2 Foodgrain Production and Imports: Toward Self-Sufficiency in Rice?

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Bangladesh faces huge obstacles in its efforts to increase foodgrain production, raise rural incomes, and reduce food insecurity. In this country of nearly 125 million people living in an area of approximately 143,000 square kilometers, there is immense population pressure on the available cultivable land. Average farm size is only 0.8 hectare, and there is virtually no scope for expansion of cultivated land (although some expansion in multiple cropping is possible). Moreover, agricultural production is susceptible to the vagaries of the weather: floods, droughts, and cyclones frequently cause substantial damage.

After the massive food shortages of the early 1970s, the Government of Bangladesh made substantial investments in the rice sector in an effort to overcome these constraints. During the 1980s these efforts paid off. Rice production increased substantially through the introduction of a Green Revolution technology package consisting of high-yielding varieties (HYVs), irrigation, and fertilizers. Wheat production expanded considerably during the 1970s, from fewer than 100,000 metric tons per year at independence to more than 1 million per year through most of the 1980s.[1] Thus, in the early 1990s Bangladesh seemed to be approaching self-sufficiency in rice, with domestic production of foodgrains (rice and wheat) accounting for 93 percent of national foodgrain supply and import of rice virtually nil during 1991–93.

Several poor harvests in the mid- and late 1990s have dampened the optimism of the first half of the decade. Average yields of HYV rice have stagnated, and production has fluctuated widely around a slower growth trend. Private sector imports, permitted only since liberalization of the private sector international trade in foodgrains in the early 1990s, have to a large extent offset these variations in production. As Bangladesh approaches the twenty-first century, considerable uncertainty surrounds the medium-term outlook for foodgrain production and available supplies. Is a period of sustained growth in production similar to that of the 1980s feasible? If not, to what extent do private trade and international markets help reduce food insecurity?

1. All further references to tons indicate metric tons.

Foodgrain Production Systems and Technical Change

Rice dominates the crop production landscape of Bangladesh. Nearly three-quarters of total gross cropped area in Bangladesh is planted to rice (Table 2.1).[2] Rice is grown in three different seasons, although not more than twice per year on any given plot of land. Traditionally, the major rice crop has been the aman crop, harvested after the monsoon rains.[3] Aman rice alone accounts for 42 percent of gross cropped area. Two smaller rice crops, aus and boro, are also cultivated, often in a crop rotation that includes aman. More than 90 percent of boro rice is irrigated, although overall only 26 percent of gross cropped area is irrigated. Thus, boro rice accounts for 71 percent of total irrigated gross cropped area. Wheat accounts for only 5 percent of the 33 million acres planted with crops.

Except for hill areas along the northern and northeastern borders and the Chittagong hill tracts in the southeast, Bangladesh is a flat alluvial plain spotted with small terrace areas in the central and northwestern regions (the Madhpur and Barind tracts) (see Hossain 1991:18–19). The monsoon (kharif) rains, beginning in April or May, provide water for planting the aus rice crop and jute and swell the rivers. Floodwaters cover much of the alluvial plain during parts of July, August, and September. Weather outside Bangladesh, however, greatly influences the extent and duration of the flooding since approximately 90 percent of the catchment area of the major rivers (the Ganges [Padma], the Brahmaputra, and the Meghna) lies outside the country.[4]

The main rice crop, aman, is generally sown between June and August. Seeds of broadcast aman are sown before the floods, and if the floods are not too severe, plants are typically harvested in November or December after the floodwaters have receded. For transplanted aman, seedlings are transplanted in the fields in late July or August and harvested three to four months later. Because most traditional aman varieties are sensitive to photoperiod, transplanting must occur before mid-September to ensure flowering of the rice plants. During the winter, or rabi season, a wider variety of crops is grown, including boro rice (mainly on irrigated land), wheat, pulses, and vegetables.

There are many crop rotations, most involving at least one crop of rice and depending largely on the depth of flooding in the monsoon (kharif) season and the availability of water during the winter (rabi) season. On lowlands that are

2. Gross cropped area counts two or more crops grown sequentially on the same piece of land as separate crops. Net cropped area measures the total amount of land cultivated during a period. The ratio of gross cropped area to net cropped area is the cropping intensity. From the early 1970s to the early 1990s, the cropping intensity in Bangladesh remained at about 1.6 (Zohir 1995: 81).

3. There are three major rice harvests in Bangladesh: aus (July–August), aman (November–January), and boro (April–June). These same terms are often used to designate varieties of rice typically grown in these seasons.

4. See Novak 1992 for a fuller description of the rivers and their influence on village life in Bangladesh.

TABLE 2.1 Distribution of cropped area in Bangladesh, 1995/96

Crop	Cropped Area		Irrigated Area		Cropped Area That Is Irrigated
	(thousand hectares)	(percent of cropped area)	(thousand hectares)	(percent of irrigated area)	(percent)
Rice	9,954.3	73.6	2,940.5	82.7	29.5
Aus	1,554.0	11.5	114.9	3.2	7.4
Aman	5,646.7	41.8	295.4	8.3	5.2
Boro	2,753.5	20.4	2,530.1	71.1	91.9
Wheat	700.9	5.2	299.9	8.4	42.8
Minor cereals	93.1	0.7	3.6	0.1	3.9
Pulses	698.5	5.2	1.6	0.0	0.2
Oilseeds	554.8	4.1	19.0	0.5	3.4
Potato	132.3	1.0	100.8	2.8	76.1
Vegetables	191.0	1.4	82.2	2.3	43.0
Sugarcane	174.4	1.3	22.7	0.6	13.0
Cotton	36.8	0.3	10.5	0.3	28.6
Others	985.8	7.3	76.1	2.1	7.7
Total[a]	13,522.1	100.0	3,556.9	100.0	26.3[b]

SOURCE: BBS (1997).

[a]Totals may not be precise owing to rounding.

[b]Average.

heavily flooded in the monsoon season (known as F3 areas), land is fallow at the beginning of the crop year (April), and generally only one crop is grown; typically this is broadcast aman or, on irrigated land, modern-variety boro. On medium lowlands (F2), land is also usually fallow at the start of the crop year, but two crops are then grown: broadcast or local transplanted aman, followed by wheat or other rabi crops. On irrigated F2 land, aman rice is followed by boro rice. On medium highlands (F1) and highlands (F0), transplanted aman is a common factor in most rotations, with large variations in winter crops sown. After the onset of the monsoons, the land is typically fallow or planted with aus, followed by transplanted aman, and then either left fallow or planted with pulses (on nonirrigated land) or boro, wheat, or potatoes (on irrigated land) (see Zohir 1995:89, tab. A.2).

According to the 1991 Bangladesh Institute of Development Studies (BIDS)–IFPRI survey of 88 villages representing the various agro-ecological zones of Bangladesh, 28 percent of net cropped area was planted with only a single crop of rice or wheat (Zohir 1995). Another 34 percent was planted with a double crop of rice or rice and wheat. In all, 62 percent of net cropped area was planted only with foodgrains, predominantly rice.

Production Trends and Variability

Bangladesh achieved impressive gains in wheat production in the 1970s and in rice production in the 1980s through investments in irrigation, increased fertilizer use, and the adoption of new seeds, especially in the boro season. Rice production grew by an average of 1.76 percent annually during 1973/74–1983/84, 2.78 percent during 1983/84–1993/94, and 1.89 percent during 1993/94–1997/98 (Table 2.2). Average rice yields rose in all three seasons, with total yields rising from 1.20 tons per hectare to 1.82 tons per hectare from the early 1970s to the late 1990s (Table 2.3). During this period areas cultivated with HYVs rose rapidly, from an average of 15 percent of rice area in 1974–76 to 51 percent in 1996–98. At the same time irrigation spread rapidly, increasing from 12 percent to 28 percent of total rice area. By the late 1990s, 91 percent of boro area was irrigated, and 92 percent was cultivated with HYVs as boro's share in rice production rose from 19 percent in the early 1970s to 41 percent in 1996–98.

The increase in boro's share of total production has contributed to a decline in variability of total annual rice production. Between 1974–84 and 1984–94, the variability of production (as measured by the standard deviation of the residuals from a semilogarithmic trend line) declined from 4.17 to 3.31 percent (Table 2.2). In addition, the variability of the boro harvest itself decreased from 14.69 percent in 1974–84, to 8.49 percent in 1984–94, and to only 3 percent in 1994–98. This decline is due mainly to the reduced variability of boro production as more boro land has come under controlled irrigation. A second factor is the negative correlation between variations in boro

TABLE 2.2 Growth rates and variability of foodgrain production, 1974–98

Rates	Aman	Aus	Boro	Total Rice	Wheat	Total Foodgrains
				(percent)		
Growth rates						
1973/74–1997/98	1.25	–2.71	6.72	2.02	8.72	2.25
1973/74–1983/84	1.18	0.25	5.26	1.76	30.17	2.62
1983/84–1993/94	2.10	–4.88	8.18	2.78	–1.34	2.50
1993/94–1997/98	–0.08	0.70	4.71	1.89	11.48	2.55
Variability						
1973/74–1997/98	6.84	11.61	12.96	4.47	51.20	4.10
1973/74–1983/84	5.75	6.54	14.69	4.17	23.28	4.03
1983/84–1993/94	7.57	7.53	8.49	3.31	12.29	3.04
1993/94–1997/98	4.93	4.46	3.00	3.55	3.86	3.29

SOURCES: FPMU, Hamid (1991), and author's calculations.

NOTE: Growth rates are computed with a semilogarithmic trend. Variability of production is measured by the standard deviation of percentage differences between production figures and the fitted value derived from the semilogarithmic line.

TABLE 2.3 Rice yields and prevalence of HYVs and irrigated area by season

	Aus	Aman	Boro	Total Rice
Average rice yield (metric tons per hectare)				
1973/74–1975/76	0.93	1.18	2.05	1.20
1983/84–1985/86	0.99	1.38	2.42	1.42
1995/96–1997/98	1.15	1.58	2.69	1.82
Average proportion of HYV area in respective rice crops (percent)				
1973/74–1975/76	8	11	56	15
1983/84–1985/86	16	12	79	27
1995/96–1997/98	29	37	92	51
Average proportion of irrigated rice area in respective total rice area (percent)				
1973/74–1975/76	2	2	93	12
1983/84–1985/86	5	3	82	15
1993/94–1995/96	8	5	91	28
Average shares of seasonal rice crop in total rice production (percent)				
1973/74–1975/76	25	56	19	100
1983/84–1985/86	20	55	25	100
1995/96–1997/98	10	49	41	100

SOURCES: FPMU, Hamid (1991), and author's calculations.

TABLE 2.4 Growth rates of modern and local rice varieties by season, 1973–98

	Total Rice			Modern Varieties			Local Varities		
	Output	Area	Yield	Output	Area	Yield	Output	Area	Yield
1973–98									
Annual	2.34	0.09	2.25	7.58	7.43	0.27	−1.52	−2.63	1.14
Aus	−2.09	−3.22	1.17	1.57	3.59	−1.95	−2.64	−3.72	1.12
Aman	1.62	−0.05	1.68	8.41	8.38	0.03	−0.96	−2.07	1.13
Boro	6.62	5.22	1.33	8.81	8.74	0.06	−3.08	−3.32	0.25
1973–87									
Annual	2.66	0.57	2.08	7.11	8.21	−1.02	0.34	−1.06	1.41
Aus	0.83	−0.51	1.35	7.45	10.39	−2.67	−0.79	−1.58	0.80
Aman	2.30	0.47	1.82	7.11	7.72	−0.56	1.10	−0.58	1.68
Boro	5.59	3.71	1.81	7.81	8.85	−0.96	−2.38	−3.47	1.12
1987–98									
Annual	1.65	−0.38	2.04	7.87	5.70	2.06	2.34	0.57	0.43
Aus	−5.44	−6.11	0.72	−2.37	−2.11	−0.26	−2.09	−8.73	−0.58
Aman	1.47	0.19	1.28	12.56	8.15	4.08	1.62	−3.35	0.28
Boro	4.95	3.75	1.15	6.00	5.66	0.32	6.62	3.71	0.64

SOURCES: BBS (various), FPMU, and author's calculations.

NOTES: For modern and local variety figures data are available up to 1995–96, and all figures have been calculated from a semilogarithmic equation: $\ln q = a + b \times \text{time}$.

production and variations in aus and, to a lesser extent, aman production.[5] Particularly in very poor aman production years, such as 1997/98 or the flood years of 1988/89 and 1998/99, high rice prices after the aman harvest have increased incentives for fertilizer and other inputs in the boro season.

The production growth rates of the 1980s have not been matched in the 1990s, however, leading to concerns about long-term production trends. As Table 2.4 shows, almost all of the growth in rice production achieved in the 1970s, 1980s, and 1990s was the result of increases in average yields.[6] For 1972/73–1997/98, the area harvested increased by only 0.09 percent per year, while production increased by 2.34 percent per year. The increases in average yields, however, do not reflect increases in productivity of either HYVs or local varieties but rather a switch from local varieties to HYVs. Yields of modern varieties have remained essentially unchanged in aggregate and have actually declined for aus. Thus, three-quarters of the total growth of rice production in Bangladesh resulted from this change in cropping patterns from local aus and boro to HYV boro rice and to the change from local to modern

5. The correlation coefficient of the residuals from the trend growth regressions are −0.52 for aus-boro and −0.61 for wheat-boro, reflecting direct competition for available land. The correlation coefficient for aman-boro is −0.45, reflecting the relatively weaker effects of aman production on boro through market prices.

6. This section draws heavily from chapter 2 of Del Ninno and Dorosh (1998).

varieties in the aman season (Baffes and Gautam 1996). Increases in local-variety aman yields account for much of the residual growth.

The area cultivated with aman rice has remained essentially constant, declining slightly from 5.91 million hectares in 1983–85 to 5.76 million hectares in 1996–98 (Table 2.5). This constancy of aman area is explained largely by the overall land constraint and the lack of water control during this season, which results in high soil moisture and poor drainage, limiting the possibilities for substituting other crops.

Substantial shifts have occurred, however, in the area cultivated in the overlapping boro and aus seasons. Area planted with boro rice increased by an average of 5.55 percent per year between 1973–75 and 1992–94, a change made possible by an expansion of controlled (groundwater) irrigation through tubewells. An increase in boro area led to a decline in aus area as aus-aman-fallow cropping sequences were replaced by fallow-aman-boro and rotations involving boro with various rabi crops. Over the 24-year period, aus area (which was mostly rainfed) fell by an average of 2.71 percent per year. This switch from aus to boro has also raised average yields since HYV boro yields (2.73 tons per hectare) are higher than those of local aus (0.87 tons per hectare).

Similarly, yields of modern wheat varieties have remained essentially unchanged. The large 25.5 percent annual average increase in wheat production in Bangladesh between 1973 and 1987 was due mainly to rapid area expansion (by 16.6 percent per year) and a shift from local to modern varieties. Between 1987 (when 100 percent of area cultivated was sown with modern varieties) and 1994, however, wheat production increased by only 1.28 percent per year.

Although the national average rice yield increased by about 50 percent between 1975 and 1995, yields of modern varieties almost stagnated. This suggests that, without further technical change, foodgrain production in Bangladesh may soon reach a plateau unless the proportion of HYVs in the total rice area can be raised from its present 51 percent to 70 percent or more by investment in irrigation and water control and the improved use of fertilizers and other inputs. Although the growth rate of yields of modern rice varieties was almost stagnant (that is, only 0.27 percent per year) during 1973–98, this was the average result of an annual decline of growth rate (−1.02 percent) during 1973–87 and an increase in growth rate (2.06 percent) during 1987–98, when the level of fertilizer use increased faster than it had during the earlier period. This points to the possibility of sustained higher yields of modern varieties through better use of fertilizer.

Bangladesh's average rice yield of 1.77 tons per hectare (equal to approximately 2.64 tons of paddy per hectare) is still low compared with average Asian paddy yields of 4 tons per hectare in Indonesia and 5 to 6 tons per hectare in China and Korea. Average yields during the boro season, however, during which 90 percent of the rice area is planted with modern varieties, are 2.73 tons

TABLE 2.5 Production of modern and local rice varieties by season, 1973–98

	Total Rice			Modern Varieties			Local Varieties		
	Output[a]	Area[b]	Yield[c]	Output[a]	Area[b]	Yield[c]	Output[a]	Area[b]	Yield[c]
1973/74–1975/76									
Annual	12,357	10,000	1.23	3,681	1,515	2.43	8,116	8,485	0.96
Aus	3,124	3,236	0.97	645	256	2.52	2,319	2,980	0.78
Aman	6,946	5,644	1.23	1,412	628	2.25	5,169	5,016	1.03
Boro	2,287	1,120	2.02	1,624	630	2.58	628	490	1.28
1983/84–1985/86									
Annual	14,723	10,390	1.42	6,292	2,759	2.27	8,431	7,631	1.11
Aus	2,944	2,974	0.99	930	483	1.93	2,014	2,492	0.81
Aman	8,136	5,913	1.38	2,229	1,107	2.01	5,907	4,806	1.23
Boro	3,643	1,503	2.42	3,133	1,170	2.68	510	333	1.53
1995/96–1997/98									
Annual	18,475	10,139	1.82	13,021	5,194	2.51	5,454	4,748	1.15
Aus	1,807	1,571	1.15	702	419	1.68	974	1,123	0.87
Aman	9,064	5,761	1.57	5,467	2,269	2.41	4,110	3,379	1.22
Boro	7,604	2,807	2.71	6,852	2,507	2.73	370	247	1.50

SOURCES: FPMU, BBS (various), and author's calculations.

NOTES: For modern and local varieties data for 1997 and 1998 are not available. Figures shown for modern and local varieties for 1995/96–1997/98 are the figures from 1996/97. Rice production figures are in milled rice.

[a]In thousand metric tons.

[b]In thousand hectares.

[c]Metric tons per hectare.

per hectare (4 tons per hectare of paddy). Achieving substantial further average yield gains is likely to require substantial investments in research, extension, and irrigation (for increased water control) as well as adequate price incentives for producers. In the long run, maintenance of the natural resource base is also crucial.

Soil nutrient status may already be deteriorating in Bangladesh (Zaman 1987). Sources of this degradation are not entirely clear, nor do observers know if this trend can be reversed by balanced and increased use of fertilizers. Degradation of nutrient status implies that yield rates will drop without enhanced levels of nutrient application. Recent agronomy trials suggest that high yields may be sustained with balanced chemical fertilizer applications. The availability of water for two rice crops per year may also become an issue in the long term, especially since efficiency of water use is low at present.

Imports, Total Foodgrain Supply, and Price

Increases in production have helped transform the foodgrain economy in Bangladesh by reducing dependence on food aid and government commercial imports and contributing to a long-term decline in real prices. Production as a share of total availability of foodgrains increased from 83.5 percent in 1973–75 to 93 percent in 1991–93 as production per capita rose from 132.2 kilograms to 152.7 kilograms. In the same period imports per capita fell from 27.4 to 12.8 kilograms, while the total availability of foodgrains rose on average from 158.4 to 165.3 kilograms per capita (Table 2.6 and Figure 2.1).

Nevertheless, aggregate foodgrain production and import figures obscure the vastly different roles of rice and wheat in foodgrain markets and policy in Bangladesh. As discussed, in spite of substantial increases in wheat production since the early 1970s, rice still accounted for 94 percent of national foodgrain production in the late 1990s. It also constituted the bulk of government commercial imports; private commercial imports of foodgrain were banned until 1991. Yet wheat dominates foodgrain imports, largely because of food aid but also because of increased demand related to rapid urbanization. Food aid flows, which began in East Pakistan in the 1960s, have been almost entirely in the form of wheat, reflecting production and excess stocks in donor countries. At the same time, scarcity of fiscal resources and foreign exchange placed tight constraints on the government's ability to import rice, particularly in the 1970s.

The quantity of food aid wheat flows has been determined by both supply and demand. On the supply side, the level of stocks and prices in donor countries (reflecting production and world market conditions) determine total worldwide food aid availability, with donor political objectives and conditions influencing allocations to Bangladesh. The demand or need for food aid is framed in terms of foodgrain requirements, which are calculated as target level of per capita food consumption minus expected levels of domestic net produc-

TABLE 2.6 Foodgrain availability and requirements in Bangladesh, 1972–98

Year (1)	Domestic Production: Rice (2)[a]	Domestic Production: Wheat (3)[a]	Domestic Production: Total (4)[a]	Net Production (5)[a]	Mid-Year Population (6)[b]	Foodgrain Consumption Requirement (7)[a]	Food Gap (7) – (5) (8)[a]	Private Imports (9)[a]	Public Distribution (10)[a]	Internal Procurement (11)[a]	National Availability (5) – (9) + (10) – (11) (12)[a]	Per Capita Availability (13)[c]	Net Production/ Availability (14)[d]
1971/72	9,931	115	10,046	9,041	73	12,020	2,979		1,763	10	10,794	148 7	83.8
1972/73	10,090	91	10,181	9,163	74	12,301	3,139		2,660	1	11,822	159.1	77.5
1973/74	11,909	111	12,020	10,818	76	12,649	1,831		1,755	71	12,502	163.6	86.5
1974/75	11,287	117	11,404	10,264	78	12,947	2,684		1,785	129	11,920	152.4	86.1
1975/76	12,763	218	12,981	11,683	80	13,245	1,562		1,722	422	12,983	162.3	90.0
1976/77	11,753	105	11,858	10,672	82	13,560	2,887		1,486	319	11,839	144.6	90.1
1977/78	12,970	356	13,326	11,993	84	13,891	1.897		1,908	560	13,341	159.0	89.9
1978/79	12,849	494	13,343	12,009	86	14,222	2,213		1,854	361	13,502	157.2	88.9
1979/80	12,740	823	13,563	12,207	88	14,537	2,330		2,498	355	14,350	163.4	85.1
1980/81	13,880	1,092	14,972	13,475	90	14,884	1,409		1,542	1,017	14,000	155.7	96.2
1981/82	13,629	967	14,596	13,136	92	15,215	2,079		2,067	303	14,901	162.1	88.2
1982/83	14,215	1,095	15,310	13,779	94	15,546	1,767		1,935	192	15,522	165.3	88.8
1983/84	14,509	1,211	15,720	14,148	96	15,894	1,746		2,051	266	15,933	166.0	88.8
1984/85	14,623	1,464	16,087	14,478	98	16,242	1,764		2,562	349	16,692	170.1	86.7
1985/86	15,038	1,042	16,080	14,472	100	16,606	2,134		1,541	349	15,664	156.2	92.4

1986/87	15,406	1,091	16,497	14,847	103	16,970	2,123		2,120	188	16,779	163.7	88.5
1987/88	15,413	1,048	16,461	14,815	105	17,335	2,520		2,503	375	16,943	161.8	87.4
1988/89	15,544	1,021	16,565	14,909	107	17,682	2,774		2,941	416	17,433	163.2	85.5
1989/90	17,856	890	18,746	16,871	109	18,030	1,159		2,164	960	18,075	166.0	93.3
1990/91	17,852	1,004	18,856	16,970	111	18,378	1,407		2,372	783	18,559	167.2	91.4
1991/92	18,252	1,065	19,317	17,385	113	18,709	1,323		2,345	1,016	18,714	165.6	92.9
1992/93	18,341	1,176	19,517	17,565	115	19,040	1,475	355	1,073	233	18,761	163 1	93.6
1993/94	18,041	1,131	19,172	17,255	117	19,371	2,116	312	1,376	166	18,777	160.5	91.9
1994/95	16,833	1,245	18,078	16,270	119	19,702	3,432	1,013	1,573	277	18,579	156.1	87.6
1995/96	17,687	1,369	19,056	17,150	121	20,033	2,883	850	1,795	422	19,373	160.1	88.5
1996/97	18,883	1,454	20,337	18,303	123	20,364	2,061	237	1,392	616	19,316	157.0	94.8
1997/98	18,824	1,803	20,627	18,564	125	20,696	2,131	1,133	1,621	617	20,701	165.6	89.7

SOURCES: BBS (various) and Hamid (1991).

NOTE: Food grain consumption requirement is calculated using the Government of Bangladesh's standard 16 ounces per person per day. Before 1985/86, however, the official food requirement was calculated using 15.5 ounces per person per day. Before 1991/92 private imports of foodgrain were not allowed.

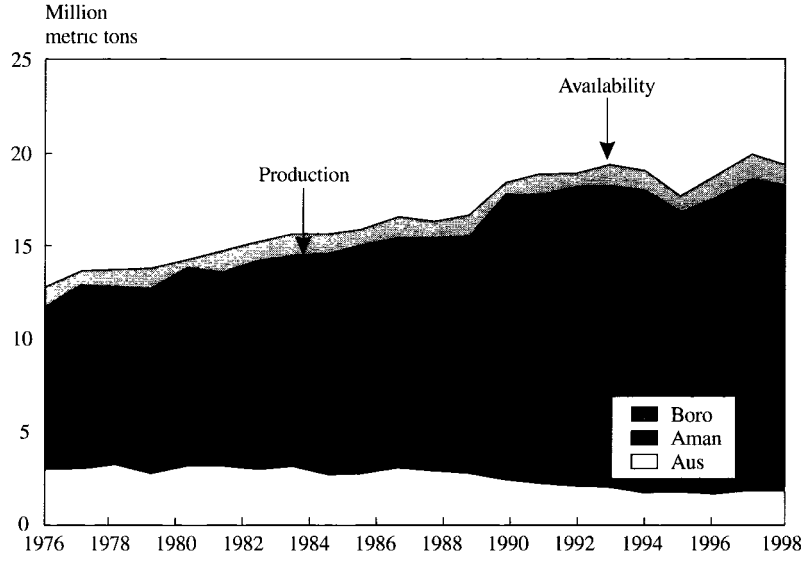
[a]In thousand metric tons.

[b]In millions.

[c]Kilograms per person.

[d]Percent.

FIGURE 2.1 Total rice production and availability in Bangladesh



SOURCES. FPMU and MOF.

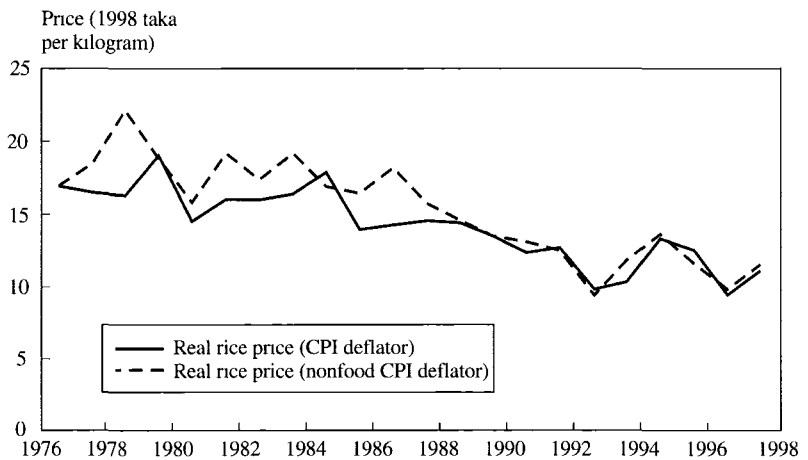
tion, changes in government stock, and commercial imports. Floods, cyclones, and droughts have increased the need for food aid to offset loss of domestic production or to provide emergency food relief. (See Chapter 8 for a detailed discussion of food aid flows to Bangladesh.)

Increases in domestic production, increased government capacity to import foodgrains commercially, and declining availability have reduced the share of food aid imports in total foodgrain supply over time. With increases in rice production, government rice imports fell somewhat during the 1980s. Nonetheless, this decline did not offset the gains in production, meaning that overall rice supplies per capita increased and market prices fell.

Real prices of rice in Bangladesh declined considerably from the mid-1970s to the early 1990s (Figure 2.2). Using the Dhaka middle-income consumer price index (CPI) as a deflator, a measure of overall inflation, the decline in rice prices between 1977–79 and 1991–93 was 34 percent. Using only the nonfood component of the CPI as a deflator, the decline in real prices of rice relative to the average price of nonfood consumer goods was 43 percent.[7] Over the same period, rice consumption per capita (proxied by net availability per capita) rose by 1.6 percent, from 137.6 to 145.4 kilograms per

7. These calculations are based on a December-to-January marketing year since the aman rice harvest occurs in November and December.

FIGURE 2.2 Real prices of coarse rice, 1977–98 (December–November marketing year)



SOURCES: DAM, BBS (various), and author's calculations.

capita per year in 1991–93. With no effect or a negative income effect on demand combined with an inelastic demand curve, a modest increase in supply translated into a steep decline in the real price of rice. A worsening income distribution may have also contributed to the fall in real prices (see Appendix).

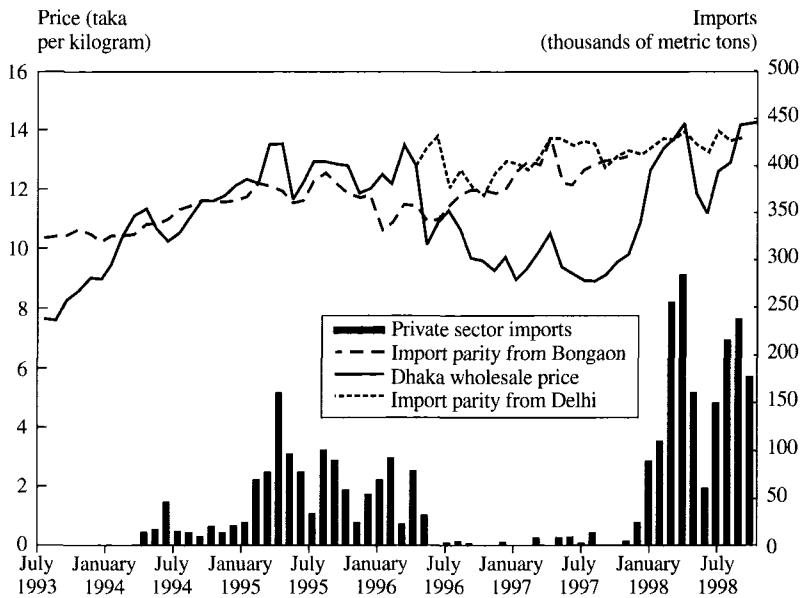
Because private trade was not allowed during this period, these rice prices reflected the balance between total domestic supply (including net government market injections) and demand. Beginning in 1994, however, in periods following poor harvests, domestic prices have risen only to import parity levels because of private sector imports from India.

Rice Prices and Imports after Trade Liberalization

Since the liberalization of international rice trade in 1994, the variation in rice prices in Bangladesh has increased, and substantial quantities of rice were imported following poor harvests in 1995/96 and in 1997/98 (Figure 2.3 and Table 2.7). In the first few months after liberalization, from April to November 1994, normal aman (November/December 1993) and boro (May/June 1994) harvests were sufficient to bring domestic supply to levels approximately equal to domestic demand at import parity prices of rice from India. As a result, even though private import trade was liberalized, only small amounts of rice were imported.[8]

8. At least 10,100 tons of the 34,000 tons of rice imports for which letters of credit were opened between July and September 1994 were from Pakistan. No country of origin was specified on most of the letters of credit in this period (see Dorosh 1999: tab. 3.1).

FIGURE 2.3 Import prices (exported from India) and quantity of private rice imports, 1993–98



SOURCES: Baulch et al. (1998), FPMU, and author's calculations.

Imports surged in 1995 and early 1996, however, due to a sequence of below-average harvests in Bangladesh and India's liberalization of rice exports in October 1994. Bad weather reduced the size of the 1994/95 aman harvest, fertilizer shortages reduced the size of the 1995 boro crop, and more bad weather reduced the 1995/96 aman crop as well.[9] Moreover, India's removal of its quantitative restrictions on rice trade freed the country's private sector to export large quantities of rice to Bangladesh. Given the poor harvests in Bangladesh, there was a substantial excess of demand over supply at import

9. The 1994/95 aman crop was small, leading to increased market prices and greater incentives for producers in the following boro season. The Ministry of Agriculture, however, authorized a large level of fertilizer exports based on projections of normal price and weather conditions. Responding to high paddy prices in the boro planting season, farmers increased their demand for fertilizer. Fertilizer shortages ensued, the open market price of fertilizer rose, and the production of boro rice was only 6.54 million tons (3.5 percent below the previous year's harvest). After the poor aman harvest in 1994/95, the government attempted to import 800,000 tons of rice through open tenders in February 1995. Contract problems involving specification and inspection delayed import arrivals, and subsequent increases in world rice prices made the export sales less attractive to exporters. As a result, only 350,000 tons of rice had arrived within eight months, with final deliveries not arriving until April 1996.

TABLE 2.7 Bangladesh foodgrain imports, 1980–98

Year	Rice				Wheat				Total Foodgrain Imports
	Food Aid	Government	Private	Total	Food Aid	Government	Private	Total	
	(thousand metric tons)								
1980	24	688	0	712	1,136	734	0	1,870	2,582
1981	19	65	0	84	732	260	0	992	1,076
1982	30	114	0	144	1,111	0	0	1,111	1,255
1983	131	186	0	317	845	682	0	1,527	1,844
1984	117	62	0	179	1,324	553	0	1,877	2,056
1985	125	570	0	695	1,181	717	0	1,898	2,593
1986	27	10	0	37	1,060	103	0	1,163	1,200
1987	108	150	0	258	1,317	192	0	1,509	1,767
1988	192	398	0	590	1,595	732	0	2,327	2,917
1989	40	21	0	61	1,316	759	0	2,075	2,136
1990	41	258	0	299	908	326	0	1,234	1,533
1991	10	0	0	10	1,530	37	0	1,567	1,577
1992	39	0	0	39	1,375	150	0	1,525	1,564
1993	19	0	0	19	716	93	355	1,164	1,183
1994	0	0	74	74	654	0	238	892	966
1995	0	230	583	813	935	390	430	1,755	2,568
1996	1	487	650	1,138	737	352	200	1,289	2,427
1997	10	9	15	34	608	103	222	933	967
1998	0	98	993	1,091	549	155	142	846	1,937
Average									
1980–84	64	223	0	287	1,030	446	0	1,475	1,763
1985–89	98	230	0	328	1,294	501	0	1,794	2,123
1990–92	30	86	0	116	1,271	171	0	1,442	1,558
1994–98	2	165	463	630	697	200	246	1,143	1,773

SOURCE: FPMU.

parity prices, so the private sector imported 1.127 million tons (an average of 66,000 tons per month) while the government imported 704,000 tons. Most of this rice came from India in small lots.[10]

Fortunately, favorable weather and stable input supplies contributed to three consecutive good rice harvests: boro 1996, aman 1996/97, and boro 1997. Increased domestic supply reduced market prices to below import parity levels. As a result, private imports were no longer profitable and thus essentially stopped. Real prices during this 1.5-year period were on average slightly below the long-term declining trend (Figure 2.4). In fact, prices even fell below export parity with India, suggesting that Bangladeshi rice exports would have been competitive with Indian exports in the world market. As Rahman (1998) discusses, however, lack of established market links and appropriate grading standards prevented such exportation.[11]

A poor aman harvest in November/December 1997 led to high domestic prices and large-scale imports. Within two months after the start of the aman harvest, Bangladeshi prices rose to the import parity price. Although some groups called for immediate large-scale foodgrain imports, the Ministry of Food opted for a cautious strategy involving only moderate increases in government imports of rice and wheat. Instead, the government encouraged private sector food imports by removing a surcharge on rice imports and increasing open market sales (OMS) and distribution to poor households while maintaining adequate foodgrain stock levels.

Given the price incentives for imports and the large gap between domestic supply and demand, substantial flows of private sector rice imports from India followed. Between December 1997 and May 1998, 916,000 tons of rice were imported through officially approved private channels. As in 1994/95, most of this trade was in small lots. Letter of credit data from January–March 1998 show that the average quantity was only 167.5 tons per letter of credit for the 1,022 letters issued (Dorosh 1999). Moreover, these letters of credit were opened by 387 different traders, who imported an average of only 896 tons of rice each. The largest ten traders (in terms of total imports) imported 69,567 tons, 20 percent of the total. Given this broad participation in the rice import trade and the small share of the largest supplier, there apparently has been little scope for individuals or small groups of traders to significantly affect market prices by restricting market supply.

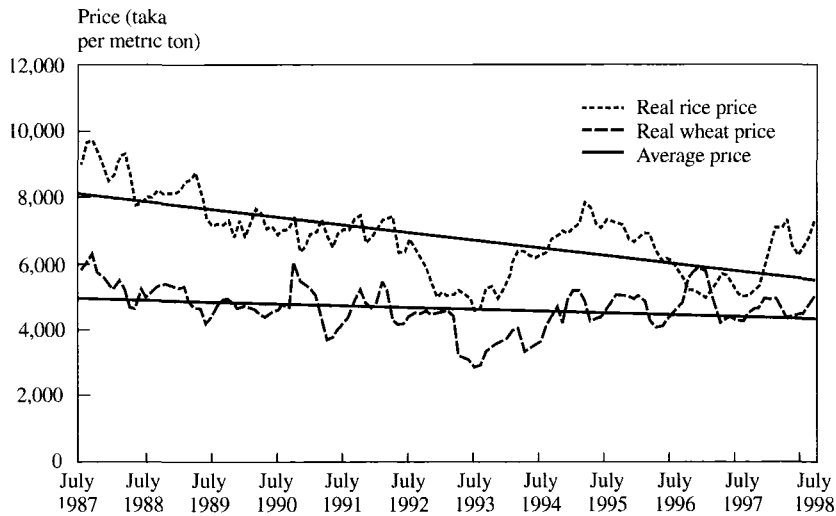
Wheat Prices, Food Aid, and Commercial Imports

Before the liberalization of foodgrain trade in the early 1990s, domestic wheat prices were determined largely by the amount of food aid, the timing of

10. Letter of credit data indicate that the average size of the 1,251 shipments of rice in 1994/95 was only 707 tons (Dorosh 1999: tab. 3.1).

11. India was exporting non-basmati rice to other countries during this period. Bangladeshi rice could not be imported legally by India (for domestic consumption or transshipment) because of a rice import ban

FIGURE 2.4 National average real wholesale price of rice and wheat, 1987–88



SOURCES: FPMU and author's calculations.

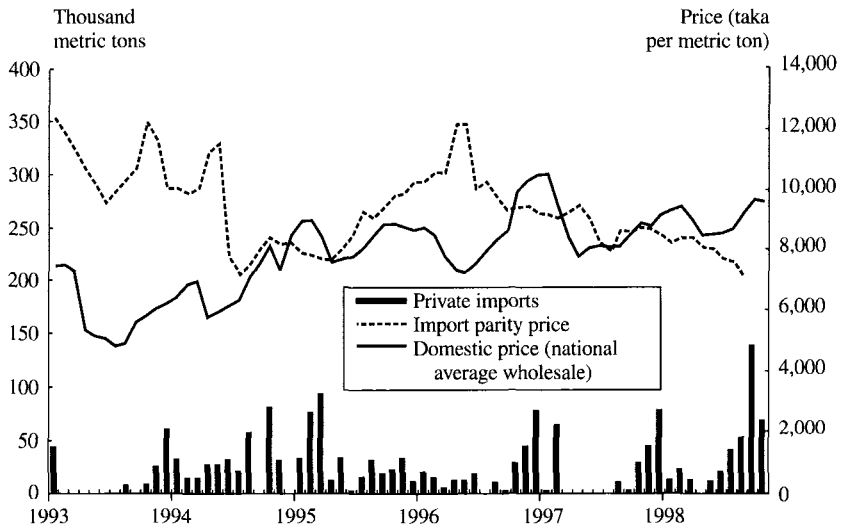
distribution, the level of domestic wheat production, and conditions in the rice market in a given year. Government interventions in the wheat market were limited mainly to distributing food aid through various channels. During the 1980s wheat procurement averaged only 8.7 percent of domestic production, and food aid inflows were on average 2.5 times larger than government commercial wheat imports at 1,162,000 tons of food aid and 473,000 tons of commercial imports. Unlike rice prices, however, real prices of wheat experienced only a slight downward trend in this period (Figure 2.4).

Liberalization of the foodgrain trade opened domestic markets to private sector imports of wheat. Such imports, however, have been on average less than rice imports. Between 1994 and 1998, private wheat imports have averaged 246,000 tons per year, compared with 463,000 tons of rice and 697,000 tons of food aid wheat. Unlike food aid imports (and domestically produced wheat), which are almost exclusively soft wheat varieties, a large share of commercial wheat imports have been more expensive hard wheat varieties better suited for baking bread, biscuits, and pastries.

Figure 2.5 shows the levels of domestic and import parity prices for wheat from 1993 to 1998. Since liberalization of trade in 1993, wheat prices have been near import parity border prices (measured on the basis of the FOB price at Gulf of Mexico ports for U.S. hard red winter wheat plus shipping costs) in most years.[12] The major exception was between September 1995 and Septem-

12. Import parity prices were in fact lower than those for 1993 due to the U.S. Export Enhancement Program, which subsidized wheat exports

FIGURE 2.5 Import parity prices and quantity of private wheat imports, 1993–98



SOURCES: FPMU and author's calculations.

ber 1996, when world prices rose sharply while domestic prices fell, leading to a large gap in April and May 1996. This divergence between domestic prices and border prices is largely due to imports of lower-quality wheat from India, large amounts of Food-for-Work (FFW) wheat distributed in early 1996, and good boro rice and wheat harvests in April–June 1996.

Producer Disincentive Effects

To avoid depressing market prices below import parity prices, the total level of food aid must not exceed the amount of wheat that would be imported by the private sector under free trade. If wheat imports (in the form of food aid) exceed the free-trade level of imports, the domestic price of wheat will fall below import parity, encouraging more wheat consumption. Unfortunately, the lower price also discourages domestic wheat production and lowers farmer incomes. How much wheat would be imported under free trade depends on the import price of wheat and the responsiveness of domestic production and demand to changes in the wheat price, as reflected in the own-price elasticities of supply and demand.

Assuming probable values of supply and demand elasticities, Table 2.8 shows estimates for the levels of wheat imports that would have resulted without food aid in 1996/97. These estimates also represent the maximum amount of food aid wheat that could be released on the domestic market during the year without depressing market prices below import parity levels. At

1996/97 world prices of $221 per ton CIF Chittagong (equal to an import parity price of taka 10.2 per kilogram), only 710,000 tons of wheat would have been imported under free trade (compared with the 933,000 tons actually imported). Thus, without food aid, wheat prices in 1996/97 would have been an estimated 12.9 percent higher and imports 223,000 tons less.[13]

Sensitivity analysis using different world prices and alternative elasticity estimates gives similar results. For calculations of price incentives, it makes sense to use an estimate of the medium-term border price to correct for temporary fluctuations in world markets. With a lower world price of $208 per ton (approximately equal to the five-year average of world prices), domestic prices would rise by only 9.1 percent to taka 9.8 per kilogram, and imports would equal 773,000 tons. According to alternate elasticities of supply and demand of 0.2 and –0.4, respectively (which models less price-responsiveness of supply and demand to changes in prices), imports would be 839,000 tons.

Thus, these rough calculations suggest that, with no commercial imports, 700,000–840,000 tons of food aid, distributed evenly over a year, could be imported without depressing domestic prices below import parity. Other factors left out of the current analysis would increase the amount of food aid wheat that could be imported without depressing market prices. Direct distribution of wheat to the poor increases demand for wheat, even apart from any reduction in market prices, by increasing their purchasing power. Earlier studies suggest that the marginal propensity to consume (MPC) wheat out of wheat payments in kind in FFW programs is larger than the MPC out of cash purchase by about 0.3. In other words, for each 1 kilogram of wheat given to FFW participants, their total wheat consumption increases by 0.3 kilograms more than the usual market-based consumption of wheat. If half of wheat food aid were distributed in a like manner, total wheat demand would increase by a further 105,000 tons (that is, 700,000 tons × ½ × 0.3).

Another important factor is domestic rice prices. In years when rice prices are high, wheat demand increases. Econometric estimates of the cross-price elasticity of demand for wheat given a change in the rice price vary, and further analysis is required.[14] Average rice prices in 1996/97, however, were somewhat below medium-term average prices. These lower prices reduce demand for wheat. In contrast, if rice prices were higher, wheat demand would increase.

Further sensitivity analysis could be done according to various scenarios for rice prices (which have cross-price effects on wheat demand and supply)

13. Why then did private traders import wheat? That answer is that they imported primarily hard wheat for biscuits and breads. They may also have misjudged the market for wheat, guessing wrongly about future prices, a complicated calculation that depends on the size and timing of food aid disbursements on the local market, the size of the wheat harvest, and movements in rice prices. Note, too, that the calculation in this chapter of projected wheat imports does not take into account fluctuations in the world price of wheat during the 1996/97 fiscal year.

14. The cross-price elasticity of demand is the percentage change in the demand for rice for a 1 percent change in the price of wheat.

TABLE 2.8 Estimated production, demand, and supply of wheat with alternative parameter values and world prices

	Base 1996/97	Current World Price	Low World Price		Medium World Price	
			Base	Inelastic	Base	Inelastic
Production (MMT)	1.454	1.566	1.486	1.464	1.534	1.480
Domestic procurement (MMT)	0.103	0.103	0.103	0.103	0.103	0.103
Offtake (MMT)	0.653	0.653	0.653	0.653	0.653	0.653
Food aid (MMT)	0.608					
Government commercial imports (MMT)	0.103					
Private imports (MMT)	0.222					
Total imports (MMT)	0.933	0	0	0	0	0
Supply (MMT)	2.081	1.959	1.887	1.868	1.930	1.882
Demand (MMT)	2.081	1.959	1.887	1.868	1.930	1.882
CIF price (dollars per metric ton)	220.500	220.500	197.000	197.000	208.000	208.000
Import parity (takas per kilogram)	10.152	10.152	9.315	9.315	9.810	9.810
Domestic price (takas per kilogram)	8.990	10.152	9.315	9.315	9.810	9.810
Percent change in price	0	12.925	3.615	3.615	9.121	9.121
Percent change in production	0	7.697	2.190	0.713	5.469	1.761
Percent change in demand	0	−5.897	−1.760	−1.410	−4.271	−3.431
Elasticity of supply	0.610	0.610	0.610	0.200	0.610	0.200
Elasticity of demand	−0.500	−0.500	−0.500	−0.400	−0.500	−0.400

SOURCE: Author's estimations as explained in the text.

NOTES: MMT indicates million metric tons. The import parity price is calculated as the CIF price in takas plus 0.45 takas per kilogram for handling and transport costs. The exchange rate is 45 takas = US$1.

and disaggregating wheat import demand by type of wheat.[15] Effects of a further devaluation of the taka, which would raise the border price of wheat but also might have major effects on the rice market, could be analyzed as well. Nonetheless, these rough calculations suggest that a moderate level of food aid, on the order of 700,000–840,000 tons of wheat, is consistent with a policy of keeping producer incentives in line with long-run import parity prices.

Timing of Food Aid Distribution and Sales

Large-scale distribution of FFW wheat occurs between January and April, after the monsoon rains and the aman rice harvest, when drier weather and soils permit road building. When the FFW programs began in the mid-1970s, there was almost no domestic production of wheat. Today, however, the major wheat harvest occurs in March and April, and distribution of FFW wheat (much of which is resold in the market) significantly depresses farmgate prices at harvest. Dorosh and Haggblade (1997) show that the price-depressing effects of FFW wheat could be minimized if the wheat food aid were monetized at other times of the year and FFW was replaced by Cash-for-Work (as CARE has done with the Integrated Food for Development [IFFD] program). Monetization of the wheat later in the year could benefit the urban poor as well, lowering prices during the months before the aman rice harvest (the September/October lean season). Alternatively, other types of work could be included in FFW programs so that direct distribution of wheat is spread out more evenly through the year.

The previous calculations show that, barring unforeseen changes in technology or a large increase in the price of wheat relative to rice, Bangladesh will likely remain a net importer of wheat in the medium run. Thus, moderate levels of food aid can substitute for commercial imports without adversely affecting producer price incentives as long as most of the imported wheat is not released on the market immediately before and after the harvest. Although theoretically other aid can be substituted for food aid on a dollar-for-dollar basis, food aid has more political support in donor countries (farm lobbies and public approval for donations of food) than does other aid. The implication is that cuts in food aid would likely mean cuts in total public resource flows to Bangladesh, to the detriment of the country's poor.

Summary

Rapid increases in foodgrain production in the 1980s, achieved through adoption of Green Revolution technology, significantly reduced Bangladeshi de-

15. In recent years the private sector has imported about 200,000 tons of hard wheat annually, mainly for use in biscuits and bread. Even with the severe assumption that hard and soft wheat cannot be substituted for one another, the total amount of soft wheat imports would be only about 200,000 tons less than the analysis here suggests.

pendence on food aid and commercial imports. The slower growth rates in the 1990s and the higher variability of output, largely due to weather, have replaced earlier optimism with pessimism about the medium-term prospects for rice production. Moreover, wheat production still accounts for only about 60 percent of domestic wheat supply in the late 1990s so that wheat self-sufficiency is unlikely to be achieved if large-scale distribution of wheat continues.

Neither rice nor total foodgrain self-sufficiency is a necessary condition for food security at the national level, however, provided that sufficient resources are available for the purchase of foodgrains in reliable international markets. Food aid and government commercial imports boosted foodgrain availability in Bangladesh in the 1970s and 1980s. Since liberalization of private trade, however, private sector imports of rice in the 1990s have several times contributed significantly to market food supplies after poor rice harvests.

As discussed later in this book, changes in production and trade policy have had profound effects on the entire foodgrain economy by influencing availability, price levels, and price variability. Future changes are certain to be major determinants of the structure of the foodgrain economy as well as the welfare of the more than 125 million people in Bangladesh.

Appendix: Determination of Rice Prices in Bangladesh

In price theory, prices are determined by the interplay of forces of supply and demand. Forces underlying demand consist of income, income distribution, the price of substitutes, taste, and the price of the commodity itself. Forces underlying supply consist of production, supply from imports and stocks, and the price of the commodity itself. Speculative activities of traders can influence price, but such speculations would affect market price through stock changes. Public procurement and distribution can also influence price: procurement from the domestic market reduces market supply from domestic production, and distribution from imported grains augments market supply. Empirical analysis of the determinants of rice price incorporating all these factors is complex and constrained by the unavailability of accurate data for some of them.

The available rice price data we have are annual average prices of rice based on the average of monthly prices (see Table A2.1). Thus, determining the annual average price involves determination of monthly prices. Such prices are the results of the interaction of demand forces with given levels of supply. Determination of the demand forces therefore constitutes the primary task of the determination of rice prices, although actual consumption or demand is not known. Conventionally, an indirect estimate of actual consumption is obtained by measuring total availability as defined in the chapter. Comparison of this per capita availability with actual per capita consumption of rice, as found through

a few household survey estimates (HSE), indicates that per capita availability was quite close to HSE (the ratio of availability to HSE consumption varying from 1.11 to 0.93 in 1973/74–1983/84). For four years beginning in 1985/86, however, this ratio fell to about 0.83. The divergence could be due to errors in production or consumption estimates. In spite of the difference, it is appropriate to see how estimates of demand functions behave using per capita availability as equivalent to per capita consumption. With this assumption, the demand function is formulated as

$$Qd = f(\text{Price}, P_{\text{other}}, Y_h, \text{Distrib}) \qquad \text{(A2.1)}$$

where

Qd = quantity demanded,
Price = price of coarse-quality rice,
P_{other} = price of other commodities in the consumption basket,
Y_h = income, and
Distrib = public distribution of rice.

Distrib is included in the demand function for its income effect arising from food subsidy and following past studies on prices (Ahmed and Bernard 1989; Shahabuddin 1992). Quantity of rice and income are taken in per capita terms. Prices and income are in real terms, using CPI as a deflator. Deflating nominal prices of rice by CPI is presumably sufficient for the exclusion of P_{other} directly in the demand function. This function is estimated following OLS methods and in a logarithmic form. Results of the regressions are presented in Appendix Table A2.2.

The results show that the own-price elasticity of demand for rice is significant in almost all cases and varies from –0.11 to –0.15, and that the coefficient of the logarithm of public rice distribution per capita is positive but not significant at an acceptable level. The income elasticity of demand is not significantly different from zero, suggesting that changes in real income have little effect on national rice consumption.

Neither including a time trend nor extending the observations to include years in the late 1970s in the regression produced any significant differences in the results (see Appendix Table A2.2).

Other empirical studies show widely varying own-price elasticities of demand and a declining trend in income (expenditure) elasticity, still with a positive sign (Dorosh 1999). In general, own-price elasticity of demand estimated from cross-section data is larger in absolute terms than the estimate from time-series data. Similarly, a cross-section estimate of expenditure (income) elasticity is generally small (0.15–0.40) but positive, while the time-series regressions yield a coefficient not significantly different from zero.

In the light of the demand parameters estimated through time-series regression, it is reasonably clear that the modest increase in per capita supply of

APPENDIX TABLE A2.1 Rice production, availability, and prices, 1977–98

Year	Midyear Population	Rice Production	Rice Procurement	PFDS Distribution	Rice Availability	Availability per Capita	CPI Deflated (national aveage) Rice Price	
							June–July Coarse	Dec.–Nov. Coarse
	(million)	(thousand metric tons)	(thousand metric tons)	(thousand metric tons)	(thousand metric tons)	(kilograms per person)	(1997 taka per kilogram)	(1997 taka per kilogram)
1976/77	81.8	11,753	317	750	11,011	134.6	18.0	16.9
1977/78	83.7	12,969	548	600	11,724	140.1	20.6	16.4
1978/79	85.6	12,849	306	570	11,828	138.2	16.8	16.4
1979/80	87.7	12,740	228	695	11,934	136.1	24.6	19.1
1980/81	89.9	13,880	841	514	12,165	135.3	16.0	14.5
1981/82	91.9	13,629	290	772	12,748	138.7	14.5	16.0
1982/83	93.9	14,215	168	496	13,121	139.7	16.7	16.0
1983/84	96.0	14,509	145	503	13,416	139.7	16.1	16.4
1984/85	98.1	14,623	133	399	13,426	136.9	18.2	17.8

1985/86	100.3	15,038	219	372	13,687	136.5	14.5	13.9
1986/87	102.5	15,406	137	495	14,223	138.8	15.3	14.2
1987/88	104.7	15,413	288	468	14,052	134.2	15.4	14.5
1988/89	106.8	15,544	364	690	14,316	134.0	14.2	14.4
1989/90	108.9	17,856	918	675	15,827	145.3	13.0	13.5
1990/91	111.0	17,852	727	971	16,311	146.9	12.8	12.3
1991/92	113.0	18,252	939	759	16,246	143.8	13.3	12.7
1992/93	115.0	18,341	233	476	16,750	145.7	12.9	9.8
1993/94	117.0	18,041	148	350	16,438	140.5	9.1	10.3
1994/95	119.0	16,833	246	329	15,233	128.0	12.4	13.2
1995/96	121.0	17,687	353	593	16,158	133.5	13.7	12.5
1996/97	123.0	18,753	513	739	17,104	139.1	11.4	9.4
1997/98	125.0	18,424	430	555	16,707	133.7	9.5	11.0

SOURCES: BBS (various), FPMU, and author's calculations.

APPENDIX TABLE A2.2 Time-series estimates of rice demand parameters in Bangladesh
Dependent Variable: Natural Logarithm of Rice Availability per Capita

Sample	Constant	In Price	Dist Dum	In Income	Time	Durbin-Watson Statistic	R^2	Adjusted R^2
1. 1980 98	5.051*	−0.127*	0.037	0.023		1.699	0.348	0.217
19 observations	(4.464)	(−2.121)	(1.508)	(0.186)				
2. 1980–98	5.117	−0.127*	0.037	0.014	0.0002	1.697	0.348	0.161
19 observations	(1.682)	(−2.010)	(0.028)	(0.039)	(0.024)			
3. 1980–98	7.349*	−0.110		−0.258	0.0038	1.476	0.265	0.118
19 observations	(2.189)	(−1.742)		(−0.819)	(0.572)			
4. 1977–98	5.820*	−0.109*		−0.071		1.457	0.249	0.169
22 observations	(6.705)	(−1.891)		(−0.817)				
5. 1977–98	5.140*	−0.127*	0.036	0.012		1.721	0.348	0.240
22 observations	(5.551)	(−2.257)	(1.661)	(0.124)				
6. 1977–98	5.311*	−0.153*	0.041	−0.000		1.637	0.361	0.201
16 observations	(3.966)	(−2.257)	(1.440)	(−0.002)				

SOURCE: Author's calculations.

NOTE: Values of t-statistics appear in parentheses.

*Significance at 95 percent confidence level.

rice during the past 15 to 18 years has caused a significant decline in the real price of rice because of a price-inelastic demand curve and a zero or negative income effect on demand for rice. Nevertheless, in light of only a modest increase in per capita supply and a sharp fall in real prices of rice, some economists have speculated that income distribution was worsening, adversely affecting demand for rice. This is an area in need of further research.

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