RESEARCH REPORT

AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH

Raisuddin Ahmed

October 1981

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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Implementing changes in relative agricultural prices is an attractive and apparently simple means of achieving many important policy objectives. Unfortunately, not only are the requirements various objectives place on price policy often conflicting, but the direct and indirect effects of price policy are so complex that it is difficult—perhaps impossible—to disentangle them sufficiently to provide unequivocal recommendations.

In this research report Raisuddin Ahmed judiciously chooses a modest portion of the many interactions among price policies, measures key production, consumption, employment, and nutritional relationships, analyzes their effects on various income groups, and draws conclusions for price policy. In effect he has chosen to analyze and quantify key elements of a general equilibrium approach. Coupling these results with his wide experience, Ahmed then suggests the appropriate range of discretion and indicates specific numbers for making judgments on price policies.

Despite the standard caveat about the need to study each country and point in time to derive relevant recommendations, in practice Ahmed's analysis of Bangladesh provides a useful guide to the analogous problems of many currently developing countries.

Particular note should be taken of the effects on employment of changes in relative prices of commodities (e.g., rice and jute) that require quite different amounts of labor; the impact of food price changes on consumption and the nutritional status of low-income people; the distributional effects of food price increases among rural people; and the differing area and yield effects engendered by changes in relative producer prices.

Most importantly, this report delineates agricultural price policy as a policy instrument subject to severe constraints in its use. It is most valuable when it is used in conjunction with other institutional and technological policies, not as a single panacea to multifaceted problems of agricultural growth and equity.

Although this study deals with a wide range of interacting price relations, policies, and price instruments, there remains a need

for in-depth studies of component parts. IFPRI conducts a wide range of such studies. Current research includes a particularly intensive analysis of fertilizer pricing policy in the context of the demand, supply, and distributional environment within which fertilizer use occurs. IFPRI's research on water economics is also pointing toward specific price policy conclusions. Research on the effect of foreign exchange rates and controls on agricultural prices and incentives continues beyond the work on Colombia by Jorge García, which has already been published. IFPRI's particular concern for increasing benefits to low-income people adds a special dimension to its work on food price policy as reflected in the large number of studies under way on food subsidies, employment subsidies, and various nutrition interventions.

John W. Mellor

Washington, D.C.
October 1981

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1

SUMMARY

The agriculture of Bangladesh is organized around small family farms with fragmented plots. Farm land is scarce but labor is abundant. Together with socioeconomic constraints, farmers must deal with the extreme natural restrictions engendered by the deltaic topography and monsoon climate. In spite of these problems, farmers respond to price incentives by increasing output, but the resulting increase in production is not large enough or sustained enough to bring about adequate improvement. Such long-term growth depends on a balanced combination of price incentives, technology, infrastructure, and supporting institutions. Too great a reliance on price incentives alone may tend to accelerate the transfer of land to large farms.

Rice is grown on nearly four fifths of the total cropped area, whereas about 7 percent is devoted to jute, which accounts for nearly half the value of the nation's exports. The bulk of the rice produced never enters market channels. From 1973/74 to 1977/78, the gross marketable surplus of rice ranged from 19 percent of gross production in moderately bad harvest years to about 23 percent in extremely good years. In 1973/74 about 77 percent of the gross marketable surplus came from 15 percent of the farms. These farms tilled about 44 percent of the total cultivated land and produced 39 percent of total output. About 53 percent of farm households, covering 41 percent of farm population and 19 percent of farm land, were net buyers of rice. However, in extremely good years (such as 1975/76 and 1977/78) only about 15 percent of farm households had a rice deficit.

This study indicates that production response to rice prices, measured as supply elasticity, varied from 0.18 to 0.26, reflecting almost equally changes in acreage and yield. The acreage effect came at the expense of other crops, mostly jute, and does not represent a net gain to the economy in production and employment.

Jute is an important cash crop and the dominant export commodity. A policy to moderately tilt relative prices in favor of jute in the domestic market would benefit the long-run growth of agricultural production and employment. The study indicates that withdrawal of the export tax on raw jute has the potential of raising farm-level jute prices about 9-13 percent.

Another policy alternative is to reduce rice prices. Decreasing the price of rice to roughly the 1976/77 level relative to the 1976/77–1978/79 average price of jute and removing the jute export tax would result in an optimal rice-jute price relationship. However, if increased foodgrain imports were to cause rice prices to drop below this optimal level, adoption of modern technology would be retarded and production growth would slow. But the foreign exchange and budgetary burden of correcting the jute-rice price relationship by importing more foodgrains may not be feasible without external food aid. Furthermore, the optimal result could be achieved without the foreign exchange and budgetary burden of importation if domestic production of rice could be increased by an equal amount and at the lower price by expanding the use of rice technology in areas where jute is not the main crop and in the kinds of rice that do not compete with jute.

The outlook is for improved world demand for Bangladesh jute during the 1980s. If this occurs, removal of the export tax alone would substantially correct the imbalance in rice-jute prices. In fact, removal of the export tax and improvements in the marketing system are the only practical policy measures (other than technological advances) by which Bangladesh can improve the competitive position of jute in domestic and world markets.

Roughly half of the production response to price incentives is realized through increased use of modern inputs. The resulting increase in production begins slowly because the initial use of these inputs is low. Eventually, however, incentive prices accelerate the spread of technology. In turn, the resulting gains in productivity of land and labor increase the production response to prices. But the intensity of use of modern inputs

also depends on the availability of rural infrastructures. Supporting institutions must be available if farmers who benefit from price policies are to invest surplus income in technological structures and equipment.

A policy of using incentive prices to increase production is subject to certain limitations. Prices generally cannot be raised continuously. Moreover, supporting institutions, infrastructures, and the supply of inputs improve. For these reasons, nonprice factors are often considered more effective than prices in achieving sustained production growth. But the reinforcing effect of price incentives on nonprice factors cannot be ignored when formulating policies.

Perhaps the main impediment to maintaining high foodgrain prices is their effect on the nutritional status of low-income households, particularly landless rural families. In countries such as Bangladesh, where nutritional intake is extremely low and the proportion of the poor in the total population is large, the impact of higher foodgrain prices is acute in the short run. The argument that an increase in the price of rice would not cause food consumption among the poor to worsen because they would substitute inferior grains for rice is found to be incorrect. The supply and demand forces are such that the prices of inferior substitutes rise faster than the prices of the finer grades when foodgrain prices in general are rising.

The effect of higher food prices on consumption is much less serious in the long run because wage income eventually rises along with prices. However, growth of wage rates and employment of wage laborers lag behind a rise in prices for a number of reasons. First, an increase in the price of rice causes rice area to be substituted for jute and jute is twice as labor intensive as local rice varieties. Second, demand for hired labor is a residual demand after employment of family labor. A fall in aggregate demand for agricultural labor of 0.6 percent results in a fall in the demand for hired labor of 2.1 percent if the effect is limited entirely to the hired labor market. It is true that surplus farmers exchange leisure for hired labor when their income rises, but the effect of this exchange is limited mainly because of the small proportion of surplus farms in the total farm population. Third, the wage labor category of the labor force is growing at a much faster rate than the growth of family labor. As the price effect generally takes time to work itself out, the increase in the supply of family labor during this time puts additional downward pressure on the wage rate. These factors combined with low labor productivity limit the impact on wage income when rice prices are raised. As a result, the adverse effects of higher foodgrain prices persist in the long run, although on a reduced scale. Moreover, there are indications that high foodgrain prices may have implications for child mortality.

Price policies are not irrelevant in this situation but the emphasis shifts to policies that indirectly support foodgrain prices. These include raising prices of labor-intensive crops, increasing income of low-income households by works programs and rural construction, reducing employment leakage in external trade, and providing landless laborers access to nonagricultural employment.

The indirect effects of price policies can be traced by analysis of household expenditure systems. Policies designed to increase the spending power of low-income households more rapidly than high-income households tend to increase demand for agricultural products faster than demand for nonagricultural products. This results in higher prices for agricultural products if, as is usually the case, they are less supply elastic. But such policies may depress overall growth of the economy because of the shift of emphasis from supply-elastic to supply-inelastic products and from households with a propensity to save to those that save less. These effects can be minimized by supporting prices for agricultural products that are produced proportionately more by small farms than by large farms and by developing capital structures in rural areas that involve labor-intensive techniques. These policies would reinforce efforts to increase agricultural production.

A higher price for foodgrains increases the income of surplus farm households in the high-income category. The resulting increases in nonagricultural consumption expenditures could result in substantial growth in employment and wage income if the rising demand were met by domestic production at stable prices rather than by imports. However, the increase in consumption is likely to be limited largely to services such as transportation, health, education, and domestic servants. Because landless rural laborers frequently do not possess the

skills these services require, they may not benefit from higher foodgrain prices. Moreover, a higher foodgrain price may induce higher wage costs in production of nonagricultural products, which would dampen the indirect employment and income effects from demand of high-income farm households.

Elasticity of the marketable surplus of rice to production is high. This means that even a moderate increase in production could bring about relatively large increases in the marketable surplus and the instability of rice prices, as has been the case in recent years. Therefore development of a marketing system that would reduce the instability of rice prices should be given high priority.

2

INTRODUCTION

The effects of agricultural price policies on the growth of agricultural production in a low-income country can be determined only by examining conditions within that country. Inquiry into the interaction and importance of price and nonprice factors is an essential part of such tests. Although it is widely accepted that farmers respond rationally to economic incentives, economists disagree on how much production in low-income countries can be influenced by price incentives and trade-offs between objectives of growth and distributive justice.[1]

Effects of a change in relative prices of farm products depend on the structure of agriculture, physical and labor resources, quality of capital, technology and management, and the attitudes of farmers.

Farm size and the degree of freedom in making production decisions are crucial factors in determining the size of the marketable surplus and the impact of price policies. An agriculture dominated by small farms tends to be geared to subsistence production and a small marketable surplus. However, as long as farmers market some portion of each crop, their allocative decisions will be influenced by market prices. For most low-income farmers, subsistence and commercial production exist side by side. This introduces a discontinuity in prices that adds rigidity to production patterns.[2] A deficit farmer tends to attach a higher price to production for home consumption than to production for sale because he generally buys at retail prices but sells in harvest season at wholesale prices. Seasonal and year-to-year fluctuations in prices may induce some farmers to try to guarantee that they have enough food for subsistence needs, particularly of primary staples. However, this would not absolutely restrict transfer of resources among farm enterprises. In fact, a blend of subsistence and commercial agriculture may reduce risk.

The distribution of the marketable surplus has important implications for the impact of prices on income distribution among various farm sizes and for investment in agriculture. If the marketable surplus originates mainly from a small proportion of farms, the direct impact of prices on investment will tend to be limited to this group. This can affect the pace of capital formation in agriculture. Although a high concentration of land is conducive to generation of a marketable surplus, it may not automatically lead to a faster pace of capital formation. If labor and capital are highly complementary and the labor market is imperfect, a high concentration of landholding may slow the pace of investment. Combined with a general lack of investment opportunities in rural areas, this may accelerate the transfer of land to large farms when agricultural prices are rising.

A change in relative prices influences the allocation and intensity of uses of resources.[3] The land resource, including soil, climate, and topography, is a basic factor of agricultural production. The land may be better suited to some crops than others so that even wide price swings may have little effect on relative profitability. Similarly, the response of production to prices is partly determined by the amount of

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[1] See particularly: Theodore W. Schultz, ed., *Distortions of Agricultural Incentives* (Bloomington, Ind.: Indiana University Press, 1978); Raj Krishna, "Agricultural Price Policy and Economic Development," in *Agricultural Development and Economic Growth* ed. H. M. Southworth and Bruce E. Johnston (Ithaca, N.Y.: Cornell University Press, 1968); Uma Lele, "Agricultural Price Policy," *Economic and Political Weekly*, August 30, 1969; and John W. Mellor, "The Functions of Agricultural Prices in Economic Development," *Indian Journal of Agricultural Economics* 23 (January-March 1968): 23-37. Schultz's emphasis on incentives covers a wide range of factors that includes price.

[2] John W. Mellor, *The Economics of Agricultural Development* (Ithaca, N.Y.: Cornell University Press, 1966).

[3] Discussion and mathematical formulation of the principles that govern this allocative process and the price responsiveness of agricultural production under certain kinds of peasant farming are presented in Amartya K. Sen, "Peasants and Dualism With or Without Surplus Labor," *Journal of Political Economy* 74 (October 1966): 425-450.

land available. If plenty of marginal land is available for cultivation, a price-induced change in profitability may bring the marginal land under cultivation. Where additional land is not available, a change in relative prices will simply cause shifts among crops with little effect on total cropped area or on aggregate agricultural production.

For a given technology, both supply and demand determine how employment of labor for the production of an agricultural product will respond to a change in relative prices of products. The productivity of labor is a crucial demand factor. If the marginal product of labor is low, an increase in the utilization of labor will result in a much smaller increase in production. Even if the supply of labor is abundant, hours of work per worker may not change significantly with a change in the real wage rate because the work day already is long. This rigidity limits the effect of a price change on production. In this case higher income and more leisure may be equally appealing to workers. Each increment in production achieved through harder work reflects in the real cost of labor the choice each worker must make between a reduction of time spent working and an increase in his income, enabling him to purchase more goods and services. Mellor has suggested policies to influence the choice of labor over leisure by increasing the availability of attractive consumer goods over a wide range of prices and removing various cultural restraints on increased consumption.[4]

Technological change and creation of capital assets provide the main route for improving productivity in agriculture. Price alone has only a limited effect. Therefore price policies should be examined in terms of their effectiveness in accelerating the use of modern inputs such as fertilizers and high-yielding variety (HYV) seeds, and development of capital structures such as irrigation and machinery. Modernization of traditional agriculture involves extensive interaction and interdependence among various sectors of the economy. It depends on availability of modern inputs, development of a comprehensive network of distribution systems, and creation of new or modification of old institutions (for example, financial institutions, agricultural extension services, and land reform). Although some claim that prices generate indirect pressure for removing constraints, this would not be sufficient in most low-income developing countries of Asia. Remedial measures in these countries would require public initiatives, at least in the initial stage, which are much less sensitive to prices than private initiatives.

Certain crop-specific agricultural machines, skills, or distribution systems have occasionally introduced rigidity in the allocation of resources in response to a change in relative prices. Such inflexibility is mostly limited to the agriculture of developed economies but could occur more frequently in developing countries as modern inputs are adopted. If a farmer has an investment in one crop that cannot be transferred to another, he is less likely to switch crops when there is a shift in relative prices.

A change in the pattern of production of an important export crop may have important implications for the foreign exchange earnings of the country. The zeal for achieving self-sufficiency in foodgrain production has driven many developing nations to pursue price policies that have adversely affected export crops. Instead of increasing security, however, such efforts may entail considerable social cost. The cost becomes particularly painful if the contraction simultaneously reduces employment in the production, marketing, and processing of export crops.

The multifaceted conflict of interests between producers and consumers imposes a formidable constraint in pursuing a high price policy for increasing foodgrain production in low-income countries. Failure to understand this has contributed to numerous controversies.

Some researchers have demonstrated that the real income of the poor is reduced much more than that of the rich by a rise in foodgrain prices.[5] Others argue that such findings are based on short-term income effects of higher food prices and assume unchanged income. They claim that wages go up with foodgrain prices, and that the poor shift consumption by shifting to cheaper

[4] John W. Mellor, "The Use and Productivity of Farm Labor in Early Stages of Agricultural Development," *Journal of Farm Economics* 45 (August 1963): 517-534.

[5] John W. Mellor, "Food Price Policy and Income Distribution in Low-Income Countries," *Economic Development and Cultural Change* 27 (October 1978): 1-26.

foodstuffs.[6] When these adjustments are complete, it is claimed that the poor also will benefit from a rise in foodgrain prices. However, adjustment takes time and present consumption cannot be deferred without adverse nutritional consequences, particularly among the poor in low-income countries. The debilitating effects on children may produce demographic problems, and similar effects on laborers may reduce productivity.

To evaluate the indirect impact of price changes, it is important to analyze household expenditures. A rise in foodgrain prices increases the income of farmers, producing a surplus. The expenditure pattern of these households will partly determine the secondary effects of higher prices. The impact on growth and employment could be large if the increased income is spent on consumers' goods produced by a sector where there are considerable underutilized resources, such as unskilled labor. But if the added income is largely spent on imported goods, the secondary effects may be mostly reflected in balance-of-payment problems and import-substitution activities.

Price Regimes and Instruments

The distinction between regional and seasonal variations in prices is important for many policy purposes. Regional variations reflect transportation costs; seasonal fluctuations reflect storage costs, assuming that these include normal profit and interest on working capital. If regional price spreads exceed transportation costs, the performance of the marketing system is questionable.

Uma Lele shows that shortcomings in the efficiency and productivity of the private marketing system stem largely from lack of transportation, communications, and information.[7] She concludes that these inadequacies are aggravated by haphazard government policies that tend to be short-term reactions to crises rather than long-term production and welfare considerations. She also argues that the marketing problems are better dealt with by strong investment in infrastructure rather than by erecting a costly parallel marketing system.

Analysis of the impact of the marketing system on prices is not a part of this study. But it should be noted that public procurement of foodgrains is usually undertaken to prevent harvest season prices from falling below a certain level regardless of whether such actions simply substitute public for private trade.[8]

The underlying forces of demand and supply are useful policy tools for affecting price changes. Trade (import and export) and stock policies provide important tools for influencing prices on the supply side.[9] Income level and distribution are important demand factors. The level of disposable income is difficult to change in a short period of time without a severe taxation policy. Therefore, income measures are usually limited to those involving distribution of purchasing power. Those that redistribute income in favor of those who have a higher income elasticity for a product tend to raise the price of that product. When construction activities, rural works programs, direct income support for the poor, subsidies for the production of labor-intensive products, and other similar activities receive priority, they can exert upward pressure on agricultural prices, particularly foodgrain prices. Development of marketing systems that reduce marketing costs of farm products may increase farm prices and reduce retail prices.

Objectives of the Study

Rice price policy was selected for this study because of its ramifications for the economy of Bangladesh. Rice accounted for

[6] Gilbert T. Brown, "Agricultural Pricing Policies in Developing Countries," in Theodore W. Schultz, ed., *Distortions of Agricultural Incentives* (Bloomington, Ind.: Indiana University Press, 1978), pp. 84-113.

[7] Uma J. Lele, *Foodgrain Marketing in India: Private Performance and Public Policy* (Ithaca, N.Y.: Cornell University Press, 1971).

[8] Raisuddin Ahmed, *Foodgrain Supply, Distribution and Consumption Policies within a Dual Pricing Mechanism: A Case Study of Bangladesh*, Research Report 8 (Washington, D.C.: International Food Policy Research Institute, 1979).

[9] Exports may also influence demand. Long-term stock building may not be economical, but nevertheless some countries pursue this goal.

about 98 percent of the total domestic production of foodgrains and 80 percent of the total cropped area in 1975/76. It contributed about 74 percent of the net value added in the crop subsector. However, because a smaller share of rice is marketed than of other crops, its contribution to the agricultural terms of trade as compared with nonagricultural sectors may be less than its share of net value added or cropped area would indicate.

The issues discussed earlier in this chapter are the main concerns of the study. Other issues involving agricultural taxation, input pricing, and intersectoral resource transfers, which bear closely on agricultural price policy, have not been included in the study. Within the context of Bangladesh, these major issues are examined from the angle of three underlying policy objectives. The first is the efficiency in resource allocation needed to derive an optimum increase in agricultural production. The second recognizes the indirect effect of agricultural prices through their linkages with nonagricultural activities. This may be called the objective of achieving dynamic efficiency in resource allocation. The third objective relates to equity. Agricultural prices have a specific and important effect on the welfare of the rural poor.

3

RICE PRICES AND LAND RESOURCES

Extreme scarcity of land and relative abundance of labor characterize Bangladesh's agriculture. In 1974 the land/man ratio (per capita cultivated land in acres) was only about 0.29, and the cultivated area per head of population economically active in agriculture was only 1.42 acres.[10] Whereas the number of people mostly dependent on agriculture has been growing at a rate of about 2.7 percent per year, cultivated area from 1960 to 1974 remained almost static. Moreover, very little additional land can be brought under cultivation, which exerts tremendous pressure for intensive land use. The role of rice prices in farmers' decisions on land allocation must be viewed within the context of intensive cropping on a deltaic topography under monsoon conditions.

Figure 1 represents cropping patterns in Bangladesh. The lower part of the figure represents lowland and the top highland, with the extent of flooding indicated. Land areas allocated to various crops in various seasons are shown by boxes.

Rainfall occurs mostly from April through October. December through February are the driest months. About 10 million acres of cultivated area are subjected to flooding. About half of this area is deeply flooded, and deep-water Aman rice is the main crop. The remaining 5 million acres are suitable for Aus rice, jute, and rabi crops during the months when the land is relatively flood free. About 1 million acres of cultivated area remain fallow every year, mainly due to irregular rainfall and crop rotation. During the winter about 8 million acres are not cropped for want of soil moisture.

The physical and demographic factors result in a tight cropping pattern. External forces such as variations in relative prices can bring about only limited changes in allocation of land among crops in one season. Changes in areas under various crops from 1965 through 1979 are summarized in Appendix 1, Table 21. Rice and jute covered about 87 percent of the gross cropped area. During the period, rice area increased by about 3 percent while jute area declined by 26 percent. The area sown with Aus rice increased about 5 percent, deep-water Aman declined about 11 percent,[11] and transplanted Aman increased only slightly. Wheat area doubled, potato area increased 32 percent, tobacco area increased 27 percent, and the area sown with pulses, sugarcane, and other minor crops declined significantly.

These changes in crop areas altered the cropping pattern. Jute lost substantial area to Aus rice, but with the spread of irrigation Aus rice lost a small area and deep-water Aman a substantial area to Boro rice. Transplanted Aman rice gained slightly in areas where flood water recedes early and where some other rabi crops could be grown. Increases in wheat and potato areas were primarily at the cost of other rabi crops.

Acreage Response to Rice and Jute

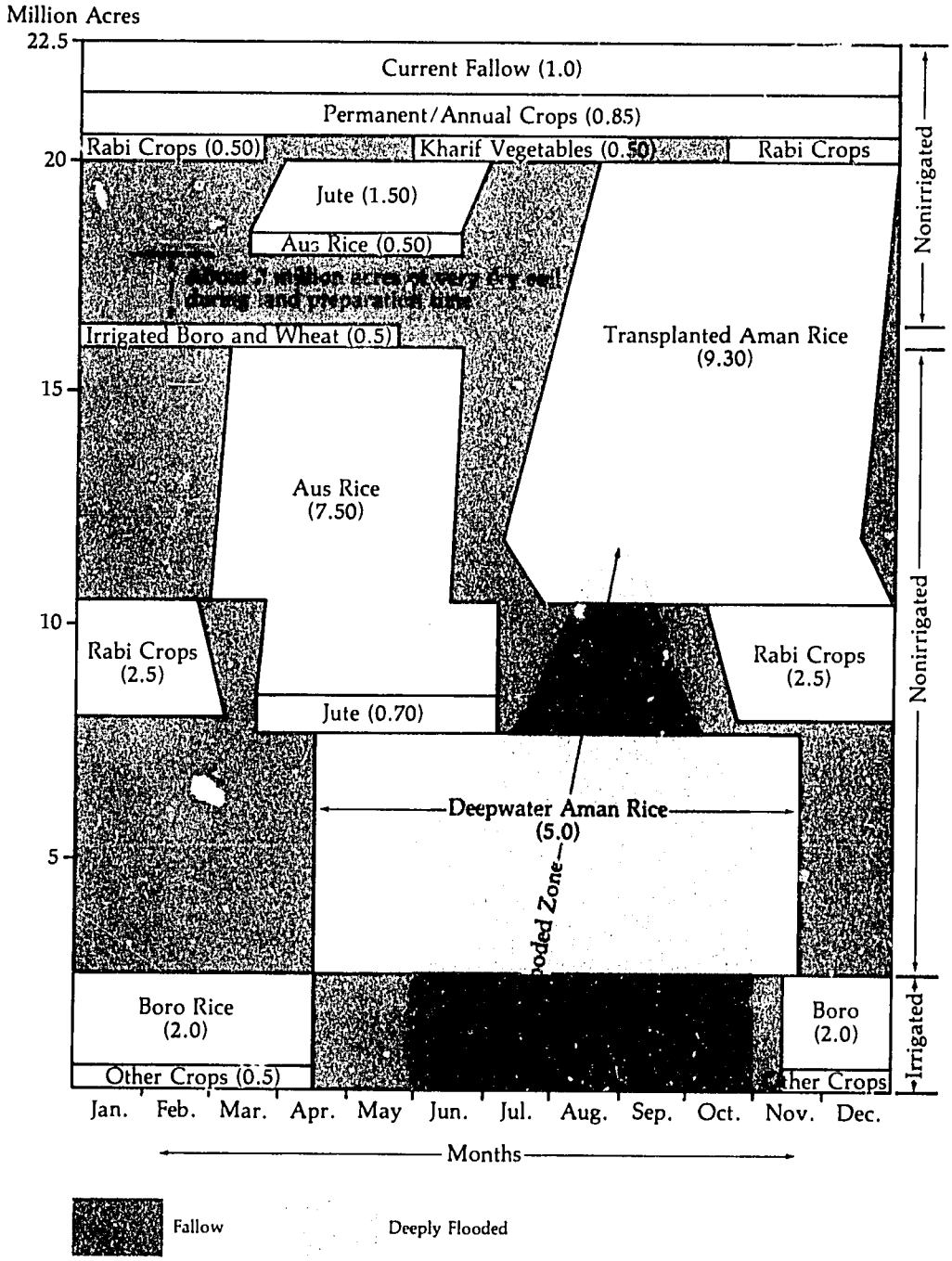
Most studies on supply response are based on Nerlovian distributed lag models with modifications.[12] Although such models are inadequate for measuring the response to changing prices or understanding the dynamic supply response in a developing country, they provide some indication of the relations between prices and the alloca-

[10] For comparison, in 1975 the per capita land/man ratios in India, Pakistan, Thailand, and Indonesia were 0.64, 0.73, 0.66, and 0.34 acres respectively.

[11] This deep-water Aman rice area was converted to Boro rice mostly by low-lift irrigation, the dominant type of irrigation in Bangladesh.

[12] Hossein Askari and John Thomas Cummings, *Agricultural Supply Response: A Survey of the Econometric Evidence* (New York: Praeger Publishers, 1976).

Figure 1—Land use and cropping pattern, 1975



Source: Based on Bangladesh, Ministry of Agriculture, "Comprehensive Land Use and Capability Survey, 1964-69." (Mimeographed.)

tion of land resources.[13]

Only two studies on the price response of rice in Bangladesh are available—one covering 1948-63 and the other, 1949-68.[14] Both found the short-run elasticity of rice acreage with respect to its price to be about 0.13. Cummings' study was the more comprehensive and analytically sophisticated. Cummings estimated the price responsiveness of rice area for the nation and for each district. The short-run elasticity for rice at the national level was highly significant and positive but was negative in 8 out of 17 districts. The weighted average short-run elasticity of rice acreage for the 8 districts (assuming a 0 supply elasticity for the others) was 0.06 compared with 0.13 at the national level. Cummings could not explain these differences. In an effort to determine the reasons for the interdistrict variations, the following variables were regressed against the estimates of short-run elasticities: proportions of rice, jute, and rabi crop areas in the total cropped area of the district; proportion of owner-operated area; proportion of farms below 2.5 acres in size which are standardized for differences in soil fertility; and the extent of deep-water flooding.[15] The results indicate that the first three factors explain about 85 percent of the interdistrict differences in the short-run price elasticities of supply when four coastal districts (Barisal, Khulna, Noakhali, and Faridpur) are excluded from the analysis. When these districts are included, the explanatory power (R^2) declines to about 0.50 and the significance of the explanatory variables also diminishes. Obviously, there must be other forces that counter the price responsiveness of farmers in these coastal districts. A likely possibility is the cyclonic hazard.

Cummings also estimated the supply response of some other crops. His estimate of the elasticity of aggregate jute area with respect to relative prices of jute is 0.40, which is close to other estimates.[16] The estimates of elasticities for all districts are positive and consistent with the national aggregate. The elasticity of supply derived from the district elasticities was 0.47—somewhat higher than that estimated using the aggregate data.

Changes in jute acreage generally accompany changes in rice acreage. Therefore, it is not unrealistic to assume a symmetric relation between changes in jute acreage relative to rice acreage and jute prices relative to rice prices.[17] With this assumption it is possible to calculate from the supply elasticity of jute that part of the supply elasticity of rice that comes through changes in jute acreage. A 10 percent fall in jute prices (therefore a 10 percent rise in relative rice prices) leads to a 4.5 percent reduction in jute area—that is, about 100,000 acres are lost to rice. This represents an increase in rice area of about 0.42 percent. The price elasticity of rice acreage shifted from jute is 0.042. For the

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[13] Marc Nerlove, "The Dynamics of Supply: Retrospect and Prospect," *American Journal of Agricultural Economics* 61 (December 1979): 874-888.

[14] John Thomas Cummings, "The Supply Response of Bangalee Rice and Cash Crop Cultivators," *Bangladesh Development Studies* 2 (October 1974): 235-251; and S. M. Hussain, "The Effect of Growing Constraint of Subsistence Farming on Farmer Response to Price: A Case Study of Jute in Pakistan," *Pakistan Development Review* 9 (Fall 1968).

[15] The estimating equation when four districts are excluded is:

$$E = \underset{(3.1909)}{82.709} - \underset{(-4.8451)}{1.544X_1} + \underset{(3.4656)}{0.5377X_2} - \underset{(-3.1213)}{0.6319X_3};$$

$\bar{R}^2 = 0.85.$

When four districts are included, the equation is:

$$E = \underset{(1.525)}{81.78} - \underset{(-2.5410)}{1.3704X_1} + \underset{(1.019)}{0.3211X_2} - \underset{(-1.02)}{0.511X_3};$$

$\bar{R}^2 = 0.50.$

where E is the index of short-run elasticity, X_1 is the extent of rice area in the total cropped area, X_2 is the proportion of owner-operated area, and X_3 is the proportion of small farms. The numbers in parentheses are t-values.

[16] A. K. M. Ghulam Rabbani, "Economic Determinants of Jute Production in India and Pakistan," *Pakistan Development Review* 5 (Summer 1965): 37-49.

[17] Symmetry is defined as changes in the area of rice and jute that are equal and absolute, but in opposite directions.

price elasticity of rice area to equal 0.09, another 116,000 acres would be required, which would have to be drawn mainly from the half million acres in vegetables and rabi crops.[18] In other words, these other crops would have to be reduced by 23.2 percent. This indicates why responsiveness of rice area to rice prices is likely to be quite small in Bangladesh.

For current policy purposes it is important to know whether the response parameters have changed since these studies were made. Following the Nerlovian model for estimating supply response, short- and long-run elasticities of rice acreage compared to relative prices of rice have been estimated for 1960/61-1977/78. Estimation procedure, data, and results are presented in Appendix 1. The estimates of short- and long-run elasticities of rice acreage compared to relative prices of rice are 0.09 and 0.12 respectively, somewhat lower than those obtained by Cummings.[19] This was expected because of the increases in the proportion of rice in the total cropped area and in the proportion of small farms.[20]

The Jute-Rice Trade-Off

In 1977/78 and 1978/79 about 48 percent of the total export earnings of Bangladesh came from jute goods and from raw jute. Foodgrains account for the largest share of commodity imports. Wheat is imported mostly under concessional arrangements (credit/grants), but rice imports are generally financed by cash.

Comparison of prices in domestic and world markets is a first step in evaluating the effect of trade options on resource allocation between the production of rice and jute. The trends of price ratios of raw jute and rice in the domestic and world markets are shown in Figure 2 and prices and price ratios in Table 1. The price trends for 1964-78 indicate that the nominal price of raw jute in the world market has increased much less than the domestic price. The price index of raw jute rose from 100 during 1965-67 to 145.4 in the world market and to 425.4 in the domestic market during 1977-79. The wide differences are primarily due to devaluations of Bangladesh currency in 1972 and 1975.[21] Moves in the world and domestic prices of rice were closer together than those of jute, though the domestic price increased at a faster rate, except in 1972/73 and 1973/74. The index of the price of rice in the world market from 1965-67 to 1977-79 increased to 197.8, whereas the domestic price index jumped to 450. These price trends clearly indicate that the devaluation of Bangladesh's currency and perhaps other factors propped up domestic jute prices relative to rice prices in the face of a nearly stagnant trend in the world price of raw jute.

Ratios of rice prices to jute prices in the world market for 1964/65-1978/79 were below 1.0, except during 1973/74 and 1974/75. In contrast, the domestic rice/jute price ratios were above 1.0 in all years except 1964/65. The price ratio in the world market represents the unit of raw jute that is required in exchange for a unit of rice. The price ratios in the domestic market may be interpreted as the domestic resource cost at the margin, measured in units of jute needed to acquire a unit of rice domestically. It is obvious from the differences between the world and domestic price ratios that a marginal acre of land in jute will finance imports of substantially more rice than would be produced on that acre. At 1978/79 price ratios, such a reallocation would imply 51 percent more rice, assuming that world demand for Bangladesh jute is infinitely elastic, which it is not.

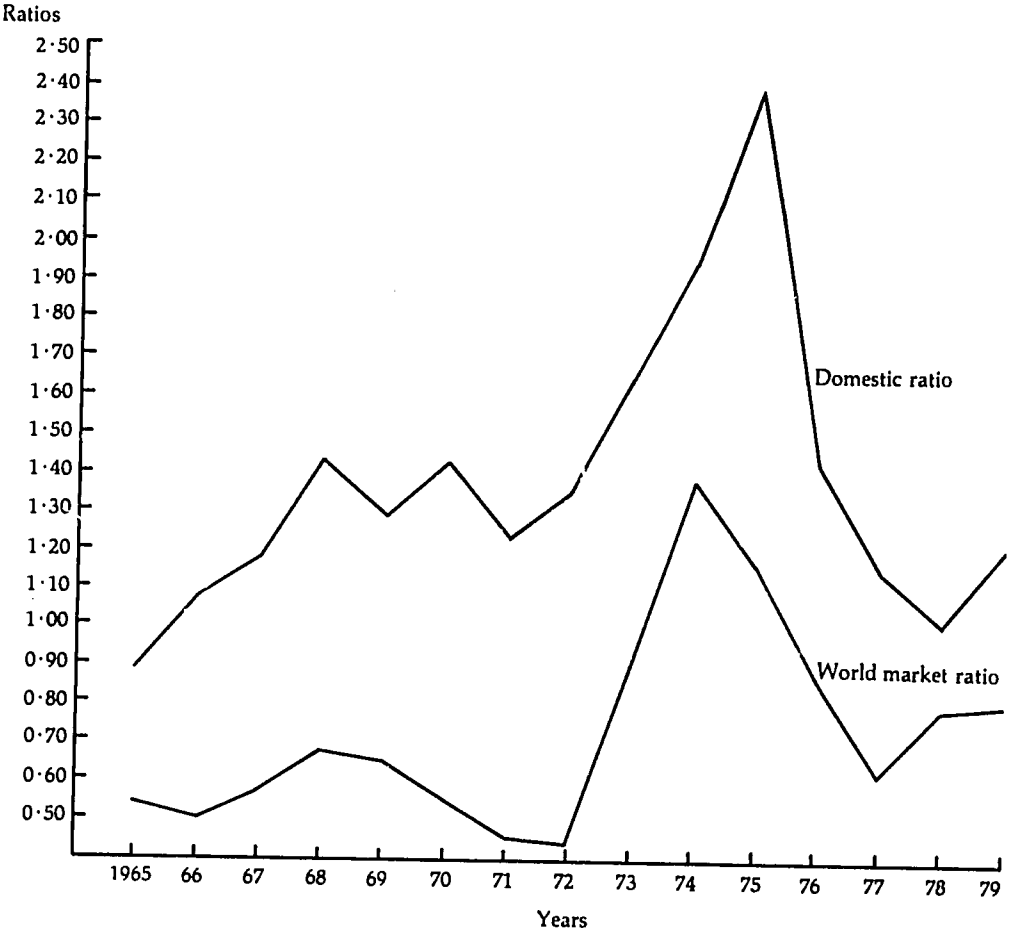
[18] Even such a shift would be subject to natural constraints. Rabi crops require less water than rice. Growing rice in the dry season without irrigation would be quite risky.

[19] Cummings, "Supply Responsiveness," p. 859.

[20] The definition of a small farm adopted in this chapter roughly corresponds to the concept of deficit farms in Chapter 6. The inverse relation between farm size and the degree of price responsiveness established here would appear to be consistent with the finding in Chapter 6 that most small farms in Bangladesh have a negative marketable surplus of rice in normal years.

[21] The Bangladesh currency, the taka, was devalued about 41 percent after the civil war ended in December 1971 and by another 47 percent in May 1975. In August 1981, 18.41 takas equalled 1 U.S. dollar.

Figure 2—Rice/jute price ratios, 1964/65-1978/79



Cost of Production

Table 22 in Appendix 1 presents the cost of production of Aus rice and jute. These estimates are based on a 1978/79 survey and were collected from the main jute-growing areas. Comparison with other studies does not show much difference in the structures of costs.[22]

The data on cost of production per unit of output indicate that seed-fertilizer technology can reduce the average cost of producing a unit of Aus rice by about 43 percent and of jute by 24 percent. Technological improvement in rice is more input-absorbing and output-increasing than in jute. The new technology increases the physical productivity (yield per acre) of Aus rice by about 182 percent and cost per acre by 62 percent. Technological improvement for jute increases yield only 38.2 percent and cost per acre 5.3 percent.[23] These differences indicate that, with expansion of irrigation, it will be increasingly difficult to expand jute production by a moderate adjustment in relative prices of jute and rice. Further technological progress in jute also will be required, which, of course, is uncertain.

[22] S. D. Choudhury and M. Ashraf Ali, *Report on Survey of Cost of Production of Jute and Aus* (Dacca: Central Jute Committee, 1962). Also see various unpublished studies by the Agro-Economic Research Unit of the Bangladesh Ministry of Agriculture.

[23] An indicator of net revenue (gross revenue minus gross cost) from the two crops also shows the superiority of rice technology over jute technology, even assuming that prices for HYV rice are 15 percent lower than for local varieties.

Table 1—Prices of rice and jute and price ratios in world and domestic markets, 1964/65-1978/79

Years	World Price of Rice[a] c.i.f.	World Price of Jute[b] f.o.b.	World Rice/Jute Price Ratio	Domestic Wholesale Price of Rice	Domestic Wholesale Price of Jute	Domestic Rice/Jute Price Ratio
	(U.S. $/ton)			(taka/ton)		
1964/65	128.1	238.5	0.537	740.0	837.2	0.884
1965/66	140.1	280.0	0.500	885.7	817.4	1.084
1966/67	172.5	298.0	0.579	1,115.7	942.0	1.184
1967/68	190.5	280.5	0.679	1,033.7	723.6	1.429
1968/69	181.7	278.5	0.652	1,166.3	904.5	1.290
1969/70	154.7	280.0	0.553	1,149.5	807.2	1.424
1970/71	127.7	280.0	0.456	1,133.6	1,009.8	1.123
1971/72	129.2	292.5	0.445	1,450.4	1,076.3	1.348
1972/73	262.3	294.0	0.892	2,269.2	1,374.0	1.652
1973/74	447.0	321.0	1.393	3,037.0	1,553.6	1.955
1974/75	423.3	362.0	1.169	6,111.1	2,464.3	2.480
1975/76	288.8	333.0	0.867	3,783.1	2,648.9	1.428
1976/77	246.3	398.3	0.618	3,367.4	2,950.4	1.141
1977/78	299.2	377.8	0.792	4,273.3	4,215.6	1.014
1978/79	326.3	410.9	0.794	4,698.8	3,880.1	1.211

Sources: Computed from Bangladesh, Bureau of Statistics, *1979 Statistical Year Book* (Dacca: Bureau of Statistics, 1979); and International Bank for Reconstruction and Development, *Price Prospects for Major Primary Commodities*, Report No. 814/80 (Washington, D.C.: IBRD, 1980).

[a] World prices of rice represent Thai 25 percent broken rice. F.o.b. prices have been converted into c.i.f. prices by increasing the f.o.b. prices by a constant proportion based on 1975/76 and 1976/77 shipping costs.

[b] Raw jute prices represent ex-Chalna/Chittagong prices for BWD grade.

World Demand for Bangladesh Jute

A recommendation to increase jute production would depend on the answers to two more questions: Would the additional production be sold in the world market at a profitable price? How can jute production be increased? Assuming that demand for Bangladesh jute at 1978/79 prices is infinitely elastic, a gain of 51 percent can be estimated from a marginal switch of land from rice to jute. However, an inelastic demand would imply a falling world price as a result of an increasing supply, thus the margin of gain would be reduced. It appears that if the price elasticity of world demand for raw jute from Bangladesh is greater than 1.9, the gain from jute at the cost of rice would be positive.[24]

The demand for raw jute is derived from that for jute goods. The price elasticity of demand for jute goods facing Bangladesh depends on the world demand elasticity, the price elasticity of supply of jute goods from the rest of the world, and the relative share of Bangladesh in the total world exports of jute goods. It can be expressed as follows:

Bangladesh's demand elasticity =

[world demand elasticity

− (rest of the world supply elasticity

× rest of the world's share)]/

Bangladesh's share.

[24] The value of demand elasticity that would imply a break-even point in the jute-rice trade-off can be found using $PJ^D/PR^D = PJ^W/PR^W$ as the optimality equation. Substituting MR_j (marginal revenue from jute sale in the world market) for PJ^W (world price of jute) gives $P_j^D/PR^D = MR_j/PR^W$. Because the prices are known, the value of MR can be derived from this. The value of elasticity of demand for jute (ED) at the optimal point is $P_j - MR_j/MR_j = 1/|Ed|$.

Grilli and Morrison estimated the world demand elasticity for jute goods to be −2.57.[25] This estimate is based on a regression equation that allows no time lag and relies on quarterly data for 1969-72. Consequently, the price elasticity may be interpreted to be short-run. The long-run elasticity would undoubtedly be much larger. The supply elasticity of the rest of the world may be about 0.5. Bangladesh's share in the total world export of jute goods was about 42 percent in 1978. With these assumptions, the short-run elasticity of world demand for jute goods facing Bangladesh would be −6.6. Assuming the long-run world demand for jute goods is 5.0[26] and keeping the other assumptions the same as for the short run, the long-run demand elasticity for jute goods facing Bangladesh would be −13.3. Thus the elasticity of demand for Bangladesh jute goods would be about two-and-a-half times larger than the elasticity of total world demand.

The world demand for raw jute can be pinpointed less precisely. Based on a theoretical derivation of demand derived from the demand for the main product (jute goods), the short-run elasticity of world demand for raw jute is guessed to be about −0.80.[27] In 1979 Bangladesh had about 64 percent of the total world raw jute export, followed by Thailand (16 percent), Burma (9 percent), and Nepal (6 percent). The short-run supply elasticity of Thai jute is known to be about 2.5.[28] Assuming this to be representative of the rest of the world, the short-run elasticity of demand for raw jute facing Bangladesh, on the basis of the previous formula, would be −2.7. The long-run demand elasticity could be still higher. These estimates, however, are too shaky to provide a good basis for making policy decisions.

The discussions so far indicate that if the distortion in price policies for rice and jute is rectified, farmers will respond positively. This implies a movement to the right along the demand curve, particularly in the short run. However, in the long run the demand curve may shift to the right, making it necessary for the government to ensure that the distortion in its price policies (such as export taxes on raw jute and import and price support policies for foodgrains) does not offset the potential effect of the demand shift. Therefore, policies for the coming years should be based on the outlook for world demand and trade for jute and jute goods (see Table 2).

According to the projection in Table 2, world trade in jute and jute goods will not grow during the 1980s, even though world consumption will increase about 0.39 percent per year during 1980-85 and 0.25 percent per year during 1985-90. Projected rapid growth in domestic consumption in producing countries, particularly in India, account for most of this increase in world consumption. For Bangladesh, however, the projection indicates that export of jute goods will increase at annual rates of 2.13 and 0.98 percent during the two periods. Part of this growth will be realized at the cost of raw jute exports, which are expected to decline at annual rates of 1.26 and 1.34 percent. Exports of raw jute and jute goods combined from Bangladesh are expected to grow 0.73 percent per year during 1980-85 and 0.10 percent per year during 1985-90.

The projected stability in the world trade for jute and jute goods during the 1980s is an impressive improvement over the 1970s when trade declined about 2.87 percent per year. The gain reflects the improved competitive position of jute with respect to synthetic substitutes. Grilli and Morrison estimated that in 1974 the rise in the price of crude oil from $1.85 to $8.00 per barrel was equivalent to a 5-8 percent rise in the average cost of synthetic substitutes.[29] At that time it was estimated that jute products would have to be 10-15 percent cheaper than synthetic substitutes to remain competitive. Since then nominal prices of crude oil have increased almost fourfold, compared

[25] Enzo R. Grilli and Ralph H. Morrison, *Jute and Synthetics*, World Bank Staff Working Paper No. 171 (Washington, D.C.: International Bank for Reconstruction and Development, 1974).

[26] Such an amount is more likely if adjusted for lag and a longer time period.

[27] International Bank for Reconstruction and Development, *Bangladesh: Current Trends and Development Issues* (Washington, D.C.: IBRD, 1979).

[28] Jere R. Behrman, *Supply Response in Underdeveloped Agriculture* (Amsterdam: North Holland, 1968).

[29] Grilli and Morrison, *Jute and Synthetics*.

Table 2—Actual and projected world production, consumption, and trade of jute and Bangladesh's share, 1960-90

Category	Actual					Projected			Growth Rates			
	1960	1965	1970	1975	1979	1980	1985	1990	1961-70	1970-79	1980-85	1985-90
	(1,000 tons)								(percent per year)			
Jute production												
World	3,574	3,560	3,617	3,232	3,660	3,780	3,875	3,925	1.10	0.13	0.50	0.26
Bangladesh	1,294	1,264	1,234	720	1,000	1,100	1,140	1,150	-0.48	-2.33	0.72	0.17
Bangladesh's share	(36.2)	(35.5)	(34.1)	(22.3)	(27.3)	(29.1)	(29.4)	(29.3)	...	...	...	...
World consumption[a]	3,571	3,531	3,451	3,608	3,665	3,765	3,840	3,890	0.11	0.67	0.39	0.26
Exports of raw jute												
World	715	1,150	872	554	502	580	550	520	1.99	-6.13	-1.06	-1.12
Bangladesh	536	722	513	280	320	410	385	360	-0.44	-5.24	-1.26	-1.34
Bangladesh's share	(75.0)	(62.8)	(58.8)	(50.5)	(63.4)	(70.7)	(70.0)	(69.2)	...	...	...	...
Exports of jute goods												
World	992	1,250	1,080	1,050	1,005	1,075	1,105	1,135	0.85	-0.80	0.55	2.43
Bangladesh	205	220	500	380	530	535	595	625	8.92	0.65	2.13	0.98
Bangladesh's share	(20.7)	(17.6)	(46.3)	(36.2)	(52.7)	(50.0)	(53.8)	(55.1)	...	...	...	...
Total exports												
World	1,707	2,400	1,952	1,604	1,507	1,655	1,655	1,655	1.34	-2.87	0.00	0.00
Bangladesh	741	942	1,013	660	850	945	980	985	1.13	-1.95	0.73	0.10
Bangladesh's share	(43.4)	(39.3)	(51.9)	(41.1)	(56.4)	(56.5)	(59.2)	(59.5)	...	...	...	...

Sources: Computed from International Bank for Reconstruction and Development, *Price Prospects for Major Primary Commodities*, Report No. 814/80 (Washington, D.C.: IBRD, 1980).

Note: The figures in parentheses are percentages.

[a] Consumption figures are given in fiber equivalents.

to a 13-14 percent increase in jute prices. Even then, jute products have lost some market to synthetic substitutes because of overcapacity in the synthetic products industries. The overcapacity no longer exists in the Western developed economies, but some increase in capacity in centrally planned economies is expected in the 1980s. These developments translate into a brighter prospect for jute goods during the 1980s.

The projected stability of world trade in jute and jute goods during the 1980s reflects constraints in production of jute more than a lack of world demand. The assumption of supply shortfalls of jute is based on its weaker competitive position with rice, which has resulted from the policies in many producing countries.[30] If these countries could increase production, world export demand for jute and jute products at constant real prices probably would increase during the 1980s.

To address the second question, what policy changes are required to bring about an increase in production of jute in Bangladesh? Comprehensive treatment of all the related issues is not possible at this time, but a few relevant measures will be discussed briefly.

The government is attempting to increase productivity in jute through seed-fertilizer technology under the Intensive Jute Cultivation Scheme program. Improved varieties of jute are being introduced in almost all districts. The scheme aims at "maintaining jute production at present levels and releasing approximately 400,000 acres for paddy growing or, alternatively, using jute's improved competitive position to capture a larger share of the world market for jute and its substitutes."[31] Because the technological development in rice is superior to that in jute, improved varieties of jute are not likely to spread to areas where they would compete for land with HYV rice. Wherever irrigation has been made available, jute has lost land to rice. However, improved varieties of jute do not require irrigation and are more competitive with unirrigated local varieties of rice.

About 80 percent of the jute production in Bangladesh comes from seven districts, with Dacca, Faridpur, Mymensingh, and Rangpur accounting for about 60 percent of the total. It seems logical that the spread of improved varieties should be concentrated in major growing areas where natural conditions provide an edge over rice. At the same time, technological improvement in rice, particularly irrigation development, should be given a higher priority in districts where jute is not a major crop. In view of the prospect that world demand for Bangladesh jute may increase during the 1980s, the policy of allowing jute area to be shifted to rice does not seem to be justified. To prevent this shift and to encourage adoption of improved varieties, the relative price of jute at the farm level has to go up. This can be done either by allowing the nominal price of jute to increase more than the rice price or by lowering the rice price relative to jute.

One plausible way of allowing the nominal price of jute to go up is to remove the export tax on raw jute, which varied from 8-11 percent of the f.o.b. prices (or 13-16 percent of farm prices) from 1975 to 1978. The export tax helps domestic jute mills procure raw jute at a cheaper price than would be possible without the tax.[32] It also generates revenue for the government. However, these results are achieved at the expense of growers and foreign customers. The tax reduces the farm price and increases the price at the export point compared to price levels without the tax.

The incidence of the tax burden for various values of demand and supply elasticities of jute is given in Table 3. It shows that the major share of the tax burden generally falls on growers. The incidence of tax burden would be larger for foreign buyers only when the elasticity of world demand for Bangladesh jute is less than

[30] The supply shortfall will influence world jute prices to go up. It is projected that the real price of jute in the world market may increase 1.46 percent per year during the 1980s. Whether this increase will be reflected on the farms depends on the government response to higher demand for jute.

[31] International Bank for Reconstruction and Development, *Bangladesh Jute Project*, Report No. 1587-BD (Washington, D.C.: IBRD, 1977).

[32] On the basis of an export tax rate of 10 percent on raw jute and a share of 62 percent for raw jute in the gross value of jute goods, the effective rate of protection of jute goods is estimated to be 16.3 percent.

Table 3—Supply and demand elasticities and shares of raw jute tax to growers and foreign buyers

Value of Demand Elasticity	Value of Supply Elasticity	Share of Tax Burden	
		Growers	Foreign Buyers
		(percent)	
0.5	0.5	50.0	50.0
1.0	0.5	66.7	33.3
1.0	0.7	58.8	41.2
2.5	0.5	83.3	16.7
2.5	0.7	78.1	21.9
3.5	0.5	87.5	12.5
3.5	0.7	83.3	16.7

Note: $|Ed|/(|Ed| + ES)$ = burden on growers and $Es/(|Ed| + ES)$ = burden on foreign buyers, where Ed is the demand elasticity and Es, the supply elasticity.

−0.5. Such a low demand elasticity is unlikely. Assuming that the most likely values of demand and supply elasticities are −2.5 and 0.5 respectively, removal of the export tax is likely to raise farm prices for jute by 9-13 percent.

There are numerous limitations to raising farm prices of jute. If jute prices cannot be raised by direct measures, it becomes imperative to moderate price policies for rice. Price support programs for rice and importation of foodgrains are two important policy tools that can be used for this purpose. Some approximations of optimal prices of rice in relation to jute will be indicated at the end of the next chapter.

4

RICE PRICES, LABOR, AND MODERN INPUTS

The previous chapter indicates that if an increase in rice production is attained through substitution of areas planted in other crops, aggregate production may not grow much. Therefore, policies designed to produce a higher relative price for rice should be based on the influence of price on the intensity of use of labor and modern inputs in rice production.

Labor productivity is one of the main determinants of how much a change in the price of a crop will affect intensity of labor use in the production of that crop. Three sets of results of an analysis of factor productivity based on concepts of average and marginal products of labor and nonlabor inputs are presented in Table 4.

Estimates under the first set are derived from a Master Survey of Agriculture on labor utilization in rice cultivation in 1964/65, which covered almost all regions of Bangladesh. The survey employed a stratified random sampling technique and collected information from 3,778 farm households. The results are, however, based on 2,251 sample households that own and operate land mostly for paddy production. This set represents traditional production conditions with only limited use of modern inputs such as fertilizer and HYV seeds. Subset 2 of this set (the northeastern region) grows mostly irrigated Boro rice without fertilizers and HYV. This is the "haor" (large depression) area of Bangladesh where seasonal shortage of labor is common.

The second set of estimates represents irrigated rice production with intense use of modern inputs. These results are based on a sample survey of 179 farms in the Low-Lift Pump Project areas in Dacca and Mymensingh districts of Bangladesh in the winter season of 1969. The nonsampling error of the survey is believed to be minimal. Average farm size in the sample was 5.3 acres, considerably larger than the average of 3.2 acres for Bangladesh in 1968. Low-Lift Pump Projects are generally organized in low-lying areas where farms are generally larger than average. The sampled farms had about 32 percent of the paddy areas sown with HYV (IR-8). However, the survey was made during the introductory phase of HYVs when farmers were receiving close supervision and advice from agricultural extension services.

The third set is based on a study by Shahadatullah using 1961 census data for districts and supplemental information from farm management studies conducted in the early 1960s.[33] The estimating techniques, assumptions, and sources of data for all the sets are presented in Appendix 2.

Figure 3 shows the marginal product curves of labor. The marginal products of labor in paddy cultivation are approximately equal to the wage rates in subsets 1, 2, and 3 of set 1 and set 2 but are much below those in subset 4, which represents central rice-jute areas. Because of the large weight of the central area in the national sample, marginal productivity of labor also is below the wage rate for all of Bangladesh (subset 5).

Theoretically, it is possible for a value of marginal product of labor to be smaller than the wage rate.[34] This could arise from the same factors that cause smaller farms to be more labor-intensive and productive than larger farms—an imperfect labor market. A comprehensive analysis of the labor market would be needed to verify the results of labor productivity as shown for the central region.

If it is assumed that there are measure-

[33] A. H. Shahadatullah, "Farm Productivity, Returns to Scale and Technological Change in a Traditional Agriculture: A Case of Bangladesh" (Ph.D. thesis, Harvard University, 1974).

[34] See Amartya K. Sen, "Size of Holding and Productivity," *Economic Weekly* 16 (February 1964); Ashok Rudra and Bela Bandopadhaya, "Marginalist Explanation for More Intense Labour Input in Smaller Farms: Empirical Verification," *Economic and Political Weekly* 8 (June 1973): 989-994; K. Bardhan, *Production Conditions in Indian Agriculture, A Study Based on Farm Management Surveys* (Cambridge: Cambridge University Press, 1974); and A. Berry and R. H. Sabot, "Labor Market Performance in Developing Countries: A Survey," *World Development* 6 (November/December 1978): 1119-1242.

Table 4—Factor productivity in rice cultivation, 1964/65 and 1968/69

Measures	Set 1[a]					Set 2[b]	Set 3[c]
	1	2	3	4	5		
Average product of labor (pounds of paddy)[d]	30.5	35.0	22.7	20.1	23.1	40.7	28.5
Marginal product of labor (pounds of paddy)	14.6	21.6	15.7	5.6	9.6	16.9	12.4
Average product of fertilizer (pounds of paddy/pound of nutrient)	n.a.	n.a.	n.a.	n.a.	n.a.	55.5	n.a.
Marginal product of fertilizer (pounds of paddy)	n.a.	n.a.	n.a.	n.a.	n.a.	10.6	n.a.
Wage rate (taka/man-day)	2.6	3.2	2.8	2.9	2.9	3.6	n.a.
Price of paddy (taka/pound)	0.1762	0.1592	0.1738	0.1786	0.1726	0.2127	n.a.
Price of fertilizer (taka/pound)	n.a.	n.a.	n.a.	n.a.	n.a.	0.63	n.a.
Average labor use (man-days/acre)	49.9	47.0	58.1	59.7	52.9	72.9	51.0
Average fertilizer use (pounds of nutrients/acre)[e]	n.a.	n.a.	n.a.	n.a.	n.a.	53.5	n.a.

Sources: Computed from analysis presented in Appendix 2. See this appendix for details. Set 1 is from Bangladesh, Bureau of Statistics, *Master Survey of Agriculture in East Pakistan*, Second Round (Dacca: Bureau of Statistics, 1964) and Bangladesh, Bureau of Statistics, *Master Survey of Agriculture in East Pakistan*, Seventh Round (Dacca: Bureau of Statistics, 1968). Set 2 is from a sample survey conducted by the Low-Lift Pump Project in 1979. Set 3 is based on 1961 census data in A. H. Shahadatullah, "Farm Productivity, Returns to Scale and Technological Change in a Traditional Agriculture: A Case of Bangladesh" (Ph.D. thesis, Harvard University, 1974).

Note: Where n.a. appears, the figures were not available.

[a] There are five subsets under Set 1. Subset 1 represents coastal belts, 2 represents the northeastern area, 3 represents western areas, 4 represents the central region, and 5 represents all of Bangladesh.

[b] Set 2 represents irrigated rice production with intense use of modern inputs.

[c] Set 3 is based on data collected by Shahadatullah.

[d] To convert from paddy to cleaned rice, use a factor of 0.67.

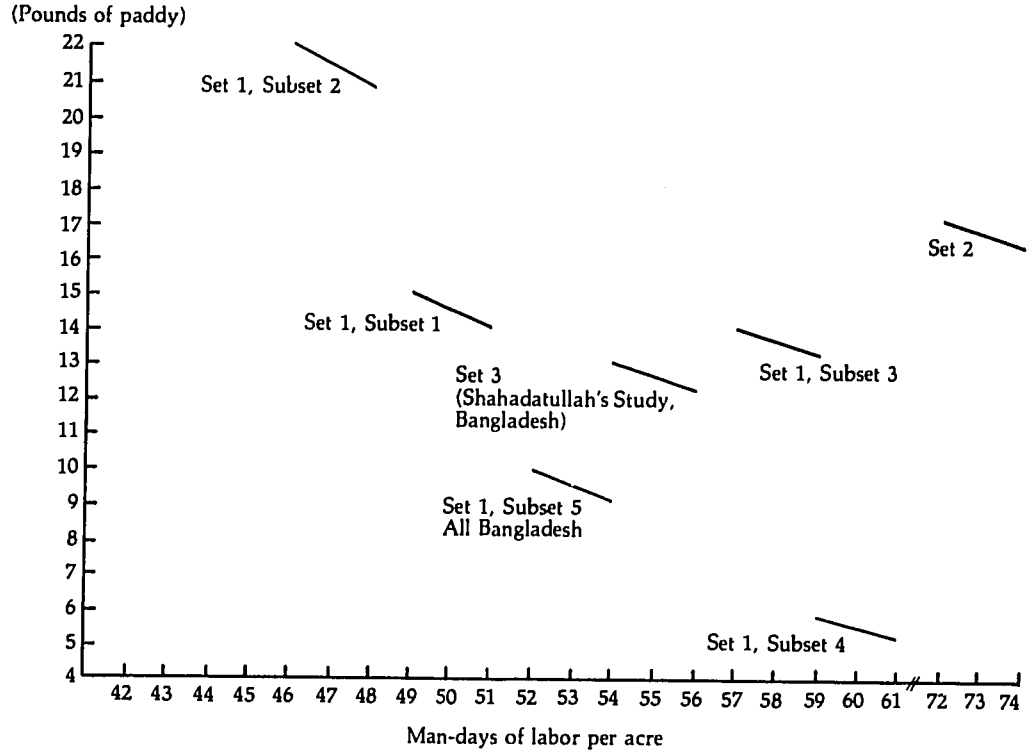
[e] To convert from nutrients to commercial fertilizer, use a factor of 2.08.

ment errors and that the analysis of the marginal product in the central region is actually close to the wage rate,[35] then the marginal product curve of this region (subset 4) would look like a continuation of the curve for subset 3. The national curve would lie between the curves of subsets 1 and 3 and nearer to the curve for set 3.

Although the estimates of labor productivity presented here come from diverse sources and cover different time periods and production conditions, they are considered valid for making general conclusions. First, the marginal product of labor is only about 12 pounds of paddy (equivalent to 8 pounds of cleaned rice) in the traditional system of rice production. The estimated elasticity of the marginal product curves ranges from −0.28 to −0.60; the average estimate of elasticity is about −0.38.

[35] This seems plausible. The coefficient of nonlabor factors in this region is much too high compared to other regions. Knowing what this factor represents, it seems unlikely that this coefficient could be so different.

Figure 3—Marginal product curves for labor in rice cultivation



Second, regional differences in the marginal product of labor indicate imperfections in the labor market that result from imperfect mobility among regions. Otherwise, interregional movement of labor would have equalized the marginal product among all regions. Imperfect mobility among regions is also suggested by the district wage rates collected by the Bureau of Statistics. However, differences in the real wage rates among subsets 1, 3, and 4 are smaller than between set 2 and the others. Set 2 represents an area somewhat isolated by large haors. Irrigated Boro rice contributes to the high marginal product of labor in contrast to other areas, but cropping is concentrated mostly in one season.

Perhaps the most interesting result is the shift to the right and upward under new technology. This is revealed by comparing labor productivity in set 2 with all subsets of set 1 and set 3. The area represented by set 2 is fundamentally different in cropping pattern and farm size from other areas in the central region. It resembles subset 2 in cropping pattern and farm size but has a more abundant labor supply. A comparison of labor productivity between set 2 and other sets and subsets indicates that the shift in the marginal product curve is of far greater importance (from the point of view of demand for labor) than any change in its slope.

The shift of the demand curve for labor as reflected in the results of set 2 depends on the spread of seed-fertilizer technology based on irrigation. Considering the elasticity of the marginal product curve for labor, it is possible to estimate the additional employment and production that would result from a lower real wage rate (via an increase in rice prices) if this increase implies only the movement along the demand curve with a perfectly elastic supply of labor. As shown in a subsequent section, a 1 percent increase in rice prices causes a 0.65 percent increase in the money wage rate of agricultural workers, which implies a 0.35 percent decline in the real wage rate. Assuming this relationship is valid, a 20 percent increase in rice prices will increase employment in rice

cultivation by 2.66 percent due to the movement along the demand curve. Such an increase in employment would increase rice production by only 1.06 percent.

Modern Technology in Rice Production

Four elements make up modern rice production technology: HYV seeds, irrigation, fertilizer, and protection against pests and diseases. The following discussions will be limited to fertilizer and irrigation, the two principal components.

HYV rice was first grown in Bangladesh in 1968/69; it covered about 15 percent of the rice area by 1977/78.[36] Only about 55 percent of the HYV rice area was irrigated but the remainder was in locations where retained soil moisture and rainfall were favorable for rice. A relatively large sample survey in 1976/77 indicated that the rate of application of fertilizer for HYV was about eight times that of local varieties (Table 5).

Comparing the rate of application of fertilizer to Boro, an irrigated variety of rice, with the nonirrigated varieties, Aus and Aman, indicates that irrigation alone causes an increase of about 28 percent in use of fertilizer. Use of NPK is much more balanced in HYV areas than in those with local varieties. Future expansion of HYV areas will depend mostly on the expansion of irrigation because most of the area suitable for rainfed HYV is already being utilized. Therefore, the impact of price policies on the expansion of irrigation will be of special importance in coming years.

Fertilizer and HYV Seeds

A study with survey data for 1969/70 shows that the percentage of farms adopting HYVs is highest in the 2.5-7.5 acre size group.[37] However, the percentages of land area allocated to HYVs decrease as farm size increases. The decrease is slow up to 7.5 acres and abrupt thereafter. A similar finding was obtained in another study in 1973 covering a larger geographical area and sample size.[38]

Results of surveys of fertilizer application by farms of various sizes, mostly by the Bangladesh Institute of Development Studies (BIDS), have been summarized by Quasem.[39] They permit several general conclusions to be drawn.

Table 5—Application of fertilizer on varieties of rice, 1976/77

Fertilizer	Aus Rice		Aman Rice		Boro Rice	
	Local	HYV	Local	HYV	Local	HYV
	(pounds per acre)					
Urea	14.0	83.7	15.2	101.8	17.7	118.4
Triple superphosphate	3.2	38.0	3.2	40.6	5.2	51.6
Murate of potash	0.3	6.6	0.4	7.6	0.2	7.0
Total	17.5	128.3	18.8	150.0	23.1	177.0

Source: Bangladesh, Ministry of Agriculture, Agro-Economic Research, *Bangladesh Agriculture in 1976/77* (Dacca: Ministry of Agriculture, 1977).

Note: HYV is high-yielding variety.

[36] Bangladesh, Bureau of Statistics, *1979 Statistical Year Book* (Dacca: Bureau of Statistics, 1979). Because statistics on area of HYV rice appeared to be exaggerated, a task force was organized by the Ministry of Agriculture in 1976. The exaggeration was confirmed, and the 1977/78 statistics on HYV rice area were adjusted accordingly.

[37] M. Muqtada, "Seed Fertilizer Technology and Surplus Labor in Bangladesh Agriculture," *Bangladesh Development Studies* 3 (October 1975).

[38] M. D. Asaduzzaman and Faridul Islam, *Adoption of HYV in Bangladesh: Some Preliminary Hypotheses and Tests*, Research Report 25 (Dacca: Bangladesh Institute of Development Studies, 1973).

[39] Md. Abul Quasem, "Factors Affecting the Use of Fertilizers in Bangladesh," *Bangladesh Development Studies* 6 (Monsoon, 1978): 331-338.

Farms less than 2.5 acres in size use more fertilizer per acre of cultivated area sown with local varieties grown under nonirrigated conditions than medium farms (between 2.5 and 5.0 acres) or large farms (more than 5.0 acres). The relation between farm size and fertilizer application appears to be negative. Within the small farm group, however, there is a positive relation between farm size and intensity of fertilizer application. This indicates that very small farms (1.0 acre or less) use less fertilizer than larger ones in the same size group. If the intensity of fertilizer application is measured as the amount of fertilizer applied per cropped acre instead of cultivated acre, the relation between farm size and intensity of fertilizer application becomes much less significant. It appears to be similar to the relation between farm size and intensity of use of labor and lands.

Under irrigated conditions in general, and with irrigated HYV rice in particular, the inverse relation between farm size and intensity of fertilizer application no longer holds true to any significant extent. In fact, under these conditions fertilizer application per acre of cultivated area appears to be significantly higher for medium farms than for small farms. However, the difference between small and large farm groups is not so significant.

The foregoing results indicate that given the opportunity, medium and large farms in Bangladesh would adopt modern inputs at a faster rate than small farms. However, opportunity depends on development of irrigation.

These studies of the intensity of fertilizer use by farm size enable indirect inferences to be drawn on the impact of rice prices on fertilizer use. Direct inferences can perhaps be deduced from interdistrict differences. Fertilizer use per acre of cultivated area in 1978/79 ranged from about 20 pounds in Faridpur to about 264 pounds in Chittagong (see Table 6). Topography, soil type, and extent of flooding influence the basic cropping pattern and the potential for fertilizer use. Another set of factors includes size of irrigated area, use of HYVs, tenancy types, labor intensity, income levels, and agricultural prices. Agricultural credit, extension services, and research are important determinants of fertilizer intensity, but generally do not vary significantly among districts. Perhaps the most important causal factors are those that determine the availability of fertilizers at farm levels at appropriate times. The interplay of these factors must be considered in determining the effect of prices on the intensity of fertilizer use.

Demand Factors. The intensity of use of fertilizer in a district, the dependent variable (DFA_i), measured by pounds of fertilizer per acre of net cropped area, is hypothesized to be a function of the following demand and supply factors:

IRT_i = extent of irrigated area measured as a proportion of cultivated area in the i^{th} district;
HYV_i = extent of area under HYVs of rice measured as HYV area as a proportion of total rice area in the district;
CRP_i = proportion of transplanted Aman rice (local varieties), sugarcane, and vegetables in the total net cropped area;
AUS_i = proportion of Aus rice (local varieties) in the total net cropped area;
JUT_i = proportion of jute in the net cropped area;
FLD_i = extent of flooding measured by the proportion of deep-water Aman area in the district;
TEN_i = extent of tenancy measured by the proportion of owner-operated area per acre of cultivated land area;
LLB_i = land/labor ratio measured by the cultivated land area per agricultural worker; and
INC_i = per capita income measured by the value added in agriculture deflated by the district population.

Supply Factors. The general policy of the government is to maintain a uniform farm price for fertilizer throughout the country. Storage facilities have been developed in all districts, but it has not always been possible to distribute them according to regional demand for fertilizer. The common pattern is to place main storage godowns at railway heads, ports, major highways, and near major centers of commerce. One reason for this pattern is that in the 1960s most fertilizer was imported and had to pass through major transportation systems. Another reason was the availability of trucking and other transportation services near important commerce centers. To correct the imbalances between the locations of demand and major storage points, small godowns were constructed or rented in all thana. (A thana is the lowest

Table 6—Intensity of fertilizer use and paddy prices by district, 1975/76-1978/79

District	1975/76		1976/77		1977/78		1978/79	
	Fertilizer Per Acre	Paddy Price	Fertilizer Per Acre	Paddy Price	Fertilizer Per Acre	Paddy Price	Fertilizer Per Acre	Paddy Price
	(pounds)	(taka/maund)	(pounds)	(taka/maund)	(pounds)	(taka/maund)	(pounds)	(taka/maund)
Dacca	92.92	71.91	98.67	67.84	128.04	81.08	145.77	96.38
Kishoreganj	71.08	61.75	80.32	62.69	112.72	74.49	126.44	88.80
Mymensingh	44.70	68.78	47.33	59.97	79.19	78.48	81.96	83.37
Tangail	54.83	71.48	58.76	65.88	78.44	80.64	81.19	92.90
Faridpur	10.18	77.28	15.94	83.82	19.46	85.12	20.14	92.97
Chittagong	165.73	66.01	190.31	65.30	232.09	78.10	264.22	97.16
Chittagong Hill tracts	34.33	66.10	35.43	63.62	41.95	76.35	55.93	95.12
Noakhali	60.80	72.01	67.23	65.63	87.50	80.15	90.56	90.38
Comilla	113.40	68.84	126.26	64.85	169.31	81.59	175.23	87.75
Sylhet	19.13	61.02	28.69	63.14	31.04	75.19	32.13	82.21
Rajshahi	28.21	66.61	36.75	61.23	47.04	79.60	48.66	79.62
Denajpur	41.11	66.27	48.31	55.98	85.38	77.71	73.64	77.05
Rangpur	28.40	63.69	36.43	56.00	57.16	76.50	49.27	71.33
Bogra	76.27	65.73	107.30	60.14	129.00	77.49	131.00	83.04
Pabna	44.41	72.93	45.29	63.83	68.90	81.66	71.84	90.42
Khulna	15.02	65.00	17.86	62.79	36.87	81.30	35.91	84.71
Barisal	40.31	70.66	25.35	59.54	54.91	77.62	57.06	84.70
Patuakhali	20.11	68.08	12.15	61.16	25.88	78.38	27.39	83.98
Jessore	28.43	75.69	37.74	62.65	38.55	78.91	39.90	84.15
Kushtia	56.35	76.91	75.46	61.37	75.59	77.76	78.25	96.22

Sources: Bangladesh, Bureau of Statistics, *1979 Statistical Year Book* (Dacca: Bureau of Statistics, 1979); Bangladesh, Bureau of Statistics, *The Year Book of Agricultural Statistics (1976/77)* (Dacca: Bureau of Statistics, 1978); and various mimeographed price bulletins from the Bangladesh Department of Marketing.

Note: Fertilizer is in commercial form. Per acre means per acre of net cropped area. One maund equals 82.29 pounds.

administrative unit, comprising about 90-100 villages.) From the thana godowns, fertilizer can be distributed to farmers through private dealers who are small businessmen in villages.

This system has not solved all supply problems at the farm. After rainfall, farmers rush to buy fertilizer, and stocks at the thana godowns are exhausted quickly. By the time replenishment arrives from higher points in the distribution system, the demand for fertilizers has diminished with the drying up of land. The probability of timely supply is much better, of course, when the thana godowns are near major storage points. With these considerations, the storage capacity per unit of cultivated area in a district (STQ_{ij}) is included as an explanatory variable. The simple correlation coefficient between this variable and the number of registered trucks per acre of cultivated area in the districts is very high (0.87). This would imply that STQ_{ij} really represents a broad category of rural infrastructure.

Price Variable. An "agricultural price" deflated by the index of fertilizer price is used as the explanatory price variable (PRC_j). The agricultural price is a composite of paddy, jute, sugarcane, and potato prices expressed as an index number. Paddy prices for Aus, Aman, and Boro rice weighted by the proportion of each in the total paddy production of each district are used to compute weighted average prices. Then the weighted average agricultural commodity price index is constructed from the indexes of paddy and other crop prices. Prices in one of the districts used as 100 and the proportions of rice, jute, sugarcane, and potatoes in the total value of these crops are used as weights.

Estimation of the Model. Data for each of the four years from 1975/76 to 1978/79 for the 20 districts are pooled for the estimation of the model.[40] In the first attempt all variables are included in a number of functional forms. The linear form is found to give the best fit; the value of corrected R^2 is as high as 0.88. But, for obvious reasons, some of the coefficients are not significant. On the basis of analysis of correlation matrices of the variables and stepwise regressions, it is observed that IRT provides the best representation for HYV. Similarly, FLD could serve as a substitute for cropping patterns (CRP, AUS, JUT).[41] Either the FLD or the crop variables should be included as explanatory variables, but not all at the same time. Exclusion or inclusion of INC and TEN does not make any significant difference in the values of the coefficients and R^2, and their coefficients are also statistically insignificant. Various experimentations with variables indicate that the coefficients of IRT, STQ, LLB, PRC, and CRP are quite stable and always remain statistically significant. The final results of the analysis are presented in Table 7.

The elasticity of DFA with respect to PRC, as shown in Table 7, is 1.09. With various sensitivity trials, this elasticity is found to range from 0.90 to 1.20.[42] When this fertilizer elasticity is converted to production elasticity (that is, the percentage change in rice production due to a percentage change in rice price), the production elasticity ranges from only 0.10 to 0.18,[43] mainly because of the low base of fertilizer application. This range implies that a 10 percent rise in paddy prices may result in an additional 150,000-200,000 tons of rice, if other conditions do not work against it.

Lack of development of irrigation, rural storage and transportation, and flood control constrains expansion of profitable crops;

[40] The equation is DFA = f(IRT, HYV, FLD, TEN, INC, LLB, STQ, PRC, CRP, AUS, JUT).

[41] This is more so for CRP than for AUS and JUT.

[42] Should this estimate be considered a short-run or a long-run elasticity? This question arises because farmers need time to adjust allocations of their resources to a new profit situation. Factors such as risk, new knowledge of fertilizer use, and interaction of structural constraints (FLD, IRT, LLB, TEN, STQ) as well as the new profit situation influence farmers' adjustment. The relationship between the intensity of fertilizer use and agricultural prices is based primarily on cross-section data. Therefore, the price response may be interpreted as a quasi long-run elasticity, reflecting the adjustment for risk, and, at least partly, the interaction among prices and structural constraints. A full account of the long-run elasticity should, however, include the effect of interaction of agricultural extension (the spread of knowledge of fertilizer use) and the new situation of profitability.

[43] In deriving production elasticity from fertilizer elasticity, the relevant parameter from the estimated production function presented in Appendix 2 is used in conjunction with the estimates made in Raisuddin Ahmed, *Foodgrain Production in Bangladesh: An Analysis of Growth, Its Sources and Related Policies* (Dacca: Bangladesh Agricultural Research Council, 1977).

Table 7—Results of the regression model explaining fertilizer use in districts, 1975/76–1978/79

Variables	Coefficients	t-Values	Mean	Elasticities
Constant term	-28.925	-0.7602	1.00	...
IRT	1.7284	4.4885	15.87	0.397
CRP	0.3154	2.6041	43.83	0.200
LLB	-0.4792	3.0536	135.01	-0.937
STQ	0.5654	8.0608	45.55	0.373
PRC	0.7746	4.1678	97.60	1.109
AUS	0.3735	1.6672	39.52	0.214
JUT	0.0612	0.4582	9.48	0.009

Notes: R^2 (corrected) = 0.79; Durbin-Watson statistics = 2.200.

these factors appear important for increasing production through intensive application of fertilizers. A recent study by the Bogra Academy for Rural Development shows much higher fertilizer use around the main centers of transportation than in isolated areas with comparable agroclimatic environment and farm sizes.[44] The results indicate that price incentives can stimulate a modest increase in production in the short run. However, a sustained long-run growth cannot be achieved without an improvement in water and transportation infrastructures in combination with price incentives. The highly significant coefficients of IRT, STQ, and CRP support this conclusion.

Factor proportion, reflected in the LLB, appears to be significant in explaining inter-district differences in use of fertilizers. This result is consistent with microstudies discussed earlier. One plausible reason is that farms with a low LLB have an intense need for augmentation of land. Fertilizer helps meet this need.

Investment in Irrigation

The impact of a higher rice price on agricultural investment and production can be traced by evaluating the patterns of surplus utilization by farms of various sizes. Surplus is defined as the excess of net income over necessary consumption expenditures. The patterns of surplus utilization found in a recent investigation are presented in Table 8. Productive investment is defined as investment directly bearing on agricultural production. An earlier study shows the same overall pattern as Table 8.[45] Unfortunately, such studies are rare in Bangladesh.

Small farms have a surplus of 4-9 percent of their income compared with 38-45 percent for large farms. However, small farms utilize 40-70 percent of their surplus on agriculturally productive investment, large farms only about 12-18 percent. The latter use proportionately more of their surplus for buying land, trade and business, and acquisition of financial assets. All farms spend 11-19 percent of their surplus on social ceremonies. The surplus spent on agriculturally productive investment by small farms is mostly for replacement of the basic structure, equipment, or draught animals necessary for cultivation. It is not large in either absolute or net terms.

Rahman found that relative profitability does not explain why large farms do not invest a larger proportion of their surplus in agriculture.[46] The main reason is lack of investment opportunities. This is, however, enmeshed with complex structural constraints that cannot be corrected simply by raising prices.

First, modern irrigation is the main investment item in agriculture and is a leading

[44] Nurul Hoque, *Use of Fertilizers by Small Farms in Bogra* (Bogra: Bangladesh Academy for Rural Development, 1980).

[45] M. Habibullah, *Some Aspects of Rural Capital Formation in East Pakistan* (Dacca: Bureau of Economic Research, Dacca University, 1963).

[46] Atique Rahman, "Agrarian Structure and Capital Formation: A Study of Bangladesh Agriculture" (Ph.D. thesis, Cambridge University, 1979).

Table 8—Pattern of surplus utilization by farm size in two rural districts, 1973/7

Income, Surplus, and Heads of Investment	Mymensingh			Comilla		
	Large Owners[a]	Small Owners[b]	Tenants[c]	Large Owners[a]	Small Owners[b]	Tenants[c]
Income (taka/household)	21,998	5,406	6,769	22,955	4,839	5,248
Surplus (taka/household)	9,883	239	329	8,761	336	473
Surplus as percentage of income	44.9	4.4	4.8	38.2	6.9	9.0
			Surplus Utilization (percentage of surplus)			
Nonproductive investment						
Land purchase	7.7	-9.0	-50.8	22.8	-26.2	-28.3
Acquisition of financial assets	9.7	1.5	18.1	9.1	6.1	6.9
Acquisition of durable consumer goods	18.1	23.9	22.8	8.6	34.1	38.3
Construction and repair other than agricultural	14.5	5.8	14.6	9.7	12.4	12.9
Education	5.1	5.1	4.6	4.0	6.9	6.3
Social ceremony	19.1	6.9	17.1	17.8	11.1	18.6
Trade and business	12.5	1.5	2.7	9.7	3.4	6.6
Miscellaneous	1.0	0.9	1.7	0.6	1.2	1.5
Total	87.6	36.0	30.3	82.3	49.1	62.8
Productive investment						
Agricultural implements	1.0	12.7	12.7	4.6	10.9	8.3
Draught animals	5.9	5.4	23.1	2.9	11.2	9.7
Irrigation	1.9	4.7	9.5	2.9	8.2	4.6
Land improvement	1.4	30.2	17.4	2.6	10.8	5.9
Agricultural construction	1.4	10.1	5.4	3.7	7.4	4.6
Miscellaneous	0.7	0.7	1.5	1.0	2.3	1.2
Total	12.4	64.0	69.6	17.7	50.9	37.3

Source: Compiled from Atique Rahman, "Agrarian Structure and Capital Formation: A Study of Bangladesh Agriculture" (Ph.D. thesis, Cambridge University, 1979).

[a] Large owners are farmers with more than 7.5 acres.

[b] Small owners are those with less than 2.5 acres.

[c] Tenants are those who have some rented land.

factor in the expansion of the use of HYVs and fertilizers. But even a small shallow tubewell of less than half a cusec capacity requires about 10 acres for efficient operation. Very few farms have this much land. Moreover, plots are scattered over wide areas. A few large farms in northern Bangladesh have invested in irrigation with the objective of selling water to others as well as irrigating their own land. This practice has been observed in the adjoining West Bengal province of India,[47] but sales are generally limited to kin or to associates in village politics. The area affected by this practice remains extremely small.

Second, appropriate infrastructure is a prerequisite for successful private investment in modern, small-scale irrigation devel-

[47] K. F. Jalal, Raisuddin Ahmed, and Shaziruddin Ahmed, *Tubewell Irrigation: A Report Based on the Visit of Bangladesh Study Team to India* (Dacca: Planning Commission, 1974).

opment. Facilities for repairs, servicing, and installation of pumps and tubewells as well as expansion of rural electrification are needed. These activities are seldom undertaken by the private sector in the initial stage of development. Efforts to attract private capital were initiated in the late 1960s. Tubewells and low-lift pumps are rented to groups or cooperatives and are paid for in installments.

The experience of 1976/77 is an interesting illustration of the influence of price and nonprice factors in the use of modern inputs. In 1976/77 the harvest prices of paddy dropped by 10-20 percent from the previous year in almost all districts. A similar fall in the number of low-lift pumps was also observed. This phenomenon has been interpreted by some as clear evidence of the disincentive effect of price.[48] A close examination of the statistics, however, shows that the number of low-lift pumps for irrigation increased by about 9 percent in 9 districts and declined by about 22 percent in 10 districts. The price of paddy declined in all districts; the price decline was slightly sharper in the 9 districts where the number of pumps increased than in the other 10 districts where the number of pumps decreased. Irrigation efficiency measured by the irrigated area per pump, however, indicates that the performance was better in 1976/77 than in the previous year. What really happened was that many inefficient pumps based on shallow water sources were not utilized in 1976/77 because water was insufficient. Early recession of floodwater resulted in lower than normal levels of retained water in some areas of Bangladesh. However, inadequate availability of water was not a cause of the shortfalls in irrigation in 1976/77 in the southern districts (for example, Barisal and Patuakhali). In these districts, lower paddy prices attracted many rich farmers, who generally provide leadership in the organization of pump groups, to invest in speculative buying of paddy rather than investing in low-lift irrigation. Therefore, the lower paddy price in 1976/77 definitely had some disincentive effect on utilization of pumps in that year.

In recent years the government has encouraged participation by the private sector in irrigation development. Pumps and tubewells are being sold to private groups or individuals who have credit available from financial institutions. Attempts are being made to develop capacities for installation and servicing of irrigation equipment. The Integrated Rural Development Program (IRDP) has organized farmers into groups or cooperatives to help them raise capital, install tubewells or pumps, solve disputes, and construct distribution channels. This has demonstrated the need for rural organizations in creating effective demand for irrigation equipment. Nearly all applications under phases 1 and 2 of the Shallow Tubewell Sale Program, which requires a 10 percent down payment, were from IRDP cooperatives or groups.[49] As of September 30, 1980, about 2,400 approved applications were awaiting delivery, 50 percent of them for more than eight months. In contrast, commercial banks sold only 16 shallow tubewells (STWs). Sales to groups approved by IRDP also exceeded those of banks and organizations (BADC) that generally sell to individuals.

The new HYV rice technology introduced on a limited scale in 1968/69 contributed to the success of IRDP in generating demand for irrigation equipment through private-sector investment. Due to the turmoil of civil war, political chaos, and natural disaster, however, the new technology did not spread rapidly until after 1970.

The relation of rice prices to the creation of institutions like IRDP and the adoption of new technology is difficult to establish. However, it is clear from earlier discussions that appropriate price incentives can accelerate the spread of technology and increase the effectiveness of such institutions as IRDP.

Toward an Optimal Price for Rice

As indicated previously, rice and jute prices would move toward an optimal relation if policies were corrected so that the rice-jute price ratio on the domestic market was

[48] Edward J. Clay, "Food Aid and Food Policy in Bangladesh," *Bangladesh Journal of Agricultural Economics* 1 (December 1978): 107-120.

[49] Bangladesh, Ministry of Rural Development, *Integrated Rural Development Program: A Joint Review by the Government and the World Bank* (Dacca: Integrated Rural Development Program, 1981).

close to the ratio on the world market. Two policy options were considered: increasing the domestic price of jute by eliminating the export tax on it, and lowering the domestic price of rice by increasing foodgrain imports. The results are presented in Table 9. The estimation procedure is explained in Appendix 3. The initial values in the table are the average levels of the variables for the period 1976/77 through 1978/79.

The following policy simulations are attempted: Under policy 1 the export tax on jute is eliminated without allowing the domestic price of rice to fall. Maintenance of a stable rice price implies additional imports of rice.

Under policy 2 the export tax on jute is eliminated and the domestic rice price is reduced by 10 percent by means of a required volume of foodgrain imports. The world prices of jute are held constant at the levels of policy 1. This requires an export subsidy on jute so that additional production can be sold in the world market.

Policy 3 is similar to policy 2 except that the subsidy on jute exports is not allowed;

Table 9—Effects of hypothetical policies on prices and production of jute and rice

Variables	Initial Values[a]	Solutions with Policy 1[b]	Solutions with Policy 2[c]	Solutions with Policy 3[d]	Solutions with Policy 4[e]	Solutions with Policy 5[f]
Domestic wholesale price of jute (taka/ton)	3,682	4,226	4,226	3,917	4,226	3,939
World price of jute (taka/ton)	6,331	5,999	5,639	5,690	5,348	5,712
Domestic wholesale price of rice (taka/ton)	4,113	4,113	3,702	3,702	3,368	3,368
World price of rice (taka/ton)	4,650	4,650	4,650	4,650	4,650	4,650
Imports of foodgrains (1,000 tons)	1,600	1,676	2,620	2,582	3,386	3,351
Exports of jute (raw) (1,000 tons)	481	549	638	623	710	620
Production of rice (1,000 tons)	12,292	12,216	11,911	11,949	11,663	11,698
Production of jute (1,000 tons)	1,002	1,076	1,159	1,144	1,231	1,141
Domestic rice/jute price ratio	1.12	0.97	0.88	0.94	0.80	0.85
World rice/jute price ratio	0.74	0.76	0.79	0.82	0.87	0.81
Export tax on jute (taka/ton)	633	0	0	0	0	0
Total foodgrain supply	13,892	13,892	14,531	14,531	15,049	15,049
Gain in foreign exchange (1)[g] (U.S. $)	...	3.41	-241.11	-234.9	-442.5	-459.3
Gain in foreign exchange (2)	...	9.80	-155.14	-152.13	-292.0	-311.7
Loss of government revenue[h] (million taka)	...	352.9	1,934.8	1,333.6	3,939.8	2,724.4

Sources: Estimated following procedures described in Appendix 3.

[a] Initial values represent averages of 1976/77 and 1978/79.

[b] Export tax on jute is eliminated but rice price is kept stable through rice imports.

[c] Export tax on jute is eliminated and domestic price of rice is reduced. Export subsidy on jute stabilizes world jute price.

[d] Same as policy 2 but there is no export subsidy on jute to stabilize prices.

[e] Export tax on jute is eliminated and domestic rice price is reduced by 18 percent by controlling the volume of rice imports. An export subsidy stabilizes world jute prices.

[f] Same as policy 4 except that there is no subsidy on jute. Market forces govern jute prices, production, and exports.

[g] Gain in foreign exchange (1) is based on exports of jute and imports of rice; gain in foreign exchange (2) is based on exports of jute and imports of wheat (the rice-wheat substitution rate is 1:1.42).

[h] Loss of government revenue incorporates loss of tax revenue, subsidies on rice imports, and the jute export subsidy.

therefore, market forces determine jute prices, production, and exports.

Policy 4 eliminates the export tax on jute and reduces the domestic rice price by 16 percent (to the actual level of 1976/77) through a required volume of foodgrain imports. The world prices of jute are held at the level of policy 1. This again implies an export subsidy on jute.

Policy 5 is similar to policy 4 except that the export subsidy is not allowed and market forces determine production, prices, and exports of jute.

The analysis assumes no changes in income, technology, or any factor other than the selected variables. The domestic demand for raw jute used by domestic mills is assumed to be constant. These mills are mostly publicly owned and their utilization of jute is not as sensitive to market forces as that of private mills. The proportion of marketing costs is also assumed to be constant.

The analysis indicates that elimination of the export tax and a slight increase in foodgrain imports would partly correct the imbalance in rice-jute price ratios in domestic and world markets. Further improvement would require a reduction in the price of rice through larger imports of foodgrains. Keeping the jute market free from taxes and approximately doubling foodgrain imports would correct relative prices. However, lowering the rice price to or below the 1976/77 level would cause a distortion in the opposite direction. This level, with jute prices at the 1976/77-1978/79 average or slightly lower, appears to be the maximum reduction for rice prices.

Policies designed to close the gap between rice-jute price ratios in domestic and world markets do not appear feasible. They can be adopted only if foodgrains are available through food aid programs or through increased domestic production at the lower price. Such an increase in domestic production may be achieved by accelerating the spread of technology in areas outside the main jute-growing districts and in types of rice that do not compete with jute. Lowering foodgrain prices increases the demand for foodgrains. Imports would require more foreign exchange than would be gained from expanded jute exports. Similarly, the cost involved in importing foodgrains and an export subsidy for jute could not be accommodated easily in the government budget. Equalization of the rice-jute price ratios in domestic and world markets by increased importation of foodgrains seems impracticable, although the gap could be considerably reduced by eliminating the export tax on jute. In this connection it may be pointed out that the implicit tax on jute may exceed the direct tax. This is indicated by the large gap between the world price and the domestic wholesale price, which is not explained by the marketing margin between wholesale and f.o.b. prices of jute, including taxes. Elimination of the direct tax and improvement of marketing conditions that may have been acting as implicit taxes on jute are practical policy measures that can be implemented at relatively low cost. Furthermore, the expected increase in world demand for Bangladesh jute would bring prices of rice and jute nearer an optimal relation if export taxes were eliminated.

5

MARKETABLE SURPLUS AND PRICE POLICIES

The distribution of the marketable surplus is determined by farm organization. The first step in determining how much of the gains from higher prices are plowed back into production is to identify the farms that generate the surplus. The size of the marketable surplus is an indicator of interaction between farm and nonfarm sectors. Literature on development economics attributes to marketable surplus a relaxing effect on the wage-good constraint on industrialization. Dobb singles it out as the fundamental limiting factor on the pace of development.[50] Lele and Mellor, working with Indian data, demonstrate that contraction of the marketable surplus adversely affects employment in the nonfoodgrain sector.[51]

Studies on the marketable surplus of rice in Bangladesh are mostly inadequate, sketchy, and outdated. Rauquibuzzaman, however, shows that the size of the marketable surplus of rice is mainly determined by domestic production and that price has an insignificant influence. He estimates that only about 10 percent of gross production was marketed surplus in 1964/65.[52] According to the Master Surveys of Agriculture, about 13 percent of the gross production of rice in the early and mid-1960's was the gross marketable surplus, with actual sale about 10 percent.[53] Sixty-one percent was consumed at home, about 9 percent was used for seed, feed, or was wasted, and about 17 percent was for nonmarket disposal, including payment of rent. These surveys do not indicate how much of the rice paid as rent was received by farmers and thus available for sale or on-farm consumption. Moreover, surveys do not provide estimates of the marketable surplus by farm size. Some recent, limited studies indicate that the marketed surplus of rice has increased in recent years.[54]

Table 10 presents estimates of the net marketable suplus of rice for 1973/74 by farm size. The net is defined as the gross marketable surplus less that purchased by farmers. The gross is defined as the surplus in production after payment of net rent and on-farm utilization for seed, feed, and human consumption, including water. The gross marketable surplus can be 0 but not negative. The difference between the gross and the net represents transactions within the farm sector. The procedure is described in Appendix 4.

In 1973/74 the aggregate gross and net marketable surpluses were 21.5 and 18.1 percent of gross production. Therefore, 3.4 percent of gross production (or 15.8 percent of the gross marketable surplus) of rice was exchanged within the farm sector. About 53 percent of farm households with about 41 percent of farm population and 19 percent of farmland were net buyers of rice. Seventy-seven percent of the gross marketable surplus came from 15 percent of the farms in the country tilling about 44 percent of the total cultivated land and producing 39 percent of total production. Distribution of the gross

[50] Maurice Dobb, *Some Aspects of Economic Development: Three Lectures* (Delhi: Delhi School of Economics, 1955).

[51] Uma Lele and John W. Mellor, "Technological Change, Distributive Bias and Labor Transfer in a Two-Sector Economy," *Oxford Economic Papers*, forthcoming.

[52] M. Rauquibuzzaman, "Marketed Surplus Function for Major Agricultural Commodities in Pakistan," *Pakistan Development Review* 2 (No. 3, 1968).

[53] Bangladesh, Bureau of Statistics, *Master Survey of Agriculture in East Pakistan*, Second Round (Dacca: Bureau of Statistics, 1964); Bangladesh, Bureau of Statistics, *Master Survey of Agriculture in East Pakistan*, Sixth Round (Dacca: Bureau of Statistics, 1966); Bangladesh, Bureau of Statistics, *Master Survey of Agriculture in East Pakistan*, Seventh Round (Dacca: Bureau of Statistics, 1968).

[54] An unpublished survey on Aman rice in 1976 by the Bangladesh Agricultural Marketing Department indicates that the marketed surplus in that crop was 33 percent. Marketed surplus represents gross sales regardless of repurchase and current production, whereas marketable surplus is the quantity of current production left after on-farm use and payments in kind.

Table 10—Net marketable surplus of rice by farm size, 1973/74

Farm Size[a]	Gross Production	On-Farm Use	Net Payment of Rent[b]	Available for Consumption and Sale	Total Consumption	Net Surplus	Net Surplus as Share of Gross Production
(acres)				(1,000 tons)			
Less than 0.34	59	4.8	3.0	51.2	116.7	-65.5	-110.0
0.35–0.56	158	13.0	8.1	136.9	230.8	-93.9	-59.4
0.57–0.89	346	29.4	18.1	298.5	394.2	-95.7	-27.7
0.90–1.38	519	45.7	41.4	431.9	510.0	-78.1	-15.0
1.39–2.14	1,460	135.5	122.5	1,201.7	1,264.5	-62.8	-4.3
2.15–3.27	1,875	187.5	151.0	1,536.5	1,463.0	73.5	3.9
3.28–4.88	2,733	278.8	199.0	2,255.2	1,739.0	516.2	18.9
4.89–7.07	1,869	196.2	118.2	1,554.6	1,007.0	547.6	29.3
7.08–9.70	1,535	165.8	11.7	1,357.5	791.0	566.5	36.9
9.71–14.09	447	52.3	-100.4	495.1	197.0	298.1	66.7
14.10 and above	720	86.4	-156.7	790.3	272.0	518.3	72.0
Total	11,721	1,195.7	415.9	10,109.4	7,985.2	2,124.2	18.1

Source: Computed following the procedure described in Appendix 4 using data from Bangladesh, Bureau of Statistics, *Household Expenditure Survey, 1973/74* (Dacca: Bureau of Statistics, 1978).

[a] Farm area includes only cultivated land and farm size represents operational holding size.

[b] Net rent payment is equal to gross rent payment minus gross rent received.

marketable surplus largely determines the distribution of direct benefits from government price support policies. However, deficit farmers with urgent obligations sell rice after harvest and buy later.[55]

The benefits to deficit farmers from price supports depend on how the program affects seasonal price spreads as shown in a previous study by the author, *Foodgrain Supply, Distribution, and Consumption Policies within a Dual Pricing Mechanism.*[56] The spread between prices in the lean season and the harvest season is wide. If rice prices are raised by reducing imports or by increasing domestic procurement and stock building without changing the seasonal pattern, the impact on farmers' income will depend on the ratio of quantities purchased to quantities sold. If this ratio is 1 (the point of self-sufficiency), there will be no gain or loss. If the ratio is more than 1, as for a deficit farm, a rise in price will adversely affect income. A reduction in the seasonal spread of rice prices is likely to be beneficial for such farms. However, domestic procurement does not ensure an automatic reduction in the gap between harvest and lean season prices. If private traders reduce their buying in the harvest season by a quantity equal to the government's procurement, and if the government does not release this quantity later in the open market, procurement will increase the seasonal spread. Even if the government distributes the entire procured quantity through rationing, as it generally does, the difference between the lean and harvest season prices will still be larger because of the income effect of rationing. To reduce seasonal spread in prices, it is essential to examine the marketing system which, however, is not the focus of this paper. Various studies indicate that the rice market in Bangladesh is reasonably competitive and efficient. If this is true, the gap in seasonal prices can be narrowed by reducing marketing costs, by developing rural infrastructures, and by decreasing risk.

Estimates of how much rice was consumed at home on small farms compared with large farms in other years of the 1970s are made

[55] *Master Survey of Agriculture*, Seventh Round, shows that about 42 percent of the rice marketed was sold within one month after harvest. Assuming that the proportion of distress sales in this quantity would be approximately the same as the proportion of cultivated land operated by deficit farmers in the total cultivated area, distress sales would account for only 0.84 percent of gross production.

[56] See Ahmed, *Foodgrain Supply*, p. 56. This report provides a detailed analysis of the seasonal spreads in rice prices.

on the basis of the relationship between gross production and home consumption in various size groups of farms in 1973/74.[57] It is assumed that no structural change occurred in agriculture. These estimates are presented in Table 11.

The years 1974/75 and 1976/77 were moderately poor rice years, whereas 1975/76 and 1977/78 were extremely good. The gross marketable surplus ranged from 19 to about 23 percent of gross production in these years. Home consumption was more stable than marketable surplus. The elasticity of home consumption (percentage change in home consumption due to a 1 percent change in production) was 0.40 compared with an elasticity of 3.34 for marketable surplus (percentage change in the marketable surplus due to a 1 percent change in production).[58] The marketable surplus has greater elasticity because the bulk of it is produced by farmers whose home consumption changes little with a rise or fall in production.

In extremely good years only about 15 percent of farm households, farming about 2 percent of the total cultivated area, have a deficit.[59] In moderately bad years the proportion rises to about 69 percent, covering about 34 percent of the total cultivated area. In other words, about 54 percent of total farm households are at the margin. However, their combined contribution to the total net marketable surplus in extremely good years does not exceed 7-8 percent.

The response of the marketable surplus of rice to price changes is estimated following the approaches developed by Behrman and Krishna (see Appendix 4). With plausible values of relevant parameters, the elasticity of the marketable surplus of rice with respect to rice price varies from 0.05 to 0.29. This means that at most a 10 percent increase in rice prices will increase the marketable surplus by about 3 percent. The marketable surplus appears to be quite responsive to the ratio of gross sales to gross production. If the ratio decreases, responsiveness increases. Similarly, if the income and price elasticity of demand for home consumption of rice increase, the elasticity of the marketable surplus will also increase.

This implies that, except in extremely good years, price support policies for rice have little significance for the vast majority of farmers. Extremely good years occur only once or twice in a decade. In the 1960s, 1963/64 was a good year due to good weather. The extremely good years in the 1970s resulted from a combination of good weather and new technology. Stability in production at a high level (similar to that in 1977/78) reinforces the influence of price policies. Appropriate kinds of irrigation development (for example, tubewells) are reasonably effective in protecting production from the vagaries of weather.[60] When price support programs compete with irrigation development for public resources, questions of priority become urgent.

The relative insensitivity of marketed surplus to price changes indicates that price as a policy tool has only a limited influence on the marketable surplus in the short run.

Overall Marketable Surplus

Table 11 begs the question of how deficit farmers can finance purchases of rice as well as other goods. More detailed information on the marketable surpluses of other crops might provide an answer, but is not available.[61]

[57] The estimated relationship is presented in Appendix 4, which elaborates on the influence of market prices on some consumption.

[58] The estimate of the elasticity of home consumption at 0.40 is for the average values of home consumption and production. For the group of farmers with a surplus the elasticity estimates range from 0.30 to 0.07.

[59] This is a generous estimate, perhaps, indicating only the lower limits of the proportion of deficit farms when changes in production are uniformly distributed among all regions and farms. Unequal changes in production among regions and farms would imply a larger than estimated proportion of deficit farms.

[60] See Shakuntla Mehra, *Instability in Indian Agriculture in the Context of the New Technology*, Research Report 25 (Washington, D.C.: International Food Policy Research Institute, 1981). Seed-fertilizer technology increases not only yields but also their variance. However, assured irrigation can neutralize the variance-increasing effect of the new technology.

[61] A complete answer ought to include an examination of the nonfarm income of farm households.

Table 11—Gross marketable surplus of rice by farm size, 1973/74–1977/78

Farm Size	1973/74		1974/75		1975/76		1976/77		1977/78	
	Gross Surplus	Proportion of Gross Production	Gross Surplus	Proportion of Gross Production	Gross Surplus	Proportion of Gross Production	Gross Surplus	Proportion of Gross Production	Gross Surplus	Proportion of Gross Production
(acres)	(1,000 tons)	(percent)	(1,000 tons)	(percent)	(1,000 tons)	(percent)	(1,000 tons)	(percent)	(1,000 tons)	(percent)
Less than 0.34	...	...	...	...	...	...	...	...	...	...
0.35–0.56	...	...	...	...	...	...	...	...	...	...
0.57–0.89	...	...	...	...	1.4	0.4	...	...	5.6	1.5
0.90–1.38	...	...	...	...	18.7	3.4	...	...	18.0	3.1
1.39–2.14	...	...	...	...	62.7	4.0	...	...	60.0	3.7
2.15–3.27	73.5	3.9	32.0	1.8	121.7	6.1	33.4	1.8	119.1	6.7
3.28–4.88	516.2	18.9	385.0	14.9	546.9	18.7	384.4	14.2	539.1	17.8
4.89–7.07	547.6	29.3	454.9	25.7	582.3	29.1	464.1	25.2	586.1	28.3
7.08–9.70	566.5	36.9	495.3	34.0	613.8	37.3	508.1	33.5	622.0	36.6
9.71–14.09	298.1	66.7	283.3	66.8	334.2	69.7	293.0	66.4	342.3	69.1
14.10 and above	518.3	72.0	492.9	72.3	577.5	74.8	511.0	71.9	592.4	74.2
Total	2,520.2	21.5	2,143.4	19.3	2,859.2	22.7	2,194.0	19.0	2,884.6	22.2

Source: Computed following the procedure described in Appendix 4.

Next to rice, jute is the most important crop in Bangladesh.[62] It is entirely a cash crop. Farmers also raise crops such as vegetables, pulses, oilseeds, and sugarcane, as well as chickens and cows. It is generally believed that small farms sell a larger proportion of most of these products than do large farms, but empirical evidence is lacking. Table 12 lends credence to this belief. The table indicates that small farms sell proportionately more vegetables, milk, and poultry products.

Table 12 also compares per capita production and consumption on large and small farms. The estimates of per capita production are derived from per capita crop land with the assumption that yield per acre does not differ between small and large farms.[63]

Small farms allocate proportionately larger areas to jute and vegetables whereas large farms lean to pulses and oilseeds (see Appendix 4, Table 26). Jute and vegetables are highly labor intensive. Vegetables, poultry, and milk, unlike jute, are produced for both home consumption and sale.

An Indian study tends to strengthen this conclusion. Although farm sizes, cropping pattern, and farm productivity differ substantially between India and Bangladesh, the underlying cause of differences in the marketable surplus among farm groups could be similar. In a pioneering study, Dharm Narain found that in India the marketed surplus as a proportion of the value of produce declines with increases in farm sizes up to a point, then increases steadily.[64] His study was concerned with the measurement of marketed rather than marketable surplus. Even so, Table 12 indicates a pattern similar to that in India. The pressures of the small farmer's money requirements against his meager resources and factor endowments compel him to sell a proportionately larger share of nongrain, labor-intensive, agricultural products than large farms.

The foregoing indicates that the impact of changes in rice prices on cropping patterns,

Table 12—Consumption and production ratios of large and small farms for selected products

Products	Ratio of Production Per Capita Between Large and Small Farms	Ratio of Consumption Per Capita Between Large and Small Farms
Pulses	6.44	2.55
Oilseeds	12.27	2.46
Vegetables	1.71	2.50
Poultry	1.37	4.57
Milk	2.75	6.45

Source: Computed from data presented in Appendix 4.

purchases of foodgrains, and sales of nongrain agricultural products deserves further investigation.

In arguments on distributive justice of price policies it is usually assumed that rural people are producers and urban people consumers of agricultural products. Therefore, a policy of maintaining a high price for foodgrains is assumed to be equivalent to a policy of shifting income distribution to the rural population. The assumed dichotomy masks the distributive impact of agricultural price policies on the nonfarm rural population. Shares in the production and distribution of rice by population groups are presented in Table 13.

The nonfarm rural population, mostly dependent on wage income from agriculture, rural services, petty trade, and commerce, is about 28 percent of the total population and three times larger than the urban population. The two groups jointly share about 42 percent of gross receipt of rent in rice (equivalent to 3.78 percent of the gross production of rice). In analyzing the distributive impact of rice prices, it would not be unrealistic to treat 37 percent of the population as producers and 63 percent as consumers of rice.

[62] Jute contributed about 8 percent to the net value added in the crop subsector of agriculture in 1977/78.

[63] Yield rate in small farms is considered to be a little higher than that in large farms. If so, estimates for small farms are conservative.

[64] Dharm Narain, *Distribution of the Marketed Surplus of Agricultural Produce by Sizes of Holdings in India 1950/51* (Delhi: Institute of Economic Growth, 1961).

Table 13—Shares in production and distribution of rice of occupational groups, 1973/74

Occupational Groups	Share in Total Population	Share in Gross Production of Rice	Share in Gross Receipts of Rent	Share in Total Consumption of Rice
Total farm population	63.0	100.0	58.0	74.0
Deficit farms	26.0	22.0	10.0	30.0
Surplus farms	37.0	78.0	48.0	44.0
Nonfarm rural population	27.8	...	37.0	19.0
Urban population	9.2	...	5.0	7.0
Total	100.0	100.0	100.0	100.0

Note: About 9 percent of gross producton was gross payment of rent in rice.

6

WELFARE IMPLICATIONS OF RICE PRICES

Landless laborers are almost twice the urban population in Bangladesh. To them there is only a slight difference between a famine and a normal year. Wage income is their main "exchange entitlement," a term coined by Sen to explain the causes of famine.[65] The concept also is an indicator of the welfare of landless laborers in an economy caught in a "below-poverty equilibrium trap."[66]

Trends in wage rates of unskilled agricultural workers, rice prices, and productivity of labor in crop production are presented in Table 14. The downward trend in real wage rates of hired agricultural laborers resulted from the failure of the money wage rate to keep pace with prices of commodities generally consumed by laborers.[67] From 1963 to 1977 the nominal price of rice increased at about 13.5 percent annually while the nominal wage rate rose about 9.7 percent, resulting in a 3.6 percent annual decline in the real wage rate. If the years of 1972/73-1974/75 are excluded as abnormal years, the annual rate of decline is about 2 percent.[68] Nominal wage rates tend to rise and fall with rice prices but at slower rates.

Failure of agricultural productivity to keep pace with the growth of the agricultural labor force is considered to be a primary cause of the declining real wage rates and the slow growth in agricultural employment. However, historical data on labor productivity and wage rates show only a moderately positive correlation. An understanding of the operation of the labor market is crucial for comprehending the linkages among wage rates, labor productivity, and commodity prices. The money wage rate is formed in the hired labor market, but the relations of family to hired labor must be taken into account in establishing the relation between rice price and wage rate.

The demand for labor as reflected in its marginal product was discussed earlier. In addition to the technological factor (for example, HYV rice), changes in the cropping pattern induced by a change in relative prices can cause the demand curve to shift. Rice-jute substitution is particularly important in this respect. The number of man-days required to produce and market jute from one acre of land is about 16-93 percent higher than that for rice, depending on whether the rice is a local or HYV variety (see Appendix 1, Table 23).[69] If manufacturing activities were included, jute's impact on employment would be still higher.[70] Jute marketing also is labor intensive. Moreover, almost all the jute produced is marketed, compared to only about 25 percent of the rice produced.

The shape of the supply curve of labor is another important determinant of the effect of a change in product prices on employment. The shape of the labor supply curve, in turn, is affected by the preferences of farmers for leisure or income. Little empirical evidence

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[65] Amartya K. Sen, "Starvation and Exchange Entitlements: A General Approach and Its Application to the Great Bengal Famine," *Cambridge Journal of Economics* 1 (March 1977): 33-59.

[66] For an elaborate exposition of the concept see Mahiuddin Alamgir, *Bangladesh: A Case of Below Poverty Level Equilibrium Trap* (Dacca: Bangladesh Institute of Development Studies, 1976).

[67] Other researchers also came to similar conclusions: for example, see Swadesh R. Bose, "Trend of Real Income for the Rural Poor in East Pakistan, 1949-66," *Pakistan Development Review* 8 (No. 3, 1968): 454-488; and A. R. Khan, *Poverty and Inequality in Rural Bangladesh* (Geneva: International Labour Organization, World Employment Program, 1976).

[68] Regression of current wage rates against current and lagged rice prices indicates that for every 1 percent change in rice prices, nominal wage rates increase by 0.65 percent in the long run under the conditions prevailing from 1963 through 1977.

[69] Introduction of HYVs of rice increases the labor requirement in rice almost to the level of jute; HYVs of jute do not increase the labor requirement significantly.

[70] In 1975 about 200,000 workers were employed by the jute mills in Bangladesh.

Table 14—Indexes of rice prices, agricultural wage rates, and labor productivity, 1963/64-1977/78

Year	Index of Nominal Price of Rice	Index of Nominal Wage Rate	Index of Real Wage Rate[a]	Index of Real Wage Rate[b]	Labor Productivity[c]
1963/64	100.0	100.0	100.0	100.0	100.0
1964/65	102.1	99.2	97.2	98.1	97.5
1965/66	126.7	103.3	81.6	85.2	98.7
1966/67	146.5	113.6	77.6	80.6	92.4
1967/68	148.6	116.5	78.4	81.5	101.0
1968/69	151.8	119.8	79.0	82.2	100.6
1969/70	149.9	117.8	78.5	81.5	103.9
1970/71	141.0	125.6	89.0	92.0	93.6
1971/72	187.4	114.9	61.3	64.5	78.0
1972/73	297.5	155.0	52.1	55.7	78.6
1973/74	402.6	228.5	56.7	59.9	86.1
1974/75	821.8	299.2	36.4	40.7	78.9
1975/76	480.9	300.8	62.6	65.7	86.8
1976/77	429.9	309.5	72.0	76.0	78.5
1977/78	551.3	386.4	70.1	74.2	86.6

Sources: Bangladesh, Bureau of Statistics, *The Year Book of Agricultural Statistics (1967-77)* (Dacca: Bureau of Statistics, 1978); Bangladesh, Bureau of Statistics, *1979 Statistical Year Book* (Dacca: Bureau of Statistics, 1979); Bangladesh, Ministry of Agriculture, *Bangladesh Agriculture in Statistics* (Dacca: Ministry of Agriculture, 1973); and M. Rauquibuzzaman and M. Asaduzzaman, *An Analysis of Rice Prices in Bangladesh, 1952-1968*, Series No. 2 (Dacca: Bangladesh Institute of Development Studies, 1972).

[a] In this index the real wage rate is deflated by the price of rice.

[b] In this index the real wage rate is deflated by the cost of living.

[c] Labor productivity is based on the gross value of crop production and on the labor force growing at a constant rate of 2.9 percent per year.

exists on labor supply behavior in rural areas of developing countries. Rosenzweig, working on microdata from rural India, concluded that the annual number of days of wage employment by individuals is determined mainly by supply rather than demand as neoclassical competitive models imply.[71] Because of a positive preference for leisure, the supply curve for individual labor is backward bending. Rosenzweig also observed that geographical immobility is a characteristic of the rural labor market in the study area. Bardhan estimated the labor supply functions, using a large set of cross-sectional data for agricultural workers in rural West Bengal, an Indian province contiguous and in many respects similar to Bangladesh.[72] He found that in the case of casual farm workers and small cultivators, the wage response to hiring out labor is positive but small; the estimated elasticity ranged from 0.20 to 0.29. However, the wage response is not significant for total labor supply of cultivators of all size groups combined, indicating a backward-bending supply curve for medium to large farms. Bardhan concluded that labor supply is primarily determined by social and demographic conditions of the labor-supplying households and their assets. Gillian Hart, from a systematic household survey in Indonesia, demonstrated that even the landless laborers remain employed (including self-employment) almost all year in work of low productivity. Changes in the wage rate would hardly influence their total hours of work. On the other hand, only a large change in the wage rate (or return to labor) would induce relatively well-to-do

[71] Mark R. Rosenzweig, "Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labor Supply in a Developing Country," *Journal of Economics* 94 (February 1980).

[72] Pranab K. Bardhan, "Labor Supply Functions in a Poor Agrarian Economy," *American Economic Review* 69 (March 1979): 73-83.

people to work harder. This pattern of behavior indicates an inelastic labor supply in rural Indonesia, a country similar to Bangladesh in many respects.[73]

If money wages respond sharply to an increase in product prices, but response of labor to wage increases is limited, the higher price will raise the wage bill and farm income without any increase in production. Although the shape of the supply curve of agricultural workers in Bangladesh has not been determined, studies on rural employment indicate that, even though there is an apparent labor surplus, voluntary unemployment and underemployment is quite large. This indicates a preference for leisure and an inelastic supply curve of labor. Iqbal Ahmed found that the aggregate rate of unemployment[74] in one area in the Comilla district in 1975/76 was about 42 percent. About 8 percent were involuntarily unemployed, 26 percent voluntarily underemployed, and 8 percent were voluntarily unemployed. The voluntarily unemployed group mainly includes rich landlords, village elites, and the educated who consider manual work in agriculture as harmful to their social prestige. The voluntarily underemployed group comprises those whose farms are too small to provide adequate employment. They also will not work as wage laborers because of loss of prestige. The third group—involuntarily unemployed—consists of small farmers and landless workers at the lowest income level. Ahmed's general picture of attitudes toward manual work by village elites and well-off farmers seems to be typical of Bangladesh.

A study in another area of the Comilla district, summarized in Table 15, leads to the following conclusions:

Farm households with less than 2.5 acres of land generally hire out family labor for wage income in agriculture. Other farm households do not appear to do so. This is consistent with Iqbal Ahmed's study.

Larger farms use as much family labor in cultivation as smaller ones, but use more in nonfarm activities. As a result, the total number of days of work in a year is higher than for small farm households. Farmers with less than 1.0 acre of land per household are virtually landless laborers. Their employment depends on the availability of wage

Table 15—Average employment of a family farm worker, Comilla, 1974/75

Farm Size	Agricultural Employment				Nonagricultural Employment	Total Employment
	On-Farm	Hired Out[a]	Off-Farm[b]	Total		
(acres)				(man-days)		
Less than 1.0	52.1	52.3	8.7	113.1	30.2	143.3
1.0–2.5	86.9	9.3	14.5	110.7	45.7	156.4
2.5–4.5	86.4	...	14.4	100.8	48.9	149.7
4.5–7.5	83.1	...	13.8	97.0	86.4	183.4
7.5 and over	56.5	...	9.4	65.9	98.3	164.2
All farms	65.9	30.5	11.1	107.5	42.2	149.7

Source: Atique Rahman, "Agrarian Structure and Capital Formation: A Study of Bangladesh Agriculture" (Ph.D. thesis, Cambridge University, 1979).

[a] Worker is hired out for wage income in agriculture.

[b] Indicates work related to agriculture but not in direct cultivation; for example, marketing of farm output and input.

[73] Gillian Patricia Hart, "Labor Allocation Strategies in Rural Javanese Households" (Ph.D. thesis, Cornell University, 1978).

[74] Iqbal Ahmed, "Unemployment and Underemployment in Bangladesh Agriculture," *World Development* 6 (December 1978): 1281-1296. Ahmed measures total unemployment, (LA−LU)/LA. He formulated (LA−LU)/LA = (LA − LW)/LA + (LW − LO)/LA + (LO − LU)/LA, where LA = total labor-days potentially available in a year from all those in the working age; LW = total labor-days potentially available in a year from those who actually worked; LO = total labor-days actually offered by those who work; and LU = total labor-days actually used.

employment rather than willingness to work. Lack of capital such as cash and financial assets, boats, carts, and so forth limits employment in nonagricultural activities for small households. Farms with land holdings from 2.5 to less than 4.5 acres have a low level of employment for two reasons: lack of capital needed for nonagricultural occupations, and unwillingness to work as a hired laborer in agriculture. Farms with 7.5 or more acres of land definitely prefer leisure to income.

The same study indicates that profitability in nonagricultural activities is no higher than in agriculture. Consequently, social and atypical economic factors must be considered in explaining the preference of large farm households for nonagricultural activities.

Separate studies by Cain and Mazumder and Farouk show that adult workers in labor households do productive work on about 80-85 percent of the days in a year and are engaged in household work and social ceremonies in most of the remainder. The need for income is so pressing that children from ages 4 to 13 are compelled to work about 45 percent of their time.[75]

The foregoing discussions indicate that the supply of labor from large and medium farm households for manual work in agriculture is much more inelastic than that from landless and small farm households.

The relationship between rice prices and the wage income (wage rate and employment) of hired agricultural laborers is estimated using a framework presented in Appendix 5. The demand for labor is specified as follows:

$$D_L = D_L(W/P_r, A, P_j/P_r),$$

where D_L is the demand for labor; W/P_r (money wage rate deflated by rice price) is the real wage rate affecting the intensity of labor use on a given land area with a given cropping pattern; A is the shift variable for autonomous changes in the crop land area; and P_j/P_r is the relative price of jute and rice explaining the shift in demand originating from a change in cropping pattern.

The supply curve is obtained indirectly from the historical data on changes in real wage rates, employment (alternatively, the extent of the shift in the demand curve), and the stock of the labor force (see Appendix 5 for the procedure). This method supports the conclusion from the previous case studies that the supply curve of agricultural labor is relatively inelastic.

The framework focuses primarily on certain aspects of the labor market (for example, dualism of family and hired labor and role of demand and supply) that are important in determining employment and wage rates. This analysis indicates that if agricultural production increases at a slower rate than family labor, the demand for hired labor tends to drift downward. The depressing effect on the wage rate is accentuated by a rapid growth in hired labor. Part of the effect of a falling real wage rate on wage income is offset by some gain in employment. However, existing evidence indicates that family labor supply is only moderately responsive to changes in income. The income elasticity of supply of family labor for the surplus farm household is estimated to be -0.24, which is equivalent to an elasticity of -0.10 for all farm households. Further research on supply behavior of family labor appears to be important.

The primary link between rice prices and labor markets is the effect of rice prices on the demand for labor. A 10 percent rise in the relative price of rice causes a 1.2 percent fall in the real wage rate but only a 0.35 percent decrease in employment of hired labor in the short run (that is, without any change in supply). If a one-year lag is assumed (that is, the price increase has been accompanied by a growing labor supply), the real wage rate would fall 4.32 percent and employment would increase 1.93 percent.

There are several explanations for this outcome. A rise in the price of rice causes a shift of land, mostly from jute but also from other crops to rice and from local varieties of rice to HYV. Jute is almost twice as labor intensive as local varieties of rice. HYV rice is more labor intensive than local varieties, but because of constraints imposed by irrigation, the shift to HYV will not compensate for the loss of labor demand in jute. The result is a leftward shift in demand for

[75] Mead Cain and A. B. M. K. A. Mazumder, *Labor Market Structure, Child Employment, and Reproductive Behavior in Rural South Asia* (New York: United Nations Population Council, 1980); and A. Farouk, "Use of Time by Individuals: A Survey in Bangladesh," paper prepared for ADC-RTN Workshop, Singapore, 1976.

agricultural labor.

The effect of this shift on demand for hired labor is only partly compensated for by the leftward shift in supply of family labor in surplus farm households. A leftward shift of 0.6 percent in aggregate demand, if entirely reflected in the hired labor market, induces a 2.1 percent shift in the same direction in the demand for hired labor.[76]

Generally, it takes at least a year for the price effects to take place. During this time, supply of hired labor also increases, producing a downward pull on the wage rate and some compensatory increase in employment.

The results presented so far indicate that, in the absence of rapid growth in production, increased employment of hired labor depends mostly on a decline in wage rates. This is not only undesirable, but may adversely affect productivity of labor through malnourishment. Indication of such a possibility is reflected in the concept of "consumption and productivity linkages" espoused by Leibenstein.[77] This concept will be discussed later.

Rice Prices, Nutrition, and Child Mortality

The caloric equivalent of the wage rate per day (the calorie content of coarse rice that could be bought for a certain wage rate) is estimated to have dropped from about 11,400 calories in the early 1960s to an average of 7,400 calories in the 1970s. On the basis of a dependency ratio (number of dependents per worker) of 2.5 and 260 days of employment in a year, a wage income of 7,400 calories per household would imply a per capita per day energy intake of only about 1,500 calories, if the entire wage income were spent on food. The 1973/74 Household Survey indicated that the per capita energy intake of the bottom 25 percent of the rural population, mostly landless workers, ranged from about 900 to 1,700 calories per day. The nutrition survey of 1975/76 put the per capita average energy intake of rural landless households at 1,925 calories.[78] This was in the best agricultural production year of the 1970s. These surveys indicate that the energy intake among rural working households is far below the estimated average energy requirement of 2,200-2,300 calories.[79]

Pioneering work on the linkage between consumption and productivity was done by Leibenstein.[80] Following him, Mirrlees, Stiglitz, and more recently Bliss and Stern attempted to develop a theory of wages centering on the consumption-productivity link.[81] Studies in this area have been hampered by inadequate information on the minimum energy requirement and its relation to work performance, body weight, time, and environmental factors. The case studies cited by Bliss and Stern, however, show a strong, positive relationship between energy intake and productivity. Although much remains to be done to prove this link empirically, its validity is considered high in poor and populous countries like Bangladesh. The policy implications of a positive link are enormous. The traditional arguments for increasing foodgrain production by raising foodgrain prices would be weakened, particularly in countries where nutritional deficiency is acute.

On the basis of income effects of group-specific price elasticities of demand for food, Mellor has demonstrated that the poor suffer most from a rise in foodgrain prices.[82] Applying his procedure to Bangladesh, the author estimates that the impact on con-

[76] This conclusion is based on the assumption that the factors that determine a given pattern of seasonability in labor demand remain stable.

[77] Harvey Leibenstein, *Economic Backwardness and Economic Growth* (New York: Wiley, 1957).

[78] Institute of Nutrition and Food Science, *Nutrition Survey of Rural Bangladesh 1975/76* (Dacca: Dacca University, 1977).

[79] Lincoln C. Chen, "An Analysis of Per Capita Foodgrain Availability, Consumption, and Requirement in Bangladesh: A Systematic Approach to Food Planning," *Bangladesh Development Studies* 3 (April 1975): 93-126.

[80] Leibenstein, *Economic Backwardness*.

[81] See Christopher Bliss and Nicholas Stern, "Productivity, Wages, and Nutrition," *Journal of Development Economics* 5 (December 1978): 331-398.

[82] Mellor, "Food Price Policy."

sumption of changes in foodgrain prices varies rather widely among income groups. Such conclusions are often contested on the grounds that the static analytical technique employed in such analyses fails to capture the price-induced effects of a possible change in wage income and the substitution of normally inferior foods for major grains. Because adjustment of wage rates to prices involves time lags, the impact of changes in rice prices on consumption has short- and long-run differences. Estimates of such differences for low-income rural households are shown in Table 16. The short-run impact includes only the direct effect of price (estimated on the basis of group-specific price elasticities), whereas the long-run impact includes the effects after adjustment in wage income has taken place. Adjustment in wage income is made on the assumption developed earlier that the long-run elasticity of the nominal wage rate to the nominal price of rice is 0.65 and the elasticity of wage employment with respect to the real wage rate is 0.4.[83]

Other prices, income, and taste patterns of consumers are all assumed to remain constant. These assumptions may appear restrictive when applied to all consumers, but are not likely to be so in the case of landless laborers in Bangladesh.

Table 16 indicates that the impact of an increase in foodgrain prices on consumption among labor households is considerably less in the long run than in the short run. However, the long-run effect would be greater than indicated if the price-wage adjustment took a long time and if wage income lagged behind the population growth rate.[84]

The results in Table 16 do not include possible effects from substitutions between rice and minor cereals. Until 1977/78 minor cereals (wheat, millet, barley, and maize) represented only about 2 percent of domestic cereal production. Production of these "famine crops" generally increases following a bad rice harvest. Rice still comprises about 82 percent of the nutritional intake of rural households.[85] A rise in rice prices tends to increase substitution of inferior grains for rice. But if this causes a sharp rise in prices of these grains, the effect of substitution on consumption will be negligible. Moreover, households depending largely on the cheaper substitutes will be worse off. This is likely to be the case where the supply response of cheaper substitutes is small. When foodgrain prices are rising generally in Bangladesh, the price of coarse rice rises faster than the prices of medium and fine quality rices and the price spread narrows (see Appendix 5, Table 28). The average spread was only 6 percent between the coarse rice price and the medium grade in 1973/74 and 1974/75. In periods of falling prices, the price of coarse rice falls faster than that of finer varieties, and the price spread widens. The average price spread was about 12 percent in 1976/77 and 1977/78.[86] The attempts of consumers to substitute low-priced for high-

Table 16—Short- and long-run changes in consumption of foodgrains by working households resulting from a market price increase of 25 percent

Income Group	Short-Run Changes	Long-Run Changes
(taka/month)	(percent)	
Less than 100	-17.0	5.3
100–149	-13.0	4.3
155–199	-11.0	4.7
200–249	9.0	4.7

Source: For estimation procedure and basic data, see Raisuddin Ahmed, *Foodgrain Supply, Distribution and Consumption Policies Within a Dual Pricing Mechanism: A Case Study of Bangladesh*, Research Report 8 (Washington, D.C.: International Food Policy Research Institute, 1979).

Note: A minus sign denotes a fall in consumption.

[83] If a price rise is brought about by a shortfall in supply caused by natural calamities, as often happens, then the price increase may not accompany an increase in employment. In that case the adverse impact of rising foodgrain prices is severe.

[84] The effect of price on consumption needs to be distinctly separated from the effect of population growth.

[85] Wheat production has expanded at a high rate in recent years. If this expansion continues for a few more years, the possibility of substitution could be substantial.

[86] Movement of prices of various grades of rice is sharper in districts than at the aggregate level.

priced foodgrains in an inflationary situation causes the prices of the generally cheaper substitutes to rise. Those primarily dependent on the cheaper substitutes are most affected. Such an outcome could be avoided by instituting programs that would increase the supply of cheaper substitutes. If the increased supply is based on domestic production, the prices of rice will have to be balanced with those of the substitutes.

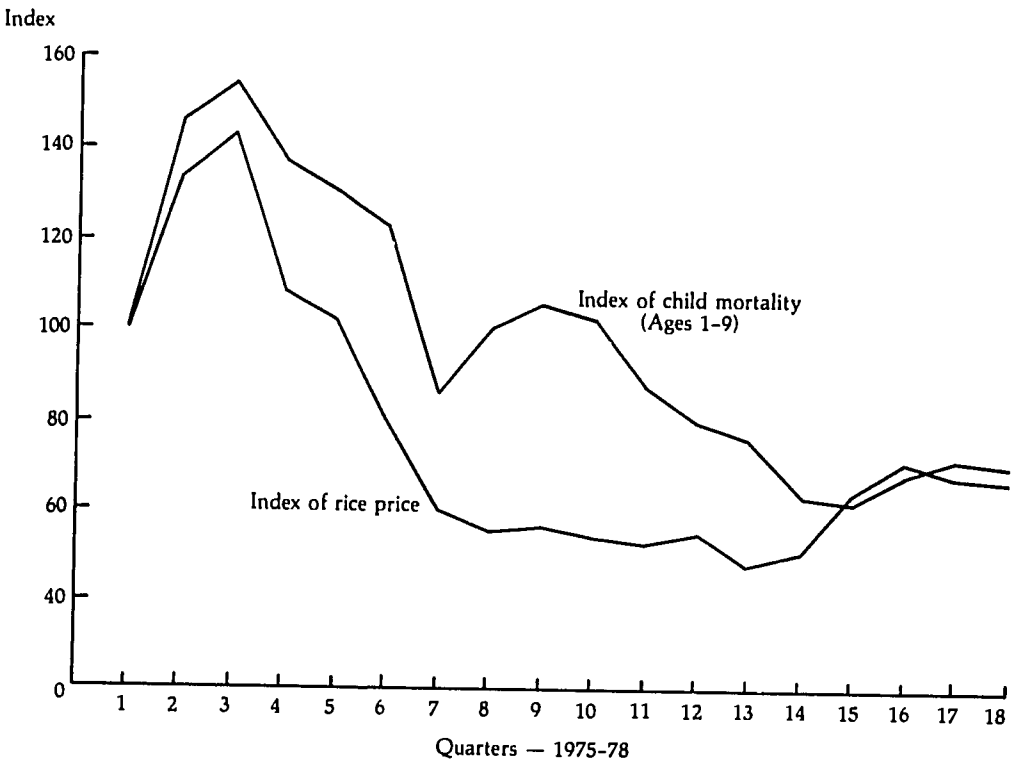
The relation between rice prices and child mortality in one rural area of Bangladesh is shown in Figure 4. This connection is developed from data provided by a nutritionist working at the International Institute for Diarrheal Disease Control.[87] Discussions with the nutritionist led to the conclusion that the effect of changes in consumption on mortality of children will be reflected generally in two to four months. Therefore, current rice prices are related to mortality after a quarterly lag.

The relation between rice prices and child mortality as shown in Figure 4 leads to a rather strong hypothesis that high rice prices can be fatal for rural children. Whereas adults can eat diverse products such as fruits, vegetables, leaves, and wheat, infants in Bangladesh families are fed mainly rice preparations and mother's milk until about the age of three.

Rice Prices and Transfer of Land

Increasing landlessness is a potential factor for social tension in rural Bangladesh. Foodgrain prices are considered primarily

Figure 4 — Quarterly rice price and child mortality, Companyganj, Comilla, Bangladesh



[87] The institute, previously known as the Cholera Research Center of Bangladesh, has been collecting elaborate household statistics in selected areas for several years.

responsible for the increase. Various household surveys show that small farmers spend about 12-64 percent of their cash resources for foodgrains. Even a moderate increase in prices forces them to borrow from village money lenders and rich farmers. A steep rise in foodgrain prices may force them to sell some assets, including land. The credit market is quite imperfect. The rules in the unorganized section of this market hasten the transfer of land offered as security from debtor to creditor.

The relation between the price of rice and transaction of land in rural Bangladesh can be assessed from the data provided in Table 17. The data indicate a positive relation between the fluctuation in rice price and land transfers.

Analysis of the long-term effects of price policies often fails to adequately consider the cumulative short-run effects of higher prices on long-run structural change. Whether concentration of land holdings in large farms is conducive to accelerated growth depends on whether the rate of adoption of modern technologies is accelerated sufficiently to compensate for the loss of production attributable to the difference in productivity between small and large farms. This is unlikely so long as socioeconomic constraints and factor market imperfections (such as fragmentation, attitude toward farm work, and so forth) exist.

Table 17—Land purchases and rice prices in rural Bangladesh, 1971-76

Year	Index of Rice Price	Land Purchases[a]	Land Purchases
			(acres)
1971	122.7	77,914	37,811
1972	189.7	210,890	95,404
1973	254.7	361,202	179,206
1974	512.1	493,338	198,401
1975	449.2	456,529	173,199
1976	349.8	435,258	180,096

Source: F. Tomasson Jannuzi and James T. Peach, *Bangladesh: A Profile of the Countryside* (Dacca: U.S. Agency for International Development, 1979).

[a] Indicates the number of transactions.

7

DEMAND LINKAGES OF FOODGRAIN PRICES

Price policies tend to change product mix and income distribution, which may affect growth of employment and production. Bell and Hazell, working with data from the Muda project, Malaysia, estimated that for every additional dollar of value added generated directly by the project about 83 cents was generated indirectly.[88] About two thirds of this was attributed to consumption expenditures of households benefiting directly from the project. The direct benefit from higher rice prices would be primarily limited to households producing surplus foodgrains. A comprehensive macro framework would be necessary to analyze fully the indirect effect of prices through linkages with their demand systems.[89] This is beyond the scope of this paper. However, some basic elements of the demand structure and commodity characteristics that at least indicate the economywide consequences of price policies are examined.

The important elements of the estimated demand structure are: average and marginal budget shares and price and total expenditure (or income) elasticities for various commodities and for two broad income classes in the rural sector. Only two income groups (low and high) were used. Any more would have reduced sample size to an unacceptable level because the data used were aggregate district averages for 18 districts and 13 income classes. The low-income group, which includes rural landless laborers, small farmers, and poor nonfarm households, is of particular interest from a policy point of view.

The demand structure is estimated using the Linear Expenditure System (LES) model adapted from Klein and Rubin.[90] Expenditures, prices, and cross-price elasticities by expenditure categories were developed from cross-sectional data. Although the methodology is based on rather strong assumptions about the preferences that determine consumer behavior, the approach is considered suitable for broad groups of commodities.

The estimated demand structures for groups of consumers' goods are presented in Tables 18 and 19. In Table 18 expenditure elasticities of various groups of food products (most of which are agricultural in origin) are considerably higher in low-income than in high-income households. For "total nonfoods," on the other hand, the expenditure elasticity is higher for high-income households. The difference is even greater for the category of "other nonfoods," which consists of services such as education, health, transportation, and domestic servants. The expenditure elasticity is twice as high for high- as for low-income households. About 48 percent of the total consumption expenditure in low-income households is for foodgrains compared to 39 percent in the high-income group. However, spending on all foods constitutes about 76 percent of total expenditure in low-income households and about 69 percent in high-income households. High-income households allocate more than 13 percent of their total consumption expenditure (32 percent of incremental expenditure) to other nonfoods. For low-income households the percentages are about 3 percent of total expenditure and 5 percent of incremental expenditure.

Own- and cross-price elasticities of demand for all commodity groups are substantially higher in low-income households (see Table 19). The absolute values of own-price elasticities in low-income households are higher than 0.5 for most commodity groups except edible oils, fuel and light, and housing. In contrast, the absolute values of own-

[88] Clive L. G. Bell and Peter B. R. Hazell, "Measuring the Indirect Effects of an Agricultural Investment Project on Its Surrounding Region," *American Journal of Agricultural Economics* 62 (February 1980): 75-86.

[89] See John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World* (Ithaca, N.Y.: Cornell University Press, 1976).

[90] Lawrence Robert Klein and H. Rubin, "A Constant Utility Index of Cost of Living," *Review of Economic Studies* 15 (No. 2, 1948): 84-87.

Table 18—Pattern of household consumption expenditures in rural Bangladesh, 1973/74

Commodity	Low-Income Groups			High-Income Groups		
	Average Budget Share	Marginal Budget Share	Expenditure Elasticity	Average Budget Share	Marginal Budget Share	Expenditure Elasticity
Foodgrains	47.82	41.59	0.87	39.09	22.36	0.57
Pulses and vegetables	7.34	7.61	1.04	6.11	4.09	0.67
Meat, fish, eggs, and milk	6.65	10.05	1.51	9.88	11.25	1.14
Edible oils	3.24	2.36	0.73	3.80	2.78	0.73
Tobacco, pan, etc.	2.80	3.53	1.26	2.90	2.74	0.94
Other foods	8.43	12.22	1.45	7.59	8.00	1.85
Total food	76.28	77.36	1.01	69.37	51.22	0.74
Clothing	4.23	6.02	1.42	6.32	8.82	1.40
Fuels and light	10.49	6.73	0.64	6.47	4.34	0.67
Housing and durables	6.06	4.86	0.80	4.72	3.22	0.68
Other nonfood (services)	2.94	5.03	1.71	13.12	32.40	2.47
Total nonfood	23.72	22.64	0.96	30.63	48.76	1.59

Sources: Computed from LES estimates using data from Bangladesh, Bureau of Statistics, *Household Expenditure Survey, 1973/74* (Dacca: Bureau of Statistics, 1978).

price elasticities are less than 0.5 for most commodity groups in high-income households except for other nonfoods (services) and clothes. The cross-price elasticities indicate that the influence of changes in foodgrain prices on the demand for other commodities and services is almost equal to changes in the prices of these commodities and services.

The low-income group represents about 43 percent of the total rural population and accounts for approximately 30 percent of total household expenditures; the high-income group is 57 percent of population and accounts for 70 percent of total expenditures. Consequently, expenditure and price elasticities for the total rural population are closer to the demand parameters of the high-income group.

Policy Implications

The analysis of household demand indicates that policies designed to increase income of low-income households at a faster rate than high-income households tend to increase demand for agricultural products faster than for nonagricultural products. If agricultural products are less supply elastic than nonagricultural products, such policies tend to raise agricultural prices relative to those of nonagricultural products. Supply elasticities of agricultural products are generally low in Bangladesh and probably lower than for nonagricultural products. Policies that support low-income households support prices for agricultural products. However, such policies could dampen the overall growth of the economy because of the shift in emphasis from supply-elastic to supply-inelastic products and from households with a higher propensity to save to those with a lower. The leakages (for example, purchases of land) from the savings of the high-income group could reduce the impact of differential saving propensities.[91] Nevertheless, policies to increase income of low-income households faster than high-income households could involve some conflicts between growth and equity. These could be minimized by price supports for products produced proportionately more on small farms than on large. Construction of capital structures in rural areas using labor-intensive

[91] Accumulation of assets by high-income households in the form of land represents an equivalent dissaving in low-income households through sale of land. This kind of accumulation, therefore, does not add to the aggregate national stock of assets.

Table 19—Demand matrix, 1973/74

Commodity Group	Own- and Cross-Price Elasticities for Commodity Group: 1	2	3	4	5	6	7	8	9	10	Expenditure Elasticities
Low-Income Group											
1. Foodgrains	-.6213	-.0371	-.0224	-.0199	-.0199	-.0304	-.0156	-.0676	-.0355	-.0068	0.87
2. Pulses and vegetables	-.3215	-.4635	-.0268	-.0237	-.0142	-.0362	-.0186	-.0806	-.0424	-.0082	1.04
3. Meat, fish, milk, eggs	-.4689	-.0645	-.6504	-.0346	-.0207	-.0528	-.0271	-.1175	-.0618	-.0119	1.51
4. Edible oils	-.2258	-.0310	-.0188	-.3144	-.0100	-.0254	-.0131	-.0566	-.0298	-.0057	0.73
5. Tobacco, pan, etc.	-.3916	-.0538	-.0326	-.0298	-.5274	-.0441	-.0227	-.0982	-.0516	-.0100	1.26
6. Other foods	-.4494	-.0618	-.0374	-.0331	-.0198	-.6365	-.0260	-.1126	-.0593	-.0114	1.45
7. Clothing	-.4414	-.0607	-.0368	-.0325	-.0195	-.0497	-.6012	-.1106	-.0582	-.0112	1.42
8. Fuel and light	-.1989	-.0273	-.0166	-.0147	-.0088	-.0224	-.0115	-.3091	-.0262	-.0051	0.64
9. Housing and durables	-.2489	-.0342	-.0207	-.0183	-.0110	-.0280	-.0144	-.0624	-.3574	-.0063	0.80
10. Other nonfoods	-.5295	-.0728	-.0441	-.0391	-.0324	-.0597	-.0306	-.1328	-.0699	-.7425	1.71
High-Income Group											
1. Foodgrains	-.3853	-.0264	-.0331	-.0159	-.0110	-.0268	-.0178	-.0280	-.0203	-.0075	0.57
2. Pulses and vegetables	-.2072	-.2747	-.0388	-.0186	-.0129	-.0313	-.0208	-.0327	-.0237	-.0088	0.67
3. Meat, fish, milk, eggs	-.3528	-.0526	-.4807	-.0317	-.0219	-.0513	-.0354	-.0557	-.0404	-.0149	1.14
4. Edible oils	-.2266	-.0338	-.0423	-.2871	-.0141	-.0342	-.0227	-.0358	-.0260	-.0096	0.73
5. Tobacco, pan, etc.	-.2902	-.0433	-.0542	-.0261	-.3597	-.0439	-.0291	-.0459	-.0333	-.0123	0.94
6. Other foods	-.3261	-.0487	-.0609	-.0293	-.0203	-.4331	-.0327	-.0515	-.0374	-.0138	1.05
7. Clothing	-.4322	-.0645	-.0807	-.0389	-.0269	-.0653	-.5519	-.0683	-.0495	-.0183	1.40
8. Fuel and light	-.2075	-.0310	-.0388	-.0187	-.0129	-.0314	-.0208	-.2771	-.0238	-.0088	0.67
9. Housing and durables	-.2111	-.0315	-.0394	-.0190	-.0131	-.0319	-.0212	-.0334	-.2727	-.0089	0.68
10. Other nonfoods	-.7650	-.1142	-.1428	-.0688	-.0474	-.1156	-.0767	-.1209	-.0877	-.9327	2.47

Source: Computed from the Linear Expenditure System (LES) using Bangladesh, Bureau of Statistics, *Household Expenditure Survey, 1973/74* (Dacca: Bureau of Statistics, 1978).

techniques that reinforce other efforts to increase agricultural production also tend to minimize growth-equity conflicts.

Foodgrain prices can be supported by reducing foodgrain imports or by creating a reserve stock through internal procurement.[92] Either boosts the income of surplus farmers—the high-income group. Initially, this increased income will create demand for nonagricultural products at a faster rate than for agricultural products. However, demand for consumption goods in low-income households will drop because the effects of higher foodgrain prices will not be fully offset by increases in wage income, particularly in the short run.

The net effect of price supports for foodgrains on the real income of low-income households in the long run depends largely on the demand linkages of high-income households. The demand for nonagricultural products induced by an increase in the income of well-to-do households generates production and distribution of these products. Labor's share of these second-round activities represents direct wage income. The wage component of the production cost of most manufactured products is quite low, ranging from about 5 percent in tobacco, beverages, food manufacturing, and basic metal products to about 22 percent in textiles, transport equipment, machinery (except electrical), and furniture (Table 20). The share of labor in the gross value of most agricultural products ranges from 45-55 percent. However, other costs (for example, raw materials) in the production and distribution of nonagricultural products have an implicit (or indirect) share of labor. If the nonagricultural product is based on agricultural raw materials, the overall share of labor will be the sum of its shares in production of the raw material and in the manufacturing of the final product.

The overall share of labor in the production of processed food is quite high, even though the direct share is low. On the other hand, the overall share is low in manufacturing industries based on imported raw materials and capital goods. In the budget of a high-income group, clothes and other nonfoods (services) together account for the largest share of total nonfood expenditures. The import content of manufactured clothes is estimated to be about 50 percent of the value of final products at the factory gate. The import content of the other nonfood category is not accurately known, but probably is small.

Table 20—Share of wages in gross value of selected industrial products, 1974/75 and 1975/76

Product	Wage/Value Ratio 1974/75	1975/76
Food manufacturing	0.07	0.07
Beverage	0.08	0.05
Tobacco	0.03	0.03
Textile	0.22	0.21
Footwear, apparel, and made-up textiles	0.17	0.13
Furniture and fixtures	0.18	0.23
Paper and paper products	0.11	0.12
Printing, publishing, and allied industries	0.15	0.16
Leather and leather products	0.05	0.04
Chemical products	0.13	0.09
Basic metal industries	0.06	0.07
Metal products except machinery	0.15	0.16
Machinery except electrical machinery	0.21	0.22
Electrical equipment	0.11	0.09
Transport equipment	0.25	0.24
Other manufacturing	0.04	0.05
All manufacturing	0.13	0.11

Source: Bangladesh, Bureau of Statistics, *Census of Manufacturing Industries, 1974/75 and 1975/76* (Dacca: Bureau of Statistics, 1979).

The indirect impact on employment of a higher foodgrain price could compensate for part of the direct loss of income of landless laborers. However, this will occur only if the additional demand for nonagricultural products generated by a higher foodgrain price is not met mainly through imports. If importation is to be relied on to meet the additional demand on the ground of trade advantage, equivalent quantities of additional manufactured goods must be exported to offset the employment leakage from increased imports.

Increased employment in nonagricultural production resulting from a higher income

[92] Using stocks to support prices is a temporary measure and can be maintained only as long as the stock can be withheld from supply. However, this could be quite a long period for some countries.

for farm households will not necessarily increase employment of landless rural laborers. Most nonagricultural jobs require skills not usually possessed by these laborers. Acquisition of these skills often requires training and a minimum level of education, which is generally limited to relatively well-to-do people. Moreover, unemployment and underemployment among the urban labor force, particularly among educated youth, is high.[93] Therefore if the increase in nonagricultural employment is not large enough to absorb urban unemployment, jobs will not be available for the rural labor force.

[93] Bangladesh, Planning Commission, *Employment Market for the Educated in Bangladesh* (Dacca: Manpower Section, 1974).

APPENDIX 1
PRICE RESPONSE OF RICE ACREAGE

The area that farmers wish to allocate to rice in any year is postulated to be a function of expected price at the time of sale, expected weather conditions during the growing period, and a trend variable. For a Nerlovian model, this can be done using the following equations:

$$A_t^D = b_1 + b_2 P_t^* + b_3 W_t + b_4 T + U_t; \quad (1)$$

$$P_t^* - P_{t-1}^* = b_5 (P_{t-1} - P_{t-1}^*); \quad (2)$$

$$A_t - A_{t-1} = b_6 (A_{t-1}^D - A_{t-1}); \quad (3)$$

where,

A_t^D is the desired acreage in year t;

P_t^* is the expected price in year t;

T is the trend variable;

U is the residual term randomly distributed;

A_t and P_t are actual acreage and price; and

W_t is the actual rainfall and flooding condition in year t.

The reduced form of the above model can be obtained as:

$$\begin{aligned} A_t = {} & b_1 b_5 b_6 + b_2 b_5 b_6 P_{t-1} \\ & + [(1 - b_5) + (1 - b_6)] A_{t-1} \\ & - (1 - b_6)(1 - b_5) A_{t-2} \\ & + b_3 b_6 W_t - (b_3 b_6)(1 - b_5) \quad W_{t-1} + b_4 b_6 T \\ & \cdots (b_4 b_6)(1 - b_5)(T - 1) + b_6 U_t \\ & - b_6 (1 - b_5) U_{t-1}; \end{aligned}$$

or

$$\begin{aligned} A_t = {} & B_0 + b_1 P_{t-1} + B_2 A_{t-1} \\ & - B_3 A_{t-2} + B_4 W_t - B_5 W_{t-1} \\ & + B_6 T - B_7 (T - 1) + B_8 U_t - B_9 U_{t-1}; \quad (4) \end{aligned}$$

where,

$B_0 = b_1 b_5 b_6$,
$B_1 = b_2 b_5 b_6$,
$B_2 = (1 - b_5) + (1 - b_6)$,
$B_3 = (1 - b_6)(1 - b_5)$,
$B_4 = b_3 b_6$,
$B_5 = (b_3 b_6)(1 - b_5)$,
$B_6 = b_4 b_6$,
$B_7 = (b_4 b_6)(1 - b_5)$,
$B_8 = b_6$, and
$B_9 = b_6 (1 - b_5)$.

To avoid a parameter identification problem, equation (4) is separately estimated for various values of the price expectation coefficient, b_5, which can be reasonably assumed to be between 0 and 1.

Using a maximum likelihood approach, the value of b_5 for which the regression error sum of squares is minimized is then chosen as the best estimate. Because of the lagged values of the dependent variable on the right side of equation (4), the Cochrane-Orcutt[94] technique is employed in the ordinary least squares regression procedure to account for possible autocorrelation problems.

Actual rice acreage data for 1960/61-1977/78 are used except that 1971/72 is excluded because of civil war. Because time series data on harvest season prices of the three varieties of rice are not available,

[94] J. D. Cochrane and D. H. Orcutt, "Application of Least Squares Regressions to Relationships Containing Auto-Correlated Error Terms," *Journal of the American Statistical Association* 5 (No. 3, 1949).

average annual retail prices of medium-quality rice are used. Because the rice harvest for the three varieties is spread over the year, the average annual price is acceptable. The nominal price of rice is converted to real price by deflating it with the index of nonrice food prices from another study by the author.[95]

The weather variable is an index constructed from the government's annual reports of areas damaged by flood, drought, cyclones, and other natural calamities. Weather-crop relations in Bangladesh are so complex that one indicator, for example, rainfall, is not adequate.[96]

The estimated parameters of the supply response of rice are presented in the following table. The figures in brackets are t-values.

Parameters	Coefficients
Constant term	+15270
	(2.9808)
Price	+51.30
	(2.1688)
Lagged area	+0.2529
	(1.8508)
Weather factor	-4.9088
	(-2.0508)
Trend	+110.05
	(2.0393)
R^2	0.8
Short-run elasticity	0.09
Long-run elasticity	0.12

Table 21—Changes in cropping pattern, 1965-79

Crops	Average Area 1965-69	Average Area 1975-79	Changeover 1975-79
	(million acres)		(percent)
Rice	24.14	24.93	3.3
Wheat	0.22	0.47	113.6
Pulses	0.89	0.81	-9.0
Oilseeds	0.74	0.72	-2.7
Spices	0.40	0.38	-5.0
Tubers	0.34	0.45	32.3
Sugarcane	0.40	0.36	-10.0
Fruits and vegetables	0.61	0.63	3.3
Jute	2.27	1.68	-26.0
Tea	0.10	0.10	0.0
Tobacco	0.11	0.14	27.3
Other	0.55	0.27	-47.3
Total cropped area	30.67	30.97	1.0
Net cropped area	22.5	22.5	

Sources: Bangladesh, Ministry of Agriculture, *Agricultural Production Levels 1947-1964* (Dacca: Bureau of Agricultural Statistics, 1965); and Bangladesh, Bureau of Statistics, *1979 Statistical Year Book* (Dacca: Bureau of Statistics, 1979).

Note: Cropping intensity is 1.36 for the period 1965-69 and 1.38 for 1975-79.

[95] Ahmed, *Foodgrain Supply.*

[96] Raisuddin Ahmed, *Foodgrain Production in Bangladesh: An Analysis of Growth, Its Sources and Related Policies* (Dacca: Bangladesh Agricultural Research Council, 1977).

Table 22—Comparison of average cost of production of local varieties and high-yielding varieties (HYVs) of Aus rice and jute, 1978/79

Cost Items	Aus Rice						Jute					
	Local Variety			HYV			Local Variety			HYV		
	Cost Per Acre	Cost Per Maund[a]	Foreign Exchange	Cost Per Acre	Cost Per Maund	Foreign Exchange	Cost Per Acre	Cost Per Maund	Foreign Exchange	Cost Per Acre	Cost Per Maund	Foreign Exchange
	(taka)		(percent)	(taka)		(percent)	(taka)		(percent)	(taka)		(percent)
Labor[b]	661	62.4	0.0	1,075	36.0	0.0	1,035	65.9	0.0	1,024	47.2	0.0
Bullocks	200	18.9	0.0	220	7.4	0.0	180	11.5	0.0	196	9.0	0.0
Seeds	126	11.9	0.0	63	2.1	0.0	29	1.8	0.0	29	1.3	0.0
Fertilizers	128	12.1	85.0	242	8.1	85.0	98	6.2	85.0	133	6.1	80.0
Pesticides	19	1.8	90.0	42	1.4	90.0	...	...	...	15	0.7	90.0
Irrigation	...	...	...	183	6.1	50.0	...	...	...	...	...	...
Credit (interest)	19	1.8	0.0	8	2.7	0.0	13	0.8	0.0	30	1.4	0.0
Total	1,153	108.8	10.9	1,863	62.3	18.0	1,355	86.3	6.1	1,427	65.8	8.9

Sources: Phillip E. Church, Nizam U. Ahmed, Harun-al-Rashid, and Akhter U. Ahmed, *1978/79 Aus Paddy Costs and Returns Survey* (Dacca: U.S. Agency for International Development/Bangladesh, 1978); and Phillip E. Church, Nizam U. Ahmed, Harun-al-Rashid, and Akhter U. Ahmed, *1978/79 Jute Costs and Returns Survey* (Dacca: U.S. Agency for International Development/Bangladesh, 1979).

Notes: Rice means cleaned rice. The yield rates for rice are 10.6 maunds per acre for local varieties and 29.9 maunds per acre for HYV. Yield rates for jute are 15.7 maunds per acre for local varieties and 21.7 maunds for HYV.

[a] 26.8 maunds equal 1 ton.

[b] Jute requires 112 man-days of labor per acre for local varieties and 111 man-days for HYV. Aus rice requires 64 man-days for local varieties and 101 man-days for HYV.

Table 23—Employment generated by an acre of land allocated to jute as compared with Aus rice, 1979

Activity	Employment			
	Jute		Aus Rice	
	Local Variety	HYV	Local Variety	HYV
	(man-days)			
Production	112.0	111.0	64.0	101.0
Home processing	...	...	4.0	11.0
Marketing[a]	20.3	28.0	1.5	4.0
Total	132.3	139.0	69.5	116.0

Sources: A. M. Muazzam Hussain and M. A. Momen, *The Jute Marketing System in Bangladesh: An Analysis of Selected Areas* (Mymensingh: Agricultural University, 1974); M. O. Farruk, *Structure and Performance of the Rice Marketing System in East Pakistan*, Cornell International Agricultural Bulletin 23 (Ithaca, N. Y.: Cornell University, 1970); Bangladesh, Ministry of Agriculture, *Report of the Task Force on Rice Processing and By-Product Utilization in Bangladesh* (Dacca: Planning Unit, 1978); and Phillip E. Church, Nizam U. Ahmed, Harun-al-Rashid, and Akhter U. Ahmed, *1978/79 Aus Paddy Costs and Returns Survey* (Dacca: U.S. Agency for International Development/Bangladesh, 1978); and Phillip E. Church, Nizam U. Ahmed, Harun-al-Rashid, and Akhter U. Ahmed, *1978/79 Jute Costs and Returns Survey* (Dacca: U.S. Agency for International Development/Bangladesh, 1979).

[a] Employment in marketing assumes that 95 percent of jute and 30 percent of rice are marketed. For jute, marketing includes baling. It is assumed that 80 percent of the jute marketed is baled.

APPENDIX 2
PRODUCTION FUNCTION OF RICE IN BANGLADESH

Several analyses of the production function of rice in Bangladesh are available; three will be discussed here. Despite considerable variation in purpose and analytical quality, they indicate the marginal contributions of various factors to total production.

The study by Shahadatullah is analytically superior to the others but has some data limitations.[97] Using district statistics as a cross-sectional sample, he employs the Constant Elasticity of Substitution (CES) specification to estimate the production function for 1960. His main objective is to examine the returns to scale in rice cultivation. The function includes only land and labor as the factors of production. The estimated function, using Kmenta's approximation of the CES function, is:

$$\text{LogQ} = \underset{(0.320)}{0.279} + \underset{(0.084)}{0.244}\ \text{LogL}$$

$$+ \underset{(0.126)}{0.611}\ \text{LogN} - \underset{(0.098)}{0.159}\ (\text{LogL} - \text{LogN})^2;$$

$$\bar{R}^2 = 0.86.$$

Standard errors are in parentheses.

Shahadatullah uses a dummy for districts that are statistically insignificant, and designates that Q is production of rice; L is area sown with rice adjusted for fertility differences and including an operator for draft power; and N is labor in standard units.

Shahadatullah estimates the value of the scale parameter (sum of the coefficients of L and N) to be 0.855, which is not statistically significant from 1. He also uses a Cobb-Douglas function and does not find a significant difference in the scale parameters of the C-D and CES functions. The marginal product of labor (at the mean level) as estimated from the equation is about 0.51 maunds of paddy, or 12.4 pounds. The elasticity of substitution between land and labor is 0.84.

The study by the Bureau of Statistics is based on a sample covering about 4 percent of the farms in Bangladesh, but there are some deficiencies in analyses and data quality (nonsampling errors).[98] The main objective is to estimate the marginal productivity of labor in rice and compare it with wage rates to determine whether there is a surplus of labor. A Cobb-Douglas specification of production function is employed. The results are presented in Table 24.

Production per acre is used as the dependent variable instead of explicitly including land as an explanatory variable. The nonlabor cost (K) represents mostly the imputed value of plowing and seeds, plus minor items such as fertilizer (about 8 percent) and land tax (3 percent).

For all regions except the central rice-jute areas, the value of the marginal product of labor is not significantly different from the wage rates. In the rice-jute areas, however, it is only about one third of the wage rate. Because of a larger weight of this region in the sample, the country estimate is similar—the value of the marginal product of labor is about half of the wage rate. It is difficult to determine whether this result reflects measurement errors. Small farms with a complex cropping pattern predominate in the central region. The imputed value of plowing for rice could have been mixed with that for jute because the seasons overlap. On the other hand, the real labor cost could be lower than the market wage rate because of many complex factors.

The study by the author was done in two areas of Dacca and Mymensingh districts of Bangladesh in 1969. The data were collected personally from a sample of farms growing Boro rice under low-lift irrigation in the winter.

Broadly speaking, production of a particular crop by a farm household depends

[97] A. H. Shahadatullah, "Farm Productivity."

[98] Bangladesh, Bureau of Statistics, *Surplus Labor in Paddy Cultivation in East Pakistan 1964/65* (Dacca: Bureau of Statistics, 1965).

Table 24—Estimates of the production function of rice, 1964/65

Region/ Primary Crop	Constant Term	Coefficient of Labor (N)	Coefficient of Nonlabor Cost (K)	R^2	MPPN[a]	Price of Rice	Wage
					(maunds)	(taka/maund)	(taka/day)
Coastal belt Aman	0.9728	0.479	0.167	0.13	0.1776	14.5	2.6
Northeastern Boro, Aus	0.0074	0.655	0.115	0.15	0.2620	13.1	3.2
Central rice, jute	0.0125	0.257	0.412	0.19	0.0672	14.7	2.9
Western rice, pulses	0.0088	0.549	0.202	0.25	0.1911	14.3	2.8
Total	0.5282	0.311	0.252	0.12	0.1158	14.2	2.9

Note: Coefficients are significant at less than 0.05. One maund equals 82.29 pounds.

[a] MPPN is the marginal physical product of labor at the mean levels of labor input and output.

on the inputs and services employed and the way they are utilized. These inputs and services include land and its quality, seeds, fertilizer, irrigation, plowing, planting, intercultural operations, protection from insects and pests, and harvesting. Differences in the amounts of inputs used and the timeliness of their application could cause differences in production. Financial resources of farmers are not direct inputs but can make crucial differences in the use of the inputs. In the low-lift pump project areas included in this study, irrigation and plant protection measures are almost uniformly provided under a collective arrangement. Land preparation, planting, intercultural operations, application of fertilizer and harvesting of this Boro crop are all done by labor. Plowing is done by animal power. The intensity of plowing is remarkably uniform among farms, ranging from 4-5 plowings in the sample of 179 farms from two separate areas. Because the crop is irrigated, rainfall is of little significance.

Interfarm differences in production are explained mostly by differences in the application of fertilizer, labor input, seeds representing local varieties and HYVs (IR-8), and the area sown with rice. The coefficient for seed variety (defined as the proportion of HYVs in total rice area) is insignificant. This unexpected result mainly arises because this was the initial year for HYVs and all seeds were distributed by the government. Because of the limited supply, the extension workers allocated seeds to each farmer according to the proportion of his land under the project areas. Therefore, seeds are excluded from the final form of the production function. The explanatory variables are: area under rice (L), man-days of labor input in production of rice (N), and fertilizer quantities applied to rice (F). The estimated form of the function was:

$$\text{LogQ} = 2.3341 + 0.3528\ \text{LogL} + 0.3586\ \text{LogN} + 0.1985\ \text{LogF};$$

$$\bar{R}^2 = 0.58.$$

All the coefficients are significant at 0.01 percent. Q represents production of rice per farm.

Estimates of marginal productivity of factors and some average farm statistics for selected districts of Dacca and Mymensingh are presented in Table 25.

Table 25—Marginal productivities of factors in rice production for selected areas of Dacca and Mymensingh, 1969

Item	Value
Marginal product of land (maunds of paddy)[a]	12.73
Marginal product of labor (maunds of paddy)	0.2057
Marginal product of fertilizer (maunds of paddy)	11.02
Average product of land (maunds of paddy)	36.08
Average product of labor (maunds of paddy)	0.5736
Average product of fertilizer (maunds of paddy)	55.51
Average farm size (acres)	5.30
Average labor per acre of rice (man-days)	72.9
Average fertilizer per acre of rice (maunds of nutrients)	0.65
Proportion of high-yielding variety area in total rice area (percent)	35.0
Proportion of hired labor in total labor per acre (percent)	40.86
Price of paddy (taka per maund)	17.50
Price of fertilizer (taka per maund of nutrients)[b]	51.84
Wage rate (taka per man-day)	3.57

[a] One maund equals 82.29 pounds. The conversion factor for rice from paddy is 0.66.

[b] The factor for converting a maund of commercial fertilizer to a maund of nutrients is 0.48.

APPENDIX 3

EFFECTS OF HYPOTHETICAL CHANGES IN POLICIES FOR JUTE AND RICE

A static microeconomic framework of supply and demand is used to determine the effects of hypothetical changes in policies on production, prices, and trade of jute and rice. Because of the obvious limitations of the framework and uncertain nature of the parameters, the results should be treated as an indication of the direction of changes rather than accurate measures of absolute magnitude.

Removing the Export Tax on Jute

The initial equilibrium state of the jute and rice market is depicted in Figure 5 as follows:

Domestic Rice Market: production = OQR_2 − OQR_2; consumption = OQR_1; and the price of imports = $OQR_1 - OQR_2$.

Domestic Jute Market quantity produced = OQ_{j1}; domestic use = Oq; domestic price = OP_{j1}; and available for export = OQ_{j1} − Oq.

Jute Export Market quantity export = OX_{j1}; export price = OP_{j3}; and export tax = $OP_{j3} - OP_{j1}$.

Next it is assumed that the export tax is withdrawn and foodgrains are imported to maintain rice prices at the same level. In the new equilibrium, the following will occur: domestic jute price (farm-level price plus a constant proportion of marketing margin) will rise to the world price at OP_{j2}. Domestic production of jute will go up from OQ_{j1} to OQ_{j2}. All of the increase will be exported because domestic demand does not change. Rice import increases by $OQR_1 - OQR_2$, a quantity equivalent to the decrease in domestic rice production. World price for rice is assumed to be unaffected by this change.

If the relevant supply and demand elasticities and initial condition are known, one can easily estimate the values of the variables at equilibrium after the tax is withdrawn. Thus,

$$P_{j2} = P_{j1}\{1 + [\dot{\varepsilon}_d/(\dot{\varepsilon}_d - \dot{\varepsilon}_s)]\}$$

$$= P_{j3}\{1 + [\dot{\varepsilon}_s/(\dot{\varepsilon}_d - \dot{\varepsilon}_s)]\};$$

where,

$\dot{\varepsilon}_d$ = elasticity of export demand for Bangladesh jute (−2.7);

$\dot{\varepsilon}_s$ = elasticity of domestic supply (production) of jute (0.45).

Increase in jute export =

$$OX_{j2} - OX_{j1} = OQ_{j2} - OQ_{j1};$$

where,

$$OQ_{j2} = OQ_{j1}\{1 + [(P_{j3} - P_{j1})/P_{j1}]\dot{\varepsilon}_s\}.$$

Rice import = $OQR_1 - OQR_2$;

$$OQR_2 = OQR_1\{1 + [(P_{j3} - P_{j1})/P_{j1}]\dot{\xi}\};$$

where,

$\dot{\xi}$ = cross-elasticity of supply of rice with respect to jute price (−0.042).

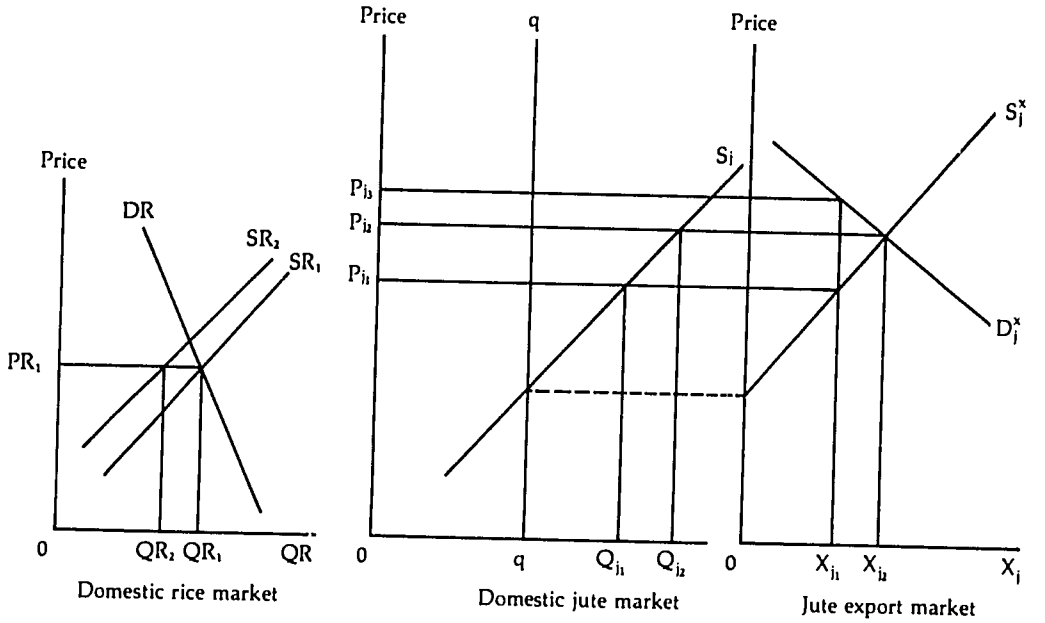
Reducing Rice Price with Foodgrain Imports and Tax-Free Export of Jute

The initial market situation and final equilibrium under these policies are depicted in Figure 7. The initial position of the domestic rice market is:

Domestic Rice Market: production = OQR_2; import = $OQR_1 - OQR_2$; consumption = OQR_1; and price = PR_1. The initial position of the domestic jute market is: production = OQ_{j1}; domestic use = Oq; available for export = OQ_{j1} − q; and price = P_{j1}. That of the jute export market is: export = OX_{j1}; and price = P_{j1}.

If the policy of reducing the rice price to PR_2 by increasing imports of foodgrains is adopted, domestic rice production will fall, demand for rice will increase, as well as jute production and export. If jute exports are not subsidized, world as well as domestic jute prices will fall to P_{j2}, and the fall in rice production will be smaller than with an export subsidy. The final equilibrium positions will be as follows:

Figure 5—Effect of tax-free exports of jute with a fixed rice price



Variables	With Export Subsidy on Jute	Without Export Subsidy
Rice production	OQR_3	OQR_4
Rice imports	$OQR_5 - OQR_3$	$OQR_5 - OQR_4$
Rice consumption	OQR_5	OQR_5
Rice price	PR_2	PR_2
Jute production	OQ_{j3}	OQ_{j4}
Jute domestic use	Oq	Oq
Jute exports	OX_{j3}	OX_{j4}
Domestic jute price	P_{j1}	P_{j2}
World jute price	P_{j3}	P_{j2}
Subsidy/unit of export	$P_{j1} - P_{j3}$	...

Estimating Formulas

The formula for total demand for rice is:

$$OQR_5 = OQR_1 + OQR_1\{1 + [(PR_2 - PR_1)/PR_1]\overset{R}{\varepsilon}_d\};$$

where $\overset{R}{\varepsilon}_d$ = demand elasticity of rice (−0.46). Production of rice with an export subsidy is:

$$OQR_3 = OQR_2\{1 + [(PR_2 - PR_1)/PR_1]\overset{R}{\varepsilon}_s\};$$

where $\overset{R}{\varepsilon}_s$ = supply elasticity of rice (0.25).

Production of rice without an export subsidy is:

$$OQR_4 = OQR_3\{1 + [(P_{j2} - P_{j1})/P_{j1}]\overset{|}{\varepsilon}_r\}.$$

Imports of rice with an export subsidy are:

$$OQR_5 - OQR_3;$$

imports of rice without an export subsidy are:

$$OQR_5 - OQR_4;\ \text{and}$$

the shift in the supply curve of jute is:

$$OQ_{j3} - OQ_{j1}.$$

Moreover,

$$OQ_{j3} = OQ_{j1}\{1 + [(PR_2 - PR_1)/PR_1]\overset{R}{\varepsilon}_j\};$$

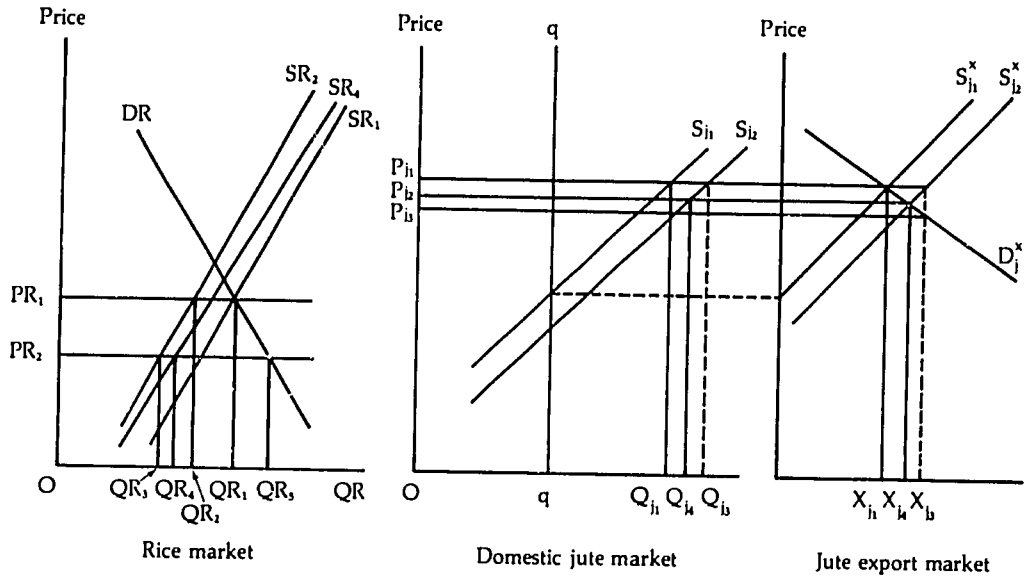
$$P_{j3} = P_{j1}\{1 + [(OQ_{j3} - OQ_{j1})/OQ_{j1}]\overset{|}{\varepsilon}_d\};$$

$$P_{j2} = P_{j1}\{1 + [(OQ_{j3} - OQ_{j1})/(\overset{|}{\varepsilon}_d - \overset{|}{\varepsilon}_s)]\};\ \text{and}$$

$$OQ_{j4} = OQ_{j3}\{1 + [(P_{j2} - P_{j1})/P_{j1}]\overset{|}{\varepsilon}_s\};$$

where, $\overset{R}{\varepsilon}_j$ is the cross elasticity of the supply of jute with respect to rice price (−0.83). Other symbols have the same meaning as before.

Figure 6—Effect of tax-free exports of jute with a variable domestic rice price



APPENDIX 4
ESTIMATION OF THE MARKETABLE SURPLUS OF RICE

The procedure for estimating the marketable surplus of rice for 1973/74 can be algebraically explained:

Q = gross production of rice;
R = net payment of rice to landlords as rent, basically for sharecropped area (net payment is gross payment of rent minus gross receipt of rent);
W = on-farm use of rice for seed and feed plus wastage;
S = net availability for home consumption, sale, and stock;
M = net marketable surplus;
M_g = gross marketable surplus;
C = total consumption of rice;
H = consumption of farm-produced rice; and
i = a subscript representing the i^{th} farm household group.

Now:

$$S_i = Q_i - R_i - W_i;$$

$$M_i = S_i - C_i; \text{ and}$$

$$Mg_i = S_i - H_i;$$

subject to the conditions for the size groups where $C_i \geq S_i$, $H_i = S_i$, and $M_i = 0$; and for the size groups where $C_i \leq S_i$, $H_i = C_i$ and $M_i > 0$.

To determine the gross production of rice (Q_i), distribution of farm households by income classes, as given in the Household Survey of 1973/74, is converted to distribution by farm sizes by developing a relationship between income and farm size, measured by cultivated acres operated by a farm household. The survey provides data on average household income from agricultural sources by broad expenditure classes of farm households. Nonfarm income as a proportion of total income is approximately the same among household classes. Whereas low-income households earn a large share of nonfarm income from wages, high-income households derive a higher proportion from business, commerce, and rents. A linear relation between average income and average farm size results in a very good fit. The distribution of farms in size groups developed by the above procedure is remarkably close to the distribution based on the 1977 survey.[99]

The second step is to develop a distribution of aggregate production of rice from the distribution of cultivated area and yield by farm sizes. The proportions of rice area in the gross cropped area for the size groups[100] and cropping intensity are obtained from the Master Survey of Agriculture (seventh round). This procedure implies a decreasing return to scale resulting from the higher cropping intensity on small farms than on large farms.

Net payment of rent is defined as gross payment minus gross rent received. Gross payment of rent is worked out on the basis of sharecropped area in each size group, assuming a 50:50 sharing arrangement. This assumption appears realistic in light of the 1977 land survey statistics. Gross rent received is determined from a study by Hossain[101] which shows that farmers receive about 58 percent of the gross rent payment by farmers. This 58 percent of the gross payment is distributed among size groups as gross receipts of rent, according to the proportions of owned land in the total operational holding.

The Master Survey of Agriculture (second round) provides information on seed, feed, and wastage by farm sizes.

From the 1973/74 Household Survey data a relationship between gross production and home consumption of rice is estimated. A number of functional forms are tried and the following gave the best result:

[99] F. Tomasson Januzzi, James T. Peach, and Ghulam Rabbani, *Report of the 1977 Land Occupancy Survey of Rural Bangladesh* (Dacca: Bureau of Statistics, 1977).

[100] Per acre yield of rice for various sizes is obtained through a linear relation of yield and farm sizes based on three points: less than 2.5 acres, 2.5-2.7 acres, and 7.5 acres and above.

[101] Mahabub Hossain, "Factors Affecting Tenancy: The Case of Bangladesh Agriculture," *Bangladesh Development Studies* 6 (Summer 1978): 139-162.

$H_i = -621.53 + 150.07 \text{ Log } Q_i$;
$\quad\quad (-14.488) \quad (15.901)$

$\bar{R}^2$ (adjusted) = 0.96.

The numbers in parentheses are t-values.

Krishna and Behrman developed an indirect procedure for estimation of the elasticity of marketed surplus with respect to price. [102] Their formulation is as follows:

$$e = yb_1 - (y - 1)[g + hk(1 + b_1)] - (y - 1)hb_2(1 - k)$$

where:

- e = price elasticity of marketed surplus of rice;
- b_1 = supply elasticity of rice with respect to its own relative price;
- b_2 = supply elasticity of other farm products (such as jute) to the relative price of rice;
- y = inverse of the sale to gross production ratio of rice;
- k = the value of rice production to net farm income;
- h = income elasticity of the demand for home consumption of rice; and
- g = price elasticity of demand for on-farm consumption of rice.

The most likely value of b_1 in the context of Bangladesh would be about 0.20, which is small but positive. The value of b_2 would be negative because it is the supply response of one product to the price of a competing product. Its value would most likely be about -0.7 to -0.85 (see Chapter 3). From discussion in the text, it would appear that the ratio of sales to gross production would be about 0.25 and therefore the value of y would be 4. Farm management studies[103] indicate the value of k to be 0.80. Though the average value of · is 0.40, the value of h for surplus farm households is only about 0.20 (see text). The parameter concerning the surplus households is more relevant here than that of all households. The values of h and k should be closely related if the demand function is to maintain its homogeneity. The values of g and h are assumed to range from 0.20 to 0.57 and -0.15 to -0.38 respec-

Table 26—Relative positions in production and consumption of selected farm products by various farm groups

Variables	Small Farms	Medium Farms	Large Farms
Average farm size (acres)	1.15	3.80	10.72
Ratio of area sown with jute to farm size	0.16	0.12	0.08
Ratio of area sown with pulses to farm size	0.16	0.15	0.20
Ratio of area sown with oilseeds to farm size	0.05	0.06	0.13
Ratio of area sown with vegetables to farm size	0.09	0.06	0.03
Ratio of number of poultry birds to farm size	5.33	2.68	1.42
Ratio of number of milk cows to farm size	0.24	0.16	0.13
Annual per capita consumption of pulses (pounds)	12.59	18.27	32.09
Annual per capita consumption of edible oils (pounds)	3.70	4.83	9.13
Annual per capita consumption of vegetables (pounds)	5.92	9.87	14.81
Annual per capita consumption of chickens (numbers)	0.84	1.56	3.84
Annual per capita consumption of fresh milk (pounds)	8.15	27.90	52.58
Family size	5.7	7.4	10.3

Sources: Production data are from Bangladesh, Bureau of Statistics, *Report of the Pilot Agricultural Census, 1976* (Dacca: Bureau of Statistics, 1978). Consumption data are from Bangladesh, Bureau of Statistics, "1973/74 Household Survey," Dacca, 1974. (Computer printout.)

[102] See Raj Krishna, "A Note on the Elasticity of Marketable Surplus of a Subsistence Crop," *Indian Journal of Agricultural Economics* 17 (July 1962); and Jere R. Behrman, "Price Elasticity of Marketed Surplus of a Subsistence Crop," *Journal of Farm Economics* 48 (November 1966): 875-893.

[103] Bangladesh, Ministry of Agriculture, *Farm Management Studies in Dinajpur, Kushtia, and Bogra* (Dacca: Agro-Economic Research Unit, 1965).

tively (see Chapter 6). With these assumed values of parameters, the value of e—the elasticity of marketed surplus—is found to range from 0.05 to 0.29. It seems that the value of e is very sensitive to the changes in the values of y, h, and g. If the marketing ratio decreases, the value of e increases quite sharply. If the absolute values of h and g increase, the value of e also increases swiftly.

APPENDIX 5

LABOR MARKET DUALISM AND AGRICULTURAL WAGES AND EMPLOYMENT

The main objective of this exercise is to measure the effect of an exogenous change in rice prices on real wage rates and employment of agricultural laborers in Bangladesh. This involves analysis of both the demand and the supply of agriculture labor. Such analyses have obvious methodological pitfalls. Writing on theories of unemployment, Robert Solow once observed, "The fuse leading from theory to policy in this field is short, and has been known to produce both heat and light throughout much of the history of economics. . .Nevertheless, one can get much mileage from the methods of conventional economic analysis if only he is willing to broaden the assumptions a little."[104] The only hope in this exercise is that resistance to methodological simplicity does not obscure the reality of the situation in Bangladesh.

The Framework

The conceptual framework for the aggregate demand for and supply of agricultural labor is presented in Figure 7. Labor markets are generally fragmented by spatial and socioeconomic factors. It is assumed that aggregation over space is valid, but the labor market is divided into two major groups—family and hired labor. The diagram for family labor shows the gap between the supply of family labor and the total demand for labor in agriculture. The supply function of family labor has been drawn as insensitive to wage rates, but could be drawn sloping upward as well. The interaction of supply and demand curves for hired labor in Figure 7 indicates that the demand for hired labor is a residual of total demand that cannot be met by family labor. Therefore, DHL is drawn as a horizontal distance between DL and SF. The final diagram represents interaction of supply and demand curves of aggregate labor in agriculture (that is, horizontal sums of hired and family labor for both supply and demand). The initial levels of actual supply, demand, employment, and wage rates in all the figures are indicated by the subscript 0.

Now, if it is assumed that the curve representing total demand for labor (DL) shifts to the right due to exogenous factors, the resulting shift in DHL will depend on the shift of SF as well as DL. If the shift in DL is the same as the shift in SF in absolute magnitude and direction, there will be no change in DHL. Under such circumstances, employment and wage rates of wage laborers will not change, even if the overall demand has increased. In reality, the SHL (supply curve for hired labor) would also shift to the right during the period in which DL and SF shifted. The rightward shift of SHL without any change in DHL implies a fall in the real wage rate and an increase in employment for wage laborers, determined by the elasticity of DHL and SHL. The elasticity of DHL has the following relationship with the elasticities of DL and SF:

$$-E_{DHL} = -E_{DL}\ L/LH - E_{SF}\ LF/LH,$$

where,

E_{DHL} = the elasticity of DHL (demand for hired labor) with respect to real wage rate,

E_{DL} = elasticity of DL (demand for labor, hired and family), and

E_{SF} = elasticity of SF (supply of family labor).

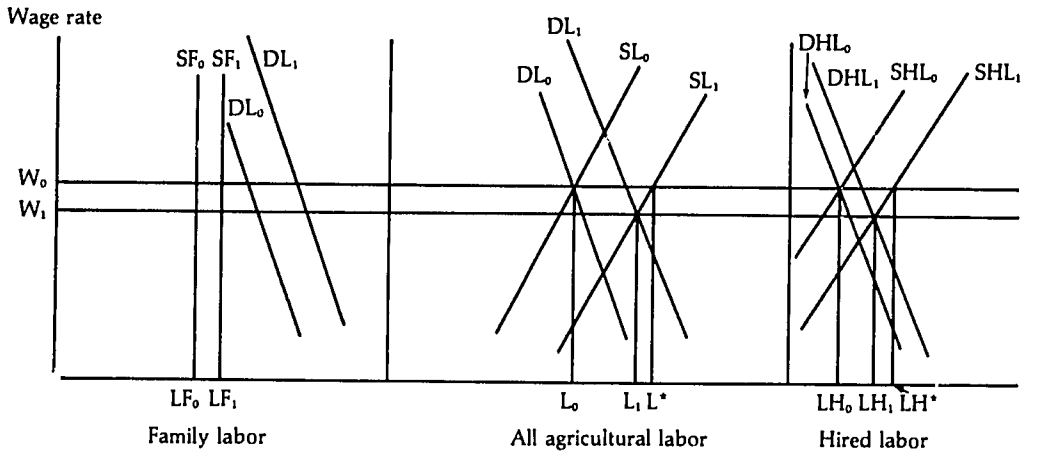
L/LH and LF/LH change over time.

It is obvious from this formulation that the demand curve for hired labor would be more elastic than that of labor in general, except in the case of a backward-bending supply curve for family labor.

The supply curve of family labor may

[104] Robert M. Solow, "On Theories of Unemployment," *American Economic Review* 70 (March 1980): 1-11.

Figure 7—Agricultural employment



shift due to changes of income from nonwage sources, as well as from population growth. Changes in rice prices would imply changes in rent income of surplus farm households, which shift the family labor supply function. The size of this shift depends on the elasticity of leisure to income for such surplus farm households. This shift in supply of family labor also will shift the demand for hired labor.

The model is validated by using data for 1963 (the average of 1962-64) and 1977 (the average of 1976-78) and testing how well the model parameters explain actual employment and wage rates.

The index of real wage rates changes from 99 to 75. The initial level of agricultural employment is 13.1 million man-years; family labor is 9.2 million and hired labor, 3.9 million.[105] The elasticity of the total labor demand curve is 0.35, based on the marginal product curves of labor presented in Chapter 3.

The shift in the total labor demand curve is estimated on the basis of fixed labor-use per acre of various crops (at a given real wage rate) and the changes in total areas under various crops during the two time periods. The fixed labor coefficients for crops in the early sixties are arrived at from master surveys, farm management studies, and other sources.[106] This procedure shows a rightward shift in the demand for labor of 1.7 percent per year or 23.8 percent for the entire period.

The shifts in the supply curves of family and hired labor are based on the growth of the agricultural labor force as indicated by the 1961 and 1974 censuses. The census definition of the labor force as those 10 years of age and older who are economically active includes those who are employed at the time of the interview and those who are looking for work. However, the female labor participation is grossly erroneous, again due to definitional problems.[107] Because of this and because female labor generally does not enter into agricultural work that cannot be performed at or near the homestead, this group is excluded from the estimates. The agricultural male labor force as defined by the census shows an annual compound growth rate of about 1.5 percent. Inclusion of female labor in the labor force would reduce this rate. A break-

[105] Farm management studies, such as the second round of the *Master Survey of Agriculture* and the population census for 1961, support this assumption.

[106] Edward J. Clay and M. S. Khan, *Agricultural Employment and Underemployment in Bangladesh: The Next Decade*, AERSS Paper No. 4 (Dacca: Agricultural Research Council, 1977).

[107] A. F. M. Habibul Huq, "Labour Force Analysis: Bangladesh, 1974," *Bangladesh Development Studies* 6 (Summer 1978): 163-190.

down of agricultural labor into occupational categories indicates that the number of wage laborers (landless agricultural laborers) grew at an annual rate of 3.1 percent compared with 1.1 percent for self-employed workers. This is an unrealistically low rate for the self-employed group and mostly reflects the ambiguity of the definition. Self-employed workers may be willing to work and be without work but still report that they are not looking for work. To reflect the supply shift more accurately, the growth rates for the male population within the working are (10 years and older) in the occupational groups of agriculture are adopted.

Category	Annual Growth Rate
Agricultural wage laborers	3.6 percent
Self-employed agricultural laborers	2.5 percent
All laborers in agriculture	2.9 percent

The elasticity of the supply of family labor is assumed to be 0. However, the income elasticity of leisure of farm family labor is estimated to be 0.08 from the data presented in the text. This is done by setting leisure (total hours available in a year minus total hours worked on agriculture) as a function of farm income for the farm size groups equal to or larger than 2.5 acres. Changes in real farm income due to changes in rice prices during 1963-77 are measured by the index of nominal rice prices deflated by the nominal wage rate and weighted by the proportion of the marketable surplus. This income elasticity of 0.08 is equivalent to the income elasticity of supply of family labor of -0.24 for surplus farms and -0.10 for all farm households.

On the basis of the information presented above, aggregate agricultural employment is estimated to have grown at an annual rate of 2.0 percent. Employment of family labor grew at 1.9 percent and that of hired labor by 2.3 percent. These figures are close to other independent estimates.

A growth rate of 1.7 percent per year during 1962-76 is indicated by independent estimates based on the Bureau of Statistics' survey on labor use by crops in the mid-1960s.[108] The effect of falling real wage rates on labor use in the years following the mid-1960s were not incorporated. In other words, these estimates really represent the employment equivalent of the shift in the demand curve.

If our estimates of agricultural employment and the underlying assumptions are correct, it is possible to estimate the implicit elasticity of the supply curve of hired labor. This estimate is formulated as follows:

$$[(LH^* - LH_1)/LH_1]/[(W_0 - W_1)/W_0].$$

LH^* is determined by the shift of the labor force available in the wage market and LH_1 is the level of employment of this force.

On the basis of the above formulation, and for the estimated average level of employment of hired laborers, the supply elasticity of hired labor is 0.29.

If the price of rice is raised 10 percent by exogenous means, the first effect is a 0.60 percent shift to the left in the aggregate demand for labor in crop production. This result is based on the elasticity of rice acreage to rice prices at 0.13 and the elasticity of HYV rice area to rice prices at 0.20. It assumes that 70 percent of the increased rice area comes from jute area and the remainder from pulse area. The leftward shift is mainly due to conversion of labor-intensive jute area into rice that is not compensated for by conversion of rice area under local varieties to labor-intensive HYV.

Second, a 10 percent increase in rice prices decreases the supply of aggregate family labor by 0.28 percent. The result of the leftward shifts of aggregate supply of family labor and aggregate demand for agricultural labor is a net leftward shift in the aggregate demand for hired labor of 1.3 percent. This causes a fall in the real wage rate of 1.2 percent and in employment of hired laborers of only 0.35 percent.

The effect of price changes on wage rates and employment of hired labor depends on whether the effects are realized im-

[108] Edward J. Clay, "Agricultural Employment in Bangladesh," in *Agrarian Structure and Change: Rural Development Experience and Policies* (Dacca: Ministry of Agriculture, 1978); and Edward J. Clay and M. S. Khan, *Agricultural Employment*

mediately or with a time lag when the labor supply function also shifts to the right. The results shown in Table 27 are for both the short run and a one-year lag. They indicate that an increase in rice prices cannot raise the money wage rate in the same proportion because of substitution of a less labor-intensive cropping pattern for a more intensive one. The money wage rates closely follow rice prices in the short run, but for a medium time span, the pressure of an increasing labor force causes the money wage rate to lag further behind changes in rice prices. The actual gap between rates of changes in rice prices and wage rates in Bangladesh reflects both substitution among crops and the high growth rate of the labor force.

Table 27—Short- and medium-run effects of a 10 percent rise in rice prices on wage rates and employment of hired laborers

Effects	Changes in Real Wage Rate	Implied Changes in Money Wage Rate	Changes in Employment
		(percent)	
Short-run	-1.20	8.80	-0.35
Medium-run	-4.32	5.68	1.93

Table 28—Price differences between medium and coarse grades of rice, 1966/67-1977/78

Year	Prices of Medium Grade	Prices of Coarse Grade	Absolute Difference	Difference as Percent of Coarse Grade
		(taka/maund)		(percent)
1966/67	44.75	42.75	2.00	4.7
1967/68	39.82	36.85	2.97	8.1
1968/69	44.46	41.43	3.03	7.3
1969/70	44.67	40.43	4.24	10.5
1970/71	45.77	41.08	4.69	11.4
1971/72[a]	n.a.	n.a.	n.a.	n.a.
1972/73	83.63	78.93	4.70	5.9
1973/74	119.33	111.70	7.63	6.8
1974/75	232.00	221.25	10.75	4.9
1975/76	141.33	128.00	13.33	10.4
1976/77	127.34	111.52	15.82	14.2
1977/78	162.02	145.52	16.50	11.3

Source: Bangladesh, Department of Marketing, *Agriculture Prices*, various issues.

Note: One maund equals 82.29 pounds.

[a] Because of the civil war, price breakdowns are not available for 1971/72.

BIBLIOGRAPHY

Ahmed, Iqbal. "Unemployment and Underemployment in Bangladesh Agriculture." *World Development* 6 (December 1978): 1281-1296.

Ahmed, Raisuddin. *Foodgrain Production in Bangladesh: An Analysis of Growth, Its Sources and Related Policies.* Dacca: Bangladesh Agricultural Research Council, 1977.

———. *Foodgrain Supply, Distribution, and Consumption Policies within a Dual Pricing Mechanism: A Case Study of Bangladesh.* Research Report 8. Washington, D.C.: International Food Policy Research Institute, 1979.

Alamgir, Mahiuddin. *Bangladesh: A Case of Below Poverty Equilibrium Trap.* Dacca: Bangladesh Institute of Development Studies, 1976.

Asaduzzaman, M.D. and Islam, Faridul. *Adoption of HYV in Bangladesh: Some Preliminary Hypotheses and Tests.* Research Report 25. Dacca: Bangladesh Institute of Development Studies, 1973.

Askari, Hossein and Cummings, John Thomas. *Agricultural Supply Response: A Summary of the Econometric Evidence.* New York: Praeger Publishers, 1976.

Bangladesh, Bureau of Statistics. *Census of Manufacturing Industries, 1974/75 and 1975/76.* Dacca: Bureau of Statistics, 1979.

———. *Employment Market for the Educated in Bangladesh.* Dacca: Manpower Section, 1974.

———. *Household Expenditure Survey, 1973/74.* Dacca: Bureau of Statistics, 1978.

———. *Master Survey of Agriculture in East Pakistan.* Second Round. Dacca: Bureau of Statistics, 1966.

———. *Master Survey of Agriculture in East Pakistan.* Sixth Round. Dacca: Bureau of Statistics, 1964.

———. *Master Survey of Agriculture in East Pakistan.* Seventh Round. Dacca: Bureau of Statistics, 1968.

———. "1973/74 Household Survey." Dacca, 1974. (Computer printout.)

———. *1979 Statistical Year Book.* Dacca: Bureau of Statistics, 1979.

———. *Report of the Pilot Agricultural Census, 1976.* Dacca: Bureau of Statistics, 1978.

———. *Surplus Labor in Paddy Cultivation in East Pakistan, 1964/65.* Dacca: Bureau of Statistics, 1965.

———. *The Year Book of Agricultural Statistics (1976/77).* Dacca: Bureau of Statistics, 1978.

Bangladesh, Department of Marketing. *Agriculture Prices,* various issues.

Bangladesh, Institute of Nutrition and Food Science. *Nutrition Survey of Rural Bangladesh, 1975/76.* Dacca: Dacca University, 1977.

Bangladesh, Ministry of Agriculture. *Agricultural Production Levels 1947-1964.* Dacca: Bureau of Agricultural Statistics, 1965.

———. *Bangladesh Agriculture in Statistics.* Dacca: Ministry of Agriculture, 1973.

———. *Report of the Task Force on Rice Processing and By-Product Utilization in Bangladesh.* Dacca: Planning Unit, 1978.

———. *Farm Management Studies in Dinajpur, Kushtia and Bogra.* Dacca: Agro-Economic Research Unit, 1965.

Bangladesh, Ministry of Agriculture, Agro-Economic Research. *Bangladesh Agriculture in 1976/77.* Dacca: Ministry of Agriculture, 1977.

Bangladesh, Ministry of Rural Development. *Integrated Rural Development Program: A Joint Review by the Government and the World Bank.* Dacca: Integrated Rural Development Program, 1981.

Bangladesh, Planning Commission. *Employment Market for the Educated in Bangladesh.* Dacca: Manpower Section, 1974.

Bardhan, Pranab K. "Labor Supply Function in a Poor Agrarian Economy." *American Economic Review* 69 (March 1979): 73-83.

Bardhan, K. *Production Conditions in Indian Agriculture. A Study Based on Farm Management Surveys.* Cambridge: Cambridge University Press, 1974.

Behrman, Jere R. "Price Elasticity of Marketed Surplus of a Subsistence Crop." *Journal of Farm Economics* 48 (November 1966): 875-893.

———. *Supply Response in Underdeveloped Agriculture.* Amsterdam: North Holland, 1968.

Bell, Clive L. G. and Hazell, Peter B. R. "Measuring the Indirect Effects of an Agricultural Investment Project on Its Surrounding Region." *American Journal of Agricultural Economics* 62 (February 1980): 75-86.

Berry, A. and Sabot, R. H. "Labor Market Performance in Developing Countries: A Survey." *World Development* 6 (November-December 1978): 1119-1242.

Bliss, Christopher and Stern, Nicholas. "Productivity, Wages, and Nutrition." *Journal of Development Economics* 5 (December 1978): 331-398.

Bose, Swadesh R. "Trend of Real Income for the Rural Poor in East Pakistan, 1949-66." *Pakistan Development Review* 8 (No. 3, 1968): 454-488.

Cain, Mead and Mazumdar, A. B. M. K. *A. Labor Market Structure, Child Employment and Reproductive Behaviour in Rural South Asia.* New York: United Nations Population Council, 1980.

Chen, Lincoln C. "An Analysis of Per Capita Foodgrain Availability, Consumption and Requirement in Bangladesh: A Systematic Approach to Food Planning." *Bangladesh Development Studies* 3 (April 1975): 93-126.

Choudhury, S. D. and Ali, M. Ashraf. *Report on Survey of Cost of Production of Jute and Aus.* Dacca: Central Jute Committee, 1962.

Clay, Edward J. "Agricultural Employment in Bangladesh." In *Agrarian Structure and Change: Rural Development Experience and Policies.* Dacca: Ministry of Agriculture, 1978.

———. "Food Aid and Food Policy in Bangladesh." *Bangladesh Journal of Agricultural Economics* 1 (December 1978): 107-120.

Clay, Edward J. and Khan, M. S. *Agricultural Employment and Underemployment in Bangladesh: The Next Decade.* AERSS Paper No. 4. Dacca: Agricultural Research Council, 1977.

Church, Phillip E.; Ahmed, Nizam U.; Harun-al-Rashid, and Ahmed, Akhter U. *1978/79 Aus Paddy Costs and Returns Survey.* Dacca: U.S. Agency for International Development/ Bangladesh, 1978.

———. *1978/79 Jute Costs and Returns Survey.* Dacca: U.S. Agency for International Development/Bangladesh, 1979.

Cochrane, J.D. and Orcutt, D. H. "Application of Least Squares Regressions to Relationships Containing Auto-Correlated Error Terms." *Journal of the American Statistical Association* 5 (No. 3, 1949).

Cummings, John Thomas. "The Supply Response of Bangalee Rice and Cash Crop Cultivators." *Bangladesh Development Studies* 2 (October 1974): 235-251.

Dobb, Maurice. *Some Aspects of Economic Development: Three Lectures.* Delhi: Delhi School of Economics, 1955.

Farouk, A. "Use of Time by Individuals: A Survey in Bangladesh." Paper prepared for ADC-RTN Workshop, Singapore, 1976.

Farruk, Mohammed Osman. *Structure and Performance of the Rice Marketing System in East Pakistan.* Cornell International Agricultural Development Bulletin 23. Ithaca, N.Y.: Cornell University, 1970.

Grilli, Enzo R. and Morrison, Ralph H. *Jute and Synthetics.* World Bank Staff Working Paper No. 171. Washington, D.C.: International Bank for Reconstruction and Development, 1974.

Habibullah, M. *Some Aspects of Rural Capital Formation in East Pakistan.* Dacca: Bureau of Economic Research, Dacca University, 1963.

Hart, Gillian Patricia. "Labor Allocation Strategies in Rural Javanese Households." Ph.D. thesis, Cornell University, 1978.

Hogue, Nurul. *Use of Fertilizers by Small Farms in Bogra.* Bogra: Bangladesh Academy for Rural Development, 1980.

Hossain, Mahabub. "Factors Affecting Tenancy: The Case of Bangladesh Agriculture." *Bangladesh Development Studies* 6 (Summer 1978): 139-162.

Huq, Habibul A. F. M. "Labour Force Analysis: Bangladesh, 1974." *Bangladesh Development Studies* 6 (Summer 1978): 163-190.

Hussain, A. M. Muazzam and Momen, M. A. *The Jute Marketing System in Bangladesh: An Analysis of Selected Areas.* Mymensingh: Agricultural University, 1974).

Hussain, S. M. "The Effect of Growing Constraint of Subsistence Farming on Farmer Response to Price: A Case Study of Jute in Pakistan." *Pakistan Development Review* 9 (Fall 1968).

Institute of Nutrition and Food Science. *Nutrition Survey of Rural Bangladesh, 1975/76.* Dacca: Dacca University, 1977.

International Bank for Reconstruction and Development. *Price Prospects for Major Primary Commodities.* Report No. 814/80. Washington, D.C.: IBRD, 1980.

———. *Bangladesh: Current Trends and Development Issues.* Washington, D.C.: IBRD, 1979.

———. *Bangladesh Jute Project.* Report No. 1587-BD. Washington, D.C.: IBRD, 1977.

Jalal, K. F.; Ahmed, Raisuddin; and Ahmed, Shaziruddin. *Tubewell Irrigation: A Report Based on the Visit of Bangladesh Study Team to India.* Dacca: Planning Commission, 1974.

Jannuzi, F. Tomasson and Peach, James T. *Bangladesh: A Profile of the Countryside.* Dacca: U.S. Agency for International Development, 1979.

Jannuzi, F. Tomasson; Peach, James T.; and Ghulam, Rabbani. *Report of the 1977 Land Occupancy Survey of Rural Bangladesh.* Dacca: Bureau of Statistics, 1977.

Khan, A. R. *Poverty and Inequality in Rural Bangladesh.* Geneva: International Labour Organization, World Employment Program, 1976.

Klein, Lawrence Robert and Rubin, H. "A Constant Utility Index of Cost of Living," *Review of Economic Studies* 15 (No. 2, 1948): 84-87.

Krishna, Raj. "Agricultural Price Policy and Economic Development." In *Agricultural Development and Economic Growth.* Edited by H. M. Southworth and Bruce E. Johnson Ithaca, N.Y.: Cornell University Press, 1968).

———. "A Note on the Elasticity of Marketable Surplus of a Subsistence Crop." *Indian Journal of Agricultural Economics* 17 (July 1962).

Leibenstein, Harvey. *Economic Backwardness and Economic Growth.* New York: Wiley, 1957.

Lele, Uma. "Agricultural Price Policy." *Economic and Political Weekly,* August 30, 1969.

———. *Foodgrain Marketing in India: Private Performance and Public Policy.* Ithaca, N.Y.: Cornell University Press, 1971.

Lele, Uma and Mellor, John W. "Technological Change, Distributive Bias and Labor Transfer in a Two-Sector Economy." *Oxford Economic Papers,* forthcoming.

Mehra, Shakuntla. *Instability in Indian Agriculture in the Context of the New Technology.* Research Report 25. Washington, D.C.: International Food Policy Research Institute, 1981.

Mellor, John W. *The Economics of Agricultural Development.* Ithaca, N.Y.: Cornell University Press, 1966.

———. "The Functions of Agricultural Prices in Economic Development." *Indian Journal of Agricultural Economics* 23 (January-March 1968): 23-37.

———. "Food Price Policy and Income Distribution in Low-Income Countries." *Economic Development and Cultural Change* 27 (October 1978): 1-26.

———. *The New Economics of Growth: A Strategy for India and the Developing World.* Ithaca, N.Y.: Cornell University Press, 1976.

———. "The Use and Productivity of Farm Labor in Early Stages of Agricultural Development." *Journal of Farm Economics* 45 (August 1963): 517-534.

Muqtada, M. "Seed Fertilizer Technology and Surplus Labor in Bangladesh Agriculture." *Bangladesh Development Studies* 3 (October 1975).

Narain, Dharm. *Distribution of Marketed Surplus of Agricultural Produce by Sizes of Holdings in India, 1950/51.* Delhi: Institute of Economic Growth, 1961.

Nerlove, Marc. "The Dynamics of Supply: Retrospect and Prospect." *American Journal of Agricultural Economics* 61 (December 1979): 874-888.

Quasem, Md. Abul. "Factors Affecting the Use of Fertilizers in Bangladesh." *Bangladesh Development Studies* 6 (Monsoon 1978): 331-338.

Rabbani, A. K. M. Ghulam. "Economic Determinants of Jute Production in India and Pakistan." *Pakistan Development Review* 5 (Summer 1965): 37-49.

Rahman, Atique. "Agrarian Structure and Capital Formation: A Study of Bangladesh Agriculture." Ph.D. thesis, Cambridge University, 1979.

Rauquibuzzaman, M. "Marketed Surplus Function for Major Agricultural Commodities in Pakistan." *Pakistan Development Review* 2 (No. 3, 1968).

Rauquibuzzaman, M. and Asaduzzaman, M. *An Analysis of Rice Prices in Bangladesh, 1958-1968.* Series No. 2. Dacca: Bangladesh Institute of Development Studies, 1972.

Rosenzweig, Mark R. "Neoclassical Theory and Optimizing Peasant: An Econometric Analysis of Market Family Labor Supply in a Developing Country." *Journal of Economics* 94 (February 1980).

Rudra, Ashok and Bandopadhaya, Bela. "Marginalist Explanation for More Intense Labour Input in Smaller Farms: Empirical Verifications." *Economic and Political Weekly* 8 (June 1973): 989-994.

Schultz, Theodore W., ed. *Distortions of Agricultural Incentives.* Bloomington, Ind.: Indiana University Press, 1978.

Sen, Amartya K. "Peasants and Dualism With or Without Surplus Labor." *Journal of Political Economy* 74 (October 1966): 425-450.

———. "Size of Holding and Productivity." *Economic Weekly* 16 (February 1964).

———. "Starvation and Exchange Entitlements: A General Approach and Its Application to the Great Bengal Famine." *Cambridge Journal of Economics* 1 (March 1977): 33-59.

Shahadatullah, A. H. "Farm Productivity, Returns to Scale and Technological Change in a Traditional Agriculture: A Case of Bangladesh." Ph.D. thesis, Harvard University, 1974.

Solow, Robert M. "On Theories of Unemployment." *American Economic Review* 70 (March 1980): 1-11.

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