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**IMPLICATIONS OF QUALITY DETERIORATION FOR  
PUBLIC FOODGRAIN STOCK MANAGEMENT AND  
CONSUMERS IN BANGLADESH**

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## ABSTRACT

In the late 1990s, government policy in Bangladesh shifted in favor of increased public foodgrain stocks, setting official minimum stock targets of 1.0 to 1.2 million tons, as compared to operational targets of about 700 to 800 thousand metric tons in the early 1990s. Because no mechanism for stock rotation involving simultaneous buying and selling grain at a wholesale level exists, higher stock levels with no increase in distribution led to an increase in average age of stocks and problems of stock quality deterioration. This paper extends earlier analyses of stock policy by focusing on a key aspect of stock management in Bangladesh: the economic costs of stock quality deterioration in storage, including the implicit costs to recipients of Public Food Distribution System (PFDS) foodgrain.

Using market prices to value procurement and distribution of rice and wheat, consumer and producer subsidies accounted for 57.4 and 20.9 percent, respectively, of net outlay in 2000/01. Implicit losses to rice consumers due to quality deterioration were significant in 2000/01: about 1.05 billion Taka (about 19 million dollars), equal to 10.9 percent of total net outlay on rice of the PFDS. Analysis of the costs and benefits of alternative stock targets based on calculations of the minimum age of stock on a monthly basis indicates that moderate increases in the size of stock (e.g. 200 thousand tons), lead to only small net marginal outlays. However, unless procurement and distribution are also raised, the age and quality of the stock for distribution deteriorates, resulting in significant losses to program recipients.

# **IMPLICATIONS OF QUALITY DETERIORATION FOR PUBLIC FOODGRAIN STOCK MANAGEMENT AND CONSUMERS IN BANGLADESH**

Paul Dorosh<sup>1</sup> and Naser Farid<sup>2</sup>

## **1. INTRODUCTION**

Since the late 1990s, there has been a gradual shift in Government of Bangladesh policy in favor of increased public foodgrain stocks. In the mid-1990s, the operational stock target of the Public Foodgrain Distribution System (PFDS) was effectively in the range of 700 to 800 thousand metric tons. However, sharp declines in food stocks in early 1998 following an unexpectedly poor aman harvest in November/December 1997 and shortages of wheat stocks after the floods in July through September 1998 have led many to conclude that higher levels of stocks were needed. The official government stock target was raised to 1.0 million metric tons in mid-1998, and the mid-term evaluation of the five-year plan in 2000 included a statement that the target level would be 1.2 million metric tons.

The determination of appropriate stocks levels involves several aspects. Working stocks are needed for smooth operation of the PFDS, which distributed 1.9 million metric tons of foodgrain in FY 1999/2000 and 1.77 million metric tons of foodgrain in 2000/01. Emergency foodgrain reserves, not necessarily in addition to working stocks, are also needed to alleviate the effects of possible relief and market stabilization needs in the event of major disasters (floods, cyclones) and crop shortages. Holding stocks involves

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real financial costs, however, including those involved in storage losses, and construction and maintenance of storage facilities, as well as the costs involved in rotating stocks through the PFDS. The costs of stock deterioration, borne by recipients of PFDS foodgrain, are generally not included in financial analyses of the costs of holding stock, though.

Several empirical modeling exercises have focused on analysis of stocks and their implications for price stabilization (Goletti, Ahmed and Chowdhury, 1991; Brennan, 1995; Goletti and Rich 1998). These analyses have highlighted several major lessons, including the importance of clarifying objectives (price stabilization, working stocks for the PFDS), and that lowest costs can be achieved through using rice for rice price stabilization and wheat for foodgrain distribution to the poor. These analyses have also emphasized that “optimal stock” should not be thought of as a single number, but as a path of stock levels over time that depend on policy regime and policy objectives. In particular, significant savings can be achieved through reliance on international trade (importing in times of shortage and exporting in times of surplus) to supplement moderate levels of stocks.<sup>3</sup>

This paper extends the earlier analyses by focusing on a key aspect of stock management in Bangladesh: the economic costs of stock quality deterioration in storage, including the implicit costs to recipients of PFDS foodgrain. These issues are important in Bangladesh because no mechanism for stock rotation involving simultaneous buying and selling grain at a wholesale level exists; rather foodgrain distribution occurs almost

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<sup>3</sup> Private sector imports of rice following the 1998 floods helped stabilize rice prices at no cost to the public exchequer, keeping domestic prices from rising above import parity levels (Dorosh, 2000). See also Dorosh, Shahabuddin and Farid (forthcoming) for a more extended review of stock modeling exercises in Bangladesh, and Timmer (1989) for a review of the rationale for government intervention in food markets.

exclusively through direct distribution in targeted programs or limited sales at a retail level. Thus, excess procurement following bumper harvests or excessive government imports following crop shortfalls can lead to large accumulations of aging stock.<sup>4</sup>

Section 2 of this paper presents a brief review of government policy and actual levels of stocks consumers. In Section 3, we outline an accounting framework that includes the value of grain to recipients of PFDS foodgrain, and give estimates of the costs and benefits of the PFDS in recent years. Section 4 analyzes alternative options for stocks and the cost of the PFDS in terms of costs and benefits to consumers and producers. The last section contains policy implications and conclusions.

## **2. PFDS STOCK POLICY AND HISTORICAL STOCK LEVELS**

PFDS stock policy and stock levels have changed over time along with the overall size of the PFDS and the major distribution channels (Figures 2.1, 2.2). In the late 1980s and early 1990s, PFDS total annual distribution ranged from 2.16 to 2.97 million tons, with much of the foodgrain distributed through ration channels, involving subsidized sales of foodgrain to ration cardholders. PFDS gross stock levels in 1989/90 and 1990/91 averaged 1.13 million tons,<sup>5</sup> equal to 6.02 times monthly average distribution in these years (Table 2.1).

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<sup>4</sup> India has experienced similar problems. In the absence of a market mechanism to rotate stocks, public distribution has failed to keep pace with rising procurement, resulting in a large increase in the volume and average age of stocks.

<sup>5</sup> Unless otherwise noted, all foodgrain stocks figures in this report indicate net stocks, i.e. gross stocks less a deduction for foodgrain in transit. In 2000/2001, 15 thousand tons of rice and 88 thousand tons of wheat were considered to be “in transit”.

Major reforms in the PFDS took place in the early 1990s with the elimination of major rationing channels (Statutory Rationing and Rural Rationing) and greater emphasis on targeted distribution. Total distribution was reduced to an average of only 1.53 million tons from 1993/94 through 1996/97. Stock levels were reduced as well, with average annual stocks ranging from 577 to 950 thousand tons over this period.

Total public foodgrain stocks since the 1998 floods, however, have increased substantially to an annual average of 1.35 million tons in FY 1999/2000 and 1.05 million tons in 2000/01. This very large PFDS stock build-up occurred mainly because of delayed import arrivals and relatively high levels of domestic procurement in response to falling market prices immediately after the harvest of consecutive bumper crops in boro (1999), aman (1999/2000), boro (2000), aman (2000/01) and latest boro (2001). About 604 thousand metric tons of rice was procured from the bumper boro harvest in 1999, and this, along with delayed arrivals of food aid for flood rehabilitation led to a sharp increase in stocks. Stocks peaked at 1.63 million metric tons in December 1999 (654 thousand metric tons of rice and 976 thousand metric tons of wheat).<sup>6</sup>

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<sup>6</sup> Subsequently, careful management of the PFDS, including cancellation of commercial wheat imports, reductions of wheat distribution and increases in rice distribution reduced the stock level and essentially cleared all the old stock by April 2001.

**Table 2.1—Annual PFDS Distribution and Gross Foodgrain Stock**

Year	Average monthly stock (000 tons)			Avg monthly off-take (000 tons)			Monthly average stock to Monthly average off-take		
	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total
1989/90	660	541	1201	56	124	180	11.73	4.36	6.66
1990/91	549	513	1062	81	117	198	6.78	4.40	5.38
1991/92	491	324	815	63	132	195	7.76	2.45	4.17
1992/93	594	592	1186	40	50	89	15.01	11.88	13.27
1993/94	258	475	733	29	86	115	8.85	5.55	6.39
1994/95	177	400	577	27	104	131	6.46	3.86	4.40
1995/96	401	488	889	49	100	150	8.13	4.88	5.95
1996/97	551	398	949	62	54	116	8.95	7.31	8.18
1997/98	297	455	752	44	91	135	6.74	5.00	5.57
1998/99	424	562	986	44	134	178	9.60	4.20	5.54
1999/00	666	682	1348	73	85	158	9.12	7.99	8.51
2000/01	643	406	1049	82	65	147	7.84	6.26	7.14

Source: MIS, Director General of Food and authors' calculations.

**Table 2.2—Periods of Low and High Stocks in the 1990s**

Periods	Average monthly stock (000 tons)			Avg. monthly distribution (000 tons)			Stock to distribution (000 tons)			
	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total	
<b>Low stock periods</b>										
1994/95	(Sep-Apr)	130	370	500	33	113	145	3.98	3.29	3.44
1997/98	(Dec-Apr)	205	313	518	58	135	193	3.55	2.31	2.68
1998/99	(Aug-Oct)	400	162	562	55	46	101	7.23	3.54	5.56
<b>High stock periods</b>										
1996/97	(Jul-Jun)	554	309	863	53	84	136	10.54	3.70	6.34
1999/00	(Jul-Jun)	662	602	1263	73	85	158	9.07	7.05	7.98
2000/01	(Jul-Apr)	682	310	993	68	127	194	10.05	2.45	5.11

Source: FPMU data and authors' calculations.

#### PERIODS OF EXCESSIVELY LOW STOCKS

During the 1990s, there were three episodes when stock levels were precariously low, at approximately 205 thousand tons or less of rice or wheat (Table 2.2). The first episode occurred from September 1994 through April 1995, when aman procurement failed because drought severely damaged the 1994/95 aman crop, and government commercial imports were delayed by up to 15 months because of failure of suppliers to deliver according to contract schedules.

A second period of low stocks, from December 1997 through April 1998, followed an unexpectedly poor aman harvest in November/ December 1997. In that year, a short drought during the critical flowering stage of the rice plants resulted in

widespread prevalence of empty husks (*chita*), and about 7.35 percent reduction in the aman harvest. Prices rapidly rose above the fixed procurement price, so that regular procurement failed. Difficulties with contracts for government commercial imports limited international procurement as well, and rice stocks fell to only 137 thousand tons in March 1998.<sup>7</sup>

Stocks were also uncomfortably low from August through October 1998, when widespread floods destroyed aman rice seedlings, ultimately reducing the November/December 1998 harvest. In response to the appeals for aid in late August 1998, donors pledged 1.083 million tons of foodgrain for flood relief, but major food aid arrivals were not expected until November.

Thus, with only 231 thousand tons of wheat stocks, expansion of distribution through the Vulnerable Group Feeding (VGF) was limited to 64 thousand tons per month (half rice and half wheat) instead of the 141 thousand tons of wheat per month proposed by the World Food Programme (WFP).<sup>8</sup>

## PERIODS OF EXCESSIVELY HIGH STOCKS

Though the situation often appears less urgent than for low stock periods, high stock periods can be problematic as well, because of quality deterioration of foodgrain in storage. Although it is technically possible to store rice and wheat for periods exceeding one year, significant deterioration in rice quality (especially discoloration) often occurs in rice stored for more than six months in PFDS godowns. Wheat storage problems are less

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<sup>7</sup> Shortly thereafter, in April 1998, the Prime Minister announced an official stock target of 1.0 million metric tons.

<sup>8</sup> Subsequent food aid arrivals enabled a large expansion in Food For Work in early 1999, however. See Dorosh (1999).

severe, particularly in government silos, though in recent years there have been serious quality problems with imported wheat stored more than six months, as well.

There have been three periods of excessively high stocks since the mid-1990s (Table 2.2). The first period, from July 1996 through June 1997, average rice stocks were 554 thousand tons, while average monthly rice distribution was only 53 thousand tons. Thus, rice stocks were on average equal to 10.54 months of rice distribution. This situation occurred because of the delayed delivery of 491 thousand tons of rice tendered by the government in 1994/95 that did not arrive until 1995/96.

The other two periods of high stocks followed the 1998 floods. Average monthly rice stocks exceeded 600 thousand tons in both 1999/2000 and the first eight months of 2000/2001, equal to 9.07 and 10.05 months of distribution, respectively. Wheat stocks were also high in 1999/2000, on average equal to 7.0 months of distribution, and some imported wheat (apparently already old when it arrived in Bangladesh) severely deteriorated in quality. Fiscal year closing PFDS gross stock for 1999/2000 (30<sup>th</sup> June, 2000) was 1.091 million tons. While currently, the end-June 2001 gross PFDS stocks stood at 865 thousand metric tons (420 thousand metric tons of rice and 445 thousand metric tons of wheat).

These problems of stock deterioration during periods of high stocks can be overcome through increases in public distribution. As is shown in sections 3 and 4, public distribution of foodgrains typically involves large subsidies. An alternative approach, open market sales at a wholesale level through public auction (and possibly simultaneous domestic procurement through competitive tender) would enable the Government of Bangladesh to rotate stocks at significantly less fiscal costs.

## SEASONAL NET PFDS STOCK TARGETS

The experiences of the 1998 flood and other periods of production shortfalls suggest the importance of minimum stock targets. Because of seasonal fluctuations in distribution and in domestic procurement, however, requirements for both emergency and working stocks fluctuate throughout the year. There are four key points during the year at which minimum end-stock levels are important: July, November, January and March (Table 2.3).

**Table 2.3—Seasonal Net PFDS Stock Targets**

			(000 metric tons)
	<b>Rice</b>	<b>Wheat</b>	<b>Total</b>
<b>July</b>	400	300	830
<b>November</b>	300	300	800
<b>January</b>	400	350	850
<b>March</b>	300	350	700

Source: Authors' calculations.

Note: \* Stock targets assume annual PFDS distribution of approximately 850 thousand tons rice and 950 thousand tons wheat, with distribution channels similar to actual distribution in 2000/01.

Sufficient stocks for possibly emergency distribution in the event of a major flood are needed at the end of July. At least 830 thousand tons of foodgrain are needed to allow for up to 600 thousand tons of emergency relief distribution from August through November. Given that large amounts of boro rice are generally procured to support producer prices from May through July, at least 400 thousand tons of the total 830 thousand tons should be rice. A minimum of 300 thousand tons of wheat is proposed for



emergency needs and normal program distribution. Generally, emergency food aid, if needed, can be expected to supplement government stocks by December.

End-November stock targets are also important because of the possible failure of aman procurement, as in November/December 1997 when there was a serious aman shortfall caused by a short hidden drought that resulted in widespread prevalence of unfilled grains (chita). Even lesser shortfalls have caused aman procurement to fail as domestic prices rose above procurement price levels (Dorosh and Shahabuddin, 1999; Dorosh, Shahabuddin and Farid, forthcoming).

Given possible needs for rice market stabilization in the event of poor aman harvest, the suggested end-January stock target is 400 thousand tons. In the event of a failed domestic aman fixed-price procurement, the GOB could procure rice domestically through open tenders, initiate GOB imports of rice through commercial channels, and encourage private sector imports (Dorosh, 2001; Dorosh, Shahabuddin and Farid, forthcoming).

Government procurement through fixed-price domestic procurement, commercial imports, food aid and domestic tenders should be sufficient to achieve a minimum level of at least 700 thousand tons of stock at the end of March, (at least 300 thousand tons of rice and 350 thousand tons of wheat). Stock targets are lowest for end-March since boro and wheat harvests and procurement (which are far less uncertain than aman harvests and procurement) begin in April.

As shown in Figures 2.1, 2.2 and 2.3, these suggested seasonal stock targets have generally been maintained throughout the 1989 through 2001 period, except for the crisis periods discussed above.

Figure 2.1—Net Closing Stocks of Rice in Bangladesh, 1990-2001

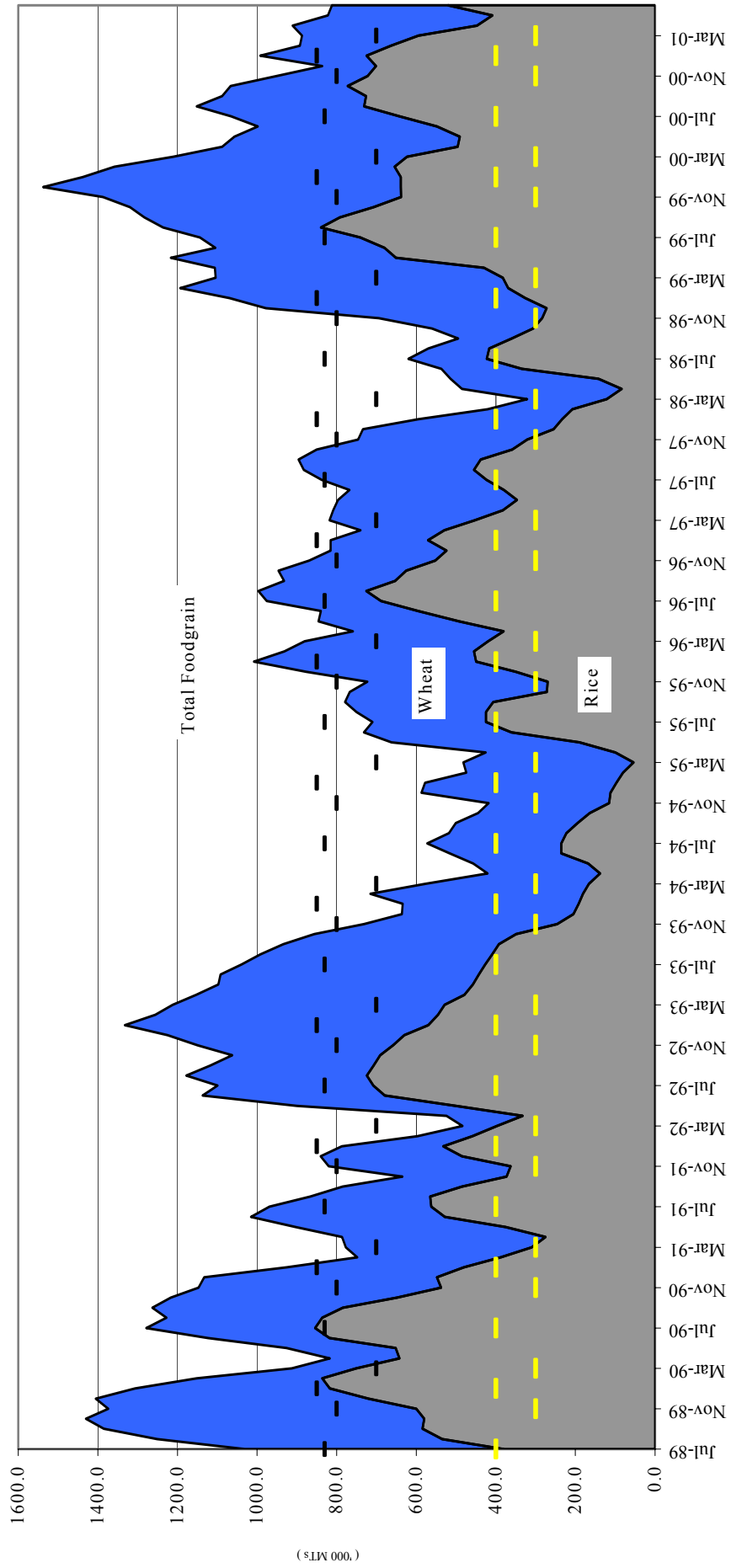
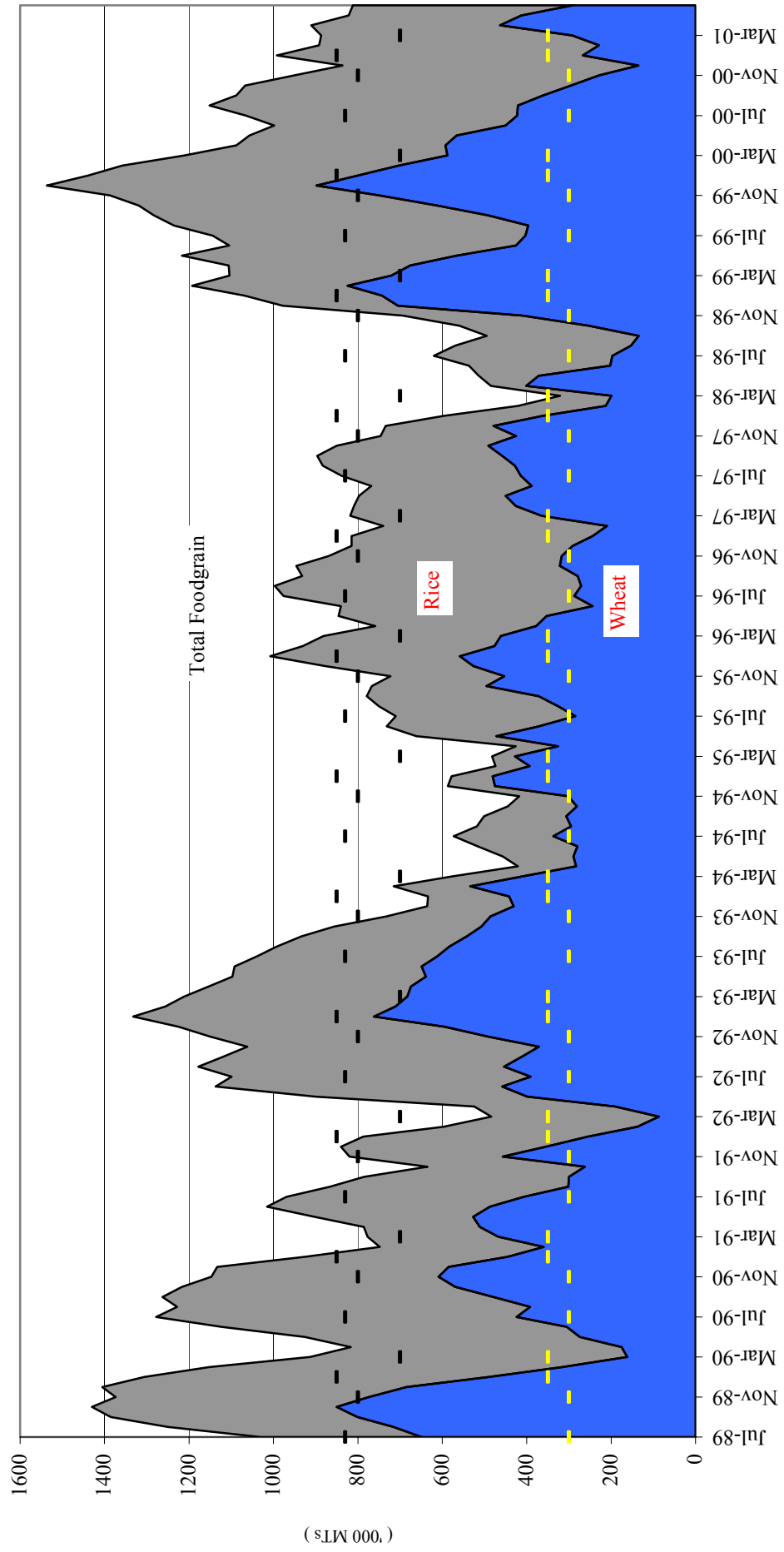
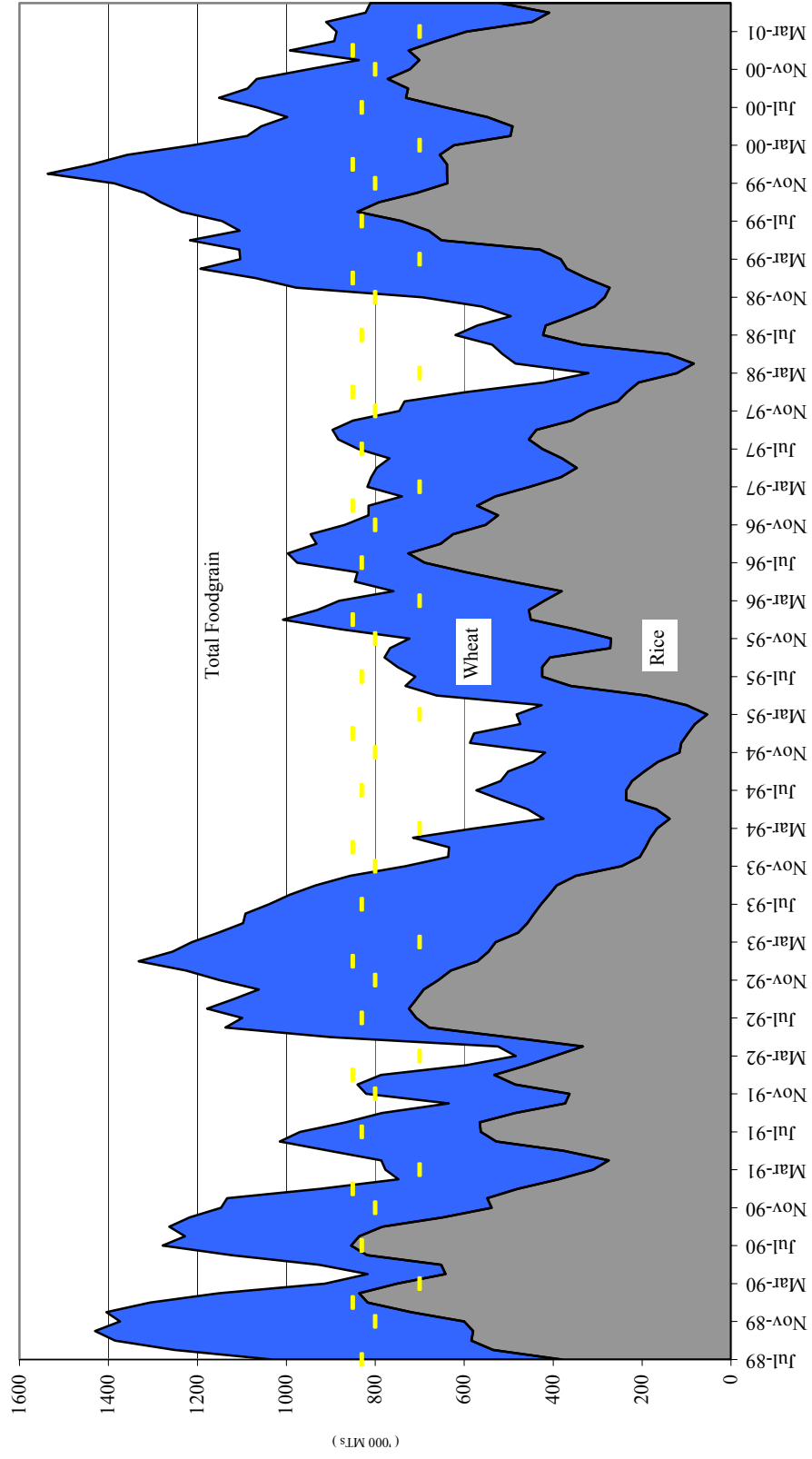


Figure 2.2—Net Closing Stocks of Wheat in Bangladesh, 1990-2001



**Figure 2.3—Net Closing Stocks of Total Foodgrain in Bangladesh, 1990-2001**



### **3. FINANCIAL AND ECONOMIC COSTS AND BENEFITS OF PFDS OPERATION**

Government of Bangladesh financial accounts for the PFDS record the receipts and outlays of the Ministry of Food. These accounts, however, record only financial flows at “book values” of the commodities and do not include adjustments for changes in prices due to changes in market conditions or due to changes in stock quality. To assess the costs and the size and distribution of the benefits of the PFDS requires an accounting system that values grain at market prices.

#### **GOB FINANCIAL ACCOUNTS FOR THE PFDS**

The GOB financial accounts for the PFDS show outlays and receipts from the standpoint of the Ministry of Food (Table 3.1). Outlays include domestic and international commercial procurement, as well as operational costs. Food aid is also shown as an expenditure of the Ministry of Food in the government accounts, being purchased from the “foreign aid” account. Receipts include transfer payments for foodgrain received from other GOB ministries (such as the Ministry of Disaster Management and Relief and the Ministry of Education).

The value of foodgrain “purchased” by other ministries for their programs involving food distribution is calculated using the “economic price” of the foodgrain. This price represents the full financial cost of the foodgrain supplied, calculated using the average procurement price during the year, plus handling and administrative costs. This book value, “economic price” does not necessarily have any relation to the market price of foodgrain at the time of the distribution, however.

Since the expenditures of other Ministries for foodgrain are considered as part of development or relief expenditures and are valued using the economic price, there is technically no subsidy involved. Thus, the official GOB food subsidy is calculated only for distribution through sales channels, such as Open Market Sales, and Essential Priorities (sales to the military and other groups), and is equal to difference between the sales price and the economic price multiplied by the quantity of grain sold in each channel. For 2000/01, the estimated food subsidy (for rice and wheat distribution only) was 2.58 billion Taka.<sup>9</sup> Intra-governmental transfers, (the book costs of all non-sales channel distribution apart from Food For Work), were equal to 12.44 billion Taka, 4.8 times as large as the official food subsidy on rice and wheat.<sup>10</sup>

#### COSTS AND BENEFITS OF THE PFDS AT MARKET PRICES

Estimating the actual value of the PFDS to producers and consumers requires an accounting system based on market prices, not on financial prices of the GOB. Market prices change throughout the year, however, affecting the value of procurement and distribution, as well as the value of stocks. Valuing stocks, procurement and distribution and market prices each month permits an analysis of the direct costs and benefits (apart from the effects on price stabilization) of the PFDS (Table 3.2).<sup>11</sup>

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<sup>9</sup> Subsidies on the sales of vegetable oil are not considered in this report.

<sup>10</sup> Food for Work expenditures are not counted here as part of the food subsidy because they represent wage payments to program participants.

<sup>11</sup> See Appendix 1 for a mathematical presentation of the accounting framework.

**Table 3.1—PFDS Financial Costs, Actual 2000/01 (billion taka)**

	<b>Rice</b>	<b>Wheat</b>	<b>Total</b>
<b>OUTLAY</b>			
Domestic Procurement	10.58	2.36	12.94
Food Aid	0.46	4.41	4.86
Commercial Imports	0.00	0.00	0.00
Marketing and Establishment Costs	1.71	1.51	3.22
<b>Total Outlay</b>	<b>12.75</b>	<b>8.28</b>	<b>21.03</b>
<b>RECEIPTS</b>			
Ration Channels	0.38	0.57	0.96
Food For Work	4.69	3.04	7.73
Change in Value of Stock	-1.92	-0.76	-2.68
<b>Total Net Outlay</b>	<b>9.59</b>	<b>5.43</b>	<b>15.02</b>
Subsidy on Sales Channels	1.53	1.05	2.58
Intra-GOB Transfers (Non-Sales, Non-FFW)	8.06	4.38	12.44

Source: FPMU data and authors' calculations.

**Table 3.2—PFDS Subsidies on Rice, Actual 2000/01, (FY 2000/2001 Prices)**

	Ministry of Food Accounts			Valuation at Market Prices			Subsidy
	Quantity (000 tons)	Price (Tk/kg)	Value (bn Tk)	Quantity (000 tons)	Price (Tk/kg)	Value (bn Tk)	Transfer (bn Tk)
<b>Sources of Foodgrain</b>							
Opening Stock (at previous year's end price)	563	14.75	8.31	563	12.21	6.88	1.43
Opening Stock (at current year's end price)	563	14.91	8.40	563	11.38	6.41	1.99
Change in Value of Opening Stock			0.09			-0.47	0.56
Domestic Rice Procurement	823	12.86	10.58	823	9.71	7.99	2.59
plus Marketing, Management cost	823	1.32	1.09	823	1.46	1.20	-0.11
Food Aid Rice Imports	32	14.30	0.46	32	14.30	0.46	0.00
plus Marketing, Management Cost	32	2.47	0.08	32	2.47	0.08	0.00
Govt Commercial Rice Imports	0	14.30	0.00	0	14.30	0.00	0.00
plus Marketing, Management Cost	0	2.47	0.00	0	2.47	0.00	0.00
Fixed Costs / Unit of Procurement	855	0.63	0.54				0.54
Total Cost of Procurement	855	14.91	12.75	855	11.38	9.73	3.02
<b>Uses of Foodgrain</b>							
Rice Distribution <sup>a</sup>	984	5.16	5.08	984	10.34	10.17	-5.09
Sales Channels	129	2.98	0.38	129	10.34	1.33	-0.95
Non-Sales, Non-FFW	540	14.91	8.06	540	10.34	5.59	-5.59
Food For Work (FFW)	315	14.91	4.69	315	10.34	3.25	1.44
Official Storage Losses <sup>b</sup>	15	14.91	0.22	15	9.88	0.15	0.07
End Stock (at current year's end price)	420	14.91	6.26	420	11.38	4.78	1.48
Consumer Subsidy on Rice							9.59
Official PFDS Consumer Subsidy (sales channels only) <sup>c</sup>			1.53				

<sup>a</sup> Market value is calculated using a (15 percent) quality-discounted price of Tk/kg 9.93 for distribution of rice stocks more than seven months old, (706 thousand tons), and a market price of Tk/kg 11.38 for rice less than seven months old (278 thousand tons).

<sup>b</sup> Market value of stock loss assumes a (15 percent) quality-discounted price of Tk/kg 9.93 for rice stocks more than seven months old, (13 thousand tons), and a market price of Tk/kg 11.38 for rice stocks less than seven months old (2 thousand tons).

<sup>c</sup> Calculated as the difference between the value of distribution at the full financial cost price (14.91 Tk/kg) and actual sales receipts.

Source: FPMU data and authors' calculations.



For example, in 2000/01, 823 thousand tons of rice were procured domestically at a total cost of 12.19 billion Taka<sup>12</sup>. The average cost of domestically procured rice is thus 14.81 Tk per kg (Tk.12.86/kg fixed procurement price plus Tk1.95/kg for marketing, management etc.). Given an average market value of rice of 11.17 Tk/kg (Tk 9.71/kg producers' price plus Tk 1.46/kg for marketing, management etc.) during the procurement months, the market value of the procured quantity was 9.19 billion Taka. Thus, the subsidy on domestic rice procurement was 3.0 billion Taka, (about 55 million dollars).<sup>13</sup> Government commercial imports are procured through international tenders at market prices. Thus, there is no subsidy involved in the procurement of government commercial imports (though distribution of this grain may involve a subsidy). The market value of imported food aid is calculated as unit cost of government commercial imports times the quantity of food aid. Note that food aid has a negotiated book price higher than the market price of commercial imports.

The value of foodgrain to consumers is calculated using the market price in the month in which the foodgrain is distributed. Moreover, rice in excess of 7 months old and wheat in excess of 8 months old is assumed to have a market value equal to only 85 percent of the market price of new foodgrain.<sup>14</sup>

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<sup>12</sup> These non-sales channels include Food For Education (shown as a sale of grain from the Ministry of Food to the Ministry of Education) and relief channels (generally shown as a sale of grain from the Ministry of Food to the Ministry of Rehabilitation and Relief).

<sup>13</sup> This subsidy on domestic procurement does not necessarily accrue to farmers. For example, in a representative sample survey on rice procurement following the 1997/98 boro harvest, almost 90 percent of the rice was procured from traders, instead of directly from farmers (Shahabuddin and Islam, 1999). Dorosh, Shahabuddin and Farid (forthcoming) argue that procurement from traders nonetheless has the same (small) impact on market prices as does an equivalent procurement from farmers.

<sup>14</sup> Assuming that foodgrain stocks are rotated on a first-in first-out basis, the amount of stock at the end of period  $t$  that is age  $x$  months or greater, can be calculated as the end stock level at time  $t-x$  and subtracting total distribution from period  $t-x+1$  through period  $t$ . This figure represents the minimum amount of stock of age 8 months. If stock is not rotated on a first-in first-out basis, then the amount of old stock could be larger. The 15 percent loss in value of the grain is based on the authors' estimates of the market value loss due to discoloration and other quality deterioration.

Using this framework, the total net outlay of the PFDS can be decomposed to show benefits and losses (Table 3.3).<sup>15</sup> The consumer subsidy, calculated as the difference between the market price of food and the sales price to consumers multiplied by the quantity distributed, is the largest component of the PFDS, accounting for 57.4 percent of net outlay in 2000/01. The producer subsidy (3.14 billion Taka, of which 2.59 billion Taka was for domestic rice producers), accounts for 20.9 percent of total net outlays. Changes in the value of stock due to price effects and quality adjustments represent 11.7 percent of net outlays. The remaining 10.0 percent of net outlays is due to excess valuation of food aid and higher marketing costs of the PFDS in comparison with the private sector.

Implicit losses to rice consumers of quality deterioration were significant in 2000/01: about 1.05 billion Taka (about 19 million dollars), equal to 10.9 percent of total net outlay on rice of the PFDS. Avoiding quality losses requires either increased shelf life or quicker stock rotation (through distribution or some form of open market sales).

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<sup>15</sup> This paper makes no attempt to estimate who actually receives the producer and consumer subsidies. Work by Ahmed (1992) indicates that in the early 1990s, there were substantial leakage in foodgrain distribution.

**Table 3.3—Decomposition of PFDS Net Outlay, Actual 2000/01 (billion Taka)**

	Rice		Wheat		Total	
<b>Total Net Outlay</b>	9.59		5.43		15.02	
Producer subsidy (at market prices)	2.59	27.0%	0.55	10.2%	3.14	20.9%
Excess book value of food aid*	0.00	0.0%	0.71	13.2%	0.71	4.8%
Excess marketing costs	0.43	4.5%	0.35	6.4%	0.78	5.2%
Consumer subsidy (at market prices)	5.09	53.1%	3.52	64.9%	8.62	57.4%
Sales Channels	0.95	9.9%	0.70	13.0%	1.65	11.0%
Non-Sales, Non-FFW	5.59	58.3%	3.46	63.7%	9.05	60.2%
FFW**	-1.44	-15.0%	-0.64	-11.8%	-2.08	-13.8%
Change in stock quality and value***	1.48	15.4%	0.29	5.3%	1.77	11.8%
<b>Total</b>	9.59	100.0%	5.43	100.0%	15.02	100.0%

Notes: \* Difference between book value of food aid and estimated market value of commercial imports.  
 \*\* Negative values for FFW indicate that the market price is below the intra-GOB transfer price.  
 \*\*\* Change in value of stock due to price and quality effects.

Source: FPMU data and authors' calculations.

#### 4. ANALYSIS OF ALTERNATIVE PFDS STOCK OPTIONS

The framework outlined in the previous section can facilitate an analysis of the benefits and costs of alternative stock policies. Because quality of foodgrain is an important aspect of policy and the GOB currently has no mechanism to rotate stocks apart from PFDS distribution, the level of stocks is closely related to the size of the PFDS. Thus, in this section, we analyze various combinations of stock and distribution levels, estimating financial costs to the government and overall benefits to producers and consumers, (ignoring the possible effects on market price stabilization).

The base scenario is designed to approximate the size of the PFDS in 2000/01, with starting and ending net stocks of rice and wheat (available at the points of distribution) each equal to 400 thousand tons, and with total distribution of 1.8 million tons, (850 thousand tons of rice and 950 thousand tons of wheat). Month-by-month procurement and distribution in the base scenario (Table 4.1) reflect typical timing and levels of actual procurement and distribution occurred in FY 2000/2001 (Table 4.2).<sup>16</sup> Table 4.1 shows, with near-ideal stock management, only 58 thousand tons of rice more than 7 months old is distributed in the base scenario. No wheat more than 8 months old is distributed.

If stock is increased to 1.0 million tons, but distribution is unchanged under Option 1 (Appendix 3), the amount of old stock distributed increases to 336 thousand tons of rice and 170 thousand tons of wheat, though net outlay is essentially unaffected (Table 4.3). Thus, quality loss as a percentage of net outlay rises from 0.9 percent in the base to 6.5 percent in Option 1 (Table 4.4).

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<sup>16</sup> The actual month-by-month procurement and distribution for 1999/2000 is given in Appendix 2.

In order to avoid the problems of accumulation of old stock, distribution could be increased along with the target stock levels under Option 2. In this scenario, however, there is a large increase in net outlay of 1.63 billion Taka, as increased distribution is assumed to take place through non-sales channels. The marginal benefit to consumers (and producers) is rather small, however, (only 0.52 billion Taka) and the marginal benefit/cost ratio is only 0.32 (Table 4.4).

Reducing stock to 0.7 million tons and keeping distribution at 1.8 million tons (the level of distribution in the base scenario) under Option 3, has very little effect on marginal outlay, but results in a minimum rice and total net stock level of only 202 thousand tons and 625 thousand tons respectively, at its lowest point during the year.

Finally, under Option 4, distribution of rice is increased by 50 thousand tons relative to the base, and wheat stocks are increased by 50 thousand tons while rice stocks are reduced by 50 thousand tons. As a result of these changes, quality loss in the system is greatly reduced because no rice stock reaches 7 months of age. The marginal net outlay of 0.62 billion Taka produces 0.82 billion Taka of benefits and the marginal benefit/cost ratio is 1.33 (Table 4.4).

Thus, costs and benefits of alternative stock targets are closely related to storage losses and the levels of distribution required to rotate stocks. Increasing the size of stock by moderate amounts, (e.g. 200 thousand tons in Option 1), leads to only small net marginal outlays, but unless procurement and distribution are also raised, the quality of the stock for distribution deteriorates.

**Table 4.1—PFDS Stocks and Flows, 2000/2001 (base scenario)**

(000 metric tons)

Month	Net Opening Stock		ADDITION										OFF-TAKE					Net Closing Stock							
	Rice	Wheat	Domestic Procurement		Food Aid		Imports		TOTAL ADDITION		Rice Distribution		Wheat Distribution		TOTAL OFF-TAKE	Rice	Wheat								
			Rice	Wheat	Total	Rice	Wheat	Commercial	Total	Rice	Wheat	Commercial	Total	Priced/ Ration				Non-Priced/ Ration	Total	Priced/ Ration	Non-Priced/ Ration	Total			
Jul	400.0	400.0	800.0	105.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	130.0	11.0	38.0	49.0	12.0	36.0	48.0	97.0	455.0	376.0	831.0	
Aug	455.0	376.0	831.0	50.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	100.0	11.0	38.0	49.0	12.0	36.5	48.5	97.5	455.0	376.5	831.5	
Sep	455.0	376.5	831.5	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	11.0	39.0	50.0	13.0	36.0	49.0	99.0	404.0	376.5	780.5	
Oct	404.0	376.5	780.5	0.0	0.0	75.0	0.0	50.0	0.0	125.0	125.0	125.0	125.0	125.0	11.0	41.0	52.0	14.0	36.0	50.0	102.0	351.0	450.5	801.5	
Nov	351.0	450.5	801.5	0.0	0.0	75.0	0.0	50.0	0.0	125.0	125.0	125.0	125.0	125.0	11.0	25.0	36.0	14.0	56.0	70.0	106.0	314.0	503.5	817.5	
Dec	314.0	503.5	817.5	75.0	0.0	75.0	0.0	0.0	0.0	75.0	75.0	75.0	150.0	150.0	11.0	36.0	47.0	15.0	72.5	87.5	134.5	341.0	489.0	830.0	
Jan	341.0	489.0	830.0	200.0	0.0	50.0	0.0	0.0	0.0	50.0	50.0	50.0	250.0	250.0	11.1	72.0	83.1	15.0	52.0	67.0	150.1	456.9	470.0	926.9	
Feb	456.9	470.0	926.9	125.0	0.0	50.0	0.0	0.0	0.0	50.0	50.0	50.0	175.0	175.0	11.3	117.0	128.3	14.0	67.0	81.0	209.3	452.6	437.0	889.6	
Mar	452.6	437.0	889.6	0.0	0.0	50.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	11.5	115.0	126.5	11.0	92.0	103.0	229.5	325.1	382.0	707.1	
Apr	325.1	382.0	707.1	25.0	150.0	175.0	0.0	50.0	0.0	0.0	0.0	50.0	50.0	225.0	11.7	99.0	110.7	10.0	97.0	107.0	217.7	237.4	473.0	710.4	
May	237.4	473.0	710.4	110.0	120.0	230.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	230.0	11.7	70.0	81.7	10.0	97.0	107.0	188.7	263.7	484.0	747.7	
Jun	263.7	484.0	747.7	175.0	50.0	225.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	225.0	11.7	25.0	36.7	10.0	122.0	132.0	168.7	400.0	400.0	800.0	
Total				865.0	320.0	1185.0	0.0	550.0	0.0	100.0	0.0	650.0	650.0	1835.0	135.0	715.0	850.0	150.0	800.0	950.0	1800.0				

Source: FPMU data and authors' calculations.

**Table 4.2—PFDS Stocks and Flows, 2000/2001 (actual)**

(000 metric tons)

Month	Net Opening Stock			ADDITION										OFF-TAKE					Net Closing Stock						
	Rice	Wheat	Total	Domestic		Imports				Rice		Wheat		Total Off-take	Rice	Wheat	Total								
				Procurement		Food Aid	Commercial	Total Imports	Total Addition	Distribution		Distribution													
				Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat	Price/ Ration	Price/ Ration												
Jul	548.2	450.1	998.3	105.6	1.6	107.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	107.2	10.6	0.7	11.2	13.7	14.6	28.3	39.5	641.9	423.1	1065.0	
Aug	641.9	423.1	1065.0	101.4	0.0	101.4	0.0	54.1	0.0	0.0	54.1	54.1	155.4	10.7	0.9	11.6	14.7	41.4	56.0	67.7	71.4	730.9	420.7	1151.6	
Sep	730.9	420.7	1151.6	9.4	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	9.4	10.2	3.6	13.7	13.7	44.0	57.7	71.4	71.4	726.1	361.3	1087.4	
Oct	726.1	361.3	1087.4	99.2	0.0	99.2	0.0	0.0	0.0	0.0	0.0	0.0	99.2	10.3	42.8	53.0	15.4	50.5	65.9	118.9	146.5	118.9	771.7	294.9	1066.6
Nov	771.7	294.9	1066.6	6.6	0.0	6.6	0.0	27.5	0.0	0.0	27.5	27.5	34.1	10.9	42.7	53.6	14.4	78.5	92.9	146.5	146.5	146.5	722.1	229.0	951.0
Dec	722.1	229.0	951.0	45.5	0.0	45.5	2.0	15.3	0.0	0.0	2.0	15.3	17.3	62.8	11.4	55.6	67.0	9.3	97.9	107.2	174.2	174.2	700.8	135.6	836.3
Jan	700.8	135.6	836.3	115.7	0.0	115.7	0.0	175.5	0.0	0.0	0.0	175.5	291.2	11.2	78.5	89.7	9.9	31.0	40.8	130.6	130.6	130.6	725.2	266.8	991.9
Feb	725.2	266.8	991.9	47.7	0.0	47.7	0.0	0.0	0.0	0.0	0.0	0.0	47.7	10.5	98.1	108.6	9.8	26.5	36.3	144.9	144.9	144.9	663.3	228.4	891.7
Mar	663.3	228.4	891.7	27.3	5.9	33.2	30.0	100.5	0.0	0.0	30.0	100.5	163.8	11.4	113.9	125.3	10.0	32.0	42.0	167.3	167.3	167.3	594.2	292.0	886.2
Apr	594.2	292.0	886.2	0.0	157.9	157.9	0.0	74.5	0.0	0.0	0.0	74.5	232.4	10.6	134.9	145.5	10.2	49.0	59.1	204.6	204.6	204.6	447.4	462.6	909.9
May	447.4	462.6	909.9	58.1	58.0	116.0	0.0	0.0	0.0	0.0	0.0	0.0	116.0	11.3	89.7	101.0	10.0	48.8	58.8	159.8	159.8	159.8	403.3	459.3	862.6
Jun	403.3	459.3	862.6	206.4	41.8	248.2	0.0	0.0	0.0	0.0	0.0	0.0	248.2	9.5	193.9	203.4	8.5	124.4	132.9	336.3	336.3	336.3	404.4	367.4	771.8
Total				822.8	265.2	1088.0	32.0	447.4	0.0	0.0	32.0	447.4	1567.4	128.5	855.2	983.7	139.4	638.6	778.0	1761.7	1761.7	1761.7			

Source: FPMU data and authors' calculations.

**Table 4.3—Alternative Stock Options**

	<b>Base</b>	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>	<b>Option 4</b>
Net stock (million tons)	0.8	1.0	1.0	0.7	0.8
Total distribution (million tons)	1.8	1.8	2.0	1.8	1.85
Stock available for distribution ('000 tons)	800	1000	1000	700	800
Rice	400	500	500	350	350
Wheat	400	500	500	350	450
Lowest available in any month ('000 tons)	707	895	975	625	715
Rice	237	337	392	202	249
Wheat	376	476	476	326	422
Total distribution ('000 tons)	1800	1800	2000	1800	1850
Rice	850	850	950	850	900
Wheat	950	950	1050	950	950
Distribution of Old Stock ('000 tons)	58	506	520	0	8
Rice (>7 months)	58	336	381	0	0
Wheat (>8 months)	0	170	139	0	8
Total net outlay (billion Taka)	14.31	14.32	15.60	14.30	14.98

Source: Authors' calculations.

**Table 4.4—Costs and Benefits of Alternative Stock Options**

	<b>Base</b>	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>	<b>Option 4</b>
Net stock (million tons)	0.8	1.0	1.0	0.7	0.8
Total distribution (million tons)	1.8	1.8	2.0	1.8	1.85
<b>Total Net Outlay (billion Taka)</b>	14.31	14.32	15.60	14.30	14.98
Excess book value of FFW wages	-1.53	-1.79	-1.87	-1.50	-1.49
Adjusted Net Outlay	15.84	16.11	17.47	15.80	16.46
Marginal Net Outlay	0.00	0.27	1.63	-0.04	0.62
Marginal Benefit*	0.00	-0.81	0.52	0.12	0.82
Marginal Benefit / Marginal Net Outlay			32%		131%
Quality Loss in as % of Net Outlay	0.9%	6.5%	6.2%	0.0%	0.1%

Note: \* Benefits equal the sum of the producer and consumer subsidies (relative to market prices).

Source: Authors' calculations



## 5. CONCLUSIONS AND POLICY IMPLICATIONS

Foodgrain stocks serve dual purposes: they provide working stocks for routine distribution and they also serve as security stocks for emergency distribution. However, increases in stock levels imply either increased distribution or quality losses. The direct costs of increased distribution are clearly shown in the government accounts. The costs to consumers of quality deterioration of PFDS foodgrain are not accounted for, however. Implicit losses to rice consumers due to quality deterioration were significant in 2000/01: about 1.05 billion Taka (about 19 million dollars), equal to 10.9 percent of total net outlay on rice of the PFDS.

Closer attention to the quality of foodgrain in storage, and the tight link between size of stocks and the amount of distribution necessary to rotate stocks is needed. Thus, decisions on procurement need to be taken in light of the potential costs of increased distribution and quality deterioration of stocks. The accounting framework provided in this report can enhance this analysis by quantifying (even if only roughly) the hidden costs of quality losses for consumers.

Further analysis of these issues might include taking into account the effects of distribution and procurement on market prices. Other analysis might also be done on the costs of alternative minimum stocks for emergency distribution needs, (which were implicitly included in the analysis shown in the preceding sections through attention given to the minimum stock at any point of the year).

Finally, the analysis shows that stock levels in 2000/01 were broadly consistent with the level of PFDS distribution, given available stock rotation options. Holding

higher stocks and keeping distribution constant would entail substantial quality losses, unless alternative means of rotating stocks (e.g. through sales and purchases at open market prices at the wholesale levels) are adopted.<sup>17</sup> Holding lower stocks would result in minimum stock levels falling below currently perceived “safe” levels for emergency distribution needs. Small changes in the stock levels, however, have relatively small effects on costs and benefits of the PFDS. Maintaining good quality storage, effective stock management and minimizing leakage are more important determinants of the overall PFDS financial efficiency.

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<sup>17</sup> Likewise, maintaining stocks at 2000/01 levels with lower total distribution (as in 2002/03) also risks substantial deterioration in stock quality.

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## Appendix 1—Decomposition of Costs and Benefits of the PFDS

This appendix presents an accounting framework for assessing the distribution of costs and benefits of the PFDS, including the valuation of stock.

In quantity terms, closing stock ( $STK_1$ ) is equal to opening stock ( $STK_0$ ) plus total procurement (PROC) less stock losses (LOSS) and distribution (DIST).

$$(1) STK_1 = STK_0 + PROC - LOSS - DIST$$

Evaluating all flows at the Ministry of Food's full average financial cost of grain in the current year ( $P_1$ )<sup>18</sup>,

$$(2) P_1 * STK_1 = P_1 * STK_0 + P_1 * PROC - P_1 * DIST - P_1 * LOSS$$

Actual distribution, however, takes place at a price of  $PC_{1,i}$ , (which varies according to distribution channel  $DIST_i$ ), not at the economic price  $P_1$ .<sup>19</sup> Adding and subtracting the value of distribution, and regrouping the terms, gives:

$$(3) P_1 * STK_1 = P_1 * STK_0 + P_1 * PROC - \sum_i PC_{1,i} * DIST_i - \sum_i (P_1 - PC_{1,i}) * DIST_i - P_1 * LOSS,$$

where the term  $\sum_i (P_1 - PC_{1,i}) * DIST_i$  represents the total consumer subsidy on distribution.

We can also rewrite the value of the initial stock ( $P_1 * STK_0$ ) at the current price  $P_1$  as the sum of the value of the initial stock at the previous period's prices and the change in value of the stock due to price changes:

$$(4) P_1 * STK_0 = P_0 * STK_0 + (P_1 - P_0) * STK_0$$

The resulting equation for the value of foodgrain flows of the Ministry of Food is:

$$(5) P_1 * STK_1 = P_0 * STK_0 + (P_1 - P_0) * STK_0 + P_1 * PROC - \sum_i PC_{1,i} * DIST_i - \sum_i (P_1 - PC_{1,i}) * DIST_i - P_1 * LOSS,$$

<sup>18</sup> This estimate of the full average financial cost of foodgrain (including an estimated value of food aid) is termed the "economic price" by the Government of Bangladesh. This definition differs from the standard definition of an economic price, which reflects opportunity cost to the society, which is reflected in the market price (in the absence of policy or other distortions).

<sup>19</sup> Note that for relief channels for which distribution is free for the recipient,  $PC_{1,i}$  is zero.

Replacing the Ministry of Food's full average financial cost price ( $P_1$ ) in equation (5) with the average market wholesale price  $p_1$ ,<sup>20</sup> gives an equation for the value of foodgrain flows at wholesale market prices:

$$(6) p_1 * STK_1 = p_0 * STK_0 + (p_1 - p_0) * STK_0 \\ + p_1 * PROC - \sum_i PC_{1,i} * DIST_i - \sum_i (p_1 - PC_{1,i}) * DIST_i - p_1 * LOSS,$$

Subtracting equation (6) from equation (5), (the value of the PFDS stocks and flows at market and at the GOB's financial prices, respectively), gives a decomposition of the costs of the PFDS in terms of the official consumer subsidy, the producer and consumer subsidies evaluated using market prices, changes in valuation of stock, and other factors:

$$(7) (P_1 - p_1) * STK_1 = (P_0 - p_0) * STK_0 + [(P_1 - P_0) * STK_0 - (p_1 - p_0) * STK_0] \\ + (P_1 - p_1) * PROC \text{ (an approximation of the total subsidy to producers)}^{21} \\ + \sum_i (p_1 - PC_{1,i}) * DIST_i \text{ (an approximation of the total economic subsidy to consumers)} \\ \sum_i (P_1 - PC_{1,i}) * DIST_i \text{ (the financial cost of the PFDS to the GOB)} \\ - (P_1 - p_1) * LOSS \text{ (the difference in the value of losses at market and GOB full cost prices).}$$

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<sup>20</sup> This formulation uses the wholesale price to value both procurement and distribution. As such it may overstate the true market price to producers and understate the true market price for consumers, though the extent of the overvaluation or undervaluation depends on the timing and location of procurement and distribution, issues that are not considered in the analysis here.

<sup>21</sup> Total procurement actually includes three components, domestic procurement, government commercial imports, and food aid. By definition, the Ministry of Food's "economic price" is the average financial cost of this procurement, valuing food aid according to donor's stated values, and government commercial imports according to prices paid through commercial tenders. However, because of quality differences and timing of procurement, the average wholesale price is only an approximation of the unit value of food aid and commercial imports. Note that the calculations of the costs of the PFDS in economic prices presented in this paper assume that there is no difference between the official (financial) prices and economic prices for commercial imports since procurement took place through competitive tenders.

**Appendix 2—PFDS Stocks and Flows, 1999/2000 (actual)**

(000 metric tons)

Month	Net Opening Stock		ADDITION										OFF-TAKE					Net Closing Stock					
	Rice	Wheat	Domestic		Imports				TOTAL ADDITION	Rice		Wheat		TOTAL OFF-TAKE	Rice	Wheat	Total						
			Procurement		Food Aid	Commercial	Total	Commercial		Total	Priced/ Non-Total	Priced/ Non-Total	Distribution					Distribution					
			Rice	Wheat	Rice	Wheat	Rice	Wheat		Rice									Wheat				
Jul	679.4	425.6	1.5	84.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	6.3	17.3	9.9	13.3	23.3	40.5	740.6	402.8	1143.4	
Aug	740.6	402.8	0.0	147.3	0.0	7.3	0.0	0.0	0.0	7.3	7.3	154.6	11.6	35.0	46.7	12.3	1.1	13.4	60.0	840.2	395.6	1235.9	
Sep	840.2	395.6	0.0	142.0	0.8	108.5	0.0	0.0	0.8	108.5	109.3	123.5	11.4	47.2	58.6	10.4	2.2	12.5	71.1	792.1	491.3	1283.5	
Oct	792.1	491.3	0.0	0.0	2.4	190.7	0.0	0.0	2.4	190.7	193.2	193.2	12.1	75.2	87.3	14.0	52.8	66.8	154.1	706.7	612.1	1318.7	
Nov	706.7	612.1	0.0	0.0	1.5	210.0	0.0	0.0	1.5	210.0	211.5	211.5	10.9	57.9	68.8	14.0	54.3	68.3	137.1	637.6	748.9	1386.5	
Dec	637.6	748.9	0.0	33.1	0.0	257.0	0.0	0.0	0.0	257.0	290.1	290.1	11.8	19.2	31.0	12.4	91.0	103.4	134.4	639.3	898.4	1537.7	
Jan	639.3	898.4	0.0	116.7	0.0	42.9	0.0	0.0	0.0	42.9	159.6	159.6	11.2	105.7	116.8	15.3	121.7	137.0	253.8	639.1	798.8	1437.9	
Feb	639.1	798.8	0.0	55.2	0.0	0.0	0.0	0.0	0.0	0.0	55.2	55.2	10.5	28.4	38.9	21.5	71.4	92.9	131.8	655.1	703.1	1358.2	
Mar	655.1	703.1	0.0	29.7	0.0	0.0	0.0	0.0	0.0	0.0	29.7	29.7	11.2	49.9	61.1	15.6	97.2	112.8	173.9	622.7	588.5	1211.2	
Apr	622.7	588.5	0.0	104.8	0.0	0.0	0.0	0.0	0.0	0.0	104.8	104.8	11.0	115.6	126.6	10.4	90.4	100.8	227.4	495.4	591.8	1087.2	
May	495.4	591.8	81.2	79.4	160.6	0.0	49.5	0.0	0.0	49.5	210.1	210.1	10.5	74.3	84.9	11.2	142.8	153.9	238.8	490.7	566.3	1057.0	
Jun	490.7	566.3	196.5	25.1	221.6	0.0	0.0	0.0	0.0	0.0	221.6	221.6	8.6	129.2	137.8	12.3	127.1	139.5	277.2	548.2	450.2	998.3	
Total			756.5	210.7	967.2	4.7	865.9	0.0	0.0	4.7	865.9	1837.8	131.8	743.9	875.7	159.3	865.3	1024.6	1900.2				

Source: FPMU data.

**Appendix 3—Summary of Stock Simulation Assumptions and Results**  
(thousand tons)

Simulation <sup>a</sup>	Base	Option 1	Option 2	Option 3	Option 4
<b>Change in Stock Level</b>	0	200	200	-100	0
<b>Change in Distribution</b>	0	0	200	-50	-50
<b>Opening and closing stock</b>					
<b>Rice</b>	400	500	500	350	350
<b>Wheat</b>	400	500	500	350	450
<b>Total</b>	800	1000	1000	700	800
<b>Distribution</b>					
<b>Rice</b>	850	850	950	850	850
<b>Wheat</b>	950	950	1050	900	900
<b>Total</b>	1800	1800	2000	1750	1750
<b>Procurement</b>					
<b>Rice Procurement (<i>aman</i>)</b>	400	400	450	425	425
<b>Rice Procurement (<i>boro</i>)</b>	465	465	515	440	440
<b>Wheat Domestic</b>	320	320	320	320	320
<b>Wheat Food Aid</b>	550	550	550	550	550
<b>Wheat Public Imports</b>	100	100	100	50	50
<b>Old Stock<sup>b</sup></b>					
<b>Rice (peak month)</b>	January	January	February	--	--
<b>Rice (amount)</b>	42	142	148	0	0
<b>Wheat (peak month)</b>	--	January	January	--	--
<b>Wheat (amount)</b>	0	98	78	0	0

<sup>a</sup> In each scenario, normal annual storage losses of 15 thousand tons of rice and 20 thousand tons of wheat are assumed.

<sup>b</sup> In the base scenario, procurement and distribution are adjusted to minimize the amount of old stock; In other scenarios, no adjustments are made to the timing of the procurement or distribution relative to the base, except in Options 3 and 4 (where 50,000 tons of rice is shifted from boro procurement in May to aman procurement in January).

Source: Authors' calculations.

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