Chapter 6

Bangladesh: Uncertain Prospects

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Introduction

Bangladesh is one of the most impoverished countries in the world. Agriculture remains the primary source of income for about 60 percent of the population. Agricultural growth therefore holds the key to the nation's pervasive poverty. So formidable are resource limitations, the climatic and environmental conditions, and the complexity of the country's agricultural institutions that the pace of agricultural growth rests heavily on gains in productivity, especially those gains arising from research and development. Bangladesh's achievements in agriculture and rural development have been significant since independence in 1971, and research and development have played a vital role in this achievement.

This chapter focuses on the evolution of research policies and institutions, the priority given to agricultural research in resource allocation, the impact of agricultural research on productivity, and a vision for the future role of research.

Generally, *research and development* means not only the generation of applicable knowledge or superior products, but also the transfer of such knowledge or products to potential users. In this chapter, however, the term refers specifically to the generation and development of knowledge or products to usable forms; we exclude extension and other activities associated with the transfer of research results.

Structural Background

Agriculture and the Economy

The transformation of Bangladesh's economy, measured by changes in the sectoral shares of gross domestic product (GDP), is shown in Table 6.1. This structural

Table 6.1 Bangladesh: Structural change in the economy, 1975–2004

Indicators	1975	1985	1995	2000	2004
Share of gross domestic product (percent)					
Agriculture	62.0	41.8	30.9	27.8	21.0
Industry	11.6	16.0	17.6	18.2	24.0
Manufacturing	7.0	9.9	9.6	9.9	16.0
Construction and mining of mineral resources	4.6	6.1	7.0	8.6	8.0
Services	26.4	42.2	51.5	54.0	55.0
Share of employment (percent)	111.6	116.0	116.6	118.5	126.0
Agriculture	78.0	72.0	NA	62.5	60.3
Industry	8.0	9.0	NA	12.0	12.7
Services	14.0	19.0	NA	25.5	27.0
Per capita income (1995 U.S. dollars)	147.0	190.0	240.0	272.0	380.0
Exports as a percentage of gross domestic product	2.9	7.4	14.2	16.1	18.0
Imports as a percentage of gross domestic product	8.1	18.3	22.5	23.1	26.0

Sources: Sector shares are from World Bank, Bangladesh Country Operations Division 1996; 2000 estimates are updated from World Bank, Bangladesh Country Operations Division 1996 using BBS Labour Force Surveys and Planning Commission documents, various years. Employment statistics are calculated from data in the labor surveys of 1977, 1979, and 1993, using intercensus trend factors, and hence are less reliable than the other data in the table. The 2004 statistics are author compilations of data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

Notes: NA indicates not available. Shares of GDP do not sum to 100 percent because categories overlap. For example, manufacturing, construction, and mining are subsectors of industry.

change clearly indicates a rapid movement away from an agriculture-dominated economy. Agriculture's share of GDP declined from 62 percent in 1975 to 21 percent in 2004, but agriculture's share of total employment has not declined as quickly. The declining share of agriculture in GDP should not be construed to reflect a diminishing role of agriculture in the overall growth of the economy or in poverty reduction. Notably, the service sector has expanded at an unusually rapid pace at this stage of economic transformation. Much of the growth in the services sector relates to the marketing and processing of agricultural products resulting from rapid commercialization and diversification in agriculture.[1] Another feature of the structural change is the extent of openness of the economy, as measured by the international trade components (exports and imports) in GDP. The sum of exports and imports constituted only 11 percent of GDP in 1975 but climbed to about 44 percent in 2004.

Poverty

Food poverty, measured by counting the number of persons consuming less than 2,212 calories per day, is especially high in Bangladesh. Most estimates from 1983–84 through 1991–92 suggest that about 50 percent of the overall population could not afford a diet meeting the caloric norm (see Ahmed, Haggblade, and

Chowdhury 2000 for a summary). Recent estimates, however, show that the average incidence of poverty might have declined slightly, to about 45 percent, between 1996 and 2000 (Sen and Mujeiri 2000). Most analysts agree that the great majority of the poor live in rural areas and that more than half the rural population live below the poverty line, compared with about one-third of urban dwellers.

Population, Land Use, and Farm Structure

In 2003, the population of Bangladesh was estimated to be 138 million, inhabiting an area of just over 50,000 square miles—of which about 22.3 million acres (69 percent of total land area) are cultivated land (FAO 2005). Competition for the use of land for agriculture, urbanization, homesteads, and infrastructure is intense; from 1983–84 through 1995–96, the cultivated area declined by 12 percent (BBS 1996). The average farm size fell from 2.26 to 1.69 acres. Because land is cultivated repeatedly within a year, the cropping intensity averages 170 percent. Rice is the dominant crop, occupying about 73 percent of the cropped area in 1996. Notwithstanding the country's large and still-growing population, the rate of population growth has fallen over time, from an average of 2.3 percent annually between 1975 and 1985 to 1.8 percent between 1985 and 1995. Since then, the annual growth rate is estimated to be 1.7 percent (World Bank 2005).

Agroecological Environment

Except for the hilly regions in the northeast and southeast, the country is mainly flat, formed at the deltaic confluence of the Ganges and the Brahmaputra and Meghna river systems. The river system, topography, rainfall, and soil types all interact to shape conditions for agricultural production. Devastating floods, severe drought, and occasional tidal ingression of saline water are quite common in Bangladesh.

Rainfall and topography are, however, two critical factors in agriculture. The normal rainfall is 2,500 millimeters per year, mostly occurring from May through September, and its distribution is more crucial in Bangladesh than the annual average. Topography generally determines how much natural protection a particular area has from floodwater. Forty percent of the cultivated land is normally inundated under 90 or more centimeters of water in peak rainy months.

Evolution of Research Institutions and Policies

The agricultural research institutions and organizations in Bangladesh are the product of a process that began in the colonial era, particularly during the years 1910 to 1940, when the British government in India introduced limited home rule, allowing

participation of natives in governance (Pray 1979, 1980). Thus, the 1928 Royal Commission on Agriculture was instrumental in the establishment of the Bengal Department of Agriculture, which made some concerted efforts to establish regional experimental stations, research centers for jute and rice, and an agricultural college in Dhaka (Alim and Sen 1969).

During the Pakistani era (1947–71), a number of significant milestones enlarged the scope of agricultural research:

- A rice research institute was established in 1968, consolidating the earlier entities established for research on rice
- Commodity-specific research institutes were established, such as the Jute Research Institute, the Tea Research Institute, the Sugarcane Research Institute, and the Forest Research Institute
- The Atomic Energy Commission was encouraged to conduct research on the application of nuclear science to agricultural research, and the Institute of Nuclear Agriculture was set up in Mymensingh
- Research on other crops (such as vegetables, fruits, pulses, oilseeds, and wheat) was organized under the Bangladesh Agriculture Research Institute
- Earlier soil research units were regrouped under the Soil Research Institute
- An agricultural university was established in Mymensingh

Since independence, efforts have focused mainly on strengthening the effectiveness and expanding the scope of agricultural research. The first task of the new Bangladesh government in this regard was to organize a research council to coordinate and monitor various institutes and to enhance resources for efficient research.

The creation of the Bangladesh Agricultural Research Council (BARC) in 1973 was a strategic step to enhance efficiency in research management. Initially BARC was conceived as a body to coordinate discrete research institutes under the ministries of agriculture, livestock, fisheries, and forestry; but through a number of legal enactments, particularly one in 1996, BARC has become the cornerstone institution responsible not only for coordination but also for the preparation and implementation of an agricultural research strategy that maintains the administrative autonomy of individual institutes. BARC has developed a master plan for

research and human development and unified incentive structures, initiated review processes for various institutes, and introduced a grant mechanism for specific research projects. The names of individual institutes under BARC, their functions, staff strength, and extent of staff attrition are shown in Table 6.2.

The table clearly indicates that research on crops dominates the national agenda, reflecting an early development policy preoccupation with achieving food-grain self-sufficiency and expanding jute exports. The research institutes are generally organized with a central research hub for each institute and a large number of substations located around the country, with the intent of tailoring research to various agroecologies. The implications of the last column in Table 6.2 will become clear when we discuss human resources for research.

NGOs and the Private Sector

Of a total of about 7,000 nongovernmental organizations (NGOs) in the country, about 1,500 are involved in agriculture, providing credit for employment- and income-generating activities and information on agricultural technology. The NGOs do little research but are involved in development programs for livestock, fisheries, sericulture, apiculture, and forestry. These activities are believed to have made significant changes in rural society, particularly in the landless communities.

Bangladesh has virtually no private institutions for agricultural research. To strengthen the incentives for private participation in research, the government enacted legal provisions for patent rights almost a century ago (in 1911), to be followed by trademark protection legislation in 1940 and a copyright act, which came into force in November 2000.[2] Although patents for nonagricultural innovations have been registered (there were 59 applications by residents in 2001, with 21 granted as of May 2003), none have been registered for seeds, crop varieties, plant types, or any other agricultural technologies.

Sources of information on private agricultural research are limited mostly to personal experiences before 1986, when a survey was conducted under a project organized jointly by the University of Minnesota and Rutgers University. The survey reports that there was little private agricultural research undertaken in Bangladesh (Pray 1987), and what there was mostly involved transferring technologies from elsewhere rather than generating new innovations locally. The most effective program was the Bangladesh Tobacco Company's applied research involving adaptive trials of imported Virginia and burley tobacco. Several pesticide companies had small R&D programs, and the largest pump manufacturer did some research on pump designs. Finally, one company was conducting trials on different varieties of vegetables.

Table 6.2 Bangladesh: Description of research institutes, 2001

Institute name	Acronym	Year of inception	Ministerial affiliation	Primary functions	Average number of scientists, 1995–2000	Scientific staff attrition, 1995–2000
Bangladesh Agricultural Research Institute	BARI	1970	Agriculture	Crop research, with the exception of rice, tea, sugarcane, and jute	700	230
Bangladesh Rice Research Institute	BRRI	1970	Agriculture	Rice research	230	58
Bangladesh Jute Research Institute	BJRI	1958	Agriculture	Jute research (various aspects)	200	8
Bangladesh Sugarcane Research Institute	BSRI	1973	Agriculture	Sugarcane breeding	75	9
Bangladesh Tea Research Institute			Commerce	Tea research	36	35
Bangladesh Institute of Nuclear Agriculture	BINA	1972	Atomic Energy Commission	Application of nuclear science to agriculture	107	2
Bangladesh Fisheries Research Institute	BFRI	1984	Fisheries	Fish culture (various aspects)	65	1
Bangladesh Livestock Research Institute	BLRI	1984	Livestock	Cattle and poultry research	35	1
Bangladesh Forest Research			Forest	Forestry (various aspects)	100	27
Soil Resource Development Institute	SRDI	1986	Agriculture	Soil and fertility research and monitoring (various aspects)	454	4

Source: BARC 2001.

Note: Number of scientists excludes research managers.

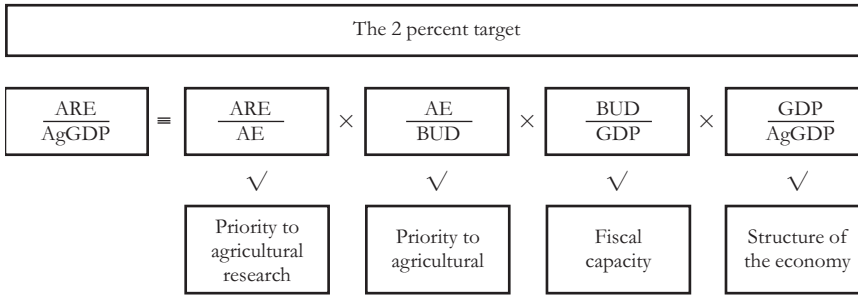
To update the 1986 survey, IFPRI and BARC sought information on private-sector agricultural R&D during September–October 2001 and February–March 2002. It appears that the scope and intensity of private-sector R&D has expanded somewhat. However, as in the mid-1980s, most of this private activity involves the importation of new technology rather than local innovation. Pesticide companies, poultry producers, fish farmers, and certain NGOs are importing a host of technologies, ranging from seeds to plant-growth regulators. Some of these importers are making efforts to fit these agricultural techniques into domestic production practices. A couple of large commercial poultry farms, for example, are importing chicks from the Netherlands, along with complementary modern technologies for controlling disease on their farms. A number of NGOs are also involved in small-scale adaptive research and dissemination of modern agricultural technology. In addition, food processing enterprises, which are increasing rapidly both in number and volume of business, are involved in R&D pertaining to packaging materials, quality of processed products, and storability of products, particularly those meant for the export market.

Even though private investors are gradually coming forward to invest in agricultural R&D, the total effort of the private sector is still small. Why is this the case? The Minnesota–Rutgers study speculated that the small size of the modern agricultural input and processing sector and government policies are responsible. The binding constraints, the report argues, are underdeveloped agriculture and government intervention in industries. While few would disagree with this broad conclusion, there are other reasons too. Risk is a formidable constraint. Other barriers include weak demand for new innovations from the large number of small and semisubsistence farmers, perceived competition from government research, and the demise of big business conglomerates.

Public Resources for Agricultural Research

To what extent should public resources be invested in agricultural research? This is a complex question with no straightforward answer, not least because resource-allocation decisions are ultimately made by politicians, not economists. Beyond the equi-marginal, benefit–cost investment principle espoused by economists (see, for example, Alston, Norton, and Pardey 1998), various rules of thumb have been used to guide the allocation of funds to agricultural R&D. The 1974 UN World Food Conference suggested that developing countries should aim for a 1985 target of allocating 0.5 percent of AgGDP to agricultural research (United Nations 1974, p. 97). The World Bank (1981, p. 8), in a widely quoted statement, asserted that a "desirable [agricultural research] investment target . . . would be an annual expen-

Figure 6.1 Bangladesh: The agricultural research-intensity ratio target



Notes: ARE indicates agricultural research expenditures, AgGDP agricultural gross domestic product, AE all agricultural expenditures, and BUD the government budget.

diture (recurrent plus capital) equivalent to about 2 percent of agricultural gross domestic product." Imperfect as this ratio may be, it serves as a reference for judging the adequacy of public resources allocated to agricultural research. However, as Pardey, Kang, and Elliott (1989) pointed out, the ratio of agricultural research expenditure to agricultural GDP is best seen within the broader context of the process of public-resource allocation, as reflected in the identity shown in Figure 6.1.

The identity expresses the ratio of agricultural research expenditure (ARE) to agricultural GDP (AgGDP) as the product of ratios. The first ratio (ARE/AE) is the share of agricultural research expenditure in all agricultural expenditures. It may be taken as the priority given to agricultural research within the agricultural strategy. The second ratio (AE/BUD) is the share of agricultural expenditures in the government budget. We call this the "priority to agriculture." The third ratio (BUD/GDP) is government expenditure's share of gross domestic product. It may alternatively be considered as the "fiscal effort" (which reflects the will of a government to take a role in the economy), the "fiscal burden" (which reflects the weight of the public sector on the economy), or the "fiscal capacity" (which reflects the existence of high-value, easily taxed sectors). The final ratio (GDP/AgGDP) is the inverse of agriculture's share of gross domestic product.[3]

Following the above framework, Bangladesh's public expenditures are analyzed at three stages. First, aggregate public expenditures are examined to indicate the size of the government in relation to the size of the economy (BUD/GDP). Second, the sectoral analysis demonstrates the priority given to agriculture relative to other sectors. Finally, the intrasectoral allocations are examined to show the priority of agricultural research in the budget for agriculture.

Aggregate Public Expenditure

The annual budget has two components: annual development program (ADP) and annual current budget. The current budget is also termed the "revenue budget." The ADP includes project-by-project allocations for the budget year and estimates of expenditures for the previous year for all ministries and agencies. It is the annual phase of implementation of development projects under a five-year plan. Most, but not all, the projects included in the five-year plan are accommodated in the ADP. These projects are supposed to be processed and approved through an interministerial committee organized under the direction of the Planning Commission before they are accommodated in the ADP. ADP can be considered in some measure akin to the public-sector investment budget.

The current budget is meant for general administration, security, and regular functions of the government. The demands for the current budget are first matched against revenue collection, and any surplus from this balancing of current budget and revenue collection (tax and nontax revenue) is available for financing the ADP. The combined demands for ADP and the current budget, when balanced against the total revenue collection, provide an initial indication of the magnitude of deficit financing. Macroeconomic considerations, on the other hand, tend to limit the extent of deficit financing from domestic sources. The deficit is therefore partly financed by foreign aid in the form of commodity grants and project aid, and partly by domestic borrowing from the banking system and nonbank public sources. Foreign financing covered an average of 85 percent of total deficits from 1985 through 1995 (World Bank, Bangladesh Country Operations Division 1996). Currently, about 52 percent of the deficit is financed from foreign sources. Final budget figures result from harmonization among all these fiscal factors. The overall fiscal deficit was about 7.5 percent of GDP in the mid-1980s and declined to about 5.6 percent in the second half of the 1990s. This change reflects reform in the tax structure, improvement in tax collection, and increased reliance on domestic borrowing.

The budget statistics for the years 1976 through 2004 are presented in Table 6.3. The absolute magnitude of annual average total public expenditures, in nominal taka terms, has increased from about Tk. 35 billion in the first period to about Tk. 409 billion in the fifth period—an increase of about 12-fold over 24 years. In terms of dollar-equivalent expenditure, the increase is only about 3-fold, the difference reflecting the effects of depreciation in the country's rate of currency exchange and inflation. In terms of expenditure at 1996 constant prices, the increase is equivalent to about 4.5 percent per annum compared with a rate of growth of GDP of about 5.0 percent per annum. Current expenditure has increased faster than development expenditure: the ratio of development expenditure to total expenditure fell

Table 6.3 Bangladesh: Trends in annual average public expenditure, 1976–2004

Indicators	1976–81	1984–90	1991–95	1995–2000	2001–04
Total expenditure					
Million taka	35,200.0	97,478.6	190,232.2	278,678.0	408,810.0
Million U.S. dollars	2,186.0	3,157.3	4,844.6	6,245.4	6,929.0
Development expenditure					
Million taka	18,135.5	47,110.0	94,892.0	129,650.0	145,786.0
Million U.S. dollars	1,137.3	1,535.1	2,414.8	2,911.6	2,471.0
Current expenditure					
Million taka	13,518.3	50,368.6	95,340.2	149,028.0	263,021.0
Million U.S. dollars	839.3	1,622.2	2,429.8	3,333.8	4,458.0
Ratio (percent)					
Development expenditure/total expenditure	51.5	48.3	49.9	46.5	35.7
Total expenditure/GDP	16.3	16.0	13.6	14.5	13.5
Development expenditure/GDP	10.1	7.9	6.4	8.3	4.8
Current expenditure/GDP	6.2	8.1	7.2	7.7	8.7
Project aid/development expenditure	32.3	56.1	47.1	41.4	37.0

Sources: For expenditures, BBS, various years; for GDP and exchange rates, World Bank 2001 and Ahmed 2002. The 2004 statistics are from the authors compilation of data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

Note: Expenditures and GDP are in current prices.

from 51.5 percent in the first period to 35.7 percent in the fifth period. The increased cost of democratic institutions and defense expenditures are largely responsible for the faster increase in current expenditure.

The ratio of public expenditures to GDP is, perhaps, more meaningful than absolute magnitudes. The ratio of total public expenditure to GDP, an indicator of the size of the government, was 16 percent in the first period, gradually declining to about 14 percent of GDP by the third period and stabilizing at that level thereafter. This modest decrease in the size of the public budget relative to GDP was a consequence of emphasizing a market-oriented strategy of development through reforms. The ratio of development expenditure to GDP declined faster than the ratio of total (development plus current) expenditure to GDP, while the ratio of current expenditure to GDP in fact increased slightly. An interesting aspect of public expenditure, particularly the development expenditure, is the extent of foreign project aid in financing the development budget. In the second half of the 1970s, only about 32 percent of developmental expenditures were financed through project aid. This proportion peaked at 56 percent during the second half of the 1980s. Thereafter, the proportion of project aid dropped to 47 percent in the first half of the 1990s and to 37 percent in the period 2001–04. The low level of project aid during the late 1970s is understandable: foreign aid flows into Bangladesh were

limited after the war of independence disrupted relationships with donors. However, the decline in project aid during the 1990s, from its peak in the second half of the 1980s, is not readily understandable. Ostensibly there are at least three reasons for this. First, it is natural to surmise that the proportion of project aid declined during the 1990s, given a worldwide contraction in the supply of foreign aid. However, this was not the case for Bangladesh. Aid commitments from donors continued to increase during this period, and the accumulated foreign aid in the pipeline was $5.7 billion as of June 2000. It is the increasing gap between commitment and utilization that caused the decline in the proportions of project aid during the 1990s. A second possibility, namely that the increasing shift of donor assistance to NGOs caused shortfalls in public-sector project aid, is also not an adequate explanation, as NGOs receive only a small share (about 15 percent) of overall project aid to Bangladesh. A third reason seems the most plausible: namely that a sharply deteriorating trend in governance, buttressed by aid conditionalities, caused a fall in the proportion of foreign-aid dispersals.

Sectoral Distribution of Public Expenditure

The definition of sectors is important when inferring priorities from the sectoral distribution of expenditures. The agricultural sector in the Bangladesh economy is traditionally defined to include crop production, marketing of food (including public food marketing), livestock, fisheries, and forestry production. Economists have tended to include rural institutions and rural infrastructures, as well as flood control and large irrigation development activities, as components of agriculture. This practice gives rise to two definitions of the agricultural sector, one somewhat narrower than the other: the first includes crops, food marketing, livestock, fisheries, and forestry, while the second also includes rural institutions and infrastructure, and water control and development. We present sectoral distributions in which agriculture, rural development and institutions, and flood control and water resources are shown separately.

The sectoral distributions of public expenditure are shown separately for ADP and current expenditures. Typically, limitations in detailed, disaggregated data for the current budget do not allow a straightforward addition of the two budgets at sectoral levels. However, for the agricultural sector, we made a concerted effort to collect detailed, disaggregated data, including data for the current budget, that we present in the intrasectoral analysis of agriculture.

The sectoral shares in the ADP are shown in Table 6.4. The agricultural sector, as traditionally defined, has been losing ground in the development budget: from a 14 percent share during 1976–81, it gradually declined to 4.0 percent during 2001–04. However, using the broader definition of the agricultural sector, inclusive of

Table 6.4 Bangladesh: Average sectoral shares of total annual development program, 1976–2004

Indicator	1976–81	1984–90	1991–95	1995–2000	2001–04
Agriculture	14.0	7.0	5.9	4.7	4.0
Rural development and institutions	3.7	3.4	6.4	8.7	12.3
Flood control and water resources	12.9	12.3	9.1	7.2	4.5
Industry	15.5	8.3	1.4	1.1	2.3
Power	10.7	15.2	12.4	11.0	15.2
Natural resources	3.6	5.2	4.4	3.9	4.2
Transport	15.4	9.4	16.9	18.5	17.4
Communication	3.0	1.9	3.6	2.7	3.5
Physical planning and housing	6.3	3.6	4.7	5.4	6.3
Education and training	4.2	4.9	10.5	12.9	13.5
Health, population control, and family planning	5.8	6.2	8.0	5.9	7.7
Social welfare, women's affairs, and youth development	0.7	0.5	0.9	1.4	1.2
Other	4.2	22.0	15.9	16.7	7.9

Sources: Compiled by the authors from unpublished Government of Bangladesh budget documents and Ahmed 2002. The 2004 statistics are from the authors' compilation of data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

rural institutions and water development, the decline has been less pronounced: an average share of 30.6 percent in 1976–81, declining to 20.8 percent in 2001–04. Notably, the share of ADP spending on rural development and institutions increased from 3.7 percent in the first period to 12.3 percent in the final period.

The share of industry shrank drastically, from 15.5 percent in the first period to only 2.3 percent in the final period. The education share tripled, the social welfare share doubled, and the transport-sector share increased only marginally between the first and the fifth periods. The shares of ADP spending directed toward power increased substantially, and those for communication, natural resources, and health changed only modestly.

These changing spending priorities among sectors are broadly consistent with recent thinking in development economics that emphasizes the important roles of improvements in human resources and increasingly market-oriented development strategies in accelerating growth. In Bangladesh, this thinking on development strategy was enacted through structural reforms that directly affected public spending priorities. Interestingly, spending on health, population control, and communications do not command the priority accorded to education.

Another significant dimension of the distribution of public expenditures among sectors is the extent of project aid in various sectors, perhaps reflecting, in part, the donors' perception of priorities among sectors. The sectoral composition of project aid is shown in Table 6.5. For the agricultural sector, narrowly defined,

Table 6.5 Bangladesh: Project aid as share of annual development program, by sector, 1976–2004

Indicator	1976–81	1984–90	1991–95	1995–2000	2001–04
Agriculture	20.0	52.0	56.2	51.7	43.9
Rural development and institutions	26.0	83.7	62.4	49.2	30.5
Flood control and water resource	23.4	61.0	47.5	55.2	27.5
Industry	53.4	60.8	20.1	22.8	29.0
Power	40.0	74.6	47.8	33.3	43.9
Natural resources	37.2	55.4	58.2	49.4	37.4
Transport	37.2	55.4	58.2	49.4	57.6
Communication	24.0	47.7	31.4	27.3	35.2
Physical planning and housing	24.1	43.2	40.4	39.0	41.4
Education and training	14.0	60.1	47.2	29.7	24.4
Health, population control, and family planning	34.9	61.2	60.0	63.0	62.6
Social welfare, women's affairs, and youth development	12.9	31.4	30.1	24.4	23.1
Other	17.2	29.6	25.4	25.2	24.2

Sources: Compiled by the authors from unpublished Government of Bangladesh budget documents and Ahmed 2002. The 2004 statistics are from the authors' compilation of data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

along with natural resources, power, health, and transport, the average proportions of project aid are higher than the national average for all sectors. From 1976 through 1981, the industry and power sectors received disproportionately large amounts of project aid, but these have fallen drastically, particularly aid for industry.

The sectoral shares in current expenditure are shown in Table 6.6. Unfortunately, current expenditures are not available in sufficiently disaggregated form to reveal longer-run sectoral trends that correspond to the ADP series just discussed. Despite these shortcomings, we can draw some conclusions. The current budget does not exhibit the marked changes in sectoral shares evident in the development budget: in 1990–94, education took the largest share of the current budget, followed closely by defense, then by general administration and debt servicing. Police and justice together accounted for 7.2 percent of the current budget. Given the country's current difficulties with law and order and governance, this share is arguably too low.

Subsidies account for about 5 to 6 percent of the current budget. The share going to food subsidies has declined but still accounts for about 3 percent of the current budget. The subsidy on public enterprises has increased, and it accounted for 2.6 percent of the current budget in 1990–94.

The share of agriculture in the current budget is quite low—barely 4 percent. Given the role of agriculture in the economy and its importance in the development

Table 6.6 Bangladesh: Average sectoral expenditure shares in current budget, 1984–90 and 1990–94

Items of expenditure	1984–90	1990–94
General administration	12.7	14.7
Justice and police	7.4	7.2
Defense	18.4	17.3
Scientific departments	0.5	0.6
Education	16.9	18.4
Health and family planning	5.4	6.0
Social welfare	9.8	7.7
Agriculture	3.8	4.1
Manufacturing and construction	0.6	0.4
Transport and communication	1.7	2.2
Other	1.0	1.0
Debt service	11.5	12.2
Food subsidy	6.5	3.1
Other subsidy	2.0	2.6
Contingency	2.7	2.5

Source: Calculated by authors from World Bank, Bangladesh Country Operations Division 1996.

Note: "General administration" primarily reflects a subsidy to compensate losses to public enterprises. This is not a true picture of the loss because the debt of public enterprises to nationalized commercial banks is not included. Recent data on current budget are available in a different form, that is, by administration division rather than a functional form as in this table. The conversion from administrative to functional forms for all sectors warrants further research.

budget, this small share perhaps reflects the low priority given to agriculture in allocation of the nation's own revenues.

Often in Bangladesh, when a project in the ADP is completed, if its operation thereafter is to be maintained, then the operation must be financed from the current budget. Given that the agriculture sector accounts for such a small share of the current budget, one wonders how agricultural development activities initiated under the development budget are sustained.

Intrasectoral Allocations in Agriculture and Agricultural Research

The analysis of intrasectoral allocations that follows is based on the narrow definition of the agricultural sector and is limited to development expenditures only (Table 6.7). The crop subsector continues to dominate, drawing 69 percent of developmental expenditures in agriculture between 1976 and 1981, a share that declined to 44 percent in the period 2001 to 2004. The food marketing subsector had a 13 percent share in the first period, dropping to 4.4 percent in the final

Table 6.7 Bangladesh: Average subsectoral expenditures in total agricultural development expenditure, 1976–2004

Subsectors	1976–81	1984–90	1991–95	1995–2000	2001–04
Crops					
Million taka	1,566.6	1,652.1	2,531.5	3,123.0	4,527.5
Percentage	68.6	50.5	45.8	51.5	43.9
Forestry					
Million taka	161.1	443.8	897.0	1,005.7	1,700.0
Percentage	7.1	13.6	16.3	16.6	16.5
Food marketing					
Million taka	294.5	266.5	397.5	355.3	452.5
Percentage	12.9	8.1	7.2	5.8	4.4
Fisheries					
Million taka	179.1	522.2	935.1	703.0	1,330.0
Percentage	7.8	16.0	16.9	11.7	12.9
Livestock					
Million taka	82.0	385.9	761.5	871.9	2,300.0
Percentage	3.6	11.8	13.8	14.4	22.3
Total agriculture (narrow)					
Million taka	2,283.2	3,270.4	5,522.6	6,058.8	1,0310.0
Percentage	100.0	100.0	100.0	100.0	100.0

Sources: Calculated by the authors from data in unpublished Government of Bangladesh budget documents and Ahmed 2002. The 2004 statistics are from the authors' compilation from data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

period.[4] This decrease reflects reforms in the public marketing of food. The share of agricultural spending directed toward fisheries increased from 8 percent in 1976–81 to about 13 percent by the early 2000s. Similarly, the forestry share increased from 7 to about 17 percent, and the livestock share from about 3 to about 22 percent. These changes in the subsectoral shares in agriculture broadly reflect shifting agricultural policy, emphasizing diversification from crop to noncrop agricultural products as sources of agricultural growth.

Agricultural Research

Table 6.8 shows the proportion of agricultural expenditures devoted to agricultural research. It appears that only 8.6 percent of agricultural development expenditures were spent on agricultural research from 1976 through 1981, increasing to 12.5 percent in the period 2001–04.[5] The total agricultural development expenditure directed to R&D, including rural institutions and water development (that is, using the broad agriculture definition), was just 3.9 percent during the period 1976–81, dropping to 2.9 percent in the period 2001–04. Adding current expenditures to the development expenditures for agricultural research provides a more

Table 6.8 Bangladesh: Average public expenditure on agricultural research, 1976–2004

Indicator	1976–81	1984–90	1991–95	1995–2000	2001–04
Expenditure (million taka)					
Research development expenditures	195.4	618.6	605.0	968.1	978.0
Research current expenditures	50.6	198.0	254.7	307.6	527.0
Total research expenditures	246.0	816.6	859.7	1,275.7	1,505.0
Research development expenditures as percentage of total development expenditures in agriculture (narrow)	8.6	18.9	11.0	15.8	12.5
Research development expenditures as percentage of total development expenditures in agriculture (broad)	3.9	5.8	3.0	3.6	2.9
Total research expenditures as percentage of agricultural gross domestic product	0.35	0.34	0.27	0.25	0.24
Project aid as percentage of research development expenditures	42.9	55.9	38.2	48.2	38.4

Sources: Calculated from data in unpublished Government of Bangladesh budget documents and information collected from BARC on individual research institutes. The statistics for 2001–04 are from authors' compilation of data obtained in connection with a public expenditure review in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

complete picture of public expenditures. When this total is expressed as a proportion of agricultural GDP, it appears that Bangladesh devotes only a tiny proportion of its resources to agricultural research—0.35 percent during the period 1976–81 and 0.24 percent for the period 2001–04. This figure is well below the 2 percent target considered appropriate for research, and half the 1995 developing-country average (0.62 percent) reported by Pardey and Beintema (2001).

The data show that the share of project aid in total agricultural research expenditures has been volatile. It was 43 percent in the period 1976–81, increasing to 56 percent in the period 1984–90, declining to 38 percent during the first half of the 1990s, and rebounding to 48 percent during the second half of that decade. Compared with the proportions of project aid in total agricultural development expenditures (Table 6.5), it appears that research enjoyed a higher share of project aid during the first two periods but lost ground during the subsequent two periods. The decrease in total research expenditures, combined with a dwindling proportion of foreign aid in the development funds directed to agricultural R&D, could represent a cause for serious concern, especially as Bangladesh has been vigorously championing poverty reduction and improving the competitive strength of its agricultural sector in an increasingly globalized market.

Table 6.9 shows how research expenditures are distributed among various commodity-oriented research institutes. Crop research institutes command a larger

Table 6.9 Bangladesh: Subsectoral shares in expenditures on agricultural research, 1976–2004

Subsector	1976–81	1984–90	1991–95	1995–2000	2001–04
Annual development program (percent)					
Crops	84.65	77.82	84.01	79.57	78.5
Forestry	3.89	4.95	3.34	5.78	7.44
Fisheries	10.85	11.07	7.55	7.77	8.25
Livestock	0.61	6.16	5.10	6.88	5.81
Total	100.00	100.00	100.00	100.00	100.00
Current budget (percent)					
Crops	90.52	85.15	87.67	87.91	85.12
Forestry	4.15	4.14	2.20	3.32	3.50
Fisheries	4.74	7.93	7.34	5.23	7.66
Livestock	0.59	2.78	2.79	3.54	3.72
Total	100.00	100.00	100.00	100.00	100.00
Total research budget (percent)					
Crops	85.80	79.60	85.00	81.60	80.80
Forestry	4.00	4.70	3.10	5.20	6.00
Fisheries	9.60	10.30	7.50	7.20	8.10
Livestock	0.60	5.40	4.40	6.00	5.10
Total	100.00	100.00	100.00	100.00	100.00

Sources: Calculated by authors from unpublished Government of Bangladesh budget documents and information collected from BARC on individual research institutes. The statistics for 2001–04 are from the authors' compilation of data obtained in connection with a public expenditure review, 2005, in preparation for the World Bank (Ahmed and Mudahar 2006 forthcoming).

share of both development and current budgets than noncrop institutes, although the crop share has declined a little since 1976. Fisheries research comes next, with about 9 percent of the total research budget. It reflects a slightly smaller share of the agricultural development budget in 2001–04 than in 1976–81, and a modest increase in the current budget share. Forestry commands 6 percent of total agricultural R&D spending, with a modestly increasing share of the development budget but a declining share of the current budget. Livestock research accounts for the smallest share of the agricultural research budget, although this share has increased markedly since 1976 in both the development and current budgets.

By the very nature of agricultural R&D there are long lags between investment and reaping the returns on that investment, and therefore some stability is needed in the flow of funds to research. Unfortunately, in the case of Bangladesh the revenue flows to agricultural research are not only relatively small but also highly unstable (Table 6.10). The yearly fluctuations in agricultural research expenditure vary from –49.88 to 73.36 percent, and they are significantly larger than fluctuations in other fiscal variables, such as ADP, current expenditures, and project aid. Nominal expenditures in agricultural research fell in 6 of the 21 years examined; other fiscal factors declined in only 2 or 3 of the 21 years.[6]

Table 6.10 Bangladesh: Range of annual fluctuation in selected fiscal variables, 1978–99

Fiscal variable	Range of fluctuation (percent)	Number of years with negative fluctuation
Development budget (ADP)	–2.41 to 33.2	2
Current budget	6.11 to 23.93	0
Total project aid	–5.30 to 35.19	3
Development budget for agriculture	–18.21 to 30.63	2
Agricultural research budget	–49.88 to 73.36	6

Sources: Calculated from data in unpublished Government of Bangladesh budget documents and information collected from BARC.

Human Resources for Agricultural Research

Innovation processes are critically reliant on access to appropriately trained and creative scientists and technicians. There are at least four dimensions to the human resource requirements of agricultural research: staff strength, balanced composition, training, and incentives.

Number of Scientists with Required Disciplinary Knowledge

Research managers, senior scientists, and junior research scientists constitute the largest group of research staff in national research institutes. Table 6.2 gives a 2001 snapshot of the scientific staff strength in various agricultural research institutes. It shows that 2,185 research managers and scientists were employed in the main agricultural research organizations of Bangladesh. About 12 percent held Ph.D.s, 75 percent M.Sc.s, and 13 percent B.Sc.s. Generally, the most senior scientists are engaged in research management; these constitute about 9 percent of the scientists employed.

Typically, an agricultural research institute is headed by a director or director general. Under the head, there are chief scientific officers (CSOs), principal scientific officers (PSOs), senior scientific officers (SSOs), and scientific officers (SOs). In addition, there are technicians to support the scientists in specific scientific operations. The head and CSOs jointly constitute the group of research managers. The PSOs, SSOs, and SOs conduct research. The PSO is the leader, the SSOs carry out the research, and the SOs provide support to the senior investigators. Based on international practices and local realities, a report on human resource development in agricultural research recommended a ratio of 1:2:4 among the positions of PSO, SSO, and SO as optimal for the agricultural research system in Bangladesh (Hasanuzzaman 2000).

However, because of a large-scale migration of scientists to jobs abroad, primarily during the years 1995 to 2000, not only the absolute levels but also the opti-

mal mix of senior and junior scientists has been adversely affected. The extent of this attrition for the period 1995–2000 is shown in Table 6.2. The loss of scientists from the Bangladesh Agricultural Research Institute (BARI), the Bangladesh Rice Research Institute (BRRI), BARC, and the Forestry Research Institute (FRI) has been serious; about a quarter to half of the scientists working in these institutes have left their jobs, mostly to pursue opportunities abroad. Because the better-qualified and skilled scientists are more likely to get jobs abroad than the ones with lesser qualifications, these departures imply a loss not only in number but also in quality. Research managers feel that the migration of scientists has created a vacuum of crisis proportions in agricultural research, and it warrants a commensurate effort to minimize the adverse impact of this brain drain.

Unfortunately, it is difficult to remedy a brain drain, especially in an era of global integration. To minimize the negative effects, efforts to develop capacity will have to be expanded, and incentives will have to be enhanced so that at least some scientists find sufficient reason to stay home.

Motivation and Incentives

Knowledge, skill, and experience are necessary but not sufficient to guarantee a productive outcome from research. The dedication and motivation of scientists are also important, and these elements are especially sensitive to the incentive structures in research institutions. Yet it is virtually impossible to offer an incentives structure to a particular branch of the government (for example, agricultural research) that is fundamentally different from that in other branches of government. Nevertheless, small improvements are possible, and a combination of some of these may be sufficient to better motivate agricultural scientists.

The salary structure of scientists ranges from about $113 to $345 per month, depending on rank. This structure cannot be changed in isolation from the government system as a whole. Some fringe benefits, such as special allowances, could be increased, but only with great difficulty. Therefore, the scope of any special change in salary and benefits exclusively for scientists remains extremely slim. Improvements in promotion procedures and special recognition, together with enhancement of the social image of scientists, could conceivably improve motivation among scientists.

Currently, even scientists with advanced degrees from Western universities are typically employed in the same position for 8 to 12 years before promotion. This peculiar situation has developed because of the small number of approved senior positions in most research institutes. The number of approved positions was determined when the various institutes were first established, and changing it is difficult within Bangladesh's public-service rules and tradition. However, with the increasing

autonomy of research institutes, granting promotion based on experience and performance, regardless of the number of approved positions, may become possible.

Social image is important in cultivating a sense of pride among scientists, particularly in societies like that of Bangladesh, whose government officers are classified into explicit classes. Not too long ago, graduates in agricultural science were held in much lower esteem than graduates in medicine or engineering. Although these attitudes and practices persist, they are undesirable and sustain an artificial and demeaning culture in public service.

Impact of Agricultural Research

Recently an opportunity opened up for a review of public expenditures in Bangladesh for a multilateral donor. In the course of this assignment, a strong case for increasing resources for agricultural research was presented. The policymakers and top professional advisers responded by contending that the success in rice production resulted from irrigation development and fertilizer policy, and the complementary inputs for high-yielding varieties (HYV) of rice. They apparently did not understand the contribution of research in the development of HYV. Increased use of fertilizers and irrigation were tried in the 1960s with little success; production increased only in the 1980s and 1990s, when modern HYVs became part of the package of complementary inputs. When this contrast was pointed out to policymakers, they seemed to be lost for a moment; strong disagreement turned to skepticism. The dialogue ended with a vague agreement to revisit this issue.

This episode is indicative of the challenge in measuring research benefits and communicating the results to policymakers. Empirical studies on returns from research are numerous. Estimated rates of return vary widely but are generally high (see Alston et al. 2000 for an excellent analytical review). It is the measurement of benefits that is the source of most confusion. The concept of total factor productivity (TFP) is useful for measuring aggregate research benefits (see Solow 1957 and Griliches 1963). The fact that real costs of complementary inputs are netted out from gross revenue in the measurement of TFP makes the residual a suitable measure of technology's contribution, particularly when the effect of any plausible economies of scale is accounted for. Nevertheless, the approach is not free of controversies (see Fagerberg 1994 and Felipe 1999).

The contribution of research to growth in rice production in Bangladesh can be measured through the estimates of TFP. Rice production represents half of agriculture, and rice research has received the highest priority. About 45 modern varieties have been released that cover 70 percent of the country's rice area. Rice yield

Table 6.11 Bangladesh: Annual growth rates in rice revenue, input costs, and total factor productivity (TFP), 1975–76 to 1997–98

	1975–76 to 1986–87	1987–88 to 1997–98	1975–76 to 1997–98
Based on current prices			
Output	10.71	3.72	7.22
Input	9.52	2.86	6.19
TFP	1.19	0.86	1.03
Based on constant prices			
Output	2.91	4.02	3.51
Input	2.12	2.65	2.41
TFP	0.79	1.37	1.10

Source: Ahmed 2001.

Note: Constant prices are for 1981–82.

has doubled, contributing to the doubling of rice production during the past two decades (Shahabuddin and Rahman 1998).

Estimates of the average rate of growth in output, input, and TFP are presented in Table 6.11. (For details on the method of calculation, see Ahmed 2001.) Values for individual years vary widely because of floods, droughts, and other natural factors, so averages over a number of years are shown—for 1975–76 to 1986–87, for 1987–88 to 1997–98, and for the entire period 1975–76 to 1997–98. Two sets of measures are provided, based on nominal and real (1981–82) prices.

In spite of the comparatively small investments in agricultural research documented above, the technological progress in agriculture, as measured by total factor productivity growth in rice, has been solid. The growth rate in TFP in rice production was slightly higher than 1 percent per annum in the period 1975–76 through 1997–98. Comparing growth rates in TFP estimated using nominal and real prices, it appears that over the entire period, the difference between the two narrows, but in the first and second decades, using different prices can influence the perspective on TFP growth. Prices do matter, mostly in the shorter rather than the longer run, in the measurement of TFP.

How does this growth in TFP compare with similar agricultural products in India? Evenson, Pray, and Rosegrant (1999), who estimated the TFP for crops in eastern India (West Bengal, Orissa, and Behar), found that the annual growth rate in crop TFP was 0.75 percent during the period 1956–87. The Bangladesh estimate considers only rice, while the Indian estimate includes rice and other crops, and so the two estimates are not strictly comparable. However, since rice is the largest crop in eastern India as well as in Bangladesh, such a comparison is still useful.

In the rice economy of Bangladesh, the real price of rice declined over the period 1975–76 to 1997–98; the decline was sharper in the second decade than in the first (Ahmed 2001). But the growth in production of rice, in the face of this declining real price, has been spectacularly sustained. This growth has been possible because of the sustained improvement in TFP. Rice prices in Bangladesh have come very close to world prices. Therefore, for further increases in production, productivity will play a more strategic role than prices.

Rice research has indeed paid off in Bangladesh. The increase of 1 percent annually in TFP in rice production implies an annual contribution of about 170,000 metric tons of rice, valued at about $42.5 million (equivalent to Tk. 1.913 billion at the official exchange rate). Annual public expenditure on rice development, using total expenditures of the BRRI and 50 percent of total expenditures on agricultural extension services, averaged Tk. 118.9 million from 1990 through 1997. Based on these figures, a crude estimate of the benefit–cost ratio of rice research is 16:1, an extremely high rate of return.

Concluding Observations

Bangladesh has a rich history of agricultural research. But building on this historical foundation has been slow, as the resources available for research have remained very limited. Only about 4 percent of total public developmental expenditure in agriculture, which is equivalent to about 0.25 percent of agricultural GDP, is allocated to agricultural research. Because of the legacy of strategic research institutions, the achievements of agricultural research have indeed been remarkable. Total factor productivity in rice, a major crop example, has grown, enabling rice production to double even though the real price of rice has fallen sharply and the area under rice has declined slightly. About 70 percent of rice area is currently planted with high-yielding varieties.

The forces of globalization have brought a number of new challenges to agricultural research in Bangladesh. The first is the ability of agricultural research to contribute to the low-cost supply of agricultural products in intensely competitive world markets. Unfettered competition in world markets offers a comparative advantage to countries with superior research skills and institutions to support their agricultural sectors, not least because nonagricultural sectors can rely on imported technology with greater ease than agriculture can. For example, imported biotechnologies often require some adaptation, and local testing and screening, at least, before release to farmers.

The second challenge facing agricultural R&D in Bangladesh is to meet the needs of agricultural diversification. Mobilizing the resources required for research

on livestock, fisheries, forestry, and high-value crops, particularly research focusing on quality improvement, must occur faster. Because the proportion of scientists with advanced degrees in noncrop branches of agricultural research is very low, developing the personnel to address these areas of research must become a high priority (Hasanuzzaman 2000).

The third challenge relates to opportunities presented by scientific developments in biotechnology. As the human-health and environmental concerns over biotechnology are adequately addressed, this relatively new branch of agricultural research is destined to cause a sea change in agricultural markets around the globe. Bangladesh has taken some initial steps to develop research capabilities in biotechnology (BARC 2001). Initiatives under the Ministry of Science and Technology include the organization of a biotechnology research institute in Bangladesh.

The systemic problem of inadequate and unstable allocation of public resources for agricultural research has been a common theme in national research evaluation documents (BANSDOC 1997). Discussions with policymakers suggest that resource availability is not perceived as a problem; resource utilization is considered the critical constraint. Scientists, on the other hand, complain about meager and uncertain resource flows, as well as the slow disbursement of funds, as the real constraints. The basic problem is rooted in institutional deficiencies.

The financing mechanism for agricultural research has to be extricated from the current budgetary process, perhaps by establishing some sort of autonomous foundation or trust fund to be administered by a body like BARC. The fund will depend primarily on public resources; therefore budgetary allocations to agricultural research will have to be included in the annual budget. Such a funding mechanism will enable scientists to pursue research activities according to a long-term research plan, avoiding the vicissitudes of annual budgetary allocations and cumbersome financial approvals required by current mechanisms.

The problems of sustaining human resource development in agriculture in general, and the situation arising from outmigration of scientists in particular, call for thoughtful evaluation and corrective measures. It is extremely difficult to stop migration by regulation. While internal improvements in incentives may reduce the outflow, it is doubtful that they can stop it. Therefore, a strong program for training and education of scientists should be undertaken, so that the vacuum can be filled quickly, with the least possible damaging effects on research activities.

Historically, agricultural research institutions have witnessed moments of enormous frustration followed by bold measures of institutional strengthening. Perhaps the current deteriorating situation in agricultural research will herald another resurgence. This time around, perhaps the resurgence will be sustained enough to render the long-run future of agricultural R&D less uncertain.

Notes

1.The subsectoral shares in agricultural GDP for 1972–75 show that the crop subsector accounted for 70 percent, fisheries 11 percent, livestock 10 percent, and forestry 9 percent. Over the past 20 years, the share of the crop subsector fell from 78 percent to 52 percent, while the share of noncrop subsectors increased from 30 percent to 43 percent by 2003/4.

2. Bangladesh has been a signatory to the Trade Related Aspects of Intellectual Property (TRIPs) agreement since January 1995, and to the World Intellectual Property Organization (WIPO) Convention since May 1985, but has yet to join the Patent Cooperation Treaty administered by that organization. The Bangladesh Patent Office operates out of the Ministry of Industries.

3. Pardey, Kang, and Elliott (1989) provided evidence on the political-economy aspects of agricultural R&D using the same sets of ratios as a basis for comparison among countries. In addition to conventional agricultural research-intensity ratios, they developed measures of a public agricultural-expenditure ratio (government expenditure on agriculture relative to AgGDP) and a relative research-expenditure ratio (public agricultural-research expenditure relative to government expenditure on agriculture).

4. In addition to food marketing, there are significant elements of input marketing and service provision in other subsectors; therefore, the share of all types of marketing in the agricultural sector could be as high as 40 to 45 percent (see World Bank, Bangladesh Country Operations Division 1996).

5. Expenditures by BARC, BARI, BRRI, BJRI, BINA, BSRI, BLRI, BFRI, BTRI, BFORI, and SRDI were included as research expenditures. Information on both development and current expenditures was collected from these institutes to supplement statistics in budget documents.

6. We attempted to use statistical regression methods to estimate the extent of the influence of various fiscal variables on the instability of research expenditures. The results were statistically poor, but the variability in project aid for research was found to be a significant cause of variability in research expenditures.

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