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Research Note

IRRIGATION AND HOUSEHOLD INCOME : A CASE STUDY OF BANGLADESH

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ABSTRACT

The study is based on a field survey of 1208 households, spread over 62 villages of Bangladesh. The objectives of the study are to analyse the level of household income and its compositions by the intensity of irrigation in a village. The findings show that household income in highly irrigated village is lower than that of low irrigated village which is contrary to our hypothesis. Lower income is mainly due to smaller size of farm by 55 per cent over the low irrigated village. Impact of irrigation is however, clearly visible from higher per acre income (by 36 per cent), facilitated by larger adoption of modern rice. Further, higher household income in low irrigated village is predominantly due to more contribution from non-agricultural sources of income. The factors effecting income are not uniform in all the areas. The two most positive factors are number of non agricultural worker in a family and the household size. Among other factors, availability of electricity in low irrigated village, irrigation in highly irrigated village and institutional credit in medium irrigated village are found positively significant. This suggests that rural development policies should be made as far as possible area specific.

INTRODUCTION

1.1 Importance

Irrigation in recent years has been considered to be the principal input to the growth of agricultural production, particularly foodgrains in Bangladesh. The primary thrust in the national agricultural policies has thus been in the rapid expansion of irrigation which facilitates adoption of high yielding varieties of rice and wheat, known as modern varieties (MVs.). Without irrigation modern rice cannot be grown at least in the dry winter months of Boro season (December to April). With the release of BR-11 variety it is now being grown even under rainfed condition in the Monsoon season (July to November) although they may yield lower than the irrigated variety. Principal policies for agricultural development followed at present relate mainly to the expansion of irrigation and fertilizer use which quicken adoption of modern rice.

Studies conducted in this regard in Bangladesh show that the irrigated rites are high yielding, more labour intensive and thus, more profitable (Hossain *et al* 1992*;* Zohir, 1992;

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and Bayes & Sayeduzzaman, 1991). These studies concentrated on individual varieties of rice without detailing out the annual financial situation of the households growing MVs in different cropping seasons of the year. Actually to adopt MVs farmers need to change the existing cropping patterns. Furthermore, modern rice being more labour intensive than local rice, its expansion results in more employment of unskilled labour and thus, higher wage earnings, translated through higher demand for labour in the area. That means, villages with larger irrigation coverages and modern rices is expected to experience higher wage rates and more man-days of employment compared to the rainfed village, predominantly by growing local rice. It is also likely that with the increase of MV acreage and consequently larger production of rice and wheat in an irrigated locality, number of traders dealing in inputs and outputs will rise and the consequent linkage effects (backward and forward) may help generate larger non-farm employment and higher income to rural households. Such new employment opportunities may not always be reaped by local people. Entrepreneurs from nearby localities and towns may also participate in these markets and thus, the selected village surveys may not reflect such employment effects which benefits the entrepreneurs from outside the locality.

Further, with the availability of modern irrigation in an area where MVs can be grown two times a year, cropping intensity may be higher than in the rainfed villages where some land may remain fallow in the dry season due to soil moisture constraint. Therefore, crop income in an irrigated village will be higher. We are not aware as to what extent the irrigated villages are better-off than non-irrigated village; or are they really so? Are there no special efforts by rural households in those non-irrigated villages to increase their income? We may hypothesize that rural households living in non-irrigated village may emphasize non-crop agriculture viz. livestock, fishery and forestry and also migrate-out at least in the lean months of employment to make best use of their available manpower and earn extra income. They may also activate themselves towards non-agricultural income earning activities. That means, shares of non-crop and non-agricultural income in non-irrigated village are likely to be higher. Such an in-depth comparative analysis of household income taking all these aspects of the irrigated agriculture is still missing. The present study attempts to examine all these relevant issues particularly income and employment with special reference to irrigation.

1.2 Hypothesis and Objectives of the Study

The principal hypothesis of the study is that with the availability of irrigation in a locality, income of rural households rises through higher intensity of modern rice cultivation and other favourable linkage effects both in agriculture and outside. That means, households in irrigated villages are financially better-off than those living in non-irrigated villages.

The primary objectives of the study are to :

i) estimate agricultural income and indicate the changes in cropping patterns, cropping intensity and yields of crops due to irrigation;

ii) compare the level of income of rural households and its compositions by the intensity of irrigation in a village;

iii) indicate the levels of employment and wages by the irrigation intensity of the village; and

iv) determine the factors effecting the differenctials in their income and distribution.

The analysis of the study is based on the data collected from 62 villages of Bangladesh, categorized into three according to the intensity of irrigation in the village, namely (i) low irrigated or rainfed village, (ii) medium irrigated village and (iii) highly irrigated village.

1.3 Survey Methodology

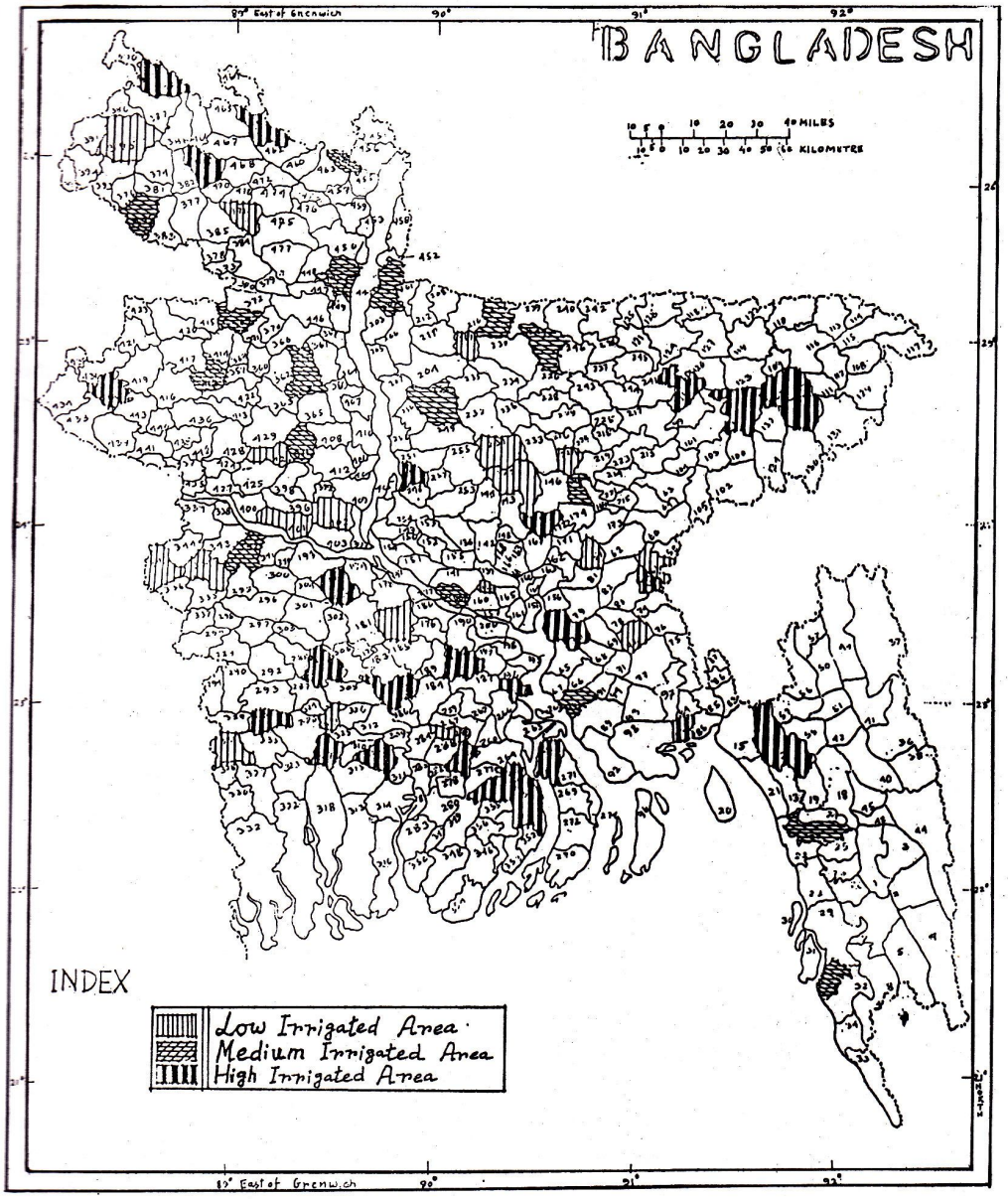
The present study uses information, collected for an earlier BIDS study on "Differential Impact of Modern Rice Technology : the Bangladesh Case". Which later on was published as a country study in a book-*Modern Rice Technology and Income Distribution in Asia,* 1994. The currently prepared paper has, however, different objective and followed a new analytical framework. The details of the selection of villages and the households may be seen in the report (Hossain *et al.* 1992). The salient features of the methodology are however, discussed below for immediate comprehension :

Random sampling method was used for selecting 64 unions, one from each of the newly created districts (excluding Chittagong Hill Tracts). Two unions were later dropped due to administrative difficulties. In each union two villages were purposively selected so that they were representative of the union in respect of the three factors-(a) number of households, (b) land-man ratio and (c) literacy rate. Thus, a total of 124 villages were selected. An in-depth household survey was carried out in one of the two villages in each union having easy access and other logistic facilities.

In each of the selected villages a complete census was carried out. The census questionnaire includes questions relating to the size of the household, amount of land owned and cultivated, major sources of income etc. The interviewed households were then grouped into four categories following the size of landownership, namely, (i) Functionally landless i. e. having land upto 0.49 acre, (ii) Small owners (land owning from 0.5 to 2.49 acres), (iii) Medium owners (2.5 to 4.99 acres) and (iv) Large owners (5.0 and more). Every landownership group was further divided into two as (a) cultivator and (b) non-cultivator. Then 20 households were selected in each village from these eight strata following the proportionate random sampling technique. The total size of sample households in those 62 villages was 1245. In the final analysis some incomplete and inconsistent questionnaires were dropped and finally the total households stood at 1208. The survey data refer to the year 1987.

For the purpose of present study the selected 62 villages were grouped into three strata-(a) low irrigated (irrgated area covers less than 5 per cent of the cultivated land), (b) medium irrigated (villages covering an area of 5 to upto 40 per cent of the cultivated land by irrigation) and (c) highly irrigated village (covering irrigated area of over 40 per cent of the cultivated

land). In these three groups there are 26, 19 and 17 villages (shown in Map) covering 496,375 and 337 households respectively.



About the representativeness of the sample households it may be reported that the functionally landless households comprised 49 per cent compared to 47 per cent, observed in the 1983-84 Agricultural Census. Similarly, the proportion of large land owners was 8 per cent against the Agricultural Census figure of 8.6 per cent. Furthermore, the average size of landownership and the cultivated holding was 1.5 and 2.2 acres respectively compared to 1.7 and 2.3 acres respectively in the Agricultural Census. We may thus, conclude that the samples are fairly representative of the country.

The paper has been organized as follows. The second section describes briefly the basic characteristics of the households, followed by another section which analyses income and employment. The fourth section concentrates on the impact of irrigation on crop practices. Section V examines the determinants of household income and its distribution. The paper ends with a summary and conclusion.

II. BASIC CHARACTERISTICS OF THE HOUSEHOLDS

In this section discussions have been kept limited to only four major characteristics. They are (a) landownership distribution, (b) family size, (c) land levels, (d) area irrigated and (e) primary occupation of the household heads. They may help us in better understanding of the area and the socio-economic conditions of households.

2.1 Landownership Distribution

Of the total households selected in the study areas low irrigated village covers 41 per cent of them, followed by 31 per cent in medium irrigated village. The households have been grouped into five according to the landownership category namely (a) completely landless (having no land, not even homestead land, (b) marginal owners (having land upto 0.5 acre), (c) small owners (owning land between 0.51 to 2.5 acres), (d) medium owners (owning land between 2.51 to 5.0 acres) and (e) large owners (owning land 5.0 acres and above). Completely landless households comprise 7 per cent vis-a-vis the large land owner numbering 7.6 per cent as shown in Table 1. Landownership distribution shows that the low irrigated village has the lowest proportion of marginal and landless households, and largest proportion of big land owners. It suggests that low irrigated village has larger land endowment having the average size of 1.7 acre compared to 1.5 acre in highly irrigated village. The average landownership size and the cultivated holdings decline with the irrigation intensity of village.

The number of farm households in the study areas rises with the irrigation intensity of village (from 63 to 70 per cent), the average being 66 per cent with their holding size of 2.2 acres. It tends to suggest that provision of irrigation encourages rural households to farming. Among the different size of farm households number of marginal farmers has been observed to be double in the highly irrigated village compared to that in low irrigated village In contrust, large farms are more than double in the low irrigated village (Table 2) compared to that in the highly irrigated village.

Table 1: Number of Households by Landownership Size by Irrigation Intensity of Village

Irrigation Intensity of the Village	Landless	Marginal	Small	Medium	Large	Total
Low Irrigated	27	196	164	60	49	496
(% of households)	(5.4)	(39.5)	(33.1)	(12.1)	(9.9)	(100.0)
Medium Irrigated	28	147	128	49	23	375
(% of households)	(7.5)	(39.2)	(34.1)	(13.1)	(6.1)	(100.0)
Highly Irrigated	31	145	113	28	20	337
(% of households)	(9.2)	(43.0)	(33.5)	(8.3)	(6.0)	(100.0)
All areas	86	488	405	137	92	1208
(% of households)	(7.1)	(40.4)	(33.5)	(11.4)	(7.6)	(100.0)

Table 2 : Number of Farm Households and Their Average Size by Irrigation Intensity of the Village

Irrigation intensity of the Village	Marginal		Small		Medium		Large		Total	
	Number	Size (ac.)	Number	Size (ac.)	Number	Size (ac.)	Number	Size (ac.)	Number	Size (ac.)
Low Irrigated	46 (14.8)	0.28	157 (50.5)	1.49	65 (20.9)	3.57	43 (13.8)	7.92	311 (100.0)	2.64
Medium Irrigated	60 (23.9)	0.27	125 (49.8)	1.36	47 (18.7)	3.58	19 (7.6)	7.62	251 (100.0)	2.00
Highly Irrigated	66 (27.8)	0.27	118 (49.8)	1.31	37 (15.6)	3.41	16 (6.8)	6.45	237 (100.0)	1.70
All areas	172 (21.5)	0.28	400 (50.1)	1.40	149 (18.6)	3.55	78 (9.8)	7.55	799 (100.0)	2.18

Note : Figures in the parentheses indicate per cent with respect to total households.

2.2 Family Size and Education

Average age of the household heads in the study areas as a whole is 42 years and it is marginally higher in medium irrigated village (47 years). The heads are found younger in marginal farms and their ages rise with the size of the farm. The family size also rises with the increase in farm size the average being six. Among the village categories family size varies little although it is the lowest (5.8) in highly irrigated village.

2.3 Land levels

Land has been divided into four types following the depth of normal flooding as classified by the MPO (Master Plan Organization). They are high, medium, medium-low and low. High lands are flood free covering 34 per cent in the low irrigated village compared to 21 and 18 per cent in the highly and medium irrigated village respectively. Low land has almost the same share (9 per cent) in all the three categories of irrigated village. About half of the land falls in the medium topography in both medium and high irrigated village compared to only one-third in the low irrigated village. The medium topography facilitates the installation of tubewells and the irrigation throughout the year. There is no systematic topographic patterns in the distribution of land when examined by size of farm.

2.4 Irrigated Area

The irrigation coverage is 12, 40 and 61 per cent of the cultivated land in low, medium and highly irrigated village respectively with an average of 32 per cent which is close to the national average. In low irrigated village small farms have the least irrigation coverage of 7 per cent although there is little difference among remaining other farms. In the highly irrigated village the irrigation coverage among different size of farms ranges between 62-71 per cent.

III. IMPACT ON INCOME AND EMPLOYMENT

According to our hypothesis provision of irrigation in a village is expected to have immediate effect on expansion of modern rice (MVs) resulting in larger production and higher income from both crop outputs and trading of outputs and inputs. To be specific, highly irrigated village will have higher income than the two other categories of villages studied. Let us examine the household income which is composed of agricultural and non-agricultural income.

3.1 Agricultural Income

In Agriculture, major sources of income are rice, non-rice crops and non-crop agriculture like fishery, livestock and forestry. Among the three irrigation categories, contribution of agriculture is the highest (about 70 per cent) in the highly irrigated villages (Table 3) compared to 60 per cent in two other ecologies indicating that irrigation has higher contribution to income.

The absolute size of agricultural income is also the highest (Tk. 16.936) in the highly irrigated village despite the lower landownership size and cultivated holding by more than 30

per cent over the low irrigated village. Per acre agricultural income (in terms of both owned and cultivated land) is also found to increase with the increase in irrigation intensity of the village. The highly irrigated village has higher per acre agricultural income by over 50%. The highly irrigated village has higher per acre agricultural income by over 50% over the low

Table 3 : Sources of Income by Irrigation Intensity of the Village

(Taka)

Irrigation Intensity of the village	Crop Agril.	Non-Crop Agril.	Wages	Agril. Income*	Trade, Transport & construction	Services & Remittance	Non-Agril. Income	Total household Income
Low Irrigated	9841 (36.5)	3918 (14.5)	2766 (10.3)	16525 (61.3)	6710 (24.9)	3712 (13.8)	10422 (38.7)	26947 (100.0)
Medium Irrigated	9180 (33.5)	3923 (14.3)	3380 (12.3)	16483 (60.1)	7446 (27.2)	3485 (12.7)	10932 (39.9)	27414 (100.0)
Highly Irrigated	9901 (40.3)	3395 (13.8)	3640 (14.8)	16936 (68.9)	5216 (21.2)	2440 (9.9)	7656 (31.1)	24592 (100.0)

Note : Figures within parentheses indicate per cent of the total HH income/year.

* Statistical tests show that the differences in per acre agricultural income are significant between the low and the medium irrigated and also between the low and the highly irrigated villages.

irrigated village. It may thus, be concluded that irrigation has a significant postive inpact on agricultural income. This is also true when rice income is taken into account. Rice income per household in the highly irrigated village is higher by 21 per cent compared to low irrigated village and it rises to over 60 per cent in terms of per acre of cultivated land. Rice has a share of 77 per cent of agricultural income in the highly irrigated village compared to 65 per cent in low and medium irrigated village. Surprisingly non-crop agriculture yielded lower income in highly irrigated village compared to the medium and low irrigated villages. This may be due to their reduced shares to cultivated land and/or lower opportunities in those sub-sectors in agriculture (fishery, livestock and forestry).

More importantly, non-rice crops like oilseeds, pulses, etc., yielded negative return in all the irrigation categories and it increases with the rise in irrigation intensity of the village. Actually irrigation is expected to favour higher income from such cash crops and vegetables. Thus our findings are counterintuitive and deserve further investigation.[1]

The immediate question that follows is how far such higher agricultural income in highly irrigated village can help raise their total household income in the study areas. Agriculture

being the principal source of income in rural Bangladesh it is expected that the household income will be the highest in the highly irrigated village which demands careful analysis of total household income vis-a-vis non-agricultural income.

3.2 Total Household Income

The average household income in the whole of study areas is Tk. 26,435 (or Tk. 4406 per capita) and it is the lowest in the highly irrigated village (Tk. 24,592) which is contrary to our hypothesis. It is lower by 9 per cent compared to that of the low irrigated village (Table 4) suggesting that the non-agricultural income is higher in low irrigated village. The highest

Table 4 : Household and Per Capita Income by Irrigation Intensity of the Village

Irrigation Intensity of the Village	Total Household Income (Taka)*	Per Capita Income (Taka)*	Land Owner-ship Size (acre)	Income Per Acre of Owned Land (Taka)
Low Irrigated	26947	4418	1.74	15487
Medium Irrigated	27414	4494	1.45	18895
Highly Irrigated	24592	4240	1.17	21019
All Areas	26435	4406	1.49	17742

* Statistical tests have been carried out and income differences are noted to be insignificant.

income is howeer, recorded in the medium irrigated village. The observed lowest income in the highly irrigated village is not however, uniformly applicable to all farm holdings. Small and medium size farms have rather higher household income by 9 and 4 per cent over their counterparts in low irrigated village indicating that irrigation might have more favourable effect on them as clearly visible in higher agricultural income (Table 5). Higher household income in low irrigated village as earlier observed appears to be due to either larger land endowment or/and something related to non-agricultural income which enabled to supercede the positive effect of irrigation on agricultural income.

3.3 Non-Agricultural Income

Income analysis reveals that despite larger contributions by agriculture (both absolute and relative sense) household income in the highly irrigated village could not reach the levels, already attained by the low irrigated village. This indicates that there are some factors in non-agricultural sectors which effected income less favourable in the highly irrigated village compared to the low irrigated villages. Close scrutiny of the different sources of non-agricultural income shows that, service and remittances have significantly lower shares in the

Table 5 : Total and Agricultural Income by Size of Farm and the Irrigation Intensity of Village

Irrigation Intensity of the Village	Total Household Income (Tk.)				Agricultural Income (Tk.)			
	Marginal	Small	medium	Large	Marginal	Small	Medium	Large
Low Irrigated	18979	23639	36052	68068	9437	15314	24522	46934
Medium Irrigated	20239	27011	38127	73054	9917	17016	26211	51896
Highly Irrigated	17298	25732	37321	62427	9362	17704	31807	55469

highly irrigated villages (10 per cent of total income compared to 14 per cent in the low irrigated village). In terms of absolute size it is lower by 34 per cent in the highly irrigated village (Table 3). Such income differences between the highly irrigated village and each of the low and the medium irrigated village are statistically highly significant. This tends to suggest that the poorly developed agriculture in low irrigated village might have forced their members to seek employment outside agriculture.

Furthermore, higher contribution from trade, transport and construction in the highly irrigated village as expected did not also materialize. It is rather lower by 28 per cent. May be the rice trading has not expanded or that dealers from outside the village are involved in such trading.[2] It may also happen that infrastructure in the irrigated village is not developed enough to attract local entrepreneurs. Field-impressions however, indicate that the highly irrigated villages are more developed at least with respect to availability of electricity and transportation. So, this is the question of entrepreneurship development. This area demands an in-depth investigation.

3.4 Annual Situations

Irrigation is expected to have positive impact on wage employment and in that respect highly irrigated village will have higher wage income as a result of more man-days of employment and higher wage rates. Wage data confirm that the highly irrigated village has larger wage earnings of Tk. 3640 per household i. e. higher by 32 per cent over that of the low irrigated village. Wage income contributes 15 per cent to total household income in the highly irrigated village vis-a-vis 10 per cent in the low irrigated village.

Higher wage earnings occur not due to higher wage rates which are almost same (Tk. 32.0 per man-day) but because of more man-days of work. It may be reported that irrigation could

help raise wage earnings but not the wage rates as that might be levelled-off by in and out migration of labour. Similar study by Ramasamy and Otsuka in South India shows that there has been labour market adjustments during the green revolution towards the equalization of the wages across the regions (Ramasamy and Otsuka, 1992). Further, security to wage employment is more in the highly irrigated village as apparent from the low incidence of permanent hired hands in the highly irrigated village.

3.4.1 Wage Earnings from Outside Works

It is also relevant to report that the average household wage income earned from outside village either in agriculture or non-agriculture is substantially higher in low irrigated village (higher by 40 per cent in agriculture and almost double in non-agriculture) which is however low (Tk. 167 in agriculture and 217 in non-agriculture). Such a higher share of migration income tends to suggest that lesser agricultural employment opportunities in low irrigated village might compel people towards temporary out-migration.

3.5 Employment and Wages : Weekly Situations

To capture the details of employment a separate questionnaire was administered for all active working members of the respondent households. Information was sought on the employment status for four days preceeding the day of interiew. The employment data show that in agriculture the participation of adult males is the highest in highly irrigated village (84%) and the least in low irrigated village (75%), the average being 80 per cent in agriculture, the largest sector of the rural employment (Table 6). It is followed by trade which employs 68

Tabe 6 : Employment of Male Workers in Some Selected Sub-Sectors of the Economy by Irrigation Intensity of the Village (Four Days a Week)

Irrigation Intensity of the Village	Agriculture		Trade		Transport		Construction		Industry	
	% of work-ers	Four Days Hours of Work	% of Work-ers	Four Days Hours of Work	% of Work-ers	Four Days Hours of Work	% of Work-ers	Four Days Hours of Work	% of Work-ers	Four Days Hours of Work
Low Irrigated	75	28	74	12	04	43	26	15	07	21
Medium Irrigated	83	26	63	13	03	30	22	21	12	24
Highly Irrigated	84	30	64	13	03	27	16	17	08	23
All Areas	80	28	68	12	04	34	22	17	09	23

Note : Working areas are not mutually exclusive and a worker may be counted a number of times if he works in different areas.

per cent of the workers. Participation in all non-agricultural sub-sectors namely trade, transport and construction are the highest in low irrigated village as reflected earlier from the shares of income. Again, with respect to total rural employment (exclusive of the service-holders) agriculture shares the highest (63%), followed by trade (20%) as shown in Table 7. Agriculture in the highly irrigated village provides more employment (two-thirds of the employment hours) although the level of employment remains almost on the same level or marginally higher in the highly irrigated village (30 hours in four days). It may thus, be concluded that irrigation facilitates larger employment in agriculture.

About the wage employment in agriculture, participation rates do not differ significantly, although it is found a bit higher in the highly irrigated village.

Table 7 : Shares of Total Employment by Sub-Sectors and the Irrigation Intensity of Village

(Percentage)

Irrigation Intensity of the Village	Crop Agril.	Non-Crop Agril.	Total Agril.	Trade	Trans-port	Cons-truc-tion	Cot-tage	Total Hours of Employment
Low Irrigated	50.4	11.8	62.2	21.0	3.7	9.6	3.6	19696
Medium Irrigated	53.2	7.9	61.1	19.1	2.3	10.4	7.0	15352
Highly Irrigated	59.0	8.3	67.3	19.5	2.4	6.6	4.2	12082
All Areas	53.5	9.6	63.1	20.0	2.9	9.1	4.9	47130

Agriculture provides wage employment to one-third of the total employed male workers. Other important sectors like construction, cottage and transport employ 25, 40 and 31 per cent of the individual sectoral employed workers. Wage employment is the least in rural trade sector, where all is self-employment.

3.6 Women Employment : Weekly Situations

Among the different sectors, women get the highest employment in non-crop agriculture i.e. livestock, fishery and forestry and the least in transport (almost zero) where muscle power is the principal working input. Non-crop agriculture employs over two-thirds ofwomen workers followed by cottage industry (37 per cent) as shown in Table 8. Crop agriculture as well as construction activities provide employment to only about 7 per cent. Involvement of women in trade is negligible. Average hours of employment per involved worker during the

four days of work in crop, non-crop-agriculture, cottage and construction is 16, 7, 13 and 6 hours respectively.

In crop-agriculture irrigation has a significant impact on women employment. Compared to the low-irrigated village women get double the employment particularly self-employment in the highly irrigated village. Level of wage employment remains almost same. In non-crop agriculture- the principal area of women workers - the effect of irrigation is negligible even among the different size of farms. In cottage industry participation of women is significantly higher in low irrigated village (45% as against 24%). In construction however, little difference has been noticed in their participations either in self or wage employment. We may conclude here that irrigation has a significant positive impact on women employment in crop agriculture.

Table 8 : Employment of Female Workers by Sectors and the Irrigation Intensity of the Village.

Irrigation Intensity of the Village	Agriculture (Proper)		Other Agriculture		Construction		Cottage Industry	
	% of Work-ers	4-days Hours of Work	% of Work-ers	4-days Hours of Work	% of Work-ers	4-days Hours of work	% of Work-ers	4-days Hours of Work
Low Irrigated	5	19	70	6	6	6	45	14
Medium Irrigated	3	18	70	8	8	8	36	13
Highly Irrigated	10	13	74	7	8	9	24	11
All Areas	6	16	71	7	7	8	37	13

IV. IMPACT OF IRRIGATION IN CROP PRACTICES

4.1 Land Allocation to Crops

Irrigation is expected to have positive effect on the land use, particularly on the adoption of modern rice and consequently on the cropping patterns and their intensity. The immediate effect will be reflected in the substitution of low value crops by high value crops, namely, modern rice and vegetables instead of local rices and other minor crops if land is suitable. Irrigation is also expected to have higher per yields. As far as the MV-rice coverage, its share to total cultivated land rises with the increase in irrigation intensity of village in both the Boro and Aman seasons (Table 9). Their average coverage in the whole of study areas is 20

Table 9 : Area Under MV-Boro and MV-Aman by Irrigation Intensity of the Village and the Size of Farm

(Percentage of Cultivated Land)

Irrigation Intensity of the Village	MV-Boro				MV-Aman			
	Small	Medium	Large	Total	Small	Medium	Large	Total
Low Irrigated	10.81	8.96	9.22	9.30	23.56	16.65	11.78	14.30
Medium Irrigated	29.41	24.56	29.65	28.20	21.55	19.78	17.87	18.80
Highly Irrigated	62.62	48.92	50.00	51.10	32.32	24.50	27.73	27.30
All Areas	33.42	27.33	28.30	28.60	25.60	20.28	18.58	19.80

and 28 per cent of the cultivated land in Aman and Boro seasons respectively. Such coverage in the highly irrigated village is five times in MV-Boro and double in Aman over their respective coverage in low irrigated village. Irrigation has thus, succeeded in expansion of modern rice.

Small farms in each category of irrigated village performed best in terms of covering the highest acreage by modern rice in both Aman and Boro seasons. This is more spectacular in MV-Boro in the highly irrigated village. The levels of adoptions in medium and large farms are almost similar. That means, there is no definite pattern in the rates of adoptions by size of farm (Table 9).

In this exercise no separate analysis has been done on the cropping pattern depending on the irrigation intensity of the village. The similar exercise with and without irrigation done earlier by Hossain *et al.* 1992 shows some changes in the intensity of certain crops. With respect to land allocation to crops it has been observed that areas under modern rice namely aus, aman and boro under irrigated condition have a coverage of 12, 28 and 54 per cent of the total cropped areas. Such shares in non-irrigated village are only 5, 12 and zero but contrarily they have larger shares in pulses (three times), sugarcane (four times), oilseeds and jute (almost double) and other minor crops (several times). Such a pattern of land allocation suggests that irrigation encourages the adoptions of modern rice by replacing cash and other minor food crops.

4.2 Cropping Patterns

Cropping pattern changes depending on the topography of land and the availability of irrigation. Irrigation in single cropped land has been found to facilitate larger adoption of MVs by reducing shares to local rice and other crops. The low and the very low land are found more

favourable to MVs. In double cropped land irrigation favours two MVs in two crop seasons in all topographies other than very low land which remains flooded in the monsoon season.

Irrigation has a favourable effect on MV adoptions with local rice (MV + local) in all topographies (Table 10). While in un-irrigated land double croppings with local variety (LV) (LV + LV) as well local rice with other non-rice crops are found predominant. Triple cropping is more important in unirrigated land specially in the low topography. The common cropping pattern emerged in all topographies is LV + LV + other non-rices. Irrigation favours triple cropping with two MVs as (MV + MV + other non-rice crops) in high land. We may

Table 10 : Cropping Patterns of Irrigated and Un-irrigated Land by Land Levels

(Figures in per cent of cultivated land)

Cropping Pattern	Hihg Land		Medium		Low		Very Low	
	Irri gated	Unirri-gated	Irri-gated	Unirri-gated	Irri-gated	Unirri-gated	Irri-gated	Unirri-gated
Single Cropped	25.32	45.53	11.63	37.73	37.64	36.38	79.24	50.52
MV	16.71	5.34	7.60	4.97	27.23	4.43	49.97	2.73
LV	3.11	13.44	3.76	27.92	9.35	28.24	29.27	40.07
Others	5.50	26.75	0.27	4.84	1.07	3.71	-	7.72
Double Cropped	68.23	48.66	82.12	45.16	59.20	35.69	20.57	37.81
MV + MV	30.82	2.90	28.31	1.11	6.15	0.19	-	-
MV + LV	23.93	6.86	38.44	4.70	36.96	1.41	11.86	1.56
MV + Others	8.71	2.96	2.47	3.53	1.06	0.86	0.63	0.31
LV + LV	1.57	15.73	5.97	18.06	7.70	19.51	3.93	19.11
LV + Others	2.22	8.46	5.43	14.13	7.21	11.05	4.15	14.68
Others + Others	0.99	11.75	1.51	3.32	0.12	2.67	-	2.15
Triple Cropped	6.45	5.82	6.55	17.10	0.19	27.93	4.90	11.67
MV+MV+Others	4.55	0.51	0.94	1.19	-	0.17	-	-
MV + LV + LV	0.30	0.08	0.78	0.18	0.15	0.50	-	2.06
MV+LV+Others	0.16	0.48	1.45	2.92	1.94	0.04	0.19	0.97
LV + LV + Others	-	0.93	-	11.51	-	24.42	-	6.25
Cropping Intensity	181.10	160.30	195.50	179.40	165.60	191.60	121.00	161.20

MV - Modern Variety, LV - Local Variety.

Source : Estimated from Plot Level Input-Output Data in Hossain *et al,* 1991.

conclude that irrigation facilitates adoption of MV rices in all topographies either as single, or double cropped.

4.3 Cropping Intensity

Surprisingly irrigation could not raise the intensity of cropping which is contrary to our hypothesis. The study finds an overall decline in cropping intensity from 182 to 167 per cent, the average being 176 per cent despite higher intensity in the high and the medium high lands where irrigation favours increasing cropping intensity. Actually farmers in low and un-irrigated land try to harvest more crops of shorter duration commonly called minor crops towards higher income as they can hardly grow MV rices without irrigation.

4.4 Crop Yields

It may be reported that local rice yields are highest in highly irrigated village except the local transplanted aman which is higher in medium irrigated village (Table 11). For modern rice, MV-Aus records the highest per acre yield in highly irrigated village. Yield of MV-Aman

Table 11 : Per Acre Yield of Some Major Crops (Survey)

(Maunds+)

Irrigation Intensity of the Village	Yield of		Yield of		Yield of		Yield of MV-Wheat
	MV-Aus	Local Aus	MV-Aman	Local T. Aman	MV-Boro	Local Boro	
Low Irrigated	41.4	17.2	42.5	24.7	75.0	26.7	28.4
Medium Irrigated	48.0	19.4	55.6	31.8	65.5	27.0	29.6
Highly Irrigated	50.4	21.5	49.8	28.2	55.6	30.6	28.2
All Areas	46.2	18.9	49.2	27.7	62.0	28.1	28.8

+ One maund is equal to 37.32 kgs.

medium irrigated village and MV-Boro in low irrigated village which is not surprising as the crop is newly introduced there and thus, grown in better land first with the availability of irrigation (Table 11). This difference in land productivity suggests that irrigation is not the only factor to higher yield. There are several other factors namely the levels of fertilizer use, size of farm, tenurial status of farmer, time of plantation of crops and agronomic practices which effect crop productivity.

V. DETERMINANTS OF HOUSEHOLD INCOME AND ITS DISTRIBUTION

5.1 Determinants of Household Income

The income of a household is determined by a wide variety of factors both technical and social. The technical factors in crop production include mainly land topography and the type of inputs used. Among social factors individual and family characteristics are quite important. Their impacts are again effected by infrastructures facilities in the area and local institutions. In the present exercise all these factors could not be taken into account as relevant data are not available. The income analysis in this sub-section has been done following the regression technique in linear form.

Regression analysis has been done for each of the three irrigation ecologies both separately (low, medium and high) as well as aggregate as shown in Table 12. The variables taken into account in this exercise are : (i) land owned (decimals) by a household (OWNL); (ii) number of agricultural labour in a household (AGLB), (iii) number of non-agricultural labour in a household (NAGL), (iv) availability of electricity in the village (ELCT) (yes = 1, no = 0)

Table 12 : Determinants of Household Income : Regression Estimates

Variable	Low Irrigated		Medium Irrigated		Highly Irrigated		All Areas	
	Coeffi-cient	'T' Values	Coeffi-cient	'T' Values	Coeffi-cient	'T' Values	Coefi-cient	'T' Values
OWNL	63.66	6.86	20.64	1.80	(-) 2.83	(-) 0.17	35.91	6.17
NAGL	10150.24	6.53	961.91	7.14	7191.96	4.58	8964.19	10.03
AGLB	1792.53	1.38	4214.21	3.49	1196.09	0.98	2045.56	2.73
HSZ	1495.04	3.65	1107.76	2.80	1395.40	2.86	1398.43	5.58
IRGL	(-) 10.09	(-) 0.69	13.13	1.06	97.26	6.25	34.46	5.39
ELCT	5049.96	2.06	2887.71	1.21	3296.05	1.60	3824.68	2.89
PHGL	(-) 25.25	(-) 0.75	(-) 71.80	(-) 1.47	(-) 119.36	(-) 2.55	(-) 50.46	(-) 2.17
PMHGL	12.99	0.34	35.71	1.10	12.50	0.37	16.20	0.82
PMLOL	8.82	0.20	13.54	0.32	142.55	2.74	54.43	2.06
PLOL	153.17	2.73	(-) 62.38	(-) 1.00	(-) 39.86	(-) 0.74	18.05	0.55
LONI	(-) 0.48	(-) 0.87	1.23	2.82	0.34	1.19	0.42	2.19
EDN	(-) 429.92	(-) 1.68	616.53	2.59	46.84	0.17	74.81	0.50
LANDSQ	(-) 0.02	(-) 2.49	0.01	0.83	0.01	0.50	0.00	0.26
R^2	0.49	-	0.60	-	0.50	-	0.48	-
Constant	1846.21	0.81	4165.27	1.99	5067.58	1.85	3308.91	2.39

(v) institutional loan (Tk. received by a household (LONI), (vi) proportion of owned land as high (PHGL), medium-high (PMHGL), medium-low (PMLOL) and low land (PLOL), (vii) cultivated land under irrigation (IRGL), (viii) years of education of the household heads (EDN), (ix) household size (HSZ) and (x) square of OWNL. The variables included in the regression estimates are expected to have differential impact depending on the ecology and socioeconomic conditions prevailing in a locality. Our hypothesis is that OWNL, NAGL, AGLB, IRGL, ELCT, EDN, LON1 will have positive effect to a varying degree as effected by technology and environemtnal factors. Further, it is hypothesized that both the high and the low land will affect household income unfavourably as the former category of land suffers from lack of soil moisture during the winter months while the latter remains flooded in the monsoon season.

In this regression exercise we find differential levels of impact of the variables included in the equation (Table 12). More surprisingly, a variable which is significantly positive in one ecology is found insignificant elsewhere and sometimes even negative (education and irrigation). So, the implications of the regression results should be carefully interpreted keeping in view the ecology and the infrastructural facilities. The common varibales which are positively significant irrespective of the ecologies are number of non-agricultural labourers and the houseold size. Agricultural labour has significant positive contribution in aggregate but not in low and highly irrigated village. The positive effect of household size tends to suggest that subsistence pressure leads to higher income. The landownership size as expected has significant positive impact other than the highly irrigated village where it is but negative which is difficult to explain. High land has negative effect in all the ecologies, may be because of soil moisture constraint in the dry season and thus, low productivity of land. The low land has significant positive impact in the low irrigated village but just opposite in the two other areas. The overall impact is however, positive. Irrigation has significant positive impact and it is very high in the highly irrigated village. Contrarily it is negative in the low irrigated village, may be because of insignificant irrigation coverage and/or poor management of the irrigation equipment in the initial years of its introduction. The availability of electricity in the village has positive effect and it is significant in the study areas as a whole and also in low irrigated village. Education is positive other than the low irrigated village where it is but negative which may be because of lack of suitable employment opportunities for educated people there.

Further insights into the regression results show that non-agricultural labourer in a household contributed more than the agricultural labour. In low irrigated village the nonagricultural worker earns a higher amount of Tk. 10, 150 which is higher than in two other irrigated areas. Electricity has also a very high contribution to income suggesting that as a development input this may be given top priority in rural development. It may also be noted that the contribution of irrigation is almost equal to that of land. Institutional credit has a

significant positive effect although negative in low irrigated village which is contrary to our hypothesis. Possibly loan in low irrigated villages could not be profitably used in agriculture under rain-fed condition.

We may conclude here that in rural areas household income is more significantly effected by both non-agriculural and agricultural worker, supply of electricity and irrigation which confirm our earlier observed results. Household size has also positive impact which tends to strengthen the Chyanovian conclusion. All these factors have differential levels of contribution depending on the irrigation intensity of the village.

5.2 Income Distribution and Level of Living

The income estimates show that households in the highly irrigated village earn lower income than those living in the low irrigated village. But this aggregate income is not enough to understand the long-term impact of irrigation. We should see the pattern of income distribution as generally reflected in the measure of 'Gini Coefficient'. The 'Gini' for per capita income distribution in the present exercise varies little among the three irrigation ecologies, although marginally high in the low irrigated village (0.42 against 0.40). This suggests that income distribution among the rural households is almost similar irrespective of the level of irrigation intensity in an area. In the case of land distribution the similar pattern also emerges among these three ecologies although the value of 'Gini Coefficient' rises to 0.67 indicating that the distribution of land is more skewed than income on per capita scale (Table 13).

Table 13 : Gini Coefficients for Land and Per Capita Income Distribution by Irrigation Intensity of the Village

Irrigation Intensity of the Village	Landownership Distribution	Per Capita Income Distribution
Low Irrigated	0.67	0.42
Medium Irrigated	0.66	0.39
Highly Irrigated	0.67	0.40
All Areas	0.67	0.40

To capture the differential levels of impact of irrigation, income data have further been examined by landownership size following the poverty level income which has been estimated to be Tk. 3971 per capita for the study year of 1987. Such income level has been derived from Hossain and Sen's estimate of Tk. 4340 for the year 1988/89 (Hossain and Sen, 1992). In their estimates they take into account the minimum consumption bundle at per capita intake of 2112 calories plus 30 per cent allowance for non-food basic expenditures. According to that poverty income total households living below poverty level account for 55 per cent of all

households or 57 per cent of the population in the study areas, the largest number of households being in the highly irrigated village (58%) as shown in Table 14.

The analysis by landownership size shows that more than one-fourth of the large land owners is also living at below poverty level and it rises to 35 per cent in the medium irrigated village (Table 14). It also shows that two-thirds of the households in the functionally landless group live at below poverty level and irrigation had little impact on their poverty status. The present findings furthermore show that poverty stricken households are much higher than the

Table 14 : Households Living Below Poverty Level by Landownership Size and the Irrigation Intensity of the Village

(Percentage of Each Category of Households)

Irrigation Intensity of the Village	Per cent of total House-Holds	Function-nally Landless (Upto 0.5 acres)	Small Land Owners (0.51-5.00 acres)	Medium Land Owners (2.51-5.00 acres)	Large Land Owners (5.01 & above acres)	Per cent of Total popu-lation Liv-ing below Poverty Level
Low Irrigated	53.6	68.6	47.0	40.0	24.5	56.0
Medium Irrigated	53.3	61.1	50.0	42.8	34.8	54.3
Highly Irrigated	57.9	67.6	51.3	46.4	25.0	60.9
All Areas	54.7	66.0	49.1	42.3	27.2	56.8

figures (43 per cent) arrived at by Hossain and Sen in 1988-89 on the bais of BIDS household expenditure survey. Such differences are not unusual as income estimates are quite complex and furthermore, part of the household expenditures is met from informal loan. Some of the selected villages were also adversely affected by the 1987 flood.

VI. SUMMARY AND CONCLUSION

The household income in the study year of 1987 was estimated to be Tk. 26,435 or Tk. 4406 per capita. It did not increase with the increase in the irrigation intensity of village as expected. The highly irrigated village had rather lower income which might be mainly due to lower landownership size. The average size of land owned in the highly irrigated village is only 1.17 acre or lower by about 50 per cent over the low irrigated village. The farm size is also lower by 55 per cent. Such a lower income is not however, uniformly applicable to all the landownership groups. The small and medium land owners earned rather higher income compared to their counterparts in the low irrigated village. They have almost same landownership size among the irrigation ecologies.

The impact of irrigation is visible in terms of income of per acre of land owned by a household. This has been found to rise with the increase in irrigation intensity of the village. The highly irrigated village earns 36 per cent higher per acre income over the low irrigated village, suggesting that the productivity of land rises with irrigation. This is also clear from absolute size of agricultural income which shares about 70 per cent of total income in the highly irrigated village compared to 61 per cent in the low irrigated village. Rice is the principal crop in highly irrigated areas which earns 77 per cent of agricultural income, in contrast to only 65 per cent in both low and medium irrigation ecologies. Such a higher rice income has been facilitated by larger adoption of modern rice in the highly irrigated village.

Lower household income in the highly irrigated village is mainly due to reduced income share from non-agricultural sources: of which service and remittances share 10 per cent of total income compared to 14 per cent in low irrigated village. In the absolute measure the low irrigated village has 34 per cent higher income from service and remittances. The other non-agricultural sources viz., trade, transport and construction also contributed significantly higher amount in low irrigated village (by 28 per cent). Such a substantial higher income from non-agriculture sources in the low irrigated village indicates that the poorly developed agriculture forces rural households to seek employment outside agriculture and even out-migration. Significant shares of non-agricultural income appear to be earned by members other than the household heads.

Irrigation also facilitates higher wage income which has higher share by 32 per cent in the highly irrigated village over the low irrigated village. Total wage income in the highly irrigated village has a share of 15 per cent to total household income. Such a larger share is an outcome of more man days of employment, but not the higher wage rate which has been found to be almost equal in all the irrigation ecologies. The same level of wage rate (Tk. 33 per man-day) appears to be the result of in and out-migration of labour.

Employment of women is highly concentrated in non-crop agriculture (livestock, fishery and forestry) followed by cottage industries. Two-thirds of the women workers are found to work in non-crop agriculture while only 7 per cent in crop-agriculture and that too in self employment. Irrigation has significant positive impact on women employment in agriculture.

The exercise relating to determination of household income shows differential levels of contribution of the variables specified in the equation depending on the intensity of irrigation in a village. In the low irrigated village variables having significant positive impact are (i) size of land owned, (ii) number of non-agricultural labour in a family (iii) household size and (iv) availability of electricity in the village. In the highly irrigated village out of the above four variables only two variables viz. (a) non-agricultural worker and (b) household size are found significant. Irrigation and low land have significant positive effects. In the medium irrigated village in addition to those four stated factors, institutional credit and education of the household heads have significant positive impact. It is also of interest to note that non-

agricultural labour contributes substantially higher amount than the agricultural labour in all the three irrigation ecologies. The differential impact suggests that development policies should be made as far as possible area or region specific.

It has been noted that irrigation could little improve the level of living of the poor (which could perhaps deteriorate without irrigation) as proportionately more households are found living at below poverty level in the highly irrigated village (58 per cent against 54 per cent in low irrigated village) although the difference among the irrigation ecologies is marginal. The income distribution on per capita scale remains almost on the small level (Gini Coefficient is 0.40). Surprisingly poverty stricken people are found in all the landownership groups including the large land owners.

Irrigation in the study areas could not have an overwhelming effect on total income as noted from lower household income in the highly irrigated village despite its significant positive contribution. Without irrigation these villages could have much lower income; so at least as a compensatory mechanism to lower land endowment, irrigation should be expanded besides the objective of agricultural production. In low irrigated or rainfed localities, along with agricultural programmes some special development projects relating to non-agricultural activities having advantages in terms of availability of raw materials and/or special skills may be undertaken. Provision of institutional credit to households involved in trading, transport etc. may also facilitated their rapid expansion. Lastly, it may be noted that non-agricultural activities can be greatly expanded by constructing all-weather roads, markets and supplying electricity in rural areas. Public development allocations in building physical infrastructures to that end should get top priority and accordingly absolute size of development allocations in rural areas may be increased.

Footnotes

1. One of the reasons appear to be flood-damage of 1987.
2. The per capita rice production has been 7.4 mounds in the low irrigated village compared to 9.1 mounds in the highly irrigated village. Fertilizer use is found substantially higher (33 per cent) in the highly irrigated village.

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