5 Income dynamics, schooling investments, and poverty reduction in Bangladesh, 1988–2004

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Introduction

Bangladesh achieved remarkable progress in alleviating poverty in the 1980s and 1990s (BBS 2007; Hossain and Sen 1992; Ravallion and Sen 1996; Sen 2003; World Bank 2007a). The Bangladesh Bureau of Statistics (BBS) estimated from the Household Income Expenditure Survey (HIES) that the incidence of poverty in rural areas fell from 55 percent in 1985–6 to 44 percent in 2005. Independent analysis by scholars using standard methodology on the BBS data confirmed that poverty incidence declined by 1 percent per year during 1982–2000 (Sen 2003) and by 2 percent per year during the 2000–5 period when economic growth accelerated to 6 percent per year compared with 4 percent per year over the previous three decades. If Bangladesh can accelerate its economic growth further to about 7 percent per year, it will be on the way to achieving the Millennium Development Goal on halving severe poverty (World Bank 2007a).

Bangladesh is a nation experiencing extreme pressure of population on limited natural resources. Despite rapid rural to urban migration, the average farm size continues to decline and had reached 0.6 hectare by 2005 (BBS 2006). Food grain production has increased at an impressive rate due to the adoption of improved technologies facilitated by the expansion of irrigation with private investment in small-scale equipment, such as shallow tube wells and power pumps. But the potential of economic growth through this means is approaching its limit. Further acceleration of growth will depend on diversification of agriculture and the rural economy, and acceleration of growth in the manufacturing and services sector. Recent experience shows that the rural nonfarm economy has indeed been the main driver of growth in the rural economy (Hossain 2004; Hossain *et al.* 2007).

The acceleration of growth in the nonfarm sector nationally, as well as in rural areas, will depend among many other things on an improvement in the quality of Bangladesh's most abundant resource—its vast labor force. The potential for improvement in human capital is vast, as 40 percent of the population is still illiterate. Although the participation of children in primary schools has increased in recent years, and the gender disparity in primary and secondary education has almost disappeared, the dropout rate is still high, and participation in secondary and postsecondary schools is at very low levels. There is a need for a substantial increase in investment in the education of children from the government and at the household level.

What factors are behind the dramatic decline in the incidence of poverty in Bangladesh? Using household-level data from a nationally representative sample survey from the same set of households in three periods of time over 1988 to 2004, this chapter aims to investigate the changing structure of household income in rural Bangladesh and identify the factors that influence the investment in schooling of children at different levels of education. To achieve our objective, we relate the dynamics of rural poverty to the shift of rural household income away from farm to nonfarm sources, changes in household factor endowments, and the adoption of improved farm technology over time. Inasmuch as household farmland resources have started to decline because of high population pressure on a closed land frontier, we can reasonably expect deterioration in the household income position and an increase in the incidence of poverty. Yet, this did not happen in a period of 16 years from 1988 to 2004 because of the spread of improved farm technology and the development of rural nonfarm activities. The chapter aims to test the hypothesis that the Green Revolution in rice production facilitated investments in schooling for children, who later on joined the nonfarm labor market and earned higher nonfarm income. Higher nonfarm income is the major factor behind the dramatic rise in household income and the reduction in poverty.

This chapter is organized as follows. The second section describes the data and reports the findings on changes in farm characteristics and schooling of children obtained from the sample surveys. The third section provides information on the structure of household income and the trend in poverty as estimated from the household survey data. The fourth section identifies the determinants of different sources of household income. The fifth section explores the determinants of the probability of school enrollment of children of school age. Finally, the sixth section summarizes and concludes this chapter.

Farm characteristics, education, and schooling of children

The data

The data for the study come from a repeat survey of a nationally representative sample of rural households in Bangladesh. The benchmark survey was implemented in 1987–8 by the Bangladesh Institute of Development Studies (BIDS) in 62 villages from 57 out of 64 districts in Bangladesh for a study on the impact of modern agricultural technology (David and Otsuka 1994; Hossain *et al.* 1994). The sample was chosen by using a multistage random

sampling method. In the first stage, 64 unions were randomly selected from a list of all unions in the country. In the second stage, one village was selected from each union that best represented the union with regard to the size of landholding and literacy rate. A census of all the households in the selected villages was conducted to stratify the households by the size of landownership and land tenure. A random sample of 20 households was chosen from each village such that each stratum is represented by its probability proportion.

The International Rice Research Institute (IRRI) studied the same villages in 2000 for a study of the impact of rice research on poverty reduction in Bangladesh sponsored by the International Food Policy Research Institute (Hossain *et al.* 2007). A sample of 30 to 31 households from each of the 62 villages was chosen using the stratified random sampling method. The stratification was based on a wealth-ranking technique of the participatory rural appraisal (PRA) method. The 2000 sample included all households and their descendants covered in the 1987–8 survey. A few new households were included to replace people who migrated from the village. A third round of the survey was conducted by IRRI in 2004 following the households present in the first two waves and their descendants. The sample size consisted of 1,240 households in 1987–8, 1,880 in 2000, and 1,927 in 2004. A few samples were excluded during the data analysis due to incomplete information.

Farm characteristics and adoption of technology

Table 5.1 shows the characteristics of farmland in the three surveys. The average size of cultivated land of farming households decreased from 0.87 hectare in 1988 to 0.65 hectare in 2000 and to 0.59 hectare in 2004. This decline is attributed to the practice of dividing the land among siblings with the split of households over time. Owner farmers constituted the largest group of households in 1988, followed by nonfarm households (including landless agricultural labor households and those engaged exclusively in rural nonfarm activities). Consequently, owner cultivation comprised the largest share of cultivated farm area over 1988–2004. Its share, however, declined over time, whereas there was an increase in the area share of leasehold tenancy and share of land under mortgage. The area under tenancy increased from 21 percent of the cultivated land in 1988 to 32 percent in 2000 and further to 40 percent in 2004. The rapid expansion of the tenancy market has resulted from the tendency on the part of large and medium landowners to engage in nonfarm activities and rent out the land to households that previously used to work as agricultural laborers. As a result, the labor market has shrunk, and the proportion of marginal and small-farm households has increased. In 2004, 61 percent of the rural households were farm households; of these, 36 percent were tenants, with 17 percent being pure tenants with no land of their own. Thus, although the endowment of land per farm household has declined, the expanding tenancy market has provided access to land to land-poor households.

Table 5.1 Farmland characteristics, Bangladesh, 1988–2004

Characteristic	*1988*	*2000*	*2004*
Number of households	1,231	1,872	1,927
Average size of farmland[a]	0.87	0.65	0.59
Land tenure status			
Nonfarming households (%)	34	42	39
Pure-tenant households (%)	9	12	17
Owner-cum-tenant households (%)	20	20	19
Owner-farm households (%)	37	26	25
Area under			
Owner cultivation (%)	79	68	60
Share tenancy (%)	15	21	24
Leasehold tenancy and mortgaged (%)[b]	6	11	16
% area planted with modern rice varieties	33	70	78
% villages with electricity	21	40	61
% area			
With pump irrigation[c]	6	12	18
With tubewell irrigation[d]	18	50	56
Rainfed	76	38	26
Rice yield (t/ha)	2.3	3.6	4.1
Modern rice	3.7	4.2	4.5
Traditional rice	1.9	2.1	2.4

a Refers to holdings of farmer households only.
b Includes land under mortgaged-in arrangements.
c Includes low-lift pump, canal, and river.
d Includes shallow tubewell and deep tubewell.

Note: Parts of this table are drawn from Nargis and Hossain (2006, Table 1, p. 4261).

Technological progress in rice production expanded rapidly, as shown by a dramatic increase in the proportion of land planted with modern varieties (MVs) of rice from 33 percent in 1988 to 70 percent in 2000 and to 78 percent in 2004 (Table 5.1). The spread of MVs was facilitated by an increase in cultivated area with irrigation. The share of cultivated area with irrigation (mostly with shallow tube wells and power pumps owned by farm households) rose from 24 percent in 1988 to 62 precent in 2000, and further to 74 percent in 2004. The presence of irrigation is by far the most important determinant of the adoption of MVs (David and Otsuka 1994; Hossain *et al.* 2007). Rice yield has increased substantially owing to the diffusion of improved technology from 2.6 t/ha in 1988 to 3.9 t/ha in 2004. The yield of both modern and traditional varieties has also increased due to improved crop management practices. There is, however, a large gap in the yield of MVs grown with full irrigation in the dry season (5.4 t/ha) and those grown during the monsoon season under rainfed conditions (3.8 t/ha). As a result, the average yield of MVs is still low at 4.5 t/ha.

Demographics, education of workers, and school enrollment

The demographic characteristics of the population are also undergoing rapid change in Bangladesh. The recent population census taken in 2001 indicated that the annual growth in population at the national level declined from 2.4 percent per year in the 1980s to 1.4 percent in the 1990s due to a rapid decline in fertility rates. A rapid rural–urban migration has taken place with the incremental population being located mostly in urban areas. A similar transformation is noted in our sample. The average size of households declined from 5.9 in 1988 to 5.4 in 2000 and to 5.3 in 2004 (Table 5.2). The number of children of primary school age (age 6 to 11) declined from 1.17 per household in 1988 to 0.73 in 2004. But, the number of children of secondary-school age remained stagnant, indicating that the fertility decline is a relatively recent phenomenon. The proportion of the economically active population (19 years old and above), however, increased substantially during 1988–2004.

Another notable change in the rural economy is the increasing mobility of the rural labor force from agriculture to nonfarm activities (not shown in the table). The number of agricultural workers per household declined mostly due to a reduction in the number of agricultural wage laborers who found employment in rural transport and construction activities. Many also work in

Table 5.2 Demographic characteristics of households, Bangladesh, 1988–2004

Characteristic	*1988*	*2000*	*2004*
Household size	5.93	5.40	5.29
Age of head	42	45	47
Average number of household members			
0 to 5 years old	1.07	0.71	0.65
6 to 11 years old	1.17	0.80	0.73
12 to 17 years old	0.79	0.84	0.79
18 to 24 years old	0.66	0.65	0.66
25 years old and above	2.24	2.40	2.45
Working-age members 19 + with			
No schooling (%)	58	41	41
Primary schooling (%)	22	27	23
Secondary schooling (%)	11	18	20
Tertiary schooling (%)	9	14	16
Total (%)	100	100	100
Average years of schooling completed by parents			
Male spouse	2.99	3.73	3.69
Female spouse	1.16	2.49	2.64
Average years of schooling completed by all other members 19 +			
Male children	3.57	6.82	7.35
Female children	1.18	3.86	4.70

petty trading, livestock and poultry farms (as a part-time activity), and agro-processing, with access to micro-credit provided by a large number of NGOs.

Occupational mobility has been facilitated by the improvement in education of the labor force. The proportion of the working-age population (over 18 years) with no formal schooling declined from 58 percent in 1988 to 41 percent in 2000 (but with no further improvement since then) and those with secondary and above secondary education have increased from 20 percent in 1988 to 32 percent in 2000, and further to 36 percent in 2004 (Table 5.2). The average schooling for the male spouse increased from 3.0 to 3.7 years from 1988 to 2004, and that of the female spouse from 1.2 to 2.6 years. More impressive is the progress in the educational attainment of the younger members in the labor force. The educational attainment of other family members in the labor force increased from 3.6 to 7.4 years for male family workers and from 1.2 to 4.7 years for female family workers.

The improvement in school participation of children is also noteworthy. Children, as a whole, gained about 0.5 more years of schooling than their parents in 1988. The gap increased to about 3 years, indicating that parents invested in children's schooling in more recent years. The school participation rate for primary-school children (age 6–11) increased from 63 percent to 93 percent for boys and from 55 percent to 94 percent for girls within 1988–2004. For the secondary-school children (age 12–17), the participation rate remained stagnant at 60 percent for the boys, but improved dramatically from 42 to 73 percent for the girls (Figure 5.1). Thus, the gender disparity in education at the primary and secondary level has disappeared. School enrollment rates of male and female children in primary school do not seem to differ markedly because primary schools are free and available even in more

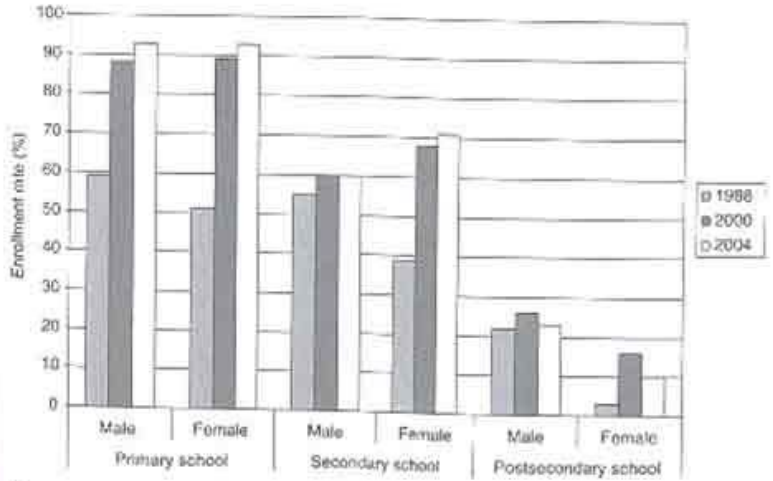


Figure 5.1 School enrollment rates by gender of children, Bangladesh, 1988–2004.

remote villages. The participation rate at the postsecondary level has remained very low, with only marginal improvement for girls.

The progress in school participation for both boys and girls at the primary level and for girls in secondary school is a result of policy support from the government of Bangladesh. In 1993, the government started the Food for Education Program, which was later replaced by the Cash for Education Program. Under this program, households that have primary-school children are eligible to receive grains (or cash) if the children are able to attend 85 percent of classes each month (Ahmed and Del Ninno 2003). Because all children are treated equally regardless of gender, this program might have contributed to the relatively equal enrollment rates of boys and girls in primary school. The government also introduced a policy of free education of girls in secondary schools in 1994, and a small stipend for them in 2001. This positive policy encouraged parents to send female children to secondary school. But parents from poor economic backgrounds withdrew male children early from secondary school to engage them in farm work. According to the law, the minimum age at marriage is 18 for girls and 21 for boys, but this is not strictly enforced. The early marriage of girls at age 13–16 is still widely prevalent in rural Bangladesh. This cultural practice is responsible for the low participation of girls in post-secondary education.

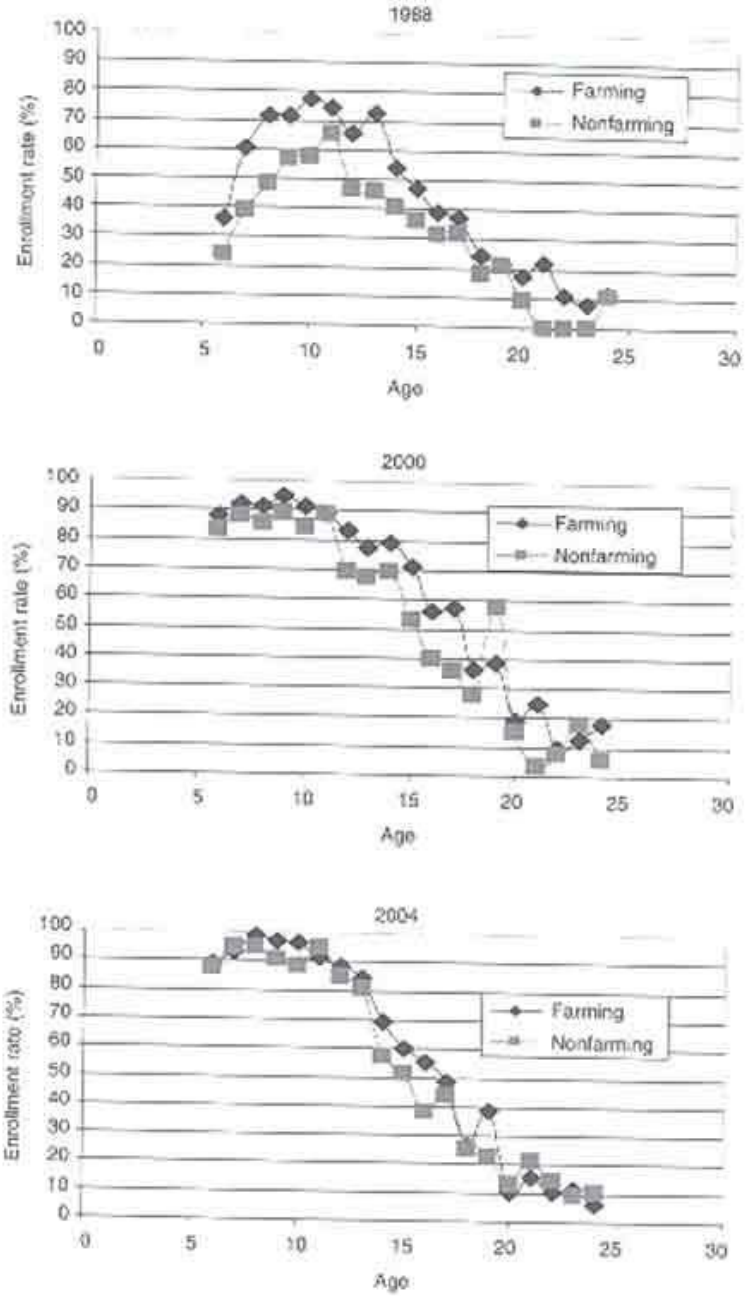
If farmland is an important source of funds to send children to school, we can expect that the children of farmer households will have a higher rate of enrollment. Figure 5.2 shows that such was the case in 1988 but was no longer the case in 2004, when children of landless households had almost the same rate of enrollment at all levels of school as the children from farm households.

In brief, we have seen notable demographic changes in Bangladeshi households, including a decline in household size, a rise in nonfarm employment, and increased in-school participation of children. These changes seem to be favorable drivers for a reduction in rural poverty in Bangladesh.

Structure of household income and incidence of poverty

Household income

Sources of income have been classified as follows: (1) farm income consisting of income from rice and nonrice crop production, fishing, poultry, and livestock and off-farm wages; and (2) nonfarm income consisting of remittances and nonfarm wage income including self-employment. Nonfarm income includes income from trade and businesses (including shop-keeping, rental payments, and contractor fees), service (salaried and personal services and pensions), and other income (from construction, transportation, agro-processing, and industrial labor). Household consumption of self-produced crops, livestock, forestry, and fishery products is imputed using the average prices for the entire sample for the reference year of the survey and then



5.2 School enrollment rates by age of children and type of households, Bangladesh, 1988–2004.

included in the respective income components. The changes in the composition of household income across these groups for both farmer and landless households can be seen in Table 5.3.

Rice production was by far the most important source of income for farm households in 1988. The share of rice production and off-farm wage income mainly coming from rice production activities declined over time, whereas the share of nonfarm income, most importantly nonfarm wage income, rose

Table 5.3 Sources of income of farmer and landless households, Bangladesh, 1988–2004

Source	*1988*	*2000*	*2004*
Farmer households			
Farm (%)	66	53	54
Rice production (%)	35	22	20
Nonrice crop production (%)	11	12	15
Fishing, poultry, and livestock (%)	12	15	14
Off-farm wages (%)	8	4	5
Nonfarm (%)	34	47	46
Remittances (%)	5	10	11
Nonfarm wages (%)[a]	29	37	35
Total (%)	100	100	100
Household income (in current Tk)	35,309	67,083	75,507
Household income (in current US$)	1,112	1,286	1,269
Household size	6.36	5.69	5.59
Per capita household income (current Tk)	5,551	11,789	13,507
Per capita household income (in current US$)	175	226	226
Landless households			
Farm (%)	39	22	23
Rice production (%)	0	4	5
Nonrice crop production (%)	1	2	2
Fishing, poultry, and livestock (%)	8	8	9
Off-farm wages (%)	30	8	7
Nonfarm (%)	61	78	77
Remittances (%)	5	18	20
Nonfarm wages (%)	56	60	57
Total (%)	100	100	100
Household income (in current Tk)	23,398	46,667	57,595
Household income (in current US$)	737	895	968
Household size	5.10	5.01	4.81
Per capita household income (in current Tk)	4,587	9,314	11,974
Per capita household income (in current US$)	144	178	201

a. Includes income from trade, business, services, and regular wage employment.

dramatically. The share of rice farming income in farm household income declined from 35 percent in 1988 to 22 percent in 2000 and to 20 percent in 2004, but it continued to be an important source of income for farm households (Table 5.3). Among the nonfarm income components, the income share from nonfarm wage including self-employment, such as trade and business, rose, and the income share of local services (teaching, medical care, religious preaching, and various types of self-service) remained steady in 2000 and 2004.

Nonfarm income comprised the largest share of total household income of the landless households. Its share rose dramatically from 61 percent in 1988 to 78 percent in 2000, but remained stable at that level during 2000–4. In contrast, the share of off-farm wage income dropped from 30 percent in 1988 to 8 percent in 2000 and to 7 percent in 2004, which is an indication of the shrinking rural agricultural labor market. The main drivers behind this change are (1) the expansion of the rural tenancy market with agricultural activities being conducted by family labor belonging to tenant households, (2) the reduction in demand for agricultural labor due to the rapid adoption of mechanization in land preparation and threshing activities, and (3) increased employment opportunities for landless households in the rural transport sector because of the development of rural roads. The expansion of the nonfarm labor market for landless households can be noted from the expanding share of income originating from rural nonfarm activities. It is interesting to observe the rise in importance of remittance income for landless households, whose share of total income rose from 5 percent in 1988 to 18 percent in 2000 and to 20 percent in 2004. Overall, we can see a clear indication of the shift in income-earning opportunities of rural households away from rice cultivation and agricultural wage labor to transport, petty trade, small businesses (supported by micro-credit), and remittances from relatives working in cities and small towns (many working in the garment industry that has also expanded rapidly in recent years). This changing income structure has also been reported in the case of the Philippines (Chapter 2) and Thailand (Chapter 4).

Poverty situation

The deficiency in income to satisfy basic needs is by far the most widely used definition of poverty. Income poverty is usually assessed from the survey data by estimating a poverty line using the cost of basic needs method (using a normative food basket and estimating the cost of the basket by prevailing market prices for each food item and making a provision that at the margin of poverty households spend 30 percent of their income on nonfood basic needs), and applying it to the distribution of household income (BBS 2007; Hossain and Sen 1992; Muqtada 1986; Ravallion and Sen 1996; World Bank 2007a). Applying this method to the data set, Nargis and Hossain (2006) estimated that the incidence of poverty declined from 62 percent in 1988 to 48 percent in 2000 and further to 44 percent in 2004.

In order to make the estimates comparable across countries in this volume, we used the World Bank norm of one dollar a day per person as the income poverty line. We used the purchasing power parity (PPP) exchange rates provided by the World Bank (Chen and Ravallion 2004) to convert the nominal incomes estimated from the survey for the three reference periods into PPP against the US dollars and then estimated different measures of poverty using the FGT indices.[1]

Table 5.4 shows the estimates of the three measures of poverty for farmer and landless households. In 2004, about 31 percent of rural households were poor; 38 percent among farm households and 35 percent among the landless. Both groups experienced a reduction in poverty incidence, but progress has been faster for the landless households than for farmer households. The gap in the incidence of poverty between the farmer and landless households was 20 percent in 1988, which was narrowed down to only 7 percent by 2004. The numbers in Table 5.4 also show substantial improvement in the intensity and severity of poverty. Progress in poverty reduction has been faster in more recent times.

Nargis and Hossain (2006) followed up the panel of households over time to observe that 28 percent of the poor households were unable to rise above the poverty line over 1988–2000. After another four years, this figure was still 27 percent. The problem of persistence of poverty aside, things appear to be changing in favor of movement out of poverty. The rate of exit from poverty, given by the percentage of households that started poor in 1988 and ended up being nonpoor in 2004, appears to be more than twice as high as the rate of entry into poverty, given by the percentage that started nonpoor in 1988 and turned poor in 2004. The rate of exit is found to be higher than the rate of entry even in the short run from 2000 to 2004.

Table 5.4 Poverty situation, Bangladesh, 1988–2004

Poverty situation	*1988*	*2000*	*2004*
Farmer			
Head-count ratio	38	37	28
Poverty gap ratio	13	12	9
Squared poverty gap ratio	6	6	4
Landless			
Head-count ratio	58	45	35
Poverty gap ratio	22	18	13
Squared poverty gap ratio	11	10	7

a. The absolute poverty line is taken at US$1 a day per person. It is estimated using the exchange rate at purchasing power parity prices and converting the nominal income by the exchange rate. Household size is used as a weight in the poverty calculations to correct for possible sampling bias associated with household size.

The dynamics of factors affecting income and poverty

To relate the decline in poverty to income transformation, we estimate separate household income determination functions for each income component for each year given by the equation

$$ln\, Y_{it} = X_{it}\beta + \varepsilon_{it}, \qquad i = 1,2,\ldots,N;\ t = 1988, 2000, 2004 \tag{5.1}$$

where Y_{it} stands for household income components consisting of rice, nonrice, and nonfarm in year t, β is a vector of regression coefficients, which measures the returns to respective explanatory variable X_{it}. The term ε_{it} is the random disturbance term assumed to be independently and identically normally distributed with zero mean and constant variance. We used the Tobit method for estimation of the parameters of the income function because many households did not have income from each of the three sources, and hence the values are truncated at the lower end.

X is a vector of household-specific characteristics such as (1) the size of farmland by tenure such as owner cultivation, share tenancy, leasehold tenancy, and rented-out arrangement; (2) infrastructure and technological variables represented by the proportion of cultivated area under irrigation (IR), the percent of cultivated land planted with modern rice varieties (MV) of rice, and a village-level dummy for access to electricity; (3) the number of workers in the young (19–30), adult (30–50), and old (51 and over) age groups, and the proportion of male workers (to reflect the gender differential in labor productivity); (4) the proportion of working-age members with primary, secondary, and tertiary schooling to reflect the differential productivity of education at different levels; (5) the proportion of family members working in cities, rural towns, and abroad and sending remittances to the family; and (6) village-level dummy variables that reflect location of the variables in different unfavorable agroecosystems (flood-prone, drought-prone, coastal saline, and coastal nonsaline; keeping the favorable ecosystems as a control) to reflect unobservable cultural and ecological attributes that the geographical location of the household reflects. A particular characteristic of rural Bangladesh is vast expansion in the supply of micro-credit during the period under study that is provided by nongovernmental organizations to land-poor households to support generation of self-employment. A household-level dummy variable, with value of unity for households borrowing from NGOs and zero otherwise, was included to assess the effect on rural incomes from different sources.

The dependent variable, income, is measured in US dollars by converting nominal values with the prevailing exchange rate during the reference year of the survey. The exchange rate moved in line with the wholesale price index; hence, the regression parameters reflect real values. The use of dollar units also facilitates international comparison of the numbers.

The adoption of MVs was facilitated by the expansion of irrigation infrastructure, so the values of the two variables are highly correlated. To

avoid the problem of attribution, the variables are measured in interaction terms (David and Otsuka 1994) by multiplying the proportion of cultivated land irrigated (IR) by MV rice area as a percent of cultivated land. The MV area was counted twice if it was cultivated twice during the year. The coefficient of IR*MV will measure the effect of technology if used under irrigated conditions, while the coefficient of (1—IR)*MV will measure the effect of modern varieties grown under rainfed conditions.

Determinants of rice income

The estimated values of the income function for rice (Table 5.5) show that land endowment is the most important determinant of income. In 2004, 1 hectare of cultivated land contributed US$587 to rice income, while 1 hectare of land rented under a sharecropping arrangement generated income of $352 per year, suggesting that 40 percent of the incremental return was paid as rent to a landowner. If the household rented out the land, the return was $221, about 37 percent of the return if the land were self-cultivated. A lower return is obtained if the land is rented in under a fixed rent or leasehold contract. The marginal returns from owned and sharecropped land remained almost constant over 1988–2004, while the returns from leasehold land declined over time because of the gradual increase in rent for such land. The returns from rented-out land increased over time. This could explain the incentives on the part of large and medium landowners to rent out land under a tenancy market in favor of engagement in rural nonfarm activities, a phenomenon of the expansion of the tenancy market in rural Bangladesh that was reported earlier.

The coefficients of the technology variables indicate that the adoption of technology contributed to an increase in rice income by 27 percent in 1988. The finding on the positive impact of farm size and technology on rice income gives support to Hypothesis 1 in Chapter 1 that land and technology are important determinants of farm income. With the rapid diffusion of the technology, however, the contribution declined to 20 percent in 2000 and further to 10–14 percent in 2004. It is interesting to note that there is no significant difference in the value of the coefficient for MV variables under irrigated and rainfed conditions. This may appear surprising since the yield of MVs grown with irrigation during the dry season (boro rice) is about 1.5 t/ha higher than MV rice grown under rainfed conditions during the monsoon season (aman rice). This result might be explained, at least partly, by the fact that the input cost on account of irrigation and chemical fertilizers is substantially higher for the cultivation of irrigated rice than for rainfed rice, and the cost difference has increased substantially due to the increase in irrigation charges. Profitability in rice cultivation is now higher for aman than for boro, but farmers continue to cultivate boro due to the higher profitability than with nonrice crops grown during the dry season, and the higher yield of boro contributes to the objective of achieving household food security.

The coefficient of the worker variable was negative in the rice equation

Table 5.5 Determinants of rice income, Bangladesh, 1988–2004 (Tobit)

Determinant	*1988*		*2000*		*2004*	
	Regression coefficient	*t-value*	*Regression coefficient*	*t-value*	*Regression coefficient*	*t-value*
Cultivated own land (ha)	578**	52.38	526**	44.59	587*	86.08
Sharecropped land (ha)	334**	11.75	356**	10.13	353*	16.81
Leased-in land (ha)	414**	9.53	208**	5.30	186**	8.96
Rented-out land (ha)	10	0.34	341**	19.94	221**	21.08
Irrigated MV[a]	0.27**	14.54	0.22**	17.88	0.14**	18.46
Rainfed MV	0.29**	13.38	0.19**	7.08	0.09**	4.88
Number of workers						
At age 19 to 30	−42.05**	−4.53	−18.71**	−2.20	−18.75**	−3.61
At age 30–50	−25.14**	−2.21	−16.71	−1.53	−24.83**	−3.53
At age 50 and above	−0.01	−0.00	−2.32	−0.19	7.32	0.96
Male worker (% of total)	−.029	−0.06	−0.133	−0.25	−0.42	−1.17
Workers with primary schooling (% of total)	0.467	1.57	−0.085	−0.32	0.121	0.66
Workers with secondary schooling (% of total)	−0.040	0.10	0.030	0.10	0.269	1.37
Workers with tertiary schooling (% of total)	0.130	0.15	0.823	1.48	0.741**	2.35
Migrated workers (% of total)	−0.482	−0.35	0.350	0.68	0.423	−1.09
Households borrowing from NGOs (dummy)	−18.30	−0.20	−39.19	−1.56	−5.44	−0.35
Village-level dummy						
Access to electricity	48.38**	2.14	14.99	0.85	2.56	0.24
Flood-prone	9.39	0.38	23.07	0.92	1.06	0.07
Drought-prone	22.83	0.87	19.70	0.79	−30.03*	−1.93
Coastal saline	40.82	1.26	49.10	1.57	29.10	1.51
Coastal nonsaline	71.48**	2.66	59.25**	2.28	18.52	1.15
Constant terms	−228**	−6.38	−268**	−7.10	−128**	5.09
Number of observations	1,225		1,872		1,927	
Log likelihood ratio	−5,589		−9,386		−9,538	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

a Modern varieties of rice.

for all age groups, indicating the presence of diminishing returns to family labor in rice farming. The transfer of labor from rice farming to nonfarm activities within rural areas, and/or from rural to urban areas, a process of agrarian transformation that Bangladesh is currently experiencing, would have a negative effect on income from rice farming.

The infrastructure variable and remittances do not affect rice income, as indicated by statistically insignificant coefficients of the variable representing village access to electricity, and the dummy variable for households receiving remittances from relatives residing in towns and abroad. The access to micro-credit from NGOs also does not affect rice income. The village-level dummy variables representing unfavorable agroecosystems did not produce consistent coefficients and the values are statistically insignificant in most cases. Rice income was found to be higher and statistically significant in the nonsaline coastal areas in 1988 and 2000. Presumably, the households in these villages benefit from natural irrigation from regular tidal fluctuations while not suffering much from the negative effects of saline soils on the sea coast. Households in drought-prone areas had statistically significant lower incomes compared to favorable ecosystems only in 2004, but not in the other two periods.

The education variables did not have statistically significant coefficients in the rice income equation, except for tertiary education. This indicates that primary and secondary education do not constrain the adoption of improved technologies in Bangladesh. The improved technologies that have spread in Bangladeshi agriculture relate to modern rice plants, which embody better genetic characteristics. New varieties are introduced to a few enterprising farmers by government extension agents and/or private-sector seed companies. If they are found to be more profitable than existing varieties, they spread through farmer-to-farmer exchange of information and supply of seeds. Education is therefore not a prerequisite for the dissemination of these simple technologies. Education may, however, be required for the extension of knowledge-intensive crop and natural resource management technologies required for reducing yield gaps and better managing soil and water resources, which are now becoming important for rice farming in Bangladesh with the horizontal expansion of improved seeds that is almost complete. For this role of education to be effective, children must be educated beyond primary school, and the curriculum must include knowledge of modern management practices that comes out of research stations.

Determinants of nonrice crop income

Land endowment is also a major driver of nonrice farm income, but the values of coefficients are lower than those for the equation for rice (Table 5.6). In 2004, 1 hectare of own land in nonrice crop farming generated an income on the margin at $179, and sharecropped land at $92. The marginal return from leasehold land, however, was almost three times higher ($571) than from owned land. This indicates that crop diversification is practiced by relatively

Table 5.6 Determinants of nonrice income, Bangladesh, 1988–2004 (Tobit)

Determinant	*1988*		*2000*		*2004*	
	Regression coefficient	*t-value*	*Regression coefficient*	*t-value*	*Regression coefficient*	*t-value*
Cultivated own land (ha)	109**	6.59	174**	9.59	221**	10.33
Sharecropped land (ha)	19.23	0.43	179**	3.66	185**	3.90
Leased-in land (ha)	121	1.75	686**	12.51	652**	14.15
Rented-out land (ha)	108**	3.02	138**	5.90	95**	4.06
Irrigated MV[a]	−0.02	−1.40	−0.003*	−1.69	−0.06**	3.84
Rainfed MV	−0.01	0.85	0.01	−0.34	−0.07*	1.67
Number of workers						
At age 19–30	80.23**	6.48	17.04	1.55	34.78**	3.12
At aged 30–50	84.82**	5.32	62.07**	4.46	110.34**	7.46
At age 50 and above	52.63**	2.70	73.40**	4.75	84.27**	5.27
Male workers (%)	2.23**	3.41	0.789	1.20	2.36**	3.21
Workers with primary schooling (% of total)	−0.552*	−1.29	−0.459	−1.35	−0.129	−0.34
Workers with secondary schooling (% of total)	−1.870**	−3.08	0.391	0.95	−0.075	−0.11
Workers with tertiary schooling (% of total)	−1.258	−0.97	1.378**	1.97	1.97	0.17
Overseas workers (% of total)	2.65	−1.21	0.242	0.35	−0.744	−0.90
Households borrowing from NGOs (dummy)	−38.19	−0.31	4.88	0.16	−27.30	−0.88
Village-level dummy						
Access to electricity	21.81	0.68	49.33**	2.24	12.06	0.54
Flood-prone	58.51*	1.67	−59.25*	1.94	−141**	−4.45
Drought-prone	−15.82	−0.42	−48.49	−1.57	35.09	1.10
Coastal saline	−34.26	−0.73	−43.42	−1.14	−241**	−6.08
Coastal nonsaline	46.14	1.19	69.51**	−2.12	−143**	−4.22
Constant terms	−57	−1.20	−51	−1.12	9.69	0.19
Number of observations	1,225		1,872		1,927	
Log likelihood ratio	−8,606		−13,692		−14,315	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

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smaller farm households, and leasehold land is used to grow high-value crops such as vegetables. Those who rent out under sharecropping or a fixed-rent system did not earn much income from nonrice economic activities. Presumably, tenants pay rent for such land in terms of rice, even if they use some of the land for nonrice crop farming.

In contrast to the rice income equation, the coefficient of the worker variable is positive and significant in the equation for nonrice farm income. The marginal returns to labor in nonrice crop production activities have also increased over time. These findings suggest a positive effect of crop diversification on the growth of rural income with the passage of time.

As in the case of rice income, education of the worker does not seem be a significant determinant of nonrice farm income. It seems that the technologies used in nonrice farm activities are also simple and a lack of education does not constrain the adoption of those technologies.

Determinants of nonfarm income

The function for nonfarm income shows a negative coefficient for the land variables (Table 5.7), indicating that farming with much access to land constrains participation in nonfarm activities. The large negative and statistically significant coefficient of the variable representing sharecropped land indicates that, because of engagement in farming, the tenant households do not engage themselves in rural nonfarm activities.

The value of the coefficient of the worker variable is high and statistically highly significant. In 2004, an additional worker in the age group 30–50 years earned on the margin $268 during the year. The marginal returns for labor were lower for both the older and younger age groups. The male workers earned about 63 percent higher returns than the female workers. The returns from labor in nonfarm activities, however, fluctuated widely over the time period under study. The returns in 2000 were substantially higher than in 1988, but declined over the 2000–4 time period. The lower returns in 2004 could be explained by the deterioration in the quality of infrastructure, particularly rural electrification.

Households located in villages with access to electricity obtained higher nonfarm income because rural electrification goes along with the growth of the rural nonfarm sector and the associated technological shift from manual to mechanical power. This contribution has declined in recent years because of a deterioration in the quality of service, with inadequate generation of power in relation to the rapid growth in demand. The supply of electricity has become increasingly irregular in recent years. The supply has been rationed more in villages than in cities and rural towns. This factor may also explain the lower marginal return from labor in 2004 than in 2000.

The dummy variable representing access to micro-credit received from NGOs was found to be positive, and the value of the coefficient is statistically significant in two of the three years. The value of the coefficient in the

Table 5.7 Determinants of nonfarm income, Bangladesh, 1988–2004 (Tobit)

Determinant	*1988*		*2000*		*2004*	
	Regression coefficient	*t-value*	*Regression coefficient*	*t-value*	*Regression coefficient*	*t-value*
Cultivated own land (ha)	−211**	−3.90	−144**	−2.42	−88**	−2.15
Sharecropped land (ha)	−548**	−3.33	−637**	−3.95	314**	3.39
Leased-in land (ha)	−174	−0.78	−314	−1.65	730**	12.58
Rented-out land (ha)	360**	3.14	318**	4.18	187**	4.16
Irrigated MV[a]	−0.057	−0.61	−0.18**	3.37	−0.12**	−3.89
Rainfed MV	−0.048*	0.45	−0.07	−0.57	0.12	1.47
Number of workers						
At age 19–30	245**	5.67	389**	10.82	172**	8.07
At age 30–50	257**	4.91	525**	11.59	268**	9.71
At age 50 and above	245**	3.92	368**	7.24	220**	7.62
Male workers (% of total)	−3.69*	−1.76	4.29**	2.02	0.634	0.45
Workers with primary schooling (% of total)	3.92**	2.92	2.22*	1.97	2.37**	3.29
Workers with secondary schooling (% of total)	6.64**	3.46	4.97**	3.68	3.78**	4.74
Workers with tertiary schooling (% of total)	20.05**	4.97	16.18**	7.12	9.57**	7.34
Migrant workers (% of total)	69.57**	10.56	18.58**	8.48	25.73**	16.27
Households borrowing from NGOs (dummy)	669*	1.79	137	1.40	151**	2.53
Village-level dummy						
Access to electricity	323**	3.15	408**	5.64	182**	4.22
Flood-prone	190*	1.67	−55	−0.55	−174**	−2.85
Drought-prone	258**	2.16	−302**	−2.92	−185**	−2.98
Coastal saline	269*	1.82	78	0.63	54	0.71
Coastal nonsaline	207	1.65	−2.81	−0.03	−135	−2.07
Constant terms	−821**	−5.24	−1,291**	−8.31	−317**	−3.24
Number of observations	1,225		1,872		1,927	
Log likelihood ratio	−6,652		−12,432		−14,964	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

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equation for 2004 indicates that households that had access to such credit earned nonfarm income of $150 more than households that did not have access to such credit.

The coefficients of all education variables are statistically significant, indicating that education is the major driver for the growth in nonfarm income. This supports Hypothesis 2 in Chapter 1 on the increasing importance of education in generating nonfarm income. The substantially higher values of the coefficient of secondary and postsecondary education indicate higher returns to investment in education if a child remains in school for a longer period. With the expansion of education, marginal returns from education in the nonfarm sector have declined over time.

The coefficient of the migrant worker variable is highly statistically significant, indicating the impact of remittances on the expansion of rural nonfarm activities and earnings of households with migrant members. Education often facilitates rural to urban migration because of better employment opportunities of educated workers and higher earnings in the manufacturing and service-sector activities located in urban areas. The positive and statistically significant coefficient of the migrant worker variable therefore signifies the effect of education on nonfarm income, which spills over from rural to urban areas.

The determinants of school enrollment

To explore the determinants of school enrollment, we used a Probit model and estimated the probability of school enrollment of children of primary, secondary, and tertiary school age groups for several determinants that may affect school participation. The determinants included in the model are (1) predicted values of rice income, nonrice income, and nonfarm income obtained from the first-stage income functions reported in Tables 5.5 to 5.7; (2) average educational attainment of adult male and female members separately; (3) the dummy for eldest son and eldest daughter as they receive positive or negative discrimination in the family with regard to educational investment; (4) the dummy for daughter (to test whether the girl child is discriminated compared with boys with regard to investment in education); (5) the number of brothers and sisters, which determines the burden on the family with regard to educational investment; (6) the dummy for age of the child; and (7) the dummy for location of the village at the division level to capture unobserved location effects and other cultural effects.[3] To simplify our presentation, we did not show the coefficients and t-values of variables 6 and 7 in Tables 5.8 to 5.10.

The probability and associated z-statistics obtained from the Probit regressions for determinants of enrollment of children in the primary, secondary, and tertiary school-age groups are reported in Tables 5.8, 5.9, and 5.10, respectively. Rice income positively and significantly affected the probability of enrollment of children in primary schools in 1988 and 2000, but the coefficient is

Table 5.8 Factors affecting school enrollment for children, primary school, Bangladesh (Probit)

Determinant	*1988*		*2000*		*2004*	
	Coefficient	*z-value*	*Coefficient*	*z-value*	*Coefficient*	*z-value*
Predicted rice income (US$100)	0.055**	4.28	0.036*	1.85	0.026	1.03
Predicted nonrice income ($100)	−0.058*	−1.68	0.040	−1.04	−0.024	−0.85
Predicted nonfarm income ($100)	0.038**	2.38	−0.002	−0.027	0.012	0.85
Education of adult male members	0.051**	3.71	0.070**	3.43	0.020	1.06
Education of adult female members	0.075**	2.81	0.081**	3.39	0.036	1.40
Dummy for eldest son	0.143	1.13	0.143	0.90	−0.030	−0.16
Dummy for eldest daughter	0.131	1.12	0.028	0.24	−0.054	0.34
Dummy for daughter	−0.204**	−2.32	0.366**	2.60	0.027	−0.13
Number of sisters	0.028	0.85	−0.118**	−2.77	−0.072	−0.77
Number of brothers	−0.082**	−3.07	0.003	0.09	0.999	1.01
Constant terms	0.277	1.00	0.370	1.39	0.991**	3.06
Number of cases	1,440		1,498		1,416	
Log likelihood ratio	−787		−462		−309	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

Table 5.9 Factors affecting school enrollment for children, secondary school, Bangladesh (Probit)

Determinant	*1988*		*2000*		*2004*	
	Coefficient	*z-value*	*Coefficient*	*z-value*	*Coefficient*	*z-value*
Predicted rice income (US$100)	0.042**	3.25	0.071**	4.63	0.030*	1.95
Predicted nonrice income ($100)	−0.058	−1.54	0.003	0.16	0.024	1.15
Predicted nonfarm income ($100)	0.033**	2.67	0.008	1.36	0.009	0.93
Education of adult male members	0.072**	4.37	0.064**	4.72	0.074**	5.36
Education of adult female members	0.049*	1.74	0.123**	6.42	0.097**	5.36
Dummy for eldest son	0.108	0.64	0.178	1.22	0.132	−0.89
Dummy for eldest daughter	0.171	1.19	−0.110	−0.97	0.156	1.42
Dummy for daughter	−0.493**	−4.87	0.314**	3.43	0.436**	2.25
Number of sisters	−0.017	−0.43	0.037	0.98	0.074	0.80
Number of brothers	−0.036	−1.17	−0.043	−1.38	−0.085	0.93
Constant terms	1.00**	−3.00	−1.59**	−6.81	−1.77**	−6.80
Number of cases	975		1,578		1,530	
Log likelihood ratio	−544		−768		−737	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

Table 5.10 Factors affecting school enrollment for children, tertiary school, Bangladesh (Probit)

Determinant	*1988*		*2000*		*2004*	
	Coefficient	*z-value*	*Coefficient*	*z-value*	*Coefficient*	*z-value*
Predicted rice income (US$100)	0.073**	4.92	0.036**	2.55	0.026*	1.68
Predicted nonrice income ($100)	−0.022**	−4.85	0.033	1.12	0.018	0.69
Predicted nonfarm income ($100)	0.008	0.78	−0.019**	−2.21	0.021**	−2.13
Education of adult male members	0.059**	2.57	0.076**	4.72	0.093**	5.28
Education of adult female members	0.134**	4.01	0.098**	5.13	0.091**	4.67
Dummy for eldest son	0.860**	2.33	0.058	0.37	0.176	−1.08
Dummy for eldest daughter	0.318	1.64	0.372**	3.00	0.031	0.026
Dummy for daughter	−1.169**	−6.87	−0.505**	−4.64**	−0.636	−3.93
Number of sisters	0.014	0.24	0.056	1.30	0.076	1.18
Number of brothers	0.037	0.80	−0.067	−2.03	−0.007	−0.11
Constant terms	−3.33**	−5.60	−2.49**	−6.42	−2.56**	−7.28
Number of cases	885		1,308		1,410	
Log likelihood ratio	−214		−524		−495	

** Denotes statistical significance of the coefficient at 5% level and * at 10% level.

not statistically significant in the equation for 2004. Indeed, none of the variables are statistically significant in the equation for primary school enrollment for 2004. It is because participation in primary school became almost universal by 2004, and, hence, there was very little variability in the explanatory variable. In the equation for the secondary and tertiary age groups, the probability of participation is also positively and significantly associated with income from rice farming for all three years. It is thus reasonable to conclude that improved rice technology has made a positive impact on school enrollment by increasing income and the demand for schooling, rendering support to Hypothesis 4 in Chapter 1 on the importance of farm income as a source of schooling funds in the early stage of development.

Nonrice income had a significantly negative impact on postsecondary enrollment in 1988 and nonfarm income had a negative impact on enrollment at the tertiary level in 2000 and 2004. The results suggest a high opportunity cost of keeping children in school for more years, particularly for low-income households engaged in nonrice and nonfarm activities. This is in contrast to the Philippine case in Chapter 2, which shows the important role of nonfarm income in financing schooling investments in the early 2000s. As noted earlier, the marginal productivity of labor, or wage income, would not decline in these activities when labor supply increases. The poor households withdraw their children, particularly the boys, from schools at an early age to augment household income by engaging them in family enterprises. Only children from the economically better-off households who can afford the investment to complete tertiary schooling (with high probability of finding a job in the service sector) continue to complete secondary schooling.

In poor households, the eldest child sometimes has to make a sacrifice with regard to schooling, as she/he has to work to augment family income. The younger children may, however, obtain a better employment opportunity if the elder siblings succeed in improving the livelihood of the family. The coefficients of the dummy variable for the eldest son and/or daughter are not statistically significant in either of the equations. Thus, the birth order of the child does not seem to be an important factor influencing investment in education in Bangladesh.

The coefficient of the dummy variable for daughter was negative and significant in the equation for primary school in 1988, but no longer so in the equation for 2000 and 2004. This shows that the discrimination against girls that prevailed earlier has disappeared as participation in primary school became almost universal in recent years. It is interesting to note that the coefficient for daughters in the equation for secondary schools is negative for 1988 but positive for 2000 and 2004 and all the coefficients are statistically significant. This shows a preference for girls over boys in the investment in secondary schooling in recent years perhaps because of the recently increasing availability of labor employment opportunities for females. This result confirms the positive impact of the affirmative policy of providing free secondary education and a stipend for girls in secondary schools that the government introduced in the mid-1990s. At the tertiary level, however, the coefficient for the dummy variable for daughter is negative and statistically significant in all three years. This shows that gender discrimination against girls with regard to investment in education at the tertiary level continues.

The most significant driver of school enrollment is the education level of adult family members. The coefficient of the average years of schooling of family workers aged 19 years and over is positive and significant in all the equations. Presumably, parents with higher education perceive higher income-earning opportunities and a better life for educated children compared with parents who are illiterate, which motivates them to invest in children's schooling. Indeed, the probability of the children being enrolled in schools is much higher if the female adult members are educated than if the male members are. Thus, the expansion of secondary school enrollment for girls in recent years will provide a further impetus for higher investment in education in the future.

Summary and conclusions

This chapter attempted to identify the extent to which the observed impressive progress in poverty alleviation in Bangladesh can be attributed to major shifts in rural household income structure from 1988 to 2004. We found that the dissemination of improved agricultural technologies, crop diversification, and occupational mobility from farm to nonfarm activities, such as trade, business, and services, enhanced growth in rural income. Rural to urban migration of workers, both domestic and overseas, also makes a significant contribution to income growth as well. Livelihood migration, be it occupational or spatial, thus appears to have opened up pathways out of poverty to a significant proportion of the poor households in Bangladesh.

The shift in the structure of household income in favor of nonfarm activities has been facilitated by the decision of households to invest in schooling of children. The regression results show that farm income and the education of adult workers are by far the most important determinants of children's school enrollment, pointing to the importance of the adoption of new rice technology. It is also important to point out that public-sector policies for developing educational infrastructure significantly stimulated private investment in human capital formation. A higher level of schooling empowers family members to engage in nonfarm occupations, which provides higher returns from education than farming.

Notes

1. The World Bank PPP is pegged in 1993 US dollars. We used the Consumer Price Index to convert the 1993 PPP to the survey year. Readers can refer to Chapter 2 for a detailed discussion of how the 1993 PPP is adjusted to reflect prices in the survey year. Chapter 2 also contains discussion of the FGT index.
2. Primary school age refers to ages 6 to 11, secondary school refers to ages 12 to 17, and postsecondary school refers to ages 18 to 24.