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DEVELOPMENTAL IMPACT OF RURAL INFRASTRUCTURE IN BANGLADESH

Raisuddin Ahmed
Mahabub Hossain

October 1990

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

In collaboration with the
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FOREWORD

The appropriate role for infrastructure, particularly rural infrastructure, in the economic development of developing countries has remained a largely unexplored and underrated issue. A dearth of case studies focusing on the nature and magnitude of the effects of infrastructure is partly responsible for this state of affairs. Realizing the potential role of infrastructure in a strategy of growth based on farm and nonfarm rural sectors, IFPRI launched a program of studies on rural infrastructure in selected countries of Asia and Africa. A series of papers prepared for a seminar on Infrastructure and Agricultural Development held in Mexico City in January 1988 have been published as IFPRI Policy Briefs 3. This case study on Bangladesh, conducted in collaboration with the Bangladesh Institute of Development Studies, is the first major project completed under the program. We believe that it will clear up many of the misconceptions that shroud the decisionmaking process in allocation of public resources.

It is true, however, that there is a need to go beyond this impact study to examine the aggregate dimensions of public expenditure and to build political institutions for the development of infrastructure. Thus the supply-side of infrastructural development is also an important part of the process—a part that this study does not address. It is hoped that these supply-side issues wil be considered in future IFPRI research.

A final word on the limitations inherent in extrapolating the findings of this study to other developing countries. Although many generalizations are expected to be valid in the context of other Asian and African countries, it must be recognized that a positive impact of infrastructure also depends on the overall policy environment of a country. Infrastructural development is not a substitute for effective policies: instead it provides a congenial environment for public policies and private investment to perform and prosper.

Finally, based on the evidence in this report, the importance of infrastructure in rural development in Bangladesh cannot be overstated. We at IFPRI hope that Ahmed and Hossain's seminal work will stimulate a number of additional analyses in this neglected area of research.

Just Faaland

Washington, D.C.
October 1990

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Collaboration with the Bangladesh Institute of Development Studies enriched the quality of the study with hard facts on national, regional, and household-level attributes and activities. Our deepest gratitude goes to Rehman Sobhan, the then director-general of BIDS, for his help in setting up the field surveys and for making the collaboration between the two institutes a productive one in all respects.

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Raisuddin Ahmed

Mahabub Hossain

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SUMMARY

This study empirically addresses issues in the neglected area of research on how infrastructure affects growth of income and alleviation of poverty in a developing economy. Contrary to the conventional view that development of rural infrastructure is likely to aggravate poverty, it finds that the development of rural infrastructure has far-reaching implications for the alleviation of poverty by indirectly generating income.

The study focuses on household economies in Bangladesh and concentrates on the benefits of infrastructure, particularly for the poorest segments of the population. It identifies, describes, and measures the effects of development of rural infrastructure on agricultural production, employment, income, consumption, savings and investment, and market and social development. Because transport and roads are the key contributors to development in rural areas, they are the primary form of infrastructure considered here.

Estimates of user-cost savings typically used to measure the effects of new roads in developed countries are not adequate for measuring the profound structural changes brought about by the construction of infrastructure in developing countries. Studies to measure the effects of road development, electrification, and institutional development have primarily focused on agricultural production and emphasized the contribution of individual factors when these factors are highly correlated. This study attempts to balance descriptive material with statistical analysis, using two methods to separate the pure effects of infrastructure from other factors. First, 16 villages were carefully selected from a larger sample of 129 so that natural endowments such as soil, topography, and water are evenly distributed. Target variables—income, for example—are compared among villages grouped according to their degree of infrastructure development. Second, econometric techniques are applied to provide a more complex measurement.

Field data were collected from about 640 households through five questionnaires administered during the calendar year 1982. Based on the data from this survey, a common index was constructed for all elements, which was used to rank villages according to their degree of infrastructure development. Villages, evaluated by their access to transport, markets, modern inputs, electricity, and social services, are divided into two groups—developed and underdeveloped.

Infrastructure affects agricultural production indirectly through prices, diffusion of technology, and the use of inputs. In estimating the extent of these effects, comparing data for the three most developed villages and the three least developed, the study finds that the price paid to farmers for paddy is about the same in all of the villages, but fertilizer prices are 14 percent lower and labor costs 12 percent higher in the developed villages than in the underdeveloped. Moreover, 105 percent more farmland is irrigated, 71 percent more is sown with high-yielding varieties (HYVs), and use of fertilizer is 92 percent higher in developed villages.

These differences in adoption of new technology and prices had only a small effect on the total use of labor, but they had a substantial effect on the composition of that total use. The combined effects of wider and more efficient use of new technology as a result of infrastructure development is estimated to have increased agricultural production in developed areas as much as 32 percent.

Infrastructure development indirectly affects the composition of employment by making nonagricultural jobs more accessible to those with better skills and some assets. This leads to a reduction in the use of family labor and an increase in the use of wage labor in agriculture, providing employment for those with marginal or no land.

The most important finding of the study is the profound effect that infrastructure has on incomes of the poor. Overall, estimations based on the most and least developed villages indicate that infrastructural endowment causes household income to rise by 33 percent: income from agriculture increases about 24 percent, that from livestock and fisheries about 78 percent, that from wages almost doubles, but income from business and industries only rises by 17 percent. Most striking, however, is the distribution of these increases: the functionally landless and small farmers garner a larger share of the increases from crops, wages, and livestock and fisheries, while the large landowners capture most of the smaller increase in business and industries.

Households in developed areas spend a larger snare of this incremental income on noncereal foods, nonfoods, and services, which generates additional rounds of economic growth. The diminishing propensity to consume cereals (48 percent in developed villages as opposed to 60 percent in underdeveloped) reflects changing taste patterns and a wider range of choices. The question is whether the increasing demand engendered by rising incomes can be met by increasing supply. According to this study, infrastructure development increases the speed of diffusion of agricultural technology, reduces the cost of marketing, and improves the operation of both input and product markets, through improved linkages with other sectors.

A comprehensive framework is used to measure the influences of infrastructure on household savings and investment, a key factor in sustaining economic growth. The savings rate, which averages about 14 percent, is slightly higher in developed villages. However, about 36 percent of the households in all income groups have no savings at all, while 75 percent of savings are generated by households in the top two income deciles.

About 78 percent of savings can be attributed to capital formation and 22 percent to transfer type transactions such as lending through mortgages, land purchases, and money lending. Nonmonetized investment is 62 percent higher in underdeveloped villages than in developed. But gross investment per household is about 14 percent higher in developed villages, even though investment in irrigation, drainage, and agricultural equipment is 27 percent smaller in developed villages. Because households in underdeveloped areas hold 34 percent more land, this difference disappears when investments are calculated on the basis of per unit of land owned rather than by household.

Infrastructure development encourages savings and investment indirectly through its positive effect on income. Current income is shown to be the dominant factor in determining how much a household saves. Estimates of the marginal propensity to save vary from 34 to 40 percent. To increase opportunities for productive investment in Bangladesh, infrastructure development must go hand in hand with other incentive policies—institutional credit for the poor, for example. Friends, relatives, and moneylenders are still the major sources of credit in rural areas, especially for the landless and small landowners; what institutional credit is available mostly goes to large landowners. Infrastructure development is found to improve access to institutional credit almost sevenfold.

Illiteracy is widespread in Bangladesh, where 60 percent of the population above age five has never attended school. In examining the effects of infrastructure on social development, such as education and health conditions in rural areas, development of infrastructure did not have a significant direct effect on literacy, which appears to be

closely related to the size of a household's landholding and a person's sex. The study does show, however, that infrastructure development has a positive effect on health.

Because the effects of infrastructure on rural development are so definitive in agriculture-based, low-income developing countries, a fresh look at policies to encourage rural infrastructure development is called for. All potential infrastructure projects should be identified, ranked according to their benefit-cost ratios, and funded accordingly. But determining benefits is a challenging task, and good judgment will always be required. In addition, strong local government institutions should be built up, the flow of government funds should be linked to local initiatives, and revenue sharing between local and central governments should be arranged.

In recent years, structural adjustment policies that discourage public expenditure have taken precedence over development of infrastructure. In light of the positive effects of rural infrastructure found in this study, the donor community should restore infrastructure development to high priority.

2

INTRODUCTION

"Infrastructure" is a frequently used word, but there is no consensus in economic literature on its precise meaning. The terms "infrastructure" and "social overhead capital" are often used interchangeably. Lewis (1955) prefers to include public utilities, ports, water supplies, and electricity in the definition of infrastructure. Higgins (1959) includes transport, public utilities, schools, and hospitals. Hirschman (1959) lists facilities for law and order, education, public health, transportation, communications, power, water supply, irrigation, and drainage. He makes a distinction between a wider concept of social overhead capital, as listed above, and a "hard core" limited to transportation and power. He sets out four conditions for distinguishing social overhead capital from directly productive activities: (1) the services provided by the activity are to facilitate, or in some sense are basic to, the carrying out of a wide variety of economic activities; (2) the services are provided in practically all countries by public agencies or by private agencies subject to public control and are provided free of charge or at rates publicly regulated; (3) the services cannot be imported; and (4) the investment needed to provide the services is characterized by "lumpiness." In the 1960s, the importance of agriculture in economic development was increasingly recognized, and the literature of that period reflects this added emphasis on agricultural research and extension, rural financial institutions, and irrigation and drainage (Nicholls 1963, De Vries 1960, Ishikawa 1967).

The focus of this study is rural infrastructure. Therefore, some elements mentioned above—port facilities, for example—are not directly relevant. The elements of rural infrastructure included in this study are specified in a later section, where an objective measure of rural infrastructure is presented in the form of infrastructure indices. The exclusion of urban and first-order infrastructures, such as national highways, railways, and ports, does not imply a downgrading of their importance. Rural infrastructures are like the secondary and tertiary arteries of the body, as critical as the main arteries for blood circulation.

Role of Infrastructure in Development

The role of infrastructure is complex and its effects are indirect. Consequently, development economists have not focused on infrastructure as much as they have on directly productive activities such as agriculture and industry. However, numerous models of development and discrete studies of growth have generated explanations of growth and development that imply a strategic but often hidden role for infrastructure. This is particularly true of models that assign a special role to agriculture. For example, von Thunen's (1842) attempt to explain geographic variations in the intensity of farming systems and productivity of labor in an industrial country is focused on urban-industrial pull and the implied critical roles of transport and communication systems in the strength of that pull. The pull effect of urban and rural growth centers—the foci of development—on the rest of the economy is similarly dependent on the physical transport and communication linkages. Ruttan's (1984) "frontier model," which contends that rapid agricultural growth in North and South America and Australia is

explained by the opening up of new land, has the transportation and communication infrastructure as its central foundation. Similarly, his "diffusion model," which formulates the process of technological spread in agriculture as a source of dramatic growth in agricultural production, is critically dependent on physical and institutional infrastructure (Ruttan 1984). Mellor's (1976) outline for the future economic development of India places infrastructure development near the top of his list of priorities. He makes a particular effort to establish the strategic role of infrastructure in producing a large multiplier effect in the economy, arising from agricultural growth and the expenditure of the resulting agricultural income on consumption.

In addition to these broad generalizations, there are numerous studies with narrow foci that began as searches for knowledge on a certain subject, with only incidental interest in infrastructure, but found profound effects of infrastructure. Results from some of these cases will be cited in the course of discussion of the impact of infrastructure development.

Infrastructure's ability to reduce the cost of marketing agricultural products is obvious and well known. Perhaps this effect of infrastructure is more important in Africa than anywhere else. An IFPRI study shows that African farmers receive only 30-50 percent of the final prices paid by consumers, compared with 70-85 percent of prices received by farmers in Asia (Ahmed and Rustagi 1987). About two-thirds of this difference is attributable to the substantial difference in transportation costs between countries in the two continents—a factor directly related to transport infrastructure. However, thinness of volume of production and marketable surplus (which can be measured as volume per square mile of area) is also a significant reason for higher transportation costs in Africa than in Asia. Infrastructural development indirectly affects thinness by influencing the productivity of land and the marketing rate of a given product, thereby increasing the volume of trade and reducing the transportation cost per unit of traded volume.

Marketing margins have far-reaching consequences for the comparative advantage of products of a country and its competitive strength in the world market. Very high marketing margins in agricultural products, when added to production costs, often make the f.o.b. price larger than that in competing countries. Similarly, internal transport costs, when added to the c.i.f. price, make the domestic price of imported products quite high, reducing the scope of trade. High marketing margins therefore tend to reduce the scope of international trade between developing and developed countries.

The effect of underdeveloped infrastructure on transmission of price is by no means inconsequential. Lack of infrastructural facilities is the principal source of market fragmentation and blurring of the transmittal of price signals. One study shows that the short-run effect of devaluation of the exchange rate is reflected in prices at the farm level to the extent of about 50 percent in the Asian context but without any systematic effect in African countries (Scandizzo 1984).

Labor is the most important factor in the production of agricultural goods and in the income of rural households in developing countries. Imperfections in rural labor markets, particularly interlocking of labor markets with land, credit, and product markets, has traditionally been viewed as a crucial constraint on income and employment of rural labor households (Bardhan 1979; Bardhan and Rudra 1978). Most of these imperfections in the labor market may be traced directly and indirectly to infrastructure underdevelopment.

The interlocking of labor markets with land and credit markets arises from the lack of opportunity for alternative jobs in the rural market. Labor households would not have to be bonded to large farmers through sharecropping if they had access to nonfarm

work. Similarly, earning opportunities outside agriculture would help alleviate the cash constraints in labor households that drive them to moneylenders who charge high interest rates.

Under the structure of farm holdings in most countries of Asia, a large proportion of small farmers are also part-time wage laborers. Because their labor is demanded on farms during peak seasons, they cannot move far from the village in search of jobs or commit labor to outside activities on a sustained basis. The degree to which such farmers can participate in the out-of-the-village job market depends on how fast they receive information on outside jobs, the distance to such jobs, and the transport facilities between villages. This aspect of creating nonfarm jobs for farm households will become particularly critical for countries like Bangladesh, where, by the turn of the century, more than 80 percent of the farmers will hold less than 2.5 acres of land. Farmers need to remain on the farm and yet have access to nonfarm employment. This is unlikely without large-scale infrastructure development in rural areas (Ahmed 1987).

As the result of social custom and low wage income, earning income from labor in rural areas is often looked down upon as a low-caste activity (Thorner and Thorner 1962). This creates a tendency among self-employed small farmers who have only recently descended to this status to avoid the wage-labor market even if they have considerable surplus labor to offer. A dualism between family labor and wage labor markets thus develops. If such laborers could get jobs far from the village where they are not known personally, they would not hesitate to participate in the wage-labor market. This possibility, of course, depends at least partly on transportation. Social custom also restrains participation of women in the labor force. Certain nonfarm jobs that could be performed in the household, such as rice milling and processing, help to break down this social barrier, allowing women to enter the labor market.

A logical consequence of the expansion of product and factor markets as argued above is the concurrent development of specialization in production. Two types of specialization are important in rural areas: one involves specialization in certain agricultural products and the other involves specialization between agricultural and nonagricultural enterprises, including processing of agricultural products. Many of these products are perishable and must be brought to market daily for minimum loss. Moreover, farmers may also produce bulky crops such as sugarcane and cassava, which involve high transportation costs. Consequently, farmers in remote, isolated villages are likely to concentrate on agricultural products that are needed for home consumption, are less bulky, and are nonperishable. They may have to engage in subsistence production of low-profit perishable crops because these cannot be easily marketed. With specialization, the cash flows of farmers in infrastructurally developed areas are likely to be higher than those of farmers in underdeveloped areas. In turn, this cash flow relaxes credit constraints, making it possible to purchase modern inputs.

The second type of specialization diverts resources of large landowners to nonagricultural trade and processing activities. Instead of attempting to farm a large area with hired labor, which can often be managerially inefficient, large farmers have the option to expand into nonagricultural business, operating from the household, if infrastructure development provides easy access to markets. This may even reduce the concentration of landholding and inequality in the distribution of agricultural income.

Infrastructural facilities are considered essential for diffusion of technology in agriculture for a number of reasons. Extension workers travel frequently in areas where transport and communications function better. Demonstration plots by agricultural extension workers tend to be established in areas with better infrastructure. Supervision of extension work also is limited to developed areas. Under traditional farming, inputs

are available in the village. Modern agricultural inputs, however, such as fertilizer, pesticides, and implements (tubewells, for example) are produced in urban areas. Infrastructural facilities are essential for distribution of these modern inputs from urban areas to farmers spread throughout the countryside. Transportation of equipment for drilling even small, shallow tubewells becomes problematic in the absence of good infrastructure. Concentration of tubewells in areas with well-developed infrastructure is a likely outcome. The distribution of fertilizer and high-yielding seed varieties (HYVs) is likely to be more extensive in infrastructurally developed than in underdeveloped areas for many reasons, including distribution cost. Similarly, access to institutional services such as health care, education, and credit is likely to be better in developed than in underdeveloped villages. Also, credit constraints are expected to be lower in areas with developed infrastructure because of a high degree of specialization and commercialization of production, including nonfarm sources of income.

The impact of infrastructure on the pattern of household consumption is likely to be substantial. It is realized through changes in prices and expansion of demand. The price effect is quite obvious and easily recognized, but the demand effect is not. Largely as the result of price differences between locally produced and imported goods, average and marginal propensities to consume locally produced goods tend to be higher than those of imported goods in infrastructurally underdeveloped villages. The expansionary demand effect can be explained by the concept of latent demand. Many products, particularly services, are not available at a reasonable cost in infrastructurally underdeveloped areas, so consumption of these products and services is thin in such areas. When no transport service is available, even a rich man must walk to a distant place. As soon as transport service is extended to the village, the latent demand for the service becomes effective demand. The linkage of household demand to the second or third rounds of economic activity is quite strong. This multiplier effect, in the context of a Malaysian rural area, was equivalent to 75 cents out of a dollar's worth of incremental income that was the indirect effect of an original investment in infrastructure (Bell, Hazell, and Slade 1982).

Policymakers often stress the need for increasing nonfarm employment, particularly in rural areas, but they often wonder how to do it effectively. Increased production in main sectors like agriculture and industry is, of course, a necessary condition, but more important is the strategy—the way in which the production increase is brought about. That infrastructure is a critical element in that strategy is demonstrated in an International Labour Organisation study that compares Taiwan, the Republic of Korea, Japan, and China (Saith 1986). This study finds that Korea and Taiwan share similar growth paths and historical backgrounds but achieve a quite different degree of success in rural nonfarm income and employment. In Taiwan, about 80 percent of rural income is received from nonfarm sources, compared with less than 48 percent in Korea. Seventy percent of farm households in Taiwan had access to electricity even in 1960, compared with only 13 percent in Korea. Density of paved roads in Taiwan was 76 kilometers per 1,000 square kilometers in 1962 and 215 kilometers in 1972, whereas in Korea less than 10 kilometers per 1,000 kilometers were paved in 1966 and less than 50 kilometers in 1975 (Saith 1986).

The foregoing discussion by no means covers all possible facets of infrastructure and its impact on the rural economy. The effects on household savings and investment behavior cannot be hypothesized on the basis of a priori logic. Empiricism is the only way. However, it is well-known in a number of countries that infrastructural backwardness is a basic cause of ineffective administration of various welfare measures and their distribution to the rural poor. As Malenbaum (1962) argues in the context of India,

change in social attitude is one of the greatest challenges for economic development. For example, social taboos and religious orthodoxies are known to frustrate progress in the family planning programs of many developing countries. The process of attitudinal change in the rural population is hastened by the movement of people and ideas, which the development of rural infrastructure indirectly facilitates.

Scope of the Study

The primary objectives of the study are to identify, describe, and measure the effects of rural infrastructure on agricultural production, employment, income, consumption, savings and investment, and market and social development. The focus is on household economies in rural areas. Although emphasizing the household level provides a picture of the effects of infrastructure development, it does not capture the effects of infrastructure on nonhousehold sectors such as corporate bodies. In this sense, the estimates of the contribution of infrastructure development are partial.

It is clear from the objectives that the emphasis of the study is on the benefits of infrastructure development, which is appropriate because it is the benefits of infrastructure that are imperfectly known and often a source of controversy in resource allocation. Analysis of issues relating to the supply side (including allocation of public resources, maintenance of infrastructure, and institutional development at local levels for construction, maintenance, and resource mobilization) is planned for a second study under consideration.

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RESEARCH METHODOLOGY AND DATA

A comprehensive review of the literature on infrastructure (Ahmed and Donovan 1989) demonstrates that there is a glaring gap in the methods for measuring effects of infrastructure. Most empirical studies are concerned with measurement of the impact of a discrete element rather than of a composite group consisting of a number of infrastructural elements. Studies on the effects of transport development are a classic example. Benefits of investment in transport development are measured by the "user cost savings" arising from the development. The approach to estimating user cost savings as a measure of benefits from a road project is shown in Figure 1. In the figure, DD is the demand curve for transport services, whereas the horizontal axis represents the volume of traffic and the vertical axis represents the unit cost of transportation. When walking and headloading were the means of transport (before the road project), the unit cost was $0C_1$ and the volume of traffic $0Q_1$. This cost was reduced to $0C_2$ when the road was developed. This reduction also induces additional traffic $(0Q_2 - 0Q_1)$, which is determined by the demand elasticity of DD. Note that this additional traffic is not considered to have arisen as the result of structural change brought about by the road project. The total benefit from development of the road is given by the area AC_1C_2B, which consists of two components:

Cost savings on existing traffic = $(0C_1 - 0C_2)0Q_1 = AC_1C_2E$, and

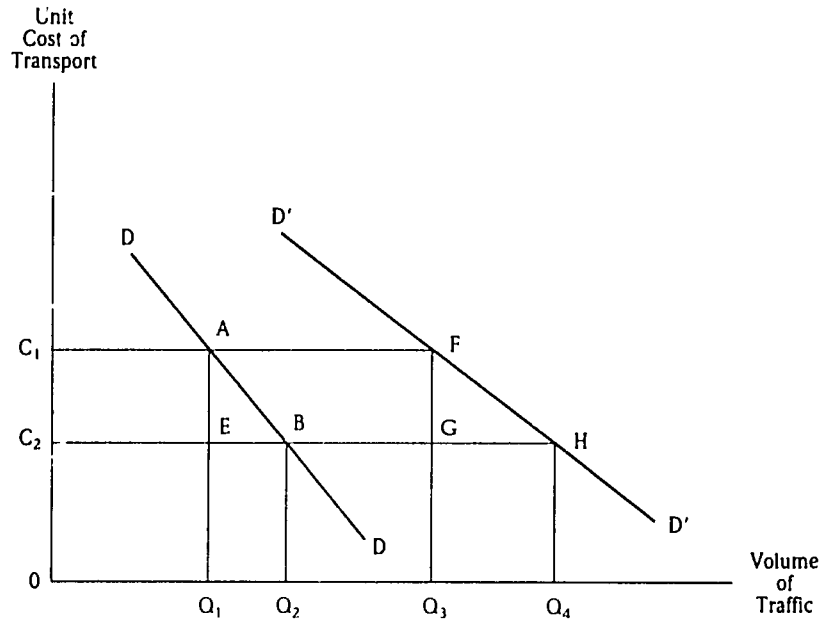
Cost savings on generated traffic = $\frac{1}{2}(0C_1 - 0C_2)(0Q_2 - 0Q_1) = AEB$.

This conventional approach (see van der Tak and de Weille 1969) is applicable in developed economies where resources are fully employed. In developing economies where resources are under- or unemployed, road development usually brings about substantial structural change. If this happens, the demand curve will shift to the right, D'D'. Under this new situation, the benefit from additional traffic generated will be ABHF, which is much larger than the benefit AEB from additional traffic under static demand conditions (DD). It would, however, be a serious underestimation of development economists to assume that they failed to see this simple logic and ignored the large benefit that arises from the shift of demand. The omission nevertheless occurs often as the result of the vacuum in factual information.

It is quite clear that the amount of structural change that can be brought about through infrastructure development is the fundamental issue. Even though most of the literature on the methodology of evaluating infrastructure is rich in advice on what prices should be used and what criteria should be adopted (for instance, on the internal rate of return versus the cost-benefit ratio), very few methodological innovations for measuring the extent of structural change can be learned from the literature. Moreover, the extent of structural change depends greatly on the interaction among various elements of infrastructure and technology. Unraveling the effects of these interactions is a challenging task.

In recent years, some researchers have used econometric techniques to measure the effects of road development, electrification, and institutional development (schools,

Figure 1—Model for measuring the effects of transport development



markets, and so forth) on agricultural production (Binswanger, Khandker, and Rosenzweig 1989, Antle 1983, Barnes and Binswanger 1986, and Beenhakker et al. 1987). Most of these empirical studies are based on intercountry or interdistrict cross-section, time-series analysis. For example, the study by Binswanger, Khandker, and Rosenzweig (1989) estimates the contribution of output prices, fertilizer prices, wage rates, irrigation, education, electricity, roads, markets, and environmental factors to the growth of agricultural output in India, using district-level measures of various variables. They found the contribution of the infrastructural variables very high; combined effects of these variables were almost 2.5 times greater than the contribution of irrigation. The problem with this type of analysis is the unreliability of estimates of the contribution of individual factors when these factors are highly correlated. Multicollinearity has never been satisfactorily solved, even though sophisticated statistical techniques are available to tackle the problem. Moreover, district data are always questionable for this type of analysis. Therefore, such results are hardly likely to convince policymakers.

Methodological Approach and the Data

The basic method adopted for measuring the effect of infrastructure is comparison of relevant target variables (for example, income) among villages with various degrees of infrastructure development. The drawback to this approach is the probability of other factors contaminating the pure effect of infrastructure, which was minimized through two main procedures. First, the 16 villages that constitute the sample for this study of rural Bangladesh were selected from an initial survey of 129 villages, so that soil and agronomic factors, topography, and water regimes associated with the study villages were either uniform or evenly distributed across a wide spectrum of infrastruc-

ture endowment. The researchers from the Bangladesh Institute of Development Studies and the International Food Policy Research Institute, who were involved in the survey, spent a considerable amount of time selecting 16 villages from a population of 129. The villages identified as the most infrastructurally backward could not always be included in the sample of 16, mainly because of the problem of data collection. Transport to and lodging of interviewers in some villages were so difficult that those villages had to be excluded from the sample.

In distinguishing the effects of infrastructure from other sources of influence, the second procedure adopted is econometrical. The econometric techniques used for different purposes are explained in the relevant sections of this report. In order to provide a flavor of the underlying processes of change and the relationships that exist, descriptive material is balanced with results of statistical analysis, which are more complex.

Information collected through a 1982 survey of households in the 16 villages, located in various parts of Bangladesh, constitute the basic data used in the study. An average village contains about 160 households with a total population of about 950 people. A census was conducted in each of the villages to collect information on the landholdings and occupational structure of each household. The households were classified into eight groups based on the size of landholding (four groups) and the occupation of the head of the household (two groups). Then a proportionate random sample was drawn from each stratum so as to have 40 households from each village. A total of 640 households from the 16 villages was selected in this way. In the course of editing, however, a few households had to be excluded due to unreliable information. The final set of households used in the analysis was marginally smaller than 640.

Field data in the form of five sets of structured questionnaires were collected throughout the calendar year. Questionnaire 1 collected detailed statistics on household characteristics, assets, and liabilities. Questionnaire 2, on costs and returns in farm production activities, was administered three times during the year, after each crop season: aus, the summer season; aman, the autumn; and boro, the winter season. Questionnaire 3 was conducted eight times during the year to collect information on weekly expenditures on food and nonfood necessities, nonfarm income and employment of family workers, and wage earnings. Through questionnaire 4, expenditures on items such as clothing, household durables, education, health, housing, acquisition of physical assets, and credit were collected quarterly. Finally, a community-level questionnaire was completed to provide an explicit basis for ranking villages according to their degree of infrastructure development. In this questionnaire, the access of study villages to transport, communication, electricity, markets, cooperatives, banks, extension services, supply sources for modern inputs, schools, colleges, hospitals, and health centers was measured.

Because of the potential synergistic effects of the various elements that together constitute the complex set of infrastructure, a common index was constructed for all elements that could be used to rank villages to reflect their status of development. To place the 16 villages in the national perspective, the status of infrastructure development in rural Bangladesh is detailed next.

Status of Rural Infrastructure (1980-82)

Aggregate Data

In 1950/51, Bangladesh (then East Pakistan) had only 240 miles of hard-surfaced road, primarily in the cities of Dhaka, Chittagong, Khulna, and Rajshahi. The urban

population was slightly less than 1 percent of total population (Pakistan, Central Statistical Office 1972). During the last three decades, Bangladesh has made modest progress in developing general infrastructure. This has occasionally touched on rural areas as an outgrowth of urban-oriented development. A picture of transportation infrastructure in rural areas in 1980/81 can be gleaned from Table 1. Hard-surfaced roads pass through 9 percent of the villages. An additional 12 percent of villages are located less than one mile from a hard-surfaced road. Forty percent of villages in Bangladesh are 5 miles or more away from a hard-surfaced road. About 20 percent are located more than 10 miles from an all-weather road. However, there are tremendous variations among districts. In 12 districts, more than 20 percent of villages are located more than 10 miles from roads. Density of good road is relatively high in Comilla, Tangail, Jessore, and Kushtia.

Access to transportation is a principal consideration, but it is not the only element that defines infrastructure. The status of development in some of the other elements of rural infrastructure is presented in Table 2. About one-fourth of the adult rural population can read and write. This level of adult literacy reflects the policy of providing extensive primary education through one school for about every two villages in the countryside. Every village possesses, on average, about 6 hand tubewells for supply of drinking water. One health center caters to health and medical services for every 20 villages. About 6 percent of the villages have access to electricity. There is one post office for every 10 villages, one primary market for every 4 villages, and one bank for every 25 villages. These indicators merely represent physical access; they do not

Table 1—Access of villages to hard-surfaced roads, 1980/81

District	Number of Villages	Percentage of Villages by Miles from Nearest Hard-Surfaced Road					
		0[a]	Less Than 1	1–3	3–5	5–10	More Than 10
		(percent)					
Chittagong	1,664	16	14	20	12	15	23
Chittagong Hill Tracts	558	8	4	6	8	11	63
Comilla	5,853	11	14	23	18	25	9
Noakhali	2,132	10	15	26	18	20	11
Sylhet	10,189	9	14	22	15	19	21
Dhaka	8,061	6	12	18	14	23	27
Faridpur	6,128	3	7	13	11	20	46
Jamalpur	2,239	6	8	17	15	28	26
Mymensingh	7,063	8	13	19	16	17	27
Tangail	2,340	8	15	26	21	22	8
Barisal	2,762	7	9	18	15	24	27
Jessore	4,103	12	14	26	19	22	7
Khulna	3,680	16	14	17	11	18	24
Kushtia	1,609	14	13	29	20	20	4
Patuakhali	1,410	6	7	18	15	29	25
Bogra	3,813	12	14	24	16	22	12
Dinagpur	5,229	10	13	21	17	23	16
Pabna	3,913	8	14	21	13	25	19
Rajshahi	7,520	8	9	15	13	22	33
Rangpur	5,384	8	12	30	12	22	26
Bangladesh	85,650	9	12	24	15	21	19

Source: Bangladesh, Bureau of Statistics, *Socioeconomic Indicators of Bangladesh* (Dhaka: Ministry of Planning, 1985a).

[a]Village is located on road.

Table 2—Extent of selected infrastructure facilities in rural areas of Bangladesh, 1980/81

Type	Average	Range Among Districts
Paved road (kilometers per 1,000-square-kilometer area)	33.0	11–47
Adult literacy (percent)	23.4	17.2–33.2
Rural water supply (number of tubewells per village)	6.0	4.0–16.0
Primary school (number per 100 villages)	51.0	30.0–61.0
Primary health centers (number per 100 villages)	4.9	2.6–12.5
Primary markets (number per 10 villages)	2.7	0.8–3.5
Electricity (proportion of villages)	5.7	1.0–12.0
Post office (number per 10 villages)	0.8	0.1–1.2
Banks (number per 100 villages)[a]	4.0	n.a.
Proportion of cultivated land under modern irrigation (percent)	18.0	1.0–37.0

Source: Bangladesh, Bureau of Statistics, *Socioeconomic Indicators of Bangladesh* (Dhaka: 1985a).
Note: n.a. is not applicable.
[a]Includes specialized banks, such as the Agricultural Bank.

indicate how effective these accesses are in extending services to particular villages or classes of people within a village.

Survey of 129 Villages

The state of rural infrastructure, as assessed through the 129-village survey, is determined by access to transport, markets, modern input supply systems, and social services.

Access to Transport. Access of villages to bus stations, inland water transport stations, and railway stations by various modes of transport, such as foot, bicycle, rickshaw, and boat, varies across the 129 villages. Table 3 shows the distribution of villages by distance from bus station and the primary modes of transport used to reach bus stations. Seven percent have a bus station in the village and another 18 percent are located less than one mile from a bus station. Walking, bicycles, and rickshaws are the primary modes of transportation from these villages to the bus station. About 37 percent of the villages are located five miles or more from the bus station. People walk or use small boats, launches or steamers, rickshaws, train service, or bicycles to travel from home to the bus station. About 10 percent of the villages report that no bus station is accessible, implying little or no use of bus services by these villagers. In all, 38 percent of villages report walking or cycling as the primary modes of transport to the bus station. Another 28 percent report rickshaws as the primary mode, and 17 percent use small boats.

About 83 percent of villages are located five miles or more from launch or steam stations (Table 4). About 60 percent of villages report that water-transport facilities, which are seasonal at best, are not accessible to them. About 61 percent of villages

Table 3—Distribution of types of transport used for access to bus stations

Distance to Bus	Foot or Bicycle	Rickshaw	Small Boat	Train	Steamer or Launch	Not Accessible	Total
			(percent of villages)				
Station in village	6.2	0.8	0.0	0.0	0.0	...	7.0
Less than 1 mile	13.2	3.1	0.8	0.0	0.8	...	17.9
1 – 3 miles	10.8	13.9	2.3	0.0	0.0	...	27.0
3 – 5 miles	3.9	4.6	2.3	0.0	0.0	...	10.8
5 – 10 miles	3.1	3.9	8.5	0.0	0.0	...	15.5
10 miles or more	0.8	1.3	3.1	2.3	4.6	9.7	21.8
Total	38.0	27.6	17.0	2.3	5.4	9.7	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

are located five miles or more from railway stations, and about 32 percent of villagers do not consider rail stations at all accessible to them. Again, the predominant modes of transport are foot or bicycle, rickshaw, bus, and boats for movement to railway stations.

Access to Markets. A primary market is a periodic market where buyers and sellers assemble generally once a week to trade agricultural products, products of rural industries, and other consumer goods. Sellers operate from mobile shops. The number of traders in such markets ranges from 500 to 2,000. A secondary market is larger than a primary market, and in contrast, businesses are housed in permanent structures, and transactions are daily. It is not uncommon for a secondary market also to function as a periodic market. Wholesale trade and stocking of goods are normal features of a secondary market.

Two types of banks usually operate in rural areas. Commercial banks accept deposits and advance loans. Specialized banks such as the Agricultural Development Bank generally advance loans only to farmers.

Access of villages to these markets and banks is analyzed in Table 4. About 71 percent of villages are within one mile of a primary market. Travel by foot, bicycle, rickshaw, and boat are the predominant modes of transport for participating in primary markets.

Access to secondary markets is obviously thinner than that to primary markets. About 20 percent of villages are located within one mile of a secondary market; about 27 percent are located five miles or more away. Within three miles, villagers go by foot, rickshaw, or cart, but as the distance increases, the use of boat, bus, and train services becomes more important for traveling to secondary markets. The 129-village survey indicates that there is about one bank for every 10 villages. There is a strong association between secondary markets and other services such as banks.

Access to Modern Inputs and Electricity. There are about nine fertilizer dealers per village in villages near the *upazila* headquarters. Similarly, villages with secondary markets have about three dealers per village. Away from *upazila* headquarters or secondary markets, the average number of fertilizer dealers is one per village, which means that there may be more than one dealer in one village, while a neighboring village may not (or need not) have any.

Table 4—Access to infrastructure of 129 villages

Service	Miles to Service					
	0[a]	Less Than 1	1–3	3–5	5–10	10 or More
	(percent of villages)					
Bus station	7.0	17.9	27.0	10.8	15.5	21.8
Train station	2.3	8.6	14.7	13.1	11.7	49.6
Launch/steamer station	3.9	1.6	8.5	3.2	7.8	75.0
Primary market	31.0	40.3	20.3	6.2	2.3	0.0
Secondary market	7.8	11.7	23.9	29.4	22.4	4.7
Bank	10.9	20.2	39.6	16.2	12.4	0.8
Post office	24.0	33.4	34.1	6.9	1.6	0.0
Upazila headquarters	1.6	5.5	23.9	20.0	31.9	17.1
Primary school	68.0	25.8	6.2	0.0	0.0	0.0
Secondary school, boys	15.6	32.1	36.0	13.9	2.4	0.0
Secondary school, girls	7.8	11.7	21.0	18.7	21.0	19.8

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Service is located in the village.

Rural electricity is important for growth of rural processing industries and as an energy input to irrigation. Irrigation systems in Bangladesh consumed about 3 percent of the total electricity in the country in 1985 (Bangladesh, Bureau of Statistics 1985b). The sample survey indicates that about 33 percent of villages with primary markets, 60 percent with secondary markets, and 100 percent with *upazila* headquarters have electricity. However, as one moves away from these leading centers, the access of villages to electricity diminishes rapidly. Only 17 percent of the villages in the sample had access to electricity.

Access to Social Services. About 57 percent of the villages have a post office within one mile and 98 percent within five miles of the village (Table 4). And about 94 percent of the villages have a primary school within a mile. These two institutions are provided publicly under a policy of universal access. However, dispersion of secondary schools (for education up to the 10th or 12th grades) is thinner than that for primary schools. Only about 48 percent of villages have a secondary school within a one-mile distance. About 16 percent of villagers have to travel five miles or more to reach a secondary school. The situation is worse for girls than for boys. Only 19 percent of the villages have a girls' school within a one-mile distance. Girls are required to travel five miles or more to a secondary school in 42 percent of the villages.

Infrastructure in 16 Study Villages and Their Ranking

Since the 16 study villages are a subset of the 129 villages surveyed earlier, a good deal has already been learned about their level of infrastructure development. These data indicate that the range is rather wide among villages in access to markets, financial institutions, transportation services, and sources of supply of modern agricultural inputs. Considering the plethora of infrastructural elements and their attributes described, an index is needed for each of the villages to rank them on a scale of infrastructure development.

A Composite Measure of Infrastructure Development

A composite measure of infrastructure not only simplifies ranking the villages by reducing a large amount of data to a single measure, it also incorporates many qualitative aspects of infrastructure in a quantitative measure. This quantitative index is essential for capturing the full extent of the infrastructural effects in quantitative analysis. For example, a "distance" variable is frequently used, sometimes successfully and sometimes not, to measure the effect of infrastructure. A village may be located only 3 miles from a secondary market and yet access to the market may be more difficult than for a village located 10 miles away, if the latter has a better transport system. Each mode of transport—from walking to boarding a train or steamer—has different implications in monetary cost and time, which are determined not only by the condition of the road (paved, dirt, semipaved, and so forth) but also by other institutional factors. For example, in Comilla, where a cooperative institutional development initiated by the Comilla rural development academy operates, villages have a larger number of rickshaws and motorized transport vehicles per mile of roads than villages in Pabna, Dhaka, and Kushtia, even though agricultural production was not higher in Comilla's villages than in the others. Interaction of transport facilities with institutional infrastructures, including banks, public offices, and storage and sale centers for modern agricultural inputs, is considered quite important, although it cannot be captured by a distance variable. Certain indirect effects of infrastructure, such as spread of information and development of entrepreneurship among local residents, are by-products of interaction among various elements of what is broadly termed infrastructure. These effects are hard to incorporate in any analysis that does not develop an overall index for infrastructure development.

An infrastructure index of a village should reflect the diversity discussed above. The infrastructure index used in this paper is based on village-level information. Data include distances from the village to 13 elements of infrastructure, the principal means of transport used, and the cost per mile of travel. The 13 elements are the primary market, secondary market, primary school, secondary school (boys), secondary school (girls), college, post office, *upazila* center, bus stop, water transport station, rail station, bank, and union council office.

A total cost of access (TC) was computed by summing the individual costs of access (IC_i) of all 13 items. TC was then correlated with the costs for each element (IC_i), resulting in 13 correlation coefficients (W_i). The components with the highest W values selected are the primary market, secondary market, secondary school (boys), bank, bus stop, and *upazila* center.

The final index (INF) was then calculated by adding the six ICs, each weighted by their correlation coefficient (W_i) divided by the sum of the six correlation coefficients. The algebra of the formulation is shown below. This formulation was then used on data for the 16 villages to construct the infrastructure index.

$$IC_i = \text{distance} \times \text{cost per mile to element } i,$$

$$TC = \sum_{1}^{13} IC_i,$$

$$W_i = \text{correlation of } IC_i \text{ with TC, and}$$

$$INF = \sum_{1}^{6} (W_i \times IC_i) / \sum_{1}^{6} W_i.$$

This procedure for measuring the degree of infrastructure development is comparable to the method developed by Sen (1980) for ranking countries by levels of economic development.[1]

Selection Procedure and Logic

Why were 6 out of the 13 elements selected, what was the basis for this selection, and what theoretical reasoning can be offered for treating these elements as infrastructural variables? Of the 13 elements, union council offices (a union council is a political and administrative unit for 8-12 villages) and water transport stations are not permanent facilities. The union council office rotates among villages within a union when the chairman of the council changes. Water transport stations are seasonal and also move from location to location. Railway stations, girls' secondary schools, and colleges were rare in the 16 villages, although they did occur in the 129 villages. Since the government provides primary schools and post offices on the basis of universal coverage (a certain number for a fixed number of villages), they were not included because of the lack of variation. Moreover, it was assumed that post offices are not very important for rural development, and primary schools, though quite important, were proxied by the inclusion of secondary schools. That this pragmatic procedure is not likely to deviate widely from a systematic procedure is supported by a subsequent exercise using factor analysis techniques and presented in the Appendix, Table 63. This factor analysis also demonstrates that the weights used in the construction of the indices are not significantly different in order—though different in absolute magnitudes—from the weights (value of communality) that could be adopted from the factor analysis. The rank correlation between these two sets of weights is 0.87. This should not be a surprise because the correlation between TC and IC_i is similar to a factor analysis where TC is the common factor and IC_i are original variables.

The infrastructural variables that were collapsed into one index number represent access to transportation, markets, education, and public services such as agricultural extension, legal services, and so forth. Thus bus stations represent access to transportation, primary and secondary markets represent product markets, and banks represent the market for credit. An *upazila* center represents access to government services. The extension workers' offices and those of other government departments (including police) are located in the *upazila* center. That these infrastructural elements play a critical role in specialization, diffusion of technology, various social developments, development of markets, and entrepreneurial capacity has already been discussed in Chapter 2.

It is generally believed that the primary school is the most important educational factor for rural development. In both the correlation exercise and the factor analysis, the leading educational factor is found to be the secondary school. The rationale is as follows: Children who go to primary school but drop out after completing primary-level education are still too young to enter the labor force. Between the time when children

[1]Sen's construction of indicators for ranking countries on a scale of economic development can be traced to a 1973 article, which was sharpened further for his 1980 comparative study of poverty. Essentially for weighting GNP, he assigns weighting vectors to different commodities. This weighting system is derived from linear transformation of the welfare function. It is true that Sen's indexes are endogenous and not used for exogenous purposes, but infrastructural indexes constructed in this study are used for explanatory purposes. In this sense, they are quite different. The lesson from Sen's approach that is relevant to this study is the concept that when many elements have interacting influences and contributions, they can often be collapsed into a single indicator or index. In his estimation of GNP, Sen adopts different treatments for military and police expenditures, environmental exhaustion, savings valuation, life expectancy, and income distribution than those usually used in national income accounting.

drop out and when they enter the labor market, they are likely to forget whatever reading, writing, and arithmetic was learned, because skills are not applied and the learning process is discontinued for a long period. Primary school, on the other hand, is critical to acquiring a useful secondary education. It is a precondition for spreading secondary education among the widely dispersed rural population. In this sense, primary and secondary schools are inseparable if functional literacy among rural people is to be improved.

The weights (w_i) provided by the correlation and factor analysis indicate that private-sector activities—bus stations, markets, banks, and secondary schools—are leading infrastructural elements, and they are interrelated with various minor elements. This implies that development of roads by the government leads to the private sector taking the initiative for development of bus stations, banks, markets, and secondary schools. On the other hand, public-sector activities such as post offices and primary schools are provided on the principle of universal coverage, and therefore they are spread geographically beyond the main centers of commerce and transport. Thus, they are less correlated with other elements of infrastructure.

Infrastructure Index

The degree of infrastructure development in 127 of the 129 villages is shown in Table 5. The names, ranking, and index numbers of the 16 villages are shown in Table 6. The index number indicates the degree of underdevelopment; the higher the value of the index number the less developed is the infrastructure. If the villages in the 129-village survey are classified into four groups: highly developed (less than or equal to 4.5), moderately developed (4.5 to 7.5), moderately underdeveloped (7.5 to 12.0), and highly underdeveloped (12.0 and above), then about 24 percent fall in the first category, 34 percent in the second, 25 percent in the third, and the remaining 17 percent in the highly underdeveloped category (Table 5). In the 16-village sample, 25 percent fall in the highly developed category and only about 6 percent in the highly underdeveloped (Table 6). It is apparent, however, that a strictly valid comparison between the two sets is difficult due to differences in sample size. It is nevertheless

Table 5—Distribution of 127 villages among the ranges of the infrastructure index

Range of Index Numbers	Number of Villages	Percent of Total	Cumulative Percentage
1.5-3.0	17	13.4	13.4
3.0-4.5	13	10.2	23.6
4.5-6.0	23	18.1	41.7
6.0-7.5	21	16.5	58.7
7.5-9.0	11	8.7	66.7
9.0-10.5	13	10.2	77.1
10.5-12.0	8	6.3	83.4
12.0-13.5	7	5.5	88.9
13.5-15.0	4	3.1	91.0
15.0-33.0	10	7.9	100.0
Total	127	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: The higher the index number, the less developed the infrastructure. Some values were missing in two villages; therefore 127 of the 129 villages were used in development of the index.

Table 6—Infrastructure index numbers of 16 study villages

Rank/Village	Index Number
Developed	
Chasapara	1.91
Bandabeel	2.88
Illashpur	3.92
Patgari	4.46
Raokuli	4.71
Raotara	4.71
Khejurdanga	5.37
Underdeveloped	
Charkhamar	6.47
Khunta	7.71
Rajarampur	9.52
Taliamara	9.63
Gobrapara	10.18
Birhat	10.19
Syedpur	10.69
Harishpur	11.09
Gobindapur	13.67

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: The higher the infrastructure index, the less developed the infrastructure.

clear that the 16-village sample represents somewhat better infrastructure than the sample of 129 villages.

In the remainder of this report, the effects of infrastructure are sometimes measured by comparing "developed" and "underdeveloped" villages and sometimes by using the infrastructure index or individual elements of the index in regression equations, depending on the nature of the analysis. In adopting the "developed" and "underdeveloped" dichotomy, the villages are divided into two groups above and below the average index. The villages with index numbers below the average are termed "developed" and those with index numbers above the average are termed "underdeveloped."

In some instances, results are presented that contrast the three most developed and the three least developed villages, which sharpens the contrast in results and is helpful in emphasizing certain effects of infrastructure development. This is particularly helpful in realizing the extent of benefits that the rural economy may derive from an investment designed to improve the infrastructural access of the most isolated villages to the level of the most developed villages in the sample.

Some Structural Attributes of Households

Three basic characteristics of households—family size, size of landownership, and distribution of households within these groups—in developed and underdeveloped villages are presented in Tables 7 and 8. This information is critical to understanding many of the statistics pertaining to developed and underdeveloped villages and comparing household averages of income, investment, and so forth in developed and underdeveloped villages.

Data in Tables 7 and 8 support three principal conclusions. First, the average family size in developed villages is about 7 percent larger than that in underdeveloped villages.

Table 7—Average family size and size of land owned by households in developed and underdeveloped villages, 1982

Landownership Group	Developed		Underdeveloped		All Households	
	Land Owned	Family Size	Land Owned	Family Size	Land Owned	Family Size
	(acres)	(number)	(acres)	(number)	(acres)	(number)
Landless	0.141	5.51	0.160	4.86	0.151	5.15
Land owned						
Small	1.128	6.41	1.135	5.33	1.132	5.84
Medium	3.168	7.20	3.376	7.47	3.292	7.36
Large	7.564	9.86	9.256	8.71	8.683	9.10

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Second, the average size of land owned is about 34 percent larger in underdeveloped areas than in developed areas. Thus, the land-person ratio is higher in underdeveloped than in developed villages. Third, the incidence of landless and small landowners is 9 to 15 percent higher in developed areas, whereas the incidence of medium and large owners is 12 to 34 percent higher in underdeveloped areas. This is to be expected because centers of infrastructure development attract population, so population density tends to increase with development.

Table 8—Distribution of households by landownership groups in developed and underdeveloped villages

Landownership Group	Developed Villages	Underdeveloped Villages	Difference[a]
		(percent)	
Landless	31.9	29.4	8.5
Land owned			
Small	36.6	31.9	14.7
Medium	23.9	27.2	−12.1
Large	7.6	11.5	−33.9

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.
[a]Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100.

4

INFRASTRUCTURE AND AGRICULTURAL PRODUCTION

Underdevelopment of infrastructure affects the spatial variation of prices of agricultural products and inputs. To the extent that the demand for inputs is price elastic, underdevelopment directly affects the use of inputs, which in turn affects agricultural production. Moreover, some agricultural inputs may not even be available in some areas. Traders may not have enough incentive to move goods into those areas because transport costs are high and markets are thin due to low potential demand at high prices. Diffusion of modern technology in remote rural areas is constrained by infrastructural backwardness.

The other mechanism through which individual farmers can advance their earnings from farming is by producing an efficient combination of products, which is made possible by easy access to markets. The close proximity of farms to markets enables farmers to produce perishable products such as vegetables, fruits, and milk and bulky products such as sugarcane in order to sell them daily in the nearby markets. If immediate access to markets is not possible, perishable products will not be produced, which generally happens in infrastructurally backward areas.

Tracing the effects of the underdevelopment of infrastructure is done in three stages. First, the impact of infrastructure on price variation is assessed, and differences in prices in developed and underdeveloped areas are estimated. Second, demand functions are estimated for various agricultural inputs in order to study price responsiveness. Infrastructure is incorporated into the model as an additional explanatory variable to see whether availability is affected by infrastructure, independent of prices. The difference in input use in developed and underdeveloped areas is estimated from these models by applying the mean values of the exogenous variables. Third, the contribution of various inputs to production is derived by estimating a profit function and then assessing the impact of infrastructure on production by estimating the differences in production in developed and underdeveloped areas due to variation in the use of inputs. This profit function approach is expected to capture the contribution of infrastructure through improvements in efficiency in input and output combination. The overall impact of infrastructure on agricultural production represents the combined effect of resource use and efficiency.

Infrastructure and Prices

In competitive markets, price variables are expected to be exogenous. The state of development of infrastructure, however, affects the transport costs and also the traders' margins, since the thinner the market, the higher the trade margin per unit needs to be to keep traders in business. The prices that farmers get include transport costs and traders' margins. Thus, farmgate prices may vary across farms, depending on the locations of consumers, farmers, and producers of agricultural inputs, as well as the state of development of infrastructure.

The following price equations are obtained from the survey data:

$$PRC_{Pd} = \underset{(141.7)}{155.9} - \underset{(-0.53)}{0.0069\,LNDO} - \underset{(-1.73)}{0.0112\,PDDQ} - \underset{(-2.58)}{0.324\,INF}; \quad (1)$$

$\bar{R}^2 = 0.03$, $F = 4.71$;

$$PRC_R = \underset{(199.8)}{299.93} - \underset{(-4.52)}{0.814\,LNDO} + \underset{(2.99)}{0.0264\,PDDQ} - \underset{(-11.19)}{1.918\,INF}; \quad (2)$$

$\bar{R}^2 = 0.25$, $F = 54.2$;

$$PRC_F = \underset{(70.6)}{113.3} + \underset{(4.41)}{0.764\,LNDO} - \underset{(-5.95)}{0.0142\,FERTQ} - \underset{(11.77)}{2.166\,INF}; \quad (3)$$

$\bar{R}^2 = 0.33$, $F = 79.6$; and

$$WAGE = \underset{(43.8)}{21.54} - \underset{(-2.28)}{0.133\,LNDO} - \underset{(-7.65)}{0.0127\,LBR} + \underset{(12.65)}{1.628\,HYV} - \underset{(-4.36)}{0.239\,INF}, \quad (4)$$

$\bar{R}^2 = 0.32$, $F = 57.4$.

The numbers in parentheses are estimated t-values. The definitions and measurements of the variables are as follows:

PRC_{Pd} = the farmgate price of paddy in taka (TK) per maund (37.4 kilograms),
PRC_R = the price of rice prevailing in the local market in taka per maund,
PRC_F = the farmgate price of fertilizer in taka per maund,
WAGE = the wage rate paid by farmers per day of labor,
LNDO = the amount of land owned in acres,
PDDQ = the amount of paddy produced per household in maunds (37.4 kilograms),
FERTQ = the amount of fertilizer used per household in seers (0.933 kilogram),
LBR = the amount of labor used in crop production in number of days,
HYV = area cropped with high-yielding varieties of rice, in acres, and
INF = the index of underdevelopment of infrastructure.

The value of the adjusted R^2 is generally low, indicating the exogenous nature of prices. As can be noted from the estimates, the amount purchased is a significant determinant of the price of labor and fertilizer. Thus farmers who purchase in bulk pay lower prices for inputs. The size of land owned by the household is also found to influence prices—large landowners pay lower prices for labor but higher prices for fertilizer. That the large landowners pay higher prices for fertilizers is a counterintuitive result, but it should be noted that this effect of farm size is independent of the effect of scale economies of bulk purchases by large farms. The wage rate is found to be

highly significantly related to the area sown in high-yielding varieties (HYVs) of rice. HYV area presumably affects the wage rate by increasing the demand for and the productivity of labor.

Large landowners and those who produce more obtain lower prices for paddy, as indicated by the negative coefficients of LNDO and PDDQ. However, the relationship is statistically very weak. The coefficient of PDDQ in the equation for rice prices is significantly positive, which is contrary to a priori expectations. Farmers usually sell their output in paddy form, and buy back rice when necessary. Those who produce large amounts of paddy presumably sell proportionately more coarse varieties than those who sell small amounts of paddy.

The index of the underdevelopment of infrastructure is found to be a highly significant variable, which explains variation in prices of fertilizer and labor even after the effect of the household-level variation in other variables is disassociated. The value of the infrastructure coefficient indicates that the price of fertilizer is higher in underdeveloped areas, whereas the wage rate is lower. This is to be expected because fertilizer is imported from outside the area, while labor is available locally. When infrastructure such as transportation and roads is underdeveloped, the mobility of labor is constrained; workers find it difficult to take advantage of demand for labor generated outside of their locality, which lowers the wage rate.

The effect of infrastructure on the price of paddy is much less pronounced than on the prices of fertilizer and labor. The value of $\bar{R}^2$ is quite low, although the regression coefficient is significantly different from zero. If infrastructure is underdeveloped, paddy prices in a village may be either high or low, depending on whether the village is a deficit or surplus paddy-growing area; hence, the effect of infrastructure on paddy prices is not unidirectional, which may explain the low value of $\bar{R}^2$. The effect of infrastructure is more significant in the case of rice than of paddy. Large-scale milling of rice, made possible by infrastructure development, makes the supply of rice cheaper and market arrival faster than under conditions of backward infrastructure. Hence, the effect of infrastructure on rice prices is likely to be significant. The values of the coefficients suggest that farmers are likely to get higher prices for rice and paddy with improvement in infrastructure.

What is the extent of the difference in prices between villages at the two ends of the scale of infrastructure development? In order to determine the magnitude of the price difference, the average values of the infrastructure index for three villages at each end of the scale are placed in the price equations and the prices are then estimated *at the mean values of the other variables.* The results are reported in Table 9. In developed villages the price of fertilizer is about 14 percent lower and the wage rate 12 percent higher than in underdeveloped villages. At 2 percent, the difference in the price of paddy is insignificant, but the price of rice is about 6 percent higher in developed villages.

Demand for Inputs

The following input demand functions are postulated for fertilizer and labor:

$$\text{FERTQ} = f(\text{LNDCR, HYV, CPTL, CRDTI, CRDTNI, PRC}_F\text{, INF}), \text{ and} \quad (5)$$

$$\text{LBR} = f(\text{LNDCR, HYV, CRDTI, CRDTNI, WAGE, INF}), \quad (6)$$

Table 9—Effect of infrastructure on agricultural prices, 1982

Commodity/ Input	Developed Villages	Under-developed Villages	Difference[a]
	(Tk/maund)		(percent)
Paddy	154.07	151.19	1.9
Rice	293.80	276.73	6.2
Fertilizer	119.34	138.60	−13.9
Labor (Tk/day)	20.19	18.06	11.8

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a] Difference = |(Developed − Underdeveloped)/Underdeveloped| × 100.

where

LNDCR = the amount of land cropped by the household in acres;

CPTL = the value of nonland capital assets, measured in 1,000 taka;

CRDTI = the amount of credit received from institutional sources, measured in 1,000 taka;

CRDTNI = the amount of credit received from informal sources, measured in 1,000 taka,

and the other variables are defined as before.

The amount of inputs used by a household is assumed to be a function of the price of the input, of the amount of land cropped, and of the amount of area devoted to HYVs, since HYVs are both labor- and fertilizer-intensive, compared with traditional varieties. The amount of nonland assets owned by a household and the credit received from outside sources may also influence input demand by improving liquidity, making it possible to finance the use of optimal amounts of inputs. The effects of underdeveloped infrastructure may be captured indirectly through prices or, as will be argued later, through its effect on the adoption of technology. In addition, infrastructure may affect the availability of inputs. The infrastructure index is kept in the input demand functions to capture effects other than those on prices and technology.

The area devoted to HYVs depends on the state of development of infrastructure. Whether the farmer chooses to allocate land to the new crop varieties is largely determined by the availability of irrigation facilities. The choice may also depend on the effectiveness of extension agents, who spread knowledge about the new varieties and the agronomic practices that affect the productivity of inputs and the profitability of cultivation. The mobility of the extension agents may be constrained by poorly developed infrastructure. In that sense, the infrastructure index directly influences the allocation of land to HYVs and indirectly influences the demand for fertilizer and labor.

The development of irrigation facilities may also be a function of the state of development of infrastructure. In Bangladesh, irrigation facilities have been developed mostly by the government, mainly with external assistance. In the case of large-scale public projects implemented by the Water Development Board, the bias against the underdeveloped areas may be absent, since the entire command area has to be developed. But small-scale irrigation equipment such as pumps and tubewells tends to spread more

quickly in the developed areas, where access to government officials in charge of the distribution of the equipment is easier. This is particularly true of tubewells, because underdeveloped infrastructure constrains movement of drilling equipment to interior areas. By 1984/85, modern irrigation facilities had spread to 1.71 million hectares of land (20 percent of cultivated area), of which only 9 percent was irrigated by canals, while 51 percent was irrigated by tubewells. Thus, by constraining the drilling of tubewells and the mobility of government officials, the underdevelopment of infrastructure may act as a significant determinant of the spatial distribution of irrigation facilities.

Agroclimatic and ecological conditions may also constrain the development of irrigation in certain areas. In the sample, 3 out of 16 villages are located in coastal areas, where salinity of water prohibits development of irrigation facilities and adoption of HYVs, which cannot tolerate saline water. Such agroclimatic factors also affect the demand for inputs. The following equations are postulated to explain the variation in the adoption of modern technology within the sample.

$$HYV = f(IRGN, LNDO, CPTL, CRDTI, CRDTNI, INF), \text{ and} \tag{7}$$

$$IRGN = f(LNDO, CPTL, DUMMY, INF), \tag{8}$$

where IRGN is the amount of owned land with access to irrigation facilities (in acres), and the DUMMY variable takes a value of one for villages located in the coastal area.

It was reported in the previous section that the prices of fertilizer and labor at the household level are to some extent determined by the amount of inputs purchased, although the correlation is weak. In order to make the price variable exogenous, the prices prevailing at the village level have been used in the input demand equations for households.

Since IRGN and HYV, which are endogenous variables, appear on the right-hand side of equations (10)-(12), this is a clear case of a simultaneous equation model with a recursive structure; irrigation determines HYV adoption, and HYV determines the demand for fertilizer and labor. The multiple equation estimator, using the three-stage least-square technique, appears to be appropriate. It explicitly permits contemporaneous correlation among disturbances in equations (7), (8), and (5) or (6). The estimates obtained by applying this method are as follows:

$$\begin{aligned} IRGN = {} & \underset{(3.34)}{0.48} + \underset{(19.34)}{0.354}\,LNDO - \underset{(-0.25)}{0.0013}\,CPTL - \underset{(-4.58)}{0.84}\,DUMMY \\ & - \underset{(-3.96)}{0.066}\,INF; \end{aligned} \tag{9}$$

$R^2 = 0.49$, $F = 107.8$;

$$\begin{aligned} HYV = {} & \underset{(2.92)}{0.68} + \underset{(9.84)}{1.207}\,IRGN - \underset{(-7.24)}{0.385}\,LNDO - \underset{(-1.21)}{0.0091}\,CPTL \\ & + \underset{(4.74)}{1.284}\,CRDTI - \underset{(-1.30)}{0.085}\,CRDTNI - \underset{(-0.42)}{1.17}\,INF; \end{aligned} \tag{10}$$

$R^2 = 0.51$, $F = 77.5$;

$$\text{FERTQ} = \underset{(2.82)}{113.87} + \underset{(1.51)}{1.713}\,\text{LNDCR} + \underset{(21.55)}{124.2}\,\text{HYV} - \underset{(-0.57)}{0.257}\,\text{CPTL}$$

$$+ \underset{(3.38)}{45.66}\,\text{CRDTI} + \underset{(0.78)}{0.249}\,\text{CRDTNI} - \underset{(-2.31)}{0.748}\,\text{PRC}_F - \underset{(-1.41)}{2.162}\,\text{INF}; \qquad (11)$$

$R^2 = 0.50$, $F = 581.6$; and

$$\text{LBR} = \underset{(8.98)}{287.98} + \underset{(3.11)}{4.792}\,\text{LNDCR} + \underset{(6.34)}{60.02}\,\text{HYV} + \underset{(4.21)}{68.74}\,\text{CRDTI}$$

$$- \underset{(-3.54)}{14.60}\,\text{CRDTNI} - \underset{(-7.70)}{11.75}\,\text{WAGE} - \underset{(0.33)}{0.655}\,\text{INF}; \qquad (12)$$

$R^2 = 0.55$, $F = 112.6$.

The values of $\bar{R}^2$ and F are from the ordinary least-square estimates.

The values of the coefficients of the price variables have the correct signs and are highly significant. The coefficients evaluated at the mean values of the variables give a price elasticity of demand for fertilizer of −0.55 and for labor of −1.33. Since these inputs are highly price responsive, and the infrastructure variable affects prices, it is apparent from the findings that infrastructure has an effect on production. The demand for fertilizer and labor are significantly and positively related to the availability of credit from institutional sources. Farmers' access to credit from formal sources depends on the spread of financial institutions (banks, cooperatives, and so forth), which are one of the elements of infrastructure. Also, establishment of financial institutions in an area often follows development of hard infrastructure, such as roads, and markets. In this sense, a credit-induced increase in the demand for inputs may also be partly attributed to development of infrastructure.

Infrastructure affects production through its impact on the adoption of HYVs. The availability of irrigation facilities is significantly inversely correlated with the state of underdevelopment of infrastructure, and irrigation is a major determinant of the adoption of HYVs. The value of the coefficient indicates that 1.0 additional acre of land under irrigation would increase the cropped area sown in HYVs by 1.2 acres. And the diffusion of HYVs increases the demand for fertilizer and labor.

The index indicates that the effects of infrastructure are primarily indirect, through prices and technology adoption. The direct effect, which is independent of prices and technology, is not significant. In the fertilizer demand equation, the value of the coefficient is negative, indicating lower fertilizer use in underdeveloped areas, but the coefficient is not significant. In the labor demand equation, the coefficient is positive but not statistically significant.

The differences in input use in villages at two ends of the scale of infrastructure development have been estimated from equations (9) through (12) by using the values of the infrastructure index for those areas and evaluating the exogenous variables at the arithmetic mean for the entire sample. The results are presented in Table 10. Due to the difference in the availability of irrigation, HYV adoption is about 71 percent higher in the developed villages. The difference in fertilizer use is also substantial—92 percent higher in developed villages than in underdeveloped. Lower fertilizer prices account for 12 percent of the difference, and higher rates of adoption of HYVs account

Table 10—Effect of infrastructure on the use of inputs

Input	Unit	Developed Villages	Under-developed Villages	Difference[a]
				(percent)
Irrigation	Percent of owned land	42.1	20.5	105
Area sown in high-yielding varieties	Percent of cropped area	42.0	24.5	71
Fertilizer	Kilograms of material per hectare of cropped land	150	78	92
Labor	Days per hectare of cropped land	119	115	4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100.

for 64 percent (Table 11). The difference in labor use is small, however—only 3.5 percent. This is because labor is locally available, and its price is lower in underdeveloped villages, which induces use of more labor in those areas. So, the infrastructure effect on the demand for labor through prices and availability of inputs is negative. The overall positive effect is due to higher rates of adoption of modern rice technology in developed villages. Labor use in developed villages is about 15 percent lower than in underdeveloped, due to the higher wage rate, but 22 percent higher due to more intensive adoption of rice HYVs.

Tubewell Irrigation and Infrastructure

Although it is evident from the 16-village study that diffusion of irrigation-based modern technology in agriculture has been faster in infrastructurally developed than underdeveloped areas, the validity of generalizing this finding based on a sample of only 16 villages is questionable. Therefore, a full count of tubewells for irrigation was conducted in all villages of 10 *upazilas* where spread of tubewell irrigation is known to be extensive. The number of irrigation tubewells, their locations vis-à-vis roads, and their operational conditions were recorded through a census conducted in 1,609 villages in May and June of 1988. Using these data, the villages are grouped into three categories: (1) those that can be reached by a motorable road (a road traveled by cars, taxis, or three-wheeled vehicles called *tempos*) and that are less than five miles from an *upazila* headquarters (easy access); (2) those that can be reached by a motorable road but are five miles or more from an *upazila* headquarters (moderate access); and (3) those that cannot be reached by motorable road (difficult access). A village is considered to have access by a motorable road if the road passes through it or less than a mile away. The analysis of the diffusion of tubewell irrigation in these three categories of villages is shown in Table 12.

The table reveals a number of interesting interactions between rural infrastructure and diffusion of small-scale irrigation technology. First, villages with difficult access have achieved a much smaller rate of diffusion of tubewell-based irrigation technology than villages with easy or moderate access by motorable road. The proportion of villages with no tubewells is 7 percent in the easy-access group, 9 percent in the moderate-access group, and 28 percent in the difficult-access group. Second, the infrastructural factor

Table 11—Differences in the use of fertilizer and labor as the result of infrastructure, developed and underdeveloped areas

Input	Developed Versus Underdeveloped Area: Difference in Adoption of HYVs	Difference in Input Prices	Difference in Availability of Inputs	Total
	(percent)			
Fertilizer	63.7	12.1	16.1	91.9
Labor	22.4	−15.3	−3.6	3.5

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: HYVs are high-yielding varieties.

influences not only the extent of diffusion but also the maintenance and use of tubewells. This is reflected in the proportion of tubewells that are in operating condition. About 97 percent of tubewells in the easy-access group are in operating condition, compared with 82 percent in the difficult-access group. The difference between the easy- and the moderate-access groups in this respect is small. Third, electrification of tubewells is five to seven times more extensive in the easy-access group than in the difficult-access group. Rural electrification generally expands along the routes of motorable roads, and this facilitates electrification in easy-access villages. Electrification of tubewells cuts operating costs by more than half. Moreover, management problems posed by transportation and storage of diesel oil in villages can be avoided by switching from diesel fuel to electricity for running tubewells.

The different rate of diffusion of deep and shallow tubewells in the three groups of villages supports the hypothesis that some public measures, though expensive, can help to overcome the constraints imposed by infrastructural backwardness. Deep tubewells are generally installed by public agencies, whereas the diffusion of shallow tubewells is left to private initiative. Diffusion of shallow tubewells in infrastructurally developed areas is more extensive than that in underdeveloped villages. Only 12 percent of villages the easy-access group have no shallow tubewells, compared with

Table 12—Diffusion of tubewell irrigation by degree of infrastructure development in 1,609 villages, 1988

Degree of Accessibility of Village	Total Number of Villages	Villages without Deep Tubewells	Villages without Shallow Tubewells	Villages with No Tubewells	Tubewells Electrified: Deep	Tubewells Electrified: Shallow	Tubewells in Working Condition
				(percent)			
Easy access	648	60	12	7	14	5	97
Moderate access	466	61	15	9	10	3	95
Difficult access	495	70	29	28	2	1	82

Source: Computed from supplementary survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1988.
Notes: Villages with easy access are near a motorable road and within 5 miles of an *upazila* headquarters; villages with moderate access are near a motorable road, but more than 5 miles from an *upazila* headquarters; and those with difficult access are not accessible by a motorable road.

29 percent in the difficult-access group. In the case of deep tubewells, this difference still exists, but it is not as pronounced. Sixty percent of the villages in the easy-access group and 70 percent in the difficult-access group have no deep tubewells, a difference of 10 percentage points, compared with a difference of 17 percentage points between the two groups for shallow tubewells. This implies that a policy to encourage the private sector to initiate small-scale irrigation development—a policy thrust currently favored by donors and multilateral aid agencies—has a better chance of success where infrastructure is developed.

Infrastructure and Efficiency of Resource Use

The relative economic efficiency of resource use in developed and underdeveloped areas can be studied by using the profit function approach suggested by Lau and Yotopoulos (1972). The profit function is derived from the application of the duality relation between the cost and the production function. The estimated parameters can be used to compare the technical efficiency and price efficiency of two groups of farms. For this purpose, farm households are divided into two groups, according to whether they are farming in infrastructurally developed or underdeveloped areas. The economic efficiency in the use of labor and fertilizer of the two groups is then compared.

In the model, farms are assumed to have fixed endowments of land, L, and capital, K, which cannot be varied in the short run. However, farms can choose variable amounts of labor, N, and fertilizer, F, the prices of which are W and C, respectively. The amounts of the variable inputs that the farm decides to use are determined by setting the marginal cost of the input, i, to $1/K_i$ times the marginal value product, where K_i is the ratio by which the opportunity cost of the input to the farmer differs from market prices. Farms are called price efficient if all the capital inputs (K_i) are equal to unity. One farm may be more technically efficient than another if it produces a larger quantity of output from the same quantity of measurable inputs. Technical efficiency may differ between two groups of farms by a multiplicative factor. Differences in economic efficiency among groups of farms may be caused by differences in either technical or price efficiency.

Using the Cobb-Douglas assumption for technology, the model yields a unit output price (UOP) profit function,

$$\mathrm{Ln}\,\pi = \mathrm{LnA} + \delta I + \alpha_1 \mathrm{LnW} + \alpha_2 \mathrm{LnC} + \beta_1 \mathrm{LnL} + \beta_2 \mathrm{LnK}, \tag{13}$$

and two input demand equations:

$$-\mathrm{WN}/\pi = \alpha_{11} I + \alpha_{12}(1 - I), \text{ and} \tag{14}$$

$$-\mathrm{CF}/\pi = \alpha_{21} I + \alpha_{22}(1 - I), \tag{15}$$

where π is the profit on the price of a unit output (gross revenue minus total variable cost), W and C are labor and fertilizer prices normalized by the output price, and I is a dummy variable taking a value of one for households operating in infrastructurally developed villages and zero for others.

The hypothesis of equal relative economic efficiency implies that δ is equal to zero. This hypothesis implies that $\alpha_{11} = \alpha_{12}$ and $\alpha_{21} = \alpha_{22}$. The hypothesis of absolute

price efficiency implies that for farms in developed areas, $\alpha_{11} = \alpha_1$ and $\alpha_{21} = \alpha_2$, and the same holds true for farms in underdeveloped areas.

The error term is assumed to be additive, with an expectation of zero and finite variance for each of the three equations. But the covariances of the errors of either equation corresponding to different farms are both assumed to be zero. Under this specification of errors, Zellner's (1961) seemingly unrelated regression equation (SURE) provides an asymptotically efficient method of estimation, the efficiency of which can be increased by imposing known constraints on the coefficients in the equations.

In estimating the model from the data, profits are measured by deducting the costs of variable inputs—seed, fertilizer, manure, pesticides, irrigation, and labor—from the gross value of output. The cost of animal labor cannot be accounted for because data are not available, so animal labor is treated as a fixed input and included in farm capital. The cost of family labor is imputed from the wage rate paid to hired workers. The market for irrigation is imperfect, and the irrigation cost varied widely depending on the source of the supply of water. Since only the HYV crops are irrigated, the cost of irrigation is also imputed by multiplying the area under HYVs by the average cost of irrigation per unit of land for the entire sample. The farm-level prices of variable inputs can only be computed for labor and fertilizer, since quantity and cost information is only available for those two inputs. For this reason, only fertilizer and labor are used as variable inputs on the right-hand side of the profit equation. A significant proportion of farms did not hire labor or use chemical fertilizer, so prices cannot be computed for them. The average price of labor and fertilizer prevailing at the village level is used for these cases. The profit, wage rate, and fertilizer price variables are normalized by paddy prices. The capital input is measured in flow terms by multiplying the replacement cost of the stock of agricultural implements and draft animals with the rate of interest charged on loans from the commercial banks. Owing to widespread crop damage from natural calamities during the reference year of the survey, there were no profits—only losses—in a large number of cases (145 out of 475 farms in the sample). Because the UOP profit function is log linear, these cases are excluded. Since lower profits may also be due to inefficiency of resource use, this could introduce sample selection bias into the results.

A major criticism of the model is that the invariability of the prices in the cross-section data vitiates the usefulness of the methodology. This is not a serious problem for the data set used here. As already noted, the prices of labor and fertilizer across farms are significantly related to the state of underdevelopment of infrastructure. The coefficient of variation of prices across villages is 24 percent for labor, 14 percent for fertilizer, and 7 percent for paddy.

Zellner's (1961) seemingly unrelated regression method yields the following estimates of the profit function (equation 13) and the factor share equations (14 and 15) in the unrestricted form:

$$\begin{aligned} \text{Ln}\,\pi = & \underset{(-1.02)}{-0.399} + \underset{(2.12)}{0.193}\,I - \underset{(-2.69)}{0.395}\,\text{LnW} - \underset{(-0.94)}{0.321}\,\text{LnC} \\ & + \underset{(12.04)}{0.778}\,\text{LnL} + \underset{(4.77)}{0.130}\,\text{LnK}; \end{aligned} \tag{16}$$

$\bar{R}^2 = 0.50$, $N = 330$;

$$WN/\pi = \underset{(-2.72)}{-0.659\,I} - \underset{(-5.36)}{1.120}(1 - I); \text{ and} \tag{17}$$

$$CF/\pi = \underset{(-3.74)}{-0.135\,I} - \underset{(-3.84)}{0.128}(1 - I). \tag{18}$$

The results of the tests of various hypotheses regarding the absolute and relative price efficiencies in the use of labor and fertilizer are presented in Table 13, as well as the constant returns to scale in production. The hypothesis that price efficiency is the same for farms in the developed and underdeveloped areas is accepted for fertilizer but is rejected for labor. Farmers in developed areas are relatively more price efficient in the use of labor than farmers in underdeveloped areas. Both groups are absolutely price efficient in the use of fertilizer, but only farmers in developed areas are absolutely price efficient in the use of labor. Presumably, farmers in underdeveloped villages have more surplus labor than those in developed villages because labor has more difficulty in taking advantage of employment opportunities outside the locality. Also, nonfarm employment opportunities are lower in underdeveloped villages. So farmers in these areas go on using family labor beyond the point in the production function where the marginal productivity of labor is equal to the wage rate. When the accepted hypotheses about price efficiency are maintained, the hypothesis of constant returns to scale is also accepted.

The estimate of the profit function under restriction of the parameters (for which the hypotheses are accepted) is as follows:

$$\begin{aligned} Ln\,\pi = {} & \underset{(-4.09)}{-1.002} + \underset{(2.72)}{0.238\,I} - \underset{(-4.01)}{0.454\,LnW} - \underset{(-5.85)}{0.112\,LnC} \\ & + \underset{(32.9)}{0.879\,LnL} + \underset{(4.54)}{0.121\,LnK}. \end{aligned} \tag{19}$$

Figures in parentheses are t-values. The value of the coefficient of infrastructure is found to be positive and statistically highly significant. It suggests that farms in developed areas are technically more efficient than their counterparts in underdeveloped areas, that is, they produce a larger quantity of output from the same amount of labor and fertilizer. This may be the result of a wider availability of irrigation facilities, higher rates of adoption of HYVs of rice, and better management in the developed villages, since it has already been shown that infrastructure affects input use and production indirectly through changes in technology and prices.

Effects on Production

The parameters of the Cobb-Douglas production function can be derived indirectly from the profit function. The estimates are statistically more consistent than the parameters derived from direct estimates of the function, because it assumes all inputs to be exogenously determined, while in practice the level of use of variable inputs may be simultaneously determined depending on their prices, a maintained assumption of the profit function approach. Because α_1 and α_2 appear in the profit function as well as

Table 13—Tests for hypotheses of relative and absolute price efficiency in the use of labor and fertilizer, and constant returns to scale

Test	Parameter Restriction	Maintained Hypothesis	Value of Chi-square	Level of Significance
1. Relative efficiency in the use of fertilizer	$\alpha_{21} = \alpha_{22}$	none	0.02	0.889
2. Relative efficiency in the use of labor	$\alpha_{11} = \alpha_{12}$	none	2.70	0.101
3. Absolute efficiency in the use of fertilizer	$\alpha_{22} = \alpha_2$, $\alpha_{21} = \alpha_2$	$\alpha_{11} = \alpha_1$	1.57	0.666
4. Absolute efficiency in the use of labor in developed areas	$\alpha_{11} = \alpha_1$	none	0.88	0.349
5. Absolute efficiency in the use of labor in underdeveloped areas	$\alpha_{12} = \alpha_1$	$\alpha_{11} = \alpha_1$	9.08	0.011
6. Constant returns to scale	$\beta_1 + \beta_2 = 1$	$\alpha_{11} = \alpha_1$ $\alpha_{21} = \alpha_2$ $\alpha_{22} = \alpha_2$	5.15	0.272

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

the respective factor share equations, imposing the restriction that they are equal in other equations improves the efficiency of the estimate.

Estimates of the output elasticities of the various inputs derived from equations (15) and (18) are presented in Table 14. The unrestricted function places the elasticity for labor at 0.23 and that for fertilizer at 0.19. When restrictions are imposed on the parameters, the elasticity for labor increases to 0.29, while that of fertilizer is reduced to 0.07. At the mean value of the variable, the marginal value product of labor is estimated at Tk 17.33 per day, which is about nine-tenths of the wage rate for hired labor. The marginal product of fertilizer is estimated at Tk 1.53 per taka of investment.

The effect of infrastructure on production can be estimated by applying the output elasticities to the difference in the use of labor and fertilizer in developed and underdeveloped villages (as reported in Table 10). If the parameters are taken from the unrestricted profit function, total crop production would be 18.0 percent higher in developed villages than in underdeveloped villages, but if the parameters are taken from the restricted profit function, the difference in production is reduced to 7.6 percent.

Conclusions

Infrastructure affects agricultural production indirectly through prices, diffusion of technology, and the use of inputs. In this chapter, a multivariate regression technique was used to isolate the effect of infrastructure on these variables, after taking into account the effects of other exogenous factors. The price of the major output, paddy, does not differ much across villages at different levels of infrastructure, but the price of fertilizer is 14 percent lower and that of labor 12 percent higher in villages with more developed infrastructural facilities. The difference in area covered by irrigation and HYVs of rice between the two groups of villages is found to be 105 percent and 71 percent, respectively.

Table 14—Indirect estimates of the output elasticities of various inputs and the marginal value products

Inputs	Output Elasticity		Marginal Value Product			Price of the Input
	Unrestricted Function	Restricted Function	Unit	Unrestricted Function	Restricted Function	
Fixed						
Land	0.454	0.561	acre	2,426	2,998	2,878
Capital	0.076	0.077	Tk	1.34	1.35	1.00
Variable						
Labor	0.230	0.290	day	13.74	17.33	19.54
Fertilizer	0.187	0.072	Tk	3.97	1.53	1.00
Sum of elasticities	1.000					

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Differences in the adoption of the new technology and prices were incorporated into the input demand functions to estimate the effect on the use of fertilizer and labor. The result suggests that there is little impact on the use of labor, but use of fertilizer is 92 percent higher in the developed villages. The estimate of the production function suggests that these effects on input demand increase production in the developed villages about 8 percent. In addition, developed villages produce about 24 percent more than underdeveloped villages, due to more efficient use of the inputs allowed by the improved production technology. The analysis thus suggests that the differences in the composition and levels of infrastructure prevailing in the two groups of villages may account for about 32 percent difference in crop output produced between these areas.

5

INFRASTRUCTURE, THE RURAL LABOR MARKET, AND EMPLOYMENT

Infrastructure affects the rural labor market and employment in several ways. First, it may influence the supply of labor by inducing laborers to work harder. According to standard economic theory, the choice between labor and leisure is determined by the cost of leisure (in wage income) relative to the prices of consumer goods that can be bought with income from labor. The state of development of infrastructure determines the availability of consumer goods produced outside the locality and their prices. High unit transport costs may inhibit the movement of some goods into interior areas; since consumer prices include transport costs, prices may be so high that the potential demand for the goods may be too low to warrant transporting them. Therefore, in underdeveloped areas some goods may not be available at all, or their prices may be so high that the incentive to earn more by working more is dampened.

Second, infrastructure development may improve the efficiency of the labor market. Underdeveloped infrastructure affects the wage rate by constraining the mobility of workers. Shortages and surpluses of labor in the market can be overcome through migration of workers, and migration tends to equalize the wage rate over a wider area. Underdevelopment of infrastructure, however, limits the size of the area over which labor is mobile and hence contributes to the fragmentation of the labor market. Thus, shortages and surpluses of labor can coexist with wide variation in wage rates and inefficient use of labor. By affecting the wage rate, infrastructure influences the choice between labor and leisure and between self-employment and wage employment.

Third, positive effects of infrastructure development on agriculture, industry, and services imply a positive effect on the demand for labor. Some elements of infrastructure, such as availability of electrical power and access to financial institutions, may determine the location of certain skill-intensive nonfarm activities, the development of which would increase labor productivity and employment. This induces more investment in formation of human capital (education and training) and increases the productivity of employment. Apart from these indirect effects, the development of infrastructure has a significant impact on employment in services and transport.

The objective of this chapter is to assess the effects of infrastructure on employment by estimating the supply of and demand for labor in the 16-village sample by incorporating infrastructure as an explanatory variable. Information on the supply of labor was collected from all members of the sample households who participated in income-earning activities by asking about their allocation of time each day of the week preceding the day of the interview for eight weeks scattered throughout the year 1982. The periods were selected on the basis of a prior knowledge of the cropping pattern of the area so as to represent normal, busy, and slack periods of employment. The supply of labor for the whole year and the composition of employment is estimated by extrapolating the data for eight weeks. The information on demand for labor is only available for crop production activities. It is estimated from the use of labor for different crops grown by the sample farmers during 1982, the information on which was collected through three rounds of interviews conducted at the end of each of the three crop seasons (boro, aus, and aman) during the year.

Infrastructure and Employment: A Descriptive Profile

This section provides a broad overview of the supply and demand for labor and the importance of the labor market in the two groups of villages that have already been classified on the basis of the state of infrastructure development. The methods used to construct the composite index of underdevelopment of infrastructure for the 16 villages were discussed in Chapter 3. The developed area consists of villages with index values lower than the mean for the entire sample; the remaining villages constitute the underdeveloped area. Employment also affects a host of other factors besides infrastructure, but in the descriptive analysis presented here, it is not possible to control for the effects of all such variables. This is attempted in a subsequent section. Because landownership affects labor and employment profoundly, the results are presented separately for four groups: (1) the landless, defined as households owning less than 0.5 acre; (2) small owners, with up to 2 acres; (3) middle-size owners, with 2-5 acres; and (4) large owners, with more than 5 acres. This classification also makes it easier to understand the behavior of different socioeconomic groups in the villages.

Supply of Workers

For the purposes of this study, a worker is defined as a person who was available for work in an income-earning activity during any of the eight weeks included in the survey. On this basis, the proportion of the population in the sample participating in the labor force is estimated at 29.7 percent, compared with 29.4 percent for the country as a whole, as estimated by the Employment and Labor Force Survey of 1983/84 (Bangladesh, Bureau of Statistics 1986).

The rate of participation in the underdeveloped and developed villages can be seen in Table 15. There is no marked difference between the two groups in labor force participation. The rate is found to be inversely related to the size of landholding. In the underdeveloped villages nearly 33 percent of the population in the landless households participated in the labor force, compared with only 25 percent in the large landowning households. Since income is highly and positively associated with the size of land owned, this suggests that the higher income households supply fewer workers,

Table 15—Participation in income-earning activities in developed and underdeveloped villages, 1982

Landownership Group	Workers as a Percent of Family Members			Female Workers as a Percent of Total Workers		
	Under-developed Villages	Developed Villages	Difference	Under-developed Villages	Developed Villages	Difference
Landless	32.9	33.1	0.2	10.1	21.8	11.7
Land owned						
Small	30.8	29.1	-1.7	8.5	14.4	5.9
Medium	27.9	29.0	1.1	3.0	10.7	7.7
Large	25.4	28.8	3.4	2.3	10.1	7.8
All households	29.3	30.1	0.8	6.4	15.1	8.7

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

an indication of a greater preference for leisure over work. Another explanation for the lower labor force participation in higher-income groups is the higher rate of school attendance by children. In the developed villages, the participation rate also declines as the size of landholding increases, but the difference is much less accentuated. In the underdeveloped villages, the large landowning households supply 23 percent fewer workers to the labor force than do the landless households, whereas the difference narrows to 13 percent in the developed villages. The landowning households with medium or large holdings are more likely to participate in economic activities in developed than in underdeveloped villages.

A large part of the increase in the supply of workers in the developed villages is due to higher participation of women in economic activities (15.1 percent, compared with 6.4 percent) in the underdeveloped villages. The proportion of female workers declines sharply as the size of land owned increases, participation being negligible among the middle-size and large landowning households. With development of infrastructure facilities, female participation increases irrespective of the landownership group, the rate of increase being relatively higher among large landowning households. For the middle-size and large landowning households the proportion of female workers is about 10 percent in developed villages and less than 3 percent in underdeveloped villages; for the landless group the figures are 22 and 10 percent, respectively.

In Bangladesh there is a social stigma against women working in the field or performing manual labor on another's account. However, under the pressure of poverty, women from very poor families try to earn income or reduce spending by organizing production activities around the homestead. Nearly two-thirds of the workers engaged in cottage industries are women. A significant number of women are coming forward to take loans from credit institutions to set themselves up in livestock and poultry raising, processing, or manufacturing. The development of infrastructure provides additional scope for undertaking such activities and increases labor force participation among women from poor households. In the upper-income groups, women having high school educations do not participate in the labor force due to lack of suitable employment. Schools, financial institutions, and government offices, which are concentrated in areas where infrastructure is highly developed, provide employment for educated women in the nonagricultural sector.

The Labor Supply and Its Composition

Since the number of hours of labor put in by a worker during a day may vary across villages, and a worker may be engaged in a number of activities during a day, engagement in productive work was recorded in the survey by hours of activity for each worker belonging to a sample household. The estimate of the supply of labor at the individual worker and household level is constructed from these data. First, average weekly labor hours for the eight weeks of the survey are measured for each activity and sector and multiplied by 52 to estimate the supply of labor in 1982. This figure is then converted into standard eight-hour person-days. The number of days of labor put in by an average worker is about 254 standard eight-hour person-days or 39 hours per week (Table 16).

Days of labor are found to be inversely related to the size of land owned (Table 16), again suggesting that at higher levels of income people substitute leisure for labor. In the underdeveloped villages, a worker in the large landownership group puts in 229 days of labor, compared with 265 days for a worker in the landless group—about 14 percent fewer days. In the infrastructurally developed villages, the difference is even more pronounced—the landless work about 4 percent more and the large landowners 7 percent less than in the underdeveloped villages. There is no significant difference

Table 16—Days of labor in developed and underdeveloped villages, 1982

Landownership Group	Days of Employment/Worker			Days of Employment/Household		
	Under-developed Villages	Developed Villages	Difference	Under-developed Villages	Developed Villages	Difference
			(percent)			(percent)
Landless	265	276	4.2	425	501	17.9
Land owned						
Small	264	257	−2.7	435	480	10.3
Medium	241	241	...	501	503	0.4
Large	229	212	−7.4	504	585	16.1
All households	254	253	...	457	502	9.9

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more. The ellipses (...) indicate a nil or negligible amount.

in the supply of labor *per worker* between the developed and underdeveloped villages, but the labor supplied per household is about 10 percent higher in the developed villages because family sizes are larger and more members participate in the labor force. This difference is pronounced for the landless and large landowning households, whereas it is insignificant for the middle landownership group.

The impact of infrastructure is stronger in the sectoral composition of the labor supply (Table 17). Labor supply in agriculture increases with the size of landholding, since land provides the opportunity for family workers to be self-employed. But the landowning households supply less labor for agriculture in the developed villages, and the landless households supply about one-third more. It appears that as nonagricultural employment opportunities are generated following the development of infrastructure, people tend to substitute relatively more productive nonagricultural labor for arduous agricultural labor. This generates more employment opportunities for the landless in agriculture.

Since the landless often cannot find enough employment on the land, they are more likely than other groups to engage in nonagricultural activities. In underdeveloped villages, about 55 percent of the labor supply in landless households works in nonagricultural activities compared with only 18 percent in the large landowner households. In developed villages the picture is different. With development of infrastructure, the share of nonagricultural laborers in the total labor supply declines to one-half for the landless, while it increases to nearly one-third for the large landowner households.

For all households, the supply of labor in nonagriculture is about 30 percent higher in developed villages than in the underdeveloped ones, suggesting that development of infrastructure increases the opportunity for nonagricultural employment. But the higher income groups are more likely to take the opportunity.

Even self-employment in some nonagricultural activities requires investment in working capital and some basic skills like functional literacy and numeracy. Widespread illiteracy and lack of access to financial institutions may constrain the poor from taking up nonagricultural employment. Thus, the landless are more likely to engage in manual, labor-intensive nonfarm activities, where labor productivity is low. As development of infrastructure creates opportunities for nonfarm jobs with higher productivity, luring

Table 17—Sectoral composition of employment in developed and underdeveloped villages, 1982

Landownership Group	Agricultural Labor			Nonagricultural Labor		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(days/household)		(percent)	(days/household)		(percent)
Landless	189	251	32.8	235	250	6.4
Land owned						
Small	276	267	-3.3	159	213	34.0
Medium	391	340	-13.0	110	163	48.2
Large	414	400	-3.4	89	185	107.9
All households	297	292	-1.7	161	210	30.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

the higher-income groups with capital and skills, more agricultural jobs become available to the landless, who can then afford to give up the nonfarm jobs with low productivity.

A detailed breakdown of the labor supply by activity in developed and underdeveloped villages is provided in Table 18. In developed villages, the supply of family labor to crop production is about one-fifth less and the supply of wage labor is about two-thirds more than in underdeveloped villages. The supply of wage labor is provided mostly by the landless and marginal landowning groups. As the demand for hired labor increases to compensate for the decline in the supply of family labor in crop production activity, the labor supply declines in earthwork and miscellaneous activities, which are undertaken mostly by the poor as distress employment. The activities that show an increase in the labor supply with development of infrastructure facilities are construction and transport, other services, and cottage industries, which are mostly skill- or capital-intensive. It may be surprising that the supply of labor in trading activities does not respond to the development of infrastructure. While the volume of trade may increase, petty trade, which is the dominant mode of transaction in interior areas due to lack of transport facilities, presumably gives way to more organized commercial trading as the transport sector develops. The increase in productivity reduces the demand for labor in trading activities.

Supply of Labor to the Market

In Bangladesh, the size of the rural labor market is small. During the survey year the sample households supplied only 32 percent of the total supply as wage labor, 22 percent in agricultural activities, and 49 percent in nonagricultural activities. This is not surprising in view of the small average size of farm holdings, most of which are incapable of generating full employment for family workers. In fact, labor is hired in crop production mainly because of the highly seasonal nature of operations, which creates occasional shortages of labor, although family workers belonging to large farm households may remain considerably underemployed at other times of the year and may have to look for nonagricultural occupations. Many agricultural households generate nonfarm employment on their own account in response to the lack of adequate employment in crop production activities.

Table 18—Supply of labor in developed and underdeveloped villages by activity, 1982

Activity	Percent of Households Participating in Activity		Employment/Participating Household		Employment/Household[a]		
	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Difference
			(days)		(days)		(percent)
Agriculture							
Cultivating family farm	85.9	74.1	234	209	201	155	-22.9
Agricultural wage labor	40.1	46.1	124	181	50	84	68.0
Livestock raising	49.4	44.2	58	60	29	27	-6.9
Fishing	28.6	17.4	60	180	17	31	82.4
Nonagriculture							
Cottage industry	7.9	12.2	120	143	10	18	44.4
Trade and shopkeeping	33.6	22.3	131	189	44	42	-5.5
Construction and transport	34.5	46.4	71	161	24	75	212.5
Services	22.3	40.3	141	142	32	57	78.1
Earthwork	28.0	11.5	102	63	28	7	-75.0
Miscellaneous activities	59.1	38.1	39	28	23	11	-52.2

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Includes all households in sample.

Data comparing the supply of hired labor in the developed and underdeveloped villages suggest that the development of infrastructure expands the size of the labor market (Table 19). In the developed villages, an average household supplied 198 days of labor outside the family, compared with 121 days in underdeveloped villages, a difference of about 64 percent. The landless households supply more labor to the market than the landowning households because land provides opportunities for generating self-employment. In the underdeveloped villages, the landless supplied about 52 percent of the labor to the market, compared with only 5 percent for the large landowning households. In developed villages all landownership groups supplied more labor to the market than they did in underdeveloped villages, but the absolute difference is highest for the landless and small landowning households. It appears that as infrastructure develops, the higher-income groups substitute self-employment on land for nonfarm jobs, creating more opportunities for hired agricultural employment for the lower-income groups, who in turn substitute agricultural wage employment for low-production, nonfarm self-employment.

Demand for Agricultural Labor

The information obtained from farm households on the use of labor in crop productivity is shown in Table 20. The average size of holding is significantly different for the two areas, particularly for the large landownership group. Since this affects the demand for labor at the household level, the information on labor use is standardized by expressing it per unit of cropped land. Total labor use is 12 percent higher in

Table 19—Supply of labor to the market by landownership group, 1982

Landownership Group	Days of Hired-Out Labor/Household			Hired-Out Labor as a Percent of Total Labor Supply	
	Under-developed Villages	Developed Villages	Difference	Under-developed Villages	Developed Villages
Landless	224	311	87	52.7	62.1
Land owned					
Small	116	200	84	26.7	41.7
Medium	52	107	55	10.4	21.3
Large	26	39	13	5.2	6.7
All households	121	198	77	26.5	39.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

developed than in underdeveloped villages, primarily due to higher levels of adoption of modern rice technology, which is more labor-intensive. But the rate of increase is proportionately much higher for hired labor than for family labor. In developed villages the use of hired labor is about 16 percent higher than in underdeveloped villages, while the use of family labor is only 9 percent higher. This information also supports the contention that as infrastructure develops, self-employment in agriculture gives way to wage employment.

An interesting point to be noted in Table 20 is that the higher labor use in crop production in developed villages is mainly on account of small and middle-size farms. Compared with underdeveloped villages, labor use in developed villages is about 12 percent higher for small farms, 18 percent higher for the middle-size farms, and less than 2 percent higher for large farms. In fact, large farms in developed villages use more family labor and less hired labor than those in underdeveloped villages. This pattern of behavior is difficult to explain. But the effect of farm size on demand for labor may partly explain this result. The average farm areas in all size groups, particularly the large, were higher in underdeveloped than developed villages. It appears that when there is an increase in the demand for hired labor among all groups of farm households,

Table 20—Demand for labor for crop production in developed and underdeveloped villages, 1982

Size of Farm	Family Labor		Hired Labor		Total Labor	
	Under-developed Villages	Developed Villages	Under-developed Villages	Developed Villages	Under-developed Villages	Developed Villages
(acres)			(days/acre of cropped land)			
Small (up to 2)	38.0	39.1	16.4	22.0	54.4	61.1
Medium (2 – 5)	25.8	27.1	16.5	22.7	42.3	49.8
Large (more than 5)	19.4	23.6	31.1	27.7	50.5	51.3
All farm households	27.1	29.6	20.8	24.1	47.9	53.7

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

the large farmers suffer more during the seasonal period of labor scarcity because of the higher absolute amount of labor that they need. They may respond by allocating more land to less labor-intensive crops or by using more family labor. Indeed, the same data show that the larger farms devote proportionately less land to labor-intensive modern varieties of rice and that many large landowners grow these crops through labor-surplus tenant farmers (Hossain 1988b).

Infrastructure and Operation of the Labor Market

In this section a multivariate analysis of the determinants of the supply of and demand for labor is attempted in order to assess precisely the impact of development of infrastructure on the rural labor market. The market may be affected by a host of factors that are exogenous to infrastructure. In assessing the effects of infrastructure, the effects of the other variables should be controlled for, which could not be done in the descriptive analysis.

Determinants of the Labor Supply

According to standard economic theory, the supply of labor is mainly determined by the price of leisure relative to the prices of consumer goods. However, the supply may vary according to the age-sex characteristics of the workers because these influence the time available for labor, and also according to the number of dependents per earner in the household because all members of the household share in the earnings. The possibility for earnings from nonlabor sources shifts the supply curve. Ownership of land and nonland fixed assets provides the scope for such earnings. Also, the higher the level of education of the worker, the higher the productivity of labor and the greater the possibility of moving to a higher-income job. The following supply function for labor is postulated:

$$SLBR = f(WAGE, WRKR, FEM, FSZ, LAND, HYV, CPTL, EDCN, LVNG, INF),$$

where

SLBR = the number of days of labor supplied by the household during the survey year,

WAGE = the wage rate prevailing in the village during the year of survey, measured in taka per day,

WRKR = the number of members who participated in income-earning activity during any of the eight weeks of the survey,

FEM = the number of female workers,

FSZ = the number of household members,

LAND = land owned by the household in acres,

HYV = land cropped with modern varieties of rice,

CPTL = the value of nonland fixed assets owned by the household, in 1,000 taka,

EDCN = the number of years of formal schooling for the head of the household,

LVNG = the standard of living in the village, as measured by

the per capita consumption expenditure per year in 100 taka, and

INF = the index of underdevelopment of infrastructure.

The standard-of-living variable is included to capture the effect of poverty in the village on the labor-leisure choice of its members. The wage rate is measured at the village level because it is more exogenous than the variable measured at the household level, which may be somewhat influenced by the endowment of land and workers in the household. The wage rate, the level of per capita consumption in the village, and the extent of adoption of modern varieties may be influenced by the state of underdevelopment of infrastructure. In order to see if correlation among these variables affects the results significantly, stepwise regressions are also run to exclude these variables from the functions.

The estimated supply function including all of the above variables at the household level is presented in Table 21. Nearly two-thirds of the variation in labor supply across households is explained by the variables included in the model. The results of the stepwise regression show that exclusion of the wage rate, standard of living, and adoption of new technology variables significantly reduces the value of the adjusted R^2, while the coefficient of the infrastructure variable does not change significantly. Therefore, it may be more appropriate to interpret the results for the equation that incorporates all the variables.

The results show that as income from nonlabor sources increases, rural households tend to supply less labor. This is indicated by the negative coefficients of the standard of living in the village, the amount of land owned by the village, the adoption of the new technology, and the level of education. For example, the value of the coefficients

Table 21—Estimates of supply function for labor, all activities

	Estimate 1		Estimate 2		Estimate 3	
Variable	Coefficient	t-Value	Coefficient	t-Value	Coefficient	t-Value
Constant	193.0	3.75***	17.4	1.48	64.5	2.74***
Number of workers	201.2	27.50***	196.5	25.80***	195.6	25.75***
Number of female workers	-70.3	-4.49***	-33.9	-2.15**	-35.2	-2.24***
Family size	8.6	3.44***	8.6	3.32**	8.7	3.36***
Land owned	-7.6	-2.94***	-11.1	-4.31***	-11.6	-4.52***
Land sown in high yielding varieties	-13.3	-2.75***	n.a.	n.a.	n.a.	n.a.
Capital	2.3	3.96***	2.1	3.42***	2.1	3.53***
Education of the household head	-4.1	-2.28***	-4.3	-2.30***	4.0	3.36***
Wage rate	7.37	4.80***	2.1	1.48	n.a.	n.a.
Consumption level of the village	-9.65	-6.56***	n.a.	n.a.	n.a.	n.a.
Index of underdevelopment of infrastructure	2.08	1.06	2.79	1.38	2.19	1.10
$\bar{R}^2$	0.67	n.a.	0.63	n.a.	0.63	n.a.
F	152.70	n.a.	135.58	n.a.	154.40	n.a.

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Note: n.a. is not applicable.

**Significant at the 0.05 level.

***Significant at the 0.01 level.

of the land variable suggests that each additional acre of land owned by a household would reduce the supply of labor by 8 days, and if that land is sown in HYVs of rice, the labor supply would be reduced by 21 days. Only the ownership of nonland capital assets seems to increase the supply of labor, presumably because it helps to generate additional self-employment.

Household composition also seems to affect the labor supply significantly. A positive coefficient of family size indicates that the larger the number of dependents per earner, the more days of work are necessary. Each additional earner in a household increases the labor supply by 201 days. A female, however, works about 70 days less than a male.

The labor supply is positively associated with the wage rate. An increase in the wage rate of Tk 1.00 on the margin increases the supply of labor by seven days. Since underdevelopment of infrastructure reduces the wage rate, which in turn reduces the supply of labor, earnings from labor tend to be less in villages with underdeveloped infrastructure facilities.

Once the effects of other variables are disassociated, infrastructure does not seem to affect the total labor supply significantly. The coefficient of the index of underdevelopment of infrastructure is positive, indicating a larger supply of labor in underdeveloped villages, but the coefficient is not statistically significant.

Infrastructure, however, affects the composition of employment. The estimated supply functions for different types of labor are reported in Table 22. It should be noted that underdevelopment of infrastructure increases the labor supplied to agriculture but reduces the supply of nonagricultural labor. This suggests that nonfarm employment opportunities are less available in the underdeveloped villages; hence rural households tend to supply more labor to agriculture. The estimated coefficients also show that in areas with less-developed infrastructure, households supply more labor to their own account and hire out less than in developed areas. The coefficient of infrastructure in both equations is highly significant statistically.

Determinants of the Demand for Labor

The survey collected information on the demand for labor only with regard to crop production activity. The following demand function is postulated:

$$DLBR = f(LNDCR, HYV, WRKR, FEM, EDCN, WAGE, TNC, INF),$$

where

- DLBR = the number of days of labor used in crop production during 1982, by household,
- LNDCR = the amount of land cropped in acres,
- HYV = the amount of land allocated to modern varieties of rice in acres, and
- TNC = the amount of cropped land rented-in from outside in acres.

The other variables are defined as before.

Estimates of the functions for the use of hired labor and total labor are presented in Table 23. A significant number of farm households in the sample did not hire in labor. In order to avoid problems in estimating parameters when the dependent variable takes a zero value, the parameters of the equation are also estimated using the Tobit method.

Table 22—Estimates of supply functions for labor by type, all rural households

Variable	Agriculture	Non-agriculture	Self-Employed	Wage Employment
Constant	148.6 (2.69)***	44.5 (0.73)	−123.5 (−2.07)**	316.5 (5.43)***
Number of workers	117.9 (15.0)***	83.3 (9.68)***	113.9 (13.44)***	87.4 (10.56)***
Number of female workers	−66.7 (−3.98)***	−3.6 (−0.19)	−0.8 (−0.04)	−69.5 (−3.93)***
Family size	10.6 (3.97)***	−2.0 (−0.69)	14.33 (4.95)***	−5.75 (−2.04)**
Land owned	4.04 (1.46)	−11.63 (−3.83)***	6.39 (2.14)**	−13.98 (−4.79)***
Land sown in high-yielding varieties	13.61 (2.62)***	−26.94 (−4.72)***	6.52 (1.16)	−19.86 (−3.62)***
Capital	1.16 (1.88)*	1.12 (1.66)*	3.99 (5.97)***	−1.70 (−2.61)**
Education of the household head	−8.91 (−4.67)***	4.85 (2.32)**	−0.39 (−0.19)	−3.67 (−1.83)*
Wage rate	0.90 (0.55)	6.47 (3.58)***	4.90 (2.76)***	2.47 (1.42)
Consumption level of the village	−6.47 (−4.10)***	−3.18 (−1.83)*	−2.53 (−1.48)	−7.12 (−4.28)***
Underdevelopment of infrastructure	3.93 (1.88)*	−1.85 (−0.42)	10.21 (4.51)***	−8.13 (−3.68)***
$\bar{R}^2$	0.47	0.21	0.48	0.28
F	56.7	17.9	59.9	25.6

Note: Figures in parentheses are estimated t-values.
*Significant at the 0.10 level.
**Significant at the 0.05 level.
***Significant at the 0.01 level.

The values of the coefficients suggest that the demand for total labor is positively associated with the amount of land cropped, the area allocated to modern varieties, the number of workers in the household, and the level of education of the head of the household. The coefficient of the area under tenancy is also positive, indicating that tenant farmers use more labor than owners. Area under tenancy and the availability of family workers, however, reduce the demand for hired labor. Higher levels of education, on the other hand, increase the demand for hired labor.

The wage rate has a strong negative influence on the demand for labor, supporting the theory that higher wages reduce the demand for labor. The value of the coefficient suggests that increasing the wage rate by Tk 1.00 would reduce the demand for farm labor by nine days. The wage elasticity of demand for labor is estimated at the mean values of the variables at −0.71 for hired labor and −1.04 for total labor. Since the development of infrastructure increases the wage rate by facilitating the mobility of labor, it would have a negative influence on labor use and agricultural production. But as the adoption of new technology advances, upward pressure is generally put on labor demand, which would increase the wage rate if the area is underdeveloped. Development of infrastructure in such cases would encourage migration of labor from outside

Table 23—Determinants of the use of labor in crop production activity

Variable	Demand for Hired Labor: OLS Estimate	Demand for Hired Labor: Tobit Estimate	Use of Total Labor: OLS Estimate
Constant	65.2 (3.56)***	56.2 (2.16)**	214.7 (8.70)***
Cropped area	8.8 (10.88)***	9.4 (32.6)***	11.1 (10.88)***
Tenanted area	-3.5 (-1.28)	-2.9 (-1.21)	14.6 (4.19)***
Area under modern varieties	28.6 (13.69)***	29.5 (17.4)***	46.9 (17.68)***
Number of family workers	-2.23 (-0.65)	-3.10 (-0.84)	17.78 (4.08)***
Number of female family workers	-5.13 (-0.60)	-8.14 (-0.60)	-24.77 (-2.26)**
Educational level of the head of household	4.67 (5.34)***	5.37 (4.64)***	3.30 (2.97)***
Wage rate	-2.97 (-3.95)***	-2.81 (-2.62)***	-9.20 (-9.63)***
Index of underdevelopment of infrastructure	-0.51 (-0.50)	-0.96 (-0.66)	-1.56 (-1.22)
$\bar{R}^2$	0.53	n.a.	0.65
F	65.8	n.a.	107.4

Notes: Figures in parentheses are estimated t-values. OLS is ordinary least squares. n.a. is not applicable.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

the locality, which would keep the wage rate down and distribute the benefits of the new technology over a wider area.

Once the effects of the other variables are controlled for, infrastructure seems to generate a weak influence on the demand for farm labor. The coefficient of the infrastructure variable is negative, indicating that more labor is used in developed villages, but the coefficient is not statistically significant. This again confirms that the effect of infrastructure is substantial but indirect. The development of infrastructure exerts a positive influence on the demand for labor through its effect on the diffusion of modern technology.

The Effect of Infrastructure on Employment

To estimate the effect of infrastructure on employment, the labor supply and demand in villages at two ends of the scale of infrastructure development are estimated by evaluating the supply and demand functions at mean values of the variables other than the infrastructure variables. Similarly, three villages at each end of the scale of infrastructure development are selected to represent developed and underdeveloped villages, and the average values of the index of underdevelopment of infrastructure are used in the supply and demand equations. The results are presented in Table 24. As explained earlier, infrastructure has a significant positive effect on the supply of hired labor, but it is offset by a negative effect on the supply of family labor; thus the total effect is

Table 24—Effect of infrastructure on employment

Variable	Underdeveloped Villages	Developed Villages	Difference	Statistical Significance
	(days worked/year)		(percent)	
Total labor supply	320	301	-6	NS
Agriculture	222	187	-16	WS
Nonagriculture	108	124	15	NS
Self-employed	275	185	-33	S
Hired labor	45	116	157	S
Demand for farm labor	163	177	9	NS

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: NS is not significant; WS is weakly significant; and S is significant.

insignificant. The difference in the use of hired labor at the two ends of the infrastructure scale is about 33 percent.

The supply of nonagricultural labor is about 15 percent higher in developed villages than in underdeveloped villages, but this is achieved by reduction of supply in agriculture. The demand for farm labor is, however, found to be about 9 percent higher in developed than in underdeveloped villages, but the effect is not statistically significant. This opposite effect of infrastructure on the supply and demand for agricultural labor suggests that the labor market is adjusted through either migration of labor or an increase in the wage rate or both. In developed villages, the wage rate is about 12 percent higher than in underdeveloped villages.

Conclusions

In sum, infrastructure affects the labor market basically by changing the composition of employment. Development of infrastructure generates opportunities for nonfarm employment, where labor is less arduous and productivity may also be higher. Therefore, households that have the necessary capital and skills substitute agricultural labor for nonagricultural, creating more opportunities for wage employment in agriculture for the remaining households. The shift of labor away from agriculture increases the productivity of labor, whereas the shift from self-employment to wage employment increases the duration of employment for the poor, who otherwise would be forced to take up self-employment in nonagricultural activities that are not very productive. The increase in the demand for hired labor in turn puts upward pressure on the wage rate, thus increasing the wage earnings of the poor from the same amount of labor. The development of infrastructure affects employment indirectly through diffusion of labor-intensive modern technology. The changes in the composition of employment induced by infrastructure development lead to an increase in labor productivity and the wage rate, and hence help alleviate poverty.

6

INFRASTRUCTURE, HOUSEHOLD INCOME, AND POVERTY

The impact of infrastructure development on household income largely reflects its effects on production and employment. This chapter measures the contribution of rural infrastructure to family income. The precise meaning of family income is defined, income generation and its distribution is described, and the contribution of infrastructure to household income is estimated quantitatively.

Definition of Income

Household or family income is defined as the return to family labor and the assets owned after the current cost of production (excluding family labor and rent for owned land and assets) is deducted from the gross value of production, which is estimated using average prices of products for all households in a village. Current cost is the cost incurred by individual households in purchasing inputs, hiring labor (including draft animals, if any), and renting services.

The disaggregation of total family income into a number of components provides a firsthand picture of the effects of infrastructure on various sources of family income. The following scheme is adopted:

1. Income from crop production (CRPI)
   - Field crops
   - Homestead and garden crops
2. Income from livestock and fisheries (LVFSI)
3. Income from business and industries (BSINDI)
4. Wage income (WGEI)
   - Agricultural wage income (AGWI)
   - Nonagricultural wage income (NAGWI)
5. Income from miscellaneous sources (MISCI)
6. Total agricultural income (AGI), which comprises
   CRPI + LVFSI + AGWI
7. Total nonagricultural income (NAGI), which comprises
   BSINDI + NAGWI + MISCI
8. Total family income (FINC), which comprises
   AGI + NAGI

A Descriptive Profile of Household Income

In the profile of household income, the components are described and then the total picture is summarized.

Income from Crop Production

The average levels of crop income per household, per acre of land, and per capita are shown in Table 25. Average crop income per household is about 10 percent higher in underdeveloped than developed areas. This difference increases to about 16 percent on a per capita basis, clearly reflecting the larger land area and smaller family size in underdeveloped areas. Crop income per acre of owned land, however, is about 20 percent higher in developed than in underdeveloped villages. Income from homestead and garden crops is about 18 percent of crop income. Households generally grow fruits, vegetables, and bamboo in home gardens.

Disaggregating household crop income into landownership groups provides further insights into this source of family income (Tables 26 and 27). The distribution of crop income by the size of land owned shows that functionally landless households (those owning less than 0.5 acres) and small farmers in developed areas obtain a relatively larger share of income from crops than their counterparts in underdeveloped areas. This difference is sharper for small farmers than for any other group. The point is made more explicit by the index of crop income per unit of land in Table 27. In general, the smaller the size of the farm, the larger the income per unit of land. But for all groups the income per unit of land is consistently higher in developed than underdeveloped villages. For the small-farmer group, the difference is about 24 percent. This may reflect differences in the adoption of new technology or crop combinations that are favored by access to markets and possibly to labor input.

Income from Livestock and Fisheries

Per capita and per household income from livestock and fish production is presented in Table 28. Of the total income originating in this subsector, about 19 percent is

Table 25—Average annual income from crop production, developed and underdeveloped villages, 1982

Source of Income	All Households	Developed Villages	Underdeveloped Villages	Difference[a]
		(Tk)		(percent)
Income per household				
Field crops	7,789	7,336	8,138	-9.9
Homestead and garden crops	1,756	1,635	1,850	-11.6
Total crop	9,545	8,971	9,988	-10.2
Income per capita				
Field crops	1,229	1,115	1,321	-15.6
Homestead and garden crops	277	248	300	-17.3
Total crop	1,506	1,363	1,621	-15.9
Income per acre				
Field crops	3,659	4,098	3,405	20.4
Homestead and garden crops	825	914	774	18.1
Total crop	4,484	5,012	4,179	19.9
		(percent)		
Share of field crop	81.6	81.8	81.5	...
Share of homestead and garden crop	18.4	18.2	18.5	-1.6

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]Difference = [(Developed − Underdeveloped)/Underdeveloped] · 100.

Table 26—Distribution of income from crops, by landownership group, in developed and underdeveloped villages, 1982

Share of Income	Landless	Small Owner	Medium Owner	Large Owner
		(percent)		
Total households				
Developed villages	31.9	36.6	23.9	7.6
Underdeveloped villages	29.4	31.9	27.2	11.5
Difference	8.5	14.7	-12.1	-33.9
Total crop income				
Developed villages	7.5	30.5	39.8	22.2
Underdeveloped villages	6.2	19.5	38.8	35.5
Difference	21.0	56.4	2.6	-37.5

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

contributed by poultry, 33 percent by milk, and 48 percent by fish. There is virtually no difference between developed and underdeveloped areas in this production pattern, but there is a large difference in the extent to which each element contributes to family income. On average, households in developed areas derive about 48 percent more income from livestock and fisheries than those in underdeveloped areas. Family income from fish and milk—both perishable products—is 46 percent higher for milk and 57 percent higher for fish in developed than in underdeveloped areas. Income from poultry—a less perishable product because it is usually sold live—is only 31 percent higher in developed than in underdeveloped areas. Easier and quicker access to markets, facilitated by infrastructure development, is a primary cause for such income differences, particularly from livestock and poultry products.

The disaggregated picture is more revealing (see the Appendix, Table 64). Functionally landless households in developed areas derive about 33 percent of their total

Table 27—Per capita and per acre income from crops by landownership groups in developed and underdeveloped villages, 1982

Share of Income	Landless	Small Owner	Medium Owner	Large Owner
Per capita income (Tk)				
Developed villages	385	1,165	2,075	2,651
Underdeveloped villages	433	1,144	1,911	3,543
Difference (percent)	-11.0	1.8	8.6	-25.2
Index of income per unit of land				
Developed villages	452	199	142	104
Underdeveloped villages	395	161	127	100
Difference (percent)	14.4	23.6	11.8	4.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: The landless are those owning less than 0.5 acres. Small owners own 0.5 up to 2.5 acres. Medium owners own 2.5 to 5.0 acres. Large owners own 5.0 acres or more.

Table 28—Average income from livestock and fisheries, developed and underdeveloped villages, 1982

Items	All Households	Developed Villages	Under-developed Villages	Difference[a]
				(percent)
Income/household (Tk)				
Poultry	276	318	243	30.9
Milk	488	592	407	45.5
Fish	693	872	555	57.1
Total	1,457	1,782	1,205	47.9
Income/capita (Tk)				
Poultry	43.5	48.3	39.4	22.6
Milk	77.0	90.0	66.1	36.2
Fish	109.3	132.5	90.1	47.1
Total	229.8	270.8	195.6	38.5
Share of total income (percent)				
Poultry	18.9	17.9	20.2	-11.3
Milk	33.5	33.2	33.8	-1.8
Fish	47.6	48.9	46.0	6.3
Total	100.0	100.0	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference [(Developed Underdeveloped)/Underdeveloped] · 100.

income from livestock and fisheries, a share that is 74 percent larger than that of their counterparts in underdeveloped villages, who derive 19 percent of their income from these products, although the difference in the proportions of landless households in the total number of households between the two areas is only about 9 percent. The point is made clearer in Appendix Table 65, where the difference in income from livestock and fisheries between developed and underdeveloped areas is shown on a per capita basis. The per capita income of landless households from livestock and fisheries is 109 percent higher in developed than in underdeveloped areas. In fact, it is higher for all groups in developed areas, although the gain of small farmers is comparatively low.

Income from Business and Industry

The average income derived from business (trade and commerce) and rural cottage industries (items such as handloomed clothes and furniture) is shown in Table 29. Cottage industry as a source of family income is concentrated in specific rural households and villages where certain artisan activities have traditionally been carried out. Therefore, the distribution of income from this source is likely to be skewed. Trade and commerce may also be skewed, but not as much as for cottage industries. Trade and commerce contribute about three-fourths and cottage industries about one-fourth of the total income from business and industry. The average income from this source is about 20 percent higher in developed than in underdeveloped areas. The difference is sharper (about 50 percent) in cottage industries than it is in business (10 percent).

Income from business and industries tends to be more egalitarian in underdeveloped than in developed areas (Appendix Tables 66 and 67). In areas with underdeveloped infrastructure, the unit cost of transport is very high; therefore, trade is conducted on a small scale by the landless and near landless who carry goods on headloads and travel

Table 29—Average income from business and rural cottage industries, developed and underdeveloped villages, 1982

Items	All Households	Developed Villages	Under-developed Villages	Difference[a]
				(percent)
Income/household (Tk)				
Business	1,388	1,464	1,330	10.1
Industries	497	618	404	53.0
Total	1,885	2,082	1,734	20.1
Income/capita (Tk)				
Business	218.9	222.5	215.9	3.1
Industries	78.4	93.9	65.6	43.1
Total	297.3	316.4	291.5	12.4
Share of business (percent)	73.6	70.3	76.7	-8.3
Share of industries (percent)	26.4	29.7	23.3	27.5

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100.

from one periodic market to another and from village to village. As infrastructure is developed, it is the richer households that reap most of the advantage from the expanded opportunities. Per capita income derived from business and industries is 100-125 percent higher for large and medium landowners in developed than in underdeveloped villages. Although a closer examination than this study affords is needed to determine the precise mechanism that causes this outcome, the following explanation seems logical. Business opportunities in underdeveloped villages are limited to purchasing agricultural products from nearby villages and selling them to other markets and ferrying headloads of consumer goods from village to village. These types of activities can be undertaken with a modest amount of capital by most households. In contrast, opportunities for trade and commerce are more abundant in developed villages, and large-scale operations pay better than headload businesses. This makes the role of capital more important, and only the richer households with better access to capital can undertake the larger activities.

Wage Income

Household income derived from selling labor services to agricultural and nonagricultural employers is included in this category (Table 30). Of the total wage income, about two-thirds originates in nonagricultural activities and one-third in agricultural activities. The average wage income of households in the developed villages is twice that in the underdeveloped villages. Wage income from nonagricultural sources is about 123 percent larger in the developed than in the underdeveloped areas. Because of larger family size, per capita wage income is only 88 percent higher in the developed than in the underdeveloped villages.

The disaggregated picture (Appendix Tables 68 and 69) reveals that the small and medium landowners derive a relatively larger share of the increased wage income associated with infrastructure development. While the per capita wage income of landless households in developed areas is only 36 percent higher than that of their counterparts in underdeveloped villages, per capita wage income of small and medium landowners in developed villages is 95 to 165 percent higher. This may be because

Table 30—Average wage income, 1982

Item	All Households	Developed Villages	Under-developed Villages	Difference[a]
				(percent)
Income/household (Tk)				
Wages from agriculture	968	1,249	751	66.3
Wages from nonagriculture	1,845	2,675	1,202	122.5
Total	2,813	3,924	1,953	100.9
Income/capita (Tk)				
Wages from agriculture	152.7	189.8	121.9	55.7
Wages from nonagriculture	291.0	406.5	195.1	108.3
Total	443.7	596.3	317.0	88.1
Share of agricultural wages (percent)	34.4	31.8	38.4	-17.2
Share of nonagricultural wages (percent)	65.6	68.2	61.6	10.7

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference [(Developed Underdeveloped)/Underdeveloped] · 100.

some nonagricultural work requires skills that landless laborers may not be able to acquire as easily as workers in better-off small and medium landowning households. In fact, further analysis of the data indicates that the small and medium landowning households increase their wage income proportionately more than all other households from nonfarm wage employment. The average wage rate (wage income divided by employment) in these categories is almost two times the wage rate in the landless category. This is due to a higher proportion of nonfarm salaried employment, at a daily wage higher than that of casual workers, in small and medium landowning households. Access to salaried jobs appears to be limited for the landless.

Income from Miscellaneous Services

Income from miscellaneous services includes remittances by household members who work in personal services and petty jobs, sometimes away from home, perhaps even in a foreign country. Another source is income from charity, including government relief donations and private help to the poor on religious or personal grounds. As Table 31 and Appendix Table 70 show, the amount of miscellaneous income is not small; the average income per household on this account is Tk 3,844. Such income is found to be slightly larger on both a household and per capita basis in underdeveloped areas. Miscellaneous income generally is distributed fairly evenly across all households, although richer households have a slightly larger share, mainly because remittances contribute a larger share in such households.

Summary of Total Family Income

The average family income in 1982 for the entire sample is estimated to be Tk 19,544, which is equivalent to a per capita annual income of about US$110 at the official exchange rate (Table 32). About 61 percent of the income is derived from agricultural sources.

Total family income is only 8 percent higher in the developed area than in the underdeveloped. But the contribution of the various components of total income differ rather drastically. Crop income per family is about 10 percent higher in underdeveloped villages because, as mentioned earlier, land area per household is higher there.

Table 31—Average income from miscellaneous services in developed and underdeveloped villages, 1982

Item	All Households	Developed Villages	Under-developed Villages	Difference[a]
		(Tk)		(percent)
Income per household	3,844	3,625	4,013	-9.7
Income per capita	606.3	550.9	651.5	-15.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference [(Developed Underdeveloped)/Underdeveloped] · 100.

Incomes from livestock and fisheries, business and industries, and wages are 20-100 percent higher in developed villages, but miscellaneous income is higher in underdeveloped villages. The differences in farm size and miscellaneous income serve to cancel out much of the effect of increased income from other sources, so that the difference in total family income between developed and underdeveloped areas is reduced to only 8 percent.

Households benefit differently from infrastructure development depending on the size of their landholdings. Per capita income of large landowners is 2.5 times higher

Table 32—Summary of total household income, developed and underdeveloped villages, 1982

Source of Income	All Households	Developed Villages	Under-developed Villages	Difference[a]
		(Tk)		(percent)
Crops	9,545	8,971	9,988	-10.2
Share in total	(48.8)	(44.0)	(52.9)	...
Livestock and fisheries	1,457	1,782	1,205	47.9
Share in total	(7.5)	(8.7)	(6.4)	...
Business and industries	1,885	2,082	1,734	20.1
Share in total	(9.6)	(10.2)	(9.2)	...
Wages	2,813	3,924	1,953	100.9
Share in total	(14.4)	(19.3)	(10.3)	...
Wages from agriculture	968	1,249	751	66.3
Wages from nonagriculture	1,845	2,675	1,202	122.5
Miscellaneous	3,844	3,625	4,013	-9.7
Share in total	(19.7)	(17.8)	(21.2)	...
Total agricultural income	11,969	12,000	11,945	0.46
Share in total	(61.2)	(58.9)	(63.2)	...
Total nonagricultural income	7,575	8,384	6,948	20.7
Share in total	(38.8)	(41.1)	(36.8)	...
Total household income	19,544	20,384	18,893	7.9
Share in total	(100)	(100)	(100)	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: Numbers in parentheses are percentages.
[a]Difference [(Developed Underdeveloped)/Underdeveloped] 100.

than that of landless households in underdeveloped villages. This gap is smaller in developed villages (Table 33). Landless households gain proportionately more from infrastructure development through income from livestock and fisheries and wages. Similarly, small landowners gain from wages (largely nonagricultural) and livestock and fisheries. Medium landowners enhance their per capita income by seizing most of the opportunities afforded by infrastructure. The benefits derived from infrastructure by large landowners are mostly gained through business and trade. The sum of all these effects results in a higher per capita income of 14.5 percent for the landless, of 4.7 percent for small owners, and of 15.4 percent for medium owners in developed villages, even though families are larger and farm sizes smaller in developed villages.

Disposable Income

Disposable income is the income available after direct taxes are paid (see the Appendix, Table 71). Rural households pay only a small amount of taxes, mainly on land and to local administrative institutions such as union councils. Payment of agricultural income taxes is almost nil.

The average effective tax rate for the entire sample is only 0.23 percent of gross family income. The effective tax rate in underdeveloped areas is 0.18 percent and that in developed areas 0.29 percent. Therefore, the effective tax rate for households in developed villages is 61 percent higher than that in underdeveloped villages. The

Table 33—Summary of per capita income, by landownership group, developed and underdeveloped areas, 1982

Source of Income	Landless	Small Owner	Medium Owner	Large Owner
		(Tk)		
Crops				
Developed	385	1,165	2,075	2,651
Underdeveloped	433	1,144	1,911	3,543
Difference	(-11.0)	(1.8)	(8.6)	(-25.2)
Livestock and fisheries				
Developed	335	193	242	433
Underdeveloped	160	162	192	312
Difference	(109.0)	(19.0)	(26.1)	(38.9)
Business and industries				
Developed	261	180	306	903
Underdeveloped	286	360	137	434
Difference	(-9.0)	(-50.1)	(123.7)	(108.0)
Wages				
Developed	945	690	345	67
Underdeveloped	693	354	130	95
Difference	(36.3)	(95.0)	(164.9)	(-29.5)
Miscellaneous				
Developed	436	518	616	778
Underdeveloped	489	602	736	795
Difference	(-10.8)	(-14.0)	(-16.3)	(-2.1)
Total family income				
Developed	2,362	2,746	3,584	4,832
Underdeveloped	2,061	2,622	3,106	5,179
Difference	(14.5)	(4.7)	(15.4)	(-6.7)

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: Numbers in parentheses are percentages.

difference would be even greater if landholdings were not larger—and thus liable for more land taxes—in underdeveloped villages. Since the legal tax rate applicable to households is generally the same for all villages, it can be assumed that infrastructural facilities contribute positively to the efficiency of tax collection, as reflected by the larger share of income that goes to taxes in developed areas.

Net Effect of Infrastructure Development

In measuring the effects of infrastructure development on household income, it should be kept in mind that household income is only a part, but a significant part, of the total effect. Any effect that spills over to other areas and households is, therefore, not covered by this approach. Such spillovers occur when a firm or government brings capital to a center of infrastructure development from outside the area and takes back profit to the original place of residence. Moreover, the methodology used to compare villages with different degrees of infrastructure development cannot take account of the effect that is transferred from developed area to underdeveloped area through factor mobility. For example, a household with a large amount of capital may be able to take its capital to a center of infrastructure development and return the income earned to its underdeveloped village. Such income will be counted as part of the income of households in underdeveloped villages, even though the earning opportunity was made possible by infrastructure development. For this reason, the estimate of the productive impact of infrastructure development is probably more accurate for crop production, livestock and fisheries, and wage income than for income earned through liquid capital assets like business. Land, family labor, and to a degree, wage labor, are less mobile than liquid capital.

Some indications of the direction and magnitude of the effects of infrastructure development, based on a comparison of averages of the two classifications of villages, have already been presented earlier in this section. However, comparing averages does not adequately capture the pure effect of infrastructure or take account of differences in factors unrelated to infrastructure. This is attempted below.

Crop Income

In Chapter 5, it was shown that bridging the infrastructural gap between the three least and the three most infrastructurally developed villages would increase crop production by at least 30 percent, which is the pure effect of infrastructure on crop production. Given this basic measurement, estimating the effect of infrastructure on income from crop production is straightforward based on the following relation:

$$CRPI = GVPAG - CST = \alpha GVPAG,$$

where

$CRPI$ = income from crop production,

$GVPAG$ = gross value of crop production,

CST = current cost of production, and

$$\alpha = \left(1 - \frac{CST}{GVPAG}\right).$$

The results are as follows:

$AGINC_d = 0.68\ GVPAG_d$ for the three most developed villages, and

$AGINC_u = 0.74\ GVPAG_u$ for the three least developed villages.

On the basis of these relations, it is estimated that an increase in agricultural *production* of 32 percent, measured as the pure effect of infrastructure development in the context of the sample villages, results in an increase in *income* from crop production of 24 percent of base income.

Wage Income

The pure effect of infrastructure development on wage income (that is, income from hiring out labor services) can theoretically be estimated on the basis of the simple methodology shown in Figure 2. In the diagram, the wage rate (W_u) and employment (E_u) represent the situation of the three least developed villages, where wage income is $W_u \cdot E_u$. When development of infrastructure reaches the level of the three most developed villages, the wage rate is equivalent to W_d and employment to E_d. The wage income under this improved situation is $W_d \cdot E_d$. The wage income that can be attributed to infrastructure development is equal to $(W_d \cdot E_d) - (W_u \cdot E_u)$.

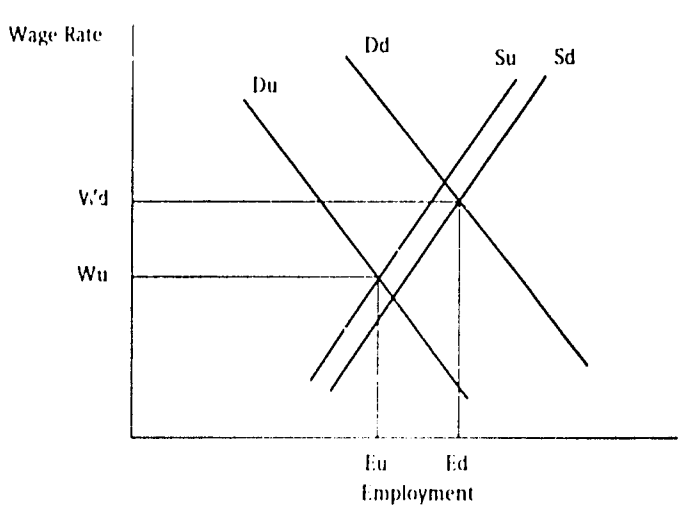
To use this model, estimates of supply and demand shifts attributed to infrastructure are necessary, as well as their elasticities. Supply parameters for hired labor were estimated in Chapter 5, but all demand parameters could not be estimated. An alternative approach—a regression model of the recursive type—is therefore adopted.

The first-stage equation is

$$WGEI = f(WRKR, EDCN, INF, WGRT, CPTL, FEM, HYV, FSZ, LAND). \quad (20)$$

The second-stage equations are

Figure 2—Determination of wage income



$$FEM = f(INF, FSZ), \quad (21)$$
$$WRKR = f(INF, FSZ, LAND), \quad (22)$$
$$LAND = f(INF, FSZ), \quad (23)$$
$$HYV = f(INF, IRGN, LAND, CPTL, CRDTI, CRDTNI), \quad (24)$$
$$CPTL = f(LAND, INF), \quad (25)$$
$$EDCN = f(INF, LAND), \text{ and} \quad (26)$$
$$WGRT = f(EDCN, INF, HYV). \quad (27)$$

The symbols are defined:

WGEI = wage income in taka per household,
WRKR = number of workers in the family,
EDCN = level of education of the head of the household,
INF = index of infrastructure underdevelopment,
WGRT = wage rate in taka per day,
CPTL = total value of capital stock in taka (excluding land),
FEM = number of female laborers in the household,
FSZ = family size,
HYV = land area under high-yielding varieties,
LAND = area of owned land,
IRGN = irrigated land area,
CRDTI = credit from institutional sources, in 1,000 taka, and
CRDTNI = credit from noninstitutional sources, in 1,000 taka.

All of the variables for the analysis of income attributable to infrastructural factors are measured at the household level, except infrastructure, which is a village-level variable. Thus, every household in a village has the same index of infrastructure underdevelopment; regression equations are estimated using all households and villages.

Equation (20) includes most of the variables that affect the supply of and demand for wage labor, and it captures the effects of these variables on household wage income. The effect of infrastructure in this equation represents the direct access effect. The indirect effect via these other variables is measured through the second-stage equations. Equations (21) through (27) measure the relations between infrastructure and the other variables, that is, the explanatory variables of equation (20). Their estimates, which use the average infrastructural index of the three most developed and the three least developed villages, provide the estimated values of explanatory factors for the two groups of villages. The estimated values of the variables are plugged into the estimated equation (20) to measure the wage income in the two groups of villages. Estimates of all of these equations are given in the Appendix, Table 72. Only the coefficients where infrastructure proved to be a significant factor in equations 21 through 27 are used to derive the wage incomes of developed and underdeveloped villages.

Estimates based on the above procedure show that the average income in the three most developed villages is 92 percent larger than the wage income per household in the three least developed villages. A substantial part of this difference in wage income

can be attributed to the larger proportion of high-wage salaried employment in developed areas compared with underdeveloped. This has resulted in a larger difference in wage income than in employment (Chapter 5). Most of this difference is the result of infrastructure development.

Income from Livestock and Fisheries

As in the case of wage income, the net effect of infrastructure on income from livestock and fishery activities is estimated through a recursive regression model. The first-stage equation is

$$LIVFSI = f(EDCN, NWCH, WRKR, INF, PLBA, CPTLA, FEM, LAND, ANML). \quad (28)$$

The second-stage equations are

$$EDCN = f(INF, LAND), \quad (29)$$
$$NWCH = f(INF, WRKR, LAND, FSZ), \quad (30)$$
$$WRKR = f(INF, FSZ, LAND), \quad (31)$$
$$PLBA = f(INF, WRKR, LAND, FSZ), \quad (32)$$
$$CPTLA = f(INF, WRKR, LAND), \quad (33)$$
$$FEM = f(INF, FSZ), \quad (34)$$
$$LAND = f(INF, FSZ), \text{ and} \quad (35)$$
$$ANML = f(INF, WRKR, FSZ, LAND), \quad (36)$$

where the new variables are defined:

LIVFSI = income per household from livestock and fisheries,
NWCH = number of family members below the age of 16 (child),
CPTLA = agricultural capital in taka (excluding land),
PLBA = number of persons engaged in permanent hired labor (adult), and
ANML = number of draft animals.

The equations are estimated in the Appendix, Table 73.

The hypotheses that underlie the specifications are founded on the field knowledge and general experience of the authors in the rural economy of Bangladesh. There are few previous studies to supplement the hypothetical basis.

In general, labor input is a basic requirement for raising milch cows, poultry, and fish. Child labor is frequently used for feeding cows and pasturing cattle. All of the in-house work of milking, cleaning cowsheds, and feeding poultry is done by women. Housing and feeding poultry and guarding them against predators are tasks done by women and children. Maintaining fisheries, on the other hand, is mainly the job of adult male workers, including hired labor, if any. Landowners have an advantage over the landless in livestock and fishery activities. Owning some amount of land is helpful in raising livestock, which are generally fed crop by-products in Bangladesh. To have a fishing pond, it is necessary to own land. Fishing in public bodies of water, however, mainly depends on the labor force of a family. But commercial fishing in rural areas is

usually a caste-specific activity. Generally the amount of draft power a household commands is determined by the number of working bullocks and cows. Using cows as draft animals increases the amount of draft power available, but it decreases the amount of milk and hence some of the income from milk production.

The dominant factor determining a household's income from livestock and fisheries is its access to market. How quickly and frequently a household can take its products to market determines the size of its income from livestock and fisheries. Milk from cows milked in the morning must be sold by noon. The case is similar for fish. If livestock products and fish are not easily marketed, households have little incentive to increase their output, since production is only for home consumption.

The net effect of infrastructure development is obtained by following the same procedure as for wage income. This estimate shows that income from livestock and fisheries in the three most developed villages is about 78 percent higher than that in the three least developed villages. This increment is the pure effect of infrastructure development.

Income from Business and Industries

The following model is estimated to measure the infrastructural effect on household income from business and industries. The first-stage equation is

$$BSINDI = f(CRDNI, CRDI, LAND, INF, EDCN, WRKR, CPTLB). \quad (37)$$

The second-stage equations are

$$CPTLB = f(CRDI, WRKR, INF, EDCN, CRDNI, LAND), \quad (38)$$
$$WRKR = f(INF, FSZ, LAND), \quad (39)$$
$$EDCN = f(INF, LAND), \quad (40)$$
$$LAND = f(INF, FSZ), \quad (41)$$
$$CRDI = f(INF, LAND, EDCN, HYV), \text{ and} \quad (42)$$
$$CRDNI = f(INF, LAND, EDCN, HYV), \quad (43)$$

where the new variables are defined:

BSINDI = household income from business and industries, and

CPTLB = working capital for business and industries.

The equations are estimated in the Appendix, Table 74.

Following the same procedure as before—solving for the average income of the three most and the three least developed villages, the difference in income attributable to infrastructure is not found to be large. The income from business and industries in developed villages is only 17 percent higher than that in the underdeveloped group. This effect is primarily the indirect contribution of infrastructure through education and noninstitutional credit. It seems that business capital and institutional credit are the two most important factors behind income from business and industries. The direction of relations between these two factors and infrastructure is as expected, but their coefficients are only weakly significant.

Capital for business and industries is the central force in generating income from these sources. Institutional credit, mainly supplied through the public system, reinforces

business and industrial capital. Since such credit is mostly based on ownership of land, it is the large landowners who derive most of the gains in capital from business and industries. Because it is easier to move capital than other resources, even large landowners located in remote areas may overcome infrastructural backwardness by availing themselves of investment opportunities in developed areas.

Clearly, if opportunities in business and rural industries that result from infrastructure development are to be accessible to all households, credit policies similar to those of the Grameen Bank will play critical roles (Hossain 1988a). How this type of credit can be expanded to larger areas, along with infrastructure development, is a subject that, though not covered here, deserves serious consideration.

Summary of Infrastructural Effects

In summarizing the impact of infrastructure on income from various sources, the income from miscellaneous sources is not taken into consideration because of difficulties in conducting similar analysis. It is assumed that this source of income does not make any difference, although it seems likely that income from sources listed under miscellaneous will be larger in developed than in underdeveloped areas.

Table 34 indicates that the difference in infrastructural endowment of the two sets of villages causes a difference of about 33 percent in income between the two groups of villages.

Conclusions

The analysis of income from crop production, livestock and fisheries, wages, and business and industries indicates that infrastructure development contributes tremendously to increased household income. Income from crop production increases by about 24 percent, and income from livestock and fisheries increases by about 78 percent due to infrastructure development. Wage income almost doubles. What is even more significant is the change in the distribution of income arising from infrastructure development. Income from crops, wages, and livestock and fisheries increases proportionately more for the landless and small farmers than for large landowners. In the case of income from business and industries, the pure effect of infrastructure is relatively small; an

Table 34—Summary of the effects of infrastructure development on income

Source of Income	Weight[a]	Increase in Income[b]	Weighted Average Increase
		(percent)	
Crop	0.49	24.00	11.76
Livestock and fisheries	0.08	78.00	6.24
Wage	0.14	92.00	12.88
Business and industries	0.10	17.00	1.70
Miscellaneous	0.19	0.00	0.00
Total	1.00	...	32.58

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]Weights are shares of total family income for all households.

[b]These increases were calculated as shown in previous sections and reflect the difference between the three most underdeveloped villages and the three most developed villages.

increase in household income of only 17 percent can be attributed to infrastructure development. Moreover, income from this source is largely garnered by richer households due to their greater access to capital. Along with infrastructure development, access to capital for poorer households through institutions of the Grameen Bank type is a critical requirement if the fruits of development are to be evenly distributed. It is likely that part of the income generated by infrastructure spills over from households to organized sectors so that a measurement based entirely on household income may fail to capture the full impact of infrastructure, particularly of income from business and industries.

The implication that development of rural infrastructure helps alleviate poverty in Bangladesh is, by far, the most important result of this research. The conventional view that development of rural infrastructure is likely to aggravate poverty is found to be baseless. To the contrary, the results indicate infrastructure development has a substantial effect on rural poverty by increasing agricultural and wage income in landless and small landowning households. The conventional view suffers from an inability to see the linkage effects of rural infrastructure that indirectly influence income-generating activities for the poor.

7

LINKAGE BETWEEN INFRASTRUCTURE AND CONSUMPTION

About 14 percent of household income in rural Bangladesh is saved and the remaining 86 percent is spent on consumption goods. The demand for consumer goods, therefore, is a powerful source of economic growth. Rural infrastructure's role in augmenting agricultural and nonagricultural production and income, particularly income from wages, livestock, and trade and services, as highlighted in the previous chapter, is realized through a complex set of interrelations. First, through its effect on agricultural production, infrastructure enhances agricultural income, which in turn creates additional demand for various consumer goods. Then production and marketing of these consumer goods generate additional income and employment opportunities in nonagricultural sectors. Second, infrastructure development facilitates production and marketing of these nonagricultural goods by cutting costs. Third, infrastructure may directly influence the taste patterns of consumers and therefore may result in different marginal propensities of expenditure in developed and underdeveloped areas. Infrastructure development changes taste patterns by making information about and demonstrations of products more accessible. These effects on consumption parameters and taste patterns, when multiplied throughout the economy, could lead to broad differences arising from any initial increase in income.

This multiplier effect, via the interindustry linkages, has been studied by different researchers in different contexts. Bell, Hazell, and Slade (1982) conclude from a study of the Muda irrigation project in Malaysia that for each dollar of agricultural income created directly by the project investment, an additional 80 cents of value added was created indirectly in the local nonfarm sectors. The source of two-thirds of this additional 80 cents was traced to consumer goods and services. In a study of the interrelationship between agricultural and industrial growth performance in India, Rangarajan (1982) shows that a 1.0 percent addition to the agricultural growth rate induced a 0.5 percent incremental growth of industrial output and a 0.7 percent additional growth of national income. Recognizing the importance of these induced growth linkages, Mellor (1976) argues that contrary to conventional wisdom, agriculture can play the role of the leading sector in the process of development.

The conventional wisdom, which says that development must come through industrialization, originated from or at least was reinforced by studies that showed agriculture to have much smaller linkage effects than industry (Chenery and Watanabe 1958). These initial studies of interindustry production, employment, and income linkages generally failed to adequately capture the indirect effects, particularly the effects on the second, third, and subsequent rounds of consumption expenditure.

In order to indicate more objectively the significance of consumption expenditures in the multiplier effect of an economy, it is perhaps necessary to define linkage effects and then present some empirical evidence. Three linkage effects have been examined in the literature: (1) production linkage (the interindustry linkage most often measured), (2) employment linkage, and (3) income generation linkage (Yotopoulos and Nugent 1976). These linkage effects are defined, respectively, as the increases in production, employment, and income resulting from a one-unit increase in the final demand.

Measurement of the production linkage has sometimes been limited to direct backward and forward linkages without taking into account indirect second and third round effects. In the literature, a concept of the total production linkage is developed that takes into account indirect second and third round production effects. The employment linkage is derived from the wage component in total production, that is, the employment coefficient. Estimation of both the production and employment linkages ignores income, which is exogenously given. No relation between final demand and income is developed and incorporated, an obviously rigid assumption. Given the households' marginal propensities to consume different commodities, the structure of final demand is also affected. The household demand thus induced further stimulates a sector's demand for intermediate products and for labor, again with indirect effects on household income. This process describes the income generation linkage effect.

A study of the Taiwanese economy by Lin (1973) illustrates the measurement of these three linkage effects (Table 35). It gives the linkage indexes and their rankings for a number of broad sectors. The results of the study are revealing though somewhat deficient in capturing the total effects of linkage because the static input-output framework used in the study is not effective enough to fully account for the interrelations of consumption, income, and production. The results nevertheless reflect a radical change in the ranking of the linkage effects by sector, depending on whether the major concern is with production, employment, or income linkages. Agriculture ranks low in production linkages but highest in employment and income linkages. One important factor that contributes to the high income linkage is the marginal propensity to consume.

The linkage coefficients described above are expressed per unit of final demand. The absolute magnitude of the linkage effects will not only depend on these coefficients but also on the level of demand that emanates from each sector. The absolute linkage

Table 35—Total interindustry linkage indices and their rankings, Taiwan, 1966

Industry	Total Production Linkage		Employment Linkage		Income Generation Linkage[a]	
	Index	Rank	Index	Rank	Index	Rank
Agricultural production for food	1.897	7	0.852	3	1.637	3
Agricultural production for raw materials	1.497	10	0.908	1	1.804	1
Working capital for agriculture	2.455	3	0.725	10	1.140	8
Food processing	2.158	6	0.673	12	1.089	11
Mining	1.580	11	0.863	2	1.673	2
Textiles and rubbers	2.623	2	0.819	6	1.100	10
Nonmetal products	2.172	5	0.764	9	1.110	9
Metal products	2.793	1	0.825	5	1.067	12
Utilities	1.883	8	0.713	11	1.355	6
Construction	2.417	4	0.839	4	1.416	5
Transport and communication	1.858	9	0.787	7	1.329	7
Other services	1.286	12	0.768	8	1.517	4

Source: W. L. Lin, "Economic Interactions in Taiwan: A Study of Sectoral Flows and Linkages" (Ph.D. dissertation, Stanford University, 1973).

[a]Income from rent and capital is assumed to be small for households and therefore is ignored.

effect for the agricultural sector may be more important than the linkage effect per unit of final demand in most developing countries because the share of agricultural products in final demand is generally the largest. Therefore, the analysis of both average and marginal budget shares is relevant to this study.

Because consumption expenditure is critically important in multiplying the economic activities in a system, this chapter devoted to the analysis of consumption expenditures emphasizes demand parameters and consumption patterns in infrastructurally developed and underdeveloped areas. An attempt is made to determine the effects of infrastructure development on indirect nonfarm activities induced by consumption expenditures. No attempt is made, however, to measure the multiplier effect since that would require a general equilibrium framework.

Consumption Pattern and Demand Parameters

Expenditures on food items, as well as some services, are based on an aggregation of weekly data. Purchases of an irregular nature (such as clothes, education, and health) and major expenditures are based on an aggregation of quarterly data to annual levels. The model is therefore a set of Engel functions relating annual expenditures on different goods and services to a measure of total income and household characteristics. It is estimated using cross-section data.

Although household income data are available from the survey, total annual consumption expenditure is used as a proxy for income. There are two reasons for this. First, consumption expenditure is usually a better indicator of permanent income, which is considered to be a more important determinant of consumption behavior (Friedman 1952). Second, the estimates of household income are often not quite reliable: although there is not much difference between the average income and total expenditure (including investment expenditure), the variability of the latter is much larger than the former. Therefore, total expenditure seems to be a more reasonable variable than estimated income for measuring the behavioral pattern of income-consumption relations.

Choice of Functional Form

A flexible functional form is desirable for estimating consumption parameters. For one thing, the chosen function must provide a good statistical fit for a wide range of commodities. A nonlinear function as developed by Hazell and Röell (1983), following the Working-Leser model, is adopted in this study:

$$S_i = \beta_i + \alpha_i/E + \tau_i \log E, \tag{44}$$

where

$S_i = E_i/E$;

E_i = the expenditure on the ith good;

E = total expenditure; and

β_i, α_i, and τ_i are constants.

Equation (44) is equivalent to the Engel function:

$$E_i = \alpha_i + \beta_i E + \tau_i E \log E. \tag{45}$$

In comparing the expenditure behavior of households with different incomes, allowance must be made for some household characteristics and infrastructural factors. Since infrastructure is a primary concern of this study, the functional form must accommodate this concern. Therefore, a number of household characteristics (family size, farm size, and so forth) and the infrastructural index are included in the Engel functions, and this has been done in a way that allows both the intercept and the slope of the Engel functions to be shifted. Let Z_j denote the jth household characteristic or infrastructural index (note that for this variable, all households in a village have the same index numbers and only villages differ), and let μ_{ij} and γ_{ij} be constants. The complete model is then

$$E_i = \alpha_i + \beta_i E + \tau_i E \log E + \sum_j (\mu_{ij} Z_j + E\gamma_{ij} Z_j). \tag{46}$$

In the expenditure share form, equation (46) is equivalent to

$$S_i = \beta_i + \alpha_i / E + \tau_i \log E + \sum_j (\mu_{ij} Z_j / E + \gamma_{ij} Z_j). \tag{47}$$

Given the chosen Engel function, the marginal and average budget shares for the ith good (MBS_i and ABS_i, respectively) and the expenditure elasticity (e_i) can be derived as follows:

$$MBS_i = dE_i/dE = B_i + \tau_i(1 + \log E) + \sum_j \gamma_{ij} Z_j. \tag{48}$$

$$ABS_i = S_i = \text{equation (47), and} \tag{49}$$

$$e_i = MBS_i / ABS_i. \tag{50}$$

Expenditures are given in per capita terms. This enables ready comparison between household groups (between developed and underdeveloped areas, villages, or income classes, for example). But since family size is also included as one of the Z variables, family size can influence both the intercept and the slope of the Engel function for an individual commodity.

Estimation of the Model

The model can be estimated using either equation (46) or (47). Equation (47) is chosen because normalizing E_i by dividing it by E removes an otherwise troublesome problem of heteroskedasticity—a problem that is inherent in cross-section data. A disadvantage of estimating the share equation is that the adjusted R^2 coefficients are typically smaller (Prais and Houthakker 1971).

In estimating the model, it is not necessary to impose any restriction to ensure that $\sum_i \beta_i = 1$ and $\sum_i \alpha_i = \sum_i \mu_{ij} = \sum_i \gamma_{ij} = \sum_i \tau_{ij} = 0$ in equation (46). Because of the way the model is specified, these conditions are automatically fulfilled. Specifically, provided that each budget share equation has an intercept on the right-hand side and that each equation contains all the same variables and is estimated by least-squares regression, adding up is assured, as shown by Prais and Houthakker (1971). This result is affected neither by the inclusion of additional nonlinear terms in E, nor by the inclusion of Z variables. Ordinary least squares (OLS) was therefore retained as the estimating procedure.

Detailed Commodity Results by Infrastructural Groups

For consumption behavior in rural households, the marginal budget shares in developed and underdeveloped groups are computed by taking into account the infrastruc-

tural index numbers and their coefficients in the regression equation (see the Appendix, Table 75). The average index of the three most developed villages is taken and that of the three least developed villages. The level of significance of the infrastructural index in the regression equation is shown in the Appendix, Table 76. When interpreting average consumption behavior and comparing it between developed and underdeveloped villages, it is critical that the income effect is not confused with the infrastructural effect. Therefore, the budget shares and expenditure elasticities are calculated at a constant level of average per capita total expenditure (Tk 2,706) for both groups. The average per capita expenditures in the two groups, however, differ by only 1.2 percent.

Cereals. Both average and marginal budget shares are substantially higher in the underdeveloped areas. Obviously, infrastructure development reduces the propensity to consume cereals. The expenditure elasticity is about 23 percent higher in underdeveloped villages. This is a phenomenon analogous to the difference in consumption patterns in urban and rural households. The marginal budget share and the expenditure elasticity are negative for wheat in both developed and underdeveloped areas.

Noncereal field crops, except sugar and oilseeds. There is little difference in consumption behavior between the two groups for these commodities. The average budget share is 9.5 percent in developed areas and 9.2 percent in underdeveloped, and the expenditure elasticity of the group as a whole differs only slightly (0.82 in developed, 0.91 in underdeveloped).

Narcotics. This group represents products such as tobacco in various forms, betel leaf, areca nuts, and so forth. Both the average and marginal propensities to consume narcotics are substantially larger in developed villages. The average share is 70 percent larger and the marginal share 125 percent larger in developed villages. This also results in a larger expenditure elasticity for narcotics in developed villages.

Sugar and Oils. The average budget share for these products is about 13 percent larger and the marginal budget share is about 33 percent larger in developed than in underdeveloped villages. The expenditure elasticity of sugar products in developed areas is about 28 percent larger, while the expenditure elasticities of oils are similar.

Tea. Tea as a beverage takes 1.1 percent of total expenditure in the developed group, but its consumption is almost zero in the underdeveloped group. Roadside tea stalls are a visible sign of trade in developed areas.

Fruits. The average budget share for fruits is higher in underdeveloped areas, but the marginal budget share is larger in developed areas, resulting in higher expenditure elasticity in developed areas.

Fish and Livestock Products. The average budget share of fish and livestock products, including milk and milk products, is about 61 percent larger in developed groups, and the marginal budget share is about 53 percent larger in developed groups. This has resulted in an overall expenditure elasticity of 1.7 in developed and 1.8 in underdeveloped groups.

Fuel and Energy. The overall propensity to spend on fuel does not differ greatly between the developed and underdeveloped areas, but there are considerable differences between the two in the pattern of substitution among various sources of energy. The negative expenditure elasticity for cow dung as a fuel in developed areas and the positive income elasticity in the underdeveloped areas could have far-reaching implications for sustaining soil fertility. As infrastructure becomes more developed, cow dung will be used as fertilizer instead of fuel. Electricity as a source of energy is not available in the underdeveloped villages. Differences in propensities to spend on other local fuel products, such as jute sticks, rice husks, and dry leaves, are conditioned by a host of factors. For example, use of rice husks is almost three times greater in underdeveloped

areas due to rice being processed at home, while in developed areas, rice is processed in mills, which results in the loss of rice husks for fuel. Similarly, jute sticks are more likely to be used for fencing than for fuel in underdeveloped areas.

Other Manufactured Consumer Goods, Including Clothes. The average budget share for this broad group of commodities is 12 percent larger in developed areas, but the marginal budget share is only 6 percent larger. This has resulted in a slightly higher expenditure elasticity for this commodity group in underdeveloped villages. However, the expenditure elasticity is generally quite high in both groups of villages. It appears that the propensity to spend on handloomed clothes is higher in underdeveloped villages.

Services. The average budget share for services in the developed group is about three times the average share in the underdeveloped group. The marginal budget share is about 160 percent larger in the developed group, resulting in an expenditure elasticity for services of 1.7 in developed areas and 3.0 in underdeveloped. It is worth noting that the propensity to spend on religious services is quite high in developed areas. The propensity to spend on health and medical services is also higher in developed villages.

In sum, it appears that infrastructure development leads to a reduction in the share of income spent on food and an increase in the share spent on nonfood items. The average share of income spent on food is 75 percent in the developed areas and 81 percent in the underdeveloped. This change results from a sharp reduction in the share spent on cereals (a share that averages 48 percent in developed areas and 60 percent in underdeveloped areas). However, the average share of noncereal foods increases modestly due to infrastructure development (the average share of noncereal foods is 27 percent in developed areas and 21 percent in underdeveloped). This change in the composition of the food basket does not lead to any loss in nutritional status for the people in the developed villages. A nutritional analysis based on this data is presented in a separate paper by Kumar (1988). A summary of broad sources of nutrition by infrastructural groups is presented in Table 36.

An analysis of calorie intake by infrastructural group indicates that at given levels of expenditure, residents of the developed villages derived an average of 1,768 calories from cereals (74 percent of 2,387 total calories), compared with 1,800 calories per capita of cereals consumed in underdeveloped villages (81 percent of 2,232). Assuming that calorie content per unit of cereal is the same in the two groups of villages, higher prices as the result of infrastructure development are perhaps partly responsible for cereals' smaller share of total expenditure in developed villages.

How much of the difference in cereal consumption at the same income level at higher levels of infrastructure development can be attributed to changes in taste and how much to differences in price levels is an interesting question. In order to derive

Table 36—Broad sources of calorie intake by infrastructure groups, 1982

Infrastructure Group	Total Calories per Capita	Share of Cereals in Total Calories	Share of Noncereals in Total Calories
		(percent)	
Three most developed villages	2,387	74.08	25.92
Three most underdeveloped villages	2,232	80.67	19.33

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

an answer, the price effect (the effect of the price difference) is estimated and then this effect is deducted from the total infrastructural effect to obtain the effect of a change in taste as a residual. This change of taste is analogous to that observed in the process of urbanization. However, price differences between developed and underdeveloped areas are not straightforward. Analysis of village-level data indicates that rice prices (averaged over the whole year) are 5.7 percent higher in developed than underdeveloped areas. But the preharvest rice price is about 2 percent higher in underdeveloped than developed villages. Using the annual average price difference and a price elasticity of demand of 0.45, it is estimated that the price effect is rather small, and most of the difference in cereal consumption between the developed and the underdeveloped villages can be attributed to change in taste presumably brought about by infrastructure development. The estimated difference in consumption of cereals would have been 22 percent between the developed and underdeveloped villages if price levels were the same. Because of the price effect and the taste effect, the actual difference is 24 percent (see Table 37).

In general, the demand for cereals and fuels is inelastic and the demand for all other commodities is elastic. The expenditure elasticity is largest for services, followed by consumer goods and livestock and fish products. Infrastructure development reduces the expenditure elasticity of cereals but enhances the elasticity of all other products except milk and milk products.

Consumption Pattern by Income Quartile and Infrastructural Status

The analysis of income quartiles has been conducted by ranking all households in 16 villages according to per capita income and then dividing the sample into quartiles. Consumption functions are estimated for each quartile using the infrastructural index as one of the Z variables along with the other usual variables.

The consumption pattern of the households in the four income quartiles is shown in Table 38. As expected, the households in the first income quartile (with the lowest

Table 37—Per capita consumption of cereals in developed and underdeveloped villages after adjustment for price effect, 1982

Item	Underdeveloped Villages	Developed Villages	Difference[a]
			(percent)
Per capita total expenditure on consumption (Tk)	2,706	2,706	0
Per capita consumption of cereals (kilograms)	230	174	24.3
Per capita consumption after adjusting for the price difference[b] (kilograms)	230	179	22.2

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]Difference = [(Underdeveloped − Developed)/Underdeveloped] × 100.

[b]To adjust, consumption in developed villages is raised by 2.57 percent, which equals the annual average price difference times the price elasticity of demand (5.7 × 0.45 = 2.57).

Table 38—Average (ABS) and marginal (MBS) budget shares, by income quartiles, in developed and underdeveloped villages, 1982

Consumption Item	First Quartile				Second Quartile			
	Developed		Underdeveloped		Developed		Underdeveloped	
	ABS	MBS	ABS	MBS	ABS	MBS	ABS	MBS
	(percent)							
Cereals	64.60	53.77	62.91	55.91	43.03	40.54	60.34	57.41
Field crops (potatoes, vegetables, pulses, spices)	9.26	3.83	9.23	12.04	8.92	4.94	6.8	6.67
Narcotics*	3.46	5.47	1.05	2.86	4.45	5.49	2.11	3.30
Sugar	0.80	2.37	0.84	1.16	2.04	2.87	0.94	0.96
Oils and fats	2.24	2.59	2.96	5.59	2.32	2.07	2.04	1.70
Fruits	0.57	1.24	1.29	2.02	1.14	1.23	0.56	0.71
Tea	0.90	1.15	0.01	6.24	1.30	1.05	6.00	6.00
Fish and livestock	1.98	5.64	3.48	8.05	10.11	7.27	4.83	9.29
Total food	83.21	76.05	81.77	87.87	73.31	65.46	77.63	80.04
Energy and fuels	8.74	6.79	10.87	2.12	8.39	8.88	12.23	7.87
Consumer goods	5.25	10.87	4.51	9.52	5.74	10.63	8.37	10.71
Services	2.86	6.71	2.81	4.71	12.51	15.02	1.77	1.34
Total nonfood	16.85	24.37	18.20	12.11	26.64	34.53	22.37	19.92
Total	100.07	100.44	99.97	99.98	99.95	99.99	100.00	99.96

Consumption Item	Third Quartile				Fourth Quartile			
	Developed		Underdeveloped		Developed		Underdeveloped	
	ABS	MBS	ABS	MBS	ABS	MBS	ABS	MBS
	(percent)							
Cereals	28.46	14.91	57.55	54.96	26.16	9.36	55.59	44.50
Field crops (potatoes, vegetables, pulses, spices)	9.17	12.80	7.58	11.18	9.31	8.59	10.08	12.56
Narcotics*	4.49	2.34	3.27	2.97	3.87	5.33	2.55	1.26
Sugar	1.28	2.81	0.55	1.29	2.52	4.84	1.44	2.27
Oils and fats	2.06	2.99	1.54	1.73	3.31	4.17	2.20	3.72
Fruits	2.14	2.09	2.05	2.15	2.53	2.96	1.18	1.85
Tea	1.35	2.69	0.01	0.14	0.94	0.74	0.02	0.02
Fish and livestock	9.44	16.06	5.47	4.60	10.60	18.16	7.68	15.50
Total food	58.42	56.69	78.02	78.74	59.24	54.17	80.74	81.09
Energy and fuels	12.71	9.26	8.30	4.30	8.12	6.31	6.40	2.47
Consumer goods	16.13	11.86	10.07	10.64	15.73	11.85	9.61	10.59
Services	12.75	22.19	3.61	6.15	16.91	27.67	3.25	5.85
Total nonfood	41.59	43.31	21.98	21.09	40.76	45.83	19.26	18.91
Total	100.01	100.00	100.00	99.83	100.00	100.00	100.00	100.00

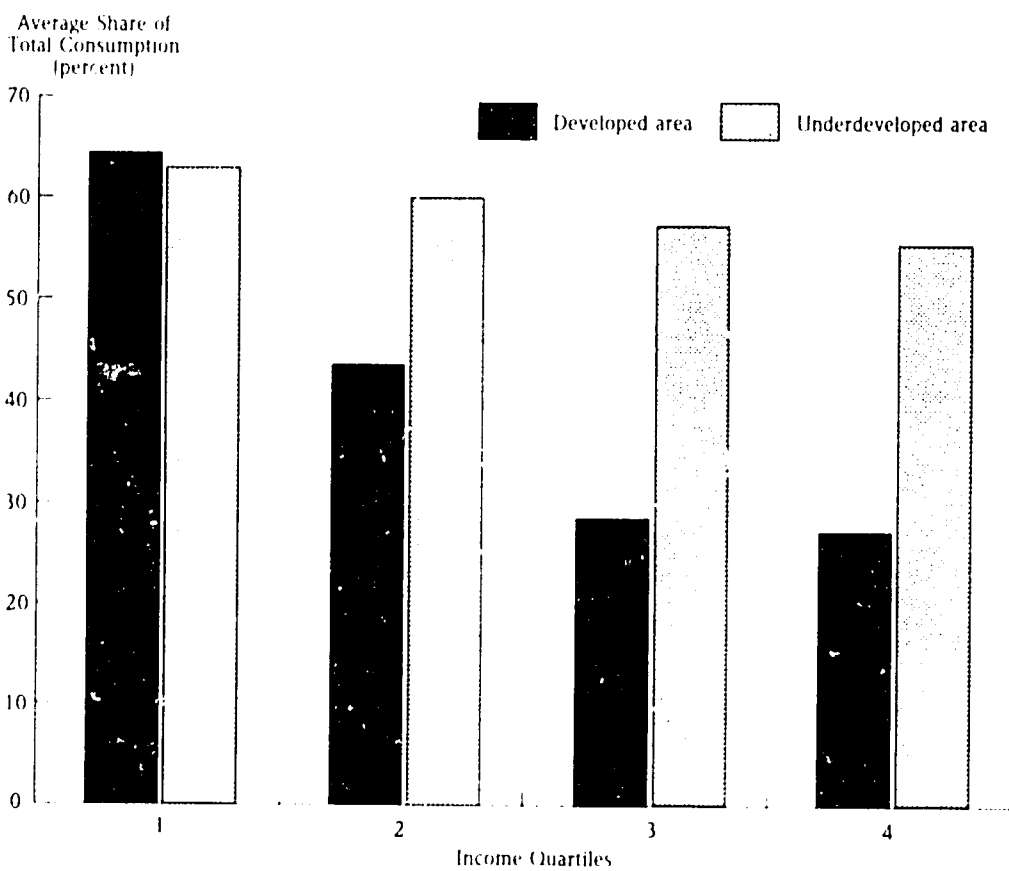
Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: Totals may not add up to 100 percent because of rounding.
*The narcotics included in this data are biri, cigarettes, betel leaf and nuts, tobacco, and jarda.

level of income) have high average and marginal shares for cereals in particular and for agricultural products in general. As households move up the income scale, this pattern reverses so that in higher income quartiles, households tend to allocate proportionately more for nonfood and less for food, particularly cereals. This change in the propensity to consume accompanying a change in income has important implications for economy-wide linkage effects related to consumption expenditure. First, policies that create special income advantages for low-income households are likely to have a

proportionately larger impact on the demand for cereals than policies favoring high-income households. This implies an upward pressure on cereal prices, particularly in the context of inelastic supply and a closed economy. In an open economy, the actual increase in cereal prices may not occur at all, but the net import of cereals must increase to counter the tendency of prices to increase. Second, the total linkage effect of household expenditure is largely determined by the sizes of the marginal and average propensities of consumption. These propensities are larger in higher income quartiles for noncereal foods and nonfoods. Because of those relations, policies that favor higher income households may generate larger linkage effects than policies that favor low-income households.

Examination of the consumption pattern by infrastructural groups shows that reduction in the propensity to consume cereals resulting from development of rural infrastructure comes about mainly through changes in household consumption patterns in the second through the fourth income quartiles (see Figure 3). Infrastructure development does not appear to make any significant difference in the propensity to consume cereals in the lowest income quartile.

Figure 3—Average propensity to consume cereals by income quartile in infrastructurally developed and underdeveloped villages



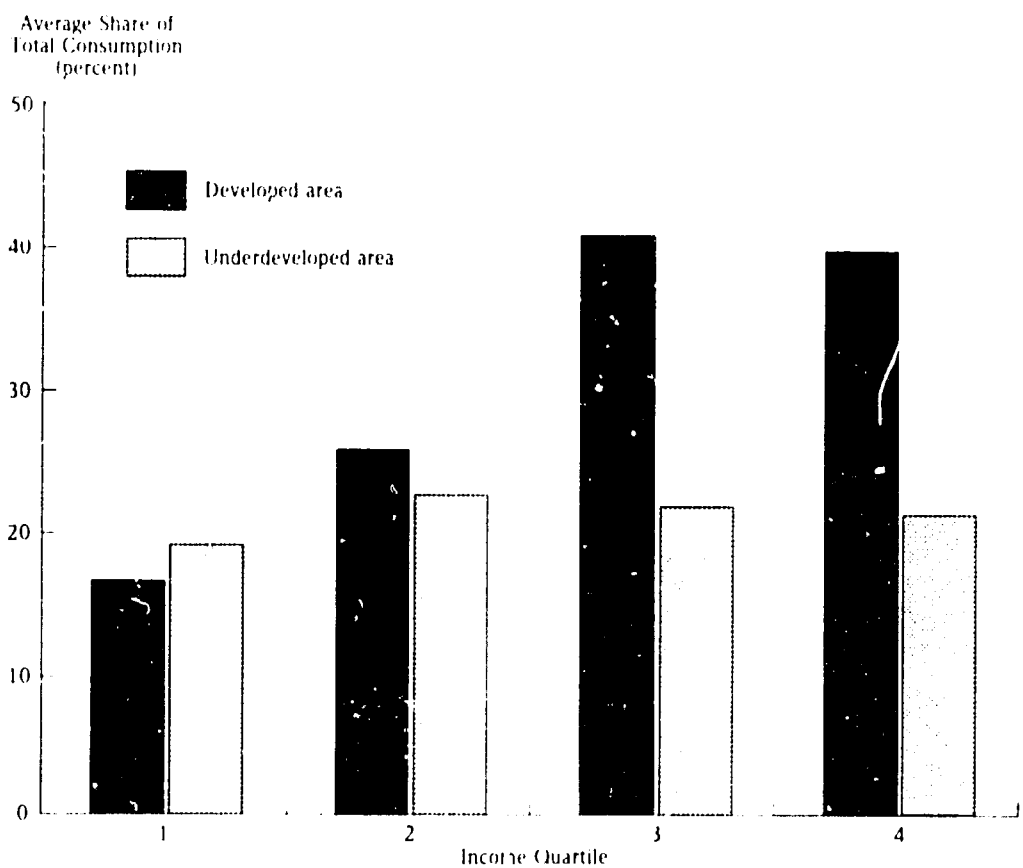
Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Note: Quartile 1 is the household group with the lowest total expenditures and Quartile 4 is the group with the highest total expenditures.

The effect of infrastructure development on the propensity to consume nonfood goods and services is portrayed more clearly in Figure 4. Note that these effects by income quartiles have been estimated by keeping the income level in each quartile the same for both developed and underdeveloped areas. Therefore, the effects reflect changes in taste patterns, as well as in price levels, caused by infrastructure development. In developed areas, the sharply increasing trend in budget share for nonfood goods and services contrasts sharply with the pattern in underdeveloped areas, where the shares maintain a virtually flat trend. How much of this difference is due to changes in taste and how much to differences in price levels could not be ascertained in the same way as for cereals. Village-level prices of nonfoods were not collected as scrupulously as those for rice.

Household behavior in consumption of nonfoods, as reflected by expenditure elasticities in various quartiles of developed areas, is quite puzzling (Appendix Table 77). The expenditure elasticities are in decreasing order with 1.45 for the first quartile and 1.12 for the highest income quartile. This is obviously a result of relatively larger marginal budget shares in the first two quartiles. Such a phenomenon could possibly

Figure 4—Average share of nonfood expenditures by income quartiles in infrastructurally developed and underdeveloped villages



Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Note: Quartile 1 is the household group with the lowest total expenditures and Quartile 4 is the group with the highest total expenditures.

be the result of the occupational distribution among quartiles. It is generally believed that salaried persons adopt urban consumption styles faster than richer agriculture-based households. In developed areas, the increase of salaried employment among the landless and small and medium landowning households has been greater than that for large landowning households. Although a detailed analysis of this phenomenon, as discerned by examining expenditure elasticities of nonfoods in developed areas, could not be pursued in the present study, the hypothesis is still worth pursuing in the future.

Conclusions

A number of important implications for infrastructure development, with economy-wide repercussions for household expenditures, have already been discussed. The empirical evidence presented has substantiated some of these implications.

First, the difference in the marginal propensity to consume between households located in infrastructurally developed and underdeveloped areas implies that infrastructure development induces increases in demand for noncereal foods and nonfood consumer goods and services. The effect on overall interindustry production, employment, and income linkages is bound to be substantial, largely because infrastructure development enhances income from various sources as shown in Chapter 6. By spending a larger share of this incremental income on noncereal foods, nonfoods, and services, households in developed areas generate additional employment and income in the economy during the subsequent rounds of activity. In addition to the income effect, infrastructure development clearly diminishes the propensity to consume cereals and increases the propensity to consume nonfood goods and services through a change in taste patterns. These changes are congenial for development of a diversified rural economy.

Second, full realization of potential linkage effects from increased final demand depends on how the supply of goods and services responds to changes in demand. Most analyses of intersectoral linkages employ a static framework of input-output tables. This approach assumes that supply is infinitely elastic, and therefore an increase in final demand is not accommodated by increased prices but in increased production and supply. Infrastructure development plays a critical role in upholding the degree of validity of this assumption and thus the amount of realized benefit from intersectoral linkages. Infrastructure development increases the speed of diffusion of agricultural technology, reduces the cost of marketing, and improves the operation of both factor and product markets. The positive influence of these changes implies a greater degree of supply response in infrastructurally developed areas.

8

INFRASTRUCTURE AND SAVINGS-INVESTMENT BEHAVIOR

The savings rate, marginal or average, is a key factor in sustaining a self-reliant pace of economic growth. Furthermore, savings are required for investment; unless this transformation of savings into investment is complete, the impact of savings on economic growth may not be perceptible. Household savings, exclusive of transfer payments, are a component of national savings frequently featured in macroeconomic policies. Knowledge of household savings and investment is critically important, not only for correctly assessing aggregate savings but also in formulating development policies. Formulation of policies designed to increase the propensity to save and invest has suffered from the dearth of knowledge about savings and investment behavior in households of developing countries. Moreover, positive price policies are common in most developing countries. The degree of supply response to changes in price policies greatly depends on whether and how the price-induced increment in income is saved and invested. This section is devoted to analysis of the impact of rural infrastructure on the savings and investment behavior of rural households within the context of a range of factors that are common in savings and investment functions. Thus, in addition to measuring the effects of infrastructure development, the study describes the nature of savings and investment propensities and patterns in rural households of Bangladesh.

Conceptual and Measurement Issues

Savings and investment in developing-country households are closely interrelated with production and consumption decisions. This interaction compounds the general problem of definition and measurement of household savings and investment flows.

Income

Although the concept of household income was explained in Chapter 6, further explanation is necessary in the context of this analysis. Two additional concepts for the measurement of income are introduced here. First, the income variable for labor involved in the creation or improvement of physical assets, including land development, is modified by adding the value of family labor, using the prevailing market wage rate. In Chapter 6, measurement of income from production excludes family labor used in production activities; income is measured as a return to family labor and owned assets. However, if construction of new assets using family labor is included in the savings and investment accounts, as defined here, then it is appropriate that this component of family labor be included in income. Second, the income flow measured from the production accounts does not always match income measured from the expenditure accounts, which define gross income as the sum of expenditures on consumption and on various savings, based on data obtained directly from the survey. Conceptually, the gap between the two income estimations should be explained by the balances of financial and credit accounts, but empirically this gap may persist due to measurement errors in data. In Table 39, which uses both estimates of income, the average savings

Table 39—Average rate of gross savings in households in 16 villages, 1982

Village	Average Rate Based on Production Accounts[a]	Average Rate Based on Expenditure Accounts[b]	Number of Cases
	(percentage rate)		
Charkhamar	9.3	11.2	38
Rajarampur	8.7	10.1	40
Syedpur	11.7	11.1	40
Gobindapur	−1.3	−1.8	40
Bandabeel	22.7	21.8	39
Raokuli	6.6	7.9	39
Harispur	18.4	20.3	40
Gobrapara	2.6	2.6	39
Birhat	22.6	18.8	40
Taliamara	26.4	23.7	40
Khejurdanga	5.0	6.9	36
Khunta	9.9	7.5	40
Illashpur	23.1	17.6	40
Chashapara	22.9	23.3	39
Patgari	2.2	2.8	40
Raotara	5.6	6.9	38
Developed	15.1	14.9	271
Underdeveloped	13.2	12.6	357
All villages	14.0	13.6	628

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]This average rate is obtained by dividing gross savings by the income measured from production accounts.
[b]This average rate is obtained by dividing gross savings by the income measured from expenditure accounts.

rates do not differ much. This will be analyzed further later in this chapter when a profile of rural savings is presented.

Savings

Savings of a household can be defined as the surplus of current income after deducting current consumption expenditures. This measurement approach for savings is not very revealing, however, and the estimate of savings thus measured may mask considerable errors in the estimates of income, shedding little light on underlying real propensities to save.

The savings of a household can be more meaningfully defined as the change in net worth and computed as the difference between the change in the value of assets and the change in liabilities. This figure has to be adjusted for capital transfer. In other words, household saving SH is defined as

$$SH = PA + FA - dL,$$

where

PA = gross change in the value of physical assets,
FA = gross change in the value of financial assets, and
dL = net change in liabilities including net inflow of capital transfer.

It should be noted that determining the *change* in the stock of assets and liabilities—not their current levels—is the main objective of the measurement. This measurement can

be obtained in two ways. Adopting a balance sheet approach, one can measure the value of assets and liabilities twice—once at the beginning and once at the end of a reference period (generally one year) and take the difference between the two measures as the estimate of gross savings. There is no need to estimate separately the extent of damage or destruction of assets if this balance sheet method is adopted.

In the second method, net acquisition of assets and changes in liabilities are directly measured from the household surveys designed to collect data on expenditures, lending and borrowing, sales and purchase of assets, construction of assets using family labor, damages and destruction of property, and so forth. This second method is followed in the estimation of savings and investments in the present study.

The following accounts from the household surveys are considered in the estimation of savings:

1. Physical assets
   - Land acquisition (purchase minus sale)
   - Construction of houses
   - Consumer durables
   - Excavation of ponds for fisheries and purchase of fishing nets
   - Improvement or additional planting minus sales or use of trees
   - Land development, including irrigation
   - Transport equipment (purchase minus sale)
   - Agricultural implements (purchase minus sale)
   - Other equipment (purchase minus sale)
   - Equipment for rural industries (purchase minus sale)
   - Sanitary and drinking water facilities (purchased, repaired, and developed through family labor)
   - Net acquisition of livestock (purchase minus sale)
   - Repair of implements
   - Business investment (net addition to business assets, such as shops)
2. Purchase of financial instruments
3. Net increase in credit given including mortgage transactions

The third item is estimated by adding credit given in the current year and repayment of past credit in the current year, including land mortgages, and deducting from this sum the amount of credit received from all sources, including land mortgages. The estimate of gross savings is arrived at by adding 1 through 3 in the list and deducting from this sum the estimated value of damage to or destruction of property.

It is clear from the list that changes in inventories of commodities, cash holdings, and gold are not included. This information could not be obtained from households despite efforts toward this end. It must, however, be reiterated that it is the changes in levels of these excluded items that matter in the estimation of savings. Such changes are likely to be small. Thus, exclusion of these items may not be a serious concern in providing a rough order of the magnitude of gross savings in rural Bangladesh.

However, inclusion of certain items as saving activities in the list requires some explanation. Consumer durables have been treated as part of savings and investment. In the literature, it is controversial whether this item should be treated as consumption

or investment expenditure. The close interdependence between production and consumption activities in rural households of Bangladesh further compounds the problem. For this study, it was arbitrarily decided to treat consumer durables as an investment. Repair of implements to maintain them in working condition should generally be considered a production expense and included in current costs, but households often responded that such repairs increase the working life of the implements. Therefore, the distinction between repair costs incurred to prolong the working useful life of implements and those made in order to keep the implements in current use could not be made easily. However, those repair costs that households reported were undertaken to enhance the working life of implements were included in savings and investments.

It is particularly complicated to estimate savings and investment in the case of livestock. Ideally, the birth of new livestock minus deaths plus net acquisition through purchase and sale should be considered. However, it was not possible to collect information on births and deaths of livestock. The estimate based on purchase minus sale gives an average that is almost zero for the entire sample, but that for individual households varies widely, some having positive and some negative values.

A comparison of 1960 and 1982 pilot agricultural census figures on the number of livestock indicates an annual growth rate of 0.4 percent for cattle, 3.5 percent for sheep and goats, and 5.5 percent for poultry. On the basis of 1982 constant prices, the annual growth rate for the livestock sector is estimated to be only 0.95 percent during the intercensal period. The average value of livestock per household at the beginning of the survey year of the sample was Tk 1,450. If this stock is assumed to have grown by 0.95 percent, then the increase in stock per household would be equivalent to Tk 14. This is 0.07 percent of the average income per household. Thus, the gross savings rate, on the basis of this alternative, underestimates livestock accounts by only 0.07 percentage points. In other words, if livestock assets in the sample increased in number at a pace equal to that between the 1960 and 1982 agricultural censuses, then the average gross savings rate of the sample households would have been 13.67 percent instead of 13.60 percent as shown later. It seems that the margin of error on the livestock account, by not properly accounting for births and deaths of livestock, is rather small.

There is a conceptual difference between savings at the household level and at the national level. The national estimate of household savings must exclude transfer payments and include adjustments for export and import (see Alamgir 1976). Buying land represents a saving for the purchasing household but a dissaving for the selling household, so that national saving is zero. The case is similar for credit and many financial assets. The items listed earlier under physical assets (excluding land) and investment on education would be approximately equivalent to the contribution of rural households to national savings. These components are examined further in the context of capital accumulation. An analysis of capital accumulation or investment in physical assets and education will be conducted at the end of this chapter, using the sum of savings from the physical assets (excluding land acquisition) in the list provided earlier.

A Descriptive Profile of Rural Savings

Investments in assets such as houses, tubewells, boats, rickshaws, and shops are too lumpy for the level of income of most households. A typical household can only invest in such assets once or twice in a lifetime through continuous accumulation of savings. A richer household can make more frequent investments than a poorer one.

Certain investments are skill specific. A household will invest in a boat or a shop or fishing equipment depending on the aptitude and entrepreneurship of its household members. Different investments entail different degrees of risk from natural forces as well as economic ones. Investment in land (either through purchase or through mortgage) is considered to be the least risky investment in rural Bangladesh. These diversities in household investment behavior are microrealities, from which this study proposes to abstract some average indicators to portray the extent and the nature of savings and investment in the rural household economy of Bangladesh.

Average Savings Rate in Households

The estimated average rate of savings for the 16 villages in Table 39 varies little between the two estimates—14.0 to 13.6 percent—although, the variation between the average rates is less modest in some villages, in Illashpur, for example. This variation between the two measures of income is expected to be larger at the household level because of wide diversity in the measures that households undertake to finance expenditures when income is destabilized. On average, the savings rate based on income from the production account is slightly higher than the rate based on income from the expenditures account, because the estimate of income from production is slightly lower than that from expenditures. Even though the average savings rate based on expenditure is about 13.6 percent, this rate varies widely among villages. Gobindapur, for example, has a negative average savings rate, whereas Taliamara, Chashapara, and Bandabeel have savings rates ranging from about 22 to 24 percent. Infrastructurally developed villages show a slightly higher rate of savings than underdeveloped villages.

The most significant result of this analysis of the average savings rate is the distribution of savings in rural areas. About 36 percent of the households are found to have a zero or negative savings rate (Appendix Table 78). But negative savers are not limited to the lowest income quartile; about 12 percent of households in the top income quartile also have no savings. Although about 57 percent of the households in the lowest income quartile are nonsaving, about 4 percent in this quartile have a savings rate of more than 10 percent. On the whole, only about 29 percent of the households in the sample save that much.

Distribution of saving and nonsaving households by landownership groups provides further insights on savings behavior (Appendix Table 79). In developed villages, about 71 percent of the landless households are savers (therefore 29 percent are nonsavers), compared with underdeveloped villages where only about 59 percent of landless households are savers. Apparently not all landless households are as poor as is generally thought, and infrastructure development seems to be positively associated with a relatively better-off position for this group. In fact, both the landless and large-owner groups have significantly more savers in developed than in underdeveloped villages. Among the small and medium landowners, however, the proportions of savers and nonsavers are not significantly different.

Among the households that have positive savings rates, the distribution of total savings is extremely skewed—more skewed than income distribution. Households in the top decile generate about 60 percent of the total gross savings in rural areas. The top two deciles together share about 75 percent of the total savings. Households in the lowest two deciles generate less than 2 percent of the total rural savings. On the other hand, the top 20 percent of households receive about 43 percent of total income, whereas the lowest 20 percent receive about 10 percent of total income.

This skewness in distribution of savings in rural areas has important implications for policies to mobilize resources in the rural sector. The role of rural banking and

taxation policies is particularly relevant in encouraging savings. Although average per capita income is generally low, this is a weak indicator of potential funds for savings or taxation. A relatively small number of households do possess a substantial potential for mobilization of financial resources in rural areas.

Composition of Gross Savings

Two broad components of the total gross savings per household—capital formation and transfer-type savings—are shown in Table 40. Investments in physical assets, excluding land purchases but including human capital development, are classified in the broad group of capital formation. Net lending, net land purchase, and purchase of financial instruments are classified as transfers. Investment in financial instruments, strictly speaking, cannot be considered entirely a transfer, but since it is so small (only about Tk 6.0 per household) and its main component is a transfer, it is treated as such.

Capital formation, averaged over the whole sample, constitutes about 78 percent of gross household savings. The remaining 22 percent is invested in transfer-type activities, which implies a net movement of capital resources out of the sample households. Most of these transfers are brought about through land purchases (46 percent of total transfers) and lending on land mortgages (50 percent); other types of lending account for the other 4 percent. Allocation of savings between capital formation and transfer-type investments differs between developed and underdeveloped groups—moderately in capital formation and substantially in transfer-type investment.

Even though the average share of capital formation in total saving is only 78 percent, variation among villages in this respect is quite large. Three out of 16 villages had capital formation far above gross savings, implying increased borrowing by households

Table 40—Composition of gross household savings, 1982

Village	Average Savings/ Household	Capital Accumulation/ Household	Transfer-Type Savings/ Household	Capital Formation as a Percent of Savings	Transfer as a Percent of Savings
		(Tk)		(percent)	
Charkhamar	2,497	1,305	1,192	52.3	47.7
Rajarampur	2,023	496	1,527	24.5	75.5
Syedpur	2,227	585	1,642	26.3	73.7
Gobindapur	-250	-61	-189	24.4[a]	75.6[a]
Bandabeel	5,621	1,334	4,287	23.7	76.3
Raokuli	1,248	646	602	51.8	48.2
Harispur	5,803	3,373	2,430	58.1	41.9
Gobrapara	435	3,186	-2,751	732.4	-632.4
Birhat	3,996	4,161	-165	104.1	-4.1
Taliamara	4,422	4,053	369	91.7	8.3
Khejurdanga	720	509	211	70.7	29.3
Khunta	1,504	1,959	-455	130.3	-30.3
Illashpur	5,229	4,265	964	81.6	18.4
Chashapara	7,245	6,124	1,121	84.5	15.5
Patgari	547	1,541	-994	281.7	-181.7
Raotara	983	898	85	91.4	8.6
Developed	3,118	2,317	801	74.3	25.7
Underdeveloped	2,523	2,019	504	80.0	20.0
All villages	2,779	2,161	618	77.8	22.2

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: A negative transfer implies increased indebtedness or money going out from a sample household, while a positive transfer implies receipt of money from outside the household.

[a]These are percentages of a total dissaving.

for the sake of capital formation. Such a phenomenon of large investment through borrowing occurs in only a small number of cases, but it inflates the village averages.

Structure of Capital Formation

Since capital formation is the largest component of gross savings and roughly represents private rural savings in the national aggregate, a further disaggregation of this broad component is desirable. However, the estimate of capital formation does not include any allowance for wear and tear of existing capital stock.

The composition of capital formation in Table 41 shows clearly that rural households invest about 50 percent of their total capital formation in housing and consumer durables— 40 percent in housing alone. Nonagricultural investment, the next largest share, is 33 percent, while agricultural investment is only about 17 percent. Land development and agricultural equipment account for most of the agricultural investment.

Gross capital formation per household is about 17 percent higher in the developed group than in the underdeveloped. The difference in investment in housing and durables between the two groups is similar. Developed villages have about 10 percent higher investment per household than underdeveloped, largely due to nonagricultural investment. It is in agricultural investment that the difference between the two groups stands out. The level of total investment in agriculture is about 47 percent higher in developed villages even though investment in irrigation and drainage and agricultural equipment is about 21 percent lower. This is the consequence of a large difference between the two groups in investment in livestock and fisheries, which is extremely high in developed villages. Underdeveloped villages are more likely to disinvest than to invest in livestock.

The higher level of investment in irrigation and agricultural equipment in underdeveloped villages may seem surprising, but it is not so in reality. First, the land area

Table 41—Structure of gross capital formation at the household level, 1982

Investment	Developed Villages		Underdeveloped Villages		Difference in Value[a]	All Households	
	Value	Share	Value	Share		Value	Share
	(Tk)	(percent)	(Tk)	(percent)	(percent)	(Tk)	(percent)
Housing and durables	1,269	49.4	1,123	51.1	13.0	1,189	50.3
Consumer durables	215	...	237	...	-9.0	227	9.6
Housing	1,017	...	866	...	17.4	935	39.5
Sanitation	37	...	20	...	85.0	27	1.2
Agricultural investment	479	18.6	326	14.8	46.9	395	16.7
Fisheries	54	...	15	...	260.0	32	1.3
Plantation	10	...	25	...	-60.0	18	0.8
Livestock	170	...	-26	...	...	63	2.7
Irrigation and drainage	96	...	137	...	-29.9	119	5.0
Agricultural equipment	149	...	175	...	-14.9	163	6.9
Nonagricultural investments	821	32.0	749	34.1	9.6	781	33.0
Transport	24	...	37	...	-35.1	32	1.3
Industries and business	797	...	712	...	-11.9	749	31.7
Total	2,569[b]	100.0	2,198[b]	100.0	16.9	2,365[b]	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]Difference [(Developed - Underdeveloped)/(Underdeveloped)] × 100.

[b]These figures differ slightly from the figures in Table 40 because property damage, theft, and certain disinvestments were deducted from gross savings in Table 40. The figures in this table do not incorporate those deductions because the damage estimates were in aggregate form, not separable by investment groups.

per household is about 34 percent larger in underdeveloped villages, and these investments are crop- and land-related investments. Investment in irrigation and agricultural equipment per acre of owned land would not be higher in underdeveloped villages. Second, investment in irrigation and drainage in underdeveloped villages has a higher component of the value of family labor in gross cost, as will be shown later. These investments are really the result of greater utilization of family labor in underdeveloped villages, where the opportunity cost of labor is lower than that in developed villages.

An issue related to the structure and estimation of capital formation in rural households concerns the extent of nonmonetized investment. Of the total value of capital formation, about 12 percent in developed and 20 percent in underdeveloped groups occur in nonmonetized form (such as family labor and home-produced materials) (Table 42). Home-produced materials, such as bamboos, thatches, and jute sticks, are used only in housing. Only monetized factors are involved in nonagricultural investment. Family labor has the largest share (68 percent) of the total nonmonetized investment. The difference between developed and underdeveloped groups in creating assets using family labor is significant. Underdeveloped villages use 38 percent more family labor in creating such assets than developed villages. Use of family labor in creating agricultural assets (land development) is three times higher in underdeveloped than in developed villages.

Determinants of Rural Savings and Investments

Following Keynesian tradition, studies on savings, particularly aggregate savings, generally focus on the measurement of average and marginal propensities to save. This focus on savings as a function of income alone is viewed by many development economists as inadequate for explaining saving and investment behavior in developing countries. (See the review by Mikesell and Zinser 1973.)

Before discussing which variables in addition to income should be considered in savings-investment functions, a number of cautionary notes are in order to ensure that comparison of results among studies does not lead to inaccurate conclusions. First,

Table 42—Extent of nonmonetized investment in gross capital formation, by infrastructural group, 1982

Type of Investment	Housing and Durables		Agricultural Investment		Nonagricultural Investment		All Types	
	DV	UNDV	DV	UNDV	DV	UNDV	DV	UNDV
Gross investment (Tk)	1,269	1,123	479	326	821	749	2,569	2,198
Family labor (Tk)	198	114	47	150	...	...	245	264
Share in gross	(15.6)	(10.2)	(9.8)	(46.0)	...	...	(9.5)	(12.0)
Own materials (Tk)	69	170	...	...	...	...	69	170
Share in gross	(5.4)	(15.1)	...	...	...	...	(2.7)	(7.7)
Total nonmonetized (Tk)	267	284	47	150	...	...	314	434
Share in gross	(21.0)	(25.3)	(9.8)	(46.0)	...	...	(12.2)	(19.8)

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Ellipses (. . .) indicate insignificant values or zero. DV is developed villages; UNDV is underdeveloped villages. Numbers in parentheses are percentages.

savings and investment at both the household and aggregate levels fluctuate tremendously from year to year due to fluctuations in production and income. Variations in savings are much larger than variations in income because consumption demand takes priority over investment demand in low-income economies (Malenbaum 1962). Second, estimates of savings from micro and macro studies differ not only because of the definitional differences explained earlier but also because of the nature of the data involved. The difference in data is particularly reflected in the much wider range of the values of variables in micro studies. Unless appropriate specification of functional forms takes care of this difference in range of values, estimates of marginal propensities to save (MPS) obtained from the two types of studies could be very different. Similar differences generally exist between studies that use group averages of cross-sectional data compared with studies that use data for individual households. Generally the estimate of MPS from the former is smaller than the one from the latter. Studies based on detailed household information rather than group averages are quite rare in literature.

Income

That income is the principal determinant of the propensity to save is well recognized. The relative roles of current income and permanent income in influencing savings behavior have drawn the attention of many researchers (Alamgir 1976). Data available in this study are not suitable for testing the permanent income hypothesis and therefore empirical results on this count are not discussed. Alamgir (1974), using aggregate data for 1960 to 1970, regressed per capita savings with per capita income separately for rural and urban areas of Bangladesh and estimated the MPS to be 11 percent for rural areas and 21 percent for urban areas. Malenbaum (1962) estimated the MPS in the Indian economy, using aggregate data, to be 30 percent during the early 1960s. From cross-section data for record-keeping farmers in Taiwan, Ong, Adams, and Singh (1972) estimated the MPS to be 35 percent in 1969 and 69 percent in 1966. Kelley and Williamson (1968) found the MPS to be 11 percent for farmers of Jogjakarta; this study also found the MPS of transitory income to be as high as 37 percent. There are numerous other studies on income and savings relations. In general, all studies indicate that the marginal savings rate is higher than the average.

Assets or Wealth and Savings

Ownership of assets such as land and nonland capital stock is believed to influence positively the savings and investment behavior of households. A number of studies (Kelley and Williamson 1968; Desai 1969; Misra and Mallick 1969) have in fact found a positive relationship between the size of landownership and the propensity to save. It is, however, important to distinguish between the independent effects of assets and income, because asset ownership is generally positively correlated with income, thus confusing the independent effects of asset and income. Assets may represent a factor that underlies a household's expectation of future returns from asset accumulation. If past experience indicates that such assets generally bring normal returns or act as security in bad times, a household may accumulate such assets even in a year when returns are not particularly favorable.

Rural Infrastructure

Inclusion of some measures of infrastructure development in rural savings and investment functions is rare. However, some studies that consider factors such as market structure, prices, and access to modern services do in fact recognize the

importance of what is called infrastructure. Easy access to attractive consumer goods because of better infrastructure development may stimulate consumption expenditure more than savings and investment. On the other hand, easy access to more productive markets may stimulate income savings and investment. The balance of the two opposing effects cannot be forecast. Moreover, if most of the positive effect of infrastructure on investment behavior is realized through the income route (that is, through infrastructure influencing income and income influencing savings and investment), then a regression exercise to capture the independent effect of infrastructure may produce insignificant results.

The effect of infrastructure on investment in the local economy cannot be captured completely by measuring the effect only in local households. Infrastructure may induce investment from government as well as organized firms or even large households from outside the locality. Unfortunately, this data set does not include any economic unit other than local households. Therefore, the measurement of the effect of infrastructure through analysis of household income, savings, and investment is only a partial measure of the effect of infrastructure.

Rate of Return from Investment

Rate of return from investment is accorded a crucial role in determining the level of investment and savings in all theoretical literature. But in empirical studies, virtually all those examined in connection with this analysis did not incorporate this variable, which is understandable in view of the complexities of obtaining a reliable measure of rate of return. Rural credit markets are so heterogeneous that construction of an index of interest rates in informal credit markets is practically impossible, except through a special research effort geared for this purpose. Moreover, it is the expected rate of return, not the actual, in any year that is the relevant variable. In any particular year, rate of return could even be negative, which an investor might expect to recover in another year. A satisfactory proxy of expected rate of return is hard to get. The closest proxy, perhaps, would be the amount of nonland capital that a household owns.

Access to Technology

New technology increases the profitability of crops; therefore, farmers are expected to invest in structures and equipment that enable them to adopt new technology. It is also known that irrigation is a primary requirement for bringing new land under HYVs. Investment in tubewells and dug wells is a possible mechanism for expanding households' capacity to increase area under irrigation. On the other hand, if irrigation is publicly provided, as is generally the case with large-scale surface water and tubewell schemes, then water charges, if paid by the farmers, constitute the primary cost of irrigation; these are treated as current costs and not as investment. When a large farmer invests in a tubewell and then sells water to others, the water charges paid by farmers include both investment costs and operation costs. In the data for this study, these water charges appear as current cost for farmers purchasing water, but the installation cost of one tubewell is considered an investment by the large farmer. Technology also expands the scope for increasing income. Therefore, the income effect of technology on savings and investment is likely to be significant. This may mask the independent effect of technology.

Other Explanatory Factors

In the literature on savings and investment, a significant number of other factors in addition to the ones discussed above are also postulated as important explanatory

variables. Credit from institutional sources, demographic factors such as the dependency ratio and age of the household head, tenancy, and education are these factors, some of which are considered in this analysis.

Finally, a complete analysis of savings and investment behavior of rural households requires data that cover both time series and cross-section information. Without the time dimension, dynamic effects cannot be measured. Moreover, the real influences of many variables are accurately perceived only over a reasonable period of time. Similarly, the effects of structural variables are captured mainly through cross-section information. But data reflecting both structural and dynamic dimensions are rarely available for any developing country. The results presented below should be judged keeping this limitation in mind.

Analysis of Savings-Investment Function

On the basis of the foregoing discussions, the following savings-investment function is postulated and estimated using regression techniques.

SINV f(INCM, INF, EDCN, SCPT, FSZ, WRKR, CRDTI, HYV, LAND, RRTA, RRTN),

where

SINV	savings in taka per capita,
INCM	income in taka per capita,
INF	index of infrastructural underdevelopment (the higher the index number, the larger the degree of underdevelopment),
EDCN	education level of the head of household,
SCPT	stock of nonland capital in taka per capita,
FSZ	family size,
WRKR	number of working members in the family,
CRDTI	amount of credit per capita from institutional sources,
HYV	proportion of land under HYVs,
LAND	per capita land owned by the household,
RRTA	rate of return from agriculture measured as the ratio of agricultural income to nonland agricultural capital,
RRTN	rate of return from nonagriculture measured as the ratio of nonagricultural income to nonagricultural capital.

Initial examination of the data shows a wide range of values in SINV that indicate the appropriateness of quadratic or cubic terms of the income variable in the functional form. Households are grouped into landowning and landless classes. All households owning 0.5 acres or less of land are classified as landless.

Results of two specifications—one restricted to only income and infrastructure variables as explanatory factors and the other fully specified in the sense that all variables are included—are shown separately in the Appendix, Table 80. It is clear from comparing the two specifications that income is the dominant factor, and other variables excluding infrastructure contribute very little, as indicated by the difference

in the values of the adjusted R^2. Income and its higher order terms are statistically highly significant. MPS is found to be quite high in farm households (46-56 percent) but relatively low in landless households (20-23 percent). Examination of the data indicates, however, that there are 10 households with extremely high levels of savings or dissavings in the sample. Excluding these 10 extreme households from the estimation of the equations results in little significant change in the adjusted R^2, but the estimated MPS for farm households is reduced significantly (Appendix Table 81). From 46-56 percent, the range of MPS for farm households is reduced to 32-42 percent. No change of MPS in landless households occurs due to the exclusion of extreme households. Clearly, concentration of savings and dissavings in a few hands makes overall savings behavior appear to be quite unstable.

Another disturbing aspect of the results emerges. Not only do the other variables (HYV, EDCN, CRDTI, WRKR, LAND, and so forth) contribute little overall to the explanation of per capita savings and investment, but most of their influence (except SCPT) is significantly different in direction than originally expected. Thus, inclusion of additional variables as explanatory variables tends to increase the MPS by about 10 points.

This result drives home the fact that savings and investment are very diverse in nature, and decisions on where to invest among these diverse groups are often interdependent. Savings are divided into four groups: (1) INVH (investment in housing, education, and durables), (2) INVA (agricultural investment), (3) INVN (nonagricultural investment), and (4) INVT (transfer type investment). Thus four equations for four types of investment are formulated and estimated simultaneously, using Zellner's method of joint generalized least squares. The results for all households (shown in Tables 43 and 44) are quite stable and similar, even when extreme cases are excluded in Table 44.

The tables indicate that for investment in housing and durables, per capita income and family size are the two significant determinants. For agricultural investment, the income level and stock of nonland capital are the two positive factors, whereas per capita land owned appears to exert significant negative influence, rather robustly, in all regression equations. This could be brought about by households with higher land-man ratios renting out land and moving to nonagricultural occupations. It may also be true if the capacity for utilization of existing stock of capital in such households is low. The result seems to parallel the controversy that exists regarding the productivity differential between small and large farms.

That HYVs do not appear to be significantly related to agricultural investment may raise a question about how these new varieties can be grown without investment. The result really reflects the fact that most costs related to HYV are current costs. Chapter 4 shows that infrastructurally developed villages allocate about 71 percent more area to HYVs and use about 92 percent more fertilizer per unit of land than the underdeveloped villages. A comparison of current costs for irrigation and fertilizer between developed and underdeveloped villages is shown in Table 45. It is clear that current cost of irrigation is equal to about 18 percent of gross capital formation (or 81 percent of gross investment in agriculture) in developed villages. The current cost of irrigation in underdeveloped villages is equal to about 10 percent of capital formation. The difference in current cost for fertilizer between developed and underdeveloped villages is also large (65 percent).

Clearly, growing HYVs requires more working capital than fixed capital. This is partly due to the institutional arrangements for providing irrigation. Modern irrigation including tubewells is provided either by the government or occasionally by large

Table 43—Regression results from simultaneous estimation of investment functions for all households

Equation and Variable	Coefficient	t-Value
Equation 1: Investment in housing and durables (INVH)		
INCM	0.0797	6.684
$(INCM)^2$	0.246E 05	3.873
$(INCM)^3$	-0.018E 09	-3.853
INF	-1.8328	-0.377
EDCN	-4.9617	-1.332
FSZ	35.403	7.087
Constant	-318.991	-5.108
Equation 2: Investment in agriculture (INVA)		
INCM	0.0428	2.454
$(INCM)^2$	0.304E 05	3.529
$(INCM)^3$	0.837E 10	1.213
INF	3.736	0.573
HYV	-0.2045	-0.411
EDCN	-0.606	-0.123
WRKR	13.541	0.699
LAND	-4.365	-6.959
SCPTA	0.1965	11.350
CRDTI	-2.074	-1.044
RRTA	-0.1148	-0.604
Constant	-181.275	-2.307
Equation 3: Investment in nonagriculture (INVN)		
INCM	0.0585	3.607
$(INCM)^2$	0.366E 05	4.214
$(INCM)^3$	-0.55E 10	-0.877
INF	-11.089	-0.91
EDCN	11.29	2.266
WRKR	-20.056	-1.02
LAND	-2.982	-1.028
SCPTN	0.067	5.813
CRDTI	-1.266	-1.259
RRTN	0.257	0.983
Constant	-128.349	-2.650
Equation 4: Transfer type investment (INVF)		
INCM	0.2693	10.837
$(INCM)^2$	-0.171E 04	-12.923
$(INCM)^3$	0.151E 08	15.625
INF	8.214	0.821
EDCN	-11.993	-1.563
LAND	3.273	-3.475
Constant	630.89	-6.035

Estimated MPS is the sum of the MPS of four equations; MPS 0.418.

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: INCM is income per capita; INF is infrastructure underdevelopment index; EDCN is education of head of household; FSZ is family size; HYV is share of land sown in high yielding varieties; WRKR is number of workers per family; LAND is land owned per capita by household; SCPTA is stock of nonland, agricultural capital; SCPTN is stock of nonland, non agricultural capital; CRDTI is credit per capita from institutional scources; RRTA is rate of return from agriculture; RRTN is rate of return from nonagriculture; and MPS is the marginal propensity to save.

Table 44—Regression results from simultaneous estimation of investment functions for households, excluding 10 extreme cases

Equation and Variable	Coefficient	t-Value
Equation 1: Investment in housing and durables (INVH)		
INCM	0.1088	2.056
$(INCM)^2$	-0.1305E 04	-1.335
$(INCM)^3$	0.115E 08	2.346
INF	-2.5447	-0.546
EDCN	-3.5781	-0.997
FSZ	31.2648	6.556
Constant	-279.712	-3.039
Equation 2: Investment in agriculture (INVA)		
INCM	0.0428E 01	2.454
$(INCM)^2$	0.304E 05	3.529
$(INCM)^3$	0.837E 10	1.213
INF	3.7361	0.573
HYV	-0.204	-0.411
EDCN	-0.606	-0.123
WRKR	13.541	0.699
LAND	-4.3648	-6.959
SCPTA	0.1965	11.350
CRDTI	-2.074	-1.044
RRTA	0.114	0.604
Constant	-181.275	-2.307
Equation 3: Investment in nonagriculture (INVN)		
INCM	0.0585	3.607
$(INCM)^2$	0.366E 05	4.214
$(INCM)^3$	-0.55E 10	-0.877
INF	-9.054	-0.823
EDCN	11.2923	2.266
WRKR	-10.056	-1.028
LAND	-2.9817	-4.852
SCPTN	0.067	5.813
CRDTI	-1.266	-1.253
RRTN	-0.257	-0.543
Constant	-128.349	-1.962
Equation 4: Transfer type investment (INVF)		
INCM	0.2692	10.837
$(INCM)^2$	-0.171E 04	-12.923
$(INCM)^3$	0.152E 08	15.626
INF	8.214	0.821
EDCN	-11.993	-1.563
LAND	-3.273	-3.475
Constant	-630.89	-5.029

Estimated MPS is the sum of the MPS of four equations; MPS = 0.54.

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: INCM is income per capita; INF is infrastructure underdevelopment index; EDCN is education of head of household; FSZ is family size; HYV is share of land sown in high yielding varieties; WRKR is number of workers per family; LAND is land owned per capita by household; SCPTA is stock of nonland, agricultural capital; SCPTN is stock of nonland, non-agricultural capital; CRDTI is credit per capita from institutional scources; RRTA is rate of return from agriculture; RRTN is rate of return from nonagriculture; and MPS is the marginal propensity to save.

Table 45—Comparison of current cost of irrigation and fertilizer between developed and underdeveloped villages, 1982

Cost	Developed Villages	Under-developed Villages	Difference[a]
			(percent)
Irrigation cost (Tk/household)	389	214	81.8
Fertilizer cost (Tk/household)	517	314	64.6
Total irrigation and fertilizer costs (Tk/household)	906	528	71.6
Irrigation cost as a percentage of average capital formation	17.5	10.1	73.3
Fertilizer cost as a percentage of average capital formation	23.3	14.8	57.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100.

farmers who invest in tubewells and sell water. The water charges paid by farmers have been treated as current costs in this study.

The rate of return measured by the income earned per unit of capital in a particular year of the survey does not show any significant influence on savings and investment propensity. But the rate of return, proxied by capital stock, has a highly significant degree of influence. As argued in the context of model specification, the rate of return in a dynamic setting reflecting multiple time periods and expectations is best proxied by capital stock. Therefore, the rate of return is a significant explanatory variable that influences propensities to save and to invest in both agricultural and nonagricultural opportunities. Besides income, the educational level of the household head and nonagricultural capital stock are principal explanatory factors for investment in nonagricultural assets. That the education variable is significant in nonagricultural investment but not in agriculture reflects the interaction of a number of factors in the economy of Bangladesh. The low level of technology, scale of farming, and the institutional setting do not make agriculture an attractive occupation for the educated. Nonagricultural occupations, on the other hand, require some basic education to conduct the tasks involved. Moreover, the long-term rate of return is probably higher in nonagriculture than agriculture.

Finally, the effect of infrastructure, the primary objective of this study, is found to have no significant direct contribution to investment and savings, even though the signs were as expected in all cases except agricultural investment. Therefore, the effect of infrastructure on savings and investment is indirect. The effect of infrastructure on income is the substantive effect that contributes to savings and investment via the income-savings relationship, which is robust. The MPS is estimated to range from 34 to 42 percent. When all households are included in the analysis, the MPS is 0.42, but when the 10 extreme households are excluded, the estimated MPS is 0.34 at the mean level of income.

The interesting aspect of the marginal propensity to save and invest is the differential propensities of various components. If the overall rural income increases by, say, Tk 10,000, about 34 percent of that amount (TK 3,400) is saved and invested by households. Of this amount, about Tk 600 (18 percent) is invested in housing, household durables, and education; Tk 300 (9 percent) is invested in agriculture; another Tk 500 (15

percent) is invested in business, transport, and industry; and the remaining Tk 2,000 (58 percent) is invested in transfer-type activities such as land purchases and lending, primarily lending on land mortgages. Therefore, the marginal propensity of capital formation is 14 percent and the marginal propensity of transfer-type savings is 20 percent. It is this 14 percent estimate of MPS that is comparable to the MPS generally measured from aggregate data of income and savings, because in macro-economic relations transfer-type savings would be zero.

Conclusions

An attempt is made in this section to measure the influence of rural infrastructure on household savings and investment within a comprehensive framework that considers infrastructure along with other determinants. The analysis points up the complexity of estimating the savings rate at the household level. It is estimated that the average savings rate is about 14 percent, and this average rate is slightly higher in developed areas than in underdeveloped areas. About 35 percent of the households are found to have a zero or negative savings rate distributed over all income groups. Savings are extremely concentrated in a few households; 75 percent of the total gross savings are generated by households in the top two deciles of the income distribution.

Of the average level of savings, about 78 percent occurs in capital formation and 22 percent in transfer-type transactions. About 50 percent of capital formation takes place in housing and human resource development, 17 percent in agricultural capital, and 33 percent in nonagricultural assets. The extent of nonmonetized investment is about 17 percent of total capital formation; the proportion of nonmonetized investment is about 62 percent higher in underdeveloped than developed villages.

Gross investment per household is about 14 percent larger in developed than underdeveloped villages, even though investments in irrigation and drainage and agricultural equipment are 27 percent smaller in developed than in underdeveloped villages. This difference results largely from the difference in investments in livestock and fisheries. Developed villages invest a much larger amount in these two activities than do the underdeveloped villages. Moreover, the difference between investment in irrigation and agricultural equipment between the developed and underdeveloped villages disappears if investments are calculated on the amount of land owned rather than by the household. Landownership per household is about 34 percent larger in underdeveloped than developed villages.

Analysis of the determinants of savings and investment behavior in rural households indicates that current income is the dominant explanatory factor. Other variables contribute only marginally to the explanatory power. The effect of infrastructure is indirect through its effect on income and via income to savings. Estimates of the MPS vary from 34 to 40 percent. However, the marginal propensity for capital formation is much smaller than the MPS in transfer-type activities (such as lending and land purchase). The 34 percent estimate of MPS consists of about 14 percent from the marginal propensity for capital formation and 20 percent from the marginal propensity to save in transfer-type transactions. The 14 percent estimate is considered the equivalent of MPS for aggregate purposes (in the macroeconomic measure of household rural savings, for example).

The effect of infrastructure on diffusion of modern technology is found to be quite extensive in Chapter 4. It initially seemed surprising that it does not have a similar effect on agricultural investment related to the use of modern technology. Further

analysis shows, however, that modern technology is highly intensive in current inputs and less so in fixed capital requirements, largely because of the institutional mechanism for supplying irrigation. The cost of irrigation (treated as a current input) is equivalent to about 18 percent of gross capital formation in developed villages. The cost of fertilizer is still higher than the cost of irrigation.

It should be noted that the average share of transfer-type investment is only 22 percent of the total gross savings, whereas the marginal share is about 59 percent. Thus, the opportunities for productive investment must be increased at an accelerated pace if the pressure on the demand side for transfer-type activities (lending through land mortgage, land purchases, money lending, and so forth) is to be reduced in the rural economy of Bangladesh. Infrastructure development along with other incentive policies—including institutional credit for the poor—will play a critical role in such a strategy of rural development.

9

INFRASTRUCTURE, RURAL MARKETS, AND SOCIAL DEVELOPMENT

Infrastructure shapes the development of the rural economy largely through its impact on the operation of various markets. It also influences formation of human capital through its impact on the provision of health and education services. Therefore, this chapter compares the operation of various markets and the health and literacy of residents in the developed and underdeveloped villages. A detailed analysis of the operation of the labor market was provided in Chapter 5, whereas the product, land, and credit markets are treated here. However, a comprehensive treatment of product markets, particularly testing for market integration, is not possible with cross-section data for only one period. Therefore, the analysis of the product market is limited to selected aspects of the paddy market and commercialization.

Spatial and Seasonal Variation in Prices

During the implementation of the survey in 1982, investigators were asked to keep records of the prices of basic necessities prevailing in the local markets in the second and fourth week of each month. For 15 out of the 16 villages under survey, there are 24 observations on prices for each commodity. In one village, Gobindapur, there is no primary market in the locality. Villagers walk five miles to a secondary market located in the *upazila* center, Kaliakoir, carrying goods on head loads (dry season) or in boats (rainy season). The prices quoted for the village are for the secondary market. Ideally, estimates should have been adjusted for the cost of transport and time forgone to obtain the true village prices. These are difficult to estimate, however, without knowing details about the mode of transport for each transaction. Also, the opportunity cost of time would vary from person to person. For other villages, true household-level prices might differ from those quoted depending on the distance of the villages from the place of trade and the mode of transportation used.

Paddy and rice are the major agricultural commodities traded in local markets. Rice accounts for nearly 60 percent of total food consumption in rural areas; nearly 40 percent of the paddy output is marketed. Rice is available in local markets throughout the year, trade is heavy, and the market is competitive. Households sell paddy, often in bulk, which is processed in mills, mostly located in secondary markets. Rice is brought back to local markets for sale to the landless who buy in small quantities throughout the year and to deficit farmers who usually buy before the harvest. The paddy market is a producer market with a high seasonality in sales, while the rice market is a consumer market with less pronounced seasonal variation. For own consumption of farm production, paddy is usually processed by the housewife, even in middle-income households, using the wooden husker *(dhenki),* while the rice purchased from the market is mostly mill processed. With development of infrastructure and access to the rice mills in nearby secondary markets, more paddy is processed by mills, even for household consumption. It is estimated in this survey that 47 percent of the rice consumed by sample households is processed in mills—36 percent in underdeveloped

villages and 61 percent in developed villages (Appendix Table 82). Thus, infrastructure increases the demand for paddy processing in mills and expands the volume of trade.

The unweighted average prices of paddy and rice for the year of survey (1982) and for the postharvest period when transactions are heavy are reported in Table 46. The spatial variation in average prices is low, with the coefficient of variation across the 16 locations estimated at only 5 percent for both paddy and rice. The difference between the highest and the lowest prices is about 17 percent. The prices are, in general, lower in underdeveloped villages, but the variation is not systematically related to the index of infrastructure. In developed villages the average price is about 2.4 percent higher for paddy and 5.7 percent higher for rice than in the underdeveloped villages. The seasonal variation in the villages of a developed area (Comilla) is compared with the variation in an underdeveloped area (Jessore) in Figure 5.

Farm households generally sell the major portion of their paddy after harvest and buy back rice before harvest. The variation in postharvest prices of paddy across locations is larger than that in yearly average prices. The difference between the lowest and the highest price is about 33 percent; the coefficient of variation across villages is 8 percent—5 percent for developed villages and 9 percent for underdeveloped villages. Postharvest prices are very low in villages that produce most of the crop in a single season: in Khulna, where most of the land is cropped during the aman season, and in Kushtia and Jessore where most of the crops are produced during the aus season. Within the same agroclimatic regions, prices are significantly higher in the developed

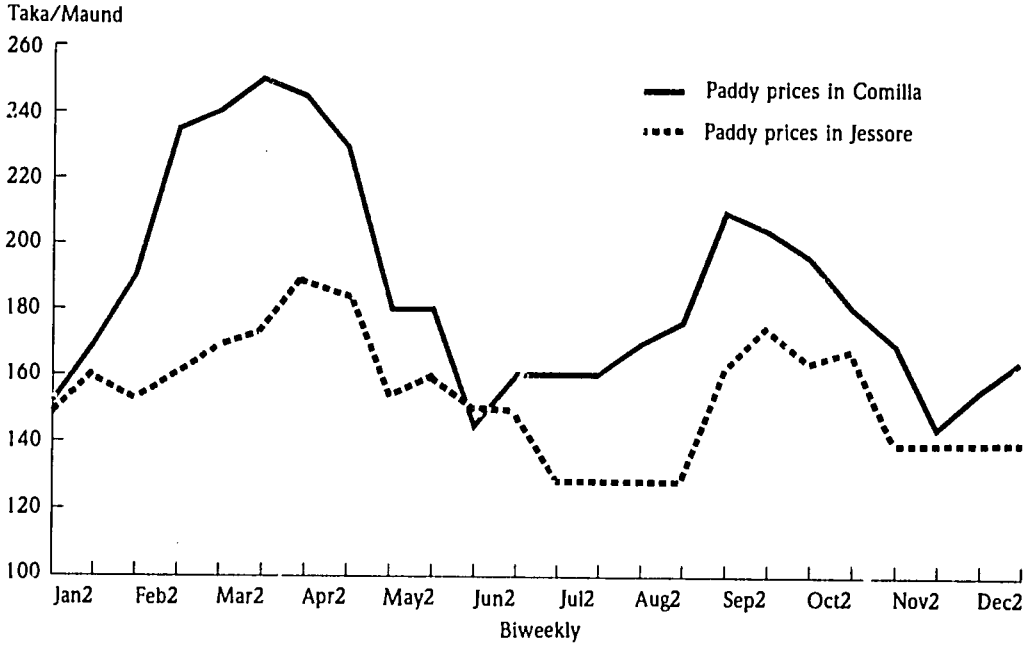
Table 46—Spatial variation in paddy and rice prices in local markets, 1982

Village	District	Infrastructure Underdevelop-ment Index	Paddy Prices[a]		Rice Prices[a]	
			Annual Average	Post-Harvest Period	Annual Average	Pre-Harvest Period
			(Tk/maund)		(Tk/maund)	
Developed			171	146	296	314
Chashapara	Comilla	1.9	186	158	302	320
Bandabeel	Kushtia	2.9	163	140	279	298
Illashpur	Comilla	3.9	189	154	304	320
Patgari	Pabna	4.5	164	150	312	339
Roakuli	Kushtia	4.7	169	134	259	293
Raotara	Pabna	4.7	162	141	310	342
Khejurdanga	Khulna	5.4	162	148	303	288
Underdeveloped			167	137	280	320
Charkhamar	Dhaka	6.5	164	139	281	320
Khunta	Comilla	7.7	175	158	292	323
Rajarampur	Dhaka	9.5	165	148	286	325
Taliamara	Khulna	9.9	171	126	287	327
Harispur	Jessore	10.1	159	136	265	289
Gobrapara	Jessore	10.2	158	129	273	303
Birhat	Khulna	10.2	170	118	280	326
Syedpur	Dhaka	10.7	168	136	270	333
Gobindapur	Dhaka	13.7	170	146	286	334
Unweighted average		...	168	141	287	318
Coefficient of variation (percent)		...	5.0	7.8	5.4	5.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]The figures are unweighted averages of the observed prices in village markets. Actual prices received and paid by farmers depend on the proportion of rates and purchases at different times.

Figure 5—Prices of paddy in underdeveloped villages (Jessore) and developed villages (Comilla)



Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

villages (compare Khejurdanga with Birhat and Taliamara, Bandabeel and Roakuli with Harispur and Gobrapara).

Although the yearly average price of rice was lower in the underdeveloped villages, the price was higher during the preharvest period when farmers purchase rice from the market. The seasonal variation in rice prices was lower in the developed villages. The ratio between the preharvest and the yearly average prices is 1.06 for developed villages compared with 1.14 for the underdeveloped villages. The seasonal variation in paddy prices was larger than that for rice prices and higher in underdeveloped villages than in developed ones.

The ratio between the annual average prices of rice and paddy is 1.71, while the physical conversion ratio between them is 1.50.[2] This implies a 14 percent margin for processing, trade, and transport. The comparison between the postharvest price of paddy and the preharvest price of rice, however, indicates substantially higher margins. The rice-paddy price ratio for 16 villages for these periods was 2.26, indicating a margin of about 50 percent. For underdeveloped villages this margin is about 56 percent compared with 35 percent for developed villages.

[2]This is also found to be the pattern for the country as a whole. During 1982 the average wholesale price of aman paddy was Tk 165 and that of aman rice Tk 280 per maund. The price spread was 70 percent, implying a margin of 13 percent (Bangladesh Department of Agriculture and Marketing 1986).

The Market as a Food Supply Source

In the survey, information was collected on the consumption of basic necessities and their sources of supply on a weekly basis for eight weeks. Annual consumption of the major food items during the survey year and the proportion obtained from the market are reported in Table 47. The data clearly show the high importance placed on subsistence crops in agricultural production. Only one-third of the major food item, rice, is obtained from the market; two-thirds of the rice consumed is obtained from household production. Even for livestock and fishery products and processed food items like *gur* (raw sugar), nearly two-fifths of consumption is met by household production. Only for tuber production, which is concentrated in certain regions, and wheat, for which imports from abroad account for nearly half of domestic supply, do consumers rely upon the market for the major portion of the food consumed. Domestic production of wheat is highly concentrated in the northwestern and western districts of the country, and the government moves a large proportion of imported wheat to interior areas of Bangladesh for implementation of rural public works programs.

Development of infrastructure, however, increases the importance of the market as a source of food. For tubers, which are highly perishable, the amount purchased by an average household is about 77 percent higher in developed villages than in underdeveloped ones. Households in developed villages also purchase significantly larger shares of meat, vegetables, and rice. For pulses, *gur*, and fish, the amount purchased is almost the same in the two groups of villages. The amount of fish and *gur* consumed may have been lower in developed villages because meat was substituted for fish and sugar for *gur*—and hence the amount purchased may have been reduced. The supply purchased from the market as a proportion of the amount consumed was higher in developed villages for all major food items except pulses and wheat.

Marketing Rates for Paddy

According to detailed information on marketing of paddy collected from farmers, 83 percent of the farmers sold paddy during the year, and 72 percent sold some within two weeks after the harvest (Table 48). Thus the market participation is widespread. About 40 percent of the produce is marketed during the course of a year and 11 percent is marketed within two weeks after the harvest. Comparison of marketing behavior in the two groups of villages indicates that the development of infrastructure has a positive effect on marketing. Farmers marketed 47 percent of the paddy production in developed villages, compared with 35 percent in underdeveloped villages. The proportion marketed immediately after harvest is about twice as high in the developed as in the underdeveloped villages.

Table 48 also compares the prices received by farmers in the two groups of villages, weighted by the proportion of sales; hence they are different from the unweighted average prices prevailing in local markets at different points of time, as reported in Table 46. Although farmers received higher prices in developed areas, the difference was only 3.5 percent. For immediate postharvest sales, the price was higher in developed areas by 7.7 percent.

The findings of the survey on the marketing of paddy for different landholding groups are reported in Table 49. Market participation and the proportion of output marketed are highly positively related only to the size of land in underdeveloped villages. Almost all farmers owning more than 2.0 acres of land participated in the market, compared with 65 percent of farmers owning less than 2.0 acres. Farmers owning

Table 47—Share of major foods purchased from markets, 1982

Food Item	Market Supply as a Percent of Consumption: Developed Villages	Market Supply as a Percent of Consumption: Underdeveloped Villages
	(percent)	
Rice	34	29
Mill processed	38	37
Dhenki processed[a]	26	24
Wheat	84	85
Tubers	92	77
Vegetables	60	46
Pulses	55	63
Fish	62	57
Meat	57	53
Gur (raw sugar)	68	56
Total	49	44

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Processed at home using a wooden husker.

more than 5.0 acres marketed about one-half of their production, compared with about one-fifth of small farmers' production. The large farmers' share was 45 percent of the total amount marketed in these villages, whereas they composed only 12 percent of the rural households and about 33 percent of the output. Consequently, price incentive policies would benefit large farmers proportionately more than smaller ones.

The situation was different in the developed villages, where a much larger proportion of the marginal and small farmers sold paddy in the market, and the proportion of output marketed was *not* systematically related to the size of landholding. On the basis of this evidence, it can be concluded that infrastructure development leads to a greater

Table 48—Marketing of paddy by farm households, developed and underdeveloped villages, 1982

Variables	Developed Villages	Underdeveloped Villages	All Villages
Production of paddy (kilograms/farm household)	2,608	2,555	2,578
Sales of paddy (kilograms/farm household)	1,213	890	1,026
Percent of farm households that sold paddy	88	80	83
Sales within two weeks after harvest (kilograms/farm household)	261	206	274
Percent of farm households that sold paddy within two weeks	72	73	72
Percent of total paddy output marketed	47	35	40
Percent of total paddy output marketed within two weeks	14	8	11
Price received (Tk/maund)	150	145	148
Price received immediately after harvest (Tk)	153	142	148

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Table 49—Marketing of paddy by size of landholding, 1982

Size of Farm	Percent of Farmers Marketing Paddy	Percent of Paddy Marketed	Share of the Group in Marketing	Within Two Weeks After Harvest: Percent of Farmers Marketing Paddy	Within Two Weeks After Harvest: Percent of Paddy Marketed
(acres)			(percent)		
Underdeveloped					
Landless	46	14	3	34	3
Land owned					
Small	74	21	13	64	8
Medium	91	36	39	86	9
Large	100	47	45	100	9
Developed					
Landless	92	52	7	72	13
Land owned					
Small	81	44	27	66	12
Medium	92	43	34	76	14
Large	100	53	32	75	15

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

degree of commercialization among farmers, including small producers. In developed villages, one-third of the market supply came from the marginal and small farmers; in the underdeveloped villages, their share was one-sixth.

In order to test the statistical significance of the effect of infrastructure on marketing of paddy, the following regression equation is estimated from the farm-level data:

$$\underset{}{MRKT} = 46.9 + \underset{(3.79)}{0.14\,PDDQ} - \underset{(-1.48)}{0.85\,FSZ} - \underset{(-0.19)}{0.04\,PRC} - \underset{(-3.55)}{2.68\,INF};$$

Log-L = 288, N = 455,

where

MRKT = the percent of output marketed by the farmer,
PDDQ = the output of paddy,
FSZ = the number of consumers in the household,
PRC = the village-level price of paddy, and
INF = the index of underdevelopment of infrastructure.

Figures in parentheses are estimated t-values. The hypothesis is that the proportion marketed will increase with the size of output and decrease with the size of the household, since a larger amount would be retained for household consumption. The equation is estimated using the Tobit method since several cases have zero observations for the dependent variable. After controlling for the effect of other variables, the coefficient of infrastructure is found to be highly statistically significant. The negative sign of the coefficient indicates that, given the level of output and family size, the more underdeveloped the village, the lower the proportion of paddy marketed. Appendix

Table 83 demonstrates similar results using the amount of paddy marketed as the dependent variable.

The regression coefficient of price in the above equation indicates that the price does not have any effect on marketing. This is presumably because infrastructure works partly through prices and partly by allowing farmers easy access to traders. This is supported by the following equation estimated only for farmers in developed villages:

$$\begin{aligned} MRKT = {} & 29.7 + 0.083\,PDDQ - 1.27\,FSZ + 2.30\,PRC - 5.99\,INF; \\ & (1.55)\,(1.67) \qquad (-1.52) \qquad (1.95) \qquad (-1.50) \end{aligned}$$

Log-L = −106, N = 195.

The price coefficient is positive, indicating that a larger proportion of output is marketed at higher prices, and it is statistically significant at the 5 percent level. The price elasticity of market supply is estimated to be 0.3. The infrastructure coefficient has the correct sign, but the estimated t-value is now weakly significant at the 13 percent level.

For underdeveloped villages, the estimated equation is

$$\begin{aligned} MRKT = {} & 94.7 + 0.130\,PDDQ + 0.23\,FSZ - 0.18\,PRC - 5.74\,INF; \\ & (2.16)\,(2.22) \qquad (0.22) \qquad (-0.72) \qquad (-3.40) \end{aligned}$$

Log-L = −166, N = 260.

Household sizes and prices in these villages had no effect on the marketing ratio, but the size of output and the state of development of infrastructure were highly significantly related to marketing.

The Land Market

Land is an important asset for most rural households. For those who own land, it is a source of regular income, a security against famine, and the foundation for a dependable livelihood for future family generations. Therefore, the traditional value system puts a high premium on ownership of land. How the land market in rural Bangladesh evolves as infrastructure development progresses is therefore an interesting question.

An aggregate analysis of land prices shows the effect of land productivity and infrastructure development on land prices. However, it does not reveal much about the nature of underlying markets in operation at the village level. This is partly attempted through the sample data. Unfortunately, the sample was not specifically designed for studying land markets and therefore is deficient in a number of land market aspects.

Who buys and sells land in rural areas? A number of conclusions can be derived from the statistics in Table 50. First, in terms of the number of households participating in the land market, the market appears to be tighter in developed villages than in underdeveloped. Only 8.0 percent of all households in developed villages are land buyers and 4.3 percent are land sellers. That there are more buyers than sellers in developed villages possibly indicates transactions with outside sellers. The proportions of buyers and sellers in underdeveloped villages are exactly the same, indicating that all transactions are probably within the group. Second, in rural areas transactions largely involve functionally landless and small farmers as the sellers and medium and large

Table 50—Proportion of total households buying and selling land, 1982

Land Market Participant	Land Owned				
	Landless	Small	Medium	Large	All
			(percent)		
Developed villages					
Buyers					
Share of all households	1.1	5.9	12.1	33.3	8.0
Share of buying households	4.5	27.3	36.4	31.8	100.0[a]
Sellers					
Share of all households	8.0	4.0	1.5	0.0	4.3
Share of selling households	58.3	33.3	8.3	0.0	99.9[a]
Underdeveloped villages					
Buyers					
Share of all households	4.8	7.0	16.5	19.5	10.4
Share of buying households	13.5	21.6	43.2	21.6	99.9[a]
Sellers					
Share of all households	8.6	14.0	7.2	12.2	10.4
Share of selling households	24.3	43.2	18.9	14.3	100.7

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Numbers may not total 100 because of rounding.

owners as the buyers. This general pattern is even clearer for developed villages than for underdeveloped ones. In developed villages, about 70 percent of those who bought land were large and medium landowners and the remaining 30 percent were functionally landless or small landowners. Of all households selling land, about 82 percent were landless and small owners and the remaining 18 percent were medium-size landowners. The pattern was similar but less extreme in underdeveloped villages, where about 65 percent of land-buying households were large and medium landowners and 35 percent landless and small landowners. Among the total land-selling households, the proportion of large and medium owners was 32 percent and the proportion of landless and small owners was 68 percent.

However, the number of buyers and sellers in the market does not explain the market density in terms of the amount of land transacted (see Table 51). The overall picture that emerges from this table indicates that less than 2 percent of the total land owned is bought and sold in a year in village land markets. But the distribution among the landholding groups of the land transactions differs between developed and underdeveloped villages.

In developed villages only 0.7 percent of the land area owned by all households is sold, while 1.6 percent of the total land owned is purchased. This indicates that owners from outside developed villages sell land to households in developed villages. This difference is negligible in underdeveloped villages. In developed villages, about 97 percent of land sold is sold by small and functionally landless households, whereas in underdeveloped villages the share of small and landless households in the total land area sold is 47 percent. Similarly, the share of large and medium owners in the total land purchased is 79 percent in developed villages, compared with 77 percent in underdeveloped villages.

The general conclusion is that the land market in rural areas is very thin, particularly in terms of the amount of land transacted. Infrastructure development further reduces the size of the market, even though it tends to widen the geographic boundaries within which the buyers and sellers operate. Generally, small landowners are the sellers and

Table 51—Shares of land area bought and sold, developed and underdeveloped villages, 1982

Landownership Group	Share of Land Area Purchased		Share of Land Area Sold	
	In Total Land Owned	In Total Land Purchased	In Total Land Owned	In Total Land Sold
	(percent)			
Underdeveloped villages				
Landless	3.3	4.5	8.4	12.9
Land owned				
Small	1.8	18.9	2.9	33.9
Medium	1.5	39.5	1.1	33.2
Large	1.2	37.1	0.6	20.0
All households	1.5	100.0	1.3	100.0
Developed villages				
Landless	0.8	1.2	12.8	45.9
Small	1.4	20.2	1.5	50.9
Medium	0.7	17.5	0.1	3.2
Large	3.0	61.1	0.0	0.0
All households	1.6	100.0	0.7	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

large landowners are the buyers, a dichotomy that sharpens with infrastructure development.

These two important factors concerning land markets—the thinness of the market and the dichotomy between buyers and sellers—seem to affect land prices. Land is also valued as income security for future generations, and both these factors reflect that. Consequently, no one wants to sell land unless under distress. Any development that improves the income-earning capacity of the poor will therefore reduce the supply of land, and infrastructure development (as is shown in the chapter on income) is such a factor. At the same time, the increased income of the richer households places upward pressure on demand. This divergence of demand and supply arising from rural development leads to an extremely sharp increase in land prices.

The Credit Market

The credit market is an important area of rural development. Understanding of the structure and conduct of this market, however, is vague. Early work on rural informal credit markets portrayed them as monopolistic and therefore exploitative (Rudra 1982). Virmani (1982) postulated that the equilibrium interest rate is a function of the opportunity cost of the funds to the lender, the transaction costs, the probability of default, and the amount of collateral. Following this formulation, it can be argued that the information cost for assessing the probability of default and the transaction costs are high in informal credit markets, which justifies high interest rates. That rural credit markets are fragmented seems to be widely accepted, although it is not clear how competition equates the cost of credit with the interest rate in fragmented markets, when such markets should have monopolistic conditions.

These concepts of rural credit markets have far-reaching implications. If the credit market is monopolistic and exploitative, then introduction of institutional credit is likely to reduce the interest rate in informal markets, although, where excess demand

for credit abounds, institutional credit will not substitute for moneylenders. If the credit market is so competitive that the interest rate in the market is equal to the cost of credit, then expansion of institutional credit may result in the contraction of informal credit without much change in the total volume (formal plus informal) of credit transactions.

It would have been ideal to examine the impact of infrastructure development on rural credit markets in the context of these issues, but the data available do not permit such a dynamic inquiry. What is presented below is a snapshot of the rural credit market, unraveling its structural facets in a comparative context of infrastructurally developed and underdeveloped situations and enabling some qualitative deductions to be made on the workings of rural credit markets and the influence of infrastructure development on these markets.

Aggregate Size

It should be noted that the aggregate size of the rural credit market given in Table 52 does not represent the total demand; it reflects the volume of total transactions, cleared through various credit rationing mechanisms, which could be much smaller than the total demand. Institutional sources provide 25 percent and noninstitutional sources 75 percent of the total credit supplied and received in rural areas. About 14 percent of all rural households borrow from institutional sources and 70 percent from noninstitutional.

Thus, the informal credit market is still the dominant source of rural credit, and participation of rural households in this market is widespread. Institutional credit accounts for only one-fourth of the total transactions in rural credit and involves only a small fraction of rural households. The average credit per borrowing household is Tk 2,254 for institutional credit and Tk 1,382 for noninstitutional credit; the weighted average of the two sources is Tk 1,600 (Tk 22.85 equaled US$1.00 in 1982). This is equivalent to about 58 percent of the average gross savings and investment per rural household estimated in Chapter 8. The average institutional credit for all borrowing and nonborrowing households is Tk 323 per household. This figure is multiplied by 12.5 million, the total number of estimated rural households in 1982, in order to obtain the national aggregate, which is estimated at Tk 4,038 million and comes close to the estimate of Tk 4,238 million based on information from the sources of supply (Hossain 1987). The difference between the two estimates is only about 5 percent. This sample may thus be considered quite representative of the national picture.

Institutional Credit and Infrastructure

Institutional credit is normally supplied through banks and cooperatives, but occasionally through specialized government departments created to handle special projects or commodity development programs. Whereas banks are usually located in areas with relatively developed infrastructure, cooperatives are widespread throughout rural areas of Bangladesh, regardless of the state of the area's infrastructure, because the government is pursuing a policy of universal coverage. This does not mean, however, that all such cooperatives are functionally effective in all locations. Among the rural financial institutions, only commercial banks accept deposits and advance loans; other financial institutions, including specialized government banks for agriculture such as the Krishi Bank, only advance loans with no facilities for savings deposits. During the years from 1980 through 1983, the average annual bank deposit in rural areas was about 11 percent larger than the average annual loan advance from these rural banks (Bangladesh Bureau of Statistics 1985b). If the Krishi Bank is excluded from this calculation, then deposits in commercial banks are about 65 percent larger than their loan advances.

Table 52—Size of the rural credit market in the sample villages, 1982

Item	Credit from Institutional Sources	Credit from Noninstitutional Sources
Amount of total credit (Tk)	202,826	605,552
Number of borrowing households	90	438
Average credit per borrowing household (Tk)	2,254	1,382
Average credit over all households[a] (Tk)	323	964
Proportion of borrowing households[b] (percent)	14.3	69.7
Shares of total credit (percent)	25.0	75.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]All households includes those that did not borrow.
[b]This is the proportion of borrowing households in the total of 628 households in the sample.

Thus, rural commercial banks can be considered largely a mechanism for transferring financial resources from rural to urban areas, whereas other institutions such as cooperatives and the Krishi Bank pump financial resources into the rural economy.

Data from the 16 villages show that the proportion of households receiving institutional credit is slightly higher in infrastructurally developed than in underdeveloped areas (Table 53), but the difference is not significant (15.1 percent compared with 13.7 percent). However, no institutional credit at all was received in 6 villages, 5 of which are in underdeveloped areas. Of the 10 villages receiving credit, 4 accounted for 76 percent. Two of the 4 villages were in infrastructurally developed areas and the other 2 in underdeveloped areas, one of which has a historical background of educational advancement. Interest in education in this relatively progressive Hindu community was nurtured during the British raj, and the value of educational progress has had a lasting impression on contemporary households in that village. Their advancement in education appears to have enabled the households to obtain better access to institutional credit, overcoming the constraint of infrastructural backwardness. Such historical advantage is incidental. If this village is excluded, the proportion of households receiving institutional credit is found to be only 3.6 percent in underdeveloped areas, compared with 15.1 percent in developed areas. The other village that is located in an infrastructurally backward area has access to institutional credit because it is part of the Comilla Cooperative Development scheme. If that village is also excluded, then virtually no household in an infrastructurally underdeveloped village received institutional credit. The lesson is that special efforts in educational and cooperative development, even if costly, can enhance access to institutional credit for households in infrastructurally underdeveloped areas. But even without special government effort, infrastructure development makes an impressive difference in access to institutional credit.

A few more findings in Table 53 deserve to be highlighted. The table shows that functionally landless households have relatively poor access to institutional credit, which is not surprising. What is striking, however, is the extent to which small farmers in developed villages receive institutional credit compared with small farmers in underdeveloped areas, both in the number of households receiving credit and in shares of total credit. The contribution of developed infrastructure to the improvement of access of small farmers to institutional credit is significant. Although the average credit received per household in developed areas is 3.3 percent smaller than that received in underdeveloped areas, the size of land owned per household is about 34 percent smaller in

Table 53—Receipt of credit from institutional sources by landownership and infrastructure groups, sample of 16 villages, 1982

Landownership Group	Developed Villages (Seven)				Underdeveloped Villages (Three)			
	Average Credit/ Household	Number of Households Receiving Credit	Share of Households Receiving Credit	Share of Total Credit	Average Credit/ Household	Number of Households Receiving Credit	Share of Households Receiving Credit	Share of Total Credit
	(Tk)		(percent)		(Tk)		(percent)	
Landless	1,233	3	3.5	4.1	1,173	10	9.5	10.5
Land owned								
Small	1,781	18	18.2	35.3	1,154	14	12.3	14.4
Medium	2,466	14	21.4	38.0	2,617	18	18.6	42.0
Large	3,412	6	28.6	22.6	5,301	7	17.1	33.1
All	2,213	41	15.1	100.0	2,287	49	13.7	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: Six of the 16 sample villages received no institutional credit.

developed than underdeveloped areas. Thus, institutional credit per acre of owned land is about 29 percent larger in developed than underdeveloped areas.

Noninstitutional Credit and Infrastructure

Noninstitutional credit involves lending and borrowing among local households. Generally friends and relatives or village moneylenders, including landowners to sharecroppers, lend money in the informal credit market. Money lending is not the primary occupation of village moneylenders. Generally, well-to-do farmers and businessmen operate in this market to obtain an additional source of income. Lending is both in cash and in kind (Table 54). Fifteen to 20 percent of the total credit from noninstitutional sources is received in kind and the rest in cash. Credit in kind represents borrowing, primarily of paddy for consumption and seeds, that has to be repaid, usually in kind but occasionally in cash. About 62 percent of households borrow cash; the difference between developed and underdeveloped areas is not significant in this respect. About 13 percent of households borrow in kind. Therefore, the proportion of households participating in the noninstitutional credit market is large.

Landless and small landowners constitute most of the borrowers in the noninstitutional credit market. For example, about 84 percent of landless households in developed and 97 percent in underdeveloped villages borrow cash from noninstitutional sources. The comparable figures for large owners is 24 percent in developed and 32 percent in underdeveloped villages. The degree of concentration of borrowers in landless and small landowning households is clearly greater in developed areas—a pattern somewhat the reverse of that observed for institutional credit. This phenomenon may simply reflect a greater demand for credit among landless and small farm households in developed villages, induced by investment opportunities created by infrastructural development. Moreover, limited access of such households to institutional credit, though greater than access in underdeveloped areas, is likely to push these households to informal markets.

It was mentioned earlier that most noninstitutional credit is supplied by friends and relatives or moneylenders. The respective shares of these two broad groups in total supply of noninstitutional credit, shown in Table 55, indicate that large landowning households borrow less frequently from noninstitutional sources, and when they do, they borrow mostly from friends and relatives. Credit from friends and relatives, which is based on mutual confidence and trust, generally bears little or no interest. It is generally a two-way traffic: one may borrow from a friend today but may also lend to him tomorrow.

Table 55 also indicates that the share of moneylenders in total noninstitutional credit is generally larger in infrastructurally developed villages than in underdeveloped. It seems that the growth of mercantile practices is accelerated by infrastructure development, and the process of commercialization expands informal credit markets, as well as product markets.

Terms of Noninstitutional Credit and Interest Rates

Although the population of Bangladesh is largely Moslem, and Islamic law prohibits payment or earning of interest, this religious stricture is not supported by the legal system of the country. Usually, rural noninstitutional credit sources do not charge any direct interest. Often, a loan agreement stipulates that X amount of money or quantity of a commodity borrowed has to be repaid in $(X + Y)$ amount of money or quantity of a commodity after n number of months. The implicit annual interest rate is of course $(Y/X) \times (12/n) \times 100$. Where land is mortgaged to the lender as collateral for a loan,

Table 54—Receipt of credit in cash and in kind from noninstitutional sources, 1982

Landownership Group	Developed Villages				Underdeveloped Villages			
	Average Credit/ Household	Number of Households Receiving Credit	Share of Households Receiving Credit	Share of Total Credit	Average Credit/ Household	Number of Households Receiving Credit	Share of Households Receiving Credit	Share of Total Credit
	(Tk)		(percent)		(Tk)		(percent)	
Credit in cash								
Landless	1,215	72	83.7	36.5	772	102	97.1	23.1
Land owned								
Small	1,391	63	63.6	36.6	1,511	56	49.1	24.8
Medium	1,767	30	46.2	22.1	2,132	46	47.4	28.8
Large	2,280	5	23.8	4.8	6,111	13	31.7	23.3
All	1,409	170	62.7	100.0	1,571	217	60.8	100.0
Credit in kind								
Landless	356	20	23.2	48.9	236	19	18.1	42.5
Land owned								
Small	354	13	13.1	31.6	203	11	9.6	21.2
Medium	345	6	9.2	14.2	410	7	7.2	27.2
Large	750	1	4.8	5.2	960	1	2.4	9.1
All	364	40	14.7	100.0	278	38	10.6	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 55—Distribution of noninstitutional credit by source of supply and landownership group, 1982

Landownership Group	Developed Villages		Underdeveloped Villages	
	Credit from Friends and Relatives[a]	Credit from Moneylenders	Credit from Friends and Relatives[a]	Credit from Moneylenders
	(percent)			
Landless	31.5	68.5	31.3	68.7
Land owned				
Small	44.3	55.7	48.2	51.8
Medium	39.2	60.8	47.7	52.3
Large	86.8	13.2	82.9	17.1
All	38.9	61.1	49.0	51.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.
[a]Borrowing from landowners by sharecroppers is included in this category.

the lender often cultivates that land until the borrower refunds the credit, subject to a minimum time of one year. In such cases the implicit interest rate is the profit for the year (taking account of multiple cropping) from crops harvested on this land. In all other cases in the data set, where no land mortgage was involved, the credit term ranged from 4 to 7 months; the average was 4.6 months.

Keeping these terms in view, estimates of implicit interest rates on noninstitutional credit in Table 56 show that households pay an extremely high rate of interest on noninstitutional credit. The mean annual rate of interest is 125 percent in developed villages and 109 percent in underdeveloped villages. For landless households, the interest rate is higher than these averages by about 27 percent in developed villages and 14 percent in underdeveloped. In developed villages the interest rate declines for large landowners, but this pattern does not hold in underdeveloped villages. However,

Table 56—Interest rates for noninstitutional credit, by landownership group, 1982

Landownership Group	Developed Villages			Underdeveloped Villages		
	Mean Interest Rate	Standard Deviation	Coefficient of Variation[a]	Mean Interest Rate	Standard Deviation	Coefficient of Variation[a]
	(annual percentage rate)					
Landless	158.6	195.0	1.23	124.3	65.3	0.53
Land owned						
Small	108.5	72.3	0.67	83.6	148.6	1.78
Medium	115.3	140.5	1.22	112.2	83.3	0.74
Large	58.4	68.9	1.18	113.6	102.3	0.90
All	124.6	137.6	1.10	109.1	102.6	0.94

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.
[a]The coefficient of variation is measured by dividing the standard deviation by the mean.

the variability of interest rates (as indicated by the standard deviation) even within a landownership group is so high that any generalization is rather risky. This no doubt reflects the varied nature of the rural informal credit market, a market that is so fragmented that almost every loan is a specific market.

In Table 57, where loan cases are broken down by the amount of interest paid, it can be seen that about 50 percent of the loans in the underdeveloped area and 32 percent of the loans in the developed area bear no interest rates. These cases of no interest charged mostly represent lending and borrowing between friends and relatives. However, not all such loans are interest free. The bulk of the loans with positive interest rates bear a rate higher than 50 percent.

Because interest-free loans in the total number of noninstitutional cases are extensive, it is natural to enquire whether such practices are limited to a certain category of households. The practice primarily occurs between friends and relatives, but is there any difference in the incidence of this practice between households with different land endowments? About 75 percent of all interest-free loans in underdeveloped villages, accounting for about 94 percent of the total volume of such credit, are limited to households classified as medium and large landowners (Table 58). In infrastructurally developed villages, these groups account for about 55 percent of all interest-free loans, and about 78 percent of the total volume. Therefore, it seems likely that interest-free loan transactions are largely a credit mechanism used by relatively rich rural households. Infrastructure development appears to reduce the incidence and the extent of interest-free credit practices.

Interest Rates in Institutional Credit Markets

Institutional credit markets are controlled by the government directly or indirectly; therefore, interest rates are likely to be more uniform in this market. However, the interest rates charged by banks are generally lower than those for credit from cooperatives. Moreover, cooperatives might legally or illegally charge varying rates to various households depending on the type of cooperative and its management structure. As a

Table 57—Distribution of noninstitutional loan cases by class of interest rate, in developed and underdeveloped villages, 1982

	Developed Villages		Underdeveloped Villages	
Annual Interest Rate	Number of Cases[a]	Percent of Interest-Bearing Cases	Number of Cases[a]	Percent of Interest-Bearing Cases
(percent)				
No interest	77	...	188	...
Interest rate charged				
Up to 13	7	3.5	2	1.2
14–24	6	3.1	4	2.1
24–49	16	10.0	11	5.5
50–99	31	19.4	54	27.1
100–149	56	35.0	75	37.7
150–200	50	31.3	48	24.1

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]The number of cases is not equivalent to the number of households because a household may have taken more than one loan.

Table 58—Distribution of interest-free noninstitutional credit by landownership groups, 1982

Landownership Group	Developed Villages: Proportion of Interest-Free Loan Cases	Developed Villages: Share in Total Interest-Free Credit	Underdeveloped Villages: Proportion of Interest-Free Loan Cases	Underdeveloped Villages: Share in Total Interest-Free Credit
	(percent)			
Landless	20.2	6.5	12.9	1.9
Land owned				
Small	25.1	15.4	12.9	3.9
Medium	23.8	19.2	18.9	10.1
Large	30.9	58.9	55.3	84.1
All	100.0	100.0	100.0	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

result, although the institutional interest rate ought not to vary much, it does in practice, at least modestly.

The average interest rate in developed villages is 13.5 percent and that in underdeveloped villages is 15.6 percent (Table 59). The rate in the latter case is thus about 15.6 percent higher. However, even for institutional credit, the relation between interest rates and landownership in underdeveloped villages is inverse, implying that small owners and landless households pay higher rates of interest than relatively large landowners. In developed villages this relationship does not hold, and interest rates are relatively uniform across landownership groups. Moreover, variability in interest rates appears to be significantly higher in small landowning and landless groups than for larger farms in underdeveloped villages, but not in developed villages. Therefore,

Table 59—Interest rates for credit in institutional markets, by landownership groups, 1982

Landownership Group	Developed Villages: Mean Interest Rate	Developed Villages: Standard Deviation	Developed Villages: Coefficient of Variation[a]	Underdeveloped Villages: Mean Interest Rate	Underdeveloped Villages: Standard Deviation	Underdeveloped Villages: Coefficient of Variation[a]
	(percent)			(percent)		
Landless	12.5	4.9	0.39	24.9	18.0	0.72
Land owned						
Small	12.7	5.6	0.44	16.1	10.2	0.63
Medium	16.0	6.6	0.41	13.9	1.5	0.11
Large	11.0	2.1	0.19	12.8	1.6	0.12
Average	13.5	5.1	0.38	15.6	8.7	0.56

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.
[a]The coefficient of variation is measured by dividing the standard deviation by the mean.

infrastructure development contributes to the reduction in interest costs of institutional credit for small farmers and landless households. At the same time, it brings uniformity in interest rates across various landownership groups.

Utilization of Institutional Credit

Although the survey did not cover utilization of rural credit in a detailed manner, the information provided gives a partial but insightful picture of the demand side of rural credit (Table 60). To compare the demand side with the supply side, total institutional credit for households is given as Tk 202,826 in Table 52, the supply side, and, from the response on utilization of credit in Table 60, the total estimate of institutional credit of Tk 187,224 represents the demand side. The estimates are remarkably close for sample surveys, the difference between the two being only 8 percent.

Table 60 shows that the largest share of institutional credit goes to supplement the working capital of business and trade in developed villages and for current agricultural inputs in underdeveloped villages. The second largest share is used to finance current inputs in agriculture in developed areas. These two categories together compose 72 percent of institutional credit in developed villages and 50 percent in underdeveloped villages. Roughly 13 percent (12.7 percent in developed and 13.3 percent in underdeveloped villages) is used for fixed agricultural investment (such as machinery and equipment).

Approximately 15 percent of institutional credit in infrastructurally developed villages is allocated to directly nonproductive activities. Consumption, debt payment, and purchase of land are considered nonproductive. These activities in underdeveloped villages add up to about 37 percent of total institutional credit.

The most remarkable result in Table 60 is the difference between developed and underdeveloped villages in the shares of credit used for working capital in business. Households in developed villages allocate a share of credit to business almost four times larger than that of households in underdeveloped villages. This is indicative of the increased opportunities for business and trade brought about by infrastructure development.

Institutional credit for rural households in Bangladesh is largely supplied by public agencies for agricultural purposes—for financing current inputs and durable invest-

Table 60—Pattern of utilization of institutional credit, 1982

Use	Developed Villages		Underdeveloped Villages		All Villages	
	Amount	Percent of Total	Amount	Percent of Total	Amount	Percent of Total
	(Tk)		(Tk)		(Tk)	
Consumption	11,101	12.4	12,580	12.8	23,681	12.6
Debt payment	1,500	1.7	14,200	14.5	15,700	8.4
Land purchase	1,125	1.3	9,500	9.7	10,625	5.7
Current input in agriculture	23,520	26.4	36,700	37.5	60,220	32.5
Current input/acre	337	...	300	...	305	...
Fixed investment in agriculture	11,300	12.7	12,998	13.3	24,298	13.0
Working capital for business and industry	40,700	45.6	12,000	12.2	52,700	28.1
Total	89,246	100.0	97,978	100.0	187,224	100.0

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

ments. The suppliers' objective for credit seems inconsistent with the pattern of needs on the demand side. There is nothing wrong in the use of credit for business and trade instead of agriculture. But recognizing the nature of demand at the household level and designing institutional credit programs to suit that demand could rectify many ill effects of programs, including corruptive practices. Households' efforts to hide their real intentions and pretend that credit will be used for agriculture are often expensive, increasing the transaction costs to borrowers.

Social Development

Education

Education is a basic human need. Illiteracy is widespread in Bangladesh and there has been little improvement over time. The 1981 population census estimated literacy rates for the adult population (15 years and over) at 29 percent—48 percent in urban areas and 25 percent in rural areas. For the population over 5 years of age, the literacy rate was estimated at 21 percent for rural areas and 41 percent for urban areas.

Access to educational institutions is treated as an element of infrastructure in this study, but other facets of infrastructure could affect education by interacting with both the supply and the demand sides. The development of transport facilities is a major factor influencing the location of an educational institution, particularly at the secondary level, since students have to be drawn from a number of villages in order to make it viable. When transport facilities are underdeveloped, households in villages located near the school are more likely to send their children to school than those in remote villages. Development of infrastructure increases the scope for employment in nonagricultural activities, some of which may require basic literacy and numeracy. Thus, the demand for education may increase with infrastructure development.

The survey used for this study was *not* conducted for explicit testing of these hypotheses. However, it provides information on the educational status of all members of the sample households, and it is analyzed here to assess the impact of infrastructure on literacy, the outcome of the supply and demand forces mentioned here. To assess the effects of infrastructure, it is necessary to control the effects of a number of important socioeconomic variables that affect literacy.

Data on the distribution of the sample population by years of schooling completed in the two groups of villages supports the national picture of low rates of literacy in the country. Three-fifths of the population never attended school and 11 percent completed only two years—not enough to have a lasting effect on literacy. Thus, only about 29 percent can be considered literate. Of the literates, one-half had only a primary education and only a few went on to the secondary level. Only 2 percent completed 10 years of schooling.

The survey also finds that there are significant differences in the educational status of men and women in Bangladesh, with about 80 percent of women functionally illiterate and 62 percent of men. The difference is not associated with the infrastructure development of the villages.

The development of infrastructure does not seem to have much effect on literacy. The chi-square value for the difference in distribution of education in developed and underdeveloped villages is not statistically significant. However, educational status does vary significantly according to the size of land held by the household (Table 61). In underdeveloped villages, nearly 80 percent of people from landless households never attended school, compared with 63 percent for small landowners and 46 percent from

Table 61—Educational status of household members by size of landholding, developed and underdeveloped villages, 1982

Infrastructure Group/ Size of Landholding	Years of Schooling Completed					
	0	1–2	3–5	6–8	9–10	11 or More
			(percent of population)			
Underdeveloped villages						
Less than 0.5 acres	78.7	11.0	5.9	2.7	1.7	...
0.5–2.0 acres	63.0	12.6	11.7	6.7	4.2	1.6
2.0 acres or more	46.1	13.0	19.4	9.9	8.4	3.4
Total	58.1	12.4	14.2	7.3	5.8	2.1
Developed villages						
Less than 0.5 acres	78.5	8.5	9.0	2.4	0.8	0.8
0.5–2.0 acres	61.7	13.9	15.5	3.7	4.1	1.0
2.0 acres or more	49.3	9.9	18.9	9.6	9.2	3.1
Total	60.1	10.9	15.3	5.8	5.8	1.8
Chi-square		154.6			122.5	
Level of significance		0.000			0.000	

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

households owning more than 2 acres. At the other end of the scale, only 2 percent of the landless population completed more than eight years of schooling, compared with 6 percent from households with more than 2 acres. For each landholding group, however, the distribution pattern is similar in the developed and underdeveloped villages. Only for the group that completed 3-5 years of schooling is the proportion of population larger in developed villages than in underdeveloped ones for the landless and small landowner groups. Thus, it appears that students drop out from primary schools earlier in underdeveloped villages than in developed villages.

The absence of any significant difference in educational levels between the developed and the underdeveloped villages may be interpreted as the consequence of a policy of universal primary education that has been followed in Bangladesh for a long time. But, because this study was not designed to adequately capture the effect of infrastructure on human capital development, this is conjecture. Moreover, years of schooling are not necessarily an indication of the development of cognitive skills (Boissiere, Knight, and Sabot 1985). The effect of infrastructure on development of cognitive skills is expected to be substantial, and it remains an area for further study.

Health

The survey collected qualitative information on the health of all members of the sample households. Four different categories of health conditions were defined: permanently disabled, chronically ill, occasionally ill, and good health. The distribution of the sample population according to these categories, as reported by each respondent, is seen in Table 62. Nearly 68 percent of the population reported being in good health, 23 percent occasionally ill, 7 percent chronically ill, and 2 percent disabled. Health was better in developed villages: 77 percent of the population were in good health, compared with 61 percent in underdeveloped villages. Seven percent of family members were disabled or chronically ill in developed villages and 11 percent in underdeveloped. The chi-square test shows that the difference is highly statistically significant.

Males were found to be healthier than females in the underdeveloped villages. About 58 percent of the females in these villages were in good health compared with

Table 62—Health of the sample population in developed and underdeveloped villages, 1982

Health Condition	Total Population		Underdeveloped Villages		Developed Villages	
	Under-developed Villages	Developed Villages	Males	Females	Males	Females
			(percent)			
Disabled	2.2	1.1	1.7	2.7	1.4	0.7
Chronically ill	8.7	5.5	8.1	9.5	5.9	5.0
Occasionally ill	28.5	16.8	27.0	30.0	16.2	17.4
Good health	60.6	76.7	63.3	57.8	76.5	76.8
Sample size	(2,195)	(1,782)	(1,130)	(1,065)	(910)	(872)
Chi-square	130.4		230.9		3.6	
Level of significance	0.000		0.000		0.469	

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

63 percent for males, and 2.7 percent of the females were permanently disabled compared with 1.7 percent for males. These findings were statistically highly significant. In developed villages, there was little difference in health between the male and female populations.

When health facilities are less accessible, as in underdeveloped villages, it appears that female members receive less medical care than male members, but the sex discrimination disappears if medical facilities are easily accessible, as in developed villages. After controlling for the effect of sex, infrastructure still has a positive effect on health. Seventy-seven percent of males were in good health in developed villages compared with 63 percent in underdeveloped villages; for females, the proportion was 77 percent to 58 percent.

Effect on Attitudes and Values

The effect of infrastructure on development of attitudes and values of the rural people is by no means inconsequential. Even though this study did not focus on this aspect of rural development, some results from another study are presented here to show how infrastructure development can influence attitudes toward birth control measures in the predominantly Muslim society of Bangladesh. Under the United Nations Development Programme, a comprehensive survey of about 800 villages was conducted in 1985 in order to evaluate the effect of rural electrification on the adoption of birth control practices (Appendix Table 84) (Hoque 1987). The electrified villages are similar to the developed villages in this study and the nonelectrified villages to the underdeveloped villages. Five out of seven developed villages covered by the 16-village survey had access to electrification, whereas only one out of nine underdeveloped villages had electricity.

It is quite evident from this table that infrastructure development has a substantial impact on the adoption of family planning practices among women. The proportion of women practicing family planning in electrified households was more than twice that in nonelectrified villages. The share of women practicing family planning in households that had not yet been connected to electricity in electrified villages was about 40 percent larger than that in nonelectrified villages. The difference in the adoption rate between electrified and nonelectrified households in electrified villages is largely due

to differences in income because those who received electricity earlier are presumably from higher income classes. Therefore, even accounting for the income effect, the net impact of infrastructure development on adoption of family planning practices is remarkably large; on average, developed villages have about twice the adoption rate of underdeveloped villages. Another important point that can be deduced from Appendix Table 84 is the proportionately higher adoption rate among the youngest age group of women in infrastructurally developed villages compared with those in underdeveloped villages. This indicates that infrastructure development generates a proportionately larger attitudinal change among young people, implying that the effect of infrastructure on social change is likely to compound with the progression of time.

A Recapitulation of the Main Findings

The average yearly prices of paddy and rice, the major commodities traded in rural areas, are higher in developed villages, but the difference is small, 2.4 percent for paddy and 5.7 percent for rice. However, the average masks significant differences across villages and seasons, influenced by such factors as whether the commodity is importable or exportable in the village and the surrounding locality, the per capita income in the locality, and the share of the season's harvest in total yearly output. For paddy, the difference between the lowest and the highest yearly average prices is found to be about 20 percent across villages under study and about 34 percent for the immediate postharvest period. Postharvest prices were very low in villages that produced most of the crop in a single season. The seasonal variation in price was larger for paddy than for rice, and it was higher in underdeveloped villages than in developed ones.

Development of infrastructure is found to have a positive effect on marketing of agricultural produce. Households in developed villages obtain a larger proportion of their basic food needs from the market than those in underdeveloped ones. About 34 percent of the rice consumed by the sample households in developed villages was purchased and 29 percent in underdeveloped villages; for vegetables and tubers, the figures were 72 and 56 percent, respectively. Two-fifths of the paddy output was marketed during the year of survey, 47 percent in developed villages and 35 percent in underdeveloped villages. The marketing ratio was positively correlated with the size of landholding in underdeveloped villages, but the relationship was not found to be systematic in the developed villages. The significantly positive relationship of marketing of paddy with infrastructure development was also confirmed by regression analysis.

The land market is tighter in developed villages than underdeveloped ones. In developed villages, land is sold mostly by the landless and marginal landowners and purchased by medium and large landowners, suggesting a tendency on the part of the nonviable holders to leave farming in response to better job opportunities in nonagricultural activities, thus resulting in the concentration of land in the hands of viable farmers. In the underdeveloped villages this tendency is less pronounced.

Institutional credit covers only a small fraction of rural households and credit requirements; noninstitutional sources are still the dominant conduits of rural credit. All informal credit and most institutional credit are in short-term loans. While access to institutional credit is relatively biased in favor of large landowning groups, the noninstitutional credit market is dominated by borrowers from landless and small landowning classes. The interest rates in the noninstitutional market, on the other hand, are about 10 times as high as in the institutional market. These rates in noninstitutional markets are extremely variable, as if every transaction constituted a separate market.

Infrastructure development is found to improve access to institutional credit almost sevenfold, but again mainly for landowning households. Infrastructure development also transforms the noninstitutional supply system from one dominated by moneylenders and friends and relatives to a system composed largely of moneylenders. Growth of mercantile practices in the credit market is hastened by infrastructure development. The analysis of the utilization of institutional credit reveals a few facets of demand for rural credit. Most institutional credit is used for supplementary working capital in business and for current inputs in agriculture. The demand for credit to finance working capital in business is sharply enhanced by infrastructure development. Use of credit for fixed investment in agriculture is quite small, and infrastructure development does not make much of a difference in this respect. Infrastructure development also contributes positively to the shift of allocation of credit from nonproductive to productive activities and to increased demand for credit in nonagricultural activities.

The development of infrastructure did not have a significant effect on the literacy rate, which is affected more by the size of landholding of the household and the sex of the member. Dropping out of primary school for those who belong to the landless and small landowning groups is earlier in underdeveloped villages than in developed ones. The development of infrastructure, however, has a significant impact on health conditions and acceptance of family planning practices.

10

IMPLICATIONS FOR PUBLIC POLICIES

If infrastructure development is as crucial an element for rural development as the previous chapters have shown, why do most governments fail to accord appropriate priority to it? Analysis of public expenditures on the road and transport sector, the central component of infrastructure, in 45 developing countries, indicates that in an early stage of economic development, governments generally allot a relatively small share to this sector, a share that gradually increases as the country's economic status approaches the lower-middle-income category (using the World Bank's classification system). Thereafter, infrastructure's share of public expenditure starts to fall. When urban-oriented infrastructure development approaches saturation and the task of development of the rural road network begins, priority directed to infrastructure development declines rapidly, perhaps reflecting what Lipton (1977) generalizes to be the urban bias in most development policies.

In light of the extensive developmental effects of rural infrastructure, which are brought out in various sections of this study, the following implications for public policies are of strategic importance.

Development Strategy and Infrastructure

It is argued here that development of rural infrastructure has to play a key role in any development strategy for Bangladesh, and such a strategy must emphasize growth and equity. Without growth, distribution of income implies the sharing of poverty. But, emphasis on growth alone is likely to accentuate the poverty in which the majority exist, creating political instability that will drag down growth itself. A development strategy for growth and equity generally places priority on agriculture and labor-intensive industrialization. Emphasis on agriculture is understandable because agriculture is the major source of income for rural people, most of whom are not rich. In order for this vast majority to participate in the process of development, agriculture has to be given priority. But there are other substantive grounds for according priority to agriculture. Agriculture produces food. If production stagnates, given population growth, food prices will go up and import demand for food may adversely affect the foreign exchange available for development projects. Higher food prices may create labor problems and suffocate the growth of industries. Moreover, since agriculture continues to be the largest source of exports, agricultural stagnation may also mean stagnation of exports. Therefore, agriculture is a critical sector in the strategy for growth and equity.

The emphasis on *labor-intensive* industrialization is also understandable, particularly in the context of medium- and long-run development. Capital for industrialization is in extremely short supply. Unless this limited supply of capital is spread thinly over a large stock of employable labor, the growth and equity objective is jeopardized. In a country where land is limited and the pressure of population on land is so high, surplus labor in agriculture must be accommodated through expansion of the nonagricultural sector in the long run. Employment-oriented industrialization is therefore another component of a development strategy that aims for growth with equity.

Although it is easy to make broad generalizations on development strategy, it is

extremely difficult to prescribe how to accomplish it. By observing government programs in Bangladesh that, at least in documents, claim to pursue a growth-equity strategy, some facts can be gleaned about how the strategy is working in practice. In both agricultural and industrial sectors, the country is pursuing a policy of generating momentum in production through the private sector, although the past legacy of public initiative still lingers. On the agricultural front, generation and diffusion of modern technology in agriculture (spread of HYVs, fertilizer, and irrigation) through comprehensive research, extension, credit, and input marketing programs have been the principal instruments used to accelerate the pace of production. Nevertheless, diffusion of technology has remained slow. Arguments for enhancing incentives through input subsidies have emerged strongly every time the level of use of inputs has shown a tendency to decline. Placing priority on technology is no doubt defensible and wise, but it is argued and evidences have been shown that the missing link is the incommensurate priority given to development of rural infrastructure. Infrastructure reinforces the effectiveness of the diffusion of technology, and technology reinforces the benefits from infrastructure.

The industrialization program is based on selective public participation in direct production, credit, and protective trade policies and on extension of advisory services. The experience of industrialization has been even more frustrating than that of agriculture. But even though the overall outcome for industrialization has been frustrating, the informal small-scale sector has grown much faster than expected. Khan and Hossain (1990) show that whatever industrial growth in value added and employment has occurred in Bangladesh is the result of growth from small-scale industries, particularly cottage industries (see Appendix Table 85). It is these small-scale industries that are labor-intensive and consistent with the proclaimed development strategy.

A number of factors that make infrastructure and industrialization quite interdependent are worth highlighting here. Industrialization through small-scale businesses involves a process of changing from the type of entrepreneurship that exists between large farms and commercial traders to small-scale industrial entrepreneurship. This transition can flourish only when risk is relatively small, transaction costs are low, and marketing procedures are relatively easy. Infrastructure development has a critical influence on all these factors. Domestic demand is an extremely effective conduit for reducing market risk, and Chapter 7 shows how infrastructure development supports that demand for manufactured consumer goods. The marketing costs and access of rural households to consumer goods are all favorably influenced by infrastructure development. Small-scale units tend to be located near rural towns for this reason. Once confidence has developed among the entrepreneurs on the basis of domestic demand, efficiency improves, and the small-scale producers of industrial goods seek international markets that further stimulate their activities. It is easier to move from a small-scale phase to large-scale industrialization than to begin with large-scale, capital-intensive industries under public or protected private sectors. Infrastructure development that links rural households with the rest of the economy is critical for the success of this strategy of industrialization.

Approaches to Public Investment Decisions

Development of infrastructure has high costs in resources. Public resources have competing demands. Therefore, decisions on allocation of public resources to infrastructure cannot be made without some criteria on rate of return. If all conceivable projects covering all public-sector investments could be identified and their rates of return estimated, they could be ranked according to these rates of return. Then all budgetary

resources could be allocated to the top-ranking projects. Unfortunately, this ideal approach is seldom practiced and may not even be practicable.

Allocation of public-sector development resources is generally conducted in two stages. In the first stage, intersectoral allocations are made, keeping intermediate and long-term objectives in view, in accordance with the investment requirements for matching the profile of production with that of demand for commodities and services. These intersectoral allocations are continually adjusted through annual programming and budgeting procedures. This commodity-oriented mechanism for allocating resources to sectors is inherently biased against infrastructure because of the general deficiency in information on the productivity of infrastructure relative to that of direct production inputs. This results in a somewhat arbitrary treatment in allocating resources for infrastructure development. Realizing the problems of assessing the proper impact of infrastructural investment and the complementary roles of infrastructure and directly productive investment, Hirschman (1958) argues that in "a country plagued by deficiency of demand and high costs of production, a development oriented government may do well by creating a surplus of social overhead capital." In the case of contemporary developing countries, particularly in Africa, Hirschman's argument is extremely relevant.

At the second level of resource allocation, intrasectoral allocations among projects are made when benefit-cost analysis serves as one of the tools for making choices among alternatives. Therefore, at this level, and through the benefit-cost analysis, the sectoral resource allocation cannot be affected. This obvious statement is placed here only to counter the observation often made by critics that resources are not adequately allocated to infrastructure development because benefit-cost analysis often does not support such increased allocation. Even though traditional benefit-cost analysis is hardly instrumental in causing change in sectoral allocation to infrastructure, it is very useful for ensuring efficiency in resource use, given a sectoral allocation.

Benefit-cost analysis of infrastructural projects (a rural road, for example) is a nightmare to analysts primarily because of the complexities of identifying multifaceted benefits and measuring them in a dynamic world. The cost side is relatively easy to identify and measure. The evolution of this analytical tool in project appraisal by national and international agencies reflects these complexities. Moler (1987) and Beenhakker et al. (1987) present some useful surveys on the World Bank's use of benefit-cost analysis for road and transport projects. The conventional approach is to consider cost savings to road users as the main benefit. Therefore, the total benefit depends on total traffic volume (that is, the current and incremental traffic as the result of the project) and the cost saving per unit of traffic (the reduction in the cost of transport due to the road). Savings in time-cost are talked about but excluded in most analyses because of the difficulty of measuring them. The measurement of the traffic volume is critical and cannot simply be proxied by a factor of current level of traffic, even when improvement of the road is involved. For example, a study in Bangladesh shows that the benefit-cost ratio for improving a deteriorated earth road to a paved road is 1.19 if only the existing traffic is taken into account. If the incremental volume of traffic arising from this improvement is taken into account, the benefit-cost ratio becomes 3.48 (Chowdhury and Hossain 1985). Such is the magnitude of difference in the ratio due to the generation of additional traffic. Measurement of what would realistically happen after the road is improved or constructed is therefore a critical task of assessment. Most analyses assume an arbitrary constant rate of increase in traffic volume, without much of a basis to support the assumptions.

Assessing the nature of the demand curve for transport in a dynamic context is fundamental in order to assume a realistic rate of increase in traffic volume. The demand

for transport will depend on the impact of the road on agricultural production, increases of the marketing ratio from commercialization, and changes in consumption patterns. Accessibility may change the consumption pattern so that more consumer goods produced in urban centers will be available and consumed in the area covered by roads, thus increasing the demand for transport.

It is clear that a benefit-cost analysis based on user cost saving and volume of traffic does not take any account of employment, income distribution, or social development of the type discussed in various chapters of this manuscript. Concerns for these effects of road development have motivated analysts and international development agencies to design multiple criteria appraisal methods (Moler 1987; Beenhakker et al. 1987). Application of such methods in real situations has remained limited, and the adoption of such methods is also dependent on subjective weights assigned to each objective. Therefore, formal benefit-cost analysis for appraisal of infrastructural projects has remained quite weak. Judgment of policymakers has served in the past and will continue to serve as a strong basis for public investment decisions. If some error in judgment is unavoidable, it is preferable to overinvest than to underinvest in rural infrastructure. What is needed to improve the objective basis of decisionmaking is more studies of the developmental effects of infrastructure:

Besides the rate-of-return criterion, there are a number of popular perceptions that foster antagonism to increased allocation of resources to rural infrastructure:

1. *Infrastructure development makes the rich richer and the poor poorer.*

Arguments pro and con the effects of infrastructure development on poverty are as follows. The antagonists argue that the distribution of benefits from infrastructure development is determined by the initial ownership of land and other assets, including liquid capital. Because infrastructure development generates its benefits through improvement in productivity of these assets, it is the rich who mainly benefit. This is the standard argument advanced in the context of most development policies.

The protagonists argue their case from several angles. First, they argue that the poor may be short in land and capital, but they have labor to offer. Therefore, the effects on wage rates and employment must be considered in judging the poverty-alleviating impact of infrastructure development. Wage income may rise faster than agricultural income and profit because, as shown earlier, infrastructure development leads to an increase in demand for hired labor as the result of diffusion of technology and growth of nonfarm activities. The demand for hired labor may also increase because the supply of family labor may be reduced in richer households if members choose leisure over income. This is an empirical issue, however.

Second, a majority of the rural poor (small farmers and the landless) have some land and capital, which, when combined with abundant labor, is an advantage in labor-intensive, small-scale livestock production, fishing, and vegetable growing in areas that have ready access to markets for these products. The absence of an immediate access to markets is a definite constraint in production of these perishable products. Infrastructure development removes that constraint.

Third, public programs for the poor are more effective if the level of infrastructure development is higher. The ineffectiveness of famine prevention measures in areas of infrastructural underdevelopment is too well known to repeat. Finally, it is argued that if special care is taken in implementing programs for the poor (such as the Grameen Bank program in Bangladesh), credit can be extended to the poor so that they can avail themselves of the opportunities created by infrastructure development.

Even if development of rural infrastructure makes asset-holding households richer at a rate faster than it increases the income of assetless households, the increase in

the absolute level of income of the poor is what matters. Although most development processes tend to increase the income of rich households faster than poor households in the early phase of development, that can hardly be a serious argument against pursuing development.

2. *Infrastructure development in rural areas is wasteful without supplementary measures.*

The essence of this popular allegation has never been clearly spelled out. Sometimes it is said that road development in a desert is wasteful. Sometimes it is argued that educated people will leave rural areas if infrastructure is developed. Sometimes it is argued that road development alone will not cause any increase in benefits if other measures are not also taken.

Nobody argues for development of a road in a desert for its own sake. But if a road in a desert has the potential to attract tourists, it may not be a bad proposition. The question of whether to build a road should be based on the potential of increasing production—not on the existing production. That the African population is sparse and the production level low in certain locations is not a serious argument against development of infrastructure in Africa: the potential for production and for relocation of population should be the main concern.

The argument that educated people will move out of rural areas is a nebulous one. If life is attractive in rural areas and jobs are available for educated young people, they will not go to urban areas. Educated people are more likely to be retained in rural areas when infrastructure exists—not the other way around.

The question of supplementary measures (appropriate public institutions, trade policies, regulations, and so forth) to make investment in roads more productive is a valid one. This is precisely the reason why infrastructure has to be defined broadly. But again, the protagonists of this argument often are misled by unclear thinking. One has to distinguish between supplementary measures that must be created by government and those that will automatically come through private investment (with a time lag), because the ultimate purpose of infrastructure is to create an environment for private investment.

3. *Infrastructure development leads to widespread corruption.*

It is argued that development of rural infrastructure through local officials and politicians increases corruption. Protagonists who raise this issue apparently assume that there is no corruption at higher levels of public service and political leadership. On the contrary, it can be argued that the rate of corruption (defined as leakage per unit of total public expenditure) will probably be higher at higher levels. A local leader with a wealth of Tk 50,000 may hesitate to usurp Tk 5,000 from a public expenditure of Tk 100,000. But a highly placed policymaker may not hesitate to milk Tk 5 million from a public investment of Tk 50 million. The allegation of corruption cannot be raised against rural infrastructure alone; it has to be examined within the overall context of a country's economic, political, and administrative structures.

Donor Policies on Infrastructure

Infrastructure development in developing countries has historically been greatly influenced by the foreign aid policies of donors. The World Bank's emphasis on high priority for infrastructure development reached its peak during the 1960s and then began to drop drastically. The transport sector's share of World Bank lending dropped from 35 percent in 1970-74 to 17 percent in 1980-84. Country-specific studies on

public expenditure also show the significant influence of foreign aid on allocations to transport, communications, and electricity. Donors must recognize the pivotal role of infrastructure in economic development and review their lending for infrastructure development. It is a paradox in donor policies that, whereas they emphasize market mechanisms to play an increasing role in development, they attach a declining priority to infrastructure development. Macroeconomic concerns, often reflected in conditions placed on foreign aid geared to reduce public expenditures, should be mitigated by the elimination of expenditures on purposes that could be performed by the private sector, not by cutting back allocations for infrastructure development. Decisions on investment in infrastructure should be separated from decisions on the relative roles of private and public sectors. Keeping the two kinds of decisions separate will enable a rational allocation of resources to infrastructural investment.

Because wage goods constitute an important component of the cost of infrastructure development, food aid is a particularly important resource for development of rural infrastructure. However, the distinction between food aid to finance infrastructure development and infrastructure development as an outlet or basis for food aid is a subtle and significant difference that must be maintained to protect the image of infrastructural priority. Infrastructural projects must stand on their own merit, and food aid should be considered a resource like any other resource. Without this distinction, infrastructure development may become the secondary objective and food aid the primary one. Food aid could be a quite effective tool in containing inflation arising from increased public expenditures, particularly in chronic food deficit countries.

Development and Maintenance of Infrastructure

Problems with maintenance are perhaps the most formidable constraints to development of rural infrastructure. In a related but separate exercise, an attempt was made to estimate the amount of financial resources required for development of rural infrastructure in Bangladesh, so that all villages in the country could be developed to the level of the three most developed villages in this study (IFPRI/BIDS 1988). Questions of maintenance and institutional requirements were also examined in that exercise, four generalizations from which are pertinent to this paper:

1. The initial investment required for construction of facilities is large but can be accommodated within a five-year frame of government resources provided priorities are rearranged. This is not a serious constraint if the government is committed to rural development.

2. Institutional constraints are far more difficult to overcome. For development and maintenance of rural infrastructure, effective local organizations—local governments at the *upazila* level—are of critical importance. At present, local governments do not have the power necessary to generate local resources, have limited authority in decision-making, and are not adequately supported by staff with technical skills such as engineers. It is essential to correct these deficiencies by turning local governments into effective institutions for governance and development of rural areas.

3. Financial resources of a recurring nature must flow regularly to the treasuries of local governments. This is essential for maintaining rural infrastructure. Maintenance of rural roads and markets is critical to sustaining the productive use of these facilities. A part of the land revenue currently going to the central government and additional taxes on the local industries, business, and trades that will benefit from the infrastructure should become sources of a regular flow of resources to local governments. The principles

of sharing land revenues and imposing new local taxes must be institutionalized. Again, none of these constraints are unsolvable if political will and commitment to rural development are strong.

4. Generation of resources by local communities for investment in infrastructure is a substitute for the "market test" of whether such investments are worthwhile, if it is linked as a condition to the allocation of resources from the central government.

APPENDIX: SUPPLEMENTARY TABLES

Table 63—Results of factor analysis of infrastructure variables in 16 villages

Original Variable	Rotated Factor Matrix 1	Rotated Factor Matrix 2	Communality h^2	Weights Used in the Index[a]
Primary market	0.7508	-0.2091	0.6074	0.443
Secondary market	0.8885	0.3420	0.9063	0.655
Bus station	0.9176	-0.0296	0.8428	0.625
Bank	0.6446	0.5505	0.7186	0.506
Secondary school	-0.0713	0.8621	0.7483	0.545
Upazila center	0.8410	0.6470	0.7114	0.405
Primary school	0.4668	0.1415	0.2379	NI
Rail station	-0.3188	0.2671	0.1729	NI
Post office	0.4418	-0.0458	0.1973	NI

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

[a]These are the weights used in the construction of indexes described in the main text (the correlation of IC_i with TC). NI means these variables are not included in the index.

Table 64—Distribution of income from livestock and fisheries, by landownership group, 1982

Landownership Group/Size of Farm	Share in Total Income: All Households	Share in Total Income: Developed Villages	Share in Total Income: Under-developed Villages	Difference
	(percent)			
Landless	26.4	33.0	19.0	73.7
Land owned				
Small	24.3	25.4	22.9	10.9
Medium	27.5	23.4	32.2	-27.3
Large	21.8	18.2	25.9	-29.7
Total	100.0	100.0	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 65—Per capita income from livestock and fisheries, by landownership group, 1982

Landownership Group	All Households	Developed Villages	Underdeveloped Villages	Difference
		(Tk)		(percent)
Landless	245.4	334.6	160.1	109.0
Land owned				
Small	178.1	193.1	162.3	19.0
Medium	210.2	241.6	191.6	26.1
Large	356.0	432.7	311.5	38.9
Average	229.8	270.7	195.7	38.3

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed − Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 66—Distribution of income from business and industries by landownership group, 1982

Landownership Group	Share in Total Income			
	All Households	Developed Villages	Underdeveloped Villages	Difference
		(percent)		
Landless	22.8	22.0	23.6	−6.9
Land owned				
Small	28.1	20.2	35.3	−42.8
Medium	20.5	25.3	16.0	58.1
Large	28.6	32.5	25.1	29.5
Total	100.0	100.0	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed - Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 67—Per capita income from business and industry, by landownership group, 1982

Landownership Group	All Households	Developed Villages	Underdeveloped Villages	Difference
		(Tk)		(percent)
Landless	274.1	260.5	286.4	-9.0
Land				
Small	266.7	179.5	359.8	-50.1
Medium	202.3	305.5	136.6	123.7
Large	605.9	902.5	434.0	108.0
Average	297.4	316.4	281.4	12.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed - Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 68—Distribution of wage income by landownership group in developed and underdeveloped villages, 1982

Landownership Group	Share in Total Wage Income		
	Developed Villages	Underdeveloped Villages	Difference
		(percent)	
Landless	42.3	50.7	-16.6
Land owned			
Small	41.3	30.9	33.6
Medium	15.2	13.5	12.6
Large	1.2	4.9	-75.7
Total	100.0	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed - Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 69—Per capita wage income, by landownership group, in developed and underdeveloped villages, 1982

Landownership Group	Developed Villages	Underdeveloped Villages	Difference
	(Tk)		(percent)
Landless	945.0	693.2	36.3
Land owned			
Small	690.3	354.0	95.0
Medium	345.1	130.3	164.9
Large	67.2	95.3	-29.5
Total	596.3	317.0	88.1

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed - Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 70—Per capita income from miscellaneous sources by landownership group in developed and underdeveloped villages, 1982

Landownership Group	Developed Villages	Underdeveloped Villages	Difference
	(Tk)		(percent)
Landless	436.0	489.0	-10.8
Land owned			
Small	517.7	601.9	-14.0
Medium	615.9	735.9	-16.3
Large	778.4	795.4	-2.1
Average	550.9	651.4	-15.4

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Difference = [(Developed - Underdeveloped)/Underdeveloped] × 100. Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 71—Incidence of rural taxes, developed and underdeveloped areas

Landownership Group	Average Family Income	Average Taxes Paid	Effective Tax Rate
	(Tk)		(percent)
Developed area	20,385	59.1	0.29
Landless	13,015	7.8	0.06
Land owned			
Small	17,602	35.2	0.20
Medium	25,805	95.5	0.37
Large	47,644	176.3	0.37
Underdeveloped area	18,893	34.1	0.18
Landless	10,016	4.0	0.04
Land			
Small	13,975	14.0	0.10
Medium	23,202	34.8	0.15
Large	45,109	112.8	0.25

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: Landless own 0 to less than 0.5 acres, small owners own 0.5 to less than 2.5 acres, medium owners own 2.5 to less than 5.0 acres, and large owners own 5.0 acres or more.

Table 72—Estimated regression equations on wage income

Equation Number	Equation	$\bar{R}^2$
20	WGEI = 42.675 + 56.28 WRKR + 2.273 EDCN − 8.357 INF (1.56) (10.69) (1.72) (−6.13) + 2.09 WGRT − 0.0007 CPTL − 50.95 FEM − 0.159 HYV (1.906) (−1.50) (−5.02) (−3.89) − 3.347 FSZ − 0.099 LAND (−1.987) (−3.175)	0.37
21	FEM = 0.458 − 0.026 INF − 0.0008 FSZ (5.99) (−3.68) (−1.073)	0.15
22	WRKR = 0.92 + 0.14 FSZ + 0.007 INF + 7.9E-0.6 LAND (7.28) (10.37) (0.70) (0.03)	0.17
23	LAND = −12.685 + 2.159 INF + 21.88 FSZ (−0.465) (0.86) (7.918)	0.13
24	HYV = 0.90 + 0.788 IRGN − 0.137 LAND + 0.0107 CPTL (5.72) (16.48) (−5.33) (1.97) + 0.0196 CRDTI + 0.0117 CRDTNI − 0.0411 INF (5.04) (3.91) (−2.27)	0.51
25	CPTL = 2193.956 + 20.127 LAND − 99.8157 INF (1.974) (7.979) (−0.732)	0.13
26	EDCN = 2.153 − 0.1056 INF + 0.006 LAND (5.099) (−2.114) (6.102)	0.29
27	WGRT = 20.06 + 0.129 EDCN − 0.176 INF (36.25) (2.170) (−2.695)	0.14

*The figures in parentheses are t-values.

Table 73—Estimated regression equations on livestock and fisheries income

Equation Number	Equation	$\bar{R}^2$
28	LIFSI = 915.86 + 7.64 EDCN + 167.41 NWCH + 500.19 WRKR (2.70) (0.267) (1.685) (4.63) − 132.94 INF + 926.67 PLBA + 0.026 CPTLA + 140.60 FEM (−4.43) (3.04) (1.48) (0.59) + 1.43 LAND − 123.93 ANML (3.30) (−1.23)	0.45
29	EDCN = 2.153 − 0.1056 INF + 0.006 LAND (5.099) (−2.114) (6.102)	0.29
30	NWCH = 0.50 − 0.22 WRKR − 0.015 INF − 6.5E-05 LAND + 0.185 FSZ (4.08) (−5.87) (−1.42) (−0.50) (13.30)	0.25
31	WRKR = 0.92 + 0.14 FSZ + 0.007 INF + 7.9E-0.6 LAND (7.28) (10.37) (0.70) (0.03)	0.17
32	PLBA = 0.023 − 0.016 WRKR − 0.006 INF + 4.8E-04 LAND + 0.006 FSZ (0.50) (−1.128) (−1.555) (9.82) (1.16)	0.17
33	CPTLA = 1,243.89 + 395.11 WRKR − 119.21 INF + 9.15 LAND (1.77) (1.73) (−1.73) (11.73)	0.19
34	FEM = 0.458 − 0.026 INF − 0.0008 FSZ (5.99) (−3.68) (−1.073)	0.15
35	LAND = −12.685 + 2.159 INF + 21.88 FSZ (−0.465) (0.86) (7.918)	0.13
36	ANML = −0.20 + 0.107 WRKR + 0.026 INF + 0.08 FSZ + 0.002 LAND (−1.39) (2.40) (2.04) (4.65) (13.18)	0.36

Notes: The figures in parentheses are t-values. The variables are defined in the text.

Table 74—Estimated regression equations on income from business and industries

Equation Number	Equation	$\bar{R}^2$
37	BSINDI = 248.78 + 2.06 CRDNI + 407.97 WRKR + 0.39 CPTLB (0.33) (1.78) (1.77) (9.33) + 80.80 EDCN − 41.92 INF + 5.70 CRDI + 0.87 LAND (1.22) (−0.60) (3.25) (1.05)	0.19
38	CPTLB = 60.09 + 8.41 CRDI + 476.13 WRKR − 70.04 INF + 76.76 EDCN (0.80) (5.12) (2.18) (−1.06) (1.21) − 1.42 CRDNI + 1.45 LAND (−1.14) (1.84)	0.16
39	WRKR = 0.92 + 0.14 FSZ + 0.007 INF + 7.9E-0.6 LAND (7.28) (10.37) (0.70) (0.03)	0.17
40	EDCN = 2.153 − 0.1056 INF + 0.006 LAND (5.099) (−2.114) (6.102)	0.29
41	LAND = −12.685 + 2.159 INF + 21.88 FSZ (−0.465) (0.86) (7.918)	0.13
42	CRDI = 6.43 − 1.21 INF + 0.07 LAND + 0.69 EDCN + 0.20 HYV (0.44) (−0.73) (3.59) (0.45) (5.58)	0.10
43	CRDNI = 72.23 − 3.23 INF − 0.003 LAND + 6.17 EDCN + 0.30 HYV (3.76) (−1.48) (−0.13) (3.07) (6.26)	0.09

Note: The figures in parentheses are t-values.

Table 75—Expenditure pattern, by developed and underdeveloped villages, 1982

Consumption Item	Developed Villages			Underdeveloped Villages		
	Average Budget Share	Marginal Budget Share	Expenditure Elasticity	Average Budget Share	Marginal Budget Share	Expenditure Elasticity
	(percent)			(percent)		
Cereals	47.5	30.9	0.65	59.6	47.6	0.80
Rice	41.9	31.7	0.76	51.3	48.1	0.94
Wheat	5.6	−0.8	−0.14	8.2	−0.5	−0.06
Kaon, maize	0.0	0.0	0.00	0.1	0.0	0.20
Potatoes and sweet potatoes	1.8	1.3	0.72	1.6	1.7	1.08
Green vegetables	3.2	1.9	0.59	3.8	3.2	0.84
Pulses	0.6	0.9	1.50	0.8	1.2	1.50
Spices	3.9	3.7	0.95	3.0	2.5	0.83
Narcotics	3.9	4.5	1.15	2.3	1.8	0.78
Biri	1.8	1.1	0.61	1.4	0.8	0.57
Cigarettes	0.5	1.2	2.40	0.0	0.0	0.00
Betel leaf and nuts	1.4	1.7	1.21	0.8	0.9	1.13
Tobacco and jarda	0.2	0.5	0.25	0.1	0.1	1.00

(continued)

Table 75—Continued

Consumption Item	Developed Villages			Underdeveloped Villages		
	Average Budget Share	Marginal Budget Share	Expenditure Elasticity	Average Budget Share	Marginal Budget Share	Expenditure Elasticity
	(percent)			(percent)		
Sugar products	1.5	2.8	1.87	1.4	2.0	1.48
Molasses *(gur)*	1.1	1.9	1.73	1.3	1.7	1.31
Sugar	0.4	0.9	2.25	0.1	0.3	4.85
Tea	1.1	1.3	1.18	0.0	0.0	0.40
Oils	2.7	3.1	1.15	2.3	2.4	1.02
Soybean oil	0.3	0.2	0.67	0.3	0.3	1.00
Mustard oil	1.8	2.3	1.28	1.7	1.8	1.06
Coconut oil	0.5	0.5	1.00	0.3	0.3	0.93
Vegetable ghee	0.1	0.1	1.00	0.0	0.0	0.00
Fruits	1.3	2.6	2.00	1.8	2.4	1.33
Milk and milk products	0.9	2.2	2.44	0.3	1.4	4.52
Milk and curds	0.8	2.0	2.50	0.3	1.3	4.33
Powdered milk	0.0	0.0	0.00	0.0	0.1	5.00
Sweetmeats	0.1	0.2	2.00	0.0	0.1	5.00
Fish, meat, and eggs	6.2	9.9	1.59	4.1	6.5	1.58
Eggs	0.3	0.5	1.67	0.3	0.6	2.00
Fish	4.8	6.2	1.29	2.9	3.3	1.14
Meat	1.1	3.2	2.91	0.9	2.6	2.89
Total food	74.6	65.1	0.87	81.0	72.8	0.90
Fuels and energy	8.3	7.2	0.87	8.7	5.5	0.63
Firewood	2.2	2.2	1.00	2.2	2.2	1.00
Jute sticks	1.7	2.2	1.29	0.3	0.2	0.67
Rice husks	0.3	0.3	1.00	0.9	0.6	0.67
Cow dung	1.3	−0.1	−0.08	1.6	0.4	0.25
Dry leaves	1.2	0.5	0.42	2.3	0.8	0.35
Kerosene	1.4	1.3	0.93	1.4	1.3	0.93
Electricity	0.2	0.8	4.00	0.0	0.0	0.00
Other consumer goods	1.9	2.4	1.29	1.4	2.2	1.55
Match sticks	0.4	0.2	0.50	0.3	0.1	0.33
Soap	0.9	1.4	1.56	0.7	1.3	1.86
Washing soda	0.2	0.1	0.50	0.2	0.1	0.50
Cosmetics and toothpaste	0.1	0.2	2.00	0.0	0.2	10.00
Shoes and leather goods	0.3	0.5	1.67	0.0	0.5	2.50
Clothes	5.6	9.7	1.73	5.2	9.2	1.77
Handloom clothes	2.7	4.9	1.81	3.2	3.9	1.22
Mill-made clothes	1.4	1.7	1.21	0.4	1.6	4.00
Ready-made clothes (domestic)	0.7	0.9	1.29	0.4	0.7	1.75
Ready-made clothes (foreign)	0.2	1.2	6.00	0.7	2.1	3.00
Old clothes	0.3	0.2	0.67	0.3	0.2	0.67
Other clothes	0.3	0.8	2.67	0.2	0.7	3.50
Services	9.3	15.7	1.70	3.3	9.9	3.00
Education	0.5	1.7	3.40	0.1	2.0	3.33
Health and medicine	2.7	3.5	1.29	1.5	3.1	2.07
Transport	1.2	2.2	1.83	0.4	0.8	2.00
Personal services	0.9	0.9	1.00	0.3	0.3	1.00
Religious services	3.6	5.4	1.59	0.3	2.1	7.00
Other miscellaneous services	0.4	2.0	5.00	0.2	1.6	8.00
Total nonfood	25.1	35.0	1.40	18.6	26.8	1.44
Total of all expenditures	100.0	100.0	...	100.0	100.0	...

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: Totals may not add up exactly to 100.0 due to rounding.

Table 76—Consumption expenditure functions: selected variables

Commodity	Constant	Log Total Expenditure	Total Expenditure Share	Infrastructure	Infrastructure Share	Family Size	Family Size Share
Cereal	2.737 (17.22)**	-0.2879 (-15.96)**	-48.6854 (-0.81)	0.0198 (9.52)**	-31.4317 (-7.37)**	0.0022 (1.18)	-5.1851 (-1.38)
Rice	2.103 (12.41)	[illegible]2145 (-11.[illegible])**	-61.094 (-0.95)	0.0196 (8.87)**	-38.376 (-8.45)**	0.0024 (1.22)	1.981 (0.50)
Wheat	0.6338 (6.25)**	-0.[illegible]729 (-6.[illegible])**	1.032 (0.027)	-0.0001 (-0.09)	7.604 (2.80)**	-0.0005 (-0.46)	6.504 (-2.72)**
Root crops	-0.0184 (-0.98)	0.0026 (1.24)	45.834 (6.45)**	0.0002 (0.90)	-1.855 (-3.69)**	0.0010 (4.76)**	-2.817 (-6.38)**
Green vegetables	-0.0987 (-2.11)**	0.138 (2.59)**	71.239 (4.01)**	0.0002 (0.28)	0.6032 (0.48)	0.0003 (0.52)	-3.791 (-3.43)**
Mustard oil	0.0095 (0.39)	0.0023 (0.84)	-1.648 (-0.18)	-0.0009 (-2.76)**	0.7054 (1.09)	0.0001 (0.37)	-0.3729 (-0.66)
Vegetable ghee	(-0.0039 (-3.10)**	0.0005 (3.38)**	0.4630 (0.96)	-0.00004 (-2.44)**	0.0536 (1.57)	0.00004 (2.81)**	-0.417 (-1.39)
Powdered milk	-0.0041 (-0.54)	0.0005 (0.53)	1.159 (0.40)	0.0001 (1.24)	-0.1740 (-0.85)	-0.0000 (-0.02)	0.0003 (0.001)
Milk curds	-0.0432 (-1.69)*	0.0081 (2.80)**	-23.138 (-2.38)**	-0.0010 (-3.00)**	1.147 (1.57)*	0.0000 (0.12)	1.536 (2.55)**
Fruits	-0.0461 (-0.96)	0.0091 (1.67)*	-36.506 (-2.00)**	0.0004 (0.68)	2.731 (2.12)**	-0.0010 (-1.71)*	1.904 (1.68)*
Sugar	-0.02300 (-1.57)	0.0036 (2.19)**	-2.478 (-0.45)	-0.0005 (-2.76)**	0.4658 (1.19)	0.0001 (0.81)	0.1034 (0.30)
Spices	0.0220 (0.91)	0.0027 (1.00)	3.143 (0.34)	-0.0012 (-3.76)**	1.614 (2.50)**	-0.8285 (-2.95)**	-0.2344 (-0.41)
Tea	-0.0146 (-1.54)	0.0034 (3.18)**	-13.438 (-3.74)**	-0.0013 (-10.62)**	1.568 (6.18)**	-0.0002 (-1.94)*	0.6308 (2.80)**
Fish	0.0744 (2.11)**	0.0007 (0.17)	-63.816 (-4.76)**	-0.0025 (-5.51)**	3.088 (3.26)**	-0.0019 (-4.59)**	3.072 (3.69)**
Beef, meat, chicken	-0.1607 (-5.34)**	0.0221 (6.49)**	-1.165 (-0.[illegible]0)	-0.0010 (-2.45)**	0.9223 (1.14)	0.0008 (2.23)**	0.6751 (0.95)
Kerosene	0.0220 (1.51)	-0.0004 (-0.27)	1.408 (0.26)	0.0003 (1.84)*	0.1433 (0.37)	-0.0005 (-2.81)**	-0.1050 (-0.31)
Electricity	-0.0109 (-3.79)**	0.0017 (5.19)**	-2.505 (-2.29)**	-0.0004 (-9.76)**	0.5229 (6.77)**	-0.0000 (-0.50)	0.0852 (1.25)
Handloomed cloth	-0.3918 (-6.04)**	0.0499 (6.77)**	79.433 (3.23)**	-0.0012 (-1.47)	2.679 (1.54)	0.0019 (2.50)**	-2.448 (-1.60)
Mill-made cloth	-0.1216 (-2.40)**	0.153 (2.67)**	19.772 (1.03)	0.0002 (0.24)	-0.5325 (-0.39)	0.0003 (0.55)	-0.2987 (-0.25)
Foreign-made cloth	-0.1101 (-1.98)**	0.0137 (2.17)**	15.160 (0.72)	0.0004 (0.60)	-1.140 (-0.76)	0.0005 (0.74)	0.0678 (0.05)
Old ready-made cloth	0.0085 (1.45)	-0.0008 (-1.18)	0.8911 (0.40)	-0.0001 (-0.71)	0.1568 (1.00)	0.0001 (1.10)	-0.1839 (-1.33)
Education	-0.1506 (-4.40)**	0.0178 (4.57)**	21.222 (1.63)	0.0004 (0.83)	-0.5476 (-0.60)	0.0021 (5.14)**	-1.085 (-1.34)
Health and medicine	-0.1749 (-3.29)**	0.0257 (4.25)**	-5.111 (-0.25)	-0.0011 (-1.63)	1.493 (1.05)	-0.0012 (-1.94)*	2.398 (1.91)*
Transportation	-0.0873 (-4.04)**	0.0130 (5.29)**	2.723 (0.33)	-0.0016 (-5.64)**	1.550 (2.67)**	-0.0001 (-0.23)	0.1535 (0.30)

(continued)

Table 76—Continued

Commodity	Constant	Log Total Expenditure	Total Expenditure Share	Infrastructure	Infrastructure Share	Family Size	Family Size Share
Total consumption of foods	2.689	−0.2224	−174.289	0.0088	−10.20	−0.0062	1.092
	(20.00)**	(−14.57)**	(−3.42)**	(5.00)**	(−2.83)**	(−3.95)**	(0.34)
Total consumption of consumer goods	−0.7273	0.0933	123.814	−0.0012	1.330	0.0033	−2.508
	(−6.94)**	(7.85)**	(3.11)**	(−0.90)	(0.47)	(2.71)**	(−1.01)
Total consumption of health, travel and personal services	−0.2877	0.0427	−0.0166	−0.0032	3.521	−0.1465	2.815
	(−4.76)**	(6.22)**	(−0.01)	(−4.10)**	(2.17)**	(−2.08)**	(1.98)*

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: The numbers in parentheses are t-values. Total Expenditure Share = (Expenditure on Commodity Total/Consumption Expenditure of Household). Infrastructure Share = (Infrastructure Index/Total Consumption Expenditures of Household). Family Size Share = (Family Size/Total Consumption Expenditures of Household).

*t-value is significant at the 10 percent level.

**t-value is significant at the 5 percent level.

Table 77—Expenditure elasticities of goods and services by income quartiles in developed and underdeveloped villages

Item	Developed Villages				Underdeveloped Villages			
	Quartile				Quartile			
	1	2	3	4	1	2	3	4
Cereals	0.84	0.94	0.52	0.36	0.89	0.95	0.95	0.79
Field crops	0.41	0.55	1.40	0.92	1.30	0.98	1.47	1.25
Narcotics	1.58	1.23	0.52	1.37	2.72	1.56	0.91	0.49
Sugar	2.96	1.41	2.20	1.92	1.38	1.00	2.34	1.58
Oils and fats	1.16	0.90	1.45	1.26	1.89	0.83	1.12	1.69
Fruits	2.17	1.08	0.98	1.17	1.56	1.27	1.05	1.56
Tea	1.28	0.81	1.99	0.79	...	...	...	...
Fish and livestock	2.85	0.72	1.70	1.72	2.31	1.92	0.84	2.02
Energy and fuel	0.78	1.05	0.73	0.78	−0.19	0.64	0.52	0.39
Consumer goods	2.07	1.85	0.73	0.75	2.10	1.28	1.05	1.10
Services	2.35	1.20	1.74	1.64	1.67	0.76	1.70	1.80
Total nonfood	1.45	1.30	1.14	1.12	0.66	0.89	0.96	0.98

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Notes: The ellipses (. . .) indicate that average and marginal budget shares for calculation of elasticity are negligible. Quartile 1 is the household group with the lowest expenditure and quartile 4 is the highest. The narcotics included in this data are biri, cigarettes, betel leaf and nuts, tobacco, and jarda.

Table 78—Distribution of sample households by income quartiles and savings rate groups, 1982

Income Quartile	Savings Rate				
	Negative or Zero	Low (0-5.5)	Medium (5.5-10)	High (More than 10)	Total
			(percent)		
1st	57.32	30.57	8.28	3.82	100
2nd	42.04	27.39	11.46	19.11	100
3rd	33.76	21.02	15.29	29.93	100
Top	12.10	10.83	13.38	63.69	100
All households	36.31	22.45	12.10	29.14	100

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Table 79—Distribution of saving households by landownership and infrastructure groups, 1982

Landownership Group	Number of Households		Proportion of Total Households in Group		Proportion of Positive Savers in Group	
	DV	UNDV	DV	UNDV	DV	UNDV
			(percent)		(percent)	
Landless	85	106	31.4	29.7	70.6	58.5
Land owned						
Small	98	115	36.2	32.2	58.2	56.5
Medium	66	94	24.4	26.3	65.2	69.1
Large	22	42	8.0	11.8	81.8	71.4
Total	271	357	100.0	100.0	65.7	62.2

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: DV is infrastructurally developed villages; UNDV is underdeveloped villages.

Table 80—Regression results for all households: per capita savings as dependent variable

Independent Variables and Equations	All Households	Landowning Households	Landless Households
Restricted equation			
INF	2.2397 (0.227)	5.1759 (0.397)	0.6096 (0.071)
INCM	0.4371 (18.206)	0.4887 (16.247)	0.1293 (2.506)
$(INCM)^2$	−1.059E-05 (−8.173)	−1.203E-05 (−6.905)	0.3708 (0.267)
$(INCM)^3$	1.3861E-09 (14.327)	1.230E-09 (10.5432)	4.272E-09 (3.235)
Constant	−1,072.4116 (−10.353)	−1,344.996 (−9.558)	−278.517 (−2.496)
$\bar{R}^2$	0.90	0.81	0.65
Estimated MPS[a] at mean level	0.405	0.463	0.203
Fully specified equation			
INF	8.694 (0.972)	12.604 (1.063)	−4.8125 (−0.603)
INCM	0.5261 (23.106)	0.5651 (20.319)	0.1595 (3.254)
$(INCM)^2$	−7.102E-06 (−5.929)	−6.943E-06 (−5.110)	1.5523 (1.190)
$(INCM)^3$	1.262E-09 (14.655)	1.169E-09 (11.407)	4.287E-09 (3.464)
CRDTI	−4.8586 (−3.265)	−4.7834 (−2.740)	−8.491 (−5.890)
EDCN	−4.6493 (−0.684)	−3.6656 (−0.447)	−15.592 (−1.601)
WRKR	62.8031 (2.108)	46.845 (1.232)	33.714 (1.259)
HYV	−237.536 (−3.853)	−327.348 (−3.890)	...
SCPT	0.0246 (1.580)	0.0332 (1.846)	0.0703 (1.702)
LAND	−9.352 (−10.960)	−10.574 (−9.913)	...
Constant	−1,079.337 (−9.934)	−1,053.29 (6.929)	−290.212 (−2.448)
$\bar{R}^2$	0.84	0.85	0.70
Estimated MPS[a] at mean level	0.52	0.561	0.234

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.

Note: The numbers in parentheses are t-values.

[a]MPS is the share of incremental income that is saved. For example, if income increases by one taka, MPS of 0.4 means that 40 percent of that one taka is saved.

Table 81—Regression results for all but 10 extreme households: per capita savings as dependent variable

Independent Variables and Equations	All Households	Landowning Households	Landless Households
Restricted equation			
INF	7.0674 (0.832)	10.6981 (0.944)	0.6097 (0.071)
INCM	0.2253 (9.050)	0.2553 (7.751)	0.1293 (2.506)
$(INCM)^2$	−1.054E-06 (−0.202)	−1.031E-06 (0.021)	1.823E-06 (0.321)
$(INCM)^3$	1.8997E-09 (11.449)	1.7826E-09 (8.729)	4.272E-09 (3.231)
Constant	−617.744 (−6.439)	−790.136 (−5.904)	−278.51 (−2.496)
$\bar{R}^2$	0.81	0.82	0.65
Estimated MPS[a] at mean level	0.284	0.323	0.203
Fully specified equation			
INF	9.6254 (1.209)	12.608 (1.183)	−4.8125 (−0.603)
INCM	0.327 (13.006)	0.3499 (10.783)	0.1595 (3.254)
$(INCM)^2$	−1.004E-06 (−0.421)	−1.120E-06 (−0.314)	−1.10E-06 (−0.04)
$(INCM)^3$	1.959E-09 (12.063)	1.877E-09 (9.444)	4.287E-09 (3.464)
CRDTI	−3.9366 (−2.940)	−3.8156 (−2.405)	−8.490 (−5.890)
EDCN	−0.256 (−0.042)	0.786 (0.107)	−15.592 (−1.609)
WRKR	64.640 (2.513)	61.867 (1.797)	33.714 (1.259)
HYV	−139.206 (−2.513)	−204.523 (−2.675)	...
SCPT	0.0719 (4.746)	0.076 (4.305)	0.070 (1.699)
LAND	−5.9368 (−7.267)	−6.769 (−6.464)	...
Constant	−730.539 (−7.228)	−717.65 (−5.052)	−290.212 (−2.45)
$\bar{R}^2$	0.85	0.85	0.72
Estimated MPS[a] at mean level	0.381	0.422	0.234

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Note: The numbers in parentheses are t-values.
[a]MPS is the share of incremental income that is saved. For example, if income increases by one taka, MPS of 0.4 means that 40 percent of that one taka is saved.

Table 82—Importance of rice milling by infrastructure and landownership, milled rice as percent of total rice, 1982

Landownership Group	Milled Rice as a Share of the Total Amount Consumed		
	Underdeveloped Villages	Developed Villages	Difference[a]
		(percent)	
Landless	40.3	73.6	33.3
Land owned			
Small	33.0	55.6	22.6
Medium	35.5	59.4	23.9
Large	36.2	56.7	20.5
All households	35.8	60.6	24.8

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
[a]Difference is the percentage for the underdeveloped villages subtracted from that for the developed villages.

Table 83—Effect of infrastructure on amount of paddy marketed per household, estimated by the Tobit Method

Variable	All Households		Underdeveloped Villages		Developed Villages	
	(1)	(2)	(1)	(2)	(1)	(2)
Constant	-25.03	7.26	3.78	21.73	-239.6	23.75
	(-0.95)	(1.28)	(0.13)	(1.74)*	(-1.70)	(2.19)**
Paddy output	0.544	0.544	0.413	0.412	0.641	0.646
	(16.59)***	(16.53)***	(8.75)***	(8.72)***	(12.44)	(12.40)
Square of paddy output	-0.000056	-0.000063	0.000025	0.00024	-0.00033	-0.00035
	(-0.90)	(-1.02)	(2.80)***	(2.74)**	(-3.05)	(-3.06)***
Household size	-1.41	-1.47	-0.115	-0.156	-2.38	-2.42
	(-3.02)***	(-3.18)***	(-0.18)	(-0.25)	(-3.32)***	(-3.42)***
Price of paddy	0.204	...	0.118	...	1.604	...
	(1.30)		(0.72)		(1.87)*	
Infrastructure underdevelopment index	-1.75	-1.83	-3.384	-3.343	-1.908	-6.232
	(-3.63)***	(-4.57)***	(-2.98)***	(-2.99)***	(-0.63)	(-2.63)***
$\bar{R}^2$	0.68	0.66	0.67	0.67	0.73	0.72
Log-L	-1,756.00	-1,757.00	-989.00	-989.00	-753.00	-756.00
Number of cases	455	455	260	260	195	195

Source: Computed from survey data collected by the International Food Policy Research Institute and the Bangladesh Institute of Development Studies in 1982.
Notes: The dependent variable is the amount of paddy marketed (maund/farm). Figures in parentheses are t-values.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Table 84—Percent of women practicing family planning in electrified and nonelectrified households, 1985

Age of Women	Electrified Villages (Developed)			Nonelectrified Villages (Under-developed)	Ratio Between		
	Households with Electricity (1)	Households without Electricity (2)	All Households (3)	All Households (4)	(1) and (4)	(2) and (4)	(3) and (4)
		(percent)		(percent)			
10–19	50.0	40.0	45.4	14.3	3.5	2.8	3.2
20–29	65.3	48.0	59.3	26.8	2.4	1.8	2.2
30–39	48.1	31.3	41.7	25.4	1.9	1.2	1.7
40–50	29.7	7.7	22.9	3.4	8.7	2.3	6.7
Total	46.6	29.5	40.6	18.2	2.6	1.6	2.2

Source: Nazrul Hoque, "Rural Electrification and Its Impact on Fertility: Evidence from Bangladesh" (Ph.D. dissertation, Pennsylvania State University, 1987).

Table 85—Industrial growth indices for Bangladesh, 1967/68 and 1981/82

Size of Industry	1967/68		1981/82	
	Employment	Value	Employment	Value
Large and medium	100	100	100	100
Small	100	47	88	39
Cottage	656	35	387	80

Source: A. R. Khan and Mahabub Hossain, *Bangladesh: A Study in Development Strategy* (London: McMillan, 1990).

Note: Large and medium-scale industries are the base.

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Raisuddin Ahmed is program director of the Food Production Policy Program at IFPRI, where he has been a research fellow since 1976. Mahabub Hossain is a senior research economist at the Bangladesh Institute of Development Studies.

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