summer paddy is the main casualty of flood in both irrigated and non irrigated fields, and in the Joraguri village flood causes widespread damage to summer paddy fields. Except No2 Khakand Guri village in irrigated field flood damage is more than that of non irrigated fields. In quantitative value term, flood damage in summer paddy is varies from 68% to 91% in non irrigated fields and thus damage in agricultural fields mostly comprises of summer paddy.

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Cropping Pattern and Cropping Intensity:

Irrigation has made significant contribution in enhancing cropping intensity. The growth of irrigation has direct bearing on the cropping intensity. In sample villages, out of 108 sample farms 75 farms have STW irrigation facilities. Out of the total irrigation facilities 60% to 70% are utilized for growing crops in winter season and remaining for autumn crops. So, not much irrigation facility is used for growing crops in the summer season. It is found that about 50% of the combined total irrigated and non irrigated cropped area of the 108 sample farmers is under Paddy cultivation. The average cropping intensity is found to be 120%. The cropping intensity, of irrigated farms is higher as compared to non irrigated farms. But the variation in the cropping intensity seems to have a correspondence with the extent of irrigated area in the sample farms.

To analyz the usefulness of shallow tube-well irrigation on cropping intensity the paired-t test is conducted between cropping intensity before implementation of STWs and after implementation of STW irrigation facilities against the null hypothesis that there is no significant difference between the cropping intensity before and after implementation of STW irrigation.

Results and Discussion:

Pared t = 2.090*

(* significant at 58 df and 5% level of significance).

Since, calculated value 2.090 is significant at 5% level of significance and 58 degrees of freedom, so null hypothesis is rejected. Therefore, there is significant difference between the cropping intensity before and after implementation of STW irrigation and STW irrigation leads to a statistically significant cropping intensity improvement in flood affected areas.

Factors behind the Variation in the Cropping Intensity:

To explain the variation in cropping intensity across farms, a multiple regression analysis was used incorporating flood damage, income from HYV crops, STW irrigated area, farm size as explanatory factors. Accordingly the following linear regression function is being chosen.

$$Y= a_1X_1+a_2X_2+a_3X_3 + a_4X_4+U$$

Where,

Y = Cropping intensity of irrigated crops; X_1 = Annual crop damaged value in net sown area (in Rs); X_2 = Annual average Income from HYV crops; X_3= Operational Holding; X_4 = Net STW irrigated area; U = Random error term.

The R square value 0.785 is found to be high even though extensive cross section data is used. Moreover the t-value of the three variables is found to be statistically significant showing the importance of the corresponding factors in explaining the variation in cropping intensity. The F statistics for over all regression is also highly statistically significant. Thus on whole, result obtained from the analysis are fairly full-bodied and commendable. Besides, the co-efficient of the explanatory variables X_1 variable is negative and X_1 can be termed as high damage in crops leads to a low cropping intensity. Annual crop damaged value in net sown area has a greater influence on the cropping intensity. But most importantly the co

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efficient of the X_3 is found to be the highest and it is positive along with very significant t value.

The above all analysis brought out that STW irrigation facility encouraged exhaustive use of land resource in the irrigated farms. There is a considerable shift in land area from other crops to HYV crops. The average cropping intensity is much higher 132.66 percent in the irrigated farm while it is only 106.66 percent in the non irrigated farm. The over all analysis regarding the impact of STW irrigation on the cropping intensity in the study area showed that irrigation water helps in expanding the cropping intensity in flood affected area.

Agricultural Production and Productivity and Farm Income:

Irrigation helps in enhancing the agricultural productivity. During the post-green revolution period, the impact of farm irrigation on agricultural production and productivity has been well recognised in India. Ghosh has indicated the pervasive character of irrigation impact that operates through interaction of area, yield and crop pattern phenomena (Ghosh, 1977). Irrigation boosts up the yield rate per hectare as it facilitates the farms to switch over to better know-how, which is dependent on the use of the chemical fertilizers and high yielding varieties of seeds.

In sample farms, production and productivity of irrigated winter crops is higher in the marginal farms as compared to non-irrigated winter crops. The productivity of each of the Rabi vegetables crops is slightly higher in irrigated field than that of none irrigated field. Considering both irrigated and non irrigated field, the average productivity is highest in case of winter local paddy and lowest in case summer local paddy in the study area. The productivity of winter HYV paddy is remarkably high 80.6 qu/ha in small farms. The productivity difference of the HYV winter paddy may be conceived that the small farmers fully utilized the STW irrigation facilities. In case of large farms, the productivity of winter HYV paddy and winter local paddy is remarkably high other variety of paddy crops. The high productivity of the winter paddy may be visualized that the large farmers effectively utilized the STW irrigation facilities. So from the above investigation in case of large farmers the HYV seed are able to get grab a great deal of benefit in irrigated fields. In case of efficiency of STW irrigation on farmer's income, HYV winter paddy is the key crop contributing highest 32% of total per hectare income in irrigated farms followed by cabbage with 18% per hectare income. This analysis indicated the positive and significant role of STW irrigation on marginal farm income. Thus irrigated crops lead to greater productivity of Kharif crops, especially to HYV crops in marginal farms.

In general view, it is observed that irrigation expansion leads to greater farm income. But there is a controversy that irrigation facilities are mostly enjoyed by large farms and the benefit of irrigation was skewed in favor of the large farmers adversely affecting the small and marginal farmers in respect of distribution of irrigation benefits. Mishra in their study of Orissa farmers in irrigated areas observed that there is no statistically significant relation to show that benefit of irrigation was skewed in favor of the large farmers (Mishra. B. Dasgupta , H.K. and Das P.K. (1973). In our study big farm operators do not derive large share of reimbursement as compared to small farm operators which is mainly due to inefficiency and

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lack of management of inputs at large scale of production. So there is no biasness of the benefit of irrigation on farm income on the farm size.

Agricultural Mechanization and Minor Irrigation:
Agricultural mechanization involves the make use of of various power sources and improved farm tools and equipment, with the intention to reduce the hard work of the human beings and animals, enhance the cropping intensity, reduce the losses at different stages of crop production. The end objective of farm mechanization is to enhance the overall efficiency and production with the lowest cost of production. During the post-green revolution period, the impact of farm mechanization on agricultural production and productivity has been well recognised in India. Depending upon the use of other inputs such as irrigation, high yielding seed varieties, chemical fertilizers, herbicides and pesticides, different States in India have attained different levels of mechanization. The positive co-relation between the irrigation and farm mechanization is found in study area. In Khakand Guri village, irrigated area has the highest percentage of farmers (81%) using tractor. It is also noted that Khakand Guri village too have highest number of irrigated farmers using chemical fertilizers. Thus the use of STW irrigation helps in more intensive farming which increases the farm mechanization. The farmers use fertilizer at a higher dose on crops such as vegetables and potato rather than on their foremost crop that is paddy. The overall fertilizer consumption rate is 6766 tones (Appendix IV) per hectare which is more than double the figure of fertilizer consumption rate for the Golaghat district. The sample farmers, usages chemical fertilizer at a higher quantity compared to farmers in the other parts of the district. A majority of farmers (55 out of 108 sample farmers) also used organic manure such as cowdung and compost in combination with chemical fertilizer instead relying entirely on the latter.

Employment and Occupational Distribution:
Employment is the key factor in the development of the farmers. Agriculture sector has the major potential for providing the employment opportunities to this huge population of unemployed people. The impact of irrigation on labour employment, particularly in a labour surplus country like India, has been a matter of concern. Irrigation generates greater demand for labour by facilitating more intensive cultivation. It is found that STW irrigation improves the employment status in flood affected areas too. In all three villages, the average man-days are slightly higher in irrigated crops (159) as compared to non irrigated crops (123) per crops. In irrigated field the highest man days is found in case of vegetable (cabbage) and lowest is in case of potato. In non irrigated field the highest man-days is found in case of sugarcane and lowest in case of mustard. Regarding the distribution of the occupation, in irrigated areas have almost the same percentage of cultivator (44%) as against the non irrigated field (46%).

It may be conclude that even though STW irrigation does not able to influence much on the occupational distribution, but it is the production and productivity as well as farm mechanization which make the difference between irrigated agriculture and non irrigated agricultural fields. The other factor is the low land holding on the part of the farmers which also negatively effect on the occupational distribution in farms along with the over dependence of farmers in agriculture. The average percentage of farmers of all villages engaged in agriculture sector is 90% which is quite high as compared to Assam 66% and all over India 56.7%.

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Food Security:

In modern times the concept of food security is very crucial in a developing economy such as India. The concept of food security undergoes a change with the stage of development reached by the society. Food security is the access by all people at all times to enough food for an active, healthy life (World Development Report, 1986).

Basic Food Security

Number of Families (%)	Balidowar		Joraguri		Khakand Guri		Average	
	Irrigated	Non Irrigated	Irrigated	Non	Irrigated	Non Irrigated	Irrigated	Non
Availability of Regular Food	93	95	78	70	99	68	90	78
Availability of Pulses in Regular Food	97	45	85	65	76	33	86	48
Egg And Milk in A Week	44	56	56	22	67	25	56	34
. Meat And Fish in a Week.	36	12	75	54	32	34	48	33

Figures in the table represent the percentage value

The data collected from the sample villages *(Table: 4)* reveals that the general food security is found to be higher in irrigated farm households. Especially in irrigated households, on average 90% have regular food supply as compared to 78% in non-irrigated farm households. In irrigated households, on average 86% have pulses in regular meal as compared to 48% in non irrigated farm households. Availability of egg and meat in once in a week is also found to be high in irrigated farm households. So it can be conclude that STW irrigation leads to positive effect in food security in farm households.

Some Policy Issues:

Policy suggestions for rapid agricultural development of the flood affected region, which can be derived on the basis of findings of the study, are summed up as the follows:

(1) In view of the increasing trend in flood damage in the valley and inadequate measures to control flood, there is the need to pursue the approach of 'living with floods'. Otherwise, the people living in the floodplain would suffer severely from recurring floods and for many, particularly the poor peasants, there is no alternative but to cultivate the land and accept the risk and loss. In the chronically flood-affected areas, summer cropping should be substituted by large-scale winter cropping and harvested before flood should be introduced in the floodplain areas backed by STW irrigation.

(2) Government should provide extensive irrigation network by initiating deep tube well and river lift irrigation in the areas along with the STW irrigation. For developing irrigation infrastructure, the region will have to depend on its river system for the water source to adequate quality groundwater.

(3) Development of Rural Agro Service Centers for providing input and equipment to the farms and farmers of flood affected areas is one of the pre requisites for the development of the agriculture. The well formed relationship of irrigation department with the farmers is another important condition for the development of irrigation. Role of irrigation department and its linkage with farmers has been an important factor in

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ensuring farmers participation in irrigation management (Ghosh, Shing , Kundu and Kumar, 2008)

(4) Development of agricultural marketing in the flood affected areas is another vital element in Assam.

(5) Development of Agro based industries for processing selected cash crops like spices, medicinal and aromatic plants, bamboo etc. which will create the concept of commercialization of agriculture in the flood affected areas. According to Malik and Singh (2008) The agro industry provides the crucial form of industrial linkage adding value to the farms produce, generating employment opportunities and increasing the farm net income.

(6) The adequate coverage and intensity of the extension service needs to be addressed for speeding up transmission of agricultural innovations to the farmers in the region. At the administrative level, the extension service needs to be modernized by making its personnel responsible for the performance of agriculture in their respective areas.

(7) Cooperative farming system can help here lot to develop a large farming system to avail the bank assistance and loans.

(8) Measures for consolidation of holdings.

Sustainability of agriculture is determined by the sustainable use of natural resources – land, water and agricultural biodiversity, including that of plants and animals. Natural calamities like floods, cyclones, hailstorms, landslides, drought, etc, are also responsible for agricultural damage in some regions and thus threatening the sustainability of agriculture. Natural calamities are uncontrollable, beyond human control and to some extent, unpredictable also. But, floods are not like that. It can be controlled and at least cost can be minimized by collective human efforts. It is also predictable too; for example, now everybody knows, floods in Assam will come in summer season, during heavy rainfall period in each year. So the need is only the technological transformation and infrastructural development for the upliftment of agriculture in Assam. Moreover, the seasonal variations in rainfall in Assam are very 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.

Conclusion:

In Assam 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. 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 damaged 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

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other areas. Irrigation in the flood affected areas has been playing vital role in increase production and productivity of agricultural sector. Before occurrence of floods, farmers usually produce winter paddy, Luhit and ITT, three times more than Sali paddy after the initiation STW and LLP irrigation. 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.

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