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Public Policy, Markets and Household Coping Strategies in Bangladesh: Avoiding a Food Security Crisis Following the 1998 Floods

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Summary. — At their peak, the 1998 floods covered two-thirds of Bangladesh, causing severe damage to the major rice crop and threatening the food security of tens of millions of households. In this paper, we first highlight the contribution of government policy interventions, including trade liberalization in the early 1990s, to stabilization of rice markets during and after the flood. Then, using a panel data set covering 750 households in three rounds over a 13-month period, we analyze impacts of the flood on household assets, consumption and nutritional outcomes. Finally, we present empirical estimates of the contribution of rice market stabilization and government transfers to household food consumption.

Key words — South Asia, Bangladesh, food security, natural disasters, demand for calories

1. INTRODUCTION

Flooding is a normal part of the ecology of Bangladesh, a country through which three major rivers drain into the Bay of Bengal. The 1998 flood, dubbed the flood of the century, was especially serious, however, because of the depth of water and its duration. At its peak in early September, the 1998 flood covered two-thirds of Bangladesh, causing severe damage to the *aman* monsoon rice crop (due to be harvested in November/December) and threatening the food security of tens of millions of households. Total rice production losses exceeded 2.0 million tons, (equivalent to about 10% of annual consumption), as the unusually long duration of the flood forestalled any possibility of re-planting rice seedlings destroyed by the standing water.

In spite of the damage to the rice harvest and major disruption of the rural economy and employment opportunities, however, no major food crisis occurred. Instead, large-scale private sector imports, made possible by trade liberalization in the early 1990s, stabilized rice markets. Government food transfers to about four million poor households also helped limit the impact of the flood on household access to food. Nonetheless, as this paper will show, the flood did exact a heavy cost in terms of increased private debts due to extensive borrowing in private markets, a major coping strategy of the poor.

The success in handling the effects of the 1998 flood stands in sharp contrast to the devastation caused by a flood in 1974 that contributed to tens of thousands of deaths by famine in 1975. Ravallion (1990) argued that the large

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increase in rice prices in this period was a major cause of famine deaths, as calorie consumption fell below survival thresholds. In this paper, we estimate the impact of rice prices and other factors on calorie consumption using household data from rural Bangladesh collected in 1998 and 1999 in order to shed light on the contribution of price stabilization on household food security following a major natural shock.

This paper examines the components of the public and private response that prevented a major food crisis. Section 2 of this paper highlights the contribution of government policy interventions, including trade liberalization in the early 1990s, to stabilization of rice markets during and after the flood. In Section 3, we examine the impacts of the 1998 flood on flood-exposed households using a panel data set covering 757 rural households in three rounds over a 13-month period. This section focuses on the impacts of the flood on household income, consumption and nutritional outcomes and examines the role of household coping strategies and government intervention. In Section 4, we use an econometric analysis of household calorie consumption to estimate the impact of rice price changes (and thus the contribution of rice market stabilization) to household food security. Conclusions and policy implications are given in Section 5.

2. FOODGRAIN MARKETS: PRODUCTION SHOCKS AND POLICY RESPONSE

Rice dominates agricultural production and food consumption in Bangladesh, accounting for 58.3% of value added in agriculture (9.1% of total GDP) and 72.8% of calories consumed in 1998. [1] Bangladesh annually produces three crops of rice: *aman*, typically transplanted in June–July with the onset of monsoon rains and harvested in November–December, *boro* transplanted in December–January and harvested in May–June, and *aus*, often directly sown in March–April and harvested in July–August. The widespread floods from July through September 1998 threatened national food security in Bangladesh, not because of the initial damage to standing crops, but because of potential damage to the major monsoon season (*aman*) rice crop and rural incomes. [2]

A large expansion in the number of participants, the size of the market, investments in infrastructure (roads, bridges, electricity and telecommunications) and a gradual easing of restrictions on the private sector trade (including lifting of a ban on commercial bank credit for foodgrain trade) have resulted in a well-functioning private market.

In late August 1998, it became clear that the flood would likely lead to a very large shortfall in rice production. The flood had already caused substantial damage to existing crops, road infrastructure and other assets. Damage to the *aus* rice crop, harvested in July and August, was 300,000 tons, (16% of the initial target production, but only 1.4% of projected rice production for 1998–99). Damage to the *aman* crop was more substantial, 1.76 million tons (18.5% of target production), making the total rice production loss 2.06 million tons. In response to a Government of Bangladesh appeal for aid, donors pledged an extra 1.083 million tons of flood relief food aid (almost exclusively wheat) to supplement the 596,000 tons of regular program food aid already planned for fiscal year 1998–99, but major flood relief food aid shipments did not arrive in Bangladesh until December 1998. As a result, targeted food grain distribution through November 1998 was limited by available public stocks. [3]

(a) *Rice and wheat markets following the flood*

Government rice policy in the aftermath of the flood was based on the realization that government imports and food aid alone would not be sufficient to make up the projected shortfall in food grain supply before the wheat and *boro* harvests in April to June of 1999. Thus, the government encouraged private sector imports of rice, a policy that predated the flood.

The *aman* rice harvest in November/December 1997 had also been poor, not because of a flood, but because of a short drought during the crucial flowering stage of rice plant development. Domestic prices rose swiftly up to import parity levels (equal to the cost of rice in Indian markets plus transport, handling and a normal profit margin), thus making it profitable for the private sector to import rice from India. In early 1998, the Government of Bangladesh took deliberate steps to encourage private sector imports of rice to stabilize domestic markets including removal of a 2.5% tariff on rice imports, expedited clearance of rice imports, and strict limits on government sales of subsidized rice. As a result, during the

first five months of 1998, the private sector imported 894,000 tons of rice from India (according to Government of Bangladesh customs figures), mainly by truck and rail across land borders.

Domestic prices fell and private sector rice imports sharply declined with the onset of the winter season *boro* rice harvest in May 1998, but soon thereafter, as the floods began, domestic rice prices again rose to import parity. By continuing its policy of encouraging private sector imports, the government enabled the private sector to import substantial quantities of rice and keep the domestic market price from rising above import parity levels. [4]

Thus, because of the poor 1997–98 *aman* harvest and the flood-damaged *aus* and *aman* harvests in 1998–99, Bangladesh rice prices (wholesale Dhaka) remained close to X: India import parity prices for most of calendar year 1998. Wholesale prices after the flood were in fact remarkably stable. The national average wholesale prices of coarse rice remained in the range of 14.14–14.83 Taka/kg from September 1998 through mid-April 1999. With a good *boro* harvest in April and May, market prices fell by 19%, from 14.46 Taka/kg (*aman* coarse rice) in the third week of April to 11.74 Taka/kg (*boro* HYV rice) in the second week of May, bringing to an end a nine-month period of high rice prices and concerns about post-flood food availability.

In comparison with private sector rice imports, government interventions in the domestic rice market were small, only 399,000 tons from July 1998 through April 1999. Private sector rice imports, equal to 2.42 million tons in this period, were thus 6.1 times larger than government rice distribution. 57.7% of rice distribution was targeted to flood-affected households through Vulnerable Group Feeding (41.5%) and Gratuitous Relief (16.2%). Total rice distribution during these months, however was only slightly above the original target, in part because the Ministry of Food faced substantial difficulties in procuring rice either through domestic or international tenders. [5]

The private sector also imported substantial volumes of wheat following the flood, even though large amounts of wheat food aid flowed into Bangladesh and distribution through VGF and Food for Work was expanded. Private sector wheat imports from July 1998 through February 1999 reached 624,000 tons, 435,000 tons more than in the same period in 1997–98. Given the large private sector imports, it appears that food aid inflows did not provide a disincentive for domestic wheat producers. [6]

(b) *Market prices in the absence of private sector imports*

Though the quantity of private sector imports from India is uncertain, it is clear that this trade substantially augmented Bangladesh rice supplies in 1997–98 and 1998–99. One measure of the impact of this trade on national food security in Bangladesh is to compare actual prices and imports with estimates of prices and imports in the absence of private sector imports from India. Given the average wholesale price of coarse rice in Dhaka of 13.3 Taka/kg in 1998–99, rice imports from December 1997 through November 1998 were 2.043 million tons, (according to the Bangladesh customs data). Had rice imports from India not been available, the next lowest cost source for private importers would have been Thailand, for which the import parity price of 15% broken rice in Dhaka in the same period was 16.1 Taka/kg. Given the 20.9% increase in import parity price, estimated rice demand would fall by between 4.2% and 6.3%, assuming an own-price elasticity of rice demand of −0.2 to −0.3. In this case, rice imports would decline by approximately 700,000 to 1 million tons. [7]

If private sector imports were unavailable (or banned) from any source, then, with no change in government imports, total supply would have been 12.1% less (apart from private stock changes) and rice prices could have risen by 40–60%, to an average of between 18.7 and 21.3 Taka/kg. [8] Such an increase in the rice price level would likely have been unacceptable to the Government of Bangladesh and public sector imports would have been increased. But public sector imports of a magnitude equal to private sector flows would not have been feasible.

During the 1998 calendar year alone, private sector imports, mainly from India, reached 2.26 million tons. Had the government of Bangladesh imported this grain itself, the average cost of the imported rice delivered to local delivery points would have been approximately 14.9–15.9 Taka/kg, 1.0–2.0 Taka/kg above the private sector import costs, due to additional marketing costs totaling 50–100 million dollars. In addition, if the government received a net price of 11.5 Taka/kg (equal to the Open Market Sales price of 12.0 Taka/kg less 0.5 Taka/kg OMS dealer's commission), the total unit subsidy would have been 3.4–4.4 Taka/kg,

and the total fiscal cost would have been 160–210 million dollars.

(c) *A comparison with earlier major production shortfalls*

As shown above, private sector imports played a major role in stabilizing rice and wheat markets following the 1998 floods. Government policy in two earlier periods of major food grain production shortfalls caused by floods in 1974 and 1988 depended much more heavily on public sector market interventions. In 1974, a large-scale famine, resulting in 30,000–100,000 deaths followed floods that damaged *aus* and *aman* crops. [9] In contrast, the 1988 floods resulted in an even sharper drop in *aman* production (similar to that in 1998), but no famine occurred.

The 1974 famine was characterized by a very sharp rise in nominal (and real) rice prices following the floods in July. Rice prices in August through November 1974 were on average 58.2% higher than in May through July 1974. This sharp rise in prices had disastrous consequences for poor households lacking the entitlements to acquire enough of their staple commodity. In contrast to 1974, however, rice prices rose by only 7.0% in these months following the floods in 1988–89 and by 12.4% in 1998–99.

This difference in market price behavior is not explained by the size of the production shortfalls: in fact, the shortfalls (as measured in terms of deviations from trend production) in 1988 and 1998 were larger than in 1974. Instead, speculative behavior by traders and the inability of the government to intervene in domestic markets (because of low public stocks and shortage of foreign exchange to purchase imports) account for the large price increase in 1974. [10] In 1988–89, a crisis was averted through drawdown of large public stocks supplied in part by government commercial imports and food aid preceding the floods. Markets were stabilized in 1998–99 with per capita stocks only half the size of those a decade earlier, however, largely because of private sector imports that added to domestic supplies and quickly stabilized prices at import parity levels. [11]

3. HOUSEHOLD IMPACTS AND COPING STRATEGIES

The 1998 flood led to major crop losses, losses of other assets and lower employment opportunities and thus affected household incomes as well as market prices. In this section, we present an analysis of the short- and medium-term impacts of the flood at the household level, using data from a panel data set of 757 rural households collected in November/December 1998 (about three months after the flood), April/May 1999 and November/December 1999. [12] In this analysis, households have been classified according to their level of direct exposure to the flood using a household's flood exposure index, which includes the depth of water in the homestead and in the house, and also the duration (number of days) of water in the house. [13]

(a) *Employment and income*

Households exposed to the flood suffered severe crop losses (equal to 24% of the total value of anticipated production for the year). For the 55% of households that lost assets, their average loss was Taka 6,936, equivalent to 16% of the total value of their pre-flood assets. Employment opportunities for daily laborers declined as well, and their average monthly earnings in July–October 1998 were 46% below those in the same months in 1997 (del Ninno *et al*., 2001a, 2001b).

Within eight months of the flood, as agricultural production and rural employment recovered, household incomes rose substantially, both for flood-exposed households as well as those not directly exposed to the flood. The average monthly household income of all households in the sample was 45% higher in April 1999 than in November 1998, and about 50% higher in November 1999, one year later. The income level of flood-exposed households also increased, by 35% between November 1998 and April 1999 and by 49% between November 1998 and November 1990, but the income of poor flood-exposed households did not increase as much as the rest of the households, however.

(b) *Food consumption*

As described in the previous section, the shortfall in rice production caused a large increase in the price of rice up to import parity levels. Vegetables and many other foods were also in short supply at the time of the flood, and households had to increase their expenditures for health care and fuel. As a result, the caloric consumption of flood-exposed households in November 1998 was 227 calories/person/day

Table 1. *Mean values of household expenditure and caloric consumption by expenditure categories, round of data collection and the flood exposure*

	November 1998			April 1999			November 1999		
	Not exposed	Exposed	All	Not exposed	Exposed	All	Not exposed	Exposed	All
Household expenditure									
Food	2,629	2,740	2,708	2,687	2,875	2,821	2,521	2,707	2,653
Nonfood	1,215	1,324	1,292	755	876	842	828	866	855
Total	3,843	4,064	4,000	3,442	3,751	3,663	3,348	3,573	3,507
Bottom 40%									
PC total	415	424	422	465	516	503	500	505	503.56
Share of food	77.76	72.62	73.90	80.09	80.02	80.03	79.69	78.86	79.07
Middle 40%									
PC total	748	743	745	674	704	695	664	670	668
Share of food	72.89	69.85	70.82	79.89	77.40	78.16	74.81	76.98	76.28
Top 20%									
PC total	1,394	1,434	1,423	1,052	996	1,013	1,051	1,033	1,038
Share of food	57.81	62.89	61.44	74.48	72.27	72.94	74.25	72.57	73.07
All									
PC total	761	747	751	679	684	683	685	674	677
Share of food	68.23	67.86	67.97	78.21	76.73	77.15	75.89	76.21	76.12
PC daily calories									
Bottom 40%	1,745	1,602	1,638	2,143	2,230	2,208	2,218	2,193	2,200
Middle 40%	2,653	2,325	2,428	2,778	2,537	2,613	2,680	2,528	2,577
Top 40%	3,049	3,140	3,114	3,176	2,847	2,943	3,204	3,015	3,071
All	2,411	2,184	2,249	2,637	2,471	2,518	2,623	2,486	2,526
Household size	5.05	5.55	5.4	5.06	5.49	5.37	4.92	5.40	5.26
Number	217	540	757	214	534	748	213	519	732

Source: FMRSP-IFPRI Households Survey 1998–99.

less than that of non flood-exposed households (Table 1). We found no evidence that indicates that the flood lead to an increase in discrimination against females in food consumption within households, however. In fact, female consumption of the main staples (rice and wheat) was not reduced by more than male consumption of these commodities as a result of the flood, nor was there an increase in male favoritism in the consumption of animal products (del Ninno *et al*., 2001a, 2001b).

The mean level of total household expenditure decreased from Taka 4,000 in November 1998 to Taka 3,663 in the April 1999 and remained relatively stable at Taka 3,507 in the November 1999 (Table 1). The main reason for this change in the average level of total expenditure is due to the decrease of nonfood expenditure from Taka 1,292 in November 1998 to Taka 842 in April 1999 and Taka 855 in November 1999. [14] On average, households spent 68% of their budget on food in November 1998, compared to 77% in April 1998 and 76% in November 1999.

As a consequence of the change in the expenditure pattern, the resulting consumption of calories per capita per day increased over the year from 2,249 to 2,518 and 2,526, respectively. This increase was particularly large for poorer households, and especially so for those exposed to the flood. Caloric consumption of poorer households went from 1,638 calories per capita per day in November 1998 to 2,208 in April 1999 and 2,200 in November 1999, made possible by a sharp decrease in the price of rice, which fell from Tk/kg 16.1 in November/December 1998 to Tk/kg 13.1 and Tk/kg 11.9 in mid- and late-1999, respectively.

Households exposed to the flood spent less on rice, more on wheat and more on prepared foods in the first than in the second and third rounds. In the following rounds, they reduced

the budget share for rice and increased the budget shares for milk and fruits. This is partly due to the changes in the price of rice and also because the consumption of wheat was mostly driven by the larger distribution of wheat transfer programs that took place in early 1999. As a result, poor households were able to increase their level of per capita daily consumption from the period immediately following the flood in round one (Table 2).

In particular, the amount spent on rice decreased over time for almost all households, with the exception of poor households and flood-exposed households, in which case the amount actually increased. Nevertheless, the per capita daily quantities of rice consumed increased substantially for poor households exposed to the flood from 303 g in November 1998 to 389 g in April 1999 and 400 g in November 1999 (Table 3).

The percentage of households consuming *atta* and wheat increased from 58% in November 1998 to 70% in April 1999 and decreased to 36% in November 1999. At the same time, the amount spent on *atta* and wheat remained constant for all households between November 1998 and April 1999 and decreased by November 1999. As a result, the per capita daily consumption of *atta* and wheat (slightly higher for flood-exposed households) increased from 51 to 65 g in April 1999 and then dropped to 20 g in November 1999 (Table 2).

(c) *Health and nutrition*

The flood caused a major deterioration in the quality of households' health environments in its wake. It damaged or destroyed peoples' homes, reduced their access to safe water, and destroyed or damaged their toilet facilities. These factors, combined with the reduction in food consumption, led to substantial increases in illness—even after the floodwaters had receded. Individuals in all age groups experienced deterioration in health status in November/December 1998, especially those who were severely or very severely flood-exposed. While adolescents had the greatest increase in illness, the most serious health problem posed by the flood was the illnesses among children. This is because, illnesses among children have more negative consequences, threatening even their survival (del Ninno *et al*., 2001a, 2001b).

The flood led to increases in both wasting and stunting among preschool children: severe or very severe flood exposure caused many children to lose weight and/or to fail to grow at a critical period in their mental and physical development. This situation was brought about by a combination of factors, including reduced access to food, the increased difficulties of providing proper care for children that came with disruptions in home life, and the greater exposure of children to contaminants.

At the time of November 1998 of data collection 55% of children in the sample were stunted and 22% were wasted. A year later, children exposed to the flood were still suffering from the consequences of the flood. 58% of the children in flood-exposed households were stunted. These children may never be able to recover from the adverse impact of the flood.

The data show that the percentage of children stunted had increased by April 1999, perhaps because of a lag between a period of deprivation and the resulting malnutrition. The situation improved substantially by November 1999, especially for non flood-exposed households. For flood-exposed households, the percentage of stunted children for those in the bottom 40 percentile remained much higher than that of households in the top 20 percentile a year after the flood. This suggests that the flood may have had a serious long lasting impact on the nutritional status of poor children that were directly exposed to the flood.

It is important to stress in this regard that the nutritional situation observed in our data for the months of November and December 1998 for November 1998 and April 1999 for April 1999, following the flood, are quite unusual for Bangladesh. In fact, the results of the nutrition surveillance project of HKI (HKI, 1999) show that the usual trend in Bangladesh is to have an increase in the percentage of children that suffer from diarrhea cases and that are wasted in the period corresponding to the annual floods, between the month of July and the month of August. The percentage of children wasted is at its lowest between the period of December and February.

The percentage of children that suffered from diarrhea in the fall of 1998 was much larger that than of 1999, a year after the flood. Overall 17% of the children in our sample suffered from diarrhea in November 1998 compared to only 9% a year later. Therefore, there is no reason to expect such a large increase in the percentage of stunting at the time of April 1999 of data collection, in April 1999, especially since the general trend reported by the Hellen Keller International (HKI) surveillance project (HKI, 1997),

Table 2. *Average per capita daily consumption of food categories by expenditure categories and round of data collection (g)—all households*

Categories	November 1998				April 1999				November 1999			
	Bottom 40%	Middle 40%	Top 20%	Total	Bottom 40%	Middle 40%	Top 20%	Total	Bottom 40%	Middle 40%	Top 20%	Total
Rice	323.99	463.69	517.14	418.44	392.47	441.50	472.84	428.29	404.57	463.05	470.09	441.21
Wheat	51.28	52.74	47.44	51.10	64.69	72.09	50.68	64.81	23.24	18.25	19.30	20.44
Bread and other cereals	0.59	2.38	3.24	1.83	2.96	4.99	5.29	4.25	4.13	4.56	8.75	5.22
Pulses	13.96	16.86	23.92	17.11	21.42	23.64	27.85	23.61	20.69	22.04	26.83	22.46
Oil	5.07	8.26	13.16	7.96	5.84	8.69	12.63	8.35	6.78	8.89	12.93	8.86
Vegetables	123.11	200.09	293.06	187.82	203.14	280.07	333.26	260.16	147.92	193.43	254.56	187.53
Meat	3.10	8.89	23.32	9.45	5.32	9.54	17.52	9.47	6.23	9.63	17.96	9.94
Egg	1.55	3.90	7.65	3.71	2.53	4.16	6.43	3.97	2.17	3.81	5.37	3.46
Milk	5.00	16.90	31.53	15.05	23.35	33.20	52.38	33.14	9.43	18.28	25.90	16.28
Fruits	10.89	28.17	58.67	27.34	40.02	79.22	118.80	71.59	49.87	69.17	97.55	67.16
Fish	19.67	43.84	81.84	41.75	15.08	28.45	43.32	26.12	43.46	51.41	75.26	53.01
Spices	21.63	24.95	29.42	24.51	21.46	24.20	28.88	24.04	22.96	23.87	27.81	24.29
Sugar and snacks	11.25	24.15	49.57	24.06	19.64	28.61	46.32	28.61	20.02	31.98	45.55	29.94
Drinks and others	6.85	9.04	15.57	9.47	7.94	9.10	12.76	9.38	9.30	11.60	18.81	12.13
Prepared foods	11.40	11.85	33.71	16.03	7.02	6.13	8.49	6.96	7.05	7.31	11.26	7.99
N	303	303	151	757	298	299	151	748	291	295	146	732

Source: FMRSP-IFPRI Households Survey 1998–99.

Table 3. *Average per capita daily consumption of food categories by expenditure categories and round of data collection (g)—households exposed to the flood*

Categories	November 1998				April 1999				November 1999			
	Bottom 40%	Middle 40%	Top 20%	Total	Bottom 40%	Middle 40%	Top 20%	Total	Bottom 40%	Middle 40%	Top 20%	Total
Rice	303.47	429.39	505.50	392.99	389.67	414.82	447.57	411.19	400.16	435.91	456.39	425.45
Wheat	55.07	57.27	51.32	55.17	68.32	65.50	51.84	63.87	23.52	20.32	16.69	20.90
Bread and other cereals	0.61	2.29	2.91	1.73	2.56	5.26	4.72	4.04	4.54	5.04	9.06	5.65
Pulses	16.12	17.19	25.13	18.35	25.07	24.45	28.53	25.54	23.41	24.85	28.59	25.01
Oil	5.29	8.33	12.68	7.96	6.03	8.65	12.17	8.29	6.91	8.99	12.47	8.84
Vegetables	112.26	173.95	285.91	171.18	207.66	270.22	318.22	254.36	136.29	178.92	242.00	174.27
Meat	3.45	9.04	23.17	9.60	6.03	9.53	14.89	9.19	6.45	9.16	17.43	9.72
Egg	1.31	3.94	7.61	3.60	2.36	4.27	6.08	3.86	1.79	3.78	5.00	3.22
Milk	3.96	14.90	26.63	12.77	24.44	34.37	49.74	33.43	7.31	17.88	22.33	14.46
Fruits	10.39	25.54	59.32	26.13	40.10	77.72	113.45	69.59	50.59	68.99	100.43	67.83
Fish	19.28	46.26	85.90	43.17	15.75	27.17	40.65	25.24	44.08	52.39	75.54	53.68
Spices	21.90	24.98	30.24	24.78	21.92	24.24	28.85	24.23	23.10	23.12	27.40	23.98
Sugar and snacks	11.48	23.74	50.10	24.02	19.66	28.78	47.00	28.76	20.78	33.87	43.38	30.44
Drinks and others	8.03	10.54	18.06	11.03	9.01	9.67	13.46	10.17	10.82	12.48	20.78	13.48
Prepared foods	14.72	14.55	41.54	20.07	9.05	7.97	9.32	8.69	9.32	8.16	14.67	9.95
N	222	209	109	540	219	206	109	534	212	202	105	519

Source: FMRSP-IFPRI Households Survey 1998–99.

shows a decrease in the rates of stunting during 1991–97.

The econometric analysis by del Ninno and Lundberg (2001) confirms that 15 months after the flood, most children appear to have regained the same nutritional status they had a few months after the flood (in November 1998). Unfortunately, over than 40% of the children in the sample, which had a very poor nutritional status in November 1998, and that were exposed to the flood, had not regained the same level of nutritional status a year later. These children were less likely to recover from the shock of the flood and therefore did suffer long-term consequences as a result of it.

(d) *Government food and cash transfers*

In response to the flood, the government of Bangladesh used two main direct transfer relief programs. In the initial flood period, immediate relief through the Gratuitous Relief program went mainly to seriously flood-exposed households; 35.7% of severely flood-exposed households received the transfer compared to 9.7% of nonflood-exposed households.

Vulnerable Group Feeding transfers started in late October and were targeted administratively through union-level committees. They were better target to the poor than to the flood-exposed households. 38.8% of the households in the bottom quintile received grain transfers compared to 17.2% and 11.2% in the top two quintiles. But, almost 20% of the nonflood-exposed households received transfers, as well (del Ninno & Dorosh, 2001).

The survey suggests that government direct transfers were for the most part well-targeted to flood-exposed households and to the poor. Yet, government transfers were small relative to the needs of households, as indicated by the share of the transfers compared to the monthly expenditure (Table 4).

Small amounts of cash transfers were part of the initial flood relief efforts, but larger cash transfers or credit programs were not part of the medium-term relief to households two–four months after the floods, even though food grain stock constraints limited the expansion of the Vulnerable Group Feeding program during this period.

(e) *Household coping mechanisms*

Households adjusted to the shock of the flood in several major ways: reducing expenditures, selling assets and borrowing. Borrowing to purchase food and to fund other expenses (such as education and health, farming, business, repayment of loans, marriage and dowry, purchases and mortgage of land/agricultural equipment purchases, etc.) has been the most important coping strategy employed by households in Bangladesh after the flood both in

Table 4. *Coping strategies, flood exposure and poverty in November 1998*

	Flood exposed				Not exposed	All households
	Bottom 40%	Middle 40%	Top 20%	All		
Monthly households expenditure (Tk)	2,414.3	3,973.9	7,720.6	4,063.6	3,843.5	4,000.5
Share of food expenditures (%)	72.4	69.5	62.2	67.4	68.4	67.7
Households in debt (%)	68.2	58.9	62.6	63.5	53.5	60.6
Share of monthly expenditure (%)	186.1	138.7	131.3	144.4	140.2	143.6
Household purchasing food on credit (%)	56.7	54.1	50.5	54.4	29.5	47.3
Share of monthly expenditure (%)	37.6	27.2	17.3	25.8	20.0	25.0
Households receiving government transfers (%)	60.7	54.1	32.7	52.6	33.6	47.2
Share of monthly transfer on expenditure (%)	3.4	2.4	0.8	2.0	2.1	2.0
Households selling assets (%)	25.2	21.3	15.9	21.9	20.3	21.4
Share of monthly expenditure (%)	45.5	51.3	75.3	51.9	44.2	49.9
Number of households	226	207	107	540	217	757

Source: FMRSP-IFPRI Households Survey 1998–99.

Table 5. *Percentage of households with outstanding loans and average amount of debt by time period, by expenditure category and flood exposure*[a]

Period	Bottom 40%		Middle 40%		Top 20%		All		
	Exposed to the flood in 1998	Hh having outstanding (%)	Average amount (Taka)	Hh having outstanding (%)	Average amount (Taka)	Hh having outstanding (%)	Average amount (Taka)	Hh having outstanding (%)	Average amount (Taka)
Up to December, 97	Not exposed	7.79	11,957.50	10.42	14,455.00	27.27	21,591.67	12.90	16,978.39
	Exposed	7.52	8,263.94	7.25	34,090.67	10.28	25,681.82	7.96	21,729.00
	All	7.59	9,227.48	8.25	26,236.40	15.23	23,547.83	9.38	19,855.52
Up to November, 98	Not exposed	66.23	4,367.94	53.13	9,751.96	54.55	10,564.58	58.06	7,727.50
	Exposed	75.22	5,375.29	65.22	7,257.34	66.36	15,737.75	69.63	8,007.77
	All	72.94	5,142.83	61.39	7,941.35	62.91	14,430.84	66.31	7,937.42
Up to May, 99	Not exposed	50.65	3,910.51	50.00	4,573.65	54.55	15,954.17	51.15	6,801.31
	Exposed	68.58	4,464.84	64.25	5,552.55	56.07	9,216.67	64.44	5,699.83
	All	64.03	4,353.40	59.74	5,292.95	55.63	11,141.67	60.63	5,966.20
Up to November, 99	Not exposed	46.75	3,838.89	39.58	7,368.84	45.45	17,176.00	43.32	8,103.58
	Exposed	64.16	3,991.35	53.62	7,142.43	52.34	9,011.96	57.78	6,013.54
	All	59.74	3,961.02	49.17	7,200.17	50.33	11,160.39	53.63	6,497.44

Source: FMRSP-IFPRI Household Survey 1998–99.

[a] Data reported here differ slightly from the data in Table 4, because the this table does not include additional recall information collected after first round of the survey in November 1998.

terms of the value of the resources and the number of households who borrowed.

More than 60% of poor, flood-exposed households in the sample borrowed money in the months immediately following the flood, and of these more than half borrowed money for food. Household debts rose to an average of 1.5 months of typical consumption compared with only a small percentage of monthly consumption in January 1998, about eight months before the floods (Table 5). This borrowing was sufficient to maintain household levels of expenditures in value terms *vis-à-vis* pre-flood level, but because of higher prices, poor flood-affected households consumed only 1,602 calories per capita per day, suggesting that targeted cash transfers and credit programs could have been an effective complement to direct food distribution. Households borrowed mostly from noninstitutional sources such as friends and neighbors rather than from Non-govermental Organizations (NGOs) and banks. Interest rates on the loans ranged from 21% from institutional sources to a maximum of 67%.

The percentage of households with outstanding debt one year after the flood, reported in Table 5 decreased progressively from November 1998, when it was at the highest with 66% of the households holding an average of 7,937 Taka in outstanding debt, to 54% in November, 1999 for 6,497 Taka. Nevertheless, even though there has been an improvement in the number of households in debt and the amount of debt, it still constitutes a large share of the total expenditure and leaves those households vulnerable another shock.

4. POLICY IMPACTS ON CALORIE CONSUMPTION

The trade liberalization that enabled private sector imports to stabilize rice prices and government-targeted food transfers both increased access to food by poor households. In this section, we estimate the contribution of these policies to maintaining household calorie consumption using price and income elasticities of demand from econometric analysis of household consumption data. [15]

We first estimate a reduced form equation of the total level of calories available at the household level regressed on income, prices and other household characteristics. Then, as a check on the reliability of these estimates, we estimate an equation for rice demand (which accounts for 67% of calories consumed by the poorest 40% of households surveyed in November 1998 and 71% in November 1999). Finally, we use the estimated parameters to simulate the effects of alternative rice prices and transfers on calorie consumption.

(a) *Determinants of calorie consumption*

Using data from the three rounds (November 1998, April 1999 and November 1999) of the FMRSP-IFPRI household flood survey (FMRSP-IFPRI Household Survey, 1998–99), we first estimate a static model in which the logarithm of total calories is assumed to be a function of prices, income, values of loans taken, household characteristics (including the composition of the household), the village flood exposure variable and an error term. [16]

$$\ln \mathrm{CAL}_t = \alpha_t + \beta_{1t} \ln P_{1t} + \cdots + \beta_{nt} \ln P_{nt} + \gamma_t Y_t + \delta_t \ln \mathrm{Loan}_t + v_t H + \varepsilon_t. \quad (1)$$

Eqn. (1) was estimated using data from each round of the survey separately, as well as with data from all three rounds together. In order to correct for endogeneity of total expenditures (a proxy for total income) and loans received, we have used fitted values for these variables, with household and village-level characteristics as instruments. [17] In order to control for the effects of unobservable errors across *thanas*, we also estimated all these equations with a fixed effects model, including dummy variables for individual thanas.

A second model that takes into account that the households are the same in each round of this panel data set was also estimated. In this model, we express all variables in terms of first differences, i.e., the change in the value of the variable between rounds (between rounds 1 and 2, and between rounds 2 and 3). In this way, we removed the effects of the time variant household unobservable component of the error term (Eqn. (2)).

$$\begin{aligned} \mathrm{d} \ln \mathrm{CAL}_t &= \ln \mathrm{CAL}_t - \ln \mathrm{CAL}_{t-1} \\ &= \alpha_t + \eta \ln \mathrm{CAL}_{t-1} + \beta_{1t} \mathrm{d} \ln P_{1t} \\ &\quad + \cdots + \beta_{nt} \ln \mathrm{d} P_{nt} + \gamma_t \mathrm{d} Y_t \\ &\quad + \delta \, \mathrm{d} \ln \mathrm{Loan}_t + vH + \mu_t. \end{aligned} \quad (2)$$

This model was first estimated for the first difference between round 2 and round 1 and then for the difference between round 3 and

round 2 separately. Both sets of regressions were run first without *thana* dummy variables, that do not change between rounds, and then included those variables. We also estimated regressions for all the first differences between round 3 and 2 and 1 together, first using *thana* dummies and then using a full fixed-effects model in which all common characteristics at village and household level were taken into account.

(b) *Determinants of rice consumption*

Similarly, we estimated equations for the demand for rice, using the value of rice expenditures as the dependent variable. As for the demand for calories, we first estimated a set of models specified in level terms (Eqn. (3)) for rounds 1, 2 and 3 separately, and with a pooled data set.

$$\ln\mathrm{VRice}_t = \alpha_t + \beta_{1t}\ln P_{1t} + \cdots + \beta_{nt}\ln P_{nt} + \gamma_t Y_t + v_t H + \varepsilon_t. \quad (3)$$

Likewise, we estimated first difference models in which the difference in the value of rice consumed between rounds of data collection are expressed as function of the lagged consumption value, the difference in prices, the difference in total expenditure and household characteristics.

$$\begin{aligned}\mathrm{d}\ln\mathrm{VRice}_t &= \ln\mathrm{VRice}_t - \ln\mathrm{VRice}_{t-1}\\ &= \alpha_t + \eta\ln\mathrm{VRice}_{t-1} + \beta_{1t}\mathrm{d}\ln P_{1t}\\ &\quad + \cdots + \beta_{nt}\mathrm{d}\ln P_{nt} + \gamma_t \mathrm{d}Y_t\\ &\quad + vH + \mu_t. \end{aligned} \quad (4)$$

(c) *Econometric results*

Table 6 presents a summary of the results. (See del Ninno, Dorosh, and Smith (2003) for a full set of results.) In the demand for calories levels model with thana fixed effects, the coefficients on the logarithm of per capita expenditure and logarithms of the prices of rice, oil, vegetables and prepared foods are all significant at the 99% confidence level, with an expenditure elasticity of demand for calories of 0.445 and a rice price elasticity of demand of −0.362. Using the first differences model, the absolute magnitudes of these elasticities fall to 0.363 and −0.142, respectively, but are both still significant at the 95% confidence level.

Using the parameters from these regressions, changes in rice prices and household incomes account for about one-fourth to one-half of the change in calorie consumption from round 1 to round 2 of the survey. The poorest 40% of households in the sample increased their per capita calorie consumption from an average of 1,069 calories/day in round one to 1,295 calories/day of rice in round two, an increase of 570 calories/day. Given an 18.7% decrease in the average rice price from 16.04 to 13.04 Tk/kg and a 19.3% increase in total expenditures from 422 to 503 Tk/capita/month, the calorie demand regression coefficients imply a 160–272 calorie increase in daily per capita consumption (Table 7).

Regressions on the value of rice consumption give results that are broadly consistent with the calorie regressions. Using data on the levels of all variables and fixed effects estimation of the equation, the expenditure elasticity of demand for rice is 0.349 and own-price elasticity of demand is −0.449 (column 3, Table 6). [18] As is the case for the calorie demand regression, elasticities from the fixed effects model using the differences in values relative to round one are smaller in absolute magnitude, 0.275 and −0.321, (column 4) for expenditure and price elasticities, respectively. The expenditure and price elasticities estimated from the rice demand regression imply a 130–179 calorie/person/day increase in rice consumption. Assuming a 0.5 income elasticity of demand for non-rice calories adds another 52 calories/person/day for a total change of 183–231 calories/person/day, within the range of estimates from the calorie demand regression. [19]

(d) *Counterfactual simulations*

How much did price stabilization and government-targeted transfers contribute to calorie consumption of the poor following the 1998 floods? As shown in Table 8, estimates based on the parameters from the calorie demand regressions suggest that per capita consumption of the rural poor would have been 44–109 calories/day less if private sector rice trade from India had been prohibited and the rice price were 19.4% higher (equal to the import parity price of rice imports from Thailand). Given the already very low average per capita consumption of only 1,638 calories/day, such a reduction could have had serious nutritional consequences. In the absence of any private sector imports, if government imports were constrained by administrative delays or shortages of funds and prices increased by 30%,

Table 6. *Summary of regression model results*

Dependent variable	Levels model (thana fixed effects)	First diff. model (household fixed effects)	Levels model (thana fixed effects)	First diff. model (village fixed effects)
	Ln calories	Ln change in calories	Ln rice value	Ln change in rice value
Lagged dependent		−1.023		−0.8938
		(6.60)***		(40.04)**
Flood exposure	0.010	0.000	−0.0181	0.000
	(−0.65)[a]	(·)	(0.59)	(·)
Log loans	0.001	0.004		
	(−0.11)	−0.3		
Log PC expend	*0.445*	*0.363*	*0.3489*	*0.2751*
	(14.79)***	(2.12)**	(7.56)**	(4.22)**
P Rice	*−0.362*	*−0.142*	*0.5511*	*0.6794*
	(9.03)***	(2.20)**	(6.70)**	(5.52)**
P Wheat/atta	−0.022	−0.073	−0.1267	0.1308
	(−0.42)	(−1.43)	(1.33)	(0.86)
P Other cereals	−0.018	−0.036	−0.0187	−0.1156
	(−1.04)	(−1.56)	(0.53)	(2.53)*
P Pulses	0.040	−0.004	0.0905	0.0007
	(−0.92)	(−0.10)	(1.18)	(0.01)
P Oil	−0.091	−0.067	−0.0787	0.0064
	(2.81)***	(2.05)**	(1.32)	(0.08)
P Vegetables	−0.091	−0.017	−0.0186	0.0819
	(3.06)***	(−0.35)	(0.36)	(1.26)
P Meat	−0.001	0.025	−0.0123	0.0150
	(−0.03)	(−0.86)	(0.24)	(0.21)
P Eggs	0.013	−0.028	−0.0716	−0.0748
	(−0.62)	(−1.39)	(1.58)	(1.37)
P Milk	−0.043	−0.024	0.0907	0.0425
	(−1.20)	(−0.54)	(1.60)	(0.46)
P Fruits	−0.009	−0.012	−0.0334	−0.0209
	(−0.64)	(−0.67)	(1.26)	(0.60)
P Fish	−0.022	0.005	0.0135	−0.0082
	(−1.19)	(−0.33)	(0.34)	(0.19)
P Spices	−0.086	−0.013	−0.2109	−0.0483
	(2.17)**	(−0.33)	(2.25)*	(0.51)
P Snacks	0.031	−0.010	−0.0013	0.0519
	(−1.23)	(−0.44)	(0.01)	(0.98)
P Tea/Bev./etc.	−0.022	−0.012	0.0295	0.0050
	(−1.41)	(−0.76)	(0.71)	(0.14)
P Prepared food	−0.051	−0.067	0.0010	−0.0843
	(2.29)**	(2.06)**	(0.02)	(0.98)
Constant	−2.024	0.953	3.6928	3.4117
	(10.06)***	(3.43)***	(12.16)**	(8.38)**
Observations	2071	1370	2061	1358
R-squared	0.55		0.42	
No. of Clusters		693		111

[a] Robust *t* statistics in parentheses.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 7. *Simulated change in calorie demand: round 1 compared with round 2*

	November/ December 1998	April/May 1999	Fitted value	
			Low elasticity[a]	High elasticity[b]
Rice price (Tk/kg)	16.04	13.04	13.04	13.04
Total expenditures (Tk/capita/month)	422	503	503	503
Total calorie consumption (cals/cap/day)	*1,638*	*2,208*		
Calorie demand function estimates				
Calorie–rice price elasticity			−0.142	−0.362
Change in calories due to rice price change			49	128
Calorie–income elasticity			0.363	0.445
Change in calories due to income change			108	134
Total change in calories (vs. Nov./Dec. 98)	*0*	*570*	*160*	*272*
Rice demand function estimates				
Rice consumption (g/cap/day)	324	392	363	378
Calorie consumption (cals/cap/day)				
Rice calories	1,069	1,295	1,199	1,248
Total change in rice calories	0	226	130	179
Price effect			73	104
Income effect			53	68
Other food calories	569	913	622	622
Total change in other food calories[c]			52	52
Total calories			1,821	1,869
Total change in calories (vs. Nov./Dec. 98)	*0*	*570*	*183*	*231*

Source: Authors' calculations.

[a] Elasticity estimates from fixed effects difference model.

[b] Elasticity estimates from fixed effects, all rounds levels model.

[c] Other food calories assumes an income elasticity of demand for other food of 0.5, with no price effects.

per capita calorie consumption could have fallen by 60–148 calories/day.

The contribution of direct transfers to households, mainly through the Vulnerable Group Feeding program, was also significant. In the absence of these transfers, per capita calorie consumption would have fallen by an estimated 20–25 calories/day. Combined, private sector trade from India and government transfers added between 64 and 133 calories per person/day in comparison with unsubsidized trade from Bangkok.

In order to maintain calorie consumption at the actual November/December 1998 levels with a 21% higher rice price, targeted transfers would have had to be three to five times larger than the 70,000 tons/month distributed during the October through December period. Moreover, to counteract the effect of the price increase for all 60 million poor individuals in Bangladesh would have required an expansion of the VGF program by a factor of 6 (using the coefficients from the thana fixed effects model) to 12 (using the coefficients from the household fixed effects), i.e., 420,000 to 840,000 tons of wheat per month.

Alternatively, cash transfers of an equivalent value could have been used to supplement household income. [20] As indicated in the previous section, private sector borrowing was a major coping strategy of the poor following the flood. With prices of rice and wheat equal to import parity levels and private sector trade flows uninhibited, cash transfers to supplement direct food transfers might have been a viable policy alternative for increasing calorie consumption during this period. In addition to possible inflationary effects on food prices, cash transfers may have incurred higher leakages (though coupling the cash transfers to food transfers may have prevented the rate of leakages from increasing). [21]

Table 8. *Estimated price and income effects on calorie consumption: counterfactual simulations*

	Rice price (Tk/kg)	Income (Tk/cap/month)	Calories/person/day		
			Price effect	Income effect	Total
November/December 1998	16.04	422			1,638
April/May 1999					
Actual	13.04	503			2,208
Difference relative to Nov./Dec. 98					
Survey results					570
Inelastic demand parameters[a]			49	108	160
Elastic demand parameters[b]			128	134	272
November/December 1999					
Actual	12.00	504			2,200
Difference relative to Nov./Dec. 98					
Survey results					561
Inelastic demand parameters			69	108	182
Elastic demand parameters			181	134	330
Counterfactual simulations, December 1998 (higher rice price; no government transfers)					
1. Rice price + 21%; inelastic	19.41	408	−44	−20	−64
2. Rice price + 21%; elastic	19.41	408	−109	−25	−133
3. Rice price + 30%; inelastic	20.85	408	−60	−20	−80
4. Rice price + 30%; elastic	20.85	408	−148	−25	−171

Source: Authors' calculations.

[a] Inelastic parameters: calorie–rice price elasticity = −0.142; calorie–income elasticity = 0.363.

[b] Elastic parameters: calorie–rice price elasticity = −0.362; calorie–income elasticity = 0.445.

5. CONCLUSIONS

In this paper, we have shown that private markets can contribute significantly to food security following a major natural disaster. Following the 1998 flood in Bangladesh, private sector imports of rice from India supplemented domestic food supplies, stabilizing rice prices and preventing a further deterioration in households' purchasing power and calorie consumption. Without this private crossborder trade, rice prices would likely have been at least 19% higher (to a level equal to the import parity price of rice from Thailand) and total calorie consumption of the poor would have fallen by an additional 44–109 calories/person/day to 1,529–1,594 calories/person/day.

Nonetheless, government policy did play a major role in avoiding a major food crisis after the flood. Government long-term agricultural and investment policies enabled a long-term expansion in the winter season (*boro*) rice crop that has reduced the country's dependence on the flood-susceptible monsoon season (*aman*) rice crop. Investments in infrastructure and promotion of private sector trade, including liberalizing rice and wheat import trade in the early 1990s, have helped develop efficient and competitive food grain markets that quickly responded to the impending production shortfall.

Short-term government policy focused on public food grain distribution targeted to flood-exposed or poor households. Government transfers through the Gratuitous Relief and Vulnerable Group Feeding programs added to household food security and helped children to maintain and improve their level of nutritional status. Nonetheless, these programs were small relative to the needs of households (only one-sixth to one-eighth the size of household borrowing).

Borrowing from private sector sources was the major household coping strategy in the initial three months after the flood. But, the reliance of poor and flood-exposed households on private sector borrowing had adverse implications for food security and economic growth in the medium term. Fifteen months after the flood, household debts still averaged 146% of one month's average consumption for the 64.2% of flood-exposed households in the bottom 40% of the expenditure distribution who were in debt. For the poorest 40% of

households total, (both flood-exposed and nonflood-exposed), debts averaged 150% of monthly expenditures (see Table 5).

To eliminate borrowing following the flood would have required a transfer of approximately Taka 5,000 (approximately $100) for each of the 60% of the household that were in debt in December 1998 several months after the flood. At the national level, total private borrowing by households may have reached $1.0 to $1.5 billion, compared to Tk 303.7 billion ($6.35 billion) in total government expenditures in 1998–99 and about $0.6 billion of annual loan disbursements Grameen and BRAC together. [22]

Moreover, the flood had a long-term negative impact on the nutritional status of those preschool children whose nutritional status was already very low. Thus, medium-term policies that reduce malnutrition among children would also be effective in softening the negative impact of natural shocks like the flood. In the absence of effective policies to address chronic malnutrition, more children will remain vulnerable and have a lower probability of recovering in the event of a natural disaster, with long-term consequences on the level of human capital.

In summary, the Bangladesh flood illustrates the crucial role that private markets and appropriate government investments and policies can play in maintaining food availability, limiting price increases and supplementing household access to food, thereby helping to avoid a major food crisis. Nonetheless, the poor did suffer both in the short term through reduced consumption and increased illness, as well as in the medium term through increases in household debt and lingering nutritional consequences. In developing countries, government resources for avoiding deleterious effects of disasters, as well as for reducing poverty, are severely limited. Reducing the negative impact of natural disasters will require effective policies and increased resources, both at the time of disasters, and perhaps more important, over the long term to reduce poverty and malnutrition, as well.

NOTES

1. Unpublished 1997–98 national accounts data (in current prices) from the Bangladesh Bureau of Statistics (BBS, 1998) and FAO, Food Balance Sheet.

2. See Ahmed, Haggblade, and Chowdhury (2000) for an in-depth description and analysis of the Bangladesh food grain sector.

3. See del Ninno, Dorosh, Smith, and Roy (2001b) for a more detailed description of the Government of Bangladesh and donor response to the 1998 flood.

4. According to official Government of Bangladesh estimates, more than two hundred thousand tons of rice per month were imported from August 1998 to March 1999. Analysis of rice demand and comparisons with India's export data suggest that this figure may overstate actual rice imports, however (Dorosh, 2001).

5. Relatively low rice stocks limited rice distribution, as problems related to the instability of prices and unreliability of suppliers constrained actual procurement of rice through commercial local and international tenders (del Ninno, Roy, & Mukherjee, 2001a; del Ninno *et al*., 2001b).

6. Domestic prices in this period were slightly below import parity of US Hard Red Winter wheat, but most wheat imported by the private sector in this period came from lower-cost suppliers (del Ninno *et al*., 2001a, 2001b).

7. This calculation assumes no problems with supply of imports from Thailand and a competitive import market involving fewer importers and larger shipments. See Dorosh (2001) for a discussion of implications of importing rice from Thailand as well as the reliability of India as a source of rice supply.

8. In the absence of private sector imports, domestic supply would have been 14.839 million tons, a 12.1% reduction in per capita supplies relative to the actual estimated levels. Assuming an elasticity of demand of −0.2 to −0.3, prices would need to rise by 12.1/0.3 (40%) to 12.1/0.2 (60%) to equilibrate market supply and demand.

9. The official death toll from the famine was 30,000 (Alamgir, 1980); unofficial reports cited in Sobhan (1979, p. 175) were as high as 100,000.

10. Ravallion (1985, 1990) provides econometric evidence that exaggerated reports of crop failure influenced

traders' expectations and led to "excessive hoarding" of stocks.

11. In addition, the large expansion in winter-season (*boro*) rice has reduced dependency on the flood-prone *aman* rice harvest. See del Ninno, Dorosh, and Islam (2002) for a more in-depth discussion of policies adopted following major production shortfalls in Bangladesh.

12. The Food Management Research Support Project-IFPRI survey covered seven flood-affected *thanas* in Bangladesh, selected according to the severity of flood as determined by the Bangladesh Water Development Board and the percentage of poor people in the district in which the *thana* is located. Individual households in each *thana* were randomly selected using a multiple stage probability sampling technique. See del Ninno *et al.* (2001a).

13. For more details on the calculations of the flood indices see del Ninno *et al.* (2001b).

14. The larger expenditures in November 1998 were due mainly to expenses on housing, health and fuel that occurred at the time of the flood. Expenditures on food, clothing, travel, personal and other cheaper and unnecessary expenses were reduced, though purchases of food on credit increased.

15. Alderman (1993), Bouis and Haddad (1992) and Grimard (1996) summarize the results of various attempts to estimate the effect of income and prices on calorie consumption (including those of Behrman & Deolalikar, 1987; Strauss & Thomas, 1990; Subramanian & Deaton, 1996; among others). Estimates of calorie income elasticities in the literature vary from 0.03–0.59 in the Philippines (Bouis & Haddad, 1992) to 0.78–0.82 in Bangladesh (Pitt, 1983).

16. No separate variable for transfers in-kind is included here. Although wheat transfers in-kind lead to significantly larger increases in wheat consumption than do cash transfers of equivalent value (del Ninno & Dorosh, 2002), we found no evidence of a statistically significant difference between the gain in calorie consumption from an in-kind transfer and the gain in calorie consumption from a cash transfer of equivalent value.

17. The instruments used in the equation include: Household characteristics: (a) Wealth and other assets; (b) Number of males and females with elementary and secondary education; (c) Number of people engaged in four types of earning income activities; (d) Housing characteristics: Electricity, number and material of buildings and sanitation; and Community level characteristics: (a) Infrastructures like roads, bridges, etc.; (b) Market: Distance from district and number of markets, shops; (c) Number of business activities, including poultry rearing; (d) Prevailing wage rates; and (e) Government subsidies in 1998 and 1999.

18. Note that since the dependent variable is the logarithm of the value of rice consumption, the coefficient on the logarithm of rice price is equal to the elasticity of demand plus one.

19. Note that much of the remaining discrepancy between the estimates presented in Table 7 and the actual 570 calories/person/day change in calorie consumption observed between rounds 1 and 2 is likely due to price changes in other goods (particularly vegetable oils, prepared foods, vegetables and meat) that may explain the 344 increase in calories/person/day from non-rice foods between these two rounds of the survey.

20. In the calorie demand regressions, food transfers do not have a significant impact on consumption apart from their effect on increasing incomes. Other studies have suggested that marginal propensities to consume (MPCs) food out of targeted food transfers may be higher than the MPCs out of cash income. See Ahmed (1993), del Ninno and Dorosh (2002) and Ahmed, del Ninno, and Chowdhury (2001).

21. Cash transfers may have had larger fiscal implications, as well, since donors may not have been as willing to provide resources for a cash program.

22. BRAC loan disbursement in 1999 was Tk 10,880 million ($218 million); Grameen disbursement in May 2001 was 1,681 million ($31.13 million).

REFERENCES

Ahmed, A. (1993). Food consumption and nutritional effects of targeted food interventions in Bangladesh. Bangladesh Food Policy Project Manuscript 31. International Food Policy Research Institute, Washington, DC.

Ahmed, A., del Ninno, C., & Chowdhury, O. H. (2001). Food For education study. Food Management and Research Support Project Working Paper 35. IFPRI, Dhaka.

Ahmed, R., Haggblade, S., & Chowdhury, T.-e-E. (2000). Out of the shadow of famine: Evolving food markets and food policy in Bangladesh. International Food Policy Research Institute, Washington, DC.

Alamgir, M. (1980). *Famine in South Asia—Political economy of mass starvation Oelgeschlager*. Cambridge, MA: Gunn & Hain Publishers.

Alderman, H. (1993). New research on poverty and malnutrition: what are the implication for policy? In M. Lipton, & J. van der Gaag (Eds.), *World Bank Regional and Sectoral Studies*, *Including the Poor*. Washington, DC: the World Bank.

BBS (Bangladesh Bureau of Statistics) (1998). Report on household expenditure survey 1995–96. Dhaka: BS.

Behrman, J. R., & Deolalikar, A. (1987). Will nutrition in developing countries improve with income? a case study for rural South India. *Journal of Political Economy, 95*(3), 108–138.

Bouis, H. E., & Haddad, L. J. (1992). Are estimates of calorie–income elasticities too high? a recalibration of the plausible range. *Journal of Development Economics, 39*(2), 333–364.

del Ninno, C., Roy, D. K., & Mukherjee, S. (2001a). Impact of the 1998 flood on household food security. FMRSP Synthesis Report No. 6. IFPRI, Dhaka.

del Ninno, C., & Lundberg, M. (2001). Long lasting impact of the 1998 flood on Nutrition in Bangladesh: Keeping kids' heads above water. Paper presented to the 17th International Congress of Nutrition Modern Aspects of Nutrition—Present Knowledge and Future Perspectives Vienna, Austria, August 27–30.

del Ninno, C., & Dorosh, P. (2002). In-kind transfers and household food consumption: implications for targeted food programs in Bangladesh. FCND-IFPRI Discussion Paper 134. IFPRI, Washington, DC.

del Ninno, C., & Dorosh, P. (2001). Averting food crisis: private imports and public targeted distribution in Bangladesh after the 1998 flood. *Agricultural Economics*.

del Ninno, C., Dorosh, P., & Islam, N. (2002). *Reducing vulnernability to natural disasters: lessons from the 1998 floods in Bangladesh*. IDS Bulletin.

del Ninno, C., Dorosh, P., & Smith, L. (2003). Public policy, food markets and household coping strategies in Bangladesh: lessons from the 1998 floods, FCND-IFPRI Discussion Paper 156. IFPRI, Washington, DC.

del Ninno, C., Dorosh, P., Smith, L., & Roy, D. K. (2001b). The 1998 floods in Bangladesh: disaster impact, household coping strategies and response. IFPRI Research Report 122. IFPRI, Washington, DC.

Dorosh, P. (2001). Trade liberalization and national food security: rice trade between Bangladesh and India. *World Development, 29*(4), 673–689.

FMRSP-IFPRI Household Survey (1998–99).

Grimard, F. (1996). Does the poor's consumption of calories respond to changes in income? Evidence from Pakistan. *Pakistan Development Review, 35*(3), 257–283.

Helen Keller International and Institute of Public Health and Nutrition (1999). 1998 NSP Annual Report National and Divisional Trends among Children and households in Rural Bangladesh. Dhaka: HKI.

Helen Keller International (1997). Report of Round 43—Rural—Nutritional Surveillance Project, April, 1997 Data Collection. Dhaka: HKI.

Pitt, M. (1983). Food preferences and nutrition in rural Bangladesh. *Review of Economics and Statistics, 65*(1), 105–114.

Ravallion, M. (1985). The performance of rice markets in Bangladesh during the 1974 Famine. *Economic journal, 95*.

Ravallion, M. (1990). *Markets and famines*. Dhaka, Bangladesh: University Press.

Sobhan, R. (1979). Politics of food and famine in Bangladesh. In E. Ahamed (Ed.), *Bangladesh politics*. Dhaka: Centre for Social Studies, Dhaka University.

Strauss, J., & Thomas, D. (1990). The shape of the calorie–expenditure curve. Yale Economic Growth Center Discussion Paper: 595. Yale University, New Haven.

Subramanian, S., & Deaton, A. (1996). The demand for food and calories. *Journal of Political Economy, 104*(1), 133–162.