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GREEN REVOLUTION, INCOME DISTRIBUTION AND RURAL POVERTY- THE CASE OF BANGLADESH

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ABSTRACT

This paper examines the impact of the seed-fertilizer-irrigation technology (simply the new technology or green revolution) on income distribution and rural poverty in Bangladesh. An agricultural wage determination model is developed for Bangladesh which shows that the new technology has the potential for raising the real wage rate, employment and output, but the impact of the new technology on income distribution between landowners and labourers depends much on whether the technology is labour-saving. Econometric results suggest that although the new technology did not increase the agricultural real wage rate, it lowered the rate of unemployment and underemployment and changed the occupational structure of the labour force, a result of which was the reduction of the incidence of rural poverty in Bangladesh in recent years. Econometric results also suggest that the new technology did not intensify the inequality of income in the rural areas of Bangladesh by raising the incidence of landlessness and near-landlessness.

I. INTRODUCTION

One of the controversial issues in agricultural economics is whether the seed-fertilizer- irrigation technology intensifies the inequality of income and raises the incidence of absolute poverty in the technology adopting developing countries. Economists participating in the debate are polarised into two camps (Chambers, 1984). The protagonists of the new technology emphasise that it can dynamically redistribute income through growth and alleviate poverty on a long term basis. Particularly, in a landscarce and overpopulated country like Bangladesh the new technology is appropriate because it is land augmenting and labour-using. This technology is labour - using because it

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requires intense cultivation practices at all stages of the production process and these operations can be performed by labour without any significant use of mechanical power (Ahmed, 1983). The yield effect of this technology is also substantial'. In a broader context, Hayami and Ruttan (1984) point out that if there had been no biological-chemical technology in agriculture, many developing countries would have moved several steps closer to the Ricardian trap of economic stagnation and greater stress over the distribution of income[2].

Despite the potential gains of the poor from the new technology through the product and labour markets, the economic consequences of the new technology that have received prominence in the literature are the proletarianisation of the peasantry and a consequent increase in the number and proportion of landless farm households, a growing concentration of land and assets in fewer hands, a widening disparity between the rich and poor households and an increase .in the incidence of absolute poverty. The arguments for the adverse effects of the new technology on poverty and income inequality include faster rates of adoption by large compared with small farmers or by owners compared with tenants, a labour-saving bias in the technology that reduces labour's income share, nonadaptability of technological innovations to all geographic areas, availability of public services to large farmers but not to small, and incentives for landlords or wealthy farmers to consolidate small holdings into larger units through eviction of tenants and buying out of small and marginal holdings (Falcon, 1970; Griffin, 1974; Pears, 1980; Staub and Blase, 1974).

The rural poverty in Bangladesh has been the subject of intensive investigation since the early 1960s[3]. Early studies on poverty in Bangladesh were concerned mainly with the quantification of both the incidence of rural poverty and the magnitude and direction of change in the incidence of poverty over time. These studies portrayed a pessimistic picture of Bangladesh as the incidence of rural poverty was rising rapidly. However, recent studies suggest that the incidence of rural poverty in Bangladesh has shown a declining trend since the mid-1980s. Although the reduction of poverty in Bangladesh is not an isolated case as the incidence of poverty in other Asian developing countries has also shown a declining trend (Chakravarty ,1990; Oshima,1990), it is significant for Bangladesh because of its dubious poverty

'superstar' status. Indeed, some commentators (e.g., Rahman, Mahmud and Haque, 1988) see the significance of declining poverty incidence in Bangladesh in the light of the government's recent economic policy changes. One cannot, however, isolate the impact of macroeconomic policy changes on rural poverty from that of other developments in the economy. One such development has been the diffusion of the new technology in agriculture since the early 1970s which, in addition to providing economic benefits to the poorer sections of the community, also changed the occupational structure of the labour force.

This paper argues that the new technology has been one of the contributory factors to the reduction of rural poverty in Bangladesh. This hypothesis is indirectly tested by examining the impact of the new technology on the correlates of rural poverty such as agricultural real wages, unemployment and the incidence of landlessness and near-landlessness. The rest of the paper is organised as follows: Section II develops an agricultural wage determination model for Bangladesh and analyses the impact of the new technology on the agricultural wage rate, underemployment and income distribution between wage labourers and landowners. Section III examines the impact of the new technology on the agricultural wage rate, unemployment and the occupational structure of the labour force in Bangladesh. Section IV examines the impact of the new technology on the incidence of landlessness and near-landlessness in Bangladesh and critically analyses the relationship between landlessness and rural poverty. Section V draws conclusion.

II. IMPACT OF THE NEW TECHNOLOGY ON AGRICULTURAL OUTPUT, WAGE RATE, UNDER EMPLOYMENT AND INCOME DISTRIBUTION BETWEEN WAGE LABOURERS AND LANDOWNERS

In order to examine the impact of the new technology on agricultural output, wage rate, underemployment and income distribution, this section develops an analytical model for agricultural wage determination in Bangladesh[4]. This model is based on the assumption that both demand and

supply factors of labour play an important role in the agricultural wage determination process in developing countries[5].

Assume that the production technology in the agricultural sector can be approximated by a production function, such that

$$q = B\ f\ (l)$$

where q is agricultural output per acre of capital-embodied land; l is labour input per acre of capital-embodied land; B is the multiplicative parameter in the production function which can be interpreted as a shift parameter (Bardhan, 1979). Assume that the properties of the production function $\delta q/\delta_l > 0$ and $\delta^2 q/\delta_l{}^2 < 0$ are satisfied.

Notice that the marginal productivity of labour implied by the above production function depends on the B parameter which suggests that, for different values for B, there will be different marginal productivity of labour[6]. The supply function of labour is assumed to be positively sloped[7].

In Figure 1, $S^w{}_l$ is the supply curve of wage labour and s_l is the aggregate supply curve of wage and family labour such that the horizontal difference between the curves s_l and $S^w{}_l$ measures the amount of family labour[8]. The unit of measure of labour is labour hours and a labourer is classified as fully-employed, underemployed or overemployed depending on the number of hours he/she works relative to the number of standard working hours in a day or week. Given the traditional production technology as represented by B, MPL_o is the marginal product of labour curve. E_o is the point where the downward sloping marginal product of labour curve cuts the upward sloping aggregate supply curve of labour, and the wage rate determined is OW_o $(=w_o)$. At the wage rate w_o, the level of employment per acre of land is Ol_o $(=l_o)$ where Ol_w $(=l_w)$ is the amount of labour supplied by wage labourers and $(l_w l_o = l_f)$ is the amount of labour supplied by family labourers. The vertical axis (due south from 0) measures the number of labourers: OX^w wage labourers, and X^wX^f family labourers. The average working hours of wage labourers are measured by $\tan \theta^w$ $(=OL_w/OX^w)$ and the average working hours of family labourers are measured by $\tan \theta^f$ $(=X^wX/X^wX^f)$.

Underemployment is one of the characteristic features of Bangladesh agriculture and it is created when a labourer shares work with others and

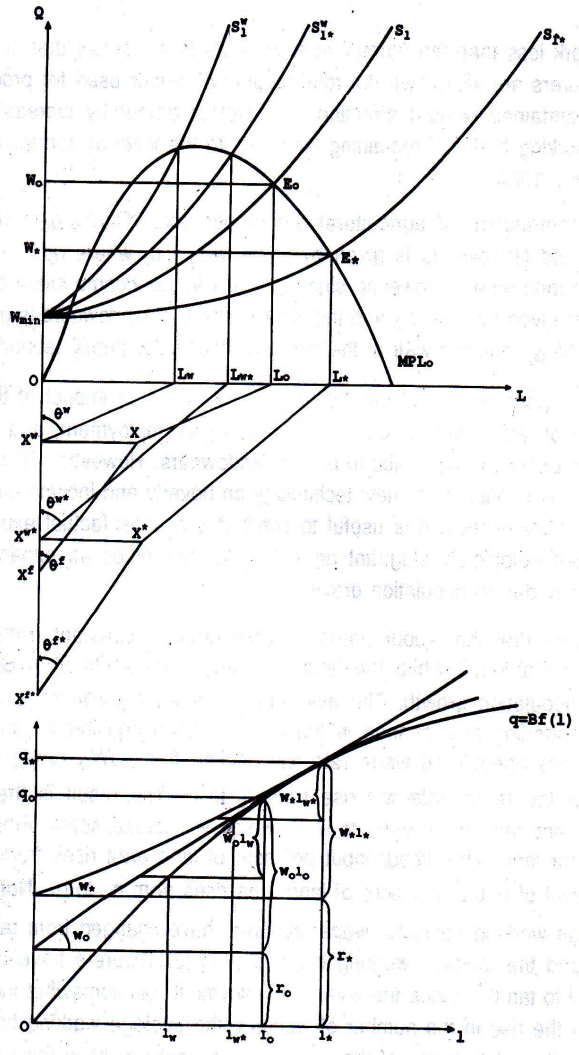

Figure 1. Effects of Population Growth on Output, Employment, Wage Rate and Income Distribution in the Agricultural Sector.

they all work less than the normal working hours in the sense that, if one or more labourers are withdrawn the total amount of labour used for production can be maintained without affecting the level of output by increasing the average working hours of remaining labourers to the level of normal working hours (Sen, 1960).

The distribution of agricultural output per acre ($Oq_o = q_o$) between labourers and landowners is given by: $q_o = w_o l_o + r_o$ where r_o is rent, the incomes of landowners. However, since $l_o = l_w + l_f$, the income share of wage labourers is given by $w_o l_w/q_o$ and the income share of landowners is given by $q_o r_o + w_o l_f/q_o$, in which $w_o l_f$ is the imputed income for family labour[9].

This benchmark model can be used to examine the impact of the new technology on agricultural output, wage rate, underemployment, and income distribution between wage labourers and landowners. However, in order to appreciate the impact of the new technology on poverty and income inequality in a proper perspective, it is useful to conduct a counter-factual experiment where a technologically stagnant agricultural sector faces an expansion of labour supply due to population growth.

Assume that the labour demand curve remains constant (reflects no technological change) while the labour supply curve shifts from S_l. to S_{l^*} owing to population growth. The new labour market equilibrium is at point E^*. Corresponding to a change in the labour market equilibrium point from E_o to E_*, the agricultural wage rate will decline from OW_o $(=w_o)$ to OW^* $(=w^*)$ and the rental rate will rise from r_o to r^*. The result is the fall in the wage-rent ratio from w_o/r_o to w^*/r^* which will cause some substitution of labour for land. The labour input per acre of land area rises from l_o to l_* and the level of output per acre of land area rises from q_o to q_*. Notice that the average working hours for wage labourers have changed from tan θ^w to tan θ^{w^*} and the average working hours for family labourers have changed from tan θ^f to tan θ^{f^*}. Since the level of employment has somewhat increased along with the rise in the number of workers, the average working hours will depend on the relative size of the expansion of employment to the increased number of workers. When tan $\theta^w <$ tan θ^{w^*}, this would imply a rise in underemployment among wage labourers, and when tan $\theta^f <$ tan θ^{f^*}, this would imply a rise in underemployment among family labourers. The impact of population growth on income distribution will depend on the size of the

increase in employment as a result of the fall in the wage-rent ratio. However, the size of the incremental employment as a result of the fall in the wage-rent ratio will depend on the location of the production curve where the increased labour is employed. If the increased labour is applied to the given production function at a zone of decreasing return to labour, the elasticity of substitution of labour for land will be less than one (i.e., less than a 1 percent increase in the labour-land ratio will result from a 1-percent decrease in the wage-rent ratio). As in the present case the incremental labour is employed to the production function of fixed technology and at a zone of decreasing return to labour, the relative income share of labour will decline from $w_o l_o/q_o$ to $w_* l_*/q_*$ as a result of the fall in the wage rate from w_o to w_*[10].

The impact of the new technology on agricultural output, wage rate, underemployment, and income distribution is shown in Figure 2.

Notice that with the introduction of the new technology (reflected in the production function: $q_\# = B_\# f_\# (l_\#)$), there has been an increase in output, employment and the wage rate. Given the wage rate $w_\#$, the incremental employment is distributed between wage labour (from OL_W (=l_W) to $OL_{W_\#}$ = ($l_{W_\#}$)) and family labour ($L_W L_o$ (=l_f) to $L_{W_\#} L_\#$ (=$l_{f_\#}$). The average working hours of wage labourers have increased from tan θ^W to tan $\theta^{W\#}$ and the average working hours of family labourers have increased from tan θ^f to tan $\theta^{f\#}$. The distribution of output per acre of land area (q#) is now given by: $q_\# = r_\# + w_\# l_{W_\#} + w_\# l_{f_\#}$. Notice that after the introduction of the new technology, the income share of labour has changed from $w_o l_o/q_o$ to $w_\# l_\#/q_\#$. One relevant question is whether the income share of labour has improved due to the introduction of the new technology (i.e,, whether $w_o l_o/q_o$ is higher, equal or lower than $w_\# l_\#/q_\#$). The answer however is not clear-cut because it depends on the nature of the shift in the production function owing to the introduction of the new technology. The income share of labour ($w_\# l_\#/q_\#$) will be higher than $w_o l_o/q_o$ if the production function shifts in such a way as to increase the labour-land ratio for a constant rent-wage ratio (r/w) at competitive equilibrium- the land-saving and labour-using technological change. On the other hand, if the technological change is of the labour-saving type, the relative income share of labour may decline. It is also theoretically possible for the labour-saving bias to be so strong that the absolute income of labour may decline (Hayami and Ruttan, 1984).

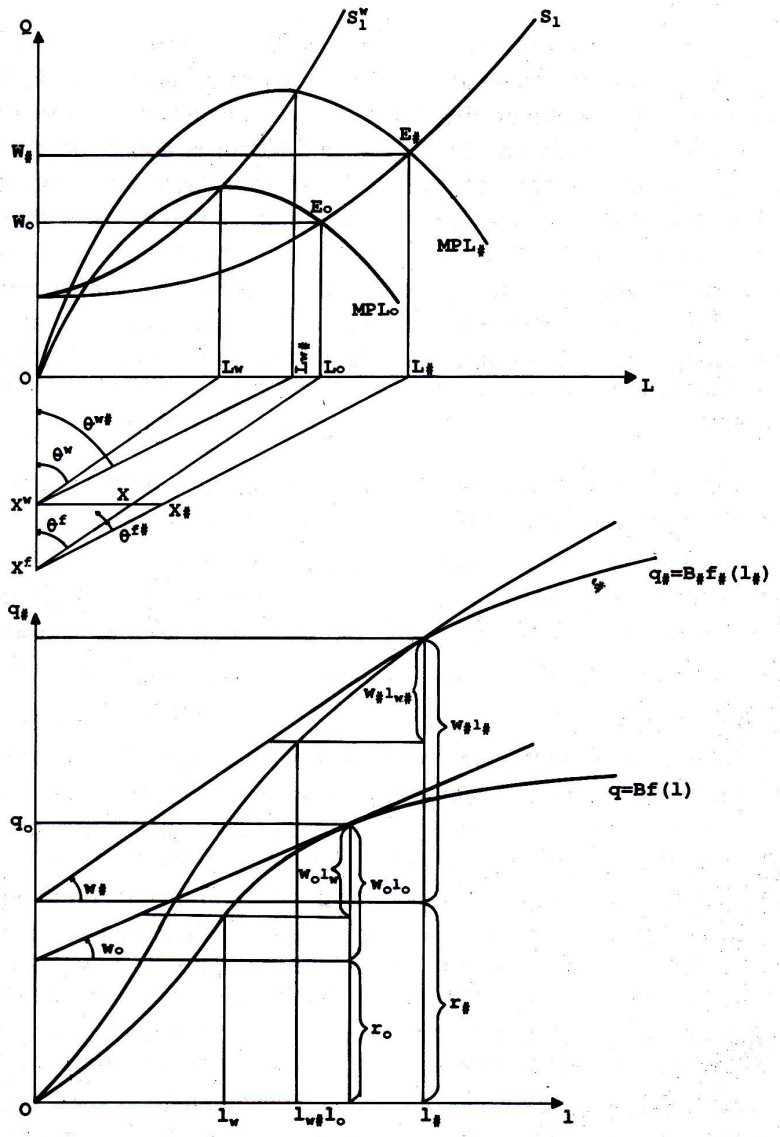

Figure 2. Effects of Technological Change on Output, Employment, Wage Rate and Income Distribution in the Agricultural Sector.

From the analytical model developed above, it can be concluded that the technological progress has the potential for raising the level of agricultural wage rate, employment and output, but its impact on income distribution between landowners and wage labourers depends much on whether the technology is labour-saving or labour-using.

III. THE NEW TECHNOLOGY, REAL WAGES AND EMPLOYMENT IN BANGLADESH AGRICULTURE

One of the important correlates of rural poverty in Bangladesh is low agricultural real wages due to low agricultural productivity. The low level of productivity is the result of a number of factors including low capital intensity and the high labour-land ratio. Although the diffusion of the new technology raised the demand for labour, the real wage rate instead of increasing has shown a long run declining trend (Chart 1).

The incidence of rural poverty in Bangladesh is not randomly distributed throughout the country. So it is useful to see what has happened to rural wages in those regions which have the high incidence of poverty. The regions like Comilla , Faridpur, Jessore , Mymensingh, Noakhali, Pabna, Rangpur and Tangail are the poverty stricken areas of Bangladesh. The real wage behaviour in these areas may provide some information about the movement of poverty incidence in Bangladesh .

Table 1 reports data for the real wage rates in 20 regions of Bangladesh for the 1954-88 period. It is found that most of the proverty stricken regions of Bangladesh were able to maintain their wage gains of the early 1980s. However, in a few areas of the northern region of the country (such as Rangpur, Dinajpur and Rajshahi), the real wage rates have fallen significantly in recent years. Since Rangpur is a poverty stricken area, it is a matter of concern that the real wage rate in this area has fallen rapidly.

As the real wage rates have shown sharp fluctuations in all regions of Bangladesh, it is possible to test the impact of the new technology on the real wage rate at both national and regional levels. Table 2 reports regression results of the real wage rate (RW) on proxies for the new technology for all

regions of Bangladesh. Two proxies for the new technology were used for estimation purposes: (i) the ratio of rice acreage under the new technology to total cropped area (ACREAGE), and (ii) consumption of fertilizer (tons/acre) (FER). An OLS estimator was used to estimate a double log-linear regression equation in which each of the proxies was used separately to avoid multicollinearity. When an equation was found to have autocorrelation problem, it was corrected by the Cochrane-Orcutt method. Given the availability of data, the sample period of estimation was restricted to the 1976-87 period.

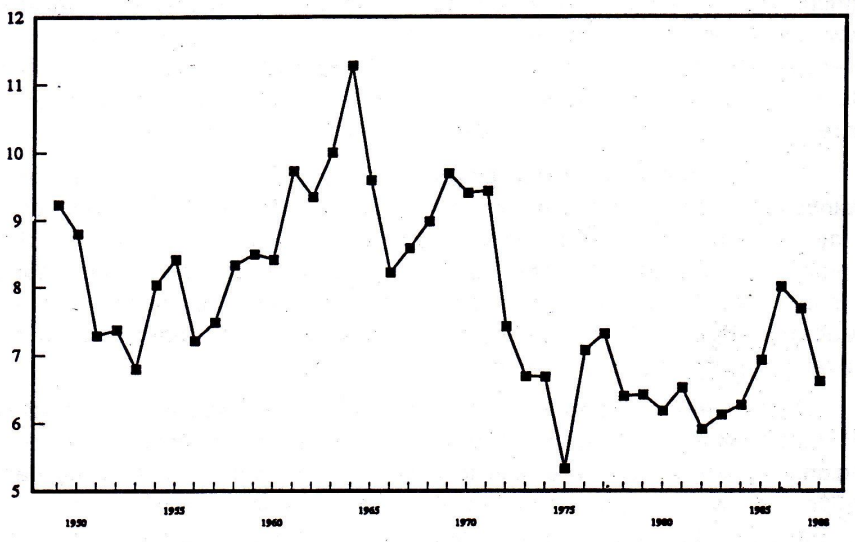

Chart 1. Agricultural Real Wage Rate (Taka per person per day).

Table 1. Real Wages of Agricultural Labourers in Bangladesh : 1954-88.

Region	1954-56	1964-66	1970	1972-75	1976-82	1983	1984	1985	1986	1987	1988
Bangladesh	8.7	11.2	9.4	6.5	6.6	6.1	6.3	6.9	8.0	7.7	6.6
Dhaka	10.4	12.0	10.2	7.9	7.3	8.5	8.3	7.1	7.9	7.7	7.1
Kishoreganj	n.a	n.a	9.3	6.4	5.7	5.2	5.1	6.0	6.7	7.5	6.7
Mymensingh	8.1	12.3	8.3	6.5	5.9	5.4	6.0	5.9	9.0	7.1	6.6
Tangail	n.a	n.a	6.4	6.3	6.4	5.4	6.8	7.1	7.4	6.9	6.4
Faridpur	7.7	10.7	7.7	5.8	6.4	5.4	4.7	4.7	6.2	7.1	6.3
Chittagong	11.7	14.2	14.4	8.7	8.4	8.7	6.8	9.6	11.4	11.7	11.4
Chit. H.T	11.4	13.6	12.9	7.7	8.8	8.9	9.5	9.0	10.9	11.1	10.0
Noakhali	8.6	12.1	11.2	8.0	7.5	8.2	7.9	9.4	10.2	9.3	8.5
Comilla	7.5	11.4	9.4	6.6	7.0	6.7	8.2	8.5	8.8	8.4	6.8
Sylhet	9.1	11.7	11.7	8.7	7.6	7.2	7.7	8.4	8.2	8.2	7.5
Rajshahi	10.1	11.3	8.8	5.8	6.0	5.4	4.6	5.4	6.7	6.6	5.6
Dinajpur	10.6	11.5	9.6	6.3	5.5	5.0	4.6	6.4	6.8	6.4	5.8
Rangpur	7.1	10.7	8.1	5.5	5.8	5.2	5.4	5.5	6.8	5.8	4.8
Bogra	8.8	10.8	9.0	5.5	5.6	5.4	4.8	5.5	6.8	6.2	5.6
Pabna	6.3	10.2	8.0	5.9	5.9	5.7	5.8	7.1	8.1	6.9	6.0
Khulna	8.7	10.7	9.1	5.1	6.4	5.6	5.0	6.2	8.1	6.8	6.3
Barisal	7.3	10.0	8.9	6.9	7.2	5.8	6.1	6.7	7.5	7.7	7.0
Patuakhali	n.a	n.a	10.1	7.4	6.4	6.1	10.6	7.9	8.1	6.4	6.6
Jessore	7.6	10.3	7.8	4.9	5.7	4.9	5.3	5.5	6.6	7.1	6.0
Kushtia	7.4	9.0	7.5	4.7	5.7	4.2	6.0	5.4	7.7	5.3	6.1

Notes: Figures for the wage rate are in Taka at 1973 prices. Year represents fiscal year.

Sources: Figures for 1953/54-1955/56 and 1963/64-1965/66 are taken from Boyce (1989) and the rest are calculated from the nominal wage rates by deflating them by the aggregate cost of living index for agricultural households in Bangladesh. Basic data are taken from various issues of the Statistical Yearbook of Bangladesh and Yearbook of Agricultural Statistics of Bangladesh.

The regression results show that the new technology did not have a significant impact on the real wage rate, except in Comilla, Dhaka, Mymensingh, Pabna and Tangail. However, it may be the case that the major

impact of the new technology has been on employment. The possibility that the new technology raised the level of rural employment and contributed to changes in the occupational structure of the labour force in Bangladesh is examined below.

Table 2. Regression Results of the Regional Real Wage Rates in Bangladesh.

Region	ln FER		ln ACREAGE	
	Coeff.	(t-ratio)	Coeff.	(t-ratio)
Dhaka	0.07	(1.71)	0.32	(2.24)
Kishoreganj	0.08	(1.08)	0.10	(0.71)
Mymensingh	0.11	(1.63)	-0.05	(0.35)
Tangail	0.14	(3.94)	0.19	(1.91)
Faridpur	0.01	(0.07)	-0.16	(2.26)
Chittagong	0.08	(0.41)	0.38	(1.32)
Noakhali	0.10	(0.79)	0.06	(0.31)
Comilla	0.16	(1.72)	-0.23	(0.91)
Sylhet	-0.08	(0.92)	0.09	(0.63)
Rajshahi	0.02	(0.26)	0.05	(0.42)
Dinajpur	0.04	(0.47)	0.10	(0.77)
Rangpur	0.08	(1.30)	0.06	(1.06)
Bogra	-0.01	(0.20)	-0.08	(0.57)
Pabna	0.15	(2.49)	0.12	(1.74)
Khulna	0.10	(1.28)	0.06	(0.50)
Barisal	0.04	(0.25)	-0.34	(1.24)
Patuakhali	....	.....	-0.50	(2.37)
Jessore	-0.15	(1.08)	-0.21	(1.06)
Kushtia	.....	.....	-0.04	(0.37)
Bangladesh	0.08	(1.25)	0.15	(0.76)

Note: A regression equation of the following form was used: ln $RW_t = \alpha o + \alpha_1$ ln FER_t (or ln $ACREAGE_t$). Data sources: Various issues of the Statistical Yearbook of Bangladesh and Yearbook of Agricultural Statistics of Bangladesh.

Impact of the New Technology on Unemployment in Bangladesh

Most survey-based studies on the new technology in Bangladesh suggest that the major impact of this technology has been on rural employment. On the basis of comprehensive survey throughout Bangladesh, Hossain (1988) found that the new technology affects the labour market through the income variable. At higher levels of income, farm households substitute leisure for labour and supply less labour in the market. This redistributes employment from higher-to-lower income groups. Such redistribution, together with an increase in the demand for labour owing to the higher labour intensity of the new technology, increases employment and puts an upward pressure on the wage rate. Ahmed (1983) found that the higher demand for labour caused by the new technology is met by wage labour, but Ahmed (1981) suggests that the increased demand for labour caused by the new technology is met by family labour and less in terms of hired labour[11].

Time series data for rural unemployment are not available. So it is not possible to examine the impact of the new technology on rural unemployment and underemployment. However, aggregate time series data for unemployment and underemployment show that the unemployment rate in Bangladesh has sharply declined since the early 1980s. For example, the unemployment rate in Bangladesh was around 40 percent in the mid-1970s, which fell to around 25 percent in 1981-82 and to just 12 percent in 1986 (Key Indicators of Developing Asian and Pacific Countries, various issues). Given that around 60 percent of the total labour force in Bangladesh are employed in the agricultural sector, it is likely that rural unemployment has fallen sharply along with the rate of national unemployment and underemployment. On the basis of such a restrictive assumption, it is possible to examine the impact of the new technology on unemployment and underemployment in Bangladesh.

A regression equation of the following form has been used to examine the impact of the new technology on the aggregate unemployment and underemployment rate (UR) in Bangladesh:

$$\ln UR_t = \alpha_0 + \alpha_1 \text{ Ln } FER_t \text{ (or ln ACREAGE)} + \alpha_2 \ln RW_t$$

An OLS estimator has been used to estimate the above equation for the sample period 1971-86. The estimated equations with two proxies for the new technology are reported in Table 3. In the results the figures in parentheses below the coefficients are absolute t-ratios, R^2 is the adjusted coefficient of determination, and DW is the Durbin-Watson statistic.

Table 3. Regression Results of the Unemployment Rate in Bangladesh

	ln FER		ln ACREAGE		ln RW		R^2	DW
Eq. No.	Coeff.	(t-ratio)	Coeff.	(t-ratio)	Coeff.	(t-ratio)		
1.	-0.65	(2.61)			-0.53	(0.60)	0.66	1.87
2.			-1.64	(2.78)	-1.69	(1.22)	0.41	1.64

Data sources: Various issues of the Statistical Yearbook of Bangladesh and Key Indicators of Developing Asian and Pacific Countries.

Regression results show that both the proxies for the new technology have a negative impact on the rate of unemployment and underemployment in Bangladesh. However, the agricultural real wage rate does not have a significant positive effect on the rate of unemployment. In fact, contrary to a priori expectations, a rise in the real wage rate appears to have a negative effect on the rate of unemployment. It appears that both employment and the real wage rate rise simultaneously due to adoption of the new technology and that the real wage rate does not lower the demand for labour much because of the complementary nature of modern inputs in the technology package. The overall results indicate that, although the new technology did not significantly increase the real wage rate in Bangladesh, it lowered the rate of unemployment and underemployment in the rural areas. Rahman, Mahmud and Haque (1988) suggest that it was through the expansion of employment that the new technology has lowered the incidence of rural poverty in Bangladesh. However, as the new technology in agriculture has been accompanied by a number of other factors that caused some changes in the overall economy, the fall in the incidence of rural poverty cannot solely be due to the adoption of the new technology. This point is taken up below.

The New Technology, Occupational Structure of the Labour Force, and the Incidence of Rural Poverty in Bangladesh.

Since the independence of the country there have been significant changes in the occupational structure of the labour force in Bangladesh. Agriculture, which has traditionally been the absorber of growing labour force through various forms of work-spreading and work-sharing, has given way to non-farm activities as the main source of employment for the incremental labour force. For example, between 1961 and 1974, around 57 percent of the incremental labour force managed to get employment in the agricultural sector. However, during the 1974-85 period there was no additional increase in employment in the agricultural sector, although the labour force increased by 65 percent. In fact, the level of agricultural labour force has decreased by 127 thousand during the 1974-85 period. As a result, the share of employment in agriculture has fallen from 74 percent in 1974 to 54 percent in 1986 (Tables 4 and 5).

There are a number of reasons for changes in the occupational structure of the labour force in Bangladesh. An important interpretation is that the economy as a whole has shown some dynamism since independence. Table 5 reports some comparative data for aggregate and sectoral growth rates of the Bangladesh economy for the 1950-85 period,. In the 1950s the real economy grew at the rate of just 1.6 percent per annum but the growth rate of population was 2.1 percent per annum, a result of which was a fall in per capita real income by 0.5 percent per annum. In the 1960s economic growth accelerated to a rate of around 4 percent per annum, which, given the population growth rate of 2.5 percent per annum, increased per capita income by 1.5 percent per annum. Since the independence of the country the economy grew at a rate of around 5 percent per annum, which, given the population growth rate of 2.2 percent per annum, raised per capita real income by 2.8 percent per annum. This growth rate of real income might have created employment opportunities in the non-farm sector to such an extent that it pulled some labour from the farm sector (Osmani, 1990). This argument is essentially based on the study by Hossain (1988) who found that the new technology in agriculture has given a strong stimulus to non-farm employment through consumption linkages. There has also been an upsurge of infrastructure development activities in both the rural and urban areas of

Table 4. Sectoral Distribution of Employment (percentages)

Fiscal Year	Labour force	Employed	Agriculture	Manufacturing	Others
	Million		percent of employed labour force		
1950	na	na	79.2	4.3	16.4
1955	na	na	77.1	5.6	17.3
1973	26.0	16.1	73.9	6.8	19.3
1974	26.7	16.9	74.0	7.1	18.9
1975	27.3	16.1	72.0	8.1	19.9
1976	28.0	17.3	72.3	7.5	20.2
1977	28.7	17.2	70.3	8.1	21.5
1978	29.4	18.2	70.3	7.7	22.0
1979	30.1	18.6	69.4	8.1	22.6
1980	30.8	18.9	68.7	7.9	23.4
1981	26.9	19.5	68.1	8.2	23.7
1982	27.4	20.5	68.5	8.2	23.4
1983	28.0	20.5	66.8	8.3	24.9
1984	28.5	25.2	55.5	9.5	35.0
1985	29.4	25.9	54.0	9.6	36.4
1986	30.4	26.7	54.3	9.8	36.0

Source: Figures for the years 1950 and 1955 are taken from Khan (1970) and the rest are taken from various issues of the Key Indicators of Developing Asian and Pacific Countries.

Bangladesh which generated substantial demand for wage labour, resulting in an increase of wage incomes of wage labourers (World Development Report, 1990). A large inflows of foreign remittances by Bangladeshi workers in the Middle Eastern countries since the early 1970s raised the level of demand for non-farm products and services[12]. A significant amount of foreign remittances was also invested in the non-farm sectors. Notice that the

Table 5. Sectoral Shares of Incremental Labour Force and Output Growth Rates.

Sector	Incremental labour force				Compound growth rate of sectoral real output		
	1961-1974		1974-1985		1950-60	1960-70	1973-85
	Thousand	Percent	Thousand	Percent	(percent per annum)		
Agriculture	2600	56.8	-127	-1.7	0.5	2.8	2.8
Manufacturing	217	4.7	1663	22.0	9.5	5.6	7.2
Large[a]	n.a	2.7	n.a	5.4	4.9	7.1	8.4
Small[a]	n.a	2.0	n.a	16.6	18.3	4.3	6.5
Construction	-56	-1.2	516	6.8	12.6	19.8	7.6
Trade	222	4.8	2769	36.6	1.0	3.3	2.6
Transport	147	3.2	819	10.8	3.5	3.8	8.0
Services					2.9	3.0	6.2
Others	1450	31.7	1929	25.5			
Total	4580	100.0	7569	100.0	1.6	4.0	4.7

Notes and sources: a=percentage figures for small and large scale manufacturing industries under the incremental labour force are taken from Osmani (1990) and the rest are computed from statistics published in the Statistical Yearbook of Bangladesh, 1989:Compound growth rates were computed by fitting the log-linear time trends. Basic data were taken from Alamgir and Berlage (1974) and various issues of the Statistical Yearbook of Bangladesh, Economic Trends and Economic Indicators of Bangladesh.

sectoral growth rates in services, construction, transport, and small industries were relatively high during the 1973-85 period. The agricultural sector has also shown a significant growth rare of around 3 percent per annum and this might have contributed to the reduction of unemployment and underemployment in the country.

In a recent paper, Hossain (1992,p.25) thoroughly investigated the reasons for the phenomenal change in the occupational structure of the labor force in Bangladesh and reached the following conclusion:

..... the phenomenal change in the occupational structure of the labor force in Bangladesh during the past two decades has been due to structural changes in output

and is not a symptom of distress adaptation of landless wage labourers to increasing poverty and landlessness..... In response to sectoral productivity gaps and differential returns to labour, there has been a shift in labour from farm to non-farm activities during the past two decades and this has been facilitated by the change in attitudes and outlooks of the rural people due to socio-political and economic changes in the country since independence.

IV. THE NEW TECHNOLOGY, LANDLESSNESS AND RURAL POVERTY IN BANGLADESH

One of the important correlates of rural poverty in Bngladesh is the high incidence of agricultural landlessness and near-landlessness. However, there is a controversy over the question whether landlessness is a symptom or a cause of rural poverty. Khan (1986,1987) suggests that in a peasant economy with family labour, land represents an independent source of subsistence. Land provides power and prestige to the landowning households (Jannuzi and Peach, 1980) and access to land means a command over other natural resources, all providing direct and indirect economic benefits to landcwning households. The landless poor, on the other hand, depend largely on wage income within and outside agriculture. As a result, a fall in the wage rate or a loss in employment opportunities may push the landless poor into the poverty trap, Faced with poverty, the small and medium farmers are forced to sell their lands to rich farmers, a result of which may be a rise in the incidence of landlessness and near-landlessness over time. Thus there appears to be a two-way relationship between landlessness and poverty: poverty increases landlessness and landlessness increases poverty.

This section reports statistics on the incidence of landlessness in Bangladesh and examines the impact of the new technology on landlessness. The relationship between landlessness and poverty is also examined.

Trend in the Incidence of Landlessness in Rural Bangladesh

Table 6 reports available estimates of the incidence of landlessness in Bangladesh at different points of time during the 1960-84 period. Despite the use of comparable definitions, the estimates of rural landlessness in

Bangladesh obtained by various authors are too far apart to make any sensible comparison. However, Abdullah and Murshid (1986) suggest that their estimates of landlessness for 1960 and 1981 can be used to measure the changes in landlessness over time. On the basis of their estimates, changes in the incidence of landlessness in different regions of Bangladesh are reported in Table 7.

The New Technology and the Incidence of Landlessness in Bangladesh

It is often claimed that the new technology is one of the contributory factors to the rise in the incidence of landlessness and near-landlessness in Bangladesh. To the extent that landlessness causes poverty, the new technology is considered to be one of the contributors to poverty in Bangladesh. However, in the absence of comparable data for landlessness over time, the above hypothesis is yet to be statistically tested. While Hossain (1988) finds a small positive impact of the new technology on the marginalisation of land, he points out that technological progress reduces the necessity to sell land and,without technological progress, the small and marginal landholdings are likely to get smaller at a faster rate because of the distress sales of land by the poor.

On an exploratory basis,the following model has been used to examine the impact of the new technology on the incidence of landlessness in Bangladesh:

$$L^i_t - L^i_{t-1} = \beta_0 + \beta_1 P^i_t + \beta_2 \text{ ACREAGE}^i_t + \beta_3 AG^i_t + \beta_4 L^i_{t-1}$$

where L^i_t= incidence of landlessness in region i at time point t; P^i_t growth rate of rural population in region i at time point t; ACREAGE^i_t = proportion of land under irrigation as a proxy for the diffusion of the new technology in region i at time point t; AG^i_t = agricultural growth rate in region i at time point t and βs are parameters to be estimated.

In the absence of alternative sets of data, data for the changes in the incidence of landlessness from 1960 to 1981 are obtained from Abdullah and Murshid (1986)and used to estimate cross-section regression equations.

Table 6. Landlessness in Rural Bangladesh: 1960-84.

Country/ region	Landlessness (percent of rural households)								
	1960	1977a	1977b	1977c	1981a	1981b	1984a	1984b	1984c
Bangladesh	32.0	14.7	28.8	50.2	34.5	39.5	8.7	19.6	28.2
Dhaka	41.9	9.5	20.8	49.7	34.3	39.2	10.0	26.5	28.6
Mymensingh	28.5	10.8	26.9	45.3	34.5	39.1	9.6	19.8	26.8
Faridpur	32.6	8.8	27.0	47.4	30.1	41.2	5.0	11.7	33.0
Chittagong	47.0	42.5	51.6	73.0	47.1	50.6	8.0	33.6	27.8
Noakhali	30.4	24.0	26.8	55.6	31.1	46.9	2.9	11.5	41.5
Comilla	26.1	14.0	30.1	58.7	25.5	38.3	3.2	11.0	35.6
Sylhet	40.2	5.8	11.3	38.1	42.8	44.3	11.8	16.1	30.8
Rajshahi	31.4	14.4	23.6	41.8	37.1	38.8	6.2	25.1	18.8
Dinajpur	38.3	25.8	39.5	48.6	37.5	38.9	15.5	24.1	15.3
Rangpur	31.2	20.1	32.6	49.3	35.5	37.2	14.8	25.6	21.2
Bogra	38.6	10.8	30.8	53.5	32.5	38.6	6.3	20.8	22.7
Pabna	33.0	10.1	30.9	47.3	37.3	43.8	9.1	24.9	24.5
Khulna	30.3	11.7	36.4	54.9	34.7	36.6	7.8	15.6	31.4
Barisal	36.5	8.7	28.1	53.1	31.8	39.2	8.3	14.0	37.3
Jessore	19.7	13.8	25.7	40.7	29.5	29.9	7.5	15.9	24.4
Kushtia	47.3	12.5	24.8	46.6	40.9	50.2	10.8	22.9	24.8

Notes: The definitions of landlessness used in different years are as follows:

1960 = rural households owning upto 0.04 acres of land; 1977a = rural households owning no land whatsoever; 1977b = rural households owning no cultivable land, other than homestead sites; 1977c = rural households owning 0.5 acres or less of land other than homestead sites; 1981a = rural households with no cultivable land; 1981b = landlessness figures for 1981a are adjusted for migration of households out of the region; 1984a = rural households having no owned area whatsoever; 1984b = rural households with homestead area but no cultivated area; 1984c = rural households with homestead area and also cultivated area upto 0.05 acre. Sources: 1960, 1981a and 1981b figures are from Abdullah and Murshid (1986), 1977a, 1977b and 1977c are from Boyce (1987) and 1984a, 1984b and 1984c are from the BBS (1986: V.I).

Table 7. Changes in Landlessness in Rural Bangladesh:1960-81.

Country/ Division	% change in number of rural landless households	% change in the proportion of landless rural households
Rajshahi	81.8	19.1
Khulna	74.6	16.3
Dhaka	79.8	17.2
Chittagong	85.8	30.7
Bangladesh	80.9	23.4

Note: Division represents a number of districts as they existed in the 1960s.
Sources: Abdullah and Murshid (1986).

Four sets of cross-section regression equations were estimated using four different measures of changes in the incidence of landlessness. Definitions of the variables and regression results are reported in Table 8.

The regression results suggest that the inter-regional variation in changes in the incidence of landlessness is significantly associated with the initial level of landlessness.The sign of the coefficient on the initial level of landlessness is negative which suggests that the higher is the initial level of landlessness, the lower is the value for the change in landlessness over time. In all the estimated equations, the proxy for the new technology bears a positive sign but in none of the equations the coefficient is statistically significant. This indicates that the new technology did not have a significant impact on the incidence of landlessness. The agricultural growth rate is also statistically insignificant in all the estimated equations. The population growth rate is statistically significant, but only in regressions where the dependent variable is defined as percentage changes in the number of landless households, unadjusted for migration.

Table 8. Regression Results of Changes in the Incidence of Landlessness.

Equation	Intercept	L60	P5181	ACREAGE	AG5081	R^2
Dependent Variable: ΔL1						
1.	51.51	-2.66	39.46			0.75
	(1.86)	(4.95)	(4.47)			
2.	47.63	-2.77	41.30	0.26		0.73
	(1.62)	(4.70)	(4.25)	(0.54)		
3.	47.87	-2.73	39.22	0.08	2.86	0.71
	(1.56)	(4.36)	(3.21)	(0.09)	(0.30)	
Dependent Variable: ΔL'						
1.	195.06	-3.59	7.11			0.48
	(3.62)	(3.44)	(0.41)			
2.	182.09	-3.96	13.24	0.88		0.40
	(3.26)	(3.54)	(0.72)	(0.94)		
3.	181.55	-4.05	17.90	1.31	-6.41	0.35
	(3.13)	(3.41)	(0.76)	(0.85)	(0.36)	
Dependent Variable: $\Delta L1^1$						
1.	35.15	-16.3	11.50			0.52
	(1.63)	(3.90)	(1.67)			
2.	30.40	-1.76	13.74	0.32		0.51
	(1.35)	(3.92)	(1.85)	(0.85)		
3.	30.62	-1.73	11.89	0.15	2.55	0.48
	(1.30)	(3.62)	(1.27)	(0.24)	(0.36)	
Dependent Variable: $\Delta L2^1$						
1.	105.28	-2.15	-4.62			0.61
	(4.80)	(5.06)	(0.66)			
2.	96.55	-2.40	-0.49	0.59		0.66
	(4.55)	(5.64)	(0.07)	(1.67)		
3.	96.41	-2.42	0.70	0.70	-1.63	0.63
	(4.36)	(5.35)	(0.08)	(1.20)	(0.24)	

Notes and data sources: Figures in parentheses are absolute t-ratios; Number of observations=16; ΔL1= % change in the number of landless rural households; ΔL'= % change in the number of landless rural households, adjusted for migration of households out of the region; $\Delta L1^1$ = % change in the proportion of landless rural households; $\Delta L2^1$ = % change in the proportion of landless rural households, adjusted for migration of households out of the region; L60 = incidence of landlessness in 1960. Data for these variables were taken from Abdullah and Murshid (1986). Other variables are defined as follows: P 5181= growth rate of rural population, average over 1951-81; AG5081 = agricultural growth rate, average over 1951-81; ACREAGE = percentage area under irrigation, average over 1971-81. Data for these variables were taken from Boyce (1989).

Relationship between Landlessness and Poverty

As indicated above, in a traditional agriculture there is :a two-way relationship between landlessness and poverty: poverty increases landlessness and landlessness increases poverty. However, such a relationship is not stable as it could be broken by external shocks to and internal changes in the economy. This is what has happened in Bangladesh. Until the early 1970s, landlessness and rural poverty in Bangladesh moved closely and this was interpreted by most as a causal relationship running from landlessness to poverty, while the incidence of landlessness was caused by rapid population growth. The idea that landlessness causes poverty has been carried over in recent studies on poverty in Bangladesh and the view that the new technology has an adverse effect on the incidence of landlessness has given the landlessness-poverty relationship much prominence. Without appreciating the intricacies of the relationship between landlessness and poverty, many have passionately put forward the hypothesis that the new technology is a contributor to poverty in Bangladesh. However, this does not appear to have been the case for Bangladesh. Even if there had been a causal relationship between landlessness and poverty, such a relationship appears to have been broken in Bangladesh since the mid 1970s. This is manifested in the fact that a rise in the incidence of landlessness in Bangladesh has been accompanied by a fall in the incidence of poverty since the mid 1980s (Ahmed *et al.,* 1991). While the causes of poverty are many and remain complex as ever, it appears that the socio-economic and political changes that have occurred in Bangladesh in recent years have loosened the roots of poverty. The social, economic and political changes that have induced the poor to break their linkages with the land have also pulled them from the poverty trap. The diffusion of the new technology has been one of the factors leading to changes in the occupational structure of the labour force in Bangladesh. While critics suggest that the rural poor are still leaving the land due to intensity of poverty caused 'by landlessness, available evidence does not support this view. However, one cannot deny the fact that the high incidence of poverty in the rural areas and the lack of opportunities for improvement of economic conditions of the poor induce them to seek better opportunities in the urban areas. Note that although the rural poor in Bangladesh can survive by

working in the agricultural sector, they cannot fulfil their rising expectations for better living while working in the farm sector. So it is not necessarily the absolute poverty that pushed the rural poor but an overall improvement of the economic condition of the poor in the rural' areas that might have raised the expectations of the poor for better living and induced them to leave the land.

The fact that the incidence of rural poverty in Bangladesh is falling in the presence of rising landlessness fits well with the modernising agriculture in Bangladesh. Evidence provided above shows that the new technology has lowered the rate of unemployment and underemployment in Bangladesh and, at a given real wage rate, increased the level of wage income of the poor. Rahman and Haque (1988) found that the level of average real household income for the bottom 40 percent of rural households increased from 634 Taka in 1974 to 1085 Taka in 1986 at 1964 prices. This represents an increase of real income of around 70 percent over a period of 12 years.

Despite the fact that there has been a fall in absolute poverty in Bangladesh, there are various other reasons which might have caused a rise in the incidence of landlessness. If it is accepted that the incidence of absolute poverty in Bangladesh has been falling, then it becomes obvious that the rise in the incidence of landlessness is not due to distress sales of land. Note that land transactions in rural areas are made for various reasons other than poverty. One of the channels is of course the leasing out of land of small and medium farmers to rich farmers. As Alauddin and Tisdell (1989) point out, the rising incidence of landlessness in Bangladesh is largely due to a rise in the incidence of sharecropping in reverse order, which arises because the small and marginal farmers are unable to' compete with the rich farmers in adopting the new technology. The decision for a small farmer to cultivate land himself/herself or to lease out is based on a number of factors including his/her non-farm employment opportunities and willingness to invest in the new technology which always carries certain risk, and small farmers by nature are risk-averters (Hossain, 1988). Again, although the rural people are seductively linked with land, due to changes in attitudes and availability of non-farm employment opportunities, many small and marginal farmers might have decided to sell their lands at higher prices, caused by higher demand for irrigated land under the new technology, to invest the proceeds of land sales in the non-farm sectors for the production of goods and services

whose demands might have been increased due to higher income levels of the rural households.

Thus, while a rising incidence of landlessness in a modernising agriculture may raise the incidence of relative poverty, it does not necessarily raise the incidence of absolute poverty. This means that the rich households may gain relatively more from agricultural modernisation, a result of which may be the rise in the incidence of relative poverty. However, at the same time the incidence of absolute poverty may fall due to a significant rise in the mean income level of the poor households without any significant change in the distribution of income against the poor.

V. CONCLUSION

The main objective of this paper has been to examine the impact of the seed-fertilizer-irrigation technology on rural poverty and income distribution in Bangladesh. An agricultural wage determination model has been developed to examine the impact of the new technology on agricultural output, wage rate, underemployment, and income distribution between landowners and wage labourers. The model suggests that the diffusion of the new technology has the potential for raising the wage rate, employment and output, but the impact of the technology on income distribution depends much on whether the technology is labour-using or labour-saving. Regression results suggest that the new technology did not have a significant positive impact on the real wage rate but it had a significant negative impact on the rate of unemployjnent and underemployment in Bangladesh. The new technology has also been one of the factors contributing to changes in the occupational structure of the labour force in Bangladesh. Since a number of non-economic factors have contributed to changes in the occupational structure of the labour force and to the reduction of rural poverty, the net effect of the new technology on poverty cannot be easily disentangled from that of other factors. Empirical results suggest that the new technology did not have a significant impact on the incidence of landlessness and hence the hypothesis that the new technology raises the incidence of poverty through an increase in landlessness is untenable. As a result of socio-economic and political changes during the past two decades, the relationship between landlessness and poverty in Bangladesh appears to have been broken. Since

the rural poor in Bangladesh are no longer absolutely dependent on land for their living, a rise in the incidence of landlessness does not necessarily mean a rise in the incidence of rural poverty.

An obvious implication is that technological progress is a key to rural employment growth, real wage increase, and alleviation of poverty in Bangladesh. Hayami and Ruttan (1984) strongly oppose the idea that the new technology is biased against the poor, although they admit that there were numerous cases where the small or poor farmers lagged significantly behind the large or wealthy farmers in the adoption of the new technology. Such cases were largely a reflection of institutional rather than technical bias. An implication is that the adverse effect of the new technology on income distribution is largely due to institutional reasons rather than a result of the technology itself. Even if the new technology marginally raises income inequality, it is likely to be tolerable in a society where the poor gain in absolute terms and expect to gain in the future (Sundrum, 1983).

Given that the rate of unemployment and underemployment in Bangladesh has gradually declined to a low level since the mid 1980s, any further diffusion of the new technology is likely to raise the real wage rate and lower the real price of food, a result of which could be a further reduction of the incidence of rural poverty. As the level of agricultural productivity in Bangladesh is much lower than even in its neighbouring countries, there is huge potential for an expansion of agricultural production from further diffusion of the new technology (Hossain, 1988). Most experts have the opinion that a moderate growth of agricultural productivity can change the status of Bangladesh from being a food deficit country to a food exporter (Boyce, 1987).

Those who criticise the new technology often fail to appreciate the noneconomic benefits that are associated with the new technology. The alternative to this technology is sheer economic and social stagnation and that would mean the confinement of the poor in the rural areas with poverty and hopelessness as they have been over centuries. Within the traditional economic and social system, the richer section of the community would continue to dominate the rural power structure and institutions and exploit the poor. It appears that whatever may be the complexion of the debate, ultimately the controversy

over the question whether the new technology is a contributor to poverty and income inequality is more a political rather than an economic issue".

NOTES

1. The importance of the new technology in Bangladesh is stated by Hossain (1988:p.131) as, "Technological progress is the key to overcoming the land constraint to growth of foodgrain production in Bangladesh. Indeed, the country has maintained the food-population balance in the post-independence period mainly through technological progress."

2. Many agricultural economists believe that the new technology is the ultimate source of agricultural modernisation and economic growth in developing countries. They also see the benefits of the new technology trickling down to the poorer sections of the community through product and labour markets. In the product market, the impact of a technologically induced rightward shift in the supply function of a staple foodgrain puts a downward pressure on its price and this benefits the urban poor and rural landless classes as consumers (Hayami and Herdt, 1977). In the labour market, the rural poor gain from this technology through higher employment and wages (Mellor, 1978).

3. See Abdullah (1990) and Ahmed et al. (1991) and the references therein.

4. The model developed here is a modified version of the model developed in Hossain (1989). It has some resemblance to the model developed by Hayami and Ruttan (1984).

5. For a critical review of the literature on agricultural wage determination process in developing countries see Hossain (1989).

6. The marginal productivity of labour under the new technology, represented by an upward variation in B, is assumed to be higher than the marginal productivity of labour under the traditional technology.

7. For discussion on the shape of the supply function of labour in a developing country like India see Bardhan (1979).

8. A wage labourer is a person who hires out labour in exchange for wages (paid in cash and/or in kind), and a family labourer is a person who works in his/her family farm and does not receive wages as remuneration but shares output with other members of the family on an egalitarian basis.

9. For simplicity, the landowners are assumed to organise production by providing capital and family labour and hiring wage labour. Since in the present model, land means capital-embodied land, the rental rate includes not only rent in pure sense but also the rate of profit for capital supplied. Compensations for supervision are included into income from family labour.

10. In a traditional agriculture there will not be much increase in wage employment as a result of the reduction of the wage rate (i,e., even if the wage rate falls, the supply of family labour may be maintained due to limited alternative employment opportunities for family workers). This indicates that, ceteris paribus, an exogenous population growth is likely to raise income inequality between wage labourers and landowners.

11. When the increased demand for labour is met by family labour, the new technology would largely lower the level of underemployment among the family labourers rather than open unemployment prevalent among the wage labourers. This has implications for income distribution between landowners with family labour and the landless and near-landless who work as wage labourers (Alauddin, 1988).

12. For example, with the use of the input-output model, Stahl and Habib (1989) studied the impact of remittances on the Bangladesh economy and concluded that "Remittances tend to be spent within those sectors which have linkages with the rest of the economy. Thus many sectors which do not benefit directly from remittance expenditure will nonetheless experience a growth in demand for their output. It is also to be anticipated that such a broad expansion of output will enlarge employment opportunities and stimulate demand for investment goods" (pp. 28384)

13. The antagonists of the new technology emphasise the need for static redistribution of rural assets through measures like land reform, progressive taxation and transfer payments to alleviate poverty. However, in a broader sense the concept of redistribution through growth is more comprehensive than static redistribution because it is linked with a strategy of economic development and because it offers a politically more practical (positive-sum) course than an exclusive concentration on (zero-sum) static redistribution (Killick, 1981). Indeed, in a critical article on land reform, Taslim (1992: p.i) shows that " the economic case for land reform in Bangladesh, contrary to frequent claims, is not well-established. A ceiling-cum-redistributive land reform, which is usually advocated, is not likely to be conducive to a prosperous agriculture. The only

certain outcome of the reform is the attenuation of the rural elite and the growth of a weak peasantry dependent upon state patronage."

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